

JOPA SAFE MARKET

SPECIFICATION

BUILDING WORKS

CONTENTS

Table of Contents

CONTENTS.....	1
PARTICULAR SPECIFICATION – BUILDING WORKS.....	6
1 CONDITIONS APPLICABLE TO ALL PARTICULAR SPECIFICATIONS.....	6
1.1 USE OF LOCALLY MANUFACTURED MATERIALS AND PRODUCTS.....	6
1.2 APPLICATION OF CLAUSES.....	6
1.3 SAMPLES.....	6
1.4 WATER.....	6
1.5 STANDARD DETAIL DRAWINGS.....	6
1.6 SCALE.....	6
1.7 UNITS OF MEASUREMENTS.....	6
1.8 INTERPRETATION OF DRAWINGS ETC.....	7
1.9 DETAILS.....	7
1.10 VERTICAL TRANSPORT.....	7
1.11 SOUTH AFRICAN STANDARD SPECIFICATIONS AND CODES OF PRACTICE.....	7
STANDARD SPECIFICATIONS.....	7
CODES OF PRACTICE.....	8
STANDARD TEST METHODS.....	8
ZIMBABWE STANDARD SPECIFICATIONS AND CODES OF PRACTICE.....	8
1.12 ACCURACY IN BUILDING WORK.....	8
EARTHWORKS.....	9
1 SITE CLEARANCE.....	9
2 EARTHWORKS (GENERAL).....	11
3 DISPOSAL OF EXCAVATED MATERIAL.....	13
4 MAINTENANCE OF EXCAVATIONS.....	13
5 WATER IN EXCAVATIONS.....	13
6 COMPLETION OF EXCAVATIONS.....	14
7 FILLING.....	14
8 SURPLUS EARTH.....	15
9 GRAVEL DRESSING.....	15
10 TOPSOILING.....	15
CONCRETE.....	15
1 CEMENT.....	16
2 SAND (FINE AGGREGATE).....	16
3 STONE (COARSE AGGREGATE).....	16
4 CONCRETE.....	17
5 VOLUME BATCHING.....	17
6 WEIGH BATCHING.....	18
7 READY MIXED CONCRETE.....	19
8 STRENGTH CONCRETE.....	19
9 ADMIXTURES TO CONCRETE.....	20
10 SLUMP TEST.....	20
11 CONCRETE TEST CUBES.....	21
12 CONCRETE QUALITY.....	23
13 CONCRETING.....	23
14 CURING OF CONCRETE.....	24
15 DESCRIPTIONS (PRICES) OF CONCRETE.....	25

Jopa Women's Safe Market – Construction Specifications

16 BUILDING ON CONCRETE FOOTINGS AND BEAMS.....	25
17 CONSTRUCTION JOINTS.....	25
18 ISOLATION OR MOVEMENT JOINTS.....	25
19 CUTTING, PUNCHING OR HACKING CONCRETE.....	25
20 FORMING KEY TO CONCRETE FOR PLASTER AND OTHER FINISHES.....	26
21 SLEEVE PIECES, TIES, ETC.....	26
22 BAGGED FINISH TO CONCRETE.....	26
23 FINISHING OF CONCRETE FOR TROWELLING.....	26
24 POWER FLOATED FINISH.....	27
25 "NO-FINES" CONCRETE.....	27
26 FORMWORK.....	27
27 SMOOTH FORMWORK.....	29
28 DAMP-PROOF UNDER-SURFACE MEMBRANE.....	29
29 REINFORCING RODS.....	29
30 CONCRETE REINFORCEMENT.....	30
31 DESCRIPTIONS (PRICES).....	32
MASONRY.....	33
1 MATERIALS.....	33
2 WORKS MORTAR TESTS.....	34
3 CEMENT MORTAR.....	35
4 COMPO MORTAR.....	36
5 BRICKWORK.....	36
6 BRICKWORK IN CEMENT MORTAR.....	36
7 MORTAR JOINTS.....	36
8 GROUT IN JOINTS IN BRICK FOUNDATION WALLS.....	37
9 BRICKWORK IN THICKNESSES.....	37
10 BRICKWORK IN LININGS.....	37
11 HALF BRICK THICK WALLS.....	37
12 CAVITY WALLS.....	37
13 BEAM FILLINGS.....	38
14 REINFORCED BRICK LINTELS.....	38
15 PRESTRESSED LINTELS.....	39
16 BAGGED FINISH TO BRICKWORK.....	40
17 RAKING OUT FOR AND POINTING FLASHINGS.....	40
18 MASTIC POINTINGS.....	40
19 BUILDING IN.....	40
20 SECURING ROOFS.....	41
21 CRAMPS TO WOOD FRAMES.....	41
22 BEDDING AND POINTING.....	41
23 FACED BRICKWORK.....	41
24 FIBRE CEMENT SILLS.....	42
25 INSTALLATION OF ELECTRICAL SERVICE.....	42
26 CABLE SLEEVES.....	42
27 SPECIAL WORKS.....	42
28 PROTECT AND CLEAN DOWN FACE BRICKWORK.....	43
29 DAMP-PROOF COURSE.....	43
30 DAMP-PROOF MEMBRANE.....	43
CEMENT PLASTER.....	44
1 CEMENT.....	44
2 SAND.....	44

Jopa Women's Safe Market – Construction Specifications

3 WATER.....	44
4 PLASTER MIXES.....	45
Table 1 – Mix proportions for common cements.....	45
5 MIXING OF PLASTER.....	45
6 SURFACE PREPARATION.....	45
7 PLASTERING.....	46
STRUCTURAL STEELWORK.....	47
1 STEEL.....	47
Table 1 – Standards governing dimensional and permissible deviations.....	47
2 STRUCTURAL STEELWORK.....	47
Table 2 – Approved parent metal-filler weld material combinations for steels acceptable for prequalified welding procedure standards.....	48
4 PRESERVATION OF STRUCTURAL STEELWORK.....	49
5 INSPECTION.....	50
METALWORK.....	50
1 STEEL.....	50
2 PRESERVATION OF STEELWORK.....	50
3 MANUFACTURED STEELWORK: GENERAL:.....	51
4 PRESSED STEEL DOOR FRAMES.....	51
5 STEEL WINDOWS.....	52
6 BURGLAR BARS TO STEEL WINDOWS.....	52
7 GAUZE SCREENS TO WINDOWS.....	53
8 STEEL SHELVEING TO MARKET STALLS.....	53
TIMBER ROOF BEAMS & COLUMNS.....	53
1 MATERIALS.....	54
Table 1 – Ordinary Nails.....	55
Table 2 – Clout nails.....	55
2 DRAWINGS.....	56
3 JOINTING OF TIMBER MEMBERS.....	56
4 INSTALLATION OF MASONRY ANCHORS.....	58
5 RESHAPING AND RESAWING OF MEMBERS.....	58
6 INSTALLATION OF ROOF TRUSSES, RAFTERS AND PURLIN BEAMS.....	58
Table 4 – Wall plate sizes.....	58
7 CEILING ASSEMBLY.....	60
STEEL ROOF COVERINGS.....	60
1 GENERAL.....	60
2 PROFILES.....	60
3 INSULATION.....	61
4 RIDGING (METAL).....	61
7 FLASHINGS.....	61
8 MAKING GOOD.....	61
JOINERY.....	61
1 GENERAL.....	61
2 JOINERY.....	62
3 WOODEN DOORS.....	62
4 HANGING OF DOORS.....	62
5 PAINTING OF DOORS.....	63
IRONMONGERY.....	63
1 IRONMONGERY.....	63
2 FIXING.....	63

Jopa Women's Safe Market – Construction Specifications

FLOOR AND WALL TILING.....	64
1 GENERAL.....	64
2 TILE CEMENT.....	64
3 CERAMIC TILES.....	64
4 GLAZED WALL TILING.....	64
INSTALLATION OF GLAZING IN WINDOWS.....	64
1 MATERIALS.....	64
2 PREPARATION.....	65
3 GLAZING WITH PUTTY.....	65
4 MIRRORS.....	66
PLUMBING AND DRAINAGE.....	66
1 REGISTERED PLUMBERS AND DRAINLAYERS.....	66
2 EXCAVATION.....	66
3 BEDDING FOR PIPES.....	67
4 BACKFILLING.....	67
5 REINSTATEMENT OF INFRASTRUCTURE.....	68
6 RAINWATER DISPOSAL AND PROTECTION AGAINST LIGHTNING.....	68
7 STORM-WATER DRAINAGE.....	70
8 SEPTIC TANK AND FRENCH DRAINS.....	71
9 SEWAGE PIPES AND FITTINGS.....	71
10 TESTING.....	71
11 WATER SUPPLIES.....	72
12 SANITARY FITTINGS.....	73
13 WATER STORAGE TANKS.....	75
14 WATER TAPS AND VALVES.....	75
15 FIRE EXTINGUISHERS.....	76
16 TESTING OF PLUMBING.....	76
17 TESTING OF WATER RETICULATION AND PIPELINES.....	76
PAINTING.....	76
1 PREPARATORY WORK FOR PAINTING.....	76
2 SURFACES TO BE DRY.....	77
3 PAINTS.....	77
3 APPLICATION OF PAINT.....	78
4 PRIMING.....	78
5 LEAVE PERFECT.....	78
ELECTRICAL INSTALLATION.....	78
1 GENERAL.....	78
2 INSTALLATION AND TERMINATION OF CONDUITS AND CONDUIT ACCESSORIES.....	81
3 INSTALLATION OF WIRING CHANNELS, UNDERFLOOR DUCTING AND POWER SKIRTING.....	94
4 INSTALLATION OF CABLE TRAYS AND LADDERS.....	99
5 FIXING MATERIALS.....	101
6 WIRING.....	102
7 INSTALLATION OF CABLES.....	105
8 INSTALLATION OF LIGHT SWITCHES AND SOCKET-OUTLETS.....	119
9 PHOTO ELECTRIC DAYLIGHT SENSITIVE SWITCH FOR OUTSIDE LIGHTING.....	121
10 INSTALLATION OF LUMINAIRES.....	121
11 CONNECTIONS TO EQUIPMENT.....	125
12 EARTHING.....	126
13 INSPECTIONS, TESTING, COMMISSIONING AND HANDING OVER.....	132
ELECTRICAL SOLAR ENERGY.....	133

Jopa Women's Safe Market – Construction Specifications

1 PURPOSE AND LOADS.....	133
2 DAILY SUNSHINE HOURS.....	133
3 SOLAR PANELS.....	133
4 INVERTERS.....	133
5 SMART BATTERY CHARGERS.....	133
ROADS, FENCE, GATES (DEPARTMENT OF ROADS SPECIFICATION).....	134

PARTICULAR SPECIFICATION – BUILDING WORKS

1 CONDITIONS APPLICABLE TO ALL PARTICULAR SPECIFICATIONS

1.1 USE OF LOCALLY MANUFACTURED MATERIALS AND PRODUCTS

Materials and products manufactured in Zimbabwe or South Africa shall be used in carrying out the work to which this specification refers, unless an imported product is prescribed specifically, or when no suitable locally manufactured product for the specific use is available.

1.2 APPLICATION OF CLAUSES

All clauses in this specification which describe the materials and methods to be used in carrying out the work specified in the specification of work to be done, or indicated on the drawings, or included in the bills of quantities, or in any detail drawings, or instructions issued by the Engineer to the Contractor during the progress of the work, shall be considered as applying to the performance of the contract.

1.3 SAMPLES

The Contractor shall furnish without delay, such samples and/or certificates as called for or may be called for by the Engineer. Materials and/or workmanship not corresponding with approved samples may be rejected.

1.4 WATER

Clean, fresh water free from vegetable or organic matter, earth, clay, acid or alkaline substances either in suspension or in solution, other than those used for purification thereof by the responsible authority, shall be used through-out. Where there is any reason to suspect the presence of impurities, the Engineer may require the Contractor to obtain a chemical analysis of the water by a competent analyst at his own cost. Should the water prove unsuitable for use the Contractor must procure water of an approved source.

1.5 STANDARD DETAIL DRAWINGS

All standard detail drawings applying to a particular service and referred to in this document, in the specification or in the bills of quantities, may be seen by Tenderers at the office of the Engineer for the carrying out of the work.

1.6 SCALE

The scale to which the drawings are prepared is only to be made use of when no figured dimensions are given, either on the drawings or in the specification. Figured dimensions are always to be followed though they may not coincide with the scale of the drawings. Where possible dimensions are to be taken from all relevant existing buildings.

1.7 UNITS OF MEASUREMENTS

Units of measurements have been standardised in accordance with "Système International d'Unites" (SI).

1.8 INTERPRETATION OF DRAWINGS ETC

Should any part of the drawings, specification or bills of quantities not be clearly intelligible to the Contractor or that the materials or articles to be used in the execution of the works be considered insufficiently described, the Engineer shall be requested in writing, to make clear, also in writing, his requirements, failing which the Contractor shall be liable to make, at his own expense, any alterations or substitutions rendered necessary through incorrect interpretation of such drawings, specification or bills of quantities.

1.9 DETAILS

Upon receipt of detail drawings for any work the Contractor shall, before putting that work in hand, ascertain that the dimensions given on the Detail Drawings correspond with the dimensions of any work already built which governs the sizes of the work for which the detail is given. In the event of the detail drawings not agreeing with the work already built, the drawings shall be at once returned for alterations as no claim for extra work will be entertained in this respect.

1.10 VERTICAL TRANSPORT

Vertical transport for workmen and materials is entirely the responsibility of the Contractor. Permission is to be obtained shafts by the Contractor on shaft(s), make good and clean Contractor wishes to commence.

1.11 SOUTH AFRICAN STANDARD SPECIFICATIONS AND CODES OF PRACTICE

STANDARD SPECIFICATIONS

SABS 82 Bending Dimensions of Bars for Concrete Reinforcement
SANS 110 Sealing compounds for the building industry, two-component, polysulphide base"
SABS 135 ISO metric black bolts, screws, and nuts (hexagon and square)
SANS 187 Butyl rubber (for waterproofing)
SABS 248 Bituminous Damp-Proof Courses
CKS 264 Flat mild steel washers
SABS 307 – 309 Bitumen Emulsion
SABS 312 Red Lead Base Primers for Structural Steel
SABS 471 Portland Cement (ordinary, rapid hardening and sulphate- resisting)
SABS 563 Specifications for Structural Timber
SANS 580 Chloroprene rubber sheet (for waterproofing)
SABS 626 Portland Blast furnace Cement
SANS 630 Decorative high gloss enamel paint for interior and exterior use
SABS 678 Primers for Wood for Interior and Exterior Use
SABS 681 Undercoats for Paints
SABS 684 Structural Steel Paint
SABS 723 Wash Primer (Metal Etch Primer)
SABS 763 Hot-dip (Galvanised) Zinc Coatings other than on continuously zinc-coated sheet and wire

SANS 801 Epoxy-tar paints
SABS 831 Portland Cement 15 (Ordinary and Rapid Hardening)
SANS 912 Calcium Plumbate Primer
SABS 920 Steel Bars for Concrete Reinforcement
SABS 934 Hot-dip (Galvanised) Zinc Coatings on Steel Sheet and Strip
SABS 952 Polyolefin film for damp-proofing and waterproofing in buildings
SABS 1024 Welded Steel Fabric for Concrete Reinforcement
SABS 1090 Sand for Plaster and Mortar
SABS 1200 Standardized Specifications for Civil Engineering Construction
SANS 1305 Sealing surround for the building industry, one-component Silicone-rubber based
SANS 2001-BE1 Construction Works. Part BE1: Earthworks (general)
SANS 2001-BS1 Construction Works. Part BS1: Site Clearance
SANS 2001-CC1 Construction Works. Part CC1: Concrete Works (Structural)
SANS 2001-CC2 Construction Works. Part CC2: Concrete Works (Minor Works)
SANS 2001-CG1 Construction Works. Part CG1: Installation of glazing in window and door frames
SANS 2001-CM1 Construction Works. Part CM1: Masonry walling
SANS 2001-CS1 Construction Works. Part CS1: Structural steelwork
SANS 2001-CT2 Construction Works. Part CT2: Structural timberwork (roofing)
SANS 2001-EM1 Construction Works. Part EM1: Cement plaster
SANS 2001-DP1 Construction Works. Part DP1: Earthworks for buried pipelines and prefabricated culverts
ISO 3575 Hot-dip (galvanized) zinc coatings on steel sheet and strip (incorporating Amendment 1, February 1970)

CODES OF PRACTICE

SABS 03 The Protection of Buildings against Lightning
SABS 021 Waterproofing of Buildings
SABS 064 Preparation of Steel Surfaces for coating
SABS 0155 Accuracy in building
SABS 0040 The application of the National Building Regulations
SANS 0160 General procedures and loadings to be adopted for the design of buildings
SABS-ISO 9000 Series Quality management systems

STANDARD TEST METHODS

STM 861 Sampling of freshly mixed concrete
STM 862 Slump of freshly mixed concrete
STM 863 Compressive strength of concrete
(IN ALL CASES THE LATEST PUBLICATION OR REVISION SHALL APPLY.)

ZIMBABWE STANDARD SPECIFICATIONS AND CODES OF PRACTICE

SADC ZW HS 983:2014: Rammed earth structures – Code of practice, replacing ZWS 724:2000

1.12 ACCURACY IN BUILDING WORK

The method of measurement and accuracy of dimensions required for the setting out of structures and for completed building work shall be as described in SABS Code of Practice 0155, unless otherwise specified in this document.

EARTHWORKS

1 SITE CLEARANCE

Applicable standard: SANS 2001 – Construction Works Part BS1: Site clearance.

SANS 2001-BS1 covers removal of vegetation, fences, posts, litter and building rubble, boulders of size up to 0.15 m³, and surface and subsurface obstructions, and demolition and removal of structures (including their basements, if any), not directly associated with or incidental to any excavation.

Clear site for the whole area of the ground to be built upon up to a distance of at least 3m beyond the perimeter of the structure of building(s) and/or extent of steps, pavings, etc to the level as indicated on the drawings.

This operation shall be deemed to include the following activities:

1. The removal and disposal of all trees and bushes (complete with roots), other vegetation, rubbish, hedges, fences, and all other material that might interfere with the construction of other works to designated sites as directed by the Engineers Representative.
2. The removal of all litter, building rubble, rocks and boulders that are lying on the surface to be cleared, or exposed during the clearing operations and disposing thereof to designated sites as directed by the Engineers Representative.
3. The removal and stacking of re-usable materials as specified by the Engineers Representative.
4. The scarifying, loosening and breaking up of hardened areas by ripping or excavation to a depth of 200 mm or otherwise specified by the Engineers Representative.

All topsoil shall be conserved for later use over the cleared area that are to be levelled over the terrain.

The level of the finished earth works shall be as shown on the drawings.

Tree trunks shall be disposed of by stockpiling at a designated area identified by the Engineers Representative.

1.1 Grubbing:

All stumps and roots larger than 75 mm in diameter shall be removed to a depth of at least 600 mm below the finished level, and at least 100 mm below the original ground level. Where a roadbed or other area has to be compacted, all stumps and roots, including matted roots shall be removed to a depth of at least 200 mm below the cleared surface.

Except in borrow areas, cavities resulting from grubbing shall be backfilled with suitable material and compacted to a density of 90 % of the modified AASHTO

maximum dry density or that of the surrounding ground, whichever is the lesser.

1.2 Disposal of material:

Material obtained from clearing and grubbing and from the demolition of structures shall be disposed of in borrow pits or other suitable places as specified by the Engineers Representative and shall be covered with soil or gravel. Consumable materials on site may be disposed of by means of burning, unless otherwise specified by the Engineers Representative.

All tree trunks and branches of girth exceeding 0,5 m shall be stripped of secondary branches, sawn into transportable lengths and stacked at designated sites, as specified by the Engineers Representative.

Fencing wire shall be neatly wound into rolls or coils and all such wire, together with all fence posts and other reusable material from structures, etc., shall be stacked at sites specified by the Engineers Representative.

All other materials that are to be reused, shall be stacked at sites as specified by the Engineers Representative.

1.3 Branches overhanging boundaries:

The branches of trees that are to be left standing shall be so trimmed as not to encroach upon the space (of height at least 7 m) vertically above any carriageway or any other designated area.

1.4 Conservation of individual trees:

Individual trees that, in terms of the scope of work, are identified to be conserved, shall be left standing, uninjured and protected against damage from all construction activities.

1.5 Re-clearing of vegetation:

If during the period of construction vegetation should again grow on any portion of the site, borrow areas, or other areas that have been cleared in accordance with this specification, re-clearing might be required. Such re-clearing shall include the removal and disposal of grass, shrubs and other vegetation, as in the first clearing operation.

1.6 Conservation of topsoil:

Where topsoil is required to be conserved as directed by the Engineers Representative, the topsoil together with any grass and other suitable vegetation shall be removed and placed at a designated area as directed by the Engineers Representative. If not used immediately, such topsoil shall be temporarily stockpiled for later use.

1.7 Compliance with the requirements:

The required levels of compaction shall be established by means of selected fill material replacement.

The density of the backfilling must match the density of the surrounding ground.

2 EARTHWORKS (GENERAL)

Applicable standard: SANS 2001 – Construction Works Part BE1: Earthworks (general).

SANS 2001-BE1 covers the excavation, filling, compaction and finishing of general excavations for buildings, carried out with heavy construction equipment or light construction equipment, or by hand.

2.1 Notification by Contractors and Excavators:

All work shall comply with all health and safety requirements, every Contractor shall at least 7 days before he/she commence with the construction work notify the relevant authority in writing of the intended construction work which will :-

- a) Include excavation work;
- b) Include working at a height where there is a risk of falling;
- c) Include the demolition of a structure; or
- d) Include the use of explosives to perform the construction work.

2.2 Excavations for foundations and floors:

Excavation work shall be so executed that material excavated and that does not contain more than 10% rock or hard fragments retained on a sieve of nominal aperture size 50 mm shall be transported directly to its final position without being stockpiled, and if stockpiling is unavoidable, materials intended for re-use shall be stockpiled separated from the other excavated materials and materials from excavations shall be used in preference to materials from borrow pits or other sources.

After an area has been stripped, excavation of trenches and holes for foundations shall be excavated to the several lengths, widths and levels shown on drawings to which the ground must be reduced and then for foundations, footings, etc., to the depths as shown on the drawings or to such other depths as may be directed by the Engineers Representative to ensure a good foundation.

Bottoms of trenches and holes shall be level, with sides trimmed vertical for the full width from top to bottom. The bottoms of trenches shall be stepped as shown but if the steppings are not shown on drawings or are not otherwise directed on site, the stepping shall be of at least the thickness specified for the concrete footings but shall be adjusted downwards to conform with an exact number of brick courses where necessary. Any excavations taken out to deep shall be made up to correct levels with approved fill material by the Engineers Representative and shall be capable of sufficient compaction to avoid settlement and shall be capable of placement without significant voids all at the Contractor's expense.

The ground under solid floors shall be excavated where necessary and levelled in readiness for the laying of the surface beds.

Before commencing any earthworks the Contractor shall satisfy himself as to the accuracy of any levels indicated on the drawings as no claim will be entertained at a later date for any alleged inaccuracy in such levels.

Degree of accuracy for excavations required is:

- a) Position on plan: - permitted deviation (pd) in plan of any point measured from the nearest grid line ± 35 mm.
- b) Dimensions on plan: - pd from the design dimensions ± 50 mm.
- c) Foundation level (i.e. level of underside of concrete except floor slab): - pd in level of surface of excavation trimmed to receive concrete ± 50 mm.
- d) Level:- pd from designed level with reference to the nearest transferred benchmark of any floor slab ± 15 mm.

Except where provision for working space has been made in the scope of work, each excavated surface on which, or against which, a permanent concrete structure will be placed shall be prepared by trimming to ensure that there is no projection outside the specific tolerance into the excavation profile. Such surface shall be cleaned by hand to remove all loose material.

Immediately before any permanent construction is commenced, the bottom of each excavation shall be cleaned of all loose material, and soft material shall be rammed or removed, as required.

2.3 Excavations to reduce levels:

The ground outside the buildings shown to be reduced in levels, shall be excavated and levelled or graded to falls as shown on the drawings.

2.4 Excavations for working space:

Working space for formwork to sides of all concrete, except columns, has been measured only where the concrete face is less than 750mm from the face of the measured excavation.

Working space for formwork to sides of columns has been measured for the width of the column face only where both:

- a) the top of the column base is more than 1,5m below the commencing level of the excavation, and
- b) the column face is less than 500mm from the face of the measured excavation.

No claim will be considered for any working space for formwork to concrete other than as above described for working space beyond the sides of trench excavations for the building of brick or block walls.

Descriptions of excavations for working space shall be deemed to include any additional risk of collapse so incurred and the returning and compacting of the excavated material as described.

2.5 Definitions:

Earth shall mean ground that can be removed by hand tools and shall include loose gravel, clay, made up ground, loose or soft shale, loose oukrip and any loose boulders less than 75mm in diameter.

Soft rock shall mean rock that can be loosened by hand, pick or crowbar and includes hard shale, compact ouklip, stone of a similar hardness and boulders from 75mm diameter up to 0,03 cubic metres in volume.

Hard rock shall mean granite, quarzitic sandstone, slate and rock of similar or greater hardness and boulders from over 0,03 cubic metres in volume.

2.6 Blasting:

No guarantee is given or implied that blasting shall be accepted but should this method of removal be necessary and permitted, the Contractor must take all responsibility and observe all conditions set forth in all Government and Local Authority Regulations and/or bylaws.

3 DISPOSAL OF EXCAVATED MATERIAL

3.1 Part return:

Material from the excavations, after testing by an approved Laboratory, where suitable and approved by the Engineers Representative, is to be returned, filled in and rammed against foundation walls, under floors, steps, etc. as necessary.

No clay shall be used as filling.

3.2 Deposit on site:

The excess material shall be deposited on site, spread and roughly levelled, where permitted by the Engineers Representative.

3.3 Cart away:

Surplus material is to be carted away to a suitable dumping site to be found by the Contractor, outside the boundary of the Site. Spoil heaps shall be flattened to present a neat level or graded surface.

4 MAINTENANCE OF EXCAVATIONS

4.1 Planking, strutting, etc.:

Planking, strutting, shoring and temporary sheet piling shall be measured as such only when prescribed.

4.2 Risk of collapse:

The Contractor shall maintain all excavated faces exceeding 1,5m deep in accordance with Government Regulations and all excavated faces not exceeding 1,5m deep affecting the safety of work and/or the workmen.

The Contractor shall carry the risk of collapse of excavated faces whether or not he takes any precautions, the nature of which shall be entirely at his own discretion.

5 WATER IN EXCAVATIONS

No water shall be allowed to accumulate in any portion of the excavations.

The excavations shall be protected against any water entering them whether by seepage, rains, storms, floods or any other means. Any water found in the excavations shall immediately be removed by pumping or baling.

It is the Contractor's responsibility to keep foundations and excavations water free and the Contractor must supply all pumps etc. that may be necessary for clearing out the water. Water must be cleared in such a way that it cannot seep or flow back into the excavations.

6 COMPLETION OF EXCAVATIONS

The Contractor shall give notice, in writing, to the Engineers Representative when the excavations are ready to receive the foundations.

The foundations shall not be laid until the excavations have been approved of, in writing, by the Engineers Representative and they shall not be covered until any variation has been measured.

7 FILLING

Filling shall be of approved clean earth in layers not exceeding 150 mm thick, well watered, rammed and consolidated to at least a density of 90% Modified AASHTO (American Associations of State Highway and Transportation Officials), which will be verified by the Engineers Representative having it tested.

All filling material shall be approved beforehand by the Engineer's Representative prior to placement. A 60kg sample of the proposed fill is required for this purpose and fourteen days must be allowed for initial sample testing.

Before filling is placed the virgin soil shall be scarified and compacted to at least 90% Modified AASHTO. Each layer of fill must be tested and approved by the Engineers Representative before the next layer is placed and compacted.

a) To defined levels:

The ground outside the building shown shall be made up with earth filling as above, finished level or graded to falls as shown on the drawings, or as directed.

b) To foundations etc.:

Filling to foundations etc. shall be of earth filling as above.

The filling of areas under solid floors shall be carried out as soon as the foundations and foundation walls have been completed.

c) Thicknesses of compacted material:

Given thickness are those for compacted material.

The Engineer's Representative shall keep notes on all filling supplied by the

Contractor.

d) Descriptions (prices):

Descriptions (prices) of all filling including filling supplied by the Contractor from an off-site source, and separately measured, are to include for any necessary stockpiling and multiple handling.

8 SURPLUS EARTH

All surplus earth, topsoil and/or other materials from excavations shall be deposited and levelled on the site, or carted away, as directed.

9 GRAVEL DRESSING

Gravel dressing to the ground outside the building shall be of approved clean gravel, well-watered and consolidated by rolling with an approved roller to a hard even surface. The dressing shall be of a consolidated 75mm thickness.

10 TOPSOILING

On completion of earthworks to the finished level and of backfilling of holes, trenches, etc., the whole surface shall be graded, shaped and compacted to final grades and levels.

Topsoil shall be placed on level and slightly graded areas and shall be lightly compacted by wheeled vehicles or by tamping, and trimmed neatly to the required lines, grades and levels. The final thickness of the topsoil after compaction shall be at least 75 mm.

Where required or directed by the Engineers Representative, grass or other vegetation shall be planted after topsoiling has been completed. On completion of planting, the planted area shall be neatly trimmed and well-watered and not allowed to dry out until it is established.

CONCRETE

Structural Works

Applicable standard: SANS 2001 – Construction Works Part CC1: Concrete Works (structural).

Minor Works

Applicable standard: SANS 2001 – Construction Works Part CC2: Concrete Works (minor works).

Foundations

Applicable standard: SANS 2001 – Construction Works Part CM2: Strip footings, Pad footings and Slab-on-the-ground Foundations for Masonry Walling

NB: All in situ concrete work (mass and reinforced) shall comply with SABS Specification 1200G ("8. Measurement and Payment" is **not** applicable) supplemented by the clauses in this section. Where SABS Specification 1200G and the clauses in this section are in conflict the clauses in this section shall take

precedence.

Where the term "plain concrete" appears in SABS Specification 1200G it shall be read as "mass concrete"

1 CEMENT

Cement shall be Portland cement complying with the requirements of SABS Specification 471 or PC15 complying with SABS Specification 831.

Samples of cement from any one, or from every consignment, may be required by the Representative/Agent for test purposes. Cement in any consignment from which a sample may have been taken for testing shall not be used until it has been approved. Allowance must be made for possible delay in that tests may take 10 days to carry out.

Bags of cement shall be stacked in a waterproof, solidly constructed shed with a central door and a floor rendered damp-proof with a tarpaulin. The bags of cement shall be closely stacked (but not against walls) in order to reduce air circulation in such a manner that the cement is used in the order in which it was received, i.e. first in first out.

Unless otherwise specified in the tender documents the use of ordinary Portland cement blended with ground granulated blast furnace slag complying with SABS Specification 1491, or ordinary Portland Cement blended with Pulverised Fly Ash complying with SABS Specification 1466 will be allowed in certain instances as an alternative, after acceptance of tender, but only with the approval of and at the sole discretion of **the Professional Team**. If not so specified in the tender documents the Contractor must demonstrate a saving in favour of the Professional Team together with his alternative tender. The saving offered will be adjudicated by the Engineer/Quantity Surveyor for the service and acceptance of the alternative will be in accordance with the reasonableness thereof.

2 SAND (FINE AGGREGATE)

The fine aggregate shall comply with the requirements of SABS Specification 1083. Other aggregates may be approved if they have a satisfactory history and/or test results.

No aggregate may be used until it has been approved. Samples having a mass of 25 kg (16,5 litre) of the aggregate proposed to be used may be required by the Representative/Agent for test purposes. Samples having a mass of 25 kg shall be forwarded every 3 months during concreting work and also if the source of supply is changed. Allowance must be made for possible delay in that the tests may take 14 days to carry out.

3 STONE (COARSE AGGREGATE)

3.1 The coarse aggregate shall comply with the requirements of SABS Specification 1083.

No aggregate may be used until it has been approved. Samples having a mass of 25 kg (16,5 litre) of the aggregate it is proposed to use may be required by the

Representative/Agent for test purposes. Samples shall be forwarded every three months during concreting work and also if the source of supply is changed. Allowance must be made for possible delay in that the tests may take 14 days to carry out.

NB: Certain fine-grained sand and stone originating from the Beaufort Series and Karoo Systems which are known by reputation, local experience or tests, to exhibit excessive shrinkage when used in concrete, may be deemed unacceptable by the Representative/Agent.

3.2 A certificate of proof is required from the Contractor that the aggregates are not alkali reactive. The cost of testing and certification are to be borne by the Contractor.

4 CONCRETE

Concrete shall be of the classes given in the following table. The proportions of the ingredients and the nominal size of the coarse aggregate for each class shall be as laid down therein, viz:

CLASS	CEMENT	AGGREGATES			STRENGTH (MPa)
	PART	FINE	COARSE	SIZE	
		PART	PART		
A	1	4	8	50	10
B	1	3	6	38	15
C	1	3	6	19	15
D	1	2	4	38	25
E	1	2	4	19	25
F	1	1½	3	19	30
G	1	1	2	19	40

The strength given in the above table shall be the minimum required at 28 days.

Unless otherwise specified. Class C concrete shall be used for mass concrete and Class E concrete for reinforced concrete.

Maximum concrete slumps acceptable for different types of construction concrete are as follows:

- (a) Vibrated reinforced concrete = 50 mm
- (b) Un-vibrated reinforced concrete = 75 mm
- (c) Mass concrete = 75 mm

When so required by the Engineers Representative, and whilst concreting is in progress, the consistency of the mixture shall be ascertained by means of the slump test as later described herein.

5 VOLUME BATCHING

The coarse and fine aggregate shall be measured by volume and, unless otherwise directed, cement shall be measured by mass: the volume of a 50 kg bag of cement shall be taken as 33 litre. Suitable measuring boxes for the coarse and fine aggregates shall be provided to the approval of the Engineers Representative.

The proportions given above are approximate only, and should the Engineers Representative consider that the voids in the coarse aggregate require more or less matrix than is formed by the proportions specified, he may vary the quantities of coarse and fine aggregates to obtain the required density and workability of the concrete, provided that the proportion of cement to the total volume of the aggregate shall not be less than that specified.

When the sand is not completely dry, allowance must be made for bulking due to the moisture content. The amount of bulking shall be determined by the Contractor in the presence of the Engineers Representative.

The proportion of water used for mixing concrete shall be determined by the Engineers Representative and once the water-cement ratio has been fixed, it shall be rigidly adhered to. On no account shall the amount of water exceed 34 litres to every bag of cement used. This figure includes the water contained in the sand.

The length of time each batch shall be mixed in the mixing machine shall be decided by the Engineers Representative.

Effective screens shall be provided to protect the mixing of concrete during windy weather.

6 WEIGH BATCHING

The proportioning of the coarse and fine aggregates by mass will be permitted, providing the method used is approved by the Engineer.

- a) All requests received by the Representative/Agent to make use of weigh batching must be submitted to the Engineer for approval.
- b) If the weigh batching process is preferred to volume batching, the proposed mix proportions are to be equivalent to the relevant volumetric mixes as documented previously herein and be based upon a minimum cement content.
- c) The following procedures must be complied with:
 - (i) The Contractor must timeously obtain written approval for the use of weigh batching and submit all information as set out below, with his application.
 - (ii) The mix transformation from volume to weigh batching shall be carried out at an approved laboratory.
 - (iii) Weigh batching equipment must be calibrated, and a certificate of accuracy must be submitted before such equipment may be used. On contracts of long duration and/or requiring large quantities of concrete, new calibration certificates may be required every four

months.

- (iv) The cement to aggregate ratio by volume for the following mixes will apply:

Class C (15 MPa) - c/a = 1:9
Class E (25 MPa) - c/a = 1:6
Class F (30 MPa) - c/a = 1:4,5
Class G (40 MPa) - c/a = 1:3

- (v) The following cement/water ratios by mass must also be complied with:

Class C (15 MPa) - c/w = 1,30 to 1,35
Class E (25 MPa) - c/w = 1,65 to 1,80
Class F (30 MPa) - c/w = 1,90 to 2,05
Class G (40 MPa) - c/w = 2,30 to 2,50

7 READY MIXED CONCRETE

Any application to use Ready Mixed Concrete shall be submitted by the Contractor to the Engineers Representative at an early stage for approval by the Engineer. Only suppliers approved by the Engineer will be considered.

8 STRENGTH CONCRETE

The Contractor shall be responsible for the design of strength concrete and for the measurement of the constituent materials to produce concrete that complies with the specified requirements.

The Engineers Representative will decide the class and grade designation of the concrete required for each part of the work and determines suitable limitations on the constituent materials and mix proportions in accordance with the said requirements.

(a) Trial mixes:

The Contractor must ensure that samples of the constituent materials of the concrete, together with evidence that they comply with the provisions, are supplied for approval in good time and provide the Engineer with—

- (i) statement from an approved independent laboratory of the results of tests, or
- (ii) an authoritative and acceptable report, or record of the previous use of, and experience with, the material concerned.

The cement, types of aggregate and their origins may not be changed throughout the duration of the contract without giving prior notification to the Engineers Representative who shall verify that the above requirements are complied with and that the important qualities of the concrete will not be impaired.

(b) Durability:

For each grade of concrete the Engineers Representative will, notwithstanding strength considerations, specify the cement/water ratio appropriate to the

exposure conditions indicated in Table 5, SABS Specification 1200G, Subclause 5.5.1.5.

(c) Consistency:

Unless otherwise indicated by the general workability of the concrete, method of transportation, conditions of placement or otherwise specified by the Engineers Representative, the suggested slump values, for different mixes of concrete shall be as specified in Clause 3.4.

(d) Workability:

Ensure that the concrete is of such workability that it can be readily compacted into the corners of the formwork and around reinforcement without segregation of the materials and without excessive "bleeding" of free water at the surface.

9 ADMIXTURES TO CONCRETE

The use of admixtures in concrete will only be considered should special circumstances warrant this and then only with the prior written approval of the Engineers Representative. The Contractor shall provide the following information:

- (a) The trade name of the mixture, its source and the Manufacturer's recommended method of use.
- (b) Typical dosage rates and possible detrimental effects of both under and over dosage.
- (c) The expected average air content of freshly mixed concrete containing an admixture which causes air to be entrained when used at the Manufacturer's recommended rate of dosage.

10 SLUMP TEST

The apparatus and the method of determination of the slump of freshly mixed concrete shall comply with SABS STM 862.

(a) Apparatus:

- (i) A mould in the form of a frustum of a cone and having the following nominal internal dimensions:
Bottom diameter: 200 mm
Top diameter: 100 mm
Height: 300 mm

The mould shall be of a metal (other than brass or aluminium) of side thickness at least 1,6 mm and shall have a smooth internal surface.

The mould shall have suitable base plate and handles to facilitate lifting it from the test specimen in a vertical direction.

- (ii) The tamping bar shall have a nominal diameter of 16 mm, a length of 600 mm and with sharp corner rounded off at one end.

(b) Procedure:

The test shall be carried out in an area that is free from vibration and shocks.

Ensure that the internal surfaces of the mould are free from set concrete and are clean and dry.

Place the mould with the bottom on a smooth, horizontal, rigid, non-absorbent surface and hold the mould firmly in place while it is being filled as follows:

- (i) Fill the mould in four layers, each thickness approximately one-quarter of the height of the mould. Tamp each layer with 25 strokes uniformly spaced over the cross-section of the mould. Tamp the bottom layer throughout its depth and ensure that when tamping the second and subsequent layers the strokes penetrate into the underlying layer.
- (ii) After the top layer has been tamped, strike off the concrete level so that the mould is exactly filled. Clean off any concrete that may have leaked out between the mould and the supporting baseplate surface. Remove the mould from the concrete immediately by slowly and carefully raising it in a vertical direction. This will allow the concrete to subside.

Immediately measure the slump, to the nearest 5 mm, by determining the difference between the height of the mould and the height of the specimen.

If a slump specimen collapses or shears off laterally regard the test as invalid, discard the result and repeat the test.

11 CONCRETE TEST CUBES

The apparatus for making and testing of concrete cubes shall comply with SABS STM 863.

(a) Apparatus:

Cubic metal moulds of steel shall be machined and adequately strengthened to resist distortion. The internal distance between faces of a mould shall be 150 mm.

The mould shall be constructed so as to facilitate the easy removal without damage of the moulded specimen.

Each mould shall have a metal base plate which shall be attached to the mould by springs or screws.

When assembling the mould for use, the joints between the sections of the mould, the contact surfaces between the bottom of the mould and the base plate, and the internal faces of the assembled mould shall be thinly coated with a grease or oil that will prevent leakage of water through the joints and adhesion of the concrete to the mould.

The tamper must be a steel bar of length 400 mm and mass 1,8 kg, and having a 25 mm square ramming face.

(b) Sampling and making cubes:

Sampling shall comply with SABS STM 861.

One set of three cubes shall be required for every 40 cubic metres, or part thereof, of concrete cast.

The sample taken from a batch of concrete and sufficient to make three cubes shall be placed in a tray or on a platform and mixed thoroughly.

The moulds shall each be filled in three layers approximately 50 mm thick. Each layer shall be compacted with the tamping rod as previously specified, with at least 35 blows to give full compaction of the concrete.

After the top layer has been compacted, strike off the surface of the concrete with a trowel, level with the top of the mould.

Any small hollows shall be filled in with additional concrete. Cement/sand slurry shall not be worked into the surface.

At this stage, the identity of each sample shall be placed on the moulded cube, by means of a label of absorbent material and not by scouring of the surface of the concrete.

(c) Curing cubes on site:

Cover the test cubes in their moulds with an impervious sheet or wet sacking and store indoors in a place that is free from vibration, excessive draughts, cold and direct sunlight.

After 24 hours the cubes shall be demoulded, remarked with a waterproof crayon or marker and placed in a curing tank for seven days before being transported to the laboratory.

The Contractor shall supply the curing tank which shall incorporate a thermostat to control the water temperature at 22 °C to 25 °C and shall be kept within a building.

(d) Testing of cubes:

The testing of all concrete cubes will be done by a laboratory approved by the Engineers Representative in accordance with SABS STM 863.

A suitable testing machine of sufficient capacity having an accuracy and repeatability that comply with the requirements for Grade A machines of BS 1610 "Method for the load verification of testing machines" shall be used to test the compressive strength of each cube.

The Contractor is responsible for the provision of the cube moulds and for

timeous delivery of the cubes to the laboratory.

12 CONCRETE QUALITY

Should the Contractor dispute any results obtained from concrete test cubes, the concrete represented by the cubes will be considered acceptable if the Contractor, at his own cost, proves to the satisfaction of the Engineers Representative that the estimated actual strength of cores taken from the structure (by an approved independent testing laboratory and determined in accordance with SABS STM 865) is not less than the specified strength. If the concrete fails to meet the strength criteria stipulated, the Engineers Representative may at his sole discretion and in addition to the options listed in SABS Specification 1200G-

- (a) accept the concrete subject to approved remedial measures being undertaken by the Contractor at his own cost; or
- (b) permit the concrete to remain, subject to reduced payment for lower strength concrete.

13 CONCRETING

It is essential that the foreman who has charge of the construction of all concrete work, whether reinforced or not, shall be skilled in this class of work, and shall personally superintend the whole construction, paying special regard to—

- (a) the quality, testing and mixing of the materials.
- (b) the laying of the material in place and the thorough compaction of the concrete to ensure solidity and freedom from voids;
- (c) the construction and removal of formwork; and
- (d) the sizes and positions of the reinforcement.

Particular care shall be taken to work concrete against formwork and around reinforcement. Internal vibrators may be used with the approval of the Engineers Representative but external vibrators which act only on the formwork will not be permitted.

Concrete to be reinforced shall be deposited in such quantities as will permit of it being properly compacted around the reinforcement.

The placing of concrete shall be completed within half-an-hour after mixing or within half-an-hour after agitating and within 2,5 hours after mixing in the case of ready mixed concrete. On no account shall concrete be incorporated into the work after it has attained its initial set.

Care shall be taken to prevent, as far as possible, the formation of laitance or scum. Laitance is to be understood to mean the scum of strengthless and inert material which forms on the surface of concrete.

Concrete must not be dropped into position from a height greater than 2,5 m unless

prior approval is obtained from the Engineer.

If an inclined chute is used for transporting concrete, it shall be of such slope as will ensure a continuous flow of concrete without the use of an excessive quantity of water and without segregation of the aggregates. The chute must be flushed out and properly cleaned before and after each working period. All waste from flushing shall be discharged outside the formwork.

In beams, each portion of a successive layer shall be placed as soon as the concrete below has been properly worked around rods and against formwork. Concreting shall be carried forward in irregular steps, that is to say, one layer shall not be completed over the whole section before the succeeding layer is commenced. Concreting of slabs and beams shall, as far as possible, be carried forward in one operation. When concreting has to be interrupted the concrete shall be left with a level, rough top surface with ends vertical. The concrete shall not be merely sloped down.

On resuming concreting, the old surface shall be roughened and all laitance thoroughly and carefully removed before any new concrete is deposited. This must be carried out by brushing the surface of the concrete while it is still green. Great care must be taken to avoid any weakness at the junction of old and new concrete, and the old surface shall be coated with a thin layer of cement and sand mortar, in the same proportions as that of the adjoining concrete.

While the concrete is setting it shall not be disturbed or shaken by traffic, either on the concrete itself or upon adjoining formwork.

No holes in concrete elements shall be patched or filled in without inspection, instruction and approval of the Engineer.

No concreting shall be carried out when the air temperature is below 4 °C when it is rising and 8 °C when it is falling.

Before concreting is commenced the Contractor shall give the Representative/Agent 24 hours notice of his intention to do so. On sites further than 200 km from the Representative/Agent, 48 hours notice must be given.

Concrete surface beds, excluding heavy industrial floors etc. shall be Class C concrete and shall be laid in suitable size panels not exceeding 20 m² in area and with the length of any panel not exceeding 4,5 m.

Where concrete beams are supported on concrete columns, the columns are to be concreted up to the underside of such concrete beams and then concreted up to the top of the beams, integral with the beams.

NB: Any finish applied to the surface of concrete floors, is to be understood as being additional to the thickness of the concrete described or shown on the drawings.

14 CURING OF CONCRETE

After the concrete has been placed, all exposed surfaces shall be kept continuously damp for at least 10 days by methods as may be approved by the Engineer, such as covering with approved building paper, or by means of wet canvas, wet sacks, wet

sand, by continuous hosing or ponding with water.

15 DESCRIPTIONS (PRICES) OF CONCRETE

Descriptions (prices) of concrete work shall be deemed to include the design of concrete mixes and all testing of concrete and materials other than compressive strength testing of concrete samples from concrete being placed in the works (the Contractor shall only be entitled to payment for those samples and compressive strength tests called for by the Engineers Representative and which pass the test requirements), handling and depositing (by hoisting or lowering) concrete in the forms, working and packing concrete around reinforcement, all "construction joints" other than "designated joints" as defined in SABS Specifications 1200G which are given separately, shaping tops of concrete components as required and striking off and curing. (Treatment of finished faces of concrete other than striking off and curing are given in separate items.)

Descriptions (prices) of concrete in surface beds cast in panels shall be deemed to include formwork, fillets and the like in forming the panels.

16 BUILDING ON CONCRETE FOOTINGS AND BEAMS

No brickwork, stone walling or other structure shall be built on concrete footings until at least three days after placement of the concrete in the case of mass concrete footings and after seven days in the case of reinforced concrete footings or as may otherwise be directed by the Engineers Representative.

No brickwork, stone walling or other structure shall be built on reinforced concrete beams or similar members until the formwork and all props or supports have been removed.

17 CONSTRUCTION JOINTS

Slip joints shall be provided between concrete slabs and beams by levelling up and trowelling smooth the bearing surfaces of brickwork with 3:1 cement mortar and covering the bearings before the concrete is cast, with two layers of one side smooth tempered hardboard, with the smooth sides in contact.

The ends and sides of beams and edges of concrete slabs shall be separated from the brickwork with 13mm thick bitumen impregnated softboard or expanded polyethylene strips placed vertically against the brickwork before the concrete is cast.

Similar slip joints shall be provided between brickwork and concrete lintels cast in situ, but without softboard or expanded polyethylene strips at ends.

Round of all construction joint edges to a radius of 3 mm.

18 ISOLATION OR MOVEMENT JOINTS

All movement joints are to be filled in with approved bitumen impregnated softboard or expanded polyethylene strip unless otherwise specified or detailed on drawings. Form similar movement joints where pathways adjoin buildings externally.

19 CUTTING, PUNCHING OR HACKING CONCRETE

No reinforced concrete shall be cut or hacked without the sanction of the Engineers Representative.

20 FORMING KEY TO CONCRETE FOR PLASTER AND OTHER FINISHES

Where rough formwork has been used, surfaces of concrete to receive plaster and other finishes, shall, immediately after the formwork has been removed, be well wetted and wire brushed whilst the concrete is still green and then slushed over with 2:1 cement grout to form a key for the finish, all to the approval of the Engineers Representative. The slushing is to be allowed to set hard before the finish is applied.

Where smooth formwork is used, surfaces of the concrete to receive plaster and other finishes shall be hacked, on the distinct understanding that hacking of concrete shall be at no extra cost to the Professional Team.

Surfaces of concrete receiving plaster or other finishes shall not be plastered or finished until the Engineers Representative has signified his opinion in writing that the surfaces are suitable to receive plaster or other finishes.

21 SLEEVE PIECES, TIES, ETC.

Where it is necessary to leave plugs or holes in beams, slabs or any other reinforced concrete, all such plugs or holes must be situated in positions approved by the Engineers Representative before concreting. Where it is necessary to carry pipes, bolts, wires or any other fittings through reinforced concrete members, approved pipe sleeves must be provided and placed in position before concreting.

Where waste, ventilation, water, heating or other pipes under 100mm diameter pass through concrete slabs and beams, galvanised mild steel sleeve pieces of diameters shown or required shall be cast into such concrete slabs and beams.

Chases shall be formed in edges of slabs or slots shall be formed in the slabs, of sizes required, where two or more pipes pass through together.

All necessary bolts, plugs, brackets, cramps, etc. shall be cast into the concrete as the work proceeds.

Where brickwork abuts against concrete, the brickwork is to be tied to the concrete with galvanised hoop-iron ties 1,6m thick by 32mm wide and approximately 600mm long to every third course of brickwork with one end of each tie cast approximately 150mm deep into the concrete. Where such fixing is impossible, i.e. where steel formwork is used, ties are to be gun-nailed against concrete with steel nails not less than 38mm long.

22 BAGGED FINISH TO CONCRETE

Concrete surfaces to receive bagged finish shall be prepared by removing sharp projections and making good defects with 3:1 cement mortar. Finish by rubbing over the whole area with wet rough sacking and cement grout to obtain an even surface.

23 FINISHING OF CONCRETE FOR TROWELLING

Direct-finish of concrete by means of delayed trowelling techniques:

- Level concrete surface by means of straight-edge after vibrating.
- Leave surface undisturbed until bleeding has ceased and surface has stiffened so that foot pressure barely indents the surface (2 – 4 hours).
- Remove bleed water and laitance.
- Hand trowel using pressure, or power trowel.
- Steel trowel to produce a smooth finish, or wood float to produce a slip-free surface.
- Do not add water or neat cement.

24 POWER FLOATED FINISH

Power floated finish to floors etc. means that surfaces shall be floated mechanically to a smooth and even finish before the concrete has set. Small areas inaccessible to the machine are to be floated by hand. Under no circumstances is cement mortar to be added while floating the concrete.

25 “NO-FINES” CONCRETE

“No-fines” concrete, for grading flat concrete roofs and the like falls, shall be in the proportion of 12 parts 19 iron cubical stone to 1 part cement mixed with 20 litres water per bag of cement and be laid to falls of not less than 15mm per linear metre for mastic asphalt and not less than 20mm per linear metre for sheet roof covering. For heavy load applications special mix designs may be required.

a) Fillets against upstands:

Form triangular fillets, size 75 × 75mm, in corners with walls, kerbs, etc. neatly mitred at angles, stopped where necessary and finished smooth ready to receive waterproofing.

b) To raised floors, bases, etc.:

“No-fines” concrete for raised floors, bases, etc. shall be in the proportions specified. Finish smooth with 3:1 sand/cement screed to receive waterproofing.

26 FORMWORK

Formwork shall include all shuttering, casing and centring of whatever material required for the laying and forming of concrete floors, slabs, beams, lintels, walls, steps, columns, piers, pilasters and any other concrete work requiring moulds or forms and shall embrace all cleats, battens, fillets, wedges, struts, trestles, braces, props, shores and other requirements of whatever material for keeping all in correct position. All materials used for formwork must be suitable and substantial and all joints must be tight enough to prevent leakage of liquid matrix.

All formwork must be designed by the Contractor and if requested to do so, he must submit fully detailed and dimensioned working drawings to the Engineers Representative for checking purposes.

Acceptance of the proposals shall not relieve the Contractor of his responsibility for the safety and stability thereof nor for any loss or damage arising out of defective design, materials and/or workmanship.

The formwork must be so constructed that its partial removal can be carried out to the satisfaction of the Engineers Representative and in such stages as are required by the working conditions.

As far as possible, wedges and clamps must be used in preference to nails. All formwork in its various sections for floors, beams, etc. must be so arranged that the whole may be raised or lowered either independently or together with other sections by means of wedges or other approved methods.

Immediately before concreting is begun, the formwork in contact with the concrete must be thoroughly cleaned, wetted and kept damp whilst the concrete is being placed.

Great care must be taken to keep the formwork wedged up to its correct height and this must be checked by taking levels immediately before concreting is commenced and immediately after it has been completed.

All beams shall have a camber of 6 mm to every 3 m of length.

The minimum periods that the formwork to the various parts of the structure is to remain in position after concreting shall be as stated in the following table:

DESCRIPTION	NORMAL CEMENT		RAPID HARDENING CEMENT	
	WEATHER		WEATHER	
	NORMAL	COLD	NORMAL	COLD
Beam sides, walls, unloaded columns	2 days	4 days	1 day	2 days
Slabs with props left under	4 days	7 days	2 days	4 days
Beam soffits with props left under including ribbed slabs	7 days	12 days	3 days	5 days
Removal of slab props	10 days	17 days	5 days	9 days
Removal of beam props	14 days	28 days	7 days	12 days

When determining the stripping time for formwork the weather shall be considered to be "normal" when the temperature is above 18 °C and "cold" when the temperature is between 5° and 10 °C, these being the average daily temperatures of the atmosphere adjacent to the concrete. When the average daily temperature lies between the above values for "normal" and "cold" weather the minimum period for stripping of formwork shall be determined by the Engineers Representative.

Notwithstanding the above minimum periods, formwork may be struck immediately the concrete in the various parts of the structure has attained the crushing strengths required by the Engineers Representative. The crushing strengths must be determined by proper tests, which shall be carried out by the Contractor.

No formwork of any nature whoever shall be struck, either after the elapse of the minimum period stated above or on the attainment of the required crushing strengths of the concrete, without the prior consent of the Engineers Representative. Such consent will not absolve the Contractor of his responsibility for the safety of the structure.

In structures having either in whole or in part, two or more reinforced concrete floors, props shall be provided under the soffit of any beam or slab of any floor which is being used to support the formwork and wet concrete of the floor above, all to the approval of the Engineers Representative. The props shall not be removed until the formwork supporting the concrete of the floor above has been struck.

On no account shall steel formwork be oiled where concrete is to receive plaster.

Formwork is measured to the net surfaces of concrete to be supported, except at intersections of beams with beams, columns, walls, etc. and tops of columns with slabs, beams, etc. where no deductions have been made and descriptions (prices) shall be deemed to include use and waste, except where the formwork is of a permanent nature or is to be left in, fitting together to all required shapes, all cutting, intersections, cambering where required, holes for rods, bolts, pipes and the like, propping, maintaining, keeping damp whilst the concrete is being deposited and removing.

Formwork "left in" and permanent formwork shall be deemed to include leaving in formwork, props, etc.

Descriptions (prices) of formwork to soffits shall be deemed to include propping not exceeding 3,5m high unless otherwise described. Descriptions (prices) of formwork to walls and columns shall be deemed to be not exceeding 3,5m high above bearing level unless otherwise described. Descriptions (prices) of formwork to soffits of solid slabs shall be deemed to be to slabs not exceeding 250 mm thick unless otherwise described.

27 SMOOTH FORMWORK

Smooth formwork shall be any material approved by the Representative/Agent which is to be used to leave concrete surfaces smooth when removed and where no other finish is to be applied.

Descriptions (prices) shall be deemed to include for rubbing off all projections at seams etc. after removal of the formwork, making good any defects with 2:1 cement mortar and leaving a smooth surface with all arises slightly rounded, all to the satisfaction of the Representative/Agent.

28 DAMP-PROOF UNDER-SURFACE MEMBRANE

The damp-proof under-surface membrane to be used shall be of a polymer film according to SABS Specification 952 type C (green) 0.25mm thick.

The damp-proof under-surface membrane shall be placed over the full floor area before the concrete floor is casted. The membrane shall be cut straight and square or to shape by the use of sharp instruments.

Joints shall have a minimum overlap of 300mm and sealed with pressure sensitive tape.

29 REINFORCING RODS

a) Mild steel:

Mild steel shall comply with the requirements of SABS Specifications 920, Type A or B.

b) High tensile steel:

High tensile steel shall comply with the requirements of SABS Specification 920, Type C or D.

30 CONCRETE REINFORCEMENT

30.1 Rod Reinforcement:

Bending and hooking of rods shall be done in accordance with SABS Specification 82. Rods shall be bent cold in an effective bending machine, or properly designed rod-bender using a steady pressure and not by hammering.

Diameters, lengths and positions of rods as shown on the drawings must be strictly adhered to. Joints in rods in beams, stairs, etc. will be permitted only where shown on the drawings.

Before being placed in position, the rods shall be thoroughly cleaned of all grease, dirt, bituminous material, scale and loose rust.

All distribution rods shall be straight and shall extend at least 150mm into beams or other support.

Unless otherwise shown on the drawings, all joints in reinforcing rods shall be lapped 40 times the diameter of the rod. The laps shall be securely tied with 1,25mm diameter annealed mild steel binding wire.

Reinforcement for piles, column footings, columns and walls shall be tied at every intersection, or as directed or shown on drawings, with similar binding wire.

Reinforcement in beams shall be tied at alternate intersections in a diamond pattern, unless circumstances demand every intersection.

Great care must be taken to retain the reinforcement in its correct position during the entire period of concreting. Blocks of fine concrete, size approximately 40 × 40mm, or plastic spacers shall be provided on the formwork to soffits of beams to ensure that the rods are retained in position and that the concrete covering to the main reinforcing rods is provided. The blocks shall be of the thickness required and shall be placed under the main reinforcing rods at approximately 600mm centres.

Reinforcement in the top of slabs and the like shall be retained in position by means of cradles (stools), formed of steel reinforcing rod as follows:

R10 for height range 100 – 300mm and maximum width of 300mm.

R12 for height range 300 – 500mm and maximum width of 450mm.

Recommended spacing of supports for horizontal bars in slabs:

No further than 600mm apart (cradles $\pm 1000\text{mm}$ c/c in both directions) for bar diameters up to 12mm.

No further than 1000mm apart (cradles $\pm 1500\text{mm}$ c/c in both directions) for bar diameters of 16mm and over.

Stools are to be placed on the bottom layer of reinforcement, securely retained in position and with correct concrete cover as specified. Cradles are to be securely wired to the slab reinforcement with binding wire. Beam rods in different layers shall be separated by means of steel spacer bars of suitable diameters and lengths.

Double mats in concrete walls shall be kept in their respective positions by means of suitable steel clips as follows:

Recommended spacing of supports for vertical bars in walls:

1 000mm centres in both directions for bars up to 12mm diameter.

1 500mm centres in both directions for bars of 16mm diameter and over.

Supports can be spaced more closely by the design Engineer, depending upon the circumstances.

All stirrups shall be properly fastened to the rods so as to retain their relative positions during the entire period of concreting.

Welding of main rods will not be permitted unless, approval has been given by the Engineers Representative. Spot welding in lieu of wiring may be used to secure rods and stirrups in position.

The concrete covering the main reinforcement, unless otherwise specified, shall not be less than that stated in the following table:

Position	Amount of Cover
Soffit of slabs	The diameter of the rods, but never less than 15mm (mm)
End of beams	40
Soffit of beams	40
Sides of beams	40
Sides of columns	40
Slab (under ground cable)	40
Concrete walls	40
Walls (exposed to ground cable)	25
Ground beams	40
Foundations	40
Water retaining structures and	75
within 1km from coast	50

Incases not included in the above table the cover shall not be less than 25mm.

Depending on the condition of exposure and fire resistance requirements, concrete cover can be varied by the design engineer but in no case shall the concrete cover be less than the diameter of rod to be covered.

The cover shall be measured from the face of the concrete to the outside of main reinforcement nearest the face of the concrete, and shall exclude plaster and similar finishing materials.

Three samples of each diameter of reinforcing rods, each approximately 600mm long, must be taken from each consignment of rods of similar diameter for testing.

If any sample is found unsatisfactory, the whole consignment of rods from which the samples were taken will be rejected.

Top reinforcement in cantilever slabs to be kept in position with a first row of stools or chairs 300mm from the beam or support, and thereafter at a maximum of 40 bar diameters under each bar.

The cover blocks, spacers, bars and stools or chairs are to be placed and/or wired in position by the steel fixer.

30.2 Welded steel fabric reinforcement:

All welded steel fabric reinforcement shall comply with the requirements of SABS Specification 1024.

The preferred dimensions are as follows:

1	2	3	4	5	6
Fabric Reference Number	Nominal pitch of wires		Nominal diameter of wires		Nominal mass*
	Longitudinal mm	Cross mm	Longitudinal mm	Cross mm	kg/m ²
617	200	200	10.0	10.0	6.17
500	200	200	9.0	9.0	5.00
395	200	200	8.0	8.0	3.95
311	200	200	7.1	7.1	3.11
245	200	200	6.3	6.3	2.45
193	200	200	5.6	5.6	1.93
100	200	200	4.0	4.0	1.00
772	100	200	10.0	7.1	7.72
655	100	200	9.0	7.1	6.55
517	100	200	8.0	6.3	5.17
433	100	200	7.1	6.3	4.33
341	100	200	6.3	5.6	3.41
289	100	200	5.6	5.6	2.89
278	100	300	6.3	4.0	2.78
226	100	300	5.6	4.0	2.26
133	100	300	4.0	4.0	1.33

*These mass values are based on the wires having mass of 0,00785 kg/mm² per metre of length.

The actual mass of the fabric should not differ from the nominal value by more than 6%.

31 DESCRIPTIONS (PRICES)

Descriptions (prices) for all steel reinforcement to concrete shall be deemed to include cutting and waste, bending, hooked ends, binding at lappings and intersections with annealed wire all as above described, hoisting or lowering and maintaining in position whilst the concrete is being deposited and cover blocks and spacers in accordance with the relevant SABS Codes of Practice.

Descriptions (prices) of standard fabric reinforcement as included in Table 1 of SABS Specification 1024 shall be deemed to include 300mm wide laps.

The mass of binding wire is not included in the mass of the reinforcement and the cost thereof shall be deemed to be included in the prices for the reinforcement.

MASONRY

Masonry walling (Including brickwork and stone masonry):

Applicable standard: SANS 2001 – Construction Works Part CM1: Masonry Walling.

SANS 2001-CM1 covers requirements for masonry walls, materials, the laying of masonry units in unreinforced and reinforced applications, the building in of door and window frames, holes and chases, the securing of timber roof structures and the fixing of slips.

SCOPE OF MASONRY WORK.

The masonry work shall consist out of the foundation section up to floor level that shall be built with solid burnt clay units in an English bond where the masonry units to be used shall be locally produced "Clinker Bricks". The building walls shall be built with face brick units in an English bond, gray of colour and with nominal dimensions of 222 × 103 × 76 mm.

The foundation floor section of the masonry work shall be face work jointing with recessed joints. The building walls shall be face brick.

All the door and window frames shall be protected by steel lintels on top of it as shown in the drawings.

1 MATERIALS

1.1 LIME

Lime shall be hydrated bedding mortar lime complying with the requirements of SABS Specification 523.

1.2 CEMENT

Cement shall be Portland cement complying with the requirements of SABS Specification 471 or PC15 complying with SABS Specification 831.

Samples of cement from any one, or from every consignment, may be required by the Representative/Agent for test purposes. Cement in any consignment from which a sample may have been taken for testing shall not be used until it has been approved. Allowance must be made for possible delay in that tests may take 10 days

to carry out.

Bags of cement shall be stacked in a waterproof, solidly constructed shed with a central door and a floor rendered damp-proof with a tarpaulin. The bags of cement shall be closely stacked (but not against walls) in order to reduce air circulation in such a manner that the cement is used in the order in which it was received, i.e. first in first out.

Unless otherwise specified in the tender documents the use of ordinary Portland cement blended with ground granulated blast furnace slag complying with SABS Specification 1491, or ordinary Portland Cement blended with Pulverised Fly Ash complying with SABS Specification 1466 will be allowed in certain instances as an alternative, after acceptance of tender, but only with the approval of and at the sole discretion of **the Professional Team**. If not so specified in the tender documents the Contractor must demonstrate a saving in favour of the Professional Team together with his alternative tender. The saving offered will be adjudicated by the Engineer/Quantity Surveyor for the service and acceptance of the alternative will be in accordance with the reasonableness thereof.

1.3 SAND

Sand shall comply with the requirements of SABS Specification 1090, unless specialist advice is obtained. A sample of 25kg must be delivered to the Engineers Representative for testing purposes.

1.4 BURNT CLAY BRICKS

- a) Burnt clay bricks shall comply with the requirements of SABS Specification 227, and shall be equal in all respects to the selected samples with nominal dimensions of 222 × 103 × 76 mm.
- b) Clay bricks for foundations shall be as described in (a) above, but extra hard burnt and with uniformity of colour and texture. The foundation section shall be built with "Clinker Bricks" approved by the Engineers Representative.
- c) Where bricks with holes are used, the holes in such bricks must only be filled in solid with mortar where specifically specified.
- d) All bricks that do not carry the SABS Mark, must be tested in a Laboratory approved by the Engineers Representative for its strength before approval.

1.5 FIREBRICKS

Firebricks shall be of well burnt refractory fireclay, resistant to spalling and cracking and of same size as ordinary bricks.

1.6 CONCRETE MASONRY UNITS

Concrete masonry units shall comply with the requirements of SANS Specification 1215 and shall be hollow on the inside, gray of colour and with nominal dimensions of 390 × 140 × 190mm.

2 WORKS MORTAR TESTS

2.1 SAMPLING

The frequency of sampling will be decided by the Engineers Representative. Sufficient mortar shall be taken from each of the points of laying to prepare a composite sample to make a set of three mortar cubes.

2.2 MOULDING

Cube moulds with a nominal size of 100mm, that comply with SABS STM 863 must be used.

Fill each mould with mortar in three equal layers and compact each layer by means of a tamper.

The tamper must be made of hard wood with a flat tamping surface with nominal dimensions of 50 × 25mm and shaped to provide a round stem of approximately 25mm diameter and long enough to afford sufficient hard grip. Immerse the tamper in water for 15 minutes before each use.

Each layer of mortar must be compacted by means of 8 evenly spaced pressing strokes of the tamper. After the final layer has been tamped, the excess mortar must be struck off level with the top edges of the moulds.

2.3 CURING

Cover the test cubes (in their moulds) with an impervious sheet followed by wet marring sacks or similar material, and store them in a place free from vibration, excessive draughts and direct sunlight.

After 24 hours mark each cube so that it can be identified. After 48 hours the cubes must be removed from their moulds and placed into water in a curing tank at 22° - 25° C for a minimum period of 7 days before they are transferred to the testing laboratory. Ensure that loss of moisture is prevented during transportation and that they are well protected against damage.

2.4 TESTING OF CUBES

The testing of cubes will be done by a Laboratory selected by the Contractor and approved by the Engineers Representative in accordance with SABS STM 863.

3 CEMENT MORTAR

Cement mortar shall be composed of 6 parts (by volume) of sand and 1 part (by volume) of cement. The material shall be mixed dry until of uniform colour and then water added, and the mixture turned over until the ingredients are thoroughly incorporated. Cement mortar shall be produced in such quantities as can be used before commencing to set as no cement mortar that has once commenced to set shall be used in any way.

Care shall be taken in mixing cement mortar to remove from the mixing machine or platform any old mortar that has already set as such mortar may not be incorporated

into any new batch.

4 COMPO MORTAR

Compo mortar shall be composed of 6 parts (by volume) of sand – depending on the quality of the sand available, 1 part of lime and 1 part of cement (by volume). The lime and sand shall be mixed dry, then wet, before the cement is added, approximately half an hour before using and the adding of the necessary additional water as required.

Compo mortar shall be produced in such quantities as can be used before commencing to set, as no compo mortar that has once commenced to set shall be used in any way.

In all cases the mortar should achieve the minimum required strength (in MPa) for the classes of mortar as set out in the SANS National Building Regulations.

5 BRICKWORK

Brickwork, wherever practicable, shall be built in English bond. No false headers shall be used and none but whole bricks employed, except where legitimately required to form bond.

Brickwork shall be built level and plumb with mortar as specified.

The bricks shall be laid on a solid bed of mortar and all joints thoroughly grouted up solid throughout the whole width of each course.

The brickwork shall be carried up in a uniform manner, no one portion being raised more than 1,2m above another at any one time.

Clay bricks shall be well saturated with water, in the stack or dump, approximately 2 hours before being used. The tops of walls left unfinished shall be wetted before work recommences.

NB: Cement or concrete bricks shall not be wetted.

All rough and fair cutting, cutting of splays, skewbacks, chamfers, etc. shall be properly formed.

Form or leave all necessary openings for pipes etc. and make good after pipes etc. are fixed in position.

6 BRICKWORK IN CEMENT MORTAR

- a) All brickwork below damp course level, all isolated piers three bricks wide and under, half brick walls and chimney stacks above ceiling level, shall be built in cement mortar as described in 3 above.
- b) Brick arches and brick lintels shall be built in cement mortar as described in 3 above in the proportion of 3:1.

7 MORTAR JOINTS

Mortar joints to brickwork generally shall be 10mm in thickness with level bedding joints and vertical perpend.

The joints in brickwork receiving plaster, tiling or similar finishes shall be raked out whilst the mortar is soft to form key for the plaster or mortar backing. The depth of the raking out will depend on the condition of the bricks; the rougher the bricks on face the shallower the raking out and the smoother the bricks the deeper the raking out.

Face brick joints shall be recessed pointed of no more than 5mm depth

The joints in brickwork shall be flushed off where walls are to be bagged, in readiness for the bagging.

8 GROUT IN JOINTS IN BRICK FOUNDATION WALLS

All joints in brick foundation walls shall be grouted in solid with 3:1 liquid cement mortar to obviate any crevices for ant (termite) tracks.

9 BRICKWORK IN THICKNESSES

Walls built in two or three half brick thicknesses shall only be built where bonded brickwork proves impractical or where required due to prescribed bond of faced brickwork, all tied together with metal ties in accordance with SABS Specification 28, of the Butterfly or Modified PWD Types, of sufficient length to allow not less than 75mm of each end to be built into the brickwork. Ties shall be evenly spaced at not more than 1m apart to every third course and staggered.

10 BRICKWORK IN LININGS

Brickwork linings to concrete shall be tied thereto with 4mm diameter galvanised crimped wire ties bent at ends and of necessary length to allow 75mm to be cast into concrete and 75mm of the other end to be built into brickwork and evenly spaced at no more than 1m apart to every third course and staggered.

11 HALF BRICK THICK WALLS

Half brick thick walls shall be built in cement mortar as described in 3 above and reinforced with 75mm wide brick reinforcement as described in 14 below, 1 row to every 8 course in height, and built 100mm into main connecting walls. The reinforcement shall be lapped 150mm at end joints, where these are necessary, and 75mm at angles.

12 CAVITY WALLS

Cavity walls shall be built with two half brick thicknesses of brickwork in stretcher bond with 50mm cavity between, and the two thicknesses tied together with 200mm long metal wall ties evenly spaced at not less than the rate of 9 ties per m² of face area. The ties shall comply with the requirements of SABS Specification 28 and be of the Butterfly or Modified PWD Type only.

The brickwork shall be built level and plumb with mortar as specified.

The cavities shall be carried up from 1 course of brickwork below damp course level up to two courses below roof plate level. The brickwork above cavities shall be built solid and where 270mm thick shall be cut and well bonded where possible.

The cavities shall be kept free of all rubbish, mortar droppings and projecting mortar.

The top of walls shall be covered with planks or sacking during wet weather to prevent rain from entering the cavities.

Form weep holes in outer skin of external cavity walls by leaving the perpendicular joints open, one every 1m apart in the second brick course below the damp-proof course.

The cavities shall not be ventilated.

At door, window and other openings the cavities shall be stopped 110mm back from jambs of openings with the inner thickness of brickwork returned and stopped against the outer thickness and not bonded to same. A 100mm wide strip of damp proof sheeting as described for damp courses in 29 below shall be built into the joint formed between the return and the outer thickness. Each damp-proof strip shall be lapped at least 50mm on to the damp-proof course between the two wall thicknesses of sills and between the two wall thicknesses of lintels.

Sills of windows shall be divided into external and internal thicknesses with strips of damp-proof sheeting as above, built in line with the damp-proof sheeting in jambs and extending 100mm beyond the jambs of openings.

The lintels shall be provided with damp-proof sheeting as described under lintels.

Cavities shall be stopped 1 course below and 1 course above and 110mm from sides of openings for air bricks and the like.

13 BEAM FILLINGS

Beam filling shall be half brick thick, built up in mortar as used in the walls below, cut in between roof timbers and carried hard up to underside of roof covering and flushed up with mortar.

14 REINFORCED BRICK LINTELS

Reinforced brick lintels shall be built with sound machine made bricks in 3:1 cement mortar with all vertical and horizontal joints filled with solid mortar throughout the required number of courses and to a distance of at least 330mm on either side of the clear opening.

The number of courses in lintels over the various size openings shall be as specified in the table hereunder and reinforcing steel wires or rods shall be built into the first horizontal joint over the bottom course to the number specified in the following table:

Clear or daylight span	Number of Courses	Reinforcement
------------------------	-------------------	---------------

Not exceeding 1m	4	One row of 75mm wide brick reinforcement as described below, for each half brick width of soffit
Over 1m to 1,5m	6	Ditto
Over 1,5m to 2,5m	7	Three 6,3mm diameter mild steel rods for each half brick width of soffit.
Over 2,5m to 3,0m	8	Ditto

Brick reinforcement shall be of hard drawn mild steel comprising two 2,8mm diameter main wires spaced 75mm apart and 2,5mm diameter cross wires spaced at not exceeding 300mm apart, welded to main wires.

The reinforcing wires and rods shall be of length at least equal to the width of the clear opening plus 300mm at each end. The reinforcement shall be evenly spaced in the brick joints with the outer wires or rods having at least 20mm cover from face of brickwork.

Brick lintels in 270mm thick cavity walls shall be built with inner face of outer thickness, for a depth of three courses above soffit, covered with sheeting as for damp course, the full length of lintels, and space between the two thicknesses for the depth of the sheeting filled in solid with 20 MPa concrete. Where cavities continue above lintels, the sheeting shall be taken up and turned on top of first course of brickwork to inner thickness of wall above the concrete filling in lintels. The sheeting is not required in lintels protected from the weather.

The lintels, except where built over pressed steel door frames and the like, shall be supported on temporary turning pieces of suitable and substantial construction left in position for at least 14 days for long spans (1 to 3m).

15 PRESTRESSED LINTELS

Prestressed lintels shall be vibrated concrete reinforced with stressed high tensile steel wires, or of burnt clay blocks with similar reinforcing wires embedded in grooves in the blocks in 1:1½ cement/sand mortar, or of other approved form of construction.

Concrete in lintels shall attain a crushing strength of at least 34 MPa at 28 days for ordinary and at 7 days for rapid hardening cement.

The reinforcing wires shall be of ductile high tensile steel wire not less than 4mm diameter and of tensile strength of at least 1 350 MPa and shall be stressed to not less than 850 MPa.

The lintels may be in single width to the thickness of wall or may be in two widths, placed side by side, and shall have a depth of not less than 60mm. top surface of lintels shall be suitably roughened, indented or shaped to give a good bond between the lintels and the mortar for the first course of brickwork above.

Lintels shall have bearings of not less than 225mm on walls at each end.

The number of reinforcing wires in lintels for the various wall thicknesses and spans shall be not less than specified in the table hereunder, and brick courses over lintels of the number indicated in the table and for the full length of lintels shall be built in 3:1 cement mortar with all joints filled solid with mortar, viz:

Nominal wall thickness (mm)	Clear daylight span	Number of wires (in total number of lintels used)	Number of brick courses over lintel
90 – 110	Not exceeding 1,8m	2	3
90 – 110	Over 1,8m to 3m	3	4
180 – 230	Not exceeding 1,8m	6	4
180 – 230	Over 1,8m to 3m	6	4
270	Not exceeding 1,8m	7	4
270	Over 1,8m to 3m	7	5
340	As described for 1 of 230mm plus 1 of 110mm, or 3 of 110mm		

Lintels in 270mm thick cavity walls shall be in two widths with joint between the two arranged directly over the window or frame below, and the brickwork above shall be built in two half brick thickness with inner face of the outer thickness covered with sheeting as for dampcourse, the full length and depth of lintels, and taken down between the two widths of prestressed lintels. The cavity to height of lintel courses shall be filled with 20 MPa concrete, and where cavities continue above the lintel courses the sheeting shall be taken up and turned on top of first course of brickwork to inner thickness of wall above the lintel course. The sheeting is not required in lintels protected from weather.

16 BAGGED FINISH TO BRICKWORK

Bagging to walls is to be carried out after the mortar in joints has set. The wall surfaces shall be rubbed over with wet rough sacking until all joints and crevices are filled up and an even surface is obtained. Cement grout shall be added if necessary to fill the joints and crevices.

17 RAKING OUT FOR AND POINTING FLASHINGS

Brick joints shall be raked out where required for fixing cover flashings and flashings, which shall be pointed in 3:1 cement mortar.

18 MASTIC POINTINGS

Where steel/Aluminium door and window frames are specified to be pointed with mastic compound they shall be pointed all round externally with an approved waterproofing compound of such composition that it will not stain surrounding surfaces and that it will adhere tenaciously, remain plastic without sagging or running, be capable of accommodating any normal movement of the joint sealed, and will receive paint without "bleeding". The pointing material shall be forced into the joints, which shall have been previously prepared to receive same, by means of a pressure gun or by other suitable method, all in accordance with the Manufacturer's instructions.

19 BUILDING IN

Ends of timbers, holdfasts, cramps, gratings, air bricks, dowels, etc. shall be built-in cement mortar.

Door and window frames, lift door frames and the like shall be set up in position for building in and securely strutted to prevent distortion whilst the brickwork, lintels, etc are being built.

Pressed steel door frames shall be grouted in solid at back with cement mortar as the work proceeds.

Wood slips, fixing bricks, hoop iron roof ties, etc. shall be built in as the work proceeds.

20 SECURING ROOFS

Roof trusses shall be fixed at each support to walls with ties of 1,6mm thick galvanised hoop iron, 32mm wide, built 750mm deep into brick work or embedded 300mm deep into concrete or wrapped around bottom layer of reinforcing in a reinforced concrete beam and wrapped over truss and fixed with four galvanised nails, 40mm long.

21 CRAMPS TO WOOD FRAMES

Wood frames to doors, windows, etc. shall be set up in position for building in as described and built in as the work proceeds with cramps to jambs of 1,6mm thick galvanised hoop iron, 32mm wide, with ends turned 50mm up against stiles of frames and each twice screwed to frame and built 450mm into wall with end turned up into brickwork joint. Cramps shall be built in approximately 0,3m up from bottom and approximately 0,3m down from head of frames and intermediately at not exceeding 0,85m apart. No frame shall have less than two cramps to each jamb irrespective of height.

Cramps to frames in 270mm thick cavity walls shall be cranked as necessary and built into inner and outer thickness of walls alternatively.

22 BEDDING AND POINTING

All door, window and similar frames shall be bedded and pointed in 3:1 cement mortar. All wall and floor plates shall be set true and level and bedded in 6:1 cement mortar.

23 FACED BRICKWORK

Faced brickwork shall be built fair and pointed with a keyed or recessed joint as specified.

Keyed joint shall mean that the joints are to be pointed with a round jointing tool, well pressed into the joints as the work proceeds.

Recessed joint shall mean that the joints are to be square recessed to a depth of approximately 5 mm formed with a rectangular jointing tool well pressed into the joints as the work proceeds.

Facing bricks shall be sorted by the brick manufacturer at his yard or by the Contractor on the site to ensure that proper mixing of the bricks within the colour range of each type of facing being used is obtained. Sudden changes in the general

colour of face work in any 1 type of facing brick will not be acceptable.

24 FIBRE CEMENT SILLS

Sills shall where in any way possible be in single lengths, cut between reveals, fitted with fixing lugs and solidly bedded in 3:1 cement mortar with a slight projection beyond the finished wall face below.

Internal sills shall be level. External sills shall be set sloping on cut brickwork.

25 INSTALLATION OF ELECTRICAL SERVICE

The installation of electrical service, where such service is being provided, will be carried out by a fully qualified electrical sub-contractor, but the Contractor must embed in the concrete and rammed earth, as the work proceeds, all conduits, boxes, etc., which will be fixed in position by the electrician, and must form recesses in walls for distribution boards, all in the positions directed. Alternatively, distribution boards may be built into walls as the work proceeds, providing prior approval is obtained from the Engineers Representative.

The Contractor shall afford every facility and shall render reasonable assistance to the electricians in carrying out their work and shall make good where necessary, in all trades, after installation has been completed.

Recesses for distribution boards

Width mm	Height mm	Depth mm
330	330	110
455	330	110
635	330	110
610	660	110
610	910	110

26 CABLE SLEEVES

Provide under buildings where required 100mm diameter plastic pipes as sleeves for electric cable taken up to floor level in cable duct or switch cupboard with easy bends. The pipes shall be as specified for drainage including laying and jointing.

27 SPECIAL WORKS

The work in connection with the installation of heating, air conditioning, ventilation, refrigeration, automatic sprinklers, telephone systems will be carried out under separate contracts. In order to facilitate this work the Contractor must act on the instructions of the Engineers Representative with regard to special preparations for fittings, leaving holes and openings, forming chases in floors, walls, etc. for pipes, cables, etc and for building in pipes, sleeves, pipe clips, bolts, etc. as required or directed.

All cutting of holes through finished floors, walls, etc. after the concrete has set, must be avoided as far as possible. The Contractor must give ample notice to the Engineers Representative who will ascertain the exact positions where pipe sleeves, pipes, pipe clips, etc. are to be fixed.

28 PROTECT AND CLEAN DOWN FACE BRICKWORK

All face brickwork, tiling, etc. liable to damage shall be covered up and protected during the progress of the remaining work and any damage done shall be made good to the satisfaction of the Engineers Representative.

All face brickwork, tiling, etc. shall be cleaned down as the work proceeds and shall be covered up with paper, pasted on, or by other approved means where necessary to prevent soiling of the surfaces during the progress of the remaining work. At completion of the works the coverings shall be removed and the surfaces cleaned down to the satisfaction of the Engineers Representative.

Any detergent or other materials used in the cleaning down of face brickwork etc. shall be of such a nature that will not harm adjoining paint and other finishings in any way.

All pavings shall be thoroughly cleaned of after laying to remove all traces of mortar and other substances, covered up and protected from damage during the progress of the works and again cleaned off at completion.

29 DAMP-PROOF COURSE

The horizontal and vertical damp-proof course shall be of black polyethylene sheeting complying with SABS Specification 952 Type B having embossed surfaces, 0,38mm thick (375 microns) and manufactured in widths of less than 1 000mm.

The damp-proof course shall be the full thickness of walls above foundations, plus the width of floor plates where these occur, and shall be laid without longitudinal joints. At end joints, angles and intermediate junctions the sheeting shall be lapped for 150mm.

Where so required all laps in the damp-proof course shall be sealed over the whole area of laps as recommended by the Manufacturer. Care shall be taken not to tear or otherwise damage the sheeting.

Similar damp-proof course, 120mm wide × 250mm long, shall be laid on sleeper piers under the floor bearers.

Similar damp-proof course, but in unbroken lengths, shall be laid behind all window sills, sealed with an approved bituminous solution to the back of the sills and taken down within the thickness of the wall and under the first full course of external brickwork.

NB: No damp-proof course shall be laid directly below the mortar or other bedding material under window sills.

30 DAMP-PROOF MEMBRANE

The damp-proof membrane under surface beds shall, unless otherwise specified, be of green polyethylene sheeting complying with SABS Specification 952 Type C – plain surface – 0,25mm thick (250 microns) and manufactured in widths of 1 000mm and greater, all laid in the widest practical widths to minimise joints, turned up and

dressed to load bearing walls and, if applicable lapped with the damp-proof course in the walls. All joints shall be sealed with pressure sensitive tape applied over the leading edge of the joint.

NB: All cutting of plastic membranes shall be carried out using sharp instruments.

CEMENT PLASTER

All cement plasterwork shall comply with the requirements of SANS 2001-EM1 Specification for Construction Works – Cement Plaster.

This part of SANS 2001 covers the application, to masonry and concrete surfaces, of cement plaster which,

- a) in its fresh state, is workable, cohesive and has water-retention properties; and
- b) in its hardened state, is durable, has sufficient strength to hold paint, withstand local impact and abrasions, is free of unsightly cracking and adheres to substrate.

1 CEMENT

Cement, unless otherwise specified, shall comply with the requirements of SANS 50197-1 or SANS 50413-1.

NOTE1 Bags should be clearly marked with the strength grade, cement type and a certification mark, and should provide guidance for plaster as given in table 1.

NOTE 2 Caution should be exercised when class 42,5 R and 52,5 N cements are used in plaster, as the resultant plaster might be brittle.

Bags of cement shall be stacked in a waterproof, solidly constructed shed with a central door and a floor rendered damp-proof with a tarpaulin. The bags of cement shall be closely stacked (but not against walls) in order to reduce air circulation in such a manner that the cement is used in the order in which it was received, i.e. first in first out.

2 SAND

Sands shall, unless otherwise specified,

- a) comply with the requirements of SANS 1090 for plaster sands, or
- b) not contain any organic material (material produced by animal or plant activities) and be such that when 2,5kg of cement is mixed with 12,5kg sand, no more than 2,7 L of water is required to bring the mix to a plastering consistency

3 WATER

Water used shall be fit for drinking.

4 PLASTER MIXES

The mix proportions of the cement plaster shall be in accordance with table 1.

Table 1 – Mix proportions for common cements

1	2	3	4
Type	Common cement kg	Loose sand	
		L Max.	Number of standard wheelbarrows
External plaster	50	150	2,5
Internal plaster	50	200	3
A standard wheelbarrow for concrete that complies with SANS 795 has a capacity of between 60 L and 70 L			

No admixtures shall be added to the mixes to improve workability or to improve the properties of the finished plaster.

The workability of the plaster can be assessed and improved in the following manner:

- a) Place a small quantity of the mix (at plastering consistency) on a non-absorbent surface and form a flattened heap about 100mm high and 200mm in diameter. Place a plasterer's trowel on top of the heap and push the trowel downwards. A mix with adequate workability is one which permits the mix to squeeze out from under the trowel, and allows the trowel to be pushed to within a few millimetres of the underlying surface. An unworkable mix will "lock up" once the trowel has moved a few millimetres and prevent further downward movement of the trowel.
- b) The workability, cohesiveness and water retention of a mix may be improved by adding hydrated building lime to the mix.

5 MIXING OF PLASTER

Sand shall be securely measured by means of calibrated buckets or wheelbarrows. Cement shall only be measured by mass.

Cement plaster shall be mixed on a surface free of contaminants. Before the addition of any water, the dry ingredients shall be mixed until a uniform colour is achieved, thus ensuring a uniform distribution of the ingredients. Material that is not applied to walls within 2 h of mixing, shall be discarded.

6 SURFACE PREPARATION

The surface to which plaster is applied shall be free from oil, dirt and other substances that might affect the bond with the plaster.

Before the application of plaster, the substrate surface shall be tested for suction by spraying a small section of the wall with a fine spray. Should droplets of water run down the surface, a proprietary bonding agent, applied to the substrate in accordance

with the manufacturer's instructions or a spatterdash layer as described below shall be used to provide a key for the plaster. Should the substrate exhibit excessive suction, the whole wall shall be dampened and allowed to surface dry before the plaster is applied.

Substrates shall be checked for surface roughness. If smooth, the surface shall be either roughened or covered with a spatterdash layer that comprises of one part cement to one and a half parts of coarse sand, with enough water to provide a sluggish pourable consistency. The application of the spatterdash shall result in the entire substrate having a rough texture with nodules approximately 5mm high and no further than 50mm apart. The spatterdash shall be kept moist for at least 3 days after being applied to a substrate.

The substrate surface shall be checked for planeness before the application of the plaster. Where the substrate surface deviates by more than 10mm from a straight edge, the high spots shall either be removed by means of hacking or cutting, or the low areas shall be filled by the application of an undercoat plaster so that the plaster thickness can be achieved.

7 PLASTERING

Before any plastering commences, all chases shall be completed and all electrical and plumbing conduits, boxes, etc. shall be fixed in position.

Plaster coats shall be applied in such a manner that the thickness achieved throughout the plastered areas are within the following limits, provided, however, that the total thickness is not in excess of 22mm on masonry substrates, and 16mm on concrete substrates:

(a) Multicoat plaster:

First undercoat:	8mm to 16mm
------------------	-------------

Second undercoat (if any)	6mm to 10mm
---------------------------	-------------

Finishing coat:	5mm to 8mm
-----------------	------------

(b) Single-coat plaster: 10mm to 16mm

Plaster shall not be applied to walls when extreme moisture and temperature conditions might affect the finished work (Plaster is particularly vulnerable to drying winds).

Plastering shall be executed in one operation. Joints in plasterwork may only be provided at intersections between surfaces or at changes in direction. Plaster shall be firmly trowelled onto walls.

Plaster shall be returned into reveals and soffits of openings and all corners shall be true and straight with salient corners slightly rounded.

Plaster shall not be allowed to dry out too quickly and shall be damped by means of a light spray for a period of not less than 3 days after being applied to the substrate. Successive coats of plaster shall only be applied after the substrate coat has hardened

sufficiently to bear a new layer or to enable a new layer to adhere to it and limit drying shrinkage crazing and cracking.

Plaster shall be discontinuous across the line of the damp-proof course, a butt joint, a movement joint or at the interface between masonry and concrete elements. The plaster shall be cut back to the substrate with a steel trowel to form a V-joint. The V-joint formed at the intersection of masonry walls with precast concrete flooring soffits shall be filled with an appropriate, elasto-plastomeric sealant.

Joints formed in the walling shall be carried through the plaster. Such joints shall be formed by cutting the plaster approximately 30 minutes after it has been applied. The material within the joints shall be removed to permit the sealing of the joints with an appropriate silicone, polyurethane or polysulphide sealant.

STRUCTURAL STEELWORK

1 STEEL

All structural steelwork shall be of mild steel complying with the requirements of SANS 1431.

The dimensions and permissible deviations of all steel profiles shall comply with the requirements of the standards listed in Table 1.

Table 1 – Standards governing dimensional and permissible deviations

1	2
Profile	Applicable standard
Angles	EN 10056-2
Hollow sections cold-formed	SANS 657-1
Hollow sections hot-formed	EN 10210-2
I, IPE and H sections	EN 10034
Imperial channels	BS 4-1
Metric channels	DIN 1026-1
Plates, flats and bars	ASTM A 6/A 6Mb
Taper flange I-sections	EN 10024

All steel surfaces shall not be more heavily pitted or rusted than rust grade C of ISO 8501-1.

Surface defects in hot-rolled sections, plates and wide flats revealed during surface preparation, and which are not in accordance with the requirements of SANS 1431, shall be rectified to comply with such requirements.

Surface defects in hot-rolled hollow sections revealed during surface preparation and which are not in accordance with the requirements of EN 10210-1, shall be rectified to comply with such requirements.

2 STRUCTURAL STEELWORK

All structural steel shall be hot rolled mild steel. For inland areas, cold rolled steel sections may be used for purlins and side cladding rails only.

Construction methods and the design of steelwork shall be in accordance with the provisions contained in the latest edition of the National Building Regulations: SABS 0400.

Notwithstanding the requirements of the foregoing specifications; materials, workmanship, setting out, erection methods, riveting, bolting, welding, etc. shall be of the best quality, all to the satisfaction of the Engineers Representative.

2.1 Welding Consumables:

Consumables for use in metal arc welding shall comply with the appropriate standards listed in Table 2.

Table 2 – Approved parent metal-filler weld material combinations for steels acceptable for prequalified welding procedure standards.

1	2	3	4	5	6
Parent metal		Process	Filler weld metal		
Minimum yield strength Mpa	Minimum ultimate tensile strength Mpa		Electrode	Minimum yield strength Mpa	Minimum ultimate tensile strength Mpa
300	450	SMAW - (Shielded metal arc welding)	AWS A5.1 E70XX	365	480
		SAW - (Submerged arc welding)	AWS A5.17 F7XX - EXXX	400	480/680
		GMAW - (Gas metal arc welding)	AWS A5.18 ER70S - X	400	480
		FCAW - (Flux-cored arc welding)	AWS A5.20 E7XT - X	400	480
350 or 355	480	SMAW - (Shielded metal arc welding)	AWS A5.1 E7015, E7016 E7018, E7028	400	480
		SAW - (Submerged arc welding)	AWS A5.17 F7XX - EXXX	400	480
		GMAW - (Gas metal arc welding)	AWS A5.18 ER70S - X	400	480
		FCAW - (Flux-cored arc welding)	AWS A5.20 E7XT - X	400	480

2.2 Structural fasteners:

The mechanical properties of bolts, screws and nuts shall be in accordance with the following standards or as stated on the drawings:

a) Class 4.8, 8.8 and 10.9 bolts and screws: SANS 1700-5-1

b) Class 4 to 11 nuts: SANS 1700-2-2

Bolts, screws and nuts shall comply with the following standards:

- a) Bolts: SANS 1700-7-1 or SANS 1700-7-3
- b) Screws: SANS 1700-7-4 or SANS 1700-7-5
- c) Nuts: SANS 1700-14-2 or SANS 1700-14-3
- d) Hot-dip galvanized bolts: SANS 1700-14-9 or SANS 1700-14-11

2.3 Holding-down (HD) bolts:

Holding-down bolts shall be fabricated from round bar that complies with the requirements of SANS 1431 grade 300WA.

2.4 Washers:

Plain washers shall be in accordance with the provisions of SANS 1700-16-2. Through-hardened washers shall be in accordance with the provisions of SANS 1700-16-3.

4 PRESERVATION OF STRUCTURAL STEELWORK

All surfaces of structural steelwork are to be thoroughly cleaned of all rust, scale, oil or grease, all in accordance with SABS Code of Practice 064 and then protected against corrosion as follows:

a) Preparatory work:

Steel to be cleaned down in accordance with SABS Code of Practice 064.

All metal surface defects such as laminations and welding spatter shall be removed by grinding. Sharp edges, rags, burrs, etc. shall be rounded off before cleaning. After fabrication, but before erection, all steel surfaces to be scraped and wired brushed to Grade St 2 of Swedish Specification SIS 05 59 00-1967. Steelwork so prepared is not to be touched by bare hands – linen gloves are to be worn. Before priming, the surface shall be vacuum cleaned or dry brushed to remove all dust and debris.

b) Priming:

As soon as possible after surface preparation, the first two coats of red lead (SABS Specification 312, Type 2, Grade 1) or zinc phosphate (SABS Specification 1319) primer is to be applied. Each coat is to have a dry film thickness of at least 25 micron for red lead and 30 micron for zinc phosphate. A minimum of 24 hours between coats, or as recommended by the Manufacturer. Any damage to the primer during handling or erection is to be prepared by removing any possible rust etc. and patch repaired to make up the original film thickness. All traces of soluble salts and corrosive airborne contaminants shall be thoroughly removed with potable water and allowed to dry prior to finishing.

c) Finishing:

After erection, apply two coats of alkyd structural steel paint complying with SABS Specification 684, Type B, in accordance with the Manufacturer's recommendations. Each coat is to have a minimum dry film thickness of 30 microns.

d) General:

No surface preparation or painting is to be performed in adverse weather conditions.

Edges are to be stripe painted before application of paint over the whole surface. Back to back sections and areas rendered inaccessible for painting after erection are to receive the full paint system before erection or fixing.

5 INSPECTION

The Contractor shall notify the Engineers Representative and design engineer of the completion of the fabrication of steelwork at the Steel Fabricator's works to enable them to make inspections if they so desires.

The Structural Engineer appointed by the Contractor shall be responsible for the construction inspections during the manufacturing (Which shall include but not be limited to workmanship with regard to the material identification, handling of steel, cutting and shaping of steel elements, machining-, dressing- and holing of steel elements, assembly including welding, finishing of steel elements with the required paint cover) and erection of the portal frame structure including the concrete footings, steel structure, and sheet covering of the roof and shall provide the Engineers Representative with a certificate of compliance to the specifications at the completion of the structure.

METALWORK

1 STEEL

All structural steelwork shall be of mild steel complying with the requirements of SABS Code of Practice 0162 for Structural Steel in General Building Construction.

2 PRESERVATION OF STEELWORK

All surfaces of structural steelwork are to be thoroughly cleaned of all rust, scale, oil or grease, all in accordance with SABS Code of Practice 064 and then protected against corrosion as follows:

a) Preparatory work:

Steel to be cleaned down in accordance with SABS Code of Practice 064.

All metal surface defects such as laminations and welding spatter shall be removed by grinding. Sharp edges, rags, burrs, etc. shall be rounded off before cleaning. After fabrication, but before erection, all steel surfaces to be scraped and wired brushed to Grade St 2 of Swedish Specification SIS 05 59

00-1967. Steelwork so prepared is not to be touched by bare hands – linen gloves are to be worn. Before priming, the surface shall be vacuum cleaned or dry brushed to remove all dust and debris.

b) Priming:

As soon as possible after surface preparation, the first two coats of red lead (SABS Specification 312, Type 2, Grade 1) or zinc phosphate (SABS Specification 1319) primer is to be applied. Each coat is to have a dry film thickness of at least 25 micron for red lead and 30 micron for zinc phosphate. A minimum of 24 hours between coats, or as recommended by the Manufacturer. Any damage to the primer during handling or erection is to be prepared by removing any possible rust etc. and patch repaired to make up the original film thickness. All traces of soluble salts and corrosive airborne contaminants shall be thoroughly removed with potable water and allowed to dry prior to finishing.

c) Finishing:

After erection, apply two coats of alkyd structural steel paint complying with SABS Specification 684, Type B, in accordance with the Manufacturer's recommendations. Each coat is to have a minimum dry film thickness of 30 microns.

d) General:

No surface preparation or painting is to be performed in adverse weather conditions.

Edges are to be stripe painted before application of paint over the whole surface. Back to back sections and areas rendered inaccessible for painting after erection are to receive the full paint system before erection or fixing.

3 MANUFACTURED STEELWORK: GENERAL:

a) Welded joints:

Welding is to be done electrically in the most up to date manner by skilled workmen and cleaned off on completion.

All welding is to be carried out using welding rods of the same chemical composition as the tubes, rods, bars, etc. to be welded. All exposed welds are to be finished off clean and smooth.

Welding to all exposed edges is to be continuous fillet welding unless otherwise described.

b) Protection:

No scaffolding shall be allowed to rest on or be fixed to steel windows, doors, frames, etc. in any way.

4 PRESSED STEEL DOOR FRAMES

Pressed steel door frames shall be of welded “one piece” construction, all in accordance with SABS Specification 1129.

5 STEEL WINDOWS

a) General requirements:

Stock residential and industrial type steel windows shall comply with the requirements of SABS Specification 727.

Suitable weather bars shall be provided to bottom of opening in and vertically pivot hung ventilators and also to the bottom of all opening out ventilators where they occur above other ventilators and elsewhere as may be required to render the opening sections watertight.

Windows and components, shall before leaving the Manufacturer's workplace, be cleaned by acid pickling, rinsing and drying all as laid down in SABS Code of Practice 064, to remove all scale, rust, grease, oil and foreign matter and then be primed with red oxide zinc chromate primer complying with the requirements of SABS Specification 909, applied by dipping or by means of a spray gun.

Windows shall be of “one piece” construction.

Windows shall be fitted with brass handles, stays, catches and other fittings as later described having a polished finish. The fittings shall be fixed in such a way as to be removable after the windows have been glazed.

After the windows have been built in, but before being glazed, they shall be overhauled, adjusted as necessary and left in good order.

b) Construction:

The various types of windows shall be constructed as follows:

Stock residential type windows:

Stock residential type windows shall be of the types shown on drawings, constructed of standard 25mm mild steel sections with metal not less than 3mm thick.

Side hung ventilators:

Each ventilator shall be hung on steel hinges having brass pins complete with casement fastener and sliding stay.

Top hung ventilators:

Each ventilator shall be hung on hinges as above complete with combined fanlight stay and fastener, size 200mm for one pane high ventilators and size 250mm for two pane high ventilators.

6 BURGLAR BARS TO STEEL WINDOWS

Where windows are fitted with burglar bars, these are to be of standard pattern welded at each intersection, flattened and welded to steel window frame to opening sections only

7 GAUZE SCREENS TO WINDOWS

Gauze screens to windows shall be constructed with pressed steel or extruded aluminium frames and filled in with approved fibreglass gauze having 1,5 ×1,5 meshes.

The screens to outward opening ventilators shall be attached to the inside of windows with studs or clips in such a way as to be readily removable, and shall have sliding portions for access to window fasteners etc. screens to top hung ventilators may be hinged for access to fasteners.

Frames to screens of inward opening windows shall be of thicker metal than those to outward opening windows or be of rolled mild steel sections and fixed on outside face of windows with screws and nuts or other approved means.

The screens are to be spray painted with enamel of approved colour and baked on or with natural anodised surfaces to aluminium screens.

8 STEEL SHELVING TO MARKET STALLS

General Requirements:

The steel shelving units in the market stalls shall be manufactured from the following materials:

Steel Posts:	38 × 38 × 1,6 mm thick square tubing to the lengths as indicated on the drawings.
Base plates:	100 × 40 × 4 mm thick steel plate with two holes of 10 mm diameter drilled for the anchor bolts. Baseplate to be welded to steel posts.
Horizontal bearers:	38 × 38 × 1.6 mm square tubing to the lengths as indicated on the drawings.
Mesh:	25x25 x2.5 mm thick weldmesh
Gates:	38x38 x1.6 mm thick rectangular tubing covered with expanded metal.

TIMBER ROOF BEAMS & COLUMNS

All timber roof beams shall comply with the requirements of SANS 2001-CT2 Specification for Construction Works – Structural Timberwork (Roofing).

Timber poles shall comply with the requirements of SANS 457-2 or SANS 457-3, as relevant.

Laths and battens shall comply with the requirements of SANS 1288, 1707-2 (eucalyptus), or SANS 1783-4 (pine), as relevant.
All timber shall be preservative treated in accordance with the requirements of SANS 10005.

Poles for use as structural elements shall have a diameter of at least 150 mm measured at thin ends.

Upright columns are to be spaced as per the drawings and shall not be less than 200 mm (top diameter) as specified by the Structural Engineer.

All bolted joints to have 20mm diameter bolts or threaded rod cut to size with galvanised steel washers

This part of SANS 2001 covers the construction of timber roof assemblies in buildings. It includes:

- a) the manufacture of bolted trusses that are designed in accordance with the requirements of SANS 10400,
- b) the erection of prefabricated timber trusses,
- c) the erection of rafters and purlin rafters,
- d) the fixing of purlins and battens, and
- e) the fixing of bracing to roofing members to support ceilings that comprise gypsum plasterboard, fibre-cement board or similar boards.

1 MATERIALS

1.1 Prefabricated roof trusses:

Prefabricated trusses shall be designed and manufactured in accordance with the relevant requirements of SANS 10400 and SANS 10243 and be constructed of South African pine complying with the requirements of SABS Specification 563 or 1245 and shall be of Grade 4 or better all marked as laid down in the relevant specifications.

1.2 Softwood roofing timber:

All timber shall be ordered in the dimensions in which it will be used and shall not be sawn into smaller cross-sectional sizes.

The moisture content of the timber shall not exceed 17 %.

1.3 Roofing poles:

Roofing poles shall comply with the requirements of either SANS 457-2 (softwood) or SANS 457-3 (hardwood) and shall be of the diameter shown in the construction drawings.

All roofing poles shall be treated in accordance with the requirements of SANS 10005.

1.4 Battens and brandering:

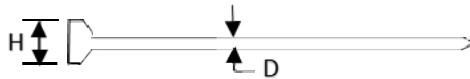
Battens and brandering shall comply with the requirements of either SANS 1783-4 or SANS 1707.

1.5 Connectors:

Nails:

Nails shall comply with the requirements of SANS 820 and shall have the dimensions as given in tables 1 and 2, as appropriate.

Table 1 – Ordinary Nails



Dimensions in millimetres

1	2	3
Length	D	H
63	3,72 to 3,25	5,9 to 7,0
75	3,05 to 3,65	6,3 to 7,7
90	3,90 to 4,10	7,8 to 9,0
100	3,90 to 5,15	7,8 to 10,7
150	5,45 to 7,25	10,4 to 15,2
175	6,95 to 7,25	13,2 to 15,2
200	6,95 to 7,25	13,2 to 15,2

Table 2 – Clout nails

1	2	3
Length	D	H
32 and greater	2,72 to 2,88	8,2 to 9,1

Nuts, bolts and threaded rods:

Nuts shall comply with the requirements of SANS 1700-14-1, SANS 1700-14-2, SANS 1700- 14-3 or SANS 1700-14-4.

Bolts shall comply with the requirements of SANS 1700-7-1, SANS 1700-7-2 or SANS 1700- 7-3, and shall have a shank that is 20 mm longer than the total thickness of the timber which is to be bolted together.

Washers:

Washers shall have the dimensions given in table 3.

Table 3 – Washer sizes (Dimensions in millimetres)

1	2	3
Bolt diameter	Washer size	
	Square	Round
Up to 8	25 × 25 × 2,4	25 × 2,4
Up to 12	36 × 36 × 6	36 × 3,6
Up to 20	60 × 60 × 6	60 × 6
Exceeding 20	75 × 75 × 6	75 × 6

Nail plates:

Nail plates, toothed connectors, split rings and shear plates shall comply with the requirements of SANS 10243.

Hangers and hurricane clips:

Metal punched plate hangers and hurricane clips shall have a Zinc galvanized coating of 275 g/m², or have an equivalent corrosion resistance, and shall bear a mark which readily identifies the manufacturer or supplier.

Hangers and hurricane clips shall be tested by an accredited testing laboratory to demonstrate that, when bolted or nailed through predrilled or pre-punched holes into structural softwood (pine) members, they can transfer, across the joint, a permissible load of not less than the following without slippage occurring:

(a) hurricane clips: 1,2 kN

(b) hangers: 4,0 kN

Masonry anchors:

Metal masonry anchors shall be of the expanding type, be corrosion resistant and have a diameter and length of not less than 10 mm and 45 mm, respectively, and shall be installed in accordance with the manufacturer's instructions.

2 DRAWINGS

Drawings of the roof assembly shall be provided showing all member sizes and connection details in sufficient detail to enable the roof to be constructed and, where required, permanently braced.

3 JOINTING OF TIMBER MEMBERS

All joints shall be close-fitting and members shall not have to be forced into position as a result of warp (bow, twist, spring or cup). Trusses shall be assembled in plane, and in such a way as to avoid damage to any of the members.

3.1 Bolted and nailed connections:

Nails shall be driven in at right angles to the grain of the timber and to such a depth that the heads are flush with the timber surface. In hardwood, nails shall be driven into predrilled holes that have a diameter of between 0,5 and 0,8 times the nail diameter.

Hurricane clips and hangers shall either be nailed in each hole with 32 mm long wire clout nails, or bolted with a single bolt that has a diameter of 8 mm for hurricane clips or 12 mm for hangers.

Holes drilled through timbers to accommodate bolts shall have a diameter that exceeds the bolt diameter by more than 1 mm. holes shall be drilled at right angles to the joints. Where timber-to-timber connections are to be made, the components shall be clamped together before drilling.

All bolts used to connect structural members shall be installed with washers under both the head and the nut. Nuts shall be tightened so that the washers just bite into the surface of the timber. Bolts shall be of sufficient length so as to allow at least one full thread to project from the nut when tightened.

In pole members, bolts shall not be installed within one pole diameter of a cracked or split end. Nails shall not be placed in cracks in pole members.

Nuts shall be so tightened that the members fit closely. If necessary, nails shall be tightened again after the timber has reached its equilibrium moisture content.

Bolts and nails in members other than poles shall not be located closer to the edge of members than 50 mm for bolts and 40 mm for nails. Bolts and nails shall be located along the centre line of the poles. Nails and bolts shall be spaced at least 20 mm and 50 mm, respectively, away from each other.

3.2 Nail-plate connectors:

Nail-plate connectors shall be pressed into timber using either a mechanical pressing device or a carpenter's hammer, depending upon their design.

When making nail-plated trusses, timber that has defects, such as wane and dead knots in the connector cplate contact area, shall not be used unless the size of the connector plate is increased by 25 mm in both length and the breadth of the original nail-plate dimensions to compensate for the nails that have become ineffective at that defect in the timber.

The average gap between any two adjacent members in nail-plated connections shall not exceed 1,5 mm. the difference in thickness between adjacent members shall not exceed 1,0 mm.

Nail-plate connectors shall be evenly embedded to ensure full penetration of all teeth without damage to the timber or fastener.

Nail-plate connectors, when fixed, shall not project beyond the outer edge of

the members which they join together. The lower edge of any nail-plate connector located over a point of support to a trussed rafter shall be at least 5 mm away from the lower edge of the member in contact with the support.

4 INSTALLATION OF MASONRY ANCHORS

Masonry anchors shall be installed in accordance with the manufacturer's instructions.

5 RESHAPING AND RESAWING OF MEMBERS

When treated softwood members are reshaped or resawn, the end grain of the exposed ends shall be painted with a suitable timber preservative.

6 INSTALLATION OF ROOF TRUSSES, RAFTERS AND PURLIN BEAMS

Trusses, rafters and purlin beams shall be supported on:

- a) wall plates, in accordance with the requirements of table 4, or similar flat bearing surface which are levelled and positioned so as to ensure that the ends of such members are vertically aligned, or
- b) hangers, twice bolted to walls with masonry anchors.

Where ends are not built into walls or supported by hangers, the ends shall be skew nailed into such bearings on each side by means of two 100 mm long ordinary wire nails. Hangers shall either be nailed in each hole with 32 mm long clout wire nails or be bolted with a single 12 mm diameter bolt.

Site alterations to trusses or rafters may only be made if such alterations do not compromise their design intent or performance in use (or both).

All rafters and roof trusses shall be tied down to the supporting walls by means of the roof anchorages which are built into the supporting walls or columns. Galvanised steel straps shall be nailed to the roofing members by means of not less than eight clout nails. Galvanised steel wires shall be tied together.

Table 4 – Wall plate sizes

1	2
Truss support span S (m)	Cross section of plate (mm)
$S \leq 10$	38×76
$10 < S \leq 15$	38×114
$S > 15$	38×152

6.1 Erection of trusses:

Preparatory work:

Before trusses are erected, the area to receive trusses shall be checked to ensure that the wall plates are level and that the holding-down wires or the hoop-iron strap

has been built into the supporting structure at the correct centres.

The positions of the trusses on the wall plates shall be marked in accordance with the drawings and the specified truss centres. Trusses adjacent to a gable shall be positioned between 50 mm and 100 mm from the inside of the gable wall.

Lifting of trusses:

Where possible, trusses shall be handled and lifted in an upright or vertical position. If the trusses are to be moved horizontally, suitable intermediate support shall be provided to prevent lateral distortion of the trusses, which can lead to possible damage.

When trusses are lifted by hand, care shall be taken to prevent excessive lateral bending when sliding them over walls and when tipping them upright on the walls. When using rigging, care shall be taken not to damage the timber and connectors at the pick-up points.

Multiple trusses that comprise identical trusses joined side by side should preferably be assembled on the ground to form a complete unit. Where a multiple truss is too heavy to lift or handle, it may be assembled in situ.

Once trusses have been lifted into position, they shall be checked for any damages that might have occurred during the lifting and handling operations. A damaged truss shall be removed or repaired so that the truss as erected does not compromise its design intent or performance in use.

Temporary bracing:

The first truss shall be lifted into position onto the wall plates and temporarily braced to the ground or wall plate with grade 5 timber that has a minimum size of 78 × 38 mm, or supported against the gable end so that the truss is both straight and vertically plumb. Thereafter, the next few trusses may be lifted into position at their correct spacing and fixed in position with temporary runners and bracing.

The erected trusses shall be lined up, levelled, plumbed and straightened before the installation of the permanent web and rafter bracing. Thereafter, the remainder of the trusses may be erected, ensuring that temporary bracing and runners are fixed as the erection of trusses proceeds.

Permanent bracing:

Upon completion, all trusses shall be checked for straightness, plumbness and that they are level, and shall be adjusted, as necessary, on the wall plate. The remainder of permanent bracing shall be fixed.

6.2 Installation of battens and purlins:

Battens and purlins shall be continuous over at least three rafters (i.e. two rafter spacings) and shall be fixed to every rafter that they cross. Battens of size 38 mm × 38 mm shall be nailed to the rafters with 75 mm wire nails, and battens of size 38 mm × 50 mm shall be set on edge with 90 mm wire nails. Purlins shall be fixed to rafters with hurricane clips. Care shall be taken not to split any of the members during

the nailing process.

The ends of battens and purlins shall be sawn square and butt-jointed centrally over the rafter member so as to provide suitable bearing and fixing. Joints in battens shall be arranged so that not more than one batten in any three is joined on any one rafter.

Purlins shall be spliced such that the splices shall be located in close proximity to rafters and shall be staggered so that there is not more than one splice in three consecutive purlins. Purlins and rafter splices shall not be located within 1,5 m from the gable ends.

7 CEILING ASSEMBLY

Branding of size 38 mm × 38 mm required to support gypsum plasterboard, fibre-cement board or similar board shall be securely spiked to the supporting timbers with 75 mm wire nails at centres that do not exceed 450 mm. cross branding shall be cut in between the longitudinal branding and skew nailed to the same, using 75 mm wire nails at centres that do not exceed 900 mm.

STEEL ROOF COVERINGS

1 GENERAL

Profiled metal sheet roof coverings shall comply with the following minimum requirements:

- a) Galvanised metal roof sheets shall have a minimum thickness of 0,8mm for roofs of 4° - 14° pitch inclusive and 0,6mm for roof pitches of 15° and upwards.
- b) Roof trusses shall be spaced at not exceeding 1,2 m centres, except where the pitch is 12° or less, when the spacing may not exceed 1 m centres.
- c) Purlins shall be spaced at not exceeding 1,0 m centres for roof pitches of 4° to 30° inclusive and at 1,2 m maximum for roofs having pitches of 31° and greater.
- d) Unless otherwise specified in this section, profiled metal roofing sheets shall be used and fixed all in accordance with SABS Code of Practice 0237.
- e) Roof sheets shall have galvanised coating of Z275 quality.
- f) All necessary cutting of sheets shall be properly performed. Cut edges at sides of valleys and where otherwise exposed shall be perfectly straight.
- g) Drive screws will be permitted.
- h) The Contractor is to submit a certificate, signed by the Merchant, stating that the galvanised roof covering supplied complies with the required thickness specified.
- i) Roof sheets shall be single lengths to each slope of the roof.

2 PROFILES

- a) Box Rib (IBR) roofing sheets shall be used with ribs of 36mm deep and 172mm pitches.
- b) All roof sheets shall be Zinc Aluminium Coated to colour approved by the Professional Team

3 INSULATION

Min 50mm ISOVER mineral wool fibres as supplied by Saint Gobain Thermal Insulation or similar. Laid taut over purlins and fixed concurrent with roof covering; overlapped longitudinally by 100mm; on and including galvanised straining wire spaced at 383mm centres; all in strict accordance with the manufacturer's specifications.

4 RIDGING (METAL)

Galvanised iron ridging for ridges of IBR roof shall be 0,60mm thick (after galvanising), coated with zinc of grade Z275.

The ridging shall be 450mm girth with roll top and bent down to edges, lapped 225mm at the heading joints, cut, properly lapped and fitted at intersections of ridge and provided with serrated closers.

Ridging shall be fixed with hook bolts to steel purlins using washers under heads and nuts and spaced at not exceeding 300mm centres.

7 FLASHINGS

Flashings, where butting against vertical wall or other surfaces, shall be of galvanised steel iron, turned up for at least 100 mm against vertical surfaces and close dressed for not less than 200 mm on top of the roofing iron.

8 MAKING GOOD

Roofs, gutters, flashings, etc. shall be carefully examined at completion of the work, any holes or other defects soldered up or otherwise made good and the whole left perfect and watertight.

JOINERY

1 GENERAL

All joinery work shall be put in hand immediately the order has been given to commence work; or after receipt of details, where such are to be supplied, and shall be wedged or glued up until just before fixing in the building. Timber stored on the site shall be properly stacked on delivery and adequately protected against extreme weather and exposure to the sun, until required for use.

a) Hardwood:

Hardwood for joinery shall comply with the requirements of SABS Specification 1099, and shall be of Clear Grade and free of sapwood.

b) Softwood:

Softwood for joinery shall comply with the requirements of SABS Specification 1359 and shall be of Clear Grade.

2 JOINERY

All exposed softwood timber in joinery which is not to be painted shall be free from large, loose or dead knots, knot holes, checks, splints, wane or other defects, and in joinery which is to be painted shall be free from all defects other than those which can be filled or otherwise made good in such a way as will not impair the paint finish. All exposed hardwood joinery timber shall be free from all knots, knot holes, checks, splints or other defects.

Purpose made joinery shall be manufactured strictly in accordance with detail drawings where these are provided.

Stock joinery shall be of the best quality.

Joinery shall not be primed until it has been inspected and approved.

Skirtings shall be in long lengths, close fitted, mitred or scribed at angles and securely fixed with hardened nails driven into the brickwork at not more than 700 mm apart.

3 WOODEN DOORS

All doors shall be framed and ledged batten wooden doors for use as yard doors where it will be exposed to the elements and have a paint finish and shall comply with the requirements of SABS Specification 1099, shall be of Clear Grade Hardwood 44mm thick and free of sapwood and bear the "MARK".

The Contractor shall provide the Engineers Representative with the full constructional detail of the doors that he proposes to use for approval.

Doors shall be hung on pressed steel door frames.

4 HANGING OF DOORS

All doors are to be hung in such a way that the completed door functions smoothly and perfectly.

The clearance gap between door and frame after hanging shall not exceed 2mm (+0mm – 1mm) at sides and head of door. The gap between meeting stiles of doors hung folding shall also comply with the foregoing.

The clearance gap between foot of door and floor may be increased to 6mm (+0mm – 3mm) to accommodate any minor unevenness in the floor surface.

Any door frame found to be distorted or out of plumb shall be reported to the Engineers Representative before any door is hung to such a frame.

When hung, no strain upon the hinges shall be detectable due to hinge binding.

Depending upon the hinges supplied with pressed steel door frames the hanging edge of door may be angled back slightly from the hinge face of door to obviate such binding.

Any door that is too wide or tall to fit the door frame shall be reduced in size by removing material equally from each edge – removing material from one edge only to obtain a fit is unacceptable.

Mortice locks are to be snugly fitted into the mortice with face plate flush with edge of door.

Lever handle door furniture is to be fixed with the backplate parallel to the edge of the door. Ensure that the handles of lever type function smoothly and do not bind.

Screws used for fixing of hinges shall be screwed into holes of suitable sizes.

In addition, prior to the final hanging of any unprotected external door, where such door opens to the outside of the building, both top and bottom concealed edges shall be sealed with not less than two coats of the finish specified for the exposed surfaces of the door. Where the door opens to the inside of the building only the bottom edge of the door shall be so finished.

5 PAINTING OF DOORS

All doors shall be painted with one coat oil based wood primer and two coats Polyurethane Enamel paint.

IRONMONGERY

1 IRONMONGERY

All ironmongery shall be of the best quality and shall be approved prior to fixing.

Articles shall be fixed with matching screws.

No keys shall pass a second lock unless master keyed.

Mortice locks shall be DORMA ST 9600 Series II heavy-duty mortice locks.

Door levers shall be DORMA Coastal Series 5300-30 Nosa door levers

2 FIXING

Ironmongery is to be taken as fixed to wood unless otherwise described.

Items described as “plugged” shall be deemed to include screwing to fibre, plastic or metal plugs.

All necessary preparation of pressed steel door frames for the fixing of ironmongery to the frames has been included with the pressed steel door frames.

All screws, nails, bolts, etc. required for completion of the work shall be supplied by the Contractor.

FLOOR AND WALL TILING

1 GENERAL

The floors and skirtings shall be protected from damage during the progress of any remaining work and at completion shall be cleaned and handed over in a perfect condition. The work shall be carried out by skilled workmen experienced in laying these type of floor finishes.

2 TILE CEMENT

All tile cement shall be of an approved mixture for ceramic tiles.

3 CERAMIC TILES

Finish floors and walls as shown on the drawings with Grade 1 acid resisting ceramic tiles, 8mm thick and of Load Group 4, but of sizes available in the market and of approved colour, all bedded to a true and even surface in ceramic tile cement mortar and with joints not exceeding 8mm wide. After the tiles have been allowed to set for a period of not less than 24 hours, the joints shall be grouted in with an approved epoxy compound.

Form ceramic tile skirtings, 100mm high, covered at junction with floor and rounded on top edge with aluminium strip.

4 GLAZED WALL TILING

Glazed tiles for wall tiling shall comply with the requirements of SABS Specification 22 and shall be white, size 152 × 152 mm and 6,5 mm or 5,0 mm thick.

The tiles shall be fixed in accordance with SABS Code of Practice 0107 with horizontal and vertical joints continuous, and shall have all joints rubbed in solid with neat white cement grout. Tiles shall be well soaked in water before fixing with cement mortar and thoroughly cleaned off after fixing. Walls shall be well wetted before tiling is commenced.

Tiling shall be returned into reveals of openings and on to window sills, and shall be butted at internal angles and provided with mitred joints to external angles. All necessary cutting to tiles shall be properly performed.

INSTALLATION OF GLAZING IN WINDOWS

1 MATERIALS

1.1 GLASS

Glass in panes not exceeding 0,65m² of surface area shall be clear float glass of "GG" quality (Glazing quality) and of 3mm thickness.

Glass in panes exceeding 0,65m² and up to 1,5m² of surface area shall be clear float glass of "GG" quality (Glazing quality), but of 4mm thickness.

Glass in thermal chimneys shall be 6.35mm intruderprufe

1.2 GENERAL PURPOSE PUTTY

Putty shall comply with the requirements of SANS 680

1.3 SETTING BLOCKS

Setting blocks shall be rot-proof, non-absorbent and capable of maintaining the requisite edge clearance without presenting local areas of stress to the glass.

2 PREPARATION

Before commencing glazing operations, it shall be confirmed that:

- a) the fixing of the frame has been completed,
- b) protective coatings or tapes have been removed from the frame,
- c) rebates are free from obstructions and debris, all surfaces which are to come into contact with the bedding material have been primed or sealed.

The surfaces, which will come into contact with glazing materials, shall be cleaned and dried.

All metal frames shall, before glazing, be painted with an anti-corrosive primer.

Where pane areas exceed 0,3m², the glass shall be placed on one or two setting blocks along the bottom edge. Setting blocks shall be between 25mm and 75mm long, except at the bottom bar of vertically pivoted windows where a single block of length at least 150mm is sufficient.

Glass sheets shall be checked for edge clearances which shall be not less than

- a) 3mm for glass of length or width up to 2m, and
- b) 5mm for glass of length or width over 2m.

Distance pieces shall be placed on opposite sides of the sheet at centres that do not exceed 300mm, within 50mm of corners and at bead fixing points.

3 GLAZING WITH PUTTY

Sufficient bedding putty shall be applied to the rebate to ensure that when the glazing material is pressed into position, the putty is squeezed out around the entire perimeter of the glazing rebate.

The glass shall be positioned that an even bearing is obtained and edge clearances are equal all the way round the pane. The pane shall thereafter be pressed and bedded into the bedding putty until it is at least 3mm from the back of the surface of the rebate.

The front putty shall thereafter be applied and finished off to a splayed finish. The back putty shall be trimmed and finished off to a smooth finish.

Upon completion the putty shall be brushed lightly with a small brush to seal the edges against the glass and the surround.

4 MIRRORS

Mirrors shall comply with the requirements of SABS Specification 1236, Class A. unframed mirrors shall have polished edges.

PLUMBING AND DRAINAGE

1 REGISTERED PLUMBERS AND DRAINLAYERS

Only registered plumbers and drainlayers shall be employed on any plumbing and drainage work.

2 EXCAVATION

Excavations shall be deemed to be in “earth” unless otherwise described.

2.1 METHOD OF EXCAVATION

In order to produce material suitable for bedding, selective methods of excavation may be used, or the excavation material may be screened, washed or otherwise treated.

Excavated material that are material of granular, non-cohesive nature that is free-draining, has maximum aggregate size of 20mm and has a compaction fraction that does not exceed 0,3 shall not be wastefully disposed of. Positive steps shall be taken to avoid burying or contaminating materials that would otherwise be suitable for use as

- a) selected fill for the blanket or selected granular material for the cradle, unless other materials are specified, or
- b) topsoil.

When otherwise suitable material from a trench is contaminated, any shortfall may be made up by obtaining suitable material from other excavations on the site, or by opening up borrow pits, or by importing from commercial or other sources.

2.2 SIZE OF EXCAVATION

Trenches shall be excavated in suitable lengths, to widths of minimum 600mm with side allowances of 300mm. The sides of each trench from the bottom up shall be as vertical as possible for at least the height of the bedding.

2.3 MINIMUM BASE WIDTH

The widths of excavations shall be sufficient to allow the proper laying, bedding and

backfilling of pipelines.

Unless otherwise specified the base width of the trench shall not be less than 600mm.

Where two or more pipes are to be placed in one trench, the base width of the trench shall be adjusted to allow a space of 100mm between each pipe.

2.4 MAXIMUM BASE WIDTH

The maximum base width shall not exceed the minimum base width specified in 2.3 above by more than 50%.

2.5 TRENCH BOTTOM

The depth of the trench shall be as specified on the drawings and the trimming and grading of the bottom of the trench shall be such that the pipe can be uniformly supported over its full length, free at the joints, and at the correct grades and levels.

Material that is unsuitable as the bottom of a trench shall be excavated and the trench shall be filled with suitable material and compacted to 90% modified AASHTO dry density.

The bottom of the trenches shall be sufficiently straight (or true to alignment in the case of curved pipelines) to enable the pipelines to be laid without reduction of the side allowances.

The trench bottom shall be kept sufficiently free from water to enable the bedding to be placed.

3 BEDDING FOR PIPES

Flexible pipes shall be supported on a cradle of continuous bed of selected granular material of compacted depth of at least 100mm and that covers the full width of the trench. The granular material shall be compacted to 90% modified AASHTO density. Additional selected granular material shall then be placed carefully and evenly between the sides of the trench and the pipeline, in layers of uncompacted thickness of approximately 100mm. Each layer shall be compacted individually to 90% modified AASHTO density until a compacted layer of minimum 100mm thick are obtained above the pipeline. Particular care shall be exercised to prevent damage, deflection, or displacement of the pipeline.

After completion of the cradle, a 300mm thick selected fill blanket shall be placed carefully in layers of 100mm uncompacted thickness over the full width of the trench and shall be compacted to 90% modified AASHTO density up to the height of at least 300mm above the crown of the pipeline. Special care shall be taken when compacting over the pipeline

4 BACKFILLING

4.1 GENERAL

Backfilling of trenches shall commence after the pipe has been laid and firmly bedded

in the specified cradle and the blanket has been placed and suitably compacted.

Backfilling shall be carried out over the full extent of the actual trench excavation and to original ground level. No filling shall be placed in water.

4.2 MATERIAL FOR BACKFILLING

Material for backfilling above the bedding (cradle and blanket) shall be obtained from trench excavations. Hard material and rock material shall not be incorporated in the backfill unless suitably mixed with other backfill material.

4.3 DISPOSAL OF SOFT EXCAVATION MATERIAL

Excavation material from the trench, which is unsuitable or has become surplus, shall be disposed of along the trench servitude.

4.4 DISPOSAL OF HARD MATERIAL AND ROCK MATERIAL

Where the quantity of hard material or rock material exceeds that which can be or is required to be incorporated in the backfill, the surplus shall be disposed of as specified in 4.3 above or removed to sites specified by the Engineers Representative.

4.5 COMPLETION OF BACKFILLING

Backfilling of trenches shall be completed expeditiously and in reasonable lengths.

5 REINSTATEMENT OF INFRASTRUCTURE

In all cases where existing infrastructure has been removed or damaged during the excavations or laying of pipelines, shall be reinstated to its original condition and to the satisfaction of the Engineers Representative.

6 RAINWATER DISPOSAL AND PROTECTION AGAINST LIGHTNING

In all cases where existing infrastructure has been removed or damaged during the excavations or laying of pipelines, shall be reinstated to its original condition and to the satisfaction of the Engineers Representative.

6.1 EAVES GUTTERS (UPVC)

UPVC eaves gutters shall be 125mm × 75mm white UV resistant PVC gutters according to SANS Specifications 967.

Gutters shall be laid to proper falls and be provided with angles, stopped ends and outlet nozzles as required.

Gutters shall be fixed on UPVC brackets and each twice screwed to steel purlin.

Brackets shall be spaced at not exceeding 1m centres.

6.2 RAIN-WATER PIPES (UPVC)

Rain-water pipes shall be 75 × 75mm UPVC downpipes. Pipes shall be provided with offsets, elbows and shoes as required.

The pipes shall be fixed 25mm clear of finished wall face on holderbats to walls, spaced at not exceeding 1,5m apart.

6.3 EAVES GUTTERS (METAL)

Sheet iron gutters shall be of galvanised sheet iron of thickness specified in the table hereunder, have beaded edges and with all joints riveted and soldered or bedded with an approved epoxy sealant.

Gutters shall be laid to proper falls and be provided with angles, stopped ends and outlet nozzles as required. Angles shall be strengthened with 50 mm wide strips of 0,60 mm thick galvanised sheet iron soldered over the internal mitres inside the gutters.

Gutters shall be fixed on galvanised mild steel brackets of size specified in the table hereunder, bent to shape of gutters with front end taken up to underside of beaded edge of gutter and each twice screwed to roof timbers. Gutters shall be bolted to brackets at front with and including 6 mm diameter galvanised gutter bolts, one to each bracket, positioned close to underside of beaded edge of gutter.

Brackets shall be spaced at not exceeding 1 m centres.

The thickness of sheet iron and size of metal from which brackets are made for the various sizes of gutters shall be in accordance with the following table:

Gutter shape	Gutter size not Exceeding (mm)	Sheet thickness (mm)	Size of metal brackets (mm)
Half round	150	0,60	32 × 3,5
Square	125 × 125	0,60	32 × 3,5
Square	175 × 175	0,80	40 × 5
Square	225 × 225	1,00	40 × 6
Rectangular	Width 150 Depth 100	0,60	32 × 3,5
Rectangular	Width 200 Depth 150	0,80	40 × 5
Rectangular	Width 250 Depth 200	1,00	40 × 6

The 5 mm and 6 mm thick brackets shall be hot dip galvanised after fabrication.

6.4 RAIN-WATER PIPES (METAL)

Sheet iron rain-water pipes shall be of 0,60 mm thick galvanised sheet iron, seamed at back and jointed with slip joints neatly soldered. Pipes shall be provided with offsets, elbows and shoes as required.

The pipes shall be fixed 25 mm clear of finished wall face on galvanised mild steel rain-water pipe brackets spaced at not exceeding 2,4 m apart, and having tails built into walls in 3:1 cement mortar.

6.4 PROTECTION AGAINST LIGHTNING

The lightning protection shall be in accordance with the latest revision of SABS Code of Practice 03 and must comply with the performance requirements laid down therein.

Ir terminals and down-conductors:

All conductors must be of electrical conductor grade aluminium alloy.

Earthing electrodes:

Earthing electrodes must consist of either extensible copper clad steel rods not less than 12mm diameter driven into the ground or of 50mm² bare copper conductor buried in a trench or a combination thereof. Where extensible earthing rods are used these are to be manufactured from copper clad steel and have a molecular bond between the two metals to prevent the moisture ingress.

Joints:

Where it is necessary to join lengths of circular section conductor, this must be done by crimping and in the case of flat conductor by either double riveting using aluminium rivets, two bolts of at least 6mm diameter and nuts.

Bonds:

Where it is necessary to bond the aluminium conductor to any other metallic surface, this must be done by bolting or riveting.

Conductor guides:

The conductor must be mounted in aluminium alloy guides conforming with the material specification BSS 1476/H/E9, which allow free longitudinal movement of the conductor for expansion and contraction of the system due to temperature variation. The guides must be attached to the structure by screwing and plugging, using two screws, which must be suitably attached.

No part of the conductor system is to come into direct contact with concrete or plaster as this may cause the aluminium to corrode.

The conductor system should be preferably be supported in guides so that an air gap exists at all times between the aluminium and concrete/plaster surface, the guides being seated upon plastic or other similar insulating material.

7 STORM-WATER DRAINAGE

7.1 SURFACE WATER DRAINS

Surface water drains shall be 1500mm wide formed of Class C concrete (cast in situ), not less than 75mm thick at any part, with drains having not less than 1000mm wide and 150mm deep segmental channels.

The drains shall be laid to even and sufficient falls on hard earth bottoms, and the *in situ* drains shall be finished on exposed surfaces with 2:1 cement mortar, trowelled

smooth and rounded on salient edges.

All stopped and returned ends, angles, sweeps around gullies, etc. shall be neatly formed.

Drains exceeding 1,8m in length shall be cast in sections not more than 1,8m in length.

8 SEPTIC TANK AND FRENCH DRAINS

8.1 BIODIGESTER TANK

The septic tank shall be constructed strictly as specified on the drawings for the biodigester.

8.2 FRENCH DRAINS

French drains shall be 0,6 m wide, of length shown and 1,8 m deep below invert of drain pipe where entering the drain. Build cavity chamber, size 300 × 300 mm internally, under end of drain pipe with dry rubble walls, in rough local hard stone, from bottom of trench up to top of drain pipe and fill remainder of trench in up to same level with clean, hard, durable stone, graded from a minimum of 40 mm to a maximum of 80 mm as shown.

The trench above the stone filling, shall be provided with approved bituminous or other suitable sheeting, laid over the stone filling and lapped 75 mm at joints.

Trench shall be filled in above sheeting with approved filling, lightly rammed.

9 SEWAGE PIPES AND FITTINGS

All sewage pipes and fittings used shall be of the PVC type bearing the SABS mark.

10 TESTING

The whole of the wastewater drainage system shall be tested as described hereunder. The Contractor shall provide all necessary testing apparatus, expanding plugs, stoppers, water, smoke composition, any other materials that may be required and all labour required for carrying out tests.

10.1 PRELIMINARY OR OPEN TEST

All underground drains and fittings shall be tested before being covered in or encased in concrete by means of air pressure.

In carrying out the air test all openings in the drains shall be plugged or sealed and all traps associated therewith filled with water. Pump air into the drains until a manometric pressure of 40 mm is indicated after which, without further pumping, the pressure shall not drop below 25 mm for a period of at least 30 seconds.

The air test may be applied to the drains in one operation or drains may be divided into sections and each section tested separately.

Before carrying out the above test, an internal inspection of the drains shall be made with a torch and mirror in the direction of the flow. The drains shall be free of invert lips and the bore of the pipes shall be straight.

10.2 FINAL TEST

After the drainage has been completed, all plumbing fittings installed and permanently connected up and trap seals filled with water, a final air test as described in 10.1 above, shall be applied to the whole system.

10.3 DEFECTS TO BE MADE GOOD

Should the drainage system fail to withstand the tests described in 10.1 and 10.2 above, all defects causing such failure shall be made good and the test repeated until the whole of the work is shown to be thoroughly sound and tight, all to the entire satisfaction of the Engineer's Representative.

In making good all defective parts shall be carefully cut out and replaced with new in a proper manner. No patching of pipes, joints or connections will be allowed.

11 WATER SUPPLIES

11.1 MILD STEEL PIPES

Mild steel water piping shall be in accordance with SABS Specification 62, galvanised inside and outside with screwed ends and shall be of medium class complete with sockets, ends, elbows, tees, long-screws, back nuts and other fittings as may be required, all complying with the requirements of SABS Specification 509.

Screwed joints shall be made with lead paint and PTFE tape to cold water piping.

Cut ends of pipes shall be reamed out to remove burrs.

Pipes shall be firmly and neatly built in or fixed to walls as directed by the Engineers Representative.

In order that no air may lodge in the pipes, a proper inclination shall be maintained in fixing same.

If practicable, bends shall be used at angles in preference to elbows. If a reduction in the size of the pipe takes place at an angle, the bend or elbow shall be of the size of the inlet or larger pipe.

No surface mounted water piping will be permitted on external wall surfaces except for a short distance of vertical rising main from ground level.

11.2 POLYETHYLENE PIPES

Polyethylene pipes shall be in accordance with SANS 4427/ISO 4427 and bear the SABS Mark. The pipe diameters and Class shall be as indicated on the drawings.

Compression joints made with compression fittings shall be used for joining pipes. Take care to use the size of fitting intended specifically for the pipe to be joined. The end of the pipe is inserted into the fitting past the rubber sealing ring and, by turning

of a threaded nut, a grip ring is compressed between the fitting and the pipe until it grips the outer surface of the pipe to prevent the pipe from pulling out of the fitting.

Except at points of positive anchorage, ensure that holder-bats, clips, brackets, etc. used to support the pipe do not grip the pipe and that they allow back-and-forth movements caused by temperature changes to take place freely and without risk of abrasion of the pipe.

Ensure that supports provide a flat smooth bearing surface without sharp edges. Firmly mounted all types of manual controls, and valves in particular, to minimize the movement transmitted to the pipe by operation of the control handwheel or handle.

Where a pipe has side connections, these connections, unless at a point of anchorage, will be subject to any thermal movement of the pipe. Each side connection shall therefore be supported at a point that is far enough away from the main pipe to ensure that excessive lateral bending does not occur in the connection.

Continuous support of the pipe is necessary and the spacing of supports shall not exceed 500mm.

11.3 COPPER PIPES

Copper pipes for domestic cold water and gas services in all cases shall comply with the requirements of SABS Specification 460 Class 0, 2 and 3. For applications below ground only Class 2 or 3 shall be used.

Pipework above ground shall be of Class 0 or 2 jointed with capillary soldered fittings. Provision must be made for union couplings in strategic places.

All copper pipes shall be jointed with approved capillary solder type fittings, each joint being formed by cutting the pipe-ends, preferably with a pipe cutter. If the tube end, to be soldered, is dirty due to cement, bitumen or tape-gum, it should be mechanically cleaned with steel wool or abrasive paper. After inserting the pipe into the fitting, apply a flame using LPG gas blow lamp to the assembly to heat the tube and fitting for not longer than about 10 seconds. Then remove the flame completely and test the temperature of the joint by placing the wire solder at the mouth of the fitting. If the solder does not melt, remove the solder and heat again with the flame for a few seconds more. If the solder melts freely, hold the solder at about 45° to the mouth of the fitting, allowing it to melt and with steady pressure the solder will be drawn into the joint.

Use only 2mm solid core wire solder. Type 97/3. A careful check should be made to ensure that a ring of solder is visible around the mouth of the fitting.

Fittings and pipes must be wiped clean with a damp cloth after jointing. Joints that have been fluxed should be soldered within 1 hour.

12 SANITARY FITTINGS

Prices of WC suites shall be deemed to include the following: WC pan, flush valve or 11 litre cistern with flushing apparatus, float valve and flush pipe and all finishings to pipes and cistern.

12.1 SUNDRY FITTINGS

Toilet roll holders:

Chromium plated brass thief proof toilet roll holder shall be fitted to wall.

Towel rails:

Chromium plated brass or aluminium towel rail with brackets shall be fitted to wall.

12.2 PEDESTAL WATER CLOSET PANS

Pedestal water closet pans shall be of the washdown type, approximately 400 mm high, of white glazed fireclay or vitreous china, complying with the requirements of SABS Specification 497.

The pans shall have “P” traps with straight outlets or right or left-hand side outlets, as required.

Pans shall be bedded onto the floors in 3:1 cement mortar.

The pans shall be fitted with approved solid hardwood or plastic double flap seats having open fronts and of size and shape required to fit the pans, each attached to the pan with non-ferrous metal fixing bolts.

12.3 FLUSHING CISTERNS

Low level cisterns shall be of the valveless siphonic type or of the flushing valve type, each with body and removable cover of white glazed fireclay or vitreous china complying with the requirements of SABS Specification 497.

Flush pipes to flushing cisterns shall have an internal diameter of not less than 34 mm for the various lengths of pipe under 1,5 m.

12.4 WASH HAND BASINS

Wash hand basins shall be of the bracket type with back skirting of white glazed fireclay or vitreous china complying with the requirements of SABS Specification 497 having weir type overflow and fitted with chromium plated grid or slot type overflow.

Basins shall be 558 × 406 mm, each fitted with an approved 32 mm chromium plated brass waste fitting with screwed outlet complete with vulcanite or rubber plug attached to basin with chromium plated chain, two 15 mm chromium plated brass, easy clean pattern, screw down pillar taps where hot and cold water is supplied to basin.

Basins shall be fixed on approved white enamelled cast iron brackets, fixed to walls with M6 bolts, 120 mm long, built into walls in 3:1 cement mortar.

12.5 WALL MOUNTED BOWL URINALS

Wall mounted urinals shall be of white glazed fireclay or vitreous china type, each approximately 700 × 300 mm in overall size, with back flush entry and secured to wall

with not less than two concealed hanger brackets. The urinals shall each be fitted with 38 mm diameter chromium plated domical grating, approved urinal flushing valve complete with push button assembly, spreader and all other necessary chromium plated fittings.

Fit each urinal outlet with a chromium plated bottle trap.

13 WATER STORAGE TANKS

13.1 MAIN WATER TANK AND TANK STAND

The main water storage tank connected to the main water supply system shall be a polythene tank mounted on a steel tank stand supplied by the manufacturer of the water tank to ensure that the bottom of the water tank shall be 3,0m above the natural ground level. The polythene water tank shall be manufactured from LLDPE, UV stabilized raw materials, and comply with F&DA (US Food and Drug Administration) regulation 177.1520 for food contact application, and carry a minimum five (5) year manufacturer's guarantee. The tank size shall be 10 000 litres. The tank must be supplied with at least a 40mm inlet connector at the top, a 40mm outlet connector at the bottom, and a 450mm lid.

The tank stand shall be manufactured from steel and shall be designed and supplied by the tank manufacturer to their specifications.

All water installations must be neat and watertight without any leakages and be tested.

13.2 RAINWATER HARVESTING WATER TANK AND TANK STAND

The polythene water tanks shall be manufactured from LLDPE, UV stabilized raw materials, and comply with F&DA regulation 177.1520 for food contact application, and carry a minimum five (5) year manufacturer's guarantee. Each tank size shall be 5 000 litres. The tanks must be supplied with at least a 40mm inlet connector at the top, a 40mm outlet connector at the bottom, and a 450mm lid. Each tank must be supplied with a 25mm outlet adaptor at its bottom and 25mm brass tap which comply to SABS Specification 226, securely mounted on the stand.

The tank base shall be constructed as per specifications on the drawing. All specifications applicable under concrete work and masonry work will apply.

All water installations must be neat and watertight without any leakages and be tested. The stand must be constructed to the specification on the plan to a height of at least 0.6m high. The water tank must be securely tied down and mounted on the stand and must have a 25mm tap.

14 WATER TAPS AND VALVES

All water taps and stop cocks shall comply with the requirements of SABS Specification 226.

Taps for hot water shall be marked with the letter "H" or with the word "Hot" or shall have red colour plastic inserts, and taps for cold water, when both cold and hot taps are provided to a fitting, shall be marked with the letter "C" or with the word "Cold" or

shall have green or blue colour plastic inserts.

Ball valves shall comply with the requirements of SABS Specification 752.

15 FIRE EXTINGUISHERS

Supply number and type of fire extinguishers as specified, all in accordance with SABS Code of Practice 0400 and to the approval of the local Fire Brigade.

Hang extinguishers on appropriate approved wall mounted hangers at heights as directed.

All extinguishers to be of the refillable handheld portable types according to the capacities indicated.

- a) Dry powder (DCP) extinguishers in accordance with SABS Specification 810.
- b) CO2 extinguishers in accordance with SABS Specifications 1151.
- c) BCF (1211) extinguishers in accordance with SABS Specification 1511.

Hang the fire extinguishers at an appropriate height against a permanent support.

16 TESTING OF PLUMBING

The plumbing work shall be tested in accordance with the instructions of the Engineers Representative and any imperfect work shall be taken out and renewed at the cost of the Contractor and again tested until found to be perfect.

17 TESTING OF WATER RETICULATION AND PIPELINES

Before carrying out the pressure test of water reticulation and pipelines the entire system must be filled with water and all air evacuated.

The test shall be carried out by pressurising the water in the system to one and a half times the expected working pressure that the installation is designed for, by means of a pump. The pressure shall be maintained at that level for a period of at least two hours during which time all pipes, joints and fittings are to be thoroughly inspected.

Any leakages that may appear must be repaired to the satisfaction of the Engineers Representative. When the system is connected to the main water supply and is operational a final inspection must be carried out under normal working pressure and any defects shall be rectified.

PAINTING

1 PREPARATORY WORK FOR PAINTING

All floors shall be swept clean, walls dusted down and surfaces not being painted covered and protected against spotting before any painting is carried out.

On woodwork:

Woodwork being painted shall be well brushed down, knots treated and all surfaces primed, stopped with hard stopping and rubbed down to an even surface ready to receive the paint.

On metalwork:

All metal surfaces being painted, except for structural steelwork, shall be cleaned of all rust, scale and dirt, removed by scraping or with steel wire brushes. All oil and grease shall also be removed and a perfectly clean surface obtained.

New galvanised metal surfaces, which are to be painted, shall be cleaned down as above and given 1 coat of self-etching wash primer complying with the requirements of SABS Specification 723.

Protective coatings on new galvanised metal surfaces, applied by the Manufacturer to prevent storage stain and white rust, shall be completely removed by the use of suitable cleaning agent and the surfaces thoroughly rinsed and allowed to dry before the surfaces are primed.

After removing rust from metalwork those portions so affected shall be treated with an approved rust inhibitor or rust neutralising paint.

On plaster:

All plastered walls, ceilings and such like surfaces being painted shall be filled, where necessary, with suitable or patching plaster and the whole rubbed down ready to receive the finishings.

2 SURFACES TO BE DRY

All wall, ceiling and similar plastered surfaces shall be perfectly dry and in a fit state to receive paint finishes, before the application of any paint.

Special care is to be taken when the plaster is specified to be finished with oil based paints.

3 PAINTS

a) Plastered walls:

Apply one coat Plascon Plaster Primer and two coats Plascon Velvagro Polyurethane Enamel paint (White) to new interior walls.

Apply one coat Plascon Plaster Primer and two coats Plascon Wall and All paint (White) to new exterior walls.

b) Doors:

Apply three coats Plascon Polyurethane Enamel paint (White), lightly sanded between coats.

c) Door- and Window frames:

Apply three coats Plascon Polyurethane Enamel paint (White), lightly sanded between coats.

d) Metal works for fixing gutters and welded mesh fence to:

Prime using red oxide zinc chromate primer. Finish with three coats Plascon Polyurethane Enamel paint (White).

3 APPLICATION OF PAINT

All coats shall be thoroughly dry and where necessary rubbed down before subsequent coats are applied.

Application of paint shall be brush or roller.

4 PRIMING

All surfaces normally primed before being painted shall be prepared and primed as before described in readiness to receive the specified paint system.

5 LEAVE PERFECT

The Contractor shall provide all necessary dust sheets, covers, etc. and shall exercise all necessary care to prevent marking surfaces, walls, floors, glass, electrical fittings etc. and shall keep all parts of the works perfectly clean and free at all times from spotting, accumulation of rubbish, debris or dirt arising from the operations.

The premises shall be left clean and fit for occupation at completion of the work.

ELECTRICAL INSTALLATION

1 GENERAL

1.1 INTRODUCTION

- (a) These Standard Specifications cover the general technical requirements for the equipment, materials, installation, testing, commissioning and maintenance of electrical installations for the Professional Team. These requirements shall be read in conjunction with the Documents as specified below.
- (b) "Document" shall mean the complete set of contract documents, including the Professional Team's Tender Conditions, Tender Qualifications, the Standard Specification and the Detail Technical Specification including all drawings and variation orders issued in terms of the contract.
- (c) "Contractor" shall mean the person, partnership, company or firm appointed for the supply, installation, testing, commissioning and maintenance of the Electrical Installation. In the case of the Electrical Installation being a subcontract, nominated in terms of the Main Contract or otherwise, the word "Contractor" shall

also mean "Sub Contractor" in terms of the Sub Contract Conditions for the specific installation. Where applicable the Builder or Principal Contractor shall be referred to as "Main Contractor".

1.2 INSTALLATION WORK

The complete installation shall comply with the requirements of this Specification. Should any discrepancies or contradictions exist between this specification and the Detail Technical Specification for the specific installation, then the latter shall take precedence.

In the event of discrepancies between the drawings, specifications and bill of quantities the Engineers Representative shall decide whether the work as executed shall be remeasured on site or whether remeasurement shall be effected from the working drawings only.

The Engineer's Representative will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Contractor and these shall be remedied at the Contractor's expense. Under no circumstances shall these inspections relieve the Contractor of his obligations in terms of the Documents.

The Contractor shall notify the Engineer's Representative timeously when the installation reaches important stages of completion (e.g. before closing cable trenches, before casting concrete, etc.) so that the Engineer's Representative may schedule his inspections in the best interest of all parties concerned.

1.3 REGULATIONS

The installation shall be erected and tested in accordance with the latest issues and amendments of the following Acts and regulations:

SABS 0142: "Code of Practice for the Wiring of Premises", or the applicable code in Zimbabwe

The Occupational Health and Safety Act, 1993 (Act 85 of 1993), or the applicable Act in Zimbabwe

The Local Government Act 1998 (Act 10 of 1998 (Gauteng), municipal by-laws and any special requirements of the local supply authority, or the applicable act in Zimbabwe.

The Fire Brigade Services Act 2000 (Act 14 of 2000), or the applicable act in Zimbabwe.

The National Building Regulations and Building Standards Act 1996 (Act 29 of 1996) or the applicable act in Zimbabwe.

The Contractor shall issue all notices and pay all of the required fees in respect of the installation to the authorities, and shall exempt the Client from all losses, claims, costs or expenditures which may arise as a result of the Contractor's negligence in complying with the requirements of the regulations.

It shall be assumed that the Contractor is conversant with the above-mentioned

requirements. Should any requirement, by-law or regulation, which contradicts the requirements of this Document, apply or become applicable during erection of the Installation, such requirement, by-law or regulation shall overrule this Document and the Contractor shall immediately inform the Engineer's Representative of such a contradiction. Under no circumstances shall the Contractor carry out any variations to the installation in terms of such contradictions without obtaining the written permission to do so from the Professional Team.

1.4 SITE CONDITIONS

Tenderers are advised to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc. will be considered after submission of tenders.

For services where prior permission is required before contractors can visit the site, a visit will be arranged for all interested parties.

1.5 ARRANGEMENTS WITH THE SUPPLY AUTHORITY

The contractor shall give all notices required by and pay all necessary fees, including any inspection fees, which may be due to the local Supply Authority unless specified to the contrary.

It shall be the responsibility of the Contractor to make the necessary arrangements with the local Supply Authority at his own cost and to supply the labour, equipment and means to inspect, test and commission the installation to the satisfaction of the Local and Supply Authorities.

The Contractor shall supply and install all notices and warning signs that are required by the relevant laws, regulations and/or the Documents.

1.6 MATERIAL AND EQUIPMENT

All material and equipment shall conform in respect of quality, manufacture, tests and performance, with the requirements of the South African Bureau of Standards or where no such standards exist, with the relevant current Specification of the British Standards Institution.

All material and equipment shall be of high quality and suitable for the conditions on site. These conditions shall include weather conditions as well as conditions under which materials are installed, stored and used. Should the materials not be suitable for use under temporary site conditions then the Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.

The Contractor shall, where requested to do so, submit samples of equipment and material to the Engineer's Representative for approval prior to installation. Samples may be retained in the Engineer's Representative's possession until the contract is completed after which they will be returned.

1.7 CONNECTIONS INVOLVING ALUMINIUM (CABLES AND TRANSFORMERS)

As a result of the fact that aluminium flows when subjected to pressure and electrical connections based on this principle thus loses proper contact during the course of time, it should be noted that bolted connections between aluminium and copper or any other metal is not acceptable.

1.8 CODES OF PRACTICE OR STANDARD SPECIFICATION

Where reference is made to any Code of Practice or Standard Specification in this document the latest edition or amendment shall be applicable, except where specified to the contrary.

2 INSTALLATION AND TERMINATION OF CONDUITS AND CONDUIT ACCESSORIES

2.1 GENERAL

2.1.1 SCOPE

This section covers the installation of conduits and conduit accessories in buildings and other structures under normal environmental conditions and for system voltages up to 600 V.

- 1 The following types of conduit installations are included:
 - (a) Screwed metallic conduit black enamelled and galvanised.
 - (b) Plain end metallic conduit black enamelled and galvanised.
 - (c) Non-metallic conduit.
 - (d) Flexible conduit.
- 2 Conduits may be installed as follows:
 - (a) In open roof spaces.
 - (b) Cast in concrete.
 - (c) Surface mounted against walls, concrete slabs, etc.
 - (d) In wall chases.
- 3 Where conduits are to be installed in concrete, this shall be undertaken while the building work is still in progress. Conduits may only be surface mounted where specified or where the Engineer's Representative has given its written consent.
- 4 Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.
- 5 Bending and setting of conduit must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied must on indication by the Engineer's Representative, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the contractor's expense.

- 6 Tenderers must ensure that general approval of the proposed conduit system to be used is obtained from the local electricity supply authority prior to the submission of their tender. Under no circumstances will consideration be given by the Engineer's Representative to any claim submitted by the contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.
- 7 For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm. In all other instances the sizes of conduit shall be in accordance with the "Wiring Code" for the specified number and size of conductors, unless otherwise directed in part 2 of this specification or indicated on the drawings.

2.1.2 OTHER SERVICES

Conduits may not be installed closer than 150 mm to pipes containing gas, steam, hot water or other materials, which may damage the conduits or conductors. Conduits may not touch pipes of other service installations in order to prevent electrolytic corrosion. Where this is unavoidable, cathodic protection shall be provided.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaries as well as all load bearing conduit shall in all instances be of the metallic screwed type.

2.2 SCREWED METALLIC CONDUIT

2.2.1 GENERAL

In general, screwed steel conduit shall be used in the wiring of buildings.

The installation shall comply with SANS 10142.

2.2.2 GALVANISED CONDUIT

Galvanised conduit and accessories shall be used in the following:

- (a) In damp areas.
- (b) In areas exposed to the weather.
- (c) For all installations within 50 km of the coast.
- (d) In plenum chambers containing humidifying equipment.
- (e) For surface mounted conduit installations in kitchens and boiler rooms.
- (f) In screeds resting directly on soil.
- (g) For connection points to future installations.
- (h) For underground conduit containing earthing conductors.
- (i) In buildings where animals are housed such as cattle, sheep, dogs, etc.

2.2.3 TERMINATIONS

1. Spouted Connections.

Conduits shall be connected directly to draw-boxes with spouted connections. Conduits shall be screwed tightly home and no threads shall be visible.

2. Draw-boxes.

A female bush and two locknuts shall be used to terminate conduits at draw-boxes and outlet boxes without spouts, should there be sufficient room in the box. Where there is insufficient room, a coupling, brass male bush and locknut may be used with sufficient allowance for the reduction of the internal diameter by the male bush.

3. Holes.

Holes to accommodate brass bushes shall be large enough to accommodate the bush with a minimum of clearance.

4. Bush-nuts.

Bush-nuts for the connection of earth conductors to conduits are not acceptable.

2.2.4 SCREWS, BOLTS AND NUTS

Steel locknuts of thick gauge steel with milled sides shall be used in all cases. Cadmium-plated bolts and nuts shall be used except where the installation is exposed to the weather in which case brass bolts and nuts shall be used. Screws shall be installed in all tapped holes in fittings and accessories to prevent damage to the screw thread by concrete or plaster. The screws shall be screwed completely down to prevent damage to the thread on the screw.

2.2.5 CONDUIT ENDS

Conduit ends shall be cut at right angles to ensure that ends butt squarely at joints. Threads shall not be visible at joints and connections except at running joints. The total length of the thread on the two conduit ends shall not exceed the length of the coupling.

2.2.6 JOINTS

All conduit ends shall be reamed and all joints tightly screwed. Only approved couplings shall be used. Running joints with long threads shall be kept to a minimum and locknuts shall be provided to ensure a strong mechanical and a continuous electrical joint. Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

2.2.7 FINISH

All joints shall be painted with red lead to prevent them from rusting in damp areas, areas within 50 km of the coast and in cases where the installation is exposed to the weather for any length of time. Where the galvanising or black paint has been damaged, the area shall first be cleaned and a coat of zinc base paint applied subsequently. Additional coats of paint shall only be applied after the undercoat has completely dried. All surface mounted non galvanised metallic conduit must be painted.

2.2.8 CONTINUITY

Mechanical and electrical continuity shall be maintained throughout the conduit installation.

2.3 PLAIN END METALLIC CONDUIT

As an alternative to the screwed conduit, plain-end conduit complying with:

- a. Unthreaded conduit shall be manufactured of mild steel with a minimum thickness of 1,2mm and shall comply with SANS 1065.
- b. Bending and setting of conduit shall be done with the correct apparatus recommended by the manufacturer of the conduit.
- c. The Contractor or Supplier shall be responsible for obtaining the approval of local authorities for the use of this system.
- d. All conduit and accessories used in areas within 50 km of the coast shall be hot-dip galvanised to SANS 32 & 121. In inland areas electro-galvanised or cadmium-plated accessories will be accepted.

Bending and setting of plain-end conduit must be done with special benders and apparatus manufactured for this purpose and which are obtainable from the suppliers of the system. Damaged conduit resulting from the use of incorrect bending apparatus shall be completely removed and any wiring already drawn into such damaged conduits shall be completely renewed at the Contractor's expense.

Screwed conduit must be used in the following instances:

- (a) In flameproof installations.
- (b) Load bearing conduit.
- (c) For the suspension of luminaries.
- (d) Surface mounted conduit.

Plain-end conduit and associated accessories shall be manufactured of mild steel having a minimum thickness of 1,2 mm and shall comply with SANS 1065. Conduit manufactured of lighter gauge material, i.e. 0,97 mm, will not be permitted.

All conduit and accessories used in areas within 50 km of the coast shall be hot-dip galvanised to SANS 32 & 121. In inland areas Electro-galvanised or cadmium-plated accessories will be accepted.

2.4 NON METALLIC CONDUIT

2.4.1 INSTALLATION CONDITIONS

Where specified for a particular service, non-metallic conduit may be installed under the following conditions:

- 1 All non-metallic conduit shall comply fully with SANS 950 and shall be installed in accordance with Appendix C of the same specification as well as SANS 10142.

- 2 Insulated heat-resistant boxes shall be used for outlets of totally enclosed luminaries and other fittings where excessive temperatures are likely to occur.
- 3 Luminaries and other fittings shall not be supported by non-metallic conduit or conduit boxes. These fittings shall be secured to the surrounding structure in a way that is acceptable to the Engineer's Representative. Refer to the standard specification for "INSTALLATION OF LUMINAIRES",
- 4 The conduit shall be supported and fixed with saddles with a maximum spacing of 1 m, even in roof spaces. (Refer to SANS 10142.) The Contractor shall supply and install all additional supporting timbers required.
- 5 It shall be possible to rewire the completed installation in the future without undue difficulty.
- 6 Non-metallic conduit and fittings shall not be used under the following conditions:
 - (a) Outside a building (unless protected, or sheltered under eaves).
 - (b) For mechanical load bearing.
 - (c) Where they may be subjected to temperatures below -10°C or above 70°C for prolonged periods.
 - (d) As primary electrical insulation.
 - (e) In areas where they may be subject to mechanical damage.
 - (f) For applications other than those for which they are designed.
 - (g) In concrete slab unless specified to the contrary.

2.4.2 PAINTING OF CONDUITS

Exposed conduit may be painted with normal oil or PVA paints, but care must be taken to ensure that the paint used does not contain any component that will soften or have any other detrimental effect on the materials from which the conduit and fittings are manufactured.

2.4.3 CONNECTING OF CONDUIT TO METAL EQUIPMENT/COMPONENTS

When any part of a non-metallic conduit system has to be connected to metal equipment or components (e.g. switchboard, surface socket-outlet or switch box, existing metallic conduit system, etc.) fittings and joints manufactured specifically for this purpose must be used. Non-metallic conduit must not be threaded to fit metallic connectors.

2.4.4 BENDS

In conduit of nominal size not exceeding 25 mm, bends may be made in accordance with par. 2.4.5. In all other cases bends must be achieved by the use of accessories that are introduced into the conduit run. Bends shall comply with SANS 10142.

2.4.5 BENDING

Conduit of nominal size up to and including 25mm may be cold bent by hand

provided that the radius of the bend is greater than six times the nominal size of the conduit, and that the external angle of the bend does not exceed 90°. The procedure (which involves the use of a bending spring) should be as follows:

- (a) Determine the angle through which the conduit is to be bent.
- (b) Warm the cold conduit over the length to be bent by rubbing with hands.
- (c) Select a bending spring which matches the conduit size and insert in to the conduit at the point where the bend is required.
- (d) Bend the conduit slowly with one motion (either with the hands alone approximately 1 m apart, or across the knee) to double the required angle, release the conduit and, when its position is stable, withdraw the bending spring (turning it in an anti-clockwise direction to reduce its diameter) and gently correct the angle
- (e) Install and secure the conduit immediately following bending.

2.4.6 ADHESIVE JOINTS

All adhesive joints must be made in a clean dry area. The surfaces of all components to be bonded must be dry and clean.

The insertion depth should be marked on the conduit end and the adhesive applied (by means of a soft clean brush) as quickly as possible to the surfaces to be bonded by brushing lengthwise along the conduit, ensuring that a thin coating of uniform thickness is formed. The joint must be made immediately after the application of the adhesive by pushing the prepared parts squarely together with a twisting motion to the full insertion depth. Care must be taken to avoid squeezing adhesive into the cableway and all excess adhesive must be wiped off.

NOTE: Solvent adhesives contain highly volatile liquids and their containers should not be left open.

2.4.7 CUTTING

A fine-tooth hacksaw should be used to cut conduit to the required length. Each cut end should be square and free from swarf, burrs and loose material. When determining the length of conduit to be cut, allowance must be made for the length of couplings or accessories attached to the conduit. Incorrect determination will cause bulging of the conduit or insufficient joint length.

2.5 FLEXIBLE CONDUIT

In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection of thermostats and sensors on equipment and where otherwise required by the Engineer's Representative, flexible conduit shall be used for the final connection to the equipment

- 1 The installation shall comply with SANS 10142.

- 2 Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw-box. The flexible conduit may be connected directly to the end of a conduit if an existing draw-box is available within 2 m of the junction and if the flexible conduit can easily be rewired.
- 3 Flexible conduit shall consist of metal-reinforced plastic conduit or PVC-covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel construction may be used. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass or mild steel plated with either zinc or cadmium.

2.6 INSTALLATION REQUIREMENTS

2.6.1 POSITIONS OF OUTLETS

All accessories such as boxes for socket-outlets, switches, lights, etc. shall be accurately positioned. It is the responsibility of the Contractor to ensure that all outlets are installed level and square, at the correct height from the floor, ceiling or roof level and in the correct position relative to building lines and equipment positions as specified. It shall be the responsibility of the Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw-boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw-boxes shall be installed in inconspicuous positions to the approval of the Professional Team's representative and shall be indicated on the "as built" drawings.

2.6.2 COVER PLATES

All draw boxes and outlets shall be fitted with cover plates, either as part of the switch or socket assembly or with blank cover plates if unused. Blank cover plates shall match other cover plates in the same area. Flush mounted cover plates in both ceilings and walls shall overlap the draw-box and edges of the recess. If the fixing lugs are substantially deeper than the finished wall surfaces, suitable coiled steel wire or tubes shall be used as spacers.

2.6.3 DRAW-WIRES

Galvanised steel draw-wires shall be installed in all unwired conduits e.g. conduits for future extensions, telephone installations and other services.

2.6.4 BENDS

A maximum of two 90 bends or the equivalent displacement will be allowed between outlets and/or boxes.

Draw-boxes shall be installed at maximum intervals of 15 m in straight runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside radius of a bend shall not be less than five times the outside diameter of the conduit. (Refer to SANS 10142)

2.6.5 WALL SOCKET-OUTLETS

Where more than one socket-outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without making any joints in the wires.

2.6.6 LUMINAIRES

Where the conduit end is used to support luminaires, a ball-and socket type lid shall be fitted to the pendant box in all cases where the conduit is longer than 500 mm. In all other cases a dome lid may be used. Where luminaires are specified which are fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

2.6.7 FLUSH MOUNTED OUTLET BOXES

The edges of flush mounted outlet boxes shall not be deeper than 10 mm from the final surface. Spacer springs shall be used under screws where necessary.

2.6.8 EXCESS HOLES

All excess holes in draw-boxes or other conduit accessories shall be securely blanked off by means of brass plugs to render the installation vermin proof.

2.6.9 DEBRIS

Care shall be taken to prevent debris or moisture from entering conduits during and after installation. Conduit ends shall be sealed by means of a solid plug which shall be screwed to the conduit end. Conduits shall be cleaned and swabbed to remove oil, moisture or other debris that may be present before conductors are installed. Swabs shall not be attached to the conductors.

2.6.10 DEFECTS

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges shall be removed from site. The Contractor shall ensure that conduits are not blocked.

2.6.11 WITHDRAWAL OF CONDUCTORS

To ensure that all electrical conductors are easily withdrawable from conduits and to ensure that there are no joints in the conductors, the Engineer's Representative will have the right to have the conductors of any circuit removed at his discretion. If the conductors are found to be in a satisfactory condition after having been withdrawn, the Professional Team shall bear the cost of withdrawing and re-installing such conductors. If the conductors are found to have been damaged during installation or removal or if joints are found, they shall be replaced and the cost shall be borne by the Contractor.

2.7 INSTALLATION IN CONCRETE

2.7.1 TIMEOUS INSTALLATION

In order not to delay building operations, the Contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Contractor or his representative shall be in attendance when the concrete is cast.

2.7.2 DRAW-BOXES

Draw-boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw-boxes shall be of the deep type. In hollow block slabs, rear-entry draw-boxes shall be used. In columns where flush mounted draw-boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw-box.

2.7.3 ELBOWS

Elbows for conduits of 32mm dia. and smaller and sharp bends will not be allowed in concrete slabs.

2.7.4 COVER PLATES

Draw-boxes and/or inspection boxes shall, where possible, be grouped together under a common approved cover plate, and must preferably be installed in passages or male toilets. The cover plate shall be secured by means of screws.

2.7.5 NEUTRAL AXIS

All conduits shall be installed as close as possible to the neutral axis of concrete beams, slabs and columns. The conduits shall be rigidly secured to the reinforcing to prevent movement towards the surface of the concrete.

2.7.6 FIXING TO THE SHUTTERING

All conduits, draw-boxes etc. shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Draw-boxes and outlet boxes shall preferably be secured by means of a bolt and nut installed from the back of the box through the shuttering. Fixing lugs may also be used to screw the boxes to the shuttering. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. Where fibreglass shuttering is used by the Builder, the equipment shall be fixed to the steel only and no holes shall be drilled or made in shuttering. All draw-boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

Before any concrete slabs are cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

2.7.7 CONCRETE FLOOR SLABS

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries or other damp areas. All socket outlets and three phase outlets in damp areas shall be supplied from above with galvanised conduit and accessories.

2.7.8 EXPANSION JOINTS

As far as possible, conduits shall not be installed across expansion joints. Where this is unavoidable a conduit expansion joint shall be provided.

2.7.9 SCREEDS

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20 mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2 m. The Contractor shall ensure that conduits are not visible above the screed where the conduits leave the screed.

2.7.10 INSPECTION

All draw-boxes, conduits, etc. which are installed in concrete shall be cleaned with compressed air and provided with draw-wires two days after removal of the shuttering. Errors that occurred during the installation of the conduits, or any lost draw-boxes, or blocked conduits shall be immediately reported to the Engineer's Representative by telephone and confirmed in writing in order that an alternative route can be planned and approved by the Engineer's Representative before the additional concrete is cast. Any additional cost shall be for the Contractor's account.

2.8 SURFACE INSTALLATIONS AND INSTALLATIONS IN ROOF SPACES

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

2.8.1 APPEARANCE

- (a) All conduits shall be installed horizontally or vertically as determined by the route and the Contractor shall take all measures to ensure a neat installation.
- (b) Where conduits are to be installed directly alongside door frames, beams, etc. that are not true, conduits shall be installed parallel to the frames, beams, etc.
- (c) All labels shall be removed from surface mounted conduit.

2.8.2 SADDLES

Conduits shall be firmly secured by means of saddles and screws and in accordance with SANS 10142. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 150 mm before and after each 90° bend and within 100mm of each outlet box.

2.8.3 JOINTS

Joints will only be allowed in surface conduit lengths exceeding 3,5 m. Threads shall not be visible at joints of completed installations, except where running joints are used. Running joints will be allowed only when absolutely necessary. All running joints shall be provided with locknuts and shall be painted with red lead immediately after installation.

2.8.4 ACCESSORIES

Inspection bends or tee pieces shall not be used. Non-inspection type bends may be used in the case of 32mm or 50 mm diameter conduits. All draw-boxes supporting luminaries or other equipment shall be fixed independently of the conduit installation.

2.8.5 OFFSETS

Where an offset is required at conduit terminations or crossovers, the conduit shall be saddled at the offset.

2.8.6 CROSS OVER

Conduit routes shall be carefully planned to avoid crossovers. Where a crossover is inevitable, one conduit only shall be offset to cross the other. Crossovers shall be as short as possible and shall be uniform. Alternatively, crossovers shall be installed in purpose-made boxes. This method shall be employed on face brick walls and in other circumstances where required by the Professional Team.

2.8.7 PARALLEL CONDUIT

Parallel conduit runs shall be equidistant, and saddles shall be installed in line. Alternatively, a special clamp may be used to secure all conduits in unison. In the case of conduits of different diameters, the latter method shall only be used if a purpose-made clamp designed to accommodate the various conduit sizes, is provided.

2.8.8 PAINTING OF CONDUIT

All surface mounted conduits and accessories shall be painted with two coats of a high quality enamel paint or as otherwise specified. The colour shall comply with the colour code specified for the installation or where no code has been specified, shall match the colour of the surrounding finishes.

2.8.9 CONDUIT IN ROOF SPACES

In open roof spaces (no ceiling) conduits shall run along the wall plates and the rafters. The installation of conduits suspended between the rafters is not acceptable.

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5 m by means of saddles screwed to the roof timbers for metallic conduit and 1m for non-metallic conduit.

Nails or crampets will not be allowed.

Under flat roofs in false ceilings or where there is less than 900 mm clearance, or in instances where the ceilings are insulated with glass-wool or other insulating material

impeding access, the conduit shall be installed in a manner which allows for wiring from below the ceilings.

Conduit runs from switchboards shall terminate in fabricated sheet steel draw-boxes installed directly above or in close proximity to the boards.

Spare conduits covering the total number of spare ways on switchboards, shall be provided between the boards and the roof draw box.

Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450mm throughout the installation. The contractor shall supply and install all additional supporting timbers in the roof space as required.

2.8.10 FIXING TO WALLS

Only approved plugging materials such as aluminium inserts, fibre plugs or plastic plugs, etc., and round-head screws shall be used when fixing saddles, switches, plugs etc. to walls. Wood plugs are not acceptable nor should plugs be installed in joints in brick walls.

2.9 FUTURE EXTENSIONS

2.9.1 OPEN ROOF SPACES

Conduits intended for future switches and socket outlets, shall terminate 40 mm above the tie beams in roof spaces with more than 900 mm free space. The conduit ends shall be threaded and fitted with a coupling and brass plug.

2.9.2 CONCRETE SLABS

Conduit ends shall protrude 150 mm from the concrete to facilitate the installation of future extensions above, below or to the side of the concrete slabs. All these conduits shall be connected to a draw-box, which is cast into the concrete within 2 m of the end of the concrete. Conduit ends shall be threaded and fitted with a coupling and brass plug. In cases where holes cannot be drilled through the shuttering to accommodate the conduit end, a deep draw-box with rear entry may be placed over the conduit end.

2.9.3 COVER PLATES

Unused boxes for switches and socket-outlets shall be covered with metal cover plates. Unused boxes for luminaries shall be covered with round galvanised metal cover plates, which fit tightly against the finished surface. The cover plate shall overlap the outlet box and recess.

2.9.4 GALVANISED CONDUIT

Galvanised conduit shall be installed at all free ends intended for future extensions. The conduit shall be treated with a paint, which will prevent corrosion and white rust.

2.10 EXPANSION JOINTS

Where conduits cross expansion joints in the structure, approved draw-boxes which provide a flexible connection in the conduit installation shall be installed.

The draw-box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw-box by means of locknuts.

The circuit conduit passing through the sleeve shall be terminated 40 mm inside the draw-box and in the case of metallic conduit, the conduit end shall be fitted with a brass bush. The gap between the sleeve and the conduit at the joint shall be sealed with 'Pratley Tic-Tac' or equal sealing compound, to prevent the ingress of wet cement. In the case of metallic conduit, an earth clip shall be fitted to the conduit projection inside the draw-box and the conduit bonded to the box by means of 2,5mm² bare copper earth wire and a brass bolt and nut.

The end of the other circuit conduit shall be secured to the draw-box by means of locknuts and a brass bush in the case of screwed metallic conduit or a standard bushed adaptor for other conduit types.

In the case of metallic conduit, a 2,5mm² bare copper wire shall be installed between the first conduit boxes on either side of the joint, in addition to an earth wire, which may be specified for the circuit. The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means of lugs and brass screws.

Suitable steel cover plates shall be screwed to draw-boxes installed along the expansion joint. The cover plates shall be installed before the ceilings are painted.

Where a number of conduits are installed in parallel they shall cross the expansion joint of the structure via a single draw-box. A number of draw-boxes adjacent to each other will not be allowed.

2.11 CHASES AND BUILDER'S WORK

Except where otherwise specified the Builder or Main Contractor shall be responsible for the builder's work related to the installation of conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes and will undertake the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for luminaries and other electrical outlets. The Contractor shall notify the Builder or Main Contractor of his requirements and the responsibility lies with the Contractor to ensure that all builder's work is clearly indicated or marked in accordance with his requirements.

Electrical materials to be built in must be supplied, placed and fixed in position by the Contractor when required to do so by the Builder or Main Contractor. The Contractor shall also ensure that these materials are installed in the correct positions.

Where no Builder or Main Contractor is available, the Contractor must provide all chases and is required to cover conduits installed in chases by a layer of 4:1 mixture of coarse sand and cement, finished 6mm below the face of the plaster and roughened. Chases shall be deep enough to ensure that the top of conduits are at

least 12 mm below the finished surface of the plaster.

Where the Contractor is responsible for the cutting of chases or the building in of conduits and other equipment, he will be held responsible for all damage as a result of this work and will be required to make good to the satisfaction of the Engineer's Representative.

This ruling is particularly applicable but not exclusively to the rewiring and renewal of existing installations. Chases shall be made by means of a cutting machine.

Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer's Representative. Where it is necessary to cut or drill holes in the concrete structure, the prior permission of the Engineer's Representative shall be obtained.

3 INSTALLATION OF WIRING CHANNELS, UNDERFLOOR DUCTING AND POWER SKIRTING

3.1 RESPONSIBILITY OF THE CONTRACTOR

The Contractor shall supply and install all wiring channels, underfloor ducting and power skirting as specified or as required for the cable, socket outlet and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junctions, T- pieces, etc. He shall further liaise with the Main contractor to verify the position of holes and access routes through the structure and finishes.

3.2 WIRING CHANNELS

3.2.1 FIXING

The Contractor shall supply and install all hangers, supports or fixings for the channels. Channels up to and including 76 x 76 mm shall be supported at maximum intervals of 600 mm and larger channels at maximum intervals of 1 m. Channel runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. Purpose made clamps, hangers, etc. shall be used as required. Where it is not possible to support the channels at the specified intervals, they shall be supported in a sound manner to the satisfaction of the Professional Team.

3.2.2 INSTALLATION IN CONCRETE

Where channels are cast into concrete, the insert type shall be used. Additional spacer blocks shall be used where necessary to prevent ducts from being deformed while the concrete is cast. Channels shall be filled with polystyrene or other suitable fillers to prevent the ingress of concrete and shall be securely fixed in position to the shuttering.

3.2.3 COVER PLATES

All channels up to and including 127mm width shall have snap-in cover plates of metal or PVC. Cover plates for wider channels shall be of metal and shall be fixed by means of screws at suitable intervals to prevent warping. Cover plates

shall be installed over the full length of the channels. Flush mounted wiring channels shall be fitted with overlapping metal cover plates with plastic edge trim to cover irregularities in the wall recess.

3.2.4 JOINTS

Adjoining lengths shall be aligned and securely joined by means of fishplates fixed by mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joints.

Where channels cross expansion joints in the structure, suitable expansion joints shall be provided in the channels by means of fishplates pop-riveted or screwed to the channel on one side of the expansion joint and floating freely in the channel on the other side of the expansion joint.

3.2.5 SUPPORT FOR CONDUCTORS

All conductors in inverted cable channels shall be retained by means of metal clips or metal spacer bars at not more than 1m centres. Where vertical duct lengths exceed 5m, conductors installed in the channels shall be secured at intervals not exceeding 5m to support the weight of the conductors. Clamps shall be provided in suitable draw-boxes for this purpose.

3.2.6 CONDUIT CONNECTIONS

Conduit connections shall be terminated by means of two locknuts and a brass female bush. Where the channel is wide enough, conduit connections may be made by means of a conduit box and hole through the back or side of the channel. All holes through which conductors pass shall be fitted with bushes or grommets or shall be sleeved.

3.2.7 INTERNAL FINISHES

Bends and T-joints shall be constructed to ensure compliance with the allowable bending radii specified in SANS 10142, Appendix D in the case of PVC-insulated cables and conductors and shall comply with the relevant specification in the case of other cables. Burrs and sharp edges shall be removed and the inside edges of the joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent laceration of the conductor insulation.

3.2.8 VERMIN PROOFING

All cable channels shall be vermin proofed after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips, which are bolted, or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

3.2.9 SERVICES

Multiple duct runs or internal metal partitions shall be used where conductors for power, control, communication and other services are present.

3.3 UNDERFLOOR DUCTING

3.3.1 GENERAL

Two or three compartment underfloor ducting as specified shall be supplied and installed in the positions and according to the layouts indicated on the drawings.

Three compartment ducting shall have a cross-section of approximately 200 x 32mm, subdivided into three approximately equal compartments, of which the centre compartment shall be used for electrical power distribution with the two outer compartments for telephone and other light current services respectively.

Unless specified, each compartment shall be provided with openings (occurring in line) at 1,5 m centres to permit installation of pedestals or recessed outlets in accordance with the design of the system. The openings shall have removable, flush, cover plates and shall have prepared fixing holes for future installation of pedestals or recessed outlets. The centre of the openings shall be offset a distance of 200 mm from the building nodule lines.

3.3.2 JUNCTIONS

The underfloor ducting installation shall be provided with flush cross-over, T junction and right angle bend draw-boxes installed in the runs of ducting, generally as indicated on the drawings. The junction boxes shall be complete with cross-over of services. The junction boxes shall have nominal 300 x 300mm removable cover plates secured by means of four countersunk screws.

3.3.3 PEDESTAL UNITS

Where the system accommodates floor pedestal units, these shall consist of pressed steel or die cast aluminium units, suitable for either two or three services, as specified in the Detail Technical Specification. Where the pedestals are installed on vinyl tiled or similar floors which will be subject to washing, a matching waterproofing gasket shall be supplied below each pedestal to render the junction waterproof.

3.3.4 INSTALLATION

The underfloor ducting, junction boxes, pedestals, outlets and other accessories shall be installed strictly in accordance with the manufacturer's instructions and according to the following procedure:

- a) The underfloor ducting shall be installed on a mortar bed, provided by the Plasterer for purposes of levelling the channel to the final floor screed level. The Contractor shall assist the Plasterer in marking out the layout of the ducting to enable the mortar bed to be laid. Final height of the underfloor ducting shall be determined in close liaison with the Builder.
- b) After installation of the mortar bed, the components of the underfloor ducting shall be assembled and installed by the Contractor, following which the screeding will be completed.

3.3.5 TERMINATIONS

Up bends manufactured by the supplier of the underfloor ducting shall be supplied and installed wherever the ducting is terminated at a switchboard, telephone duct or telephone distribution box or where the ducting terminates behind power skirting.

3.3.6 WIRING

Power circuit wiring shall be installed in the centre compartment of the underfloor ducting. Sufficient slack shall be provided to allow for the installation of a floor pedestal outlet at each opening in the ducting, whether an outlet is specified at that position or not. This provision shall take the form of loops in the wiring, including the earth wire, wherever the openings occur. The loops shall be pushed back into the channel and the cover plates replaced. In the instances where pedestals/outlets are not installed, these provisions shall of necessity only be made for the area covered by the circuit and not for the run from the switchboard.

The entire underfloor ducting installation shall be effectively earthed and bonded together.

Galvanised draw-wires shall be supplied and installed along the entire length of the telephone and light current service compartments of the underfloor ducting. The draw wires shall be interrupted at the junction boxes, with enough slack left coiled up to facilitate the drawing in of cables by others.

3.3.7 EXPANSION JOINTS

Where expansion joints in the buildings are crossed by underfloor ducting, expansion joints shall be provided as detailed in 2.4 of this section.

3.4 POWER SKIRTING

3.4.1 GENERAL

Two or three compartment power skirting as specified shall be supplied and installed in the positions and according to the layouts indicated on the drawings.

The top compartment shall be used for power wiring and switched socket outlets, whilst the bottom compartments shall be for telephone and other light current services.

3.4.2 MODULE

The power skirting shall be manufactured from 1mm (minimum) thick sheet steel or aluminium (as specified) in approximately 2,5m lengths.

The covers shall be manufactured in modular lengths, as specified in the Detail Technical Specification or otherwise in 1 m lengths and shall be secured to the wall channel by means of toggle or swivel nuts. Snap-in covers are also acceptable.

At the building module lines, covers of specified length or otherwise in 250 mm lengths shall be installed, against which partition walls may be installed, thereby

trapping these covers. The removable modular covers shall be installed between these "fixed" covers.

Each modular cover associated with the power compartment shall be punched and prepared for the installation of either a 13A or a 16A, 3-pin standard flush switched socket outlet, whether any is specified or indicated for that module or not. Where socket outlets are not installed, the punched holes shall be blanked off with a metal blanking plate, painted the same colour as the power skirting and installed at the back of the covers. These blanking plates shall be easily removable to permit future installation of socket outlets.

Unless otherwise specified, no provision shall be made on the covers of the telephone or light current services compartments for the installation of sockets.

Factory-made end covers shall be installed at the ends of all runs of power skirting. All internal and external bends or offsets shall be factory-made and shall be installed to provide a neat and workmanlike appearance.

3.4.3 PAINTING

The power skirting shall be painted in a colour as specified in the Detail Technical Specification. Aluminium power skirting shall be anodised. The power skirting channels and covers shall be individually wrapped or packed to protect them against damage in transit and before installation.

3.4.4 SOCKET-OUTLETS

Standard 13 A or 16 A, 3-pin flush switched socket outlets (100 x 50 mm nominal size) shall be supplied and installed in the positions indicated on the drawings and as specified in the Detail Technical Specification.

The switched socket outlets shall be secured to the channel by means of suitable brackets.

After installation of the modular front covers, they shall be screwed to the socket outlets to ensure proper alignment between the two components. Separate standard covers need not be provided for the socket outlets.

3.4.5 CONDUIT FEEDERS

Conduits for the circuit wiring to the power skirting shall be installed in the floor slab and shall terminate in flush conduit or boxes, behind the power skirting and installed to match the height of the power, telephone and light current services compartments of the skirting.

The wiring/cables shall pass through large diameter holes cut in the rear of the power skirting. The holes shall be suitably bushed or trimmed to prevent damage to the wiring or cables.

Alternatively conduits feeding to the telephone compartment may be terminated in boxes facing upwards in the floor slab immediately below the power skirting, with suitable bushed or trimmed openings being provided through the bottom of the power skirting duct for the cables to pass through. (Applicable only where the power skirting

occurs at floor level).

3.4.6 POWER SKIRTING AT DOORWAYS

Where a section of power skirting is interrupted by a doorway, bridging conduits shall be installed to interconnect the power skirting sections. Where conduits are not specifically indicated, a minimum of 1 x 32mm bridging conduit shall be installed for each of the power, light current and telephone compartments.

3.4.7 CLEANING

Prior to fitting front covers, the power skirting shall be thoroughly cleaned to remove all dust and rubble and damage to paintwork where this has occurred, shall be repaired.

4 INSTALLATION OF CABLE TRAYS AND LADDERS

4.1 GENERAL

Cable trays and cable ladders complying with the Professional Team's specification shall be supplied and installed where specified and/or where generally suitable for cable distribution.

4.2 RESPONSIBILITY OF THE CONTRACTOR

The Contractor shall supply and install all cable trays and/or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T pieces etc. He shall further liaise with the Main Contractor for the provision of holes and access through the structure and finishes.

4.3 SUPPORTS

Cable tray supports shall consist of two steel hangar rods, at least 8mm in diameter, on both sides of the tray with a substantial steel cross-member on the underside of the tray and bolted to the rods. Alternatively, cable trays may be cantilevered from walls on suitable brackets.

4.4 SPACING OF HORIZONTAL SUPPORTS

Horizontal trays shall be supported at the following maximum intervals:

- (a) 1,2 mm to 1,6 mm thick metal with 12mm to 19 mm return trays - 1m maximum spacing
- (b) 2,5 mm thick metal trays with 76 mm return - 1,5m spacing.
- (c) Cable ladders with 76mm side rail of 2mm thickness and with crossrungs - 1,5m spacing
- (d) Metal cable ladders other than c) above, including site manufactured angle iron types - 1m spacing
- (e) 3 mm thick PVC trays with 40mm return - 1m maximum spacing
- (f) 4 mm thick PVC trays with 60mm return - 1,5m maximum spacing

In addition to the above spacing on the longitudinal run, trays and ladders shall be

supported at each bend, offset and T-junction.

4.5 JOINTS

Joints shall be smooth and without projections or rough edges that may damage the cables. The Contractor will be required to cover joints with rubber cement or other non hardening rubberised or plastic compounds if in the opinion of the Professional Team joints may damage cables.

Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall be made by means of wrap-around splices of the same material as the tray and at least 450mm long. The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray.

Splices as described above shall be provided at joints, which do coincide with supports if the loaded tray sags adjacent to the joint due to the interruption of the bending moment in the tray.

4.6 FIXING TO SUPPORTS

Trays shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened against the tray surface to avoid projections which might damage cables during installation.

4.7 FIXING TO THE STRUCTURE

Where installed on concrete or brick, the supports for cable trays and ladders shall be securely fixed by means of at least 2 heavy duty, expansion type anchor bolts. Cantilevered trays shall be supported by a minimum of two 6mm diameter expansion bolts per support.

It is the responsibility of the Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense. The fixing shall take into account site conditions that prevail during installation.

Where installed on vertical steelwork, cable trays and ladders shall be fixed by means of 6mm diameter bolts and nuts

On horizontal steelwork, use may alternatively be made of "CADDY" type fasteners.

Horizontal trays and ladders shall in general be installed 450 mm below slabs, ceilings, etc. to facilitate access during installation of cables.

Multiple runs shall be spaced at least 300 mm apart unless a different spacing is specified in the Detail Technical Specification.

4.8 INSTALLATION OF CABLES

Cables shall be installed adjacent and parallel to each other on the trays, and snaked slightly to allow for expansion. Cables shall present a neat appearance and shall under no circumstances be bunched. Cables shall be clamped at maximum

intervals of 3 m when installed on horizontal trays and at maximum intervals of 600 mm when installed on vertical trays.

4.9 EARTHING

Metal trays and ladders shall be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed. These additional conductors or tapes shall always be installed in outdoor applications and in coastal regions.

4.10 CORROSION

PVC trays shall be used in corrosive atmospheres. All supports shall be adequately protected against corrosion, preferably with a powder coated paint finish.

5 FIXING MATERIALS

5.1 RESPONSIBILITY

It is the responsibility of the Contractor to position and securely fix conduits, ducts, cables and cable channels, switchboards, fittings and all other equipment or accessories as required for the Installation. The Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

5.2 FINISHING

All unpainted supporting steelwork installed by the Contractor shall be wire brushed and given one coat of rust-resisting primer, followed by one coat of high quality enamel paint before any other equipment is fixed.

5.3 STRUCTURAL STEEL

Supports, brackets, hangers, etc. may only be welded to structural steel members where prior permission of the Engineer's Representative has been obtained. "CADDY" or similar fasteners may be used to fix equipment to structural steel members.

5.4 SCREWS AND BOLTS

Where holes exist in equipment to be fixed, bolts and fixing screws as specified shall be used. Where sizes are not specified, the largest bolt or screw that will fit into the hole shall be used.

5.5 WALL PLUGS

Where the fixing holes in brick or concrete walls are smaller than 10mm dia. and where the mass of the equipment is less than 10kg, wall plugs may be used to fix conduits, cables and other equipment. Fibre or plastic plugs shall be used. Wooden Plugs are not acceptable. Aluminium plugs may be used in face bricks. Plugs installed in joints between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round-headed screws of the correct diameter to match the specific plug shall be used throughout.

5.6 ANCHOR BOLTS

Where the fixing holes are 10mm and larger or where the mass of the equipment is 10kg, equipment shall be fixed by means of expanding anchor bolts or by means of bolts cast into the concrete or built into walls.

5.7 GALVANISED EQUIPMENT

Brass screws bolts and nuts shall be used to fix galvanised equipment.

5.8 SHOT FIRED FIXING

Materials such as metal cable ducts or channels may be fixed against walls and concrete slabs by means of the shot-fired fixings.

The Contractor shall ascertain whether this method of fixing will carry the weight of the material including conductors, cables and other items of equipment to be installed later. Should it be found that the method of fixing is inadequate and supports tend to loosen, the Contractor will be required to fix the material by an alternative method to the satisfaction of the Engineer's Representative.

Where the shot-fired method is used, warning signs shall be placed at all entrances leading to the area where this work is in progress. The Contractor shall take all reasonable precautions to prevent accidents. Refer also to The Occupational Health and Safety Act.

Nails and explosive charges recommended by the manufacturer shall be used throughout.

5.9 CLAMPS AND BRACKETS

Clamps and brackets used to fix or support equipment such as cable trays, ducts, etc. shall be of a purpose made type suitable for the specific application.

6 WIRING

This section covers wiring in approved wire-ways for electrical installations in buildings or other structures under normal environmental conditions for 50 Hz systems not exceeding 600 V.

6.1 TYPE OF CONDUCTORS

PVC-insulated or equivalent, stranded copper conductors and bare stranded or green PVC- insulated copper earth conductors shall be used exclusively. Only where cables are specified or in instances where the exceptions stipulated in SANS 10142 are applicable, may the Contractor deviate from this requirement.

6.2 WIRE-WAYS

All unarmoured conductors shall be installed in conduits, cable channels (trunking) or power skirting and shall under no circumstances be exposed. Cable channels and power skirting shall be of metal construction unless specifically approved to the

contrary.

Tenderers must note that common wire-ways will only be permitted for relatively light current-carrying conductors such as lighting and socket-outlet circuits. Heavy current-carrying conductors such as feeders to distribution boards and large power points, must be installed in separate conduits or wire-ways.

6.3 ORDER OF WORK

Wiring shall only be carried out after the wire-way installation has been completed, but before painting has commenced. Debris and moisture shall be removed from the wireways prior to the installation of the conductors.

6.4 CIRCUITS

Conductors that are connected to different switchboards, shall not be installed in the same wireway. The wiring of one circuit only will be allowed in a 20 mm dia. conduit with the exception of the wiring from switchboards to fabricated sheet metal boxes close to switchboards in which case more than one circuit will be allowed. For larger conduit sizes the requirements of SANS 10142, shall be met.

6.5 LOOPING AND JOINTS

A loop-in wiring system where conductors are looped from outlet to outlet, shall be employed. Joints in conductors shall be avoided as far as possible but where it becomes unavoidable, joints will be accepted in cable channels only and not in conduits. Joints shall be soldered or shall alternatively consist of approved ferruling, properly covered with heat-shrink sleeves. The use of PVC insulation tape is not acceptable.

6.6 GROUPING OF CONDUCTORS

In cases where the conductors of more than one circuit are installed in the same wireway, the conductors of each separate circuit (including earth conductor) shall be taped at intervals of 1m with PVC insulation tape. The conductors of different circuits shall however remain separate in order that any given circuit can be withdrawn. Conductors entering switchboards or control boards shall be grouped and bound by means of plastic or metal bands (not tape).

6.7 CABLE TRAYS

Conductors may only be installed directly on cable trays if specifically approved by the Professional Team. In these cases cable trays shall be at least 2m above walkways or working areas. Conductors of the same circuit shall be grouped in the same manner as described in the previous paragraph. All the conductors on the cable tray shall then be tied down securely to the cable tray at intervals of 2m or less by means of plastic or metal bands (not tape).

6.8 DRAWING IN OF CONDUCTORS

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted. Care shall also be taken that the conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the

durability of the conductor.

6.9 THREE-PHASE OUTLETS

With the exception of three-phase outlets, circuits connected to different phases shall not normally be present at lighting, switch or socket outlet boxes. Where this is unavoidable, barriers shall be provided between terminals or connections of the various phases and the box shall be suitably labelled internally to indicate the presence of three phase voltages.

A neutral conductor shall be installed to all three phase outlets intended for equipment connection, whether sockets or isolators, irrespective of whether the particular equipment normally requires a neutral or not.

6.10 VERTICAL CONDUIT INSTALLATION

Conductors installed in vertical wire-ways shall be secured at intervals not exceeding 5m to support the weight of the conductors. Clamps shall be provided in suitable draw boxes for this purpose.

6.11 CONNECTIONS

The insulation of conductors shall only be removed over the portion of the conductors that enter the terminals of switches, socket outlets or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

6.12 EARTHING CONDUCTORS

When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and then soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

The installation shall be earthed to comply with SANS 10142.

The installation shall be bonded to comply with SANS 10142.

6.13 COLOURS

The colours of conductor insulation shall comply with SANS 10142. The colours of conductors for sub-circuits shall as far as possible correspond with the colour of the supply phase. The colours of conductors for wiring to two-way and intermediate switches shall preferably differ from the colour of phase conductors.

6.14 SINGLE POLE SWITCHES

Single pole switches shall be connected to the phase conductor and not to the neutral conductor.

6.15 SIZE OF CONDUCTORS

Where conductor sizes are not specified, the following minimum conductor sizes

shall be used:

Lighting circuits:- 1,5mm² and 2.5mm² copper earth conductor

Socket outlet circuits:- 2,5mm² and 2,5mm² copper earth conductor.

Bell circuits:- 1,5mm²

Stove circuits:- 10mm² and 6mm² copper earth conductor

Clock circuits:- 1,5mm²

6.16 PARTITIONS

When wiring is installed in removable partitions, the vertical and/or horizontal metal supports of the walls may be utilised for wiring on condition that:

- (a) the conductors are not exposed,
- (b) the metal supports are properly earthed
- (c) a separate bare earth continuity conductor is drawn in together with the current carrying conductors and is earthed to the metal parts of the switches and/or the socket outlets, and
- (d) conductors are installed in the metal and non-inflammable sections of the partitions.

Conductors enclosed in a copper braiding (harness wiring) may be installed in removable partitions. The braiding can be used as earth continuity conductor. The wiring shall be joined to the conduit (or cable) installation by interconnecting the conductor and the earth conductors in a draw-box using suitable ferrules and heat-shrink sleeves or screwed terminals.

7 INSTALLATION OF CABLES

This section covers the installation of cables for the distribution of power in buildings, other structures and in ground for system voltages up to 11 kV, 50 Hz.

7.1 GENERAL

1 CABLE TYPES

- (a) All cables and jointing and termination accessories used for power distribution shall comply with the requirements of the regulations of legislation listed in 1.3.
- (b) Cables with copper conductors shall be used throughout unless otherwise specified or approved.
- (c) All unarmoured cables shall be installed in metal trunking, sleeves or conduit unless clearly specified to the contrary.

- (d) XLPE Cables shall only be used in exceptional circumstances with the written permission of the Engineer's Representative.

2 COMPETENCE OF PERSONNEL

It is a definite requirement that the Contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for joining and terminating cables.

7.2 IDENTIFICATION OF CABLES

Cables shall be identified at all terminations by means of punched metallic bands or marked with labels or tags. (Refer also to SANS 10142).

The use of PVC tape with punched characters is not acceptable.

The identification numbers of cables shall be shown on "as built" drawings of the Installation.

7.3 TRENCHING

7.3.1 GENERAL

The Contractor shall be responsible for all trenching excavations unless specified to the contrary.

The Contractor shall, before trenching commences, familiarise himself with the routes and site conditions and the procedure and order of doing the work shall be planned in conjunction with the general construction programme for other services and building requirements.

The Contractor shall acquaint himself with the position of all the existing services such as stormwater pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose he shall approach the Engineer's Representative, the local municipal authority and any other authority which may be involved, in writing.

The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.

The Contractor shall take all the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

7.3.2 MECHANICAL EXCAVATORS

Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other plant, services or other installations

likely to be damaged by the use of such machinery.

The use of power driven mechanical excavators shall be subject to the approval of the Engineer's Representative. Should the excavator produce trenches that exceed the required dimensions, payment based on volumetric excavation rates will be calculated on the required dimensions only.

7.3.3 BLASTING

No guarantee is given or implied that blasting will not be required.

Should blasting be necessary and approved by the Engineer's Representative, the Contractor shall obtain the necessary authority from the relevant Government Professional Teams and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

7.3.4 ROUTES

Trenches shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by the Engineer's Representative beforehand.

The Professional Team reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at the documented rates.

The removal of obstructions along the cable routes shall be subject to the approval of the Professional Team.

7.3.5 SHORING AND WATERLOGGING

The Contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to waterlogging or other ground conditions. Refer to the the Occupational Health and Safety Act.

The strength of shoring must be adequate for site conditions prevailing and the shoring must be braced across the trench.

The Contractor shall provide all pumps and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard.

7.3.6 TRENCHING

Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of the Engineer's Representative.

Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification.

The bottom of the trench shall be of smooth contour, and shall have no sharp dips or rises which may cause tensile forces in the cable during backfilling.

The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for backfilling on completion of cable laying.

Surplus material shall be removed from site and disposed of at the cost of the Contractor.

Trenches across roads, access ways or footpaths shall not be left open. If cables cannot be laid immediately the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

In the event of damage to other services or structures during trenching operations the Contractor shall immediately notify the Engineer's Representative and institute repairs.

Prior to cable laying the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after laying shall be removed.

Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, the Engineer's Representative shall be notified before installing the cables. The Engineer's Representative will advise on the course of action to be taken.

Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, they shall be replaced by a person qualified to do so.

7.3.7 DIMENSIONS OF TRENCHES

Cable trenches for one or two cables shall not be less than 300 mm wide and need not be more than 450 mm wide. This dimension shall be valid for the total trench depth.

The width shall be increased where more cables are installed to allow for the spacings stipulated in par. 4.2.

Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the requirements of the relevant SANS Specification regarding the bending radii of cables are met when determining trench widths.

Trench depths shall be determined in accordance with cable laying depths and bedding thickness.

Payment will be made on a volumetric excavation rate calculated on the basis of the given maximum dimensions or the actual dimensions, whichever is the lesser.

7.3.8 JOINT HOLES

Where cable joints are required to be made in the course of a cable run, a joint hole

shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded.

7.3.9 BEDDING

The bottom of the trench shall be filled across the full width with a 75mm layer of suitable soil sifted through a 6mm mesh and levelled off.

Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1,5°C m/W) may be used for this purpose. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. The use of crusher sand is acceptable.

Where no suitable soil is available on site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations.

After cable laying a further layer of bedding shall be provided to extend to 75 mm above the cables

The bedding under joints shall be fully consolidated to prevent subsequent settling.

7.3.10 CABLE SLEEVES

Where cables cross under roads, railway tracks, other service areas, etc. and where cables enter buildings, the cables shall be installed in Polyethylene (6mm thickness), asbestos cement pipes or earthenware pipes. Pitch fibre and PVC pipes are not acceptable because of the adhesion that occurs after a period of time between the pipe and the sheathing or outer serving of the cables.

Pipes shall be joined in accordance with the manufacturer's instructions.

Sleeves shall cross roads and railway tracks at right angles.

Sleeves shall have a minimum diameter of 100mm. They shall extend at least 2m beyond the tracks of a railway line or of the outermost tracks where there is more than one line. In the case of roads, the sleeves shall extend at least 1m beyond the road edge or kerb on both sides of the road.

All sleeves shall be graded 1:400 for water drainage.

Cable sleeves shall be installed to the spacings and depths stated in paragraph 4 below.

Galvanised metallic sleeves up to and including 76mm dia. shall be supplied and installed by the contractor.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

7.3.11 BACKFILLING

The Contractor shall not commence with the backfilling of trenches without prior

notification to the Engineer's Representative so that the cable installation may be inspected. Should the Contractor fail to give a timeous notification, the trenches shall be re-opened at the Contractor's cost. Such an inspection will not be unreasonably delayed.

For high voltage cables (1 kV to 11 kV) a coloured plastic marking tape shall be installed 400 mm above the cable. The tape shall be yellow, marked with the words "ELECTRIC CABLE" in red. These markings shall not be more than 1m apart from centre to centre.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material, is 75mm.

The Contractor shall have allowed in his tender for the importation of suitable backfill material if required.

The backfill shall be compacted in layers of 150mm and sufficient allowance shall be made for final settlement. The Contractor shall maintain the refilled trench at his expense for the duration of the contract. Surplus material shall be removed from site and suitably disposed of.

On completion, the surface shall be made good to match the surrounding area.

In the case of roadways or paved areas the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

7.3.12 CABLE MARKERS (FOR HV CABLES ONLY, EXCEPT WHERE OTHERWISE SPECIFIED)

Cable markers shall be provided along all HV cable routes but need only be provided along LV cable routes where specified.

Cable markers shall consist of concrete blocks in the shape of truncated pyramids, approx. 300mm high, 150 x 150mm at the top and 250 x 250mm at the bottom.

Brass plates shall be cast into the tops of the blocks in such a manner that they cannot be prised loose. The wording "ELECTRIC CABLE/ELEKTRIESE KABEL" shall be stamped on the brass plates as well as direction arrows and the cable voltage rating.

Cable markers shall be installed on the surface along all the underground routes and shall project 35 mm above normal ground level unless the projected markers could be a hazard to pedestrian or other traffic in which case they shall be installed flush with the surface.

Cable markers shall be installed at the beginning and end of a cable run (e.g. where a cable enters a substation or building), at all changes of direction, above all joints, above cable pipe entries and exits and at intervals not exceeding 50 m along the cable route

The position of cable markers shall be indicated on the "as built" drawings.

7.4 INSTALLATION OF UNDERGROUND CABLES

7.4.1 INSTALLATION DEPTHS

Cables shall be installed at the following minimum depths below final ground level :
Up to 11kV : 800mm

All cable depth measurements shall be made to the top of the cable when laid directly in ground or to the top of the duct or sleeve where these are provided.

The above depths shall apply to the top layer where cables are installed in layers.

The Contractor may only deviate from the above depths provided prior authority in writing has been obtained from the Engineer's Representative. In this event the cables shall be protected with a suitable concrete covering.

The depth of cable pipes or ducts beneath railway lines or roads shall be not less than 1,1 m below the formation level.

7.4.2 CABLE SPACINGS

Cables installed in the same trench shall be laid parallel to each other with the following spacings between cables (LV: up to 1 kV; HV: 1 kV to 11 kV):

LV/LV	:	2 cable diameters
LV/HV	:	150mm
minimum HV/HV	:	
		150mm minimum
LV/HV/PILOT	:	1 cable diameter

Where HV and LV cables have to be installed in the same trench, both shall be laid at a depth of 800 mm and then covered with 200mm of soil. The soil shall then be compacted, and then backfilled layer by layer and compacted until the trench is completely backfilled.

Cables for telephones, communication systems and other low voltage systems (less than 50 V) shall be separated from power cables by at least 1m. All control or pilot cables without a lead sheath and steel armouring shall be laid at least 300mm from power cables.

Cables shall not be buried on top of each other unless layers are specified. The minimum spacing between layers shall be 200mm.

7.4.3 CABLE LAYING

Except where ducts, tunnels or pipes are provided, cables shall be laid directly in the ground.

The cable shall be removed from the drum in such a manner that the cable is not subjected to twisting or tension exceeding that stipulated by the cable manufacturer.

Cable rollers shall be used as far as possible to run out cables. Rollers shall be spaced so that the length of cable in the trench will be totally suspended during the laying operation and sufficiently close to prevent undue sagging and the cable from touching the ground. Rollers shall also be placed in the trench in such a manner that

they will not readily capsize.

Cable rollers shall have no sharp projecting parts liable to damage the cables.

Where cables have to be drawn around corners, well-lubricated skid plates shall be used. The skid plates shall be securely fixed between rollers and shall constantly be examined during cable laying operations.

Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. In the case of oil filled cables, a cable sock may never be used. Special eyes giving access to the interior of the cable, must be utilised.

The maximum allowable tension when pulling a cable, is 70 N/mm² of conductor area.

It will be assumed that the price or rates contained in the tender includes for the installation of cables in pipes and ducts or below existing or newly installed services.

The Professional Team shall be informed timeously of the intention to carry out all cable laying operations to allow an inspection of the works by the Engineer's Representative if so required.

7.5 INSTALLATION OF CABLES IN CONCRETE TRENCHES

7.5.1 GENERAL

This paragraph covers the installation of cables in building trenches, service ducts, etc. The trenches, ducts, etc. inside buildings will be constructed and installed by others.

7.5.2 INSTALLATION

Cables shall be installed in one of the following ways:

- (a) On horizontal cable trays
- (b) On horizontal metal supports with suitable clamps.
- (c) On vertical cable trays or metal supports fixed to the side of the trench. The cables shall be clamped in position.

Cables shall not be bunched and laid on the floor of the building trenches.

7.5.3 COVERS

The covering of concrete trenches shall as a rule fall outside the scope of the electrical installation. The Contractor shall however be responsible for the cutting or drilling and smoothing of holes for cables through chequer plates, concrete or other coverings as required.

Cables shall enter and exit the trench through sleeves protruding 300mm beyond the covering. The sleeves shall be permanently secured in position and the open space

between the cable and sleeves shall be sealed with a non-hardening, watertight compound.

7.5.4 FILLED TRENCHES

Where specified, floor trenches shall be filled with fine crusher sand (no river or sea sand)

If a sand filling is specified, the cables shall be fixed to non-corroding supports.

Sand-filled trenches other than in substations shall be covered in one of the following ways:

- (a) Reinforced concrete covers.
- (b) Sand and cement screed.
- (c) Removable chequer plates.

Method (a) above shall be used where vehicular traffic may be encountered over trenches. Unless otherwise specified allowance for a mass of 2 tons shall be made.

7.6 FIXING OF CABLES TO TRAYS OR STRUCTURES

7.6.1 INSTALLATION

Cables may be installed in one of the following ways:

- (a) On horizontal cable trays.
- (b) Against vertical cable trays with suitable clamps.
- (c) Against horizontal or vertical metal supports or brackets with suitable clamps.
- (d) On clamps which are fixed to the structure.

7.6.2 CLAMPS

Suitable clamps (cleats) which will secure cables without damage shall be used. Metal clamps or drilled hard wood blocks shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

7.6.3 SPACING OF SUPPORTS

Two methods of supporting cables are found in practice. The most generally known method is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable. The alternative method is the unrestrained installation where the distance between supports should be great enough to ensure that there will be obvious sag in each span between supports.

7.6.4 SPACING OF SUPPORTS OF UNRESTRAINED CABLES

Large single core cables shall always be installed according to this method. Generally, single core cables with conductors exceeding a cross sectional area of 185mm² should be supported at spacings in excess of 2m since the sag between supports will safely accommodate any thermal expansion.

Reducing the spacing between the supports to 1,5m or less shall be avoided at all costs, as expansion cannot be taken up by a change of sag and chances of sheath failure become considerable.

7.6.5 SPACING OF SUPPORTS OF RESTRAINED CABLES

Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multi-core control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 550mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900mm for armoured cables. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142. A minimum of 20mm ventilation clearance shall be maintained between cables and the wall to which they are cleated.

7.7 GROUPING AND SPACING OF CABLES IN BUILDINGS AND STRUCTURES

7.7.1 SPACING CORRECTION FACTORS

Cables shall as a rule be spaced two cable diameters apart, for which no grouping correction factor need be applied.

7.7.2 CABLES ON DIFFERENT LEVELS

Where parallel cable runs are installed at different levels (e.g. on parallel cable trays) and where the spacing of the layers is not specified, a minimum spacing of 300mm shall be maintained.

7.7.3 SINGLE CORE CABLES

Where single core cables are installed along a three-phase circuit, the cables shall be installed in trefoil formation and bound together at 300mm intervals.

7.7.4 HIGH VOLTAGE CABLES

High voltage cables shall be separated from other cables and services throughout the installation and shall as far as possible be installed in separate floor trenches, pipes or metal channels. Where this is not feasible a minimum spacing of 500 mm shall be maintained.

7.7.5 CABLES FOR OTHER SERVICES

Cables for telephones, communication systems and other low voltage systems (less than 50V) shall be separated from power cables. In building ducts a physical barrier shall be provided between power cables and cables for other services. Where armoured cables are used for such other services, they shall be installed on separate cable trays or shall otherwise be at least 1m away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

TABLE 1

Cross-Sectional Area of Cable Conductors (mm²)	MAXIMUM SPACING OF SUPPORTS (CLEATS) (mm) FOR RESTRAINED CABLES			
	Wire Armoured Cables		Other than Wire Armoured Cables and Unarmoured Cables	
	Horizontal Cable Routes	Vertical Cable Routes	Horizontal Cable Routes	Vertical Cable Routes
1,5	450	750	300	400
2,5	450	750	300	400
4,0	600	750	300	400
6,0	600	750	300	400
10,0	750	900	400	450
16,0	750	1000	400	550
25,0	900	1000	450	550
35,0	900	1000	450	550
Bigger than 35,0	900	1000	450	550

For larger cables the spacing shall be 10 x outside diameter of the cable.

7.8 TERMINATION AND JOINTING OF CABLES

7.8.1 GENERAL

Cable ends shall be terminated with glands or in cable boxes with the associated accessories such as clamps, shrouds, etc. complying in all respects with the Engineer's Representatives instructions.

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear will be in the following positions:

- No. 1 conductor : left (red) (A)
- No. 2 conductor : centre (white) (B)
- No. 3 conductor : right (blue) (C)

Exposed armouring shall be covered with bitumen-base paint.

All cable ends shall be supplied with the necessary earth connection.

A channel or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases. Refer to SANS 10142.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and glands employed.

7.8.2 TERMINATION OF PVC INSULATED CABLES

Cable ends shall be terminated by means of adjustable glands.

The glands shall be fitted in accordance with the cable and gland manufacturer's instructions.

The correct size and type of gland shall be used for the particular cable and application.

7.8.3 CONNECTION OF CABLE CONDUCTORS

Suitable lugs shall be used, preferably solidly sweated to the cable conductor ends. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1 : "COMPRESSION JOINTS IN COPPER".

Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.

Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductor, need not be lugged but the correct terminal size shall be used.

Ferrules shall be used as far as possible where cable conductors are connected directly to equipment with screws against the conductor strands.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs.

7.8.4 JOINTS

Joints in cable runs will not be allowed unless specified in the Detail Technical Specification or authorised by the Engineer's Representative.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions and by personnel competent in jointing the types of cables used.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. Where necessary a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the hole shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The joint shall not impair the anti-electrolysis characteristics of the cable.

The Contractor shall notify the Engineer's Representative timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer's Representative because of insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer's Representative at the cost of the contractor.

LV cable joints shall be of the epoxy-resin type.

Joints shall be fully water and airtight and shall be free of voids and air pockets.

The crossing of cores in joints will not be permitted under any circumstances.

7.9 TESTING

Each cable shall be tested after installation in accordance SANS 1507 (up to 1 kV) and SANS 97 (up to 11 kV) as well as the requirements of the Local and Supply Authorities.

LV Cables shall be tested by means of a suitable megger at 1 kV and the insulation resistance shall be tabulated and certified.

TABLE 2

Cable Rating (kV)	TEST VOLTAGE (Applied for 15 minutes) (kV)				
	Paper-insulated cables				XLPE-insulated cables
6,6 11	Between conductors		Conductors to sheath		Conductors to screen
	AC (r.m.s)	DC	AC (r.m.s)	DC	DC
	12 20	18 30	12 20	18 30	11 18

* High Voltage test with DC to 2kV for 1 minute only. Discharge cable slowly via discharge stick (1 minute). Clamp all conductors to earth for 24 hours.

HV Cables shall be high voltage tested in accordance with Table 2 and the exact leakage current shall be tabulated and certified.

The Contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The cost of testing shall have been included in the tender price.

The Contractor shall notify the Engineer's Representative timeously so that a he/she may witness the tests.

On completion of the tests on any cable, the Contractor shall without delay, submit three copies of the certified Test Reports to the Engineer's Representative.

7.10 MEASUREMENTS

All measurements for payments shall be made jointly by the Engineer's Representative and the Contractor and the Contractor shall obtain the signature of the Engineer's Representative including approval of such measurements.

No allowance shall be made for the breaking away of the trench sides, other earth

movements or for trenches excavated in excess of the stipulated dimensions.

The classification shall be as follows:

Very hard rock shall mean rock that can only be excavated by means of explosives.

Hard rock shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of jack hammers and other mechanical means of excavations.

Soft rock and earth shall mean rock and earth that can be loosened and removed by hand-pick and shovel.

Where very hard rock and hard rock are encountered, the prior approval of the Engineer's Representative shall be obtained before proceeding with the excavation. This requirement is stipulated in order to afford the Engineer's Representative the opportunity to determine whether an alternative cable route is justified.

All cable lengths indicated in the Detail Technical Specification and/or shown in the cable route drawings shall be regarded as estimates and are given for tendering purposes only. The successful tenderer shall measure actual cable lengths on site before ordering.

The final price for the supply and installation of all cables will be adjusted, on the basis of the actual lengths of installed cables, in accordance with the unit rates quoted at the time of tendering. Cable lengths shall be measured on site to the nearest 500mm for this purpose and surplus cable will not be paid for.

7.11 COMPLETION

The Professional Team reserves the right to inspect the installation at any stage during the course of construction. Such inspections will however not deem the portions inspected as being complete or accepted and the Contractor shall remain responsible for completing the installation fully in accordance with the Contract Documents.

The Contractor shall carry out a final "as built" survey of the cable routes and present to the Professional Team "as built" route plans of the complete installation. The following information shall be reflected on the plans or submitted as separate schedules with the plans:

- (a) Overall length of each cable.
- (b) Locations of all joints (if any) in relation to permanent reference points. Dimensions shall be shown and the method of triangulation i.e. two dimensions to each joint, shall be used
- (c) Identification of each cable.

The works will be deemed to be incomplete until all tests have been conducted successfully and all "as built" drawings and schedules have been handed to the Professional Team.

8 INSTALLATION OF LIGHT SWITCHES AND SOCKET-OUTLETS

8.1 GENERAL

8.1.1 POSITION OF OUTLETS

Switches and socket-outlets shall be accurately positioned in accordance with the drawings. It is the Contractor's responsibility to ensure that all outlets are installed level and square, at the correct height from the floor and at the correct position relative to building lines and equipment positions as specified. It is the Contractor's responsibility to determine the correct final floor level and ceiling level in conjunction with the Main Contractor.

8.1.2 COVER PLATES

All switches and socket-outlets shall be fitted with standard metal cover plates. The colour of cover plates shall be as specified or shall otherwise match the surrounding finishes as closely as possible. Unless specified to the contrary, ivory cover plates shall be installed on painted walls. Cover plates in the same area shall have the same colour. Flush mounted cover plates shall overlap the draw-box and edges of the recess. Cover plates shall under no circumstances be cut unless authorised by the Professional Team.

8.1.3 ESCUTCHEON PLATES

Where flush mounted switches or socket-outlets are installed in special wall finishes e.g. wood or board panels, acoustic tiles or other cladding, etc. and where the wall finishes must be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the outlet boxes and shall be fixed independently of the boxes and cover plates. Bevelled cover plates shall be fixed to the outlet boxes and shall fit firmly against the escutcheon plate.

8.1.4 APPEARANCE

The sides of adjacent switches, plugs, push-buttons etc. shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be placed around flush mounted outlets and accessories where the standard cover plates do not cover the cut-outs in the finishes.

8.1.4 DEEP BOXES

Where switch or socket-outlet boxes have been set deep, spiral type steel wire spacers shall be used to fix the yoke of the switch or socket.

8.2 INSTALLATION OF SOCKET OUTLETS

8.2.1 MOUNTING HEIGHT

Unless specified to the contrary, socket-outlets shall be installed at the following heights above finished floor level, measured to the centre of the outlet:

Flush mounted in general:	300mm
Showrooms, shops, servant's quarters:	1,4m
Domestic kitchens, tea kitchens:	1,05m
Commercial kitchens:	1,4m
Factories, workshops, garages:	1,4m

8.2.2 WALLS

In cases where socket-outlets must be mounted at a nominal height of 300mm and where the lower portion of the wall consists of face bricks and the upper portion is plastered, the outlets shall be installed in the plastered portion of the wall. If however the plastered portion of the wall commences 500mm or more above floor level the outlets shall be installed in the face bricks. Where a wall has different surface finishes the outlets shall be installed within the same finish and not in the dividing lines between the different wall finishes. All outlets shall be installed at least 150mm away from door frames.

8.3 INSTALLATION OF LIGHT SWITCHES

8.3.1 MOUNTING

Light switches shall be installed 1,4m above finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch. All single switches shall be installed with the long side of the toggle vertical.

8.3.2 DOORS

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall be verified before the switch-box is installed. Switch boxes in brick or concrete walls shall be installed 150mm from the door frame. Light switches installed in partitions or door frames shall be of the type designed for that purpose.

8.3.3 WALLS

Where the lower portion of a wall is face brick and the upper portion plastered, light switches shall be installed wholly in the plaster provided that the lower edge of the plaster is not higher than 1,6m above the finished floor level. In general where different wall finishes are used in the same area. Switches shall be installed within the same finish and not on the dividing lines between finishes.

8.3.4 PARTITIONS

Light switches installed in partitions shall preferably be of the type designed to be accommodated in the partition construction. Switches installed in the metal supports do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

8.3.5 WATERTIGHT SWITCHES

Switches that are exposed to the weather or are installed in damp areas, shall be of the watertight type

8.3.6 MULTIPLE SWITCHES

Where several switches are required in one position, multi-lever switches in a common switch box shall be provided wherever possible. All circuits wired into this box shall be on the same phase in order that voltages in excess of 250 V are not present in the box. Where it is not possible or practical to do this, barriers shall be installed and a label shall be prominently displayed within the box stating that voltages in excess of 250 V are present.

9 PHOTO ELECTRIC DAYLIGHT SENSITIVE SWITCH FOR OUTSIDE LIGHTING

9.1 INSTALLATION

The outside lighting of each individual building i.e. light circuits marked "T" on the drawings, shall be controlled by photo-electric daylight sensitive switches.

The positions of the switches as indicated on the drawings are provisional and the exact positions shall be confirmed with the Engineer's Representative on site.

Individual outside lighting circuits on a building may be connected directly to the daylight sensitive switch.

Where two or more lighting circuits are to be controlled by a single daylight sensitive switch, a contactor actuated by the unit shall be provided in the switchboard.

A by-pass switch enabling the lights to be turned on at any time, shall be provided.

9.2 CONSTRUCTION

The unit shall comprise a photocell, thermal actuator and change-over switch. The cover of the unit shall be manufactured from a tough, durable material providing protection against tampering. The cover shall have good weathering properties. It shall be ultraviolet-resistant and shall not deteriorate when exposed to sunlight for prolonged periods.

The unit shall be of the wall mounting type and shall be supplied complete with a suitable bracket.

The operational level shall be factory pre-set for "ON" at a light level of approximately 54 lux and "OFF" at approximately 108 lux. Voltage variations shall not materially affect the operational levels.

A time delay of not less than 15 seconds shall be provided to prevent the unit from functioning due to short period changes in illumination.

The unit shall be effectively safeguarded against voltage surges by means of a suitable surge protector which shall preferably form an integral part of the unit.

10 INSTALLATION OF LUMINAIRES

10.1 POSITIONS

The mounting positions of luminaries shall be verified on site. All luminaries shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space unless otherwise indicated. The layout as shown in the Documents shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Professional Team, before commencing erection of the installation.

10.2 COVER PLATES

Cover plates shall be fitted over all draw-boxes and outlets intended for luminaries that are not covered by the luminaries canopy, lamp-holder, ceiling rose or similar accessories.

10.3 FIXING TO DRAW BOXES

Where an outlet box or draw-box provides the necessary support for a luminaries, all luminaries with the exception of fluorescent luminaries mounted against ceilings, shall be fixed directly to the box. Fluorescent luminaries and luminaries with a mass in excess of 10kg shall however be suspended independently of the outlet box.

10.4 HANGERS AND SUPPORTS

Where provision has not been made for the fixing of luminaries, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any other fixing method approved by the Professional Team.

10.5 SUSPENDED LUMINAIRES

The necessary hangers shall be provided where luminaries which are of the non-suspension type have to be fixed below false ceilings or roof slabs. The use of 20mm conduits fixed to the roof slab or ceiling is preferred. Provision shall be made for adjustments to enable the levelling of luminaries. Suspended conduits shall be fixed to the ceiling by means of screwed dome lids, bolts and nuts. Ball-and-spigot type dome lids shall be used where conduit lengths exceed 600mm. Wiring shall be installed in the conduit hangers.

10.6 SUSPENDED WIRING CHANNELS

Luminaries (especially fluorescent luminaries) may also be suspended from ceilings by means of suspended metal channels. The metal channel may be supported by conduits or threaded rods. Should metal rods be utilised, these shall be screwed to anchor bolts fixed in the roof slab. Wiring shall either be installed in conduits fixed to the metal channel or in the metal channels and covered with a suitable cover plate. Purpose-made clamps shall be used to fix the luminaries to the cable channel.

10.7 CEILING BATTENS

Where wooden blocks are used to suspend luminaries, ceiling battens shall not be cut. The wooden blocks shall be cut to fit around battens and shall be screwed to the ceiling. Battens may however be cut where fluorescent or incandescent luminaries with metal canopies have to be installed against a false ceiling.

10.8 GLASS-BOWL LUMINAIRES

Unless specified to the contrary, suspended glass-bowl luminaires shall be installed with the underside at least 2,1 m above finished floor level.

10.9 FLUORESCENT LUMINAIRES FIXED TO CONCRETE SLABS

Fluorescent luminaires to be installed directly against concrete slabs or walls shall be securely fixed to the outlet box and at two additional points. Shot-fired fixings are not acceptable. Where approved, fluorescent luminaires may be installed against metal wiring channels in which the wiring is housed. The channel fixing may in this case be shot-fired. Purpose-made fluorescent fixing adaptors shall be used to fix luminaires to cable channels.

10.10 FLUORESCENT LUMINAIRES FIXED TO CEILINGS

In all cases where luminaires are fixed to false ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation. Should any doubt exist in this regard, the matter shall be referred to the Engineer's Representative.

In cases where the weight of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.

Surface mounted fluorescent luminaires shall fit firmly against the ceiling brading without leaving gaps between luminaire and ceiling. The luminaire shall be fixed directly to the ceiling by means of brass plated round-head wood screws and washers.

In the case of tiled ceilings with exposed or concealed T-section supports, surface mounted luminaires shall be fixed only to the tiles by means of butterfly screws or bolts with nuts and washers. The tiles shall be suitably reinforced.

Luminaires may alternatively be fixed to metal cross-pieces resting in the ceiling tees.

Drilling of holes in ceiling tees to support luminaires will not be allowed.

Luminaires shall be fixed in neat relation to the ceiling lay-out.

10.11 CONTINUOUS ROWS OF LUMINARIES

In cases where fluorescent luminaires are installed in tandem, only one connection outlet need be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and locknuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the luminaire bodies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at porcelain terminal blocks. "SCREW IT" or similar connectors may only be used if prior permission is obtained from the Professional Team. The wiring for any other circuits or outlets, even though these may be in the same row, may not be installed through the luminaire bodies. The Contractor shall ensure that continuous rows are

straight and parallel to the relevant building lines.

10.12 RECESSED LUMINARIES

Where recessed luminaries are specified, the Contractor shall maintain close liaison with the ceiling Contractor. In the case of tiled ceilings, the luminaries shall preferably be installed while the metal supports are being installed and before the tiles are placed in position. The Electrical Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles with the other contractors concerned.

All mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.

In all false ceilings where wiring channels are used, recessed luminaries shall be connected to the wiring channels by means of unswitched 5 A socket-outlets.

The following requirements shall be adhered to:

- (a) Socket outlets used shall comply with the Professional Team's quality specification for "UNSWITCHED AND SWITCHED SOCKET-OUTLETS", par. 4 of Section 11 and shall be of 5 A minimum rating.
- (b) The connector cord attached to the luminaire may not exceed 3m in length and shall consist of 1,5mm² minimum, 3-core, PVC-insulated flexible cord.
- (c) The 5A socket-outlets shall be positioned such that they are not more than 600mm above the false ceiling.

10.13 SPECIAL CEILINGS

In cases where special ceilings e.g. aluminium strips, decorative glass, metal leaves, etc. are to be installed, the Contractor and the Manufacturer of the ceiling shall agree upon the method of fixing of luminaries in the ceiling.

10.14 BULKHEAD LUMINAIRES

Surface mounted bulkhead luminaries shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw-box at the top or rear of the luminaire. The PVC- insulated conductors shall terminate in a porcelain terminal strip in the draw-box. Silicon- rubber-insulated conductors shall be installed from the terminal strip to the luminaire lamp- holder. "SCREW-IT" or similar connectors may only be used if prior permission is obtained from the Professional Team.

10.15 TYPE OF CONDUCTOR

PVC-insulated conductors, unless protected by an approved heat-resistant sheathing, shall not be used where the temperature of the insulation is likely to exceed 70°C. In unventilated luminaries or luminaries capable of housing incandescent lamps over 60W, the interconnecting wiring from the lamp-holder to the circuit wiring shall consist of silicon-rubber insulated conductors. Silicon-rubber insulated conductors shall be used exclusively in the case of high bay fittings. Refer also to the provisions of SANS 10142.

10.16 WIRING OF LAMP HOLDERS

The central terminal of Edison Screw (E.S.-type) LAMP-HOLDERS shall be connected to the phase conductor and the screwed housing to the neutral conductor.

10.17 HIGH BAY LUMINAIRES

High bay luminaires shall be securely suspended from the roof structure

The luminaires may be fixed to suspended wiring channels containing the wiring on condition that:

- (a) rigid channels with a maximum width of 42 mm be used,
- (b) the channels are supported at intervals that will prevent sag or warp and
- (c) the channels are large enough to accommodate the wiring.

The Luminaires may be suspended from metal roof trusses with the aid of "CADDY" or similar fasteners.

Luminaires shall preferably be connected to unswitched 5A socket outlets.

Silicon- rubber insulated flexible cord shall be used exclusively to connect the luminaire to the outlet.

A safety chain to keep the luminaire from falling when loosened shall be provided.

11 CONNECTIONS TO EQUIPMENT

11.1 GENERAL

This section covers the final electrical connections to switchboards and various equipment in general electrical installations under normal environmental conditions for system voltages up to 600 V.

11.2 CONNECTIONS TO SWITCHBOARDS

11.2.1 CONDUIT ENTRIES

Where sufficient space for conduit entries as well as adequate space for future conduit entries is available, conduits may be terminated directly on the switchboard.

Alternatively, conduits connected to switchboards shall terminate in a common fabricated sheet steel draw-box installed in the vicinity of the switchboard. In open roof spaces this draw-box shall be placed in a roof space of not less than 900mm clearance.

Lighting and socket-outlet circuits may be separately grouped in common conduits or metal ducts (trunking) from the distribution board to the draw-box. The drawbox shall be of sheet steel with a minimum thickness of 1,6mm and shall be fitted with a removable cover plate.

11.2.2 FLUSH MOUNTED SWITCHBOARDS

Where flush mounted switchboards are required, the recessed switchboard tray shall be built into the brick or concrete wall. All conduits from the floor or roof shall be fully recessed and shall be bonded directly to the tray by means of locknuts on both sides and the ends of the conduits fitted with a brass bush.

11.2.3 SURFACE MOUNTED SWITCHBOARDS

Where surface mounted switchboards are specified but where the conduits can be fully recessed, the conduit shall be connected to a recessed connection box installed behind the switchboard. An opening with the same dimensions as the connection box shall be cut in the back of the switchboard and fitted with a suitable grommet.

11.2.4 SPARE CONDUITS

Where conduits from a switchboard run into a false ceiling space above the board, a minimum of two 25mm and two 20mm spare conduits shall be installed into the ceiling space immediately above the board.

11.2.5 CABLE CONNECTIONS

Where underground cables are to be connected to switchboards, it shall be the responsibility of the Contractor to ensure that metal, earthenware, asbestos-cement or other approved sleeves are built in correctly to enable installation and connection of the cable to the switchboard.

PVC or pitch fibre sleeves are not acceptable.

Sleeves shall be installed with a fall from inside to outside of the building to facilitate drainage. The sleeves shall be sealed with a non-hardening compound after installation of the cables to render the installation vermin proof and waterproof.

A metal cable channel with removable metal cover plate shall be installed by the Contractor and shall extend from the switchboard to the floor or into the ceiling void as required. The channel shall coincide with the position of sleeves. The channel shall be flush mounted except in the case of surface mounted switchboards and then only with the permission of the Engineer's Representative.

The cable channel shall be large enough to permit the installation of cable glands and future cables, particularly where spare sleeves have been provided.

The colour of the channel cover shall match that of the associated switchboard.

11.2.6 CABLE TRENCHES

Where cables in floor trenches have to be connected to wall mounted switchboards, approved sleeves or conduits shall be installed from the side of the trench to the bottom of the switchboard. These sleeves shall be positioned and fixed before the concrete is cast.

12 EARTHING

This section covers the earthing of electrical installations in buildings or other structures. The total earthing system of any electrical installation shall be in complete accordance with SANS 10142.

12.1 GENERAL RECOMMENDATIONS ON THE PRACTICAL INSTALLATION OF EARTH ELECTRODES

12.1.1 REQUIREMENTS OF AN EFFECTIVE EARTH

An effective earth must prevent dangerous over voltages arising between metallic structures, frames, supports or enclosures of electrical equipment and the ground during fault conditions.

An effective earth must be able to permit fault currents of sufficient magnitude to flow so as to operate protective devices to isolate the fault before damage can occur.

The ohmic resistance of an effective earth must be low enough to ensure that the step potential on the ground in the vicinity of the earthing point is within safe limits under fault conditions i.e. a voltage gradient not exceeding 40 V/m for fault durations exceeding 1s.

12.1.2 TYPES OF EARTH ELECTRODES

Three types of earth electrodes are suitable:

1 Trench Earths

Trench earths comprise a bare copper or galvanised iron conductor laid at a minimum of 800mm below ground level, usually when underground cables are installed. This type of earth electrode provides a relatively large contact area between electrode and surrounding ground, makes contact with a variety of types of soil and soils of varying moisture content en route and is economical to install.

2 Spike Earths

Spike earths comprise rods of bare copper, copper-coated steel, stainless steel or galvanised steel designed for the purpose of penetrating ground to depths of up to several meters. A low resistance earth may sometimes be obtained by driving multiple spikes at some distance from each other in order to provide parallel paths.

In hard or rocky ground, it is usually necessary to drill holes into which earth spikes are inserted and then packed with soft soil.

3 Foundation Earths

Foundation earths comprise bare copper or galvanised iron conductors laid under the foundations of buildings, miniature substations, distribution pillars, bases of wooden, concrete or steel poles and structures. Because soil under foundations usually retains moisture, foundation earths are located to take advantage of this favourable condition. Furthermore, they are economical to

install.

12.1.3 MATERIALS FOR EARTH ELECTRODES

Bare copper, either in stranded, strip or rod form, is considered the most suitable general purpose material for earth electrodes. Its main disadvantage is its cost and susceptibility to theft.

Bare galvanised iron and steel, either in stranded, strip or rod form, has a satisfactory record of survival in non-aggressive soils and is more economical than copper.

Bare aluminium is unsuitable as electrode material.

12.1.4 CORROSION

Because galvanised ferrous metals corrode sacrificially to copper, galvanised iron and steel electrodes should not be buried in close proximity to bare copper.

12.2 TECHNICAL REQUIREMENTS OF NEUTRAL EARTHING

The following relevant aspects have been extracted from the "AMEU (Association of Municipal Electricity Utilities) CODE OF PRACTICE FOR THE APPLICATION OF NEUTRAL EARTHING ON LOW VOLTAGE DISTRIBUTION SYSTEMS."

12.2.1 DISTRIBUTION SYSTEMS

Multiple Earthed Neutral (MEN) and Protective Multiple Earthing (PME) systems.

Distribution equipment associated with transformer substations that are either ground mounted or pole mounted and fed by underground cable or overhead line, with or without an earth continuity conductor, (ECC), should be installed, connected and earthed in accordance with the following requirements:

- (a) Where the resistance to earth of the HV equipment earth is 1 ohm or less, it is permissible to earth the LV neutral to the HV earth electrode.
- (b) Where the HV equipment earth exceeds 1 ohm the LV neutral shall be earthed at a minimum distance of 6m from the HV equipment earth (i.e. 6m from the HV electrode/s and also from any earthed metalwork connected thereto).
- (c) Notwithstanding the requirements of (a) above, where transformers are associated with HV overhead lines, it is considered good practice to separate the HV and LV earth electrodes. The minimum earth separation should be 6m or one LV span.
- (d) The overall resistance to earth of the neutral of an LV distributor or distribution system must not exceed 10 ohms.
- (e) The LV neutral may be connected to other supply neutrals, earth electrodes, cable sheaths and armouring and these connections used to obtain the required earthing value of 10 ohms or less specified in par. (d). above.

- (f) The neutral of underground and overhead LV distributors must be earthed at the remote ends of each distributor.
- (g) Where the overall resistance to earth of the neutral of the distribution system exceeds 10 OHMS, the neutral shall be earthed at intermediate positions on the distributor/s to reduce its resistance to earth to below this limit.
- (h) The cross-sectional area of the neutral of all LV distributors must not be less than that of a phase conductor.
- (i) No circuit-breakers, isolators, fuses, switches or removable links shall be installed in the neutral between the transformer star point and the remote end of any LV distributor or service connection.
- (j) All metallic sheathing and armouring of cables and all metalwork associated with meter cabinets, fuse pillars, etc., supporting or enclosing LV cables shall be bonded to the distributor neutral conductor.
- (k) Where a Separate Neutral Earth (SNE) cable is part of an MEN or PME system, the armouring and/or metallic sheath and any ECC shall be bonded to the neutral at the supply end of the cable.
- (l) To ensure the integrity of the neutral, it is recommended that all connections and joints on or to overhead line conductors be made by compression fittings or, alternatively double bolted connectors.
- (m) MEN or PME may be applied to any single LV distributor without alterations to other LV distributors supplied from the same transformer.

12.2.2 PROTECTIVE NEUTRAL BONDING (PNB) SYSTEM

Since the neutral is earthed at one point only, the question of multiple earthing does not arise and there is therefore no necessity to meet the MEN/PME technical requirements.

12.2.3 SERVICE CONNECTIONS

1 MEN System

The following conditions apply to consumers' service connections as well as service connections to traffic signals, road signs, street lighting and other power-consuming equipment installed in public places:

- (a) All service connections must be by means of cable with an insulated phase, an insulated neutral conductor and an ECC
- (b) A single phase service connection comprises a live, a neutral and an ECC.
- (c) A polyphase service connection comprises two or three phase conductors, a neutral and an ECC.
- (d) The service neutral and ECC must be solidly and separately connected

to the distributor neutral at the tee-off point.

- (e) The consumer's earthing lead is connected to the Supply Authority's earth terminal which is in turn connected to the ECC in the service cable at the consumer's supply point
- (f) The neutral must not be connected to earth at the consumer's supply point.
- (g) If required by the Supply Authority, an earth electrode must be installed at the consumer's supply point.
- (h) In a service connection to traffic signals, street light and other power-consuming equipment installed in public places, such equipment is earthed to the ECC of the service connection.

2 PME System

- (a) All service connections must be by means of a cable with an insulated phase and an insulated neutral conductor
- (b) A single phase service comprises a live conductor and a neutral.
- (c) A polyphase service connection comprises two or three phase conductors and a neutral
- (d) The consumer's earthing lead is connected to the supplier's neutral and to a mandatory earth electrode at the consumer's supply point.
- (e) A label must be attached at the consumer's supply point on his premises indicating that the installation is part of a PME system.

Note: It is not recommended that the PME system be applied to supply traffic signals, street signs or other power-consuming equipment installed in public places, because the PME system is inherently unsafe under "broken-neutral" conditions.

12.3 EARTHING OF A GENERAL ELECTRICAL INSTALLATION

12.3.1 GENERAL

All earth conductors shall be stranded copper with or without green PVC insulation. The conductors shall comply with the Professional Team's quality specification for "PVC-INSULATED CABLES", Section 4. All earth conductor sizes shall be determined in accordance with SANS 10142, par. 4.6 where the earth does not form an integral part of the cable.

12.3.2 SWITCHBOARDS

A separate earth connection shall be supplied between the earth busbar of the main switchboard and the earth busbar of every sub-switchboard. These connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors. Alternatively armoured cables with earth continuity conductors included in the

armouring may be utilised.

12.3.3 SUB-CIRCUITS

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply switchboard in accordance with SANS 10142.

12.3.4 RING MAINS

Common earth conductors may be used where various circuits are installed in the same wiring channel in accordance with SANS 10142. In such instances the sizes of earth conductors shall be specifically approved by the Engineer's Representative. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

12.3.5 CONNECTIONS

Under no circumstances shall connection points, bolts, screws, etc. used for earthing be utilised for any other purpose. It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the ends shall be tinned and lugged. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1: "COMPRESSION JOINTS IN COPPER."

12.3.6 NON METALLIC CONDUIT

Where non-metallic conduit is specified or allowed, stranded copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including switch boxes, socket-outlet boxes, draw-boxes, switchboards, luminaries, etc. The securing of earth conductors by means of self-threading screws will not be permitted.

12.3.7 FLEXIBLE CONDUIT

An earth conductor shall be installed in all non-metallic flexible conduit. This earth conductor shall not be installed external to the flexible conduit but within the conduit with the other conductors. The earth conductor shall be connected to the earth terminals at both ends of the circuit.

12.3.8 WATER PIPES

Metal cold water mains shall be bonded to the earth busbar in the Main Switchboard by solid 15 x 2mm copper strapping. All other hot and cold water pipes shall be connected by 12 x 0,8mm perforated or solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipe work by brass nuts and bolts and against walls be brass screws at 150mm centres. In all cases where metal water pipes, down pipes, flues, etc. are positioned within 1,6 m of switchboards, an earth connection consisting of copper strapping shall be installed between the pipe work and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each switchboard.

12.3.9 ROOFS

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed. One bare 10mm² copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor of each switchboard. The roof and gutters shall be connected at 15m intervals to this conductor by means of 12 x 0,8mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

13 INSPECTIONS, TESTING, COMMISSIONING AND HANDING OVER

13.1 PHYSICAL INSPECTION PROCEDURE

Once the Contractor has completed the installation, written notice shall be given to the Engineer's Representative in order that a mutually acceptable date can be arranged for a joint inspection.

During the course of the inspection, the Engineer's Representative will compile a list of items (if any) requiring further attention. A copy of this list will be provided to the Contractor who will have a period of 7 days in which to rectify the offending items of the installation.

The Contractor shall then provide written notice that he is ready for an inspection of the remedial work to the offending items.

This procedure will continue until the entire installation has been correctly completed to the satisfaction of the Engineer's Representative.

13.2 TESTING AND OPERATIONAL INSPECTION PROCEDURE

In addition to the above the Contractor shall have the complete installation tested and approved by the local authorities where applicable.

Subsequent to the above testing and approval, the Contractor shall in the presence of the Engineer's Representative test all circuits with respect to:

- (a) Phase balance.
- (b) Insulation level.
- (c) Polarity.

Upon completion of the installation and within 3 months of the handover date, the Contractor shall provide and make available a recording voltmeter to record the voltage at three locations in the complex over a period of 48 hours each. These locations will be nominated by the Engineer's Representative.

13.3 "AS BUILT" DRAWINGS

As each portion of the work is completed, the Contractor shall provide the Engineer's Representative with as built drawings showing the exact location measured from fixed points of all cables, transmission lines, each outlet point, etc.

In addition a complete reticulation diagram showing all supply cables and switchboards shall be provided behind a plastic cover in the substation or adjacent to the Main Switchboard if not located in a substation.

The installation will not be regarded as complete until all of the above requirements listed in 1, 2 and 3 above have been met.

SOLAR SPECIFICATIONS

PURPOSE & LOADS

The solar power source is designed to charge the batter pack sized to feed the only the lighting loads in the buildings for two days. The system will consist of an array of photovoltaic panels, a single-phase grid tied hybrid inverter with a charge controller, a Battery pack and switching contactor and breakers to ensure safety.

From table 2 the expected lighting only load schedule the connected load of 4.525kW i.e 5kVA @ 0.9066pf and a notified maximum demand of the electrical connection that would be required is 2.3kW i.e 2.5kVA at between 05h00 and 07h00, with a total of 31.65kWhrs per day.

DAILY SUNSHINE HOURS

Solar Power is an average of 5.109 kWh/kWp per day, this varies between 4.66 kWh/kWp per day in Feb and 5.69 kWh/kWp per day in Aug

SOLAR PANELS

24 x 450 Wp = 10.8 kWp photovoltaic panels, strung is 3 strings of 8 panels each.

INVERTERS

One three phase 10kW inverters is required to meet the anticipated peak demand

SMART BATTERY CHARGERS

Taking the battery capacity required is 65 kWh. Using UP5000 Victron Energy 48V Lithium Batteries or equivalent which have a capacity of 4.8kWhrs (100Ah) – a total of 14 batteries are required.

**MINISTRY OF TRANSPORT
AND ENERGY**

DEPARTMENT OF ROADS

Manual

**STANDARD
SPECIFICATIONS**

APRIL 1989

ROADS DEPARTMENT

MINISTRY OF TRANSPORT

STANDARD

SPECIFICATIONS

APRIL 1989

DIRECTOR OF STATE ROADS
ROADS DEPARTMENT
MINISTRY OF TRANSPORT
KAGUVI BUILDING
FOURTH STREET
HARARE

(P.O. BOX 8109, CAUSEWAY)

BRIDGE AND ROAD SPECIFICATION
INDEX TO SECTIONS COMMON TO BOTH BRIDGE AND
ROADWORKS

Section No.	Title	Page No.
C.1	Establishment & General	5
C.2	Accommodation, Vehicles & Equipment	7
C.3	Construction of Detours	10
C.4	Provision of Water	18
C.5	Removal of Existing Structures	21
C.6	Excavation & Backfilling for Structures	22
C.7	Haul & Overhaul	27
C.8	Portland Cement Concrete	30
C.9	No-Fines Concrete	45
C.10	Formwork & Surface Finish	46
C.11	Steel Reinforcement	54
C.12	Slope Protection and Anti-Erosion Works	61
C.13	Statistical Control	70
C.14	Testing	77

INDEX TO SECTIONS ON BRIDGE CONSTRUCTION

Section No.	Title	Page No.
B.1	Site Access and Clearing of the Bridge Site	78
B.2	Piled Foundations	80
B.3	Void Formers	92
B.4	Steel Bearings	93
B.5	Rubber Bearing Pads	97

B.6	Steel Expansion Joints	99
B.7	Rubber Seals for Expansion Joints	101
B.8	Epoxy Nosings, Joint Sealants and Seatings	103
B.9	Steel Parapets	106
B.10	Guardrail	109
B.11	Name Plates	112
B.12	Welded Plate Girders	113
B.13	Friction Grip Splices	120
B.14	Painting of Structural Steelwork	125
B.15	Bridge Approaches	128

INDEX TO SECTIONS ON ROAD CONSTRUCTION

Section No.	Title	Page No.
R.1	Clearing for the Road	134
R.2	Construction of Pipe Culverts	136
R.3	Construction of Box Culverts	142
R.4	Construction of Precast Arched Culverts	147
R.5	Preparation of Roadbed	152
R.6	Construction of the Subgrade	154
R.7	Expansive Soils	166
R.8	Collapsing Soils	168
R.9	Drains	170
R.10	Semi-Controlled Compaction	175
R.11	Controlled Compaction	177
R.12	Stabilisation with Lime or Cement	181
R.13	Gravel Crushing	183

R.14	The Supply of Materials for use in the Construction of the Pavement	185
R.15	Construction of the Pavement	189
R.16	Prime Coat	195
R.17	Surface Treatment	199
R.18	Resealing	207
R.19	Emulsion Slurry	216
R.20	Bituminous Concrete	222
R.21	Spalling & Crushing Stone	234
R.22	Fencing	237
R.23	Cattle Grids	242
R.24	Supply & Placing of Precast Channels, Flumes, Kerb Blocks, Guidestones Guard Posts and Kilometre Markers	244
R.25	Allowance for Extra Works	246
R.26	Carriageway Markings	248
R.27	Traffic Signs	253

**SECTION NO. C.1
ESTABLISHMENT AND GENERAL**

1. INSURANCES

A certificate from an approved Insurance Company to the effect that the Contractor has taken out all the insurances required in terms of clauses 24, 25, 26 and 27 of the General Conditions of Contract shall be submitted to the Director by the Contractor within 30 days of the award of the tender, or such period as stated in the Tender Document.

2. BOND OF SURETY

The bond of surety, in conformity with clause 12 of the General Conditions of Contract, shall be submitted to the Director by the Contractor within 30 days of the award of the Tender, or such period as stated in the Tender Document.

3. ESTABLISHMENT ON SITE

The item included in the Bill of Approximate Quantities is provided to reimburse the Contractor for the cost of all operations necessary for and directly related to the establishment on site. The Contractor shall detail these costs in the form provided in the contract document. The item includes full compensation for -

- (a) erection of adequate and suitable accommodation for the Contractor's labour force on site;
- (b) supply of drinking water and provision of sanitary facilities (at the camp site) to the satisfaction of the Ministry of Health;
- (c) erection of a works office for the Contractor, adequately furnished and of appropriate size;
- (d) any other operation necessary for establishment on site and to enable work to commence on the project.

4. GENERAL COSTS

The item included in the Bill of Approximate Quantities is provided to reimburse the Contractor for the cost of operations of a general nature occurring during the entire period of the work. The Contractor shall detail these costs in the form provided in the contract document. The item includes full compensation for -

- (a) maintenance of Contractor's accommodation and site office;
- (b) periodic site visits by the Contractor's supervisory staff not resident on site;
- (c) provision for all test samples and testing in compliance with the specification;
- (d) any other operation which is related solely to the duration of the work and cannot be fairly allocated to the measured items in the Bill of Quantities.

5. PAYMENT

5.1 Insurances and Bonds of Surety

The sums tendered for the provision of the bond of surety and insurances will be paid in full in the first interim certificate.

5.2 Establishment on Site

The sum tendered for establishment on site will be paid in full on completion of erection of the Contractor's works office and camp, but not before work has commenced on the project, to the satisfaction of the Engineer.

5.3 General Costs

The sum tendered for general costs will be paid in equal monthly instalments, calculated on the estimated period of the contract, subject to the minimum value of a certificate being achieved.

SECTION NO. C.2 ACCOMMODATION, VEHICLES AND EQUIPMENT

1. ACCOMMODATION

- 1.1 A provisional item is included in the Bill of Approximate Quantities for the supply and delivery of accommodation, sanitary facilities and furniture for the exclusive use of the Engineer and his staff. The Contractor may be required to supply and deliver these items after the Ministry has agreed to their suitability.
- 1.2 The Contractor may be required to erect the Engineer's accommodation and sanitary facilities. Such work shall only be undertaken on written instructions from the Engineer.
- 1.3 The Contractor shall be responsible for providing all the labour and equipment necessary for keeping the accommodation and sanitary facilities and surroundings clean and in good repair.
- 1.4 The accommodation, sanitary facilities and furniture shall be, and remain, the property of the Ministry.

2. VEHICLES & EQUIPMENT

- 2.1 A provisional item is included in the Bill of Approximate Quantities for the supply of vehicles and equipment as required by the Engineer.
- 2.2 The Contractor should obtain firm quotations and delivery dates from established firms experienced in the supply of the equipment required. Quotations for several different types of equipment should be obtained and these shall be submitted for consideration by the Engineer and approval by the Ministry.
- 2.3 The Contractor may be required to supply and deliver this equipment after the Ministry has agreed to its suitability.
- 2.4 All equipment shall be, and remain, the property of the Ministry.

3. ERECTION, SERVICING AND MAINTENANCE

- 3.1 The Contractor shall be responsible for the erection, servicing, and maintenance of the Engineer's accommodation, vehicles and equipment as outlined hereunder.
- 3.2 The Contractor shall make access from the work area to the building sites and shall clear and level these sites as directed by the Engineer. He shall also make access to, clear and level any further buildings sites occasioned by subsequent resiting of accommodation.

- 3.3 The Contractor shall erect the buildings, including any necessary foundations, install all internal plumbing and fittings and construct the necessary drains and soakaways. He shall also dismantle, transport and re-erect any buildings occasioned by subsequent resiting of accommodation.
- 3.4 The Contractor shall arrange for the supply of drinking water and sanitary facilities all to the satisfaction of the Ministry of Health. He shall also supply all incidental equipment necessary to complete these facilities.
- 3.5 The Contractor shall maintain the Engineer's office accommodation in a neat and tidy condition for the duration of the contract. He shall also maintain the plumbing and sanitary facilities in all accommodation for the duration of the contract.
- 3.6 The Contractor shall maintain in good working order, all vehicles and equipment supplied to the Engineer in accordance with paragraph 2 of this section.
- 3.7 The extent and exact nature of all work outlined above and all additional services shall be agreed in writing before any work is commenced.

4. PAYMENT

- 4.1 Supply and Delivery of Accommodation
 - 4.1.1 The actual cost to the Contractor (less all trade discounts) of the accommodation provided under this section will, upon production of properly receipted accounts, be refunded to the Contractor.
 - 4.1.2 An additional payment in the form of a percentage of the amount refunded under this clause will be paid to the Contractor to cover all profits, overheads, cost of transport to the site and other incidental expenditure. The Contractor shall fill in the percentage he requires when he prices the Bill of Approximate Quantities.
 - 4.1.3 This item will cover payment for all buildings, furniture and fittings incidental to completion of the accommodation.
- 4.2 Supply and Delivery of Vehicles and Equipment
 - 4.2.1 The actual cost to the Contractor (less all trade discounts) of the vehicles and equipment provided under this section will, upon production of properly receipted accounts, be refunded to the Contractor.

4.2.2 An additional payment in the form of a percentage of the amount refunded under this clause will be paid to the Contractor to cover all profits, overheads, cost of transport to the site and other incidental expenditure. The Contractor shall fill in the percentage he requires when he prices the Bill of Approximate Quantities.

4.2.3 This item will cover payment for all survey and laboratory equipment, vehicles and other equipment incidental to the completion of the water supply and sanitary facilities.

4.3 Erection, Servicing and Maintenance

In the case of accommodation and equipment all work undertaken for the execution of the Contractor's responsibilities under paragraph 3 of this Section will be paid for by plant hire and daywork, provided it has been ordered in writing by the Engineer.

In the case of vehicles all work undertaken for the execution of the Contractor's responsibilities under paragraph 3 of this Section will be paid for by the kilometre recorded, provided it has been ordered in writing by the Engineer.

All additional services that the Engineer may require under clause 3.7 of this section shall be paid for as plant hire and daywork, provided they have been ordered in writing by the Engineer.

SECTION NO. C.3
CONSTRUCTION OF DETOURS

1. REQUIREMENTS AND DESCRIPTION OF WORK
 - 1.1 Any measure necessary for the safety and convenience of the public will be the responsibility of the Contractor who shall treat them as of prime importance.
 - 1.2 The Contractor shall provide flagmen, signs, fences, barriers and lights for the proper direction of traffic, as directed by the Engineer and shall comply with all regulations governing such matters.
 - 1.3 All signs shall remain the property of the Government upon completion of the contract.
2. CONSTRUCTION OF DETOURS
 - 2.1 Where it is necessary to divert traffic from an existing road detours shall be constructed on the alignment indicated by the Engineer.
 - 2.2 The Contractor will be given possession of the site in sections, sufficiently ahead of road construction works to enable detours to be built in good time and to the Engineer's satisfaction, before the need for them occurs.
 - 2.3 The standard of construction and the vertical and horizontal alignment shall be specified by the Engineer.
 - 2.4 Detours shall be cleared to a minimum width of 10m or as agreed with the Engineer.
 - 2.5 Construction of detours shall be to a formation width of 7 metres. The Contractor shall shape and grade the detours making full use of all suitable material from alongside the route. If sufficient material is not available the Contractor shall import the required material from other sources as indicated by the Engineer.

The material shall be watered where necessary and the Contractor shall route his construction equipment over the detours during construction in order to compact any loose material to the satisfaction of the Engineer.

Temporary pipe culverts shall be constructed at locations indicated by the Engineer.
 - 2.6 Gravelling of detours will be carried out where instructed by the Engineer. The Contractor shall provide, spread,

water and compact the material to a density sufficient to carry traffic without undue wear and tear to the road surface and to the satisfaction of the Engineer.

- 2.7 Surfacing of detours will be covered if necessary under the Amendments to the standard specifications in the contract documents.

3. BARRICADES AND SIGNS

- 3.1 The Contractor shall provide and erect barricades, traffic signs and other items, as detailed in this section.
- 3.2 Barricades shall be substantially made and painted in alternate bands of black and white and shall extend across the road. Gaps shall not be left in the barricades for the entrance of construction traffic.
- 3.3 Separate provision shall be made for construction traffic so that the entrance used by it cannot be mistaken for a public entrance.
- 3.4 An example illustrating the standard of sign posting required on detours is given on the sketch at the end of this section, but the actual sign posting to be provided at any location will be determined by the Engineer dependent upon prevailing circumstances.
- 3.5 All signs shall be in the form prescribed in the Roads and Road Traffic (Traffic Signs and Signals) Regulations. Upon request the Contractor will be supplied with the name and address of the firm that is the supplier to the Ministry at the time. The Contractor will be required to supply all signs needed on the Contract to the same standard as supplied to the Ministry.
- 3.6 Upon completion of the contract, the barricades and signs shall remain the property of the Government. They shall be stacked at a site and in a manner approved by the Engineer.

4. MAINTENANCE OF DETOURS

- 4.1 The maintenance of detours will be the responsibility of the Contractor and shall adequately provide for the comfort, convenience and safety of the public.
- 4.2 Maintenance of detours during use, will be as agreed with the Engineer.

5. ROUTING OF TRAFFIC OVER PAVEMENT

Traffic shall not be routed over any completed layer of the pavement without the written authority of the Engineer. The Contractor at his cost will be required to carry out restoration works to such layer to the satisfaction of the Engineer if due to any unauthorised use.

6. FACILITIES TO ADJACENT OWNERS

6.1 The Contractor shall be responsible for ensuring that access to property adjacent to the new road is retained. Siting of all such access shall be to the satisfaction of the Engineer.

6.2 The Contractor shall be responsible for ensuring that landowners are not unnecessarily inconvenienced by the use of any detour. Gates shall be provided whenever existing fences are cut.

7. REHABILITATION

7.1 Rehabilitation of detours will be carried out as directed and to a standard indicated by the Engineer.

7.2 When the new road has been opened to traffic, and the detours are no longer required, unless some other use has been found for them, they shall be scarified, the material in windrows alongside the detours graded back, and any necessary anti-erosion works carried out. All signs, barricades, etc., must be removed and any pipes which have been utilized for temporary stream crossings must be removed.

7.3 An old road which has been used as a detour, but is not to remain a public road, will normally be ripped as soon as the new road is opened to traffic. If a landowner requires any section of the old road or detour to be left intact, the following procedure must be carried out: The Resident Engineer shall obtain from the landowner a signed certificate to the effect that he requests the section of road to be left intact and that he accepts all responsibility for the road thereafter. This certificate must be filed in the Provincial Office.

8. MEASUREMENT

8.1 Clearing

The unit of measurement will be the hectare of detour cleared for its full width.

8.2 Construction of Detours

The unit of measurement for the construction of detour shall be in hectares of formation width of detour actually constructed and shall include for all operations necessary to complete the construction of the detour as specified.

8.3 Temporary Pipe Culverts

The unit of measurement shall be the linear metre of pipe culvert installed for each pipe diameter.

8.4 Gravelling

The unit of measurement will be the cubic metre of gravel placed loose on the detour.

8.5 Maintenance Grading of Detours

The unit of measurement will be the hectare of detour graded.

8.6 Watering

The unit of measurement will be the cubic metre of water placed on the road as directed by the Engineer.

8.7 Barricades & Signs

Provision of barricades and signs will be measured on a lump sum basis.

8.8 Overhaul for gravel and water will be measured as given in "Haul and Overhaul" (See section C.7).

8.9 Rehabilitation

The unit of measurement will be the hectare.

9. PAYMENT

9.1 Clearing

Payment shall be as given in "Clearing for the Road" (See section R.1.).

9.2 Construction of Detours

The rate shall include for all operations necessary to complete the construction of the detour as specified.

9.3 Installation of Temporary Pipe Culverts

The rate for each linear metre of each pipe diameter will include for all operations necessary to install the culverts as specified plus their removal on completion of the project.

9.4 Gravelling

The rate for each cubic metre of loose gravel placed shall include for the supply, haul up to 1 km, dump spread and compact as ordered by the Engineer.

9.5 Maintenance Grading of Detours

The rate will include for the provision of all labour, plant and equipment necessary for grading the full width of the detour as directed by the Engineer.

9.6 Watering

The rate for every cubic metre of water shall include full compensation for the provision, pumping, hauling and distribution of the water.

9.7 Barricades and Signs

Payment for Barricades and Signs will be on a lump sum basis.

The lump sum shall include for the provision, erection, maintenance, removal and stacking on approved sites of all temporary barricades, traffic signs, warning boards, lights, flagmen, etc., required to direct traffic safely over the deviations in accordance with the specification. One fifth of the lump sum tendered will be paid after the Contractor has constructed necessary barricades and signs to direct the traffic over that deviation. The remaining portion of the lump sum shall be payable on each following certificate in the proportion of the value of work done to the date of the certificate to the total tendered Contract Amount.

9.8 Overhaul

Payment for overhaul will be as given in "Haul & Overhaul"

9.9 Rehabilitation

The rate will be for each hectare rehabilitated and will include for all labour, plant, equipment and all operations necessary to complete the rehabilitation and remove any temporary culverts.

SECTION NO. C.4
PROVISION OF WATER

1. GENERAL

- 1.1 The Government will undertake all advance planning for the provision of adequate supplies of water for the duration of the contract.

The Government will obtain the required authorities and permissions from The Water Court and landowners for the abstraction of adequate public and private water for the needs of the Contract.

- 1.2 The Government does not accept responsibility for the continuous availability of water from any source.

- 1.3 The Contractor shall be responsible for the supply and transport of all water necessary for the due and proper performance of the contract, as described in detail in the various sections. He shall provide all pumping, storage, bowsers and sprinklers of approved pattern capable of giving an even flow and distribution of water.

- 1.4 All water used for domestic and concrete purposes shall be subject to periodical approval by the Engineer. Samples of water shall be taken, as directed by the Engineer, at least once every 3 months and forwarded in clean glass containers - at least 2 litres - to the Government analyst or other approved laboratory, for testing. All this to be at Contractor's expense.

- 1.5 The Engineer may order the Contractor in writing to use the water supply most economical for the Government.

- 1.6 Should the Contractor wish to make alternative arrangements for water supplies, he shall obtain the prior approval of the Engineer and shall make his own arrangements with the owners. Copies of all agreements must be lodged with the Engineer.

2. AVAILABILITY OF SUPPLIES

2.1 Natural Sources

- 2.1.1 The Contractor will be required to abstract water from the supply points indicated by the Engineer. However, should the Contractor desire to abstract water from a source other than those indicated by the Engineer and for which no authority has been obtained he shall inform the Engineer in writing so that application may be submitted to the Water Court. In such cases the Government shall not be responsible for any delays that may ensue.

2.2 Additional Sources

2.2.1 If the Engineer so directs, the Contractor shall provide water supplies either by construction of dams or the sinking of boreholes. The former may only be constructed with the permission of the Water Court. The Contractor may only construct these dams and/or boreholes on the written instruction of the Engineer and they shall be located at the point/s indicated by the Engineer.

2.2.2 If the Engineer so directs, the Contractor may be required to erect a suitable pipeline and construct storage reservoirs along it. The Contractor may only construct the pipeline and storage reservoirs on the written instructions of the Engineer and on the alignment and in places agreed to by him in writing.

2.3 Equipment

All equipment provided for the works described above shall be, and shall remain, the property of the Ministry.

3. MEASUREMENT AND PAYMENT

3.1 Water

There will be no measurement or payment for any water used or consumed except where the sections provide for the measurement and payment of water, in such case reference shall be made to the relevant sections.

3.2 Overhaul

Overhaul of water will be measured and paid for as given in "Haul and Overhaul" (See section C.7).

3.3 Construction

All work undertaken for the construction of temporary dams, boreholes, pipelines and reservoirs referred to in this section will be measured and paid for as plant hire and daywork, provided it has been ordered in writing by the Engineer.

3.4 Equipment

All equipment incidental to the construction outlined in paragraph 3.3 above will be paid for as given in "Accommodation and Equipment" (See section C.2).

3.5 Access Roads

All work undertaken for the construction and maintenance of access roads to water points will be measured and paid for as outlined in Section R14 "The supply of materials for use in the construction of the pavement", provided it has been agreed and ordered in writing by the Engineer.

4. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. C.5
REMOVAL OF EXISTING STRUCTURES

1. EXTENT OF THE WORK

Any existing structure which obstructs any road or bridge construction site shall be demolished. The extent of the work shall be as indicated on the drawings or as directed by the Engineer. The Contractor shall use a safe method of demolition and all recoverable components shall be stacked neatly at a site indicated by the Engineer.

2. SALVAGEABLE MATERIAL

2.1 The demolition shall be carried out so that all materials which, in the opinion of the Engineer are salvageable, are removed without damage, to the place indicated for stacking.

2.2 All such materials shall remain the property of the Government.

3. USE OF DEMOLISHED MATERIALS

Concrete and/or stone which has been removed from the demolished structure may be used as fill material if the pieces are not larger than 300 mm in greatest dimension. The exact manner of use shall be approved by the Engineer.

4. CLEARING OF SITE

4.1 After the structure has been demolished and the materials removed the site shall be trimmed and treated as indicated on the General Arrangement Drawings or as instructed by the Engineer.

4.2 Material excavated for this purpose shall be removed from the site and disposed off in accordance with the Engineer's instructions.

5. MEASUREMENT

The unit of measurement shall be in "lump sum".

6. PAYMENT

The price for the removal of an existing structure will include full compensation for the excavation of the work as specified and for all work incidental and necessary thereto.

SECTION NO. C.6 EXCAVATION AND BACKFILLING FOR STRUCTURES

1. DESCRIPTION

Excavation for structures covers the removal of all material of any kind, necessary for their construction, in accordance with the Drawings or as directed by the Engineer and the subsequent placing of the backfill, as specified below, by means of any equipment, plant and labour necessary for the satisfactory execution of the work.

2. CLASSIFICATION

2.1 Excavation for structures is divided into the following three categories in accordance with the method of excavation necessary, notwithstanding the method actually used. Mixed or borderline materials shall be divided by the Engineer between the two relevant categories.

2.1.1 Common Excavation

Common excavation is any material which, in the Engineer's opinion, can be excavated without the use of pneumatic tools or explosives.

2.1.2 Hard Excavation

Hard excavation is material which, in the Engineer's opinion, requires for its excavation the use of pneumatic tools.

2.1.3 Rock Excavation

Rock excavation is material which, in the Engineer's opinion, requires for its excavation the use of explosives.

2.2 At the conclusion of the excavation for each element of the structure the Engineer and Contractor shall sign a certificate detailing the quantities of each category of excavation. No claims will be entertained if the certificate has not been completed.

3. REMOVAL OF EXCAVATED MATERIAL

The Contractor shall remove all excavated material and deposit it at sites indicated by the Engineer.

4. SUBSOIL CONDITIONS

4.1 The subsoil information given on the Drawings has been obtained from investigations at selected points.

- 4.2 The Contractor shall take such steps as he considers necessary to satisfy himself as to the true nature of the subsoil conditions.

5. DEPTH OF FOUNDATIONS

The depth of foundations, as shown on the Drawings is approximate only. The actual depth will be directed by the Engineer, in writing, during the work.

6. PREPARATION OF FOUNDATIONS

All rock or other hard material shall be cleaned and cut to a firm surface, level, stepped or roughened as directed by the Engineer. All loose material shall be removed and all soft seams cleaned out and filled with concrete, mortar or grout, as directed by the Engineer.

7. INSPECTION

- 7.1 Before any foundation is covered up, it must be inspected by the Engineer and, if he directs, the nature of the strata under the foundation shall be ascertained by boring or probing the foundation. The Contractor shall give the Engineer due notice when any foundation is ready for inspection.

- 7.2 No concrete may be placed on a foundation that has not been approved by the Engineer.

8. SPECIAL TREATMENT OF FOUNDATIONS

- 8.1 Where the bottom of an excavation does not provide suitable foundation for a culvert, the unsuitable material shall be excavated to depths indicated by the Engineer. Such excavation shall be made good with well consolidated approved natural or cement stabilised material or in concrete as shown on the drawings or as directed by the Engineer.

- 8.2 Where the bottom of the excavation consists entirely of rock it will be sufficient to make up to foundation level with a blinding layer of class 20 concrete.

- 8.3 Where the foundation comprises part rock and part soil the rock should be excavated at least 200mm below founding level and backfilled to level with the adjacent soil.

- 8.4 Foundations on steep gradients (2,5% and over) should be stepped in the case of soil and dowelled in the case of rock as directed by the Engineer.

9. BACKFILL TO EXCAVATIONS

- 9.1 Unless otherwise directed by the Engineer all spaces excavated and not taken up by permanent work shall be backfilled with approved selected material up to the level at which excavation commenced.
- 9.2 Backfills shall be thoroughly compacted to a degree of not less than that of the surrounding material.
- 9.3 All compaction shall be carried out at a moisture content approved by the Engineer.

10. PUMPING

The Contractor shall make provision for de-watering the excavation. He shall provide and operate all pumps and temporary sumps necessary to keep water, from whatever source, out of the excavation during concreting operations. Sumps shall be reinstated to the satisfaction of the Engineer. Stream diversions may only be constructed on the written direction of the Engineer.

11. UNAUTHORIZED EXCAVATION

Any excavation carried to a greater depth than directed by the Engineer, shall be filled up by the Contractor with Grade C10 concrete, as given in "Portland Cement Concrete", (See section C8) and no payment will be made for any of this work or materials.

12. EXPLOSIVES REGULATIONS

The Contractor shall take all necessary precautions to safeguard the public when using explosives and shall in every way comply with current explosives regulations. Instructions as per paragraph 2.8 Section R.6 shall be complied with.

13. SAFETY REGULATIONS

The Contractor shall take all necessary precautions to safeguard workmen in open excavations and shall comply with any relevant code of practice and any safety regulations in respect of lateral support for surface excavations.

14. MEASUREMENT

- 14.1 The unit of measurement for excavation is the cubic metre.
- 14.2 The quantity of excavation for each element of the structure will be calculated as the plan area of the element as shown on the Drawings, multiplied by the average depth of actual excavation for the element.

14.3 The following items will be measured separately:

- (a) 0 - 2 metre depth, common excavation.
- (b) 2 - 4 metre depth, common excavation.
- (c) 4 - 6 metre depth, common excavation.
- (d) 6 - 8 metre depth, common excavation.
- (e) 8 - 10 metre depth, common excavation.
- (f) Hard excavation "extra over" items (a) to (e) above.
- (g) Rock excavation "extra over" items (a) to (e) above.

14.4 The depth of excavation will be measured from the level at which excavation actually commences.

14.5 Material excavated in excess of these calculations will not be included in the measurement even though such excavation may have been necessary for the construction of the structure.

14.6 Material excavated in a fill which has been previously placed by the Contractor, shall not be included in the measurement, unless specifically agreed in writing by the Engineer.

14.7 Special Treatment to Foundations

The unit of measurement for natural or cement stabilised backfill under the culvert foundation will be the cubic metre measurement after compaction.

14.8 Stabilising agent

The unit of measurement of the stabilising agent is the Tonne.

15. PAYMENT

15.1 Excavation

The rate for each cubic metre of excavation will include full compensation for supervision, labour, plant, equipment and materials necessary for the execution of the following operations and for all work incidental and necessary thereto -

- (a) excavating in the various types of material as classified in paragraph 2 of this section, and removal of such material;
- (b) any shoring necessary to prevent earth falls or slides;
- (c) preparing the foundation as specified;
- (d) probing as specified;
- (e) providing, watering and compacting backfill as specified;

- (f) transporting, excavated material and/or backfill (excluding overhaul);
- (g) providing and operating all equipment for de-watering the foundations and reinstating temporary sumps as specified.

15.2 Special Treatment to Foundations

15.2.1 Natural Backfill

The rate for each cubic metre of natural backfill under culvert foundations will include full compensation for the supply of the material plus supervision, labour, plant and equipment necessary for the execution of the work as specified.

15.2.2 Stabilised Backfill

The rate for each cubic metre of stabilised backfill under culvert foundations will additionally include full compensation for the off-loading, spreading, mixing and other additional work or operation necessitated by the addition of the stabilising agent. In heaving soil it shall also include for the preheaving of the underlying expansive material with water.

15.3 Stabilising Agent

The rate for each tonne of stabilising agent will include full compensation for the supply and transport of the agent to the point of application.

16. BORING

Boring ordered by the Engineer will be paid for as plant hire and daywork.

17. OVERHAUL

Overhaul of excavated material, backfill and water will be measured and paid for as given in "Haul and Overhaul" (See section C.7).

SECTION NO. C.7
HAUL AND OVERHAUL

1. DEFINITIONS

- 1.1 Haul is the distance between the points of loading and off-loading measured along the shortest practicable route as determined by the Engineer.
- 1.2 Free haul is the distance (1 km) which vehicles must travel loaded on any trip before qualifying for overhaul payment. The rate tendered and paid for material hauled will include allowance for free haul as well as for loading time, waiting and unloading time, etc., which are common to trips of all lengths.
- 1.3 Overhaul distance is the length of haul less free haul.

2. MEASUREMENT

2.1 General

There will be no measurement of overhaul unless specific sections of the specification provide for such measurement.

2.2 Units

The unit of measurement for overhaul is the cubic metre kilometre.

2.3 Earthworks for Structures

2.3.1 The quantity transported will be calculated as the volume of material before excavation.

2.3.2 Overhaul will be calculated as the sum of the product of the quantities transported, in cubic metres and the overhaul distance for each quantity measured to the nearest 0,1 km.

2.4 Earthworks for Roads

2.4.1 The mass-haul curve printed by the Computer and supplied together with the Earthworks Print-out, indicates the optimum disposal of all the excavated material, excluding expansive material, antheaps, intersections and lay-bys. The measurement of overhaul will be based on this curve or on any modifications to it agreed to by the Engineer. The Earthwork Print-out and mass-haul curve will only be supplied to the successful tenderer.

2.4.2 The volume transported will be measured in cut.

- 2.4.3 The haul will be measured between the centre of gravity of a body of material to be excavated and its centre of gravity when deposited in fill or waste, according to the mass-haul curve.
 - 2.4.4 Overhaul will be calculated as the sum of the product of the volume in cubic metres of each body of material transported and the overhaul distance for that body of material measured to the nearest 0,1 km.
- 2.5 Gravel for Roads
- 2.5.1 The gravel haul diagram indicates the most economic utilisation of the gravel supplies available. It may be necessary for the Engineer to modify the utilisation plan, and therefore the hauls, depending on site conditions.
 - 2.5.2 The volume transported will be measured as compacted on the road.
 - 2.5.3 Overhaul will be calculated as the sum of the product of the volume transported, in cubic metres and the overhaul distance for each quantity measured to the nearest 0,1km.
 - 2.5.4 In the case of gravel hauled from a pit and dumped on the section of road that straddles the intersection of the haul road and road under construction, the dumped sections of road lying on either side of the intersection must be treated separately in the haul and overhaul calculations.
- 2.6 Water
- 2.6.1 The quantity of water measured and paid for shall be that quantity measured under sections "Construction of Detours" (see Section C.3), "Slope Protection and Anti Erosion Works" (see Section C.12), "Preparation of Road Bed" (see Section R.5), "Semi Controlled Compaction" (see Section R.10) and "Controlled Compaction" (See section R.11) Measurements in terms of sections "Preparation of Road Bed" and "Semi Controlled Compaction" shall be actual volumes hauled and used provided that the Engineer is satisfied that the Contractor has taken all reasonable steps to avoid wastage of water. In respect of Section "Controlled Compaction" the volume shall be a calculated volume.

- 2.6.2 Overhaul will be calculated as the sum of the product of the quantities measured and transported or calculated, in cubic metres, and the overhaul distance for each quantity measured to the nearest 0,1 km.

3. PAYMENT

The rate for each cubic metre-kilometre of overhaul will include full compensation for all supervision, labour, fuel and necessary incidentals.

SECTION NO. C. 8 PORTLAND CEMENT CONCRETE

1. GENERAL

1.1 Scope

This specification covers the quality specifications for the materials that constitute concrete, the testing of fresh concrete, the placing of concrete, the strength of hardened concrete and the requirements for designed mix concrete accepted on the basis of compressive strength. Prescribed mix concrete or acceptance on the basis of flexural strength or minimum cement content will only be used after the appropriate requirements have been agreed, in writing, by the Engineer.

It is the intent of this specification to secure for every part of the structure, homogeneous concrete which will have the required strength and durability.

1.2 Grade of concrete

The grade of concrete used in each part of the structure shall be as specified on the Drawings. The concrete shall comply with the characteristic compressive strength at 28 days specified below.

The characteristic strength is defined as the value of strength below which 5 percent of the population of all possible strength measurements are expected to fall.

GRADE OF CONCRETE	C10	C15	C20	C25	C30	C40	C50
CHARACTERISTIC COMPRESSIVE STRENGTH MPa (=N/mm ²)	10.0	15.0	20.0	25.0	30.0	40.0	50.0

1.3 Concrete Mixes

A guide for seven day strength and mix proportions for certain grades of concrete using aggregates normally found in Zimbabwe is given in Table 8.1 at the end of this section.

1.4 Cement Content

Structural concrete having a cement content outside the range 300-500kg/m³ shall not be used without the written approval of the Engineer.

2. MATERIALS

2.1 Cement

The cement shall comply with the latest S.A.Z.S No. A46 "Portland Cement". All the cement used in the works shall be from the same source unless otherwise authorised in writing by the Engineer.

Certificates from the supplier stating the composition, date of manufacture and batch number for each consignment of cement delivered to site shall be provided.

2.2 Water

Water shall be clean and free from injurious amounts of acids, alkalis, sugar and other organic substances. Water suitable for drinking purposes shall be acceptable. If so required by the Engineer, the suitability of the water shall be proved by tests carried out by an approved laboratory.

2.3 Aggregates

The aggregates shall comply with latest S.A.Z.S 233 "Aggregates from Natural Sources for Concrete".

2.4 Plums

Plums shall be hard stones free from decomposition, or minerals deleterious to concrete, 150mm to 400mm in diameter. These may only be used where authorised in writing by the Engineer and shall be washed if he so directs.

2.5 Additives

No additives may be used in the concrete without the Engineer's written approval.

3. DELIVERY AND STORAGE

3.1 Cement

3.1.1 The cement shall be delivered to the works in properly secured containers in which it will remain until used. The cement shall be used in the order in which it has been delivered.

3.1.2 The cement shall be stored off the ground and protected from the effects of moisture and condensation to the satisfaction of the Engineer.

- 3.1.3 Cement shall not be stored in stacks exceeding 12 sacks in height.
- 3.1.4 Cement which has been damaged by weather or any other cause shall not be used in the works.
- 3.1.5 Cement from broken sacks shall not be used in the works.
- 3.1.6 Cement exceeding six weeks in age shall not be used in the works.
- 3.1.7 Bulk delivery and storage methods require the Engineer's written approval.

3.2 Aggregates

- 3.2.1 The Aggregates shall be stored so that they remain clean. Any aggregate which has become contaminated will be rejected.
- 3.2.2 Aggregates shall be stored by size and source. Every necessary precaution shall be taken to ensure that graded aggregates do not become segregated. Stockpiles of aggregate shall not exceed two metres in height.
- 3.2.3 Aggregates shall be so handled that the moisture content remains reasonably uniform for each day's run.

4. SAMPLES

4.1 Aggregates

As soon as possible after the award of the Contract the Contractor shall deliver direct to the Provincial Road Engineer, samples of the actual fine and coarse aggregates he proposes to use during the contract.

For each source of supply the required mass of samples shall be as follows :-

- 4.1.1 fine aggregate - 120 kg
- 4.1.2 coarse aggregate - 240 kg total, the proportion of each size to be in accordance with the mix design proposals.
- 4.1.3 Cement - 1 sack (50kg) of the type to be used.

4.2 Water

Samples shall be submitted to the Engineer as given in "Provision of Water" (See section C.4).

5. MIX DESIGN PROPOSALS

5.1 Mix design proposals for the various classes of concrete in the works must be submitted in writing to the Engineer as soon as possible after the award of the Contract. No concrete may be placed in the works before the Engineer has approved the Contractor's mix design proposals.

5.2 To make due allowance for the variability in production of concrete it is necessary for the mix design proposals to use a target design strength greater than the specified characteristic strength. This difference between design strength and specified strength is termed the margin. The magnitude of the margin to be used depends on the degree of control exercised in the production of the concrete. The term degree of control is a statistical concept and can best be determined from past records of concrete production.

An indication of suitable figures for design strengths related to the degree of control is given in Table 8.2 at the end of this section.

5.3 The aggregate grading shall conform to the requirements given in paragraph 2.3. of this section. If the grading of the sand for fine aggregate is too coarse it shall be blended with a suitable filler approved by the Engineer. Suitable aggregate gradings are given in Table 8.3 at the end of this section.

5.4 The Contractor should allow at least six weeks for approval of his mix design proposals but such approval may be expedited if the proposals are supported by the results of preliminary cube tests undertaken by a recognised laboratory.

5.5 The Contractor shall not change the sources of supply of the materials or vary the mix proportions without the Engineer's written approval.

6. WORKS STRENGTH TESTS

6.1 Testing Facilities

6.1.1 Three weeks before the start of the concrete work the Contractor shall inspect the concrete testing equipment and the arrangements for curing and storing of concrete cubes provided by the Engineer.

- 6.1.2 In the absence of written complaints, the Contractor will be deemed to have accepted and shall abide by the results obtained from the use of the facilities.

6.2 Concrete Sampling

- 6.2.1 Concrete cubes for testing will be made, cured, stored, transported and tested in compression in accordance with the appropriate test methods given in BS 1881.
- 6.2.2 Curing temperatures for concrete cubes will be appropriate to tropical conditions and shall be between 26 and 29 degrees Celsius.
- 6.2.3 For each grade of concrete poured each day five samples will be taken from randomly selected batches of concrete.
- 6.2.4 The samples will be taken at intervals during the concrete pour so that they are representative of the entire body of concrete.
- 6.2.5 For each grade of concrete poured each day an additional sample will be taken for each ten cubic metres of concrete in excess of twenty cubic metres.
- 6.2.6 From each sample two concrete cubes will be made and tested as outlined below.

6.3 Cube Testing

- 6.3.1 For each grade of concrete poured each day two cubes from the same sample will be tested at seven days and the cube strengths used as a guide to the likely strength that will be achieved at 28 days.
- 6.3.2 For the remaining concrete cubes from each day's pour the two cubes from each sample will be tested at 28 days and the two cube strengths will be averaged to provide one test result.

6.4 Compliance with strength requirements

Compliance with the characteristic strength will be assumed if the conditions given in both 6.4.1 and 6.5.2 are met :

- 6.4.1 The average strength determined from any group of four consecutive test results exceeds the specified characteristic by 3 MPa (=3 N/mm²) for concretes of grade C20 and above, 2 MPa (=2 N/mm²) for concretes of grade C15 and below, and:

- 6.4.2 The strength determined from any test result is not less than the specified characteristic strength minus 3 MPa ($=3 \text{ N/mm}^2$) for concretes of grade C20 and above, 2 MPa ($=2 \text{ N/mm}^2$) for concretes of grade C15 and below.

6.5 Quantity of Concrete represented by Test Results

- 6.5.1 The quantity of concrete represented by any group of four consecutive test results will be deemed to include the batches from which the first and last samples were taken together with all intervening batches.
- 6.5.2 When a test result fails to meet the requirements of paragraph 6.4.2 only the particular batch from which the sample was taken will be deemed to be at risk.
- 6.5.3 If the working conditions vary considerably from day to day the Engineer may direct the test results for each day be considered in isolation.

6.6 Consistency of Test Results

Where the test results, upon statistical analysis reveal a "Standard Deviation" above 5,5 MPa ($=5,5 \text{ N/mm}^2$) the Engineer may order the Contractor to submit his proposals for improving the control of the concrete production before proceeding with any further concreting.

7. MIXING AND PLACING

7.1 Measuring of Constituents

- 7.1.1 Cement will be measured by mass. If no apparatus for gauging by mass is available the concrete shall be mixed in batches containing a whole number of sacks of cement. The nominal mass of a sack of cement is 50 kg but it should be noted that significant variations from this mass can occur. The volume of a 50 kg sack of cement will be taken as 0,033 m³. Measurement of cement by volume will not be permitted under any circumstances.
- 7.1.2 Fine and coarse aggregate will be measured by mass. Where the Engineer approves batching by volume, the aggregate shall be placed loosely in an approved container, without consolidation, and screeded off.

- 7.1.3 Water will be measured by volume in a container which discharges the correct amount for each batch. The container shall be so constructed and calibrated that the amount of water may be observed and controlled at all times and shall be in the charge of a competent operator. An adjustment shall be made in the quantity of the missing water, for any water present in the aggregates.

7.2 Mixing

- 7.2.1 The concrete shall be thoroughly mixed in approved mechanical drum-type mixers of minimum capacity 0,30m³ of loose material.
- 7.2.2 Mixers and other equipment shall have sufficient total capacity to produce the required amount of concrete within a normal working day of 10 hours.
- 7.2.3 A spare mixer, of capacity approved by the Engineer, shall be held in readiness to run on 15 minutes' notice in the event of a breakdown of one of the stock mixers.
- 7.2.4 Before a grade of concrete is used for the first time on the works the Contractor shall demonstrate that the equipment can produce adequately mixed concrete within three minutes. A minimum mixing time, which shall not be less than one and half minutes, shall be agreed and used for the entire works. However the mixing times shall not be so long as to cause segregation of the concrete constituents.

7.3 Placing

- 7.3.1 Except where otherwise directed, concrete shall not be placed unless the Engineer, or his representative, is present and has previously examined and approved in writing the positioning, fixing and condition of the reinforcement and of any other items to be embedded in the concrete, and the cleanliness, alignment, dimensions and suitability of the containing surfaces.
- 7.3.2 To facilitate the inspection of form work and steel fixing the Contractor shall give the Engineer 24 hours notice of his intention to pour concrete in any part of the works.

- 7.3.3 Before concreting commences the surfaces against which concrete is to be placed including the reinforcement shall be sprayed with water and allowed to drain.
- 7.3.4 The concrete shall be discharged from the mixer and transported to the works by a means approved by the Engineer. Placing of concrete in any part of the works shall be completed within 30 minutes of discharge from the mixer.
- 7.3.5 The concrete shall be deposited as near as possible to its final position, working from a stop end, if any. It shall be placed so as to avoid segregation of the concrete or displacement of the reinforcement, other embedded items and formwork.
- 7.3.6 Concrete in walls shall be brought up in horizontal layers not more than 300 mm in compacted thickness, or the length of the vibrating element where compaction is carried out by internal immersion vibrators.
- 7.3.7 Once commenced, concreting must be continued without interruptions and may be stopped only at an expansion joint, shrinkage joint or a construction joint. Concreting need not necessarily be stopped at all construction joints shown on the Drawings.
- 7.3.8 Concrete shall not be dropped freely through a height greater than 1,5 metres. The Contractor shall use appropriate equipment when placing concrete to ensure that segregation does not take place.
- 7.3.9 If concrete is to be placed in standing water the equipment and method of placing must be approved in writing by the Engineer.
- 7.3.10 Under no circumstances shall concrete be placed in running water.

7.4 Concreting Sequence

- 7.4.1 The sequence of placing concrete shown on the Drawings shall be rigidly followed..
- 7.4.2 Any amendments to the placing sequence shall be approved in writing by the Engineer.

7.5 Ready Mix Concrete

- 7.5.1 The use of ready mix concrete in any part of the works shall be subject to the approval of the Engineer. If ready mix concrete is used then placing of concrete shall be completed within one and half hours of the introduction of mixing water to the cement and aggregates.
- 7.5.2 At any time during placing of the concrete slump tests may be taken. If such tests indicate that the consistency of concrete would prevent adequate compaction, the remaining concrete in that batch shall be removed from site.

7.6 Control Tests

- 7.6.1 Slump tests will be carried out at any time during the pour to ensure consistency of the cement/water ratio.
- 7.6.2 Moisture content of the fine aggregates will be ascertained and compared with a predetermined bulking curve, any variation from the curve will require an adjustment to the volume of fine aggregates used.
- 7.6.3 Weigh batching machines will be checked for accuracy before starting work and at least once during each working day.

7.7 Compaction

- 7.7.1 The concrete shall be compacted to the satisfaction of the Engineer and thoroughly worked into corners of the formwork and around reinforcement and other embedded items.
- 7.7.2 Unless otherwise specified concrete shall be vibrated by an immersion or poker type vibrator of appropriate size.
- 7.7.3 The external type of formwork vibrator may be used for precast concrete work.
- 7.7.4 There shall be at least one vibrator in use at each point where the concrete is being deposited. A stand-by vibrator shall be kept on hand ready for immediate use.

7.7.5 Over-vibration, resulting in segregation, must be avoided. The vibrators shall be withdrawn slowly to prevent the formation of voids. Vibrators shall not be used to move the concrete along the forms nor so as to cause vibrations in the steel reinforcement.

7.7.6 The vibration technique must be arranged to produce a concrete surface free from honey-combing, surface crazing or excessive dusting.

7.8 Concrete with plums

7.8.1 The plums shall be well soaked with water immediately before they are deposited in the concrete and no plum shall be within 50 mm of the outer surface of the concrete or any other plum.

7.8.2 Concrete with plums shall only be used where specifically indicated on the Drawings.

7.9 Construction Joints

7.9.1 Construction joints shall be provided by shaped keys as detailed on the Drawings or as directed by the Engineer.

7.9.2 All laitance and loose particles shall be removed and the surface of the construction joint shall be thoroughly cleaned with wire brushes.

7.9.3 On bridge superstructures, when placing fresh concrete against concrete previously set, an approved "wet and dry" epoxy adhesive shall be applied to the cleaned surface of the set concrete. Other methods may be used as directed by the Engineer.

7.9.4 Concrete placed in the first 50 mm adjacent to a construction joint shall have one quarter of the coarse aggregate omitted from the batching.

8. ADVERSE CONDITIONS

8.1 The Contractor shall place a maximum and minimum thermometer in an exposed but shaded place; thermometer readings shall be taken and recorded daily.

8.2 Concrete shall not be placed when the air temperature is at or below 8°C or when in the opinion of the Engineer it is likely to drop below 2°C within 24 hours.

8.3 In hot weather the Contractor shall take suitable steps to shield aggregates, water supply, mixer and fresh concrete

from the direct rays of the sun to ensure that the temperature of the concrete discharged from the mixer is not higher than 30°C.

- 8.4 When the air temperature is 30°C or higher, the Contractor shall protect the part of the structure, where concrete is being placed, from the direct rays of the sun.
- 8.5 Concrete shall not be placed during rain unless the fresh concrete is protected from the rain. When work ceases because of rain a temporary construction joint will be constructed as directed by the Engineer.
- 8.6 The Contractor shall ensure that river water does not rise over any concrete work within twelve hours after it has been placed.

9. CURING

- 9.1 As soon as possible after placing, the concrete shall be protected from the drying effects of sun and wind by a method approved in writing by the Engineer.
- 9.2 Approved methods may include :
 - 9.2.1 Covering horizontal surfaces with a layer of sand at least 50mm thick, or with canvas, hessian or other absorbent materials, all coverings being kept constantly wet for at least 7 days. If water is in short supply a liquid curing membrane may be used as described in 9.2.2.
 - 9.2.2 Applying a liquid curing membrane approved by the Engineer to vertical surfaces, in accordance with manufacturer's recommendation. Such membrane shall be applied immediately the formwork is struck and the surface watered. If rubbing down is required the membrane shall be applied when that operation is completed.

10. FAILURE TO MEET THE SPECIFIED REQUIREMENTS

- 10.1 If the test results from works cubes indicate that the strength requirements have not been met the Engineer may order the Contractor to :
 - (a) remove the rejected concrete and replace it at his own expense; and/or
 - (b) submit his proposals for adjusting the mix design and/or improving the standard of quality control before proceeding with any further concreting.

- 10.2 If any additional tests ordered by the Engineer indicate that the concrete in the structure does not meet the strength requirements the Engineer may order the Contractor to :
- (a) remove the rejected concrete and replace it at his own expense; and/or
 - (b) submit his proposals for rectifying the defects and/or improving the placing technique before proceeding with any further concreting.
- 10.3 If any concrete member shows defects of workmanship such as low density, excessive voids or surface honeycombing and in the Engineer's opinion is unsuitable to fulfil the purpose for which it was designed the concrete will be rejected and shall be replaced by the Contractor at his own expense.
- 10.4 If any concrete is damaged during the work and in the Engineer's opinion is thereby rendered defective, it will be rejected and shall be replaced by the Contractor at his own expense.

11. MEASUREMENT

11.1 Cast in-situ Concrete

- 11.1.1 The unit of measurement for cast-in-situ concrete is the cubic metre.
- 11.1.2 The quantity of concrete for each element of the structure will be calculated from the dimensions given on the Drawings or authorised by the Engineer. No deductions will be made for reinforcing steel, weepholes, scupper pipes or bearing recesses provided in the concrete.
- 11.1.3 Where the vertical dimension of an element depends upon site conditions the quantity of each element will be calculated from the nett horizontal plan area of the concrete as given on the Drawings and the average vertical dimension as agreed in writing between the Contractor and the Engineer.
- 11.1.4 Each grade of concrete for each element of the structure will be measured separately.

11.2 Precast Concrete

The unit of measurement for precast concrete units is the number off. (Except for pipe culverts which will in accordance with Section R.2 "Construction of Pipe Culverts").

12. PAYMENT

12.1 Cast-in-Situ Concrete

The rate for each cubic metre of concrete will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply of all materials, excluding steel reinforcement;
- (b) mixing, transporting, placing and vibrating the concrete;
- (c) forming construction joints and shrinkage joints;
- (d) supply and fixing of scupper pipes or weepholes embedded in the concrete;
- (e) forming bearing recesses and malthoid bearings;
- (f) the provision of unformed surfaces as specified in "Formwork and Surface Finish";
- (g) curing and protection of completed concrete work.

12.2 Precast Concrete

The rate for each concrete unit will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply of all materials, excluding steel reinforcement;
- (b) supply of all moulds for precast units;
- (c) manufacture of units;
- (d) delivery of units to site;
- (e) fixing units in position.

13. TESTS

13.1 Testing shall be in terms of Section C14 - Testing.

13.2 The costs of the mix design proposals outlined in 5.1 above will be borne by the Contractor in terms of Section C14, Testing.

TABLE 8.1
GUIDE TO CONCRETE MIX PROPORTIONS

GRADE OF CONCRETE		C10	C15	C20	C25	C30	C35
CHARACTERISTIC STRENGTH MPa (=N/mm ²)	7-DAY	7	10	13	17	21	23
	28-DAY	10	15	20	25	30	35
RANGE OF COMBINED AGGREGATE/CEMENT RATIO BY MASS	MAX	91/2:1	81/2:1	71/2:1	61/2:1	6 : 1	
	MIN	61/2:1	51/2:1	5:1	41/2:1	4 : 1	
CEMENT/WATER RATIO FOR AVERAGE SITE CONTROL		1,35	1,50	1,70	1,85	2,05	
MAXIMUM SLUMP (mm)		60	60	50	50	40	
RANGE OF Cement Content Kg/m ³ OF concrete	MIN	210	240	270	300	330	
BY MASS	MAX	280	320	360	400	440	

Notes : This table relates to vibrated concrete.
The relationship between 7-day and 28-day strength varies
widely.
Volume of 50-kg sack of cement is 0,033 m³

TABLE 8.2
DESIGN STRENGTH FOR MIX DESIGN

SPECIFIED CHARACTERISTIC STRENGTH MPa (=N/mm ²)	DESIGN STRENGTH MPa (=N/mm ²)		
	GOOD CONTROL	AVERAGE CONTROL	POOR CONTROL
10	17	19	21
15	22	24	26
20	27	29	31
25	32	34	36
30	37	39	41
35	42	44	46
40	47	49	51

TABLE 8.3
SUITABLE AGGREGATE GRADINGS

B.S. SIEVE mm	PERCENTAGE BY MASS PASSING			
	COARSE AGGREGATE			FINE AGGREGATE
	40 mm	20 mm	10 mm	
53,0 . . .	100			
37,5 . . .	85 - 100			
26,5 . . .	0 - 50	100		
19,0 . . .	0 - 25	85 - 100		
13,2 . . .	0 - 5	0 - 50	100	
9,5 . . .		0 - 25	85 - 100	
6,7 . . .		0 - 5	0 - 50	100
4,75 . .			0 - 10	90 - 100
2,36 . .				80 - 100
1,18 . .				45 - 100
0,6 . .				20 - 75
0,3 . .				5 - 35
0,15 . .				0 - 15
0,075 . .				0 - 5

SECTION NO. C.9
NO-FINES CONCRETE

1. GENERAL

No-fines concrete shall be placed in position as shown on the Drawings.

2. MATERIALS

2.1 The no-fines concrete shall consist of natural or crushed coarse aggregate, fine aggregate, cement and water.

2.2 The aggregate, cement and water shall be as given in "Portland Cement Concrete" (See section C.8).

2.3 The coarse aggregate grading shall be as given in "Portland Cement Concrete" (See section C.8).

3. CONSTRUCTION

3.1 No-fines concrete shall be made by thoroughly mixing 10 parts of coarse aggregate to one part of fine aggregate to one part of cement. The cement/water ratio shall be controlled within the limits 1,8 and 2,4

3.2 During placing, cement paste shall be prevented from accumulating at the bottom of the concrete.

3.3 No-fines concrete shall be placed to the dimensions shown on the Drawings.

4. MEASUREMENT

4.1 The unit of measurement of no-fines concrete is the cubic metre.

4.2 The quantity of no-fines concrete will be calculated from the dimensions given on the Drawings or variation thereof authorised in writing by the Engineer.

5. PAYMENT

5.1 The rate for each cubic metre of no-fines concrete will include full compensation for the execution of the work as specified and for all work incidental and necessary thereto.

SECTION NO. C.10 FORMWORK AND SURFACE FINISH

1. GENERAL

The general term formwork includes both shuttering to contain the fresh concrete and staging to support the shuttering to the required line and level.

2. FORMWORK MATERIALS

2.1 Equipment used for staging shall be approved by the Engineer. The equipment shall be in good condition and any defective parts or members will be rejected.

2.2 Timber used for formwork shall be sound, well-seasoned and free from loose knots, large cracks, warping and other defects. Timber that cracks or warps before the placing of concrete will be rejected.

2.3 Steel forms shall be capable of remaining true to shape. Forms which do not provide a smooth surface or cannot be properly aligned will be rejected.

2.4 Plywood, blockboard or similar sheeting shall be in good condition. Sheeting which has become porous will be rejected.

2.5 All forms shall be clean and free from rust, dust, grease or other foreign matter before concreting.

2.6 All bolt and rivet heads which will be in contact with the concrete surface shall be countersunk flush with the surrounding surface.

3. DESIGN OF FORMWORK

3.1 The Contractor shall submit to the Engineer a detailed design and drawings of his proposals for superstructure staging and formwork at least 28 days before erection thereof commences.

3.2 The Contractor shall submit to the Engineer a detailed design and drawing of formwork proposals for each element of the substructure at least seven days before erection thereof commences.

3.3 The Contractor shall not erect any staging or formwork before the design proposals have been approved in writing by the Engineer.

3.4 In the design of formwork, concrete is to be considered as a liquid of density 2 500 kg/m³.

3.5 For the design of staging, the following loads must be considered -

- (a) Concrete having density of 2 500 kg/m³.
- (b) An estimate of the mass of formwork.
- (c) An allowance of 2,5 kN/m² for incidental loading on horizontal surfaces.

3.6 The formwork shall be so designed that -

- (a) it can be readily removed without causing damage to the hardened concrete;
- (b) it is capable of maintaining the required shape during placing and compaction of the concrete;
- (c) it remains true to line and level while in place.

3.7 The staging shall be so designed that -

- (a) it can be readily removed without causing damage to the concrete;
- (b) it can be removed in the sequence shown on the drawings or as directed by good construction practice;
- (c) it does not permit undue deflection during placing and compaction of the concrete.

3.8 Notwithstanding approval by the Engineer of any staging or formwork design, the Contractor shall be solely responsible for the strength, safety and adequacy of all staging and formwork.

4. CONSTRUCTION OF FORMWORK

4.1 The formwork and staging shall be constructed in accordance with the approved design or authorized amendments thereto.

4.2 An appropriate foundation for the staging shall be prepared so as to afford reasonable protection against undue settlement or undermining by floodwaters.

4.3 The staging shall be erected in a workmanlike manner and shall be adequately braced against all possible loadings.

4.4 An agreed allowance for settlement of staging shall be incorporated in the superstructure formwork so that the soffit of the completed structure conforms to the levels shown on the Drawings.

4.5 All formwork joints shall be tight enough to prevent leakage of mortar from the concrete. All sharp corners inside the forms shall be provided with 20 mm by 20 mm fillets unless otherwise shown on the Drawings or directed by the Engineer.

- 4.6 Formwork shall be adequately braced with ties and wedges to prevent variation of dimensions occurring during placing and compacting of concrete.
- 4.7 Formwork ties shall be such that when they are removed or cut back no part of the tie or casing is less than 20 mm from the surface of the concrete.
- 4.8 Hardwood wedges must always be used in pairs to provide adequate bearing. Single wedges will not be permitted.
- 4.9 Assembled formwork which in the Engineer's opinion will not produce a finished concrete member within the specified tolerances will be rejected.
- 4.10 Assembled formwork which in the Engineer's opinion will not provide consistent and adequate concrete cover for the steel reinforcement will be rejected.

5. REMOVAL OF FORMWORK

- 5.1 The formwork shall be removed without damage to the concrete.
- 5.2 The use of mould oil or other agent to facilitate the removal of formwork is subject to the Engineer's approval.
- 5.3 Any procedure for the removal of formwork and staging indicated on the Drawings shall be rigidly followed.
- 5.4 Formwork shall remain in position for the minimum periods specified in Table 10.1 at the end of this section.
- 5.5 The period of maintaining formwork in place may be increased by the Engineer if the normal rate of gain in strength of concrete is not achieved or if the average air temperature falls below 10⁰C for extended periods.

6. EXTERNAL LOADING

No pier, abutment or superstructure shall be subjected to external loads until all the concrete affected by such loading has achieved the required 28 days cube strength.

7. FORMED SURFACES

7.1 General

- 7.1.1 There will be three classes of formed surface according to the standard of surface finish required and the type of form permitted.

7.1.2 Holes in the surface of concrete left by the removal of ties shall be made good with sand/cement paste of approved composition.

7.1.3 Any formwork shall be capable of producing a surface within the specified tolerances.

7.2 Class F.1.

For class F.1. formed surface, the forms may consist of any suitable material.

7.3 Class F.2.

For class F.2. formed surface, the forms shall consist of plywood or similar sheeting, or of steel, in approved condition. The joints shall be arranged in a grid pattern to the satisfaction of the Engineer.

Small surface irregularities due to the light imprint of the grain of wrought boards and their joints and minor imperfections caused by trapped air or water will be acceptable. The surface shall be free from voids, honeycombing, large irregularities and projecting fins.

7.4 Class F.3.

For class F.3. formed surface, the forms shall comply with the requirements for the F.2. surface. Immediately on removal of the forms, the surface of the concrete shall be well washed with water after which a Portland Cement wash shall be applied and rubbed in with Carborundum blocks until the resulting surface meets with the Engineer's approval. This operation shall be completed within 48 hours of removal of the forms.

8. UNFORMED SURFACES

8.1 General

There will be two classes of unformed surface according to the type of surface finish required.

8.2 Class U.1.

For class U.1. unformed surface, the concrete shall be levelled and screeded to produce a uniform plain or ridged surface. Surplus concrete shall be struck off by a straight-edge immediately after compaction.

8.3 Class U.2.

For class U.2. unformed surface, the concrete shall be finished as for the U.1. surface and then floated with a hard, smooth timber or steel float. The floating shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked to the surface. The finished surface shall be free from trowel marks.

9. DEFECTIVE FINISHES

9.1 Surface finish which, in the Engineer's opinion, does not comply with the requirements of this section of the specification will be rejected.

9.2 Rejected surface finishes shall be made good to the satisfaction of the Engineer.

10. TOLERANCES

The permissible tolerances in formed and unformed surfaces are given in Tables 10.2 and 10.3 at the end of this section.

11. MEASUREMENT

11.1 The unit of measurement for formed surfaces is the square metre.

11.2 The quantity of surface will be calculated as the area of the relevant concrete surface.

11.3 Surfaces of different classes and/or nature will be measured separately.

11.4 No measurement will be made for the provision of unformed surfaces.

11.5 No measurement will be made for the provision of any grooves or recesses in the formed surface.

11.6 Chamfers and fillets whose legs are over 50 mm will be measured as surfaces. Legs of 50 mm or less will be ignored and the concrete surface measured to the line of intersection of the two relevant faces.

12. PAYMENT

The rate for each square metre of formed surface shall include full compensation for the supply, construction, erection and subsequent removal of staging, forms, linings, special mouldings and ancillary hardware as necessary to produce the specified finished surfaces, and for all work incidental and necessary thereto.

TABLE 10.1
PERIOD OF MAINTAINING FORMWORK IN PLACE

TYPE OF STRUCTURE	PART OF STRUCTURE	MINIMUM NUMBER OF DAYS	
		SIDES	SOFFITS
Piers and abutments	All parts	2	7
Solid or cellular slab decks	Deck slab and cantilevers	2	14
Beam and slab super-structure	Beams and diaphragms	2	14 days after concreting of deck slabs
	Deck slab and cantilevers	2	10
Steel concrete composite superstructure	Deck slab and diaphragms and cantilevers	2	10
	Lower slab		14 days after concreting of deck slab
Concrete box girders	Webs and diaphragms	2	-
	Deck slab and cantilevers	2	10
All superstructures . .	Footwalks, kerbs and parapets	2	10

TABLE 10.2
CONCRETE TOLERANCES
in millimetres
FORMED SURFACES

PART OF STRUCTURE	DEPARTURE FROM ALIGNMENT AND GRADE		VARIATIONS IN CROSS-SECTIONAL DIMENSIONS	
Foundation	+20	-10	+40	-10
Abutment and Pier Footing, Road Slab	+10	-5	+20	-10
Abutment Stem/Stopwall Pier Stem/ Cap	+5	-2	+10	-5
Beam, Diaphragm Deck Slab	+5	-2	+5	-5
Kerb, Footwalk	+2	-2	+5	-2
Parapet	+2	-2	+2	-2

PART OF STRUCTURE	ABRUPT IRREGULARITIES	DEVIATION FROM 2 METRE TEMPLATE
Foundation, Permanently hidden faces of Abutment	5	10
Exposed faces of Abutment, All pier faces	2	5
Soffit of Deck Slab, Beam, Diaphragm Internal faces of Beams, Diaphragms Box Girder Ribs	2	5
Soffit of Cantilever, External faces of Beams, Box Girders	2	5
Side of Kerb, Footwalk Parapet . . .	2	2

Tolerances for precast items shall be as specified on the drawings.

TABLE 10.3
CONCRETE TOLERANCES
in millimetres
UNFORMED SURFACES

PART OF STRUCTURE	DEPARTURE FROM GRADE	ABRUPT IRREGULARITY	DEVIATION FROM 2 METRE TEMPLATE
Hidden Footing	+10 -5	5	10
Exposed Footing	+5 -5	2	5
Carriageway	+5 -2	5	5
Footwalk/Kerb	+2 -2	2	2
Parapet	+2 -2	2	2
Bearing Sill	+2 -2	1	2

SECTION NO. C.11
STEEL REINFORCEMENT

1. MATERIALS

1.1 Mild Steel Bars

Mild Steel reinforcement shall be in the form of plain round bars and shall comply with the latest B.S. 4449 "Hot rolled steel bars for the reinforcement of concrete"

1.2 Square Twisted Bars

Square twisted steel reinforcement shall be cold worked to eliminate the yield point and shall comply with the latest B.S.4461 "Cold worked steel bars for the reinforcement of concrete" (but not including C.1.2.(3), definition of nominal size).

1.3 Steel Fabric

Steel fabric shall be made from hard drawn steel wire and shall comply with the latest SABS 1024 "Welded wire mesh for concrete reinforcement".

1.4 Certification

1.4.1 All the steel reinforcement shall be manufactured by approved manufacturers.

1.4.2 Each consignment of steel reinforcement shall be accompanied by the manufacturer's certificate of compliance with the relevant standard.

1.5 Tolerances and Bending

Lengths of bars and bending dimensions shall comply with the latest B.S. 4466 "Bending dimensions and scheduling of bars for the reinforcement of concrete".

1.6 Nominal Size

The nominal size of bar reinforcement will be as defined in paragraph 4 of this section.

1.7 Testing

1.7.1 The Contractor shall notify the Engineer of the name of the reinforcement supplier, and shall afford the Engineer opportunities, when cutting and bending are in progress, of examining the workmanship and of sampling the stocks used in the fabrication of the reinforcement.

- 1.7.2 The Engineer may require that the reinforcement be tested in accordance with the relevant standard.
- 1.7.3 The Engineer may take samples for testing from the stocks of the supplier or alternatively the Engineer may take samples for testing from the steel after delivery to site.
- 1.7.4 If samples are to be taken from steel already delivered to site provision will be made in the steel schedules for additional bars to be delivered.
- 1.7.5 The Contractor shall supply, cut, shape and deliver the test pieces selected by the Engineer to a testing laboratory approved by the Engineers, regardless of whether the selection is as paragraph 1.7.1 or 1.7.4.
- 1.7.6 If any test piece fails to comply with the test requirements the whole consignment of reinforcement will be rejected.

2. PLACING AND FIXING

- 2.1 Reinforcement shall be free from dirt, oil, paint, grease, loose mill scale, and loose or thick rust before placing. It shall be placed in the positions shown on the Drawings, and firmly held in position during the placing and setting except where the spacing is less than 300 mm in each direction when alternate intersections shall be tied. When bars are lapped, they shall be separated by a distance not less than the maximum size of the coarse aggregate plus 5 mm
- 2.2 Distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved supports. If blocks are used for this purpose, they shall be precast mortar blocks of approved shape and dimensions. The use of pebbles, pieces of broken stone, brick or wooden blocks will not be permitted.
- 2.3 Splicing of reinforcing bars except where shown on the Drawings will not be permitted without the written approval of the Engineer.
- 2.4 The Engineer will inspect all steel fixing once the reinforcement is completely in position but may direct that intermediate inspections be made when the layout is complex. The Contractor must obtain the written approval of all steel fixing before concrete can be poured in any part of the works.

- 2.5 Notwithstanding the approval by the Engineer of any steel fixing the Contractor shall be solely responsible for the accuracy and conformity with the Drawings of all steel reinforcement.

3. WELDING

3.1 General

- 3.1.1 Welding of reinforcing bars may be carried out only where shown on the Drawings or authorised by the Engineer in writing.
- 3.1.2 Before welding square twisted bars, any untwisted end shall be cut off.
- 3.1.3 The metal-arc process or the fusion process, shall be used for welding.
- 3.1.4 Metal-arc welding shall comply with the latest B.S.5135 "Metal-arc welding of carbon and carbon manganese steels".
- 3.1.5 All welds shall be inspected by the Engineer before being placed in the structure. Those showing any signs of cavities or foreign matter will be rejected.

3.2 Testing

- 3.2.1 The personnel, equipment and method to be used for welding of bars must be approved in writing by the Engineer.
- 3.2.2 The Engineer may direct that specimen welds be submitted for inspection and testing. Specimen welds shall be made by the personnel and equipment to be used for the particular job.
- 3.2.3 Welded bars shall be examined by radiography in accordance with the latest B.S. 2600 "Methods for radiographic examination of fusion welded butt joints in steel" or ultrasonically in accordance with the latest B.S. 3923 "Methods for ultrasonic examination of welds".
- 3.2.4 The Engineer may direct that samples be taken from the welded bars to be used in the structure. The bar shall be cut 500 mm on either side of the weld to form a test piece one metre long. All samples shall be tested in tension and shall comply with the tensile strength requirements of the relevant standard detailed in paragraph 1 of this section.

3.3 Acceptance

3.3.1 If defects are revealed by radiographic or ultrasonic examination the Engineer may order the Contractor to -

- (a) provide as many extra lapping bars as the Engineer considers necessary; or
- (b) re-weld as many bars as the Engineer considers defective. Positioning of re-welds must be approved by the Engineer. The 500 mm of bar on each side of rejected welds shall not be used.

3.3.2 If samples taken from welded bars to be used in the structure fail to comply with the tensile strength requirements all welded bars supplied will be rejected.

4. DEFINITIONS

4.1 Nominal Density

The total mass of bar reinforcement per metre will be taken from the figures indicated in Table 11.1.

4.2 Nominal Size

4.2.1 The nominal size of a plain round bar will be the diameter of the bar.

4.2.2 The nominal size of a square twisted bar will be the length of the side of the bar prior to twisting.

4.3 Available Sizes

The actual cross-sectional area and mass per metre run of available round bar sizes is given in Table 11.1, Part A at the end of this Section. The nominal cross-sectional area and actual mass per metre run of available square twisted bars is given in Table 11.1, Part B at the end of this Section. These figures have been supplied by the Quality Control Department of ZISCO, The Zimbabwe Iron & Steel Company.

5. MEASUREMENT

5.1 Bar Reinforcement

5.1.1 The unit of measurement for bar reinforcement is the tonne (1 000kg).

5.1.2 The total mass of bar reinforcement will be calculated from the scheduled length multiplied by the actual mass per metre run given in Table 11.1.

5.1.3 Round bars and Square bars will be measured separately.

5.1.4 The following bar sizes will be measured separately

- (a) size 14 mm and under up to 12 m length;
- (b) size 16 mm and over up to 12 m length;
- (c) each size of bar of a specified length over 12 m

5.1.5 Welded frame units will be measured separately.

5.2 Fabric Reinforcement

5.2.1 The unit of measurement for fabric reinforcement is the tonne (1 000kg).

5.2.2 The total mass of fabric reinforcement will be calculated from the nett plan area of the reinforcement and the mass per square metre given in SABS 1024.

5.2.3 Fabrics of different nominal mass will be measured separately.

5.3 Butt Welds

5.3.1 The unit of measurement of butt welds is the number off.

5.3.2 Welds for each size and type of bar will be measured separately.

6. PAYMENT

The rate for each tonne of reinforcement or each butt weld will include full compensation for the execution of the following operations and for all work incidental and necessary thereto :-

6.1 Bar Reinforcement

- (a) supply and delivery of all materials;
- (b) cutting, bending, placing and fixing as detailed on the Drawings;
- (c) welding of reinforcing frames;
- (d) supply and delivery of test pieces.

6.2 Fabric Reinforcement

- (a) supply and delivery of all materials;
- (b) cutting and placing as detailed on the Drawings;
- (c) provision of the laps as specified on the Drawings;
- (d) supply and delivery of test pieces.

6.3 Butt Welds

- (a) supply of all materials;
- (b) execution of the work as specified;
- (c) supply and delivery of test pieces;
- (d) provision of lapping bars or rewelding due to rejection of welds.

7. TESTING

Testing shall be in terms of Section C14 - Testing.

TABLE 11.1
CROSS-SECTIONAL AREA AND MASS
PART A - ROUND BARS

NOMINAL SIZE	ACTUAL CROSS - SECTIONAL AREA	ACTUAL MASS PER METRE RUN
mm	mm ²	kg
6	28,3	0,222
8	50,3	0,395
10	78,5	0,616
12	113,1	0,887
14	154,0	1,210
16	201,1	1,580
20	314,2	2,47
22	380,3	2,98
25	490,9	3,85
30	707,1	5,55

PART B - SQUARE BARS

NOMINAL SIZE	NOMINAL CROSS - SECTIONAL AREA	ACTUAL MASS PER METRE RUN
mm	mm ²	kg
8	64	0,502
10	100	0,785
12	144	1,130
14	196	1,537
16	256	2,008
20	400	3,14
22	484	3,80
25	625	4,91
30	900	7,07

NOTE: ABOVE FIGURES SUPPLIED BY QUALITY CONTROL DEPARTMENT, ZISCO.

SECTION NO. C.12
SLOPE PROTECTION AND ANTI-EROSION WORKS

1. GENERAL

Road embankments, cut slopes, drains and stream channels shall be protected by the installation of L-channels and flumes, cladding with natural rock, in-situ concrete or interlocking concrete blocks and by the use of gabions or bolsters at locations shown on the Drawings or where ordered by the Engineer.

Where shown on the drawings or as indicated by the Engineer top soiling coupled with grass planting or seeding will be carried out.

2. MATERIALS

2.1 Natural Rock

Natural rock for cladding shall be sound, durable and free from decomposition. Each stone shall not be less than 200 mm in any two dimensions. Smaller stones may only be used to fill interstices.

Natural rock for stonework in bolsters shall be as for cladding except each stone shall not be less than 100 mm in any two dimensions.

2.2 Steel Fabric

Steel fabric for cladding or gabions shall comply with the latest SABS 1024 "Welded wire mesh for concrete reinforcement". Unless otherwise directed by the Engineer the mesh shall be 100 mm x 100 mm and the wire thickness shall be 3,55 mm.

2.3 Wire and Fencing Standards

Galvanised wire and fencing standards incorporated in cladding shall comply with the latest S.A.Z.S 284 "Steel fencing materials".

2.4 Grout

Cement and sand for grouting shall be as given in "Portland Cement Concrete" (See section C.8).

2.5 Concrete Blocks

- (a) Concrete Blocks for cladding shall comply with the latest S.A.Z.S 119 "Precast concrete masonry blocks".
- (b) Concrete blocks shall be solid and manufactured from high density aggregate.
- (c) Concrete blocks shall comply with the compressive

- strength requirements specified on the Drawings.
- (d) The plan dimension of blocks shall be free but blocks must be interlocking. The block thickness shall be as specified on the Drawings.
 - (e) The blocks shall be within a tolerance of $\pm 5\text{mm}$ of the plan dimensions stated by the manufacturer.
 - (f) The blocks shall have a mass and cement content not less than that stated by the manufacturer.

2.6 Plain Concrete

Cement, sand and aggregate for plain concrete cladding shall be as given in "Portland Cement Concrete" (See section C.8).

2.7 Topsoil

Approved topsoil shall be a natural, friable, soil possessing characteristics of representative productive soils in the vicinity from which it is obtained. It shall be reasonably free from subsoil, claylumps, stones, or similar objects larger than 50 mm in greatest diameter, brush, stumps, roots, objectionable weeds or litter.

3. CONSTRUCTION

3.1 Gabions

- (a) A trench shall be excavated to the level of the lowest gabion as shown on the Drawings or as directed by the Engineer. Care shall be taken to avoid excavating beyond the line of the back of the gabions. The trench shall be approved by the Engineer before placing of gabions commences.
- (b) A steel wirecage shall be prefabricated to the dimensions shown on the attached Drawings or as directed by the Engineer. The gabion steel shall be folded flat for transportation and completed on site. The gabions shall be closed by forming hooks on the protruding wires of the mesh.
- (c) The cages shall be carefully filled with rocks. Rocks shall be tightly packed to achieve a minimum of voids between rocks. The rocks on the external faces shall be of uniform size and placed to produce a neat and uniform appearance.

3.2 Preparation of Slopes

- (a) The area to be covered with cladding must first be trimmed to the line, level and slope indicated on the Drawings (as specified and paid under R6). The prepared surface shall be firm and well compacted and must be approved by the Engineer before placing of rock, concrete blocks, topsoil importation and grass planting commences.

- (b) Toe trenches shall be excavated to the dimensions shown on the Drawings or as directed by the Engineer. The toe trench shall be backfilled as indicated on the Drawings.

3.3 Plain Rock Cladding

After preparation of the slope has been completed as specified on the drawings and as specified and paid under R5 the area to be cladded must be excavated to a depth of 200 mm. The excavated area must then be backfilled with hand placed stones laid in contact with each other and firmly bedded into the excavated slope. The thickness of rock normal to the slope shall be not less than 200 mm. Interstices between the large stones shall be filled with smaller stones rammed into position. The finished surface shall present an even tight appearance.

3.4 Wired Rock Cladding

Where wired rock cladding is specified the anchor stones or fencing standards shall be placed as shown on the Drawings. A wire mesh or steel fabric mesh covering shall be laid as detailed on the Drawings. Laps in wire mesh or steel fabric must be provided with adequate overlap and be securely tied together with galvanized steel wire. At the edge of the cladding the wire mesh or steel fabric shall be bent over to provide total enclosure of the rock surface.

3.5 Grouted Rock Cladding

Where grouted rock cladding is specified the large stones shall be laid as for plain rock cladding but the interstices shall be filled with grout. The grout shall consist of one part of cement to four parts of sand unless otherwise directed. Before final set of the grout, the surface shall be swept with a stiff broom. The grouted surface shall be kept moist for at least 4 days. Weepholes must be provided in the surface at a frequency of one per square metre unless otherwise directed.

3.6 Plain Concrete Cladding

After preparation of the slope has been completed as specified on the drawings and in section R5 - "Construction of the Subgrade", the area to be cladded must be excavated to a depth of 150mm. The bottom of the excavated area must

be firm and well compacted and must be approved by the Engineer before backfilling with concrete commences. The concrete backfilling must be brought back to the line, level

and slope of the embankment indicated on the drawing. The outer edges of the concrete must be shuttered. The surface finish shall be as given in C9 "Formwork and Surface Finish" for Unformed Surfaces Class U2. Weepholes must be provided in the surface at a frequency of one per square metre unless otherwise directed.

3.7 Concrete Interlocking Blocks

After trimming and approval of the surface to be covered with block cladding a layer of fine non-plastic material shall be laid on the surface to a thickness of 20mm. The interlocking blocks shall be laid in a pattern previously approved by the Engineer and lightly tapped in position. Excessive adjustment of each block at this stage will impair the smooth appearance of the finished surface and should be avoided. Upon completion of the surface fine sand shall be brushed over the blocks to fill the minor interstices and thereby create full interlock.

3.8 Bolsters

Bolsters are to be constructed as indicated on the drawings or as directed by the Engineer. They shall be constructed in no-fines concrete unless suitable stone exists on site in which case the bolsters may be constructed in grouted stonework.

If grouted stone is used, the central portion, 300 mm wide, shall be constructed in no-fines concrete to the full 600 mm bolster depth.

Bolsters shall be constructed proud of the drain invert level as shown on the drawing.

Both upstream and downstream faces shall be shuttered when the construction is in "no-fines" concrete (see section C.9).

Construction in both grouted stonework and no-fines concrete shall be carried out true to line and level.

3.9 Importation of Topsoil

After preparation of the slopes has been completed and approved the area to be covered by grass planting shall be overlaid with imported topsoil to a depth of 100 mm. The topsoil shall be dumped in separate piles, uniformly

distributed on the designated slopes at a rate which will provide not less than the quantity specified. The topsoil shall then be evenly spread over the areas by hand or other methods approved by the Engineer. Spreading shall be carried on in such a manner that seeding or grass planting operations can proceed with a minimum of soil preparation or filling.

3.10 Grass Seeding

After the areas to be seeded have been trimmed to line, level and slope and topsoil has been spread as specified in 3.9 seeding shall commence.

The seed of the type and in the quantity recommended by the manufacturer shall be uniformly distributed over the areas shown on the plans or as directed by the Engineer, by either hand or mechanical means. If the sowing of the seed is by hand, the seed shall be sown in two directions at right angles to each other.

The seeded areas shall be watered as directed by the Engineer so as to prevent washing of slopes or dislodgement of the seed.

3.11 Grass Planting

Grass Planting is done using grass roots, i.e. runners or tufts. The area to be planted must first be top soiled as described in para. 3.9 above. Superphosphate 20% (single superphosphate) must then be spread evenly over the prepared surface at the rate of 9.00 kg per 80 square metres then forked into a depth of 125-150mm. The soil should then be watered thoroughly to encourage settlement and to induce germination of weed seeds. After partial drying out, spread Compound "D" at the rate of 4,5kg per 80 square metres and lightly mix into the top 50mm of soil. This operation should smother the young newly germinated weeds. The soil must be well watered before planting commences. Fix a guide line across the area to be planted and make a shallow furrow about 50mm deep. Runners are then to be laid in the furrow filling in the soil and firming it down as the planting proceeds. The whole area is covered in this manner spacing the planting lines 150mm to 300mm apart. If tufts instead of runners are used they should be planted in a similar manner using lines 150-300mm apart and tufts space along each line at a similar spacing.

Once the area being planted is covered with newly grown runners a top dressing of ammonium nitrate at the rate of 2.7 kg per 80 square metre is to be applied. To prevent any scorching, water should be applied immediately after such a dressing.

4. MEASUREMENT

4.1 Excavation

Excavation in toe and bolster trenches will be measured as given in "Excavation and Backfilling for Structures" (See section C.6).

4.2 Cladding

The unit of measurement for cladding is the square metre of completed surface.

4.3 Toe Wall

The unit measurement for rock filling to toe walls is the cubic metre.

4.4 Gabions

The unit of measurement for gabions is the number off for each size.

4.5 No-Fines Concrete in Bolsters

The unit of measurement for no-fines shall be as given in "No-fines Concrete", (See section C.9).

4.6 Grouted Stonework in Bolsters

The unit of measurement is the cubic metre.

4.7 Topsoil Importation

The unit of measurement is the cubic metre computed as the product of the area and the specified depth.

4.8 Grass Planting

The unit of measurement is the square metre.

4.9 Grass Seeding

The unit of measurement is the square metre.

4.10 Grass Seeds

The unit of measurement is the kilogram.

4.11 Fertilizer

The unit of measurement is the kilogram.

4.12 Water

Water shall be measured in cubic metres of water applied as directed.

5. PAYMENT

5.1 Excavation

The payment for excavation in toe and bolster trenches will be as given in "Excavation and Backfilling for Structures" (See section C.6).

5.2 Cladding

The rate for each square metre of cladding will include full compensation for all slope preparation, specified excavation, supply of materials, construction of the surface as specified and for all work incidental and necessary thereto.

5.3 Toe Wall

The rate for each cubic metre of rock filling will include full compensation for the supply of all materials, construction of the toe wall as specified and for all work incidental and necessary thereto.

5.4 Gabions

The rate for each size of gabion will include full compensation for the execution of the following operations and for all work incidental and necessary thereto:-

- (a) supply of all materials for the gabion;
- (b) fabrication of the gabion, delivery to site and place;
- (c) supply of all stone-filling for the gabion;
- (d) filling the gabion with rock and completion of the wire cage.

5.5 No-Fines Concrete in Bolsters

The rate for no-fines concrete in bolsters shall be as given in "No-Fines Concrete", (See section C.9).

5.6 Grouted Stonework in Bolsters

The rate for each cubic metre of grouted stonework in bolsters shall include full compensation for the supply of all materials, construction of the bolster as specified and for all work incidental and necessary thereto.

5.7 Topsoil Importation

The rate for each cubic metre of topsoil will include full compensation for furnishing all materials; for preparation, placing and spreading the materials and for all labour, equipment, tools and incidentals necessary to complete the item.

5.8 Grass Planting

The rate for each square metre of grass planted will include full compensation for the supply of the grass, as specified; its planting; all labour, equipment tools and incidentals necessary to complete the planting and fertilization operations. The supply of fertilizer will be paid separately.

5.9 Grass Seeding

The rate for each square metre of area seeded will include full compensation for the supply of all materials as specified (with the exception of seed and fertilizer); their distribution; all labour, equipment, tools and incidentals necessary to complete the seeding.

5.10 Grass Seeds

The rate for each kilogram of seed, as directed by the Engineer, shall include full compensation for the supply and delivery to site of application.

5.11 Fertilizer

The rate for each kilogram of fertilizer, applied as directed by the Engineer, shall include full compensation for the supply and delivery to site of application.

5.12 Water

The rate for every cubic metre of water will include compensation for the provision, pumping, hauling and distribution of the water.

5.13 Overhaul of Water

Overhaul of water will be as given in "Haul and Overhaul" (Section C.7).

SECTION C.13 STATISTICAL CONTROL

1. DESCRIPTION OF THE WORK

This specification outlines a statistical method of acceptance control for judgement of compliance with the specified density requirements.

In all cases where the statistical judgement plans are used, they shall be strictly adhered to and decisions based on these plans shall not be altered, in order not to distort the risks of compaction being wrongly accepted or rejected.

Despite acceptance of density judged by this statistical method the Engineer has the right to reject the compaction for other causes such as obviously defective material, excessive lack of uniformity in the material, excessive variation due to any assignable cause and visible signs of poor workmanship. Similarly he has the right to accept compaction which is rejected by this statistical method but which is considered to be acceptable for any reason e.g. because the layer is cement treated or the materials used are unusual e.g. slag.

The Engineer reserves the right to carry out such tests as he may consider necessary on any localised portion of a lot which appears to be defective.

If required, the defects in the localised portion shall be rectified before it is included in the lot for general acceptance control. The results of such special tests on localised portions shall not be included as part of the random tests required for statistical acceptance control of the lot.

2. DEFINITIONS

2.1 Lot

A lot is normally taken as not more than 3 000 square metres of compaction or a day's work whichever is less. Each lot will be selected by the Engineer to represent as far as possible similar material compacted under conditions which did not vary during the course of the work.

2.2 Random Sample

A random sample is a group of 'n' test measurement taken at 'n' separate test positions obtained from the lot in an unbiased way. The value of 'n' should be 6 or more but is normally taken as 6.

2.3 Sample mean \bar{x}_n

\bar{x}_n is the arithmetic mean of a set of 'n' test results constituting the sample.

$$\bar{x}_n = \frac{\sum x}{n}$$

2.4 Sample Standard Deviation, S_n

The sample standard deviation, S_n , is defined by

$$S_n = \frac{\sqrt{\sum x^2 - \frac{(\sum x)^2}{n}}}{n-1}$$

where

\bar{x}_n is the sample mean

x is the value of an individual test result or measurement

n is the number of individual test results or measurements

2.5 Specification Limit

The specification limit, L_s , is defined as that value of density below which 10% of the population of all possible density measurements are expected to fall.

2.6 Acceptance Limit

The acceptance limit, L_a , is the limiting value of the sample mean above which the lot will be accepted.

2.7 Rejection Limit

The rejection limit, L_r , is the limiting value of the sample mean below which the lot will be rejected.

2.8 Conditional Acceptance

If the sample mean falls between the acceptance and rejection limits then the work may be conditionally accepted subject to the imposition of specified conditions. Such work may be resubmitted with or without reworking of the lot.

2.9 Resubmission

When a lot is resubmitted an additional random sample of 'n' test results will be obtained from the lot.

When a lot has not been reworked, or when the reworking, as judged by the Engineer, did not significantly change the properties of the lot, the mean and standard deviation will be recalculated using the original and additional test results and will be judged against the criteria for a resubmission.

Where the reworking of the lot makes a significant change in the properties of that lot as judged by the Engineer, the reworked lot shall be regarded as a new lot, and judged as such on the new test results against the criteria for an initial submission.

2.10 Outliers

Where, in a sample, any test result differs significantly from the other values obtained, this difference may be due to an assignable cause, in which case such a result shall be regarded as an outlier and discarded when assessing the test.

To determine whether a test result is an outlier, the following procedure will be adopted:

$$\text{Calculate the value of } T_o = \frac{x_o - \bar{x}_n}{S_n}$$

Where \bar{x}_n is the sample mean

S_n is the sample standard deviation

x_o is the value of the test result with the greatest difference from the mean

For 'n' test measurements if the value of T_o is greater than the value of T given in the following table then x_o is an outlier.

n	4	5	6	7	8	9	10	11	12
T	1,46	1,67	1,82	1,94	2,03	2,11	2,18	2,23	2,29

The outlier shall be discarded and replaced by another random test value. The sample mean \bar{x}_n , and the sample standard deviation S_n , shall then be recalculated. If the outlier cannot be replaced these values should be calculated using the remaining n-1 test results. The final number of test results used in the assessment after the elimination of outliers, shall never be less than four.

2.11 Factors K_a and K_r

These are factors used in the calculation of the acceptance limit and the rejection limit as given below.

$$La = Ls + Ka Sn$$

$$Lr = Ls + Kr Sn$$

3. JUDGEMENT PLAN

3.1 Factors Ka and Kr

For acceptance of density the factors Ka and Kr will be taken as given in Table 1. An upper limit for sample standard deviation is also given in Table 1.

TABLE 1

Submission	Factor	Limit Sn	
		Ls > 93	Ls < 91
Initial	Ka = 1,25	3,2	4,0
Resubmission	Ka = 1,43	2,8	3,5
All	Kr = 0,77	4,0	5,2

3.2 Specification Limits

For the acceptance of density the specification limits will be taken as given in Table 2. The Ls to use is that for the maximum triaxial class as indicated in Table 3 for the relevant pavement design. The design standard applicable together with the maximum triaxial class (but this should be checked) for the section of road can be obtained from the working drawings (plan and profile sheets).

Example If a 1M design is specified the maximum triaxial class for base 1 is 2,6 and the Ls to use is therefore 96 regardless of the possibility of actually using material of class 2,4.

TABLE 2

Pavement Design Material Class	Ls (% Mod AASHTO)
Crushed Stone Base Class 2,4	100
Other Base Materials Class 2,4	98
Base Class 2,6	
Base Class 2,8	96
Base Class 3,0	
Base Class 3,3	93
Base Class 3,6	
Top 750 mm wedge treatment	
Base Class 3,9	
Controlled compaction of subgrade:-	91
(i) Top 150 mm T5 treatment	
(ii) Lower layers of wedge treatment	
Wearing course gravels.	
Semi-controlled compaction:-	
(i) T3 treatments and	
(ii) Lower layers T5 subgrade treatment.	89
Top 150 mm roadbed where CBR < 3	87*

* To be used only with the approval of the Engineer.

3.3 Acceptance of Compaction

Any area of compaction constituting a lot will be accepted if:

- (a) The acceptance limit L_a with a factor $K_a = 1,25$ is achieved upon initial submission and the sample standard deviation is less than 3,2 when $L_s > 93$ or 4 when $L_s < 91$.
- (b) The acceptance limit L_a with a factor $K_a = 1,43$ is achieved upon re-submission of a lot which has not been effectively reworked and the sample standard deviation is less than 2,8 when $L_s > 93$ or 3,5 when $L_s < 91$.
- (c) The acceptance limit L_a with a factor $K_a = 1,25$ is achieved upon submission of a lot which has been effectively reworked or reconstructed and the sample standard deviation is less than 3,2 where $L_s > 93$ or 4 when $L_s < 91$.

TABLE 3

Class of Material	Standard of Pavement				
	3 M	1 M	0,3 M	0,1 M	0,05 M
2,4	All layers	All layers	All layers	All layers	All layers
2,6	below 150 mm				
2,8	below 300 mm	below 150 mm			
3,0	below 300 mm	below 150 mm	below 120 mm		
3,3	below 300 mm	below 150 mm	below 120 mm	below 120 mm	
3,6	below 300 mm	below 270 mm	below 120 mm	below 120 mm	below 120 mm
3,9	below 450 mm	below 270 mm	below 240 mm	below 150 mm	below 120 mm
3,3 S	below 300 mm	below 300 mm	below 150 mm	below 150 mm	below 150 mm
3,6 S	below 300 mm	below 300 mm	below 150 mm	below 150 mm	below 150 mm

3.4 Conditional Acceptance of Compaction

Any area of compaction constituting a lot will be conditionally accepted for part payment if:

- (a) The rejection limit L_r with a factor of $K_r = 0,77$ is achieved on initial submission or resubmission and the sample standard deviation is less than 4 when $L_s > 93$ or 5,2 when $L_s < 91$.
- (b) The appropriate acceptance limit is achieved but the sample standard deviation is above the limits for acceptance but less than 4,0 when $L_s > 93$ or 5,2 when $L_s < 91$.

3.5 Rejection of Compaction

Any area of compaction constituting a lot will be rejected if the rejection limit L_r is not achieved or the sample standard deviation is greater than 4,0 when $L_s > 93$ and 5,2 when $L_s < 91$. Any area of work which has been rejected shall be reconstructed.

4. CONDITIONS OF USE

For contract work the statistical acceptance plan shall be subject to the following conditions:

- (a) The conditional acceptance of compaction is made at the entire discretion of the Engineer.
- (b) The Contractor may elect to reconstruct any compaction in the conditional acceptance range.
- (c) The Contractor will be required to bear the cost of any testing which results in the rejection of compaction.
- (d) The Contractor will be required to improve his compaction techniques if:
 - (i) The area of compaction subject to conditional acceptance is excessive.
 - (ii) The area of compaction offered for resubmission is excessive.
- (e) When the lot is accepted but falls in the conditional acceptance range a payment of 80% of the tendered rate will be made. The reduced rate will be applied to the total quantity of material in the lot.

SECTION NO. C. 14
TESTING

All testing shall be in terms of Clause 44 of the General Conditions of Contract. The Engineer reserves the right to independently carry out testing to any part, or all, of the works in accordance with Clause 44 of the General Conditions of Contract.

SECTION NO. B.1 SITE ACCESS AND CLEARING OF BRIDGE SITE

1. SITE ACCESS

The Contractor shall be responsible for the construction and maintenance of access roads to the bridge site, aggregate deposits and water points unless suitable access already exists at the time work commences. The location and standards of any access road shall be agreed in writing with the Engineer before any work is commenced.

2. CLEARING OF BRIDGE SITE

2.1 The bridge site shall be cleared over a width of 12 metres each side of the road centreline. Clearing shall extend over the full width of the river and its bank between points 25 metres beyond the face of each abutment.

2.2 The Contractor shall clear the area of all timber, brush, grass, roots and debris to the satisfaction of the Engineer.

2.3 The Contractor shall comply with any amended requirements for clearing the bridge site as indicated on the Drawings.

2.4 The timber cleared shall be corded immediately adjacent to the cleared area.

2.5 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All such material not required by the landowner shall be burned at a location indicated by the Engineer.

2.6 The bed and banks of the river shall be trimmed as shown on the Drawings.

2.7 On completion of the contract, the area cleared shall be left clean and tidy.

3. MEASUREMENT

3.1 Site Access

All work undertaken for access roads will be measured as outlined in section R14, The Supply of Materials for use in the Construction of the Pavement.

3.2 Site Clearing

The unit of measurement will be the hectare of site cleared.

4. PAYMENT

4.1 Site Access

All work undertaken for the purpose of site access listed hereunder will be paid for as outlined in section R14, The Supply of Materials for use in the Construction of the Pavement, provided it has been agreed, in writing, with the Engineer -

- (a) construction and maintenance of access road to the bridge site;
- (b) construction and maintenance of access roads to the approved aggregate deposits;
- (c) construction and maintenance of access roads to approved water points;
- (d) reinstatement of all access roads to the satisfaction of the Engineer.

4.2 Clearing of Bridge Site

The price for clearing the bridge site will include full compensation for the execution of the work as specified and for all work incidental and necessary thereto.

SECTION NO. B.2 PILED FOUNDATIONS

1. GENERAL

1.1 Description

1.1.1 This specification covers cast-in-situ driven displacement piles, cast-in-situ percussion bored piles and driven precast piles.

1.1.2 The Contractor shall furnish the Engineer with full details of the method of piling he proposes to adopt in the construction.

1.1.3 The Contractor shall not commence work before the piling method has been approved in writing by the Engineer.

1.2 Subsoil Conditions

1.2.1 The subsoil information given on the Drawings has been obtained from investigations at selected points only.

1.2.2 The Contractor should take such steps as he considers necessary to satisfy himself as to the true nature of the subsoil conditions. A provisional item is included on the Bill of Approximate Quantities to cover expenditure incurred by the Contractor in such subsoil investigations as he may consider necessary.

1.3 Records

During piling operations, the Contractor shall submit to the Engineer a written record of the strata encountered in respect of each pile and the depth at which each pile is founded.

2. DESIGN

2.1 The pile shall be of reinforced concrete construction with a minimum cross-sectional area as specified on the Drawings.

2.2 The cross-section of pile adopted and the reinforcement details shall be determined by the Contractor to ensure that the pile is capable of carrying the compressive, tensile and horizontal loads given on the Drawings.

2.3 The Contractor shall not commence work before the structural details of the pile have been approved in writing by the Engineer.

- 2.4 The Engineer will provide the Contractor with details of the design loads for which the pile group configuration has been designed. The Contractor shall confirm in writing to the Engineer that the configuration and structural details of the pile group, as mutually agreed, is acceptable to the Contractor in terms of the guarantee which is given by the piling Contractor for satisfactory performance of the piles under the given loading.

3. ALTERNATIVE PILING SYSTEM

Should the Contractor wish to tender for a piling system not covered by this specification full details of the proposed scheme must be provided with the tender. Alternative proposals must be supported by design calculations, drawings and quantities to enable the merits of the scheme to be fully evaluated.

4. FORMATION OF PILES

The formation of piles shall comply with the relevant requirements of the latest CP 2004 "Foundations" with the following amplification.

4.1 Cast-in-situ Driven Displacement Piles

Driven displacements piles shall be of a type in which a tube is driven into the ground by hammering on a plug placed at the bottom of the tube. When the tube is deep enough to enable the resulting pile to carry the specified loads driving is stopped. The tube is then withdrawn a short distance and the plug is driven out of the end of the tube.

4.2 Cast -in-situ Percussion Bored Piles

Percussion bored piles shall be of a type in which a tube is driven into the ground by hammering on the top of the tube. During driving earth within the tube is removed by percussion coring tools. When a firm stratum is reached driving is stopped.

4.3 Enlarged Base and Pile Shaft

An enlarged concrete base shall be formed monolithic with the pile shaft by depositing successive charges of concrete at the bottom of the tube and consolidating the concrete by direct blows of a hammer. The pile shaft is formed by successive charges of concrete being deposited and consolidated as the tube is withdrawn. Adequate precautions shall be taken to prevent necking and to avoid disturbance of the reinforcement.

4.4 Rock Socket

Where indicated on the Drawings the pile shall extend into the rock surface to prevent transverse movements.

4.5 Driven precast piles

Driven precast piles shall be of reinforced concrete. The Contractor shall manufacture the piles in a factory or yard or he may elect to manufacture at the site of the works. The Contractors or Manufacturer's works at which the precast piles in terms of the contract are being made shall at all reasonable times be open for inspection by the Engineer. Where directed, piles shall not be despatched from the works prior to inspection and acceptance by the Engineer.

The piles shall be cast on a rigid horizontal platform in approved moulds. Particular care shall be taken in fixing the reinforcement and pile shoes accurately. The main longitudinal bars shall not butt against the pile shoe. Provision for lifting shall be made during casting in the position and in accordance with the details shown on the drawings.

Piles shall be cured for a period sufficient to develop the required strength. Removal from moulds may only be undertaken when a strength of 25 MPa has been reached. The piles may not be lifted, stacked or driven until the concrete has attained the required strength. The piles will be transported and stacked in a manner approved by the Engineer. Each pile shall be clearly marked with the date of casting and the pile number and pile shall be driven in their correct order of age. The use of rapid hardening Portland cement, special cements or additives shall be subject to the written approval of the Engineer.

All moving, handling, lifting, loading and unloading operations shall be carried out in such a manner that the pile is not subjected to undue jerking, jarring, overloading, twisting or to distortion likely to result in damage to the pile or to any other section of the works and in such a manner as ordered or specified.

5. CONSTRUCTION

5.1 Setting Out

5.1.1 The Engineer will set out the centreline of the bridge and the face line of each abutment or pier and will provide the reduced level of a reference peg.

- 5.1.2 All subsequent setting out will be the responsibility of the Contractor.

5.2 Site Preparation

- 5.2.1 The site shall be cleared of surface and overhead obstructions and ramps prepared to permit access of equipment.
- 5.2.2 Cast-in-situ Piling shall be undertaken from a dry, level and firm working area in a continuous operation.

5.3. Concrete

- 5.3.1 The grade of concrete used for the construction of piles shall be as indicated on the Drawings.
- 5.3.2 The concrete shall comply with the relevant requirements specified in "Portland Cement Concrete" see section C.8 with the following amplification:
- (a) The maximum cement/water ratio to achieve the required workability shall be used. The combined aggregate/cement ratio shall remain constant.
 - (b) No concrete shall be placed in the piles before the Contractor has received written approval of the mix design from the Engineer.
 - (c) The concrete shall be freshly mixed and thoroughly compacted to avoid the formation of voids in the pile shaft.
 - (d) Adequate precautions shall be taken to ensure that concreting is carried out under dry conditions.
 - (e) Adequate precautions shall be taken to prevent the leaching of cement from the fresh concrete by subterranean water.
 - (f) If dry conditions cannot be achieved concreting shall be carried out in still water conditions. Approved underwater concreting equipment in good condition shall be used.

5.4 Reinforcement

Steel reinforcement used in the piles shall comply with the relevant requirements given in "Steel Reinforcement" with the following amplifications:

- 5.4.1 The concrete cover to all reinforcement, including binding wire shall be at least 40mm.
- 5.4.2 The reinforcement shall be adequately spaced to ensure the free flow of concrete around it.
- 5.4.3 The reinforcement shall extend over the full length of the pile and the main bars shall project above the trimmed level of the pile as indicated on the Drawings.

5.5 Tolerances

- 5.5.1 The piles shall be set out and constructed to the dimensions shown on the Drawings.
- 5.5.2 A tolerance of 60mm will be allowed on any pile as driven, and the maximum permissible deviation from the alignment of any finished pile is 10mm per metre.
- 5.5.3 The Contractor shall undertake any additional work which in the opinion of the Engineer is necessary due to any of the tolerances being exceeded.

5.6 Finishing of pile heads

- 5.6.1 The trimmed level is the finished top level of the pile as indicated on the Drawings.
- 5.6.2 Cast-in-situ pile shall be concreted to a level between 75mm and 300mm above the final trimmed level to ensure sound concrete at the trimmed level. Any piles concreted higher than 300 mm above the trimmed level shall be trimmed down by the Contractor. The trimming of the piles, to the final level and the bending of the pile reinforcement as necessary for bonding into the pile caps, shall be undertaken when the pile cap is constructed.
- 5.6.3 In the case of precast piles the piles must be cut off at the trimmed level as specified with care being taken to avoid damage to the reinforcement.

The reinforcement so exposed is then cut off at the specified level and bent down as shown on the drawings for bonding into the pile caps.

6. OBSTRUCTION

Where boulders or other obstructions make it impossible to install any pile in the position shown and to the proper length, the Contractor shall resort to all usual methods to install the piles as required, including spudding, jetting or other feasible means. If it is not possible to complete properly any pile after resorting to such methods the Engineer may order additional piles to be installed. All such work including any additional piles, shall be paid for in accordance with the tendered rates where these are applicable or as an extra to the contract at rates agreed before the work commences.

7. LOAD TEST OF PILES

- 7.1 If the Engineer directs, a test load of magnitude 50 percent in excess of the working load shall be applied as a kentledge placed on a platform bearing on a selected pile.
- 7.2 The test load shall be imposed at a steady rate of 10 percent of the test load per hour.
- 7.3 The full test load shall be maintained on the pile for at least 72 hours.
- 7.4 The test load shall be removed at a steady rate of 20 percent of the test load per hour.
- 7.5 Readings of settlement during loading and recovery during unloading shall be taken in increments of loading corresponding to 10 percent, of the test load. The process of loading or unloading shall cease for 10 minutes before any readings is taken.
- 7.6 Readings of settlement shall be taken every six hours during the period the full test load is maintained on the pile. Unloading of the test load shall not commence if significant settlement of the pile is being recorded under full test load.
- 7.7 The pile will be considered to have passed the test load if the settlement under full test load is less than 3 percent of the pile diameter and permanent settlement after removal of load is less than 1 percent of the pile diameter.
- 7.8 Settlement and recovery shall be measured to an accuracy of 0.1 mm from a datum which will not itself be affected by any movement of the ground due to test loading or other causes.
- 7.9 Graphs of the records obtained shall be plotted, showing -
 - (a) load and settlement plotted above and below common base line of time;

(b) settlement plotted below a base line of load.

7.10 If the settlement under test load is greater than that indicated in paragraph 8.7. the Engineer may direct that two other piles be tested.

7.11 If any pile fails the requirements of the load test the Contractor shall construct such additional piles and/or take such other remedial measures as may be ordered by the Engineer.

8. GUARANTEE

8.1 The piling Contractor shall furnish a written guarantee that the piles will withstand the specified applied load without settlement or failure for two years from the date of completion of the contract. The guarantee shall be upheld and supported by an approved insurance policy, which will adequately provide for the cost of reinstating the piles and repairing or re-building the bridge in the event of settlement or failure.

8.2 The piling Contractor shall furnish written confirmation that the design loads given by the Engineer in terms of paragraph 2.4. are a reasonable assessment of the conditions which could occur in the bridge structure.

8.3. Unless adverse comment is made on the design assumptions before work commences inadequacy of the pile design will not be accepted as a reason which releases the piling Contractor from his obligation under the guarantee of the piles.

8.4 The piling Contractor will not necessarily be held responsible for settlement which can be proved to have been caused by old quarries, caverns or springs, or by the presence of acids or other destructive matter in the ground or ground water, other than those known to exist before commencement of piling.

9. CASING TO PILES

Sub-soil water conditions in the piling area may necessitate the use of a permanent casing for the piles to avoid leaching of cement from the concrete in the piles. Casing may only be used by written agreement between the Engineer and Contractor. The Engineer's written approval of the type of casing must be obtained before work commences.

10. MEASUREMENT

10.1 Cast-in-situ Piles

10.1.1 Transport of Equipment.

The unit of measurement will be a lump sum.

10.1.2 Setting Up Equipment

The unit of measurement for setting up the equipment at each pile position is the number off.

10.1.3 Enlarged Base and Rock Socket

The unit of measurement for forming an enlarged base to each pile or providing a rock socket for each pile is the number off.

10.1.4 Construction of Pile Shaft

- (a) The unit of measurement of construction of the pile shaft is the metre.
- (b) Vertical piles and raking piles will be measured separately.
- (c) The length of pile will be calculated as the distance from the lowest point reached by the piling tube to the trimmed level of the pile, measured along the line of the pile.

10.1.5 Empty Driving

- (a) The unit of measurement for empty driving is the metre.
- (b) The length of empty driving will be calculated as the depth of the trimmed level of the pile below ground level at the time of driving, at each pile position.

10.1.6 Casing to Piles

- (a) The unit of measurement for casing to piles is the metre.
- (b) Casing to piles will be measured as the actual lengths of pile casing used.

10.2 Precast Piles

10.2.1 Transport of Equipment

The unit of measurement will be a lump sum.

10.2.2 Setting up Equipment

The unit of measurement for setting up the equipment at each pile position is the number off.

10.2.3 Provision of Pile Section

The unit of measurement for precast pile sections inclusive of any ancillary items shall be the linear metre of pile section driven and accepted prior to trimming.

10.2.4 Driving of Pile Section

The unit of measurement for driving pile sections will be the linear metre of precast pile section driven and accepted prior to trimming.

10.2.5 Trimming of Piles Section

The unit of measurement for trimming pile sections is the number off.

10.2.6 Cast-in Situ end pieces

The unit of measurement for cast-in-situ end pieces will be the linear metre cast.

11. PAYMENT

11.1 Cast-in-Situ Piles

11.1.1 Transport of Equipment

The price for transport of equipment will include full compensation for the transport of all equipment to the bridge site and removal from the site on completion of the work and for all work incidental and necessary thereto.

11.1.2 Setting up Equipment

The rate for setting up the piling equipment at each pile position will include full compensation for the execution of the work as specified and for all other work incidental and necessary thereto.

11.1.3 Enlarged Base

The rate for forming an enlarged base to each pile will include full compensation for the supply of all materials and the construction of the enlarged base as specified and for all work incidental and necessary thereto.

11.1.4 Rock Socket

The rate for providing a rock socket at each pile will include full compensation for all work

necessary to form the socket and construct the base within the socket as specified and for all work incidental and necessary thereto.

11.1.5 Construction of Pile Shaft

The rate of each metre of pile shaft will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) driving and extraction of tubing;
- (b) supply of all materials and pile construction;
- (c) fixing reinforcement and charging the casing to form the piles;
- (d) trimming piles to the trimmed level indicated on the Drawings;
- (e) allowance for delays caused by normal constructional problems;
- (f) cost of additional piles and/or remedial measures due to piles being driven outside the allowable tolerances or failing to meet the requirements of the load test.

11.1.6 Empty Driving

The rate per metre for empty driving will include full compensation for all work made necessary by the difference between ground level and trimmed pile level and for all work incidental and necessary thereto.

11.1.7 Casing to Piles

- (a) The rate per metre for casing to piles will include full compensation for the supply and installation of the casing as specified and for all work incidental and necessary thereto.
- (b) This item will only be paid if the Engineer has agreed that casing is essential.

11.1.8 Load Tests

- (a) The price for the load test of a selected pile will include full compensation for the execution of the test as specified and for all work incidental and necessary thereto.
- (b) The cost of additional pile tests due to the selected pile failing the requirement of the load test shall be borne by the Contractor.

11.1.9 Subsoil Investigations

- (a) The price for the subsoil investigation will include full compensation for all work necessary for the Contractor to satisfy himself that the subsoil contents are as indicated on the Drawings.
- (b) This item will be paid only if a sub-soil investigation is actually carried out.

11.2 Precast Piles

11.2.1 Transport of Equipment

The price for transport of equipment will include full compensation for the transport of all equipment to the bridge site and removal from the site on completion of the work and for all work incidental and necessary thereto.

11.2.2 Setting up Equipment

The rate for setting up the piling equipment at each pile position will include full compensation for the execution of the work as specified and for all other work incidental and necessary thereto.

11.2.3 Provision of Piles Sections

The rate for each metre of pile driven and accepted prior to trimming shall include compensation for the precasting of the pile as specified, careful delivery to site and safe storage prior to driving.

11.2.4 Driving of Piles Sections

The rate shall include full compensation for all work necessary to drive the pile section, connect separate pile sections and include in the works as specified at the positions shown on the drawings.

11.2.5 Trimming of Piles Sections

The rate will be for the number of piles trimmed to lines and levels as shown on the drawings and as specified.

11.2.6 Cast in Situ End Pieces

The rate per metre for end pieces will include full compensation for all work made necessary by the difference between trimmed pile level and level achieved by driving the last precast pile section.

12. DELAYS

If the piling Contractor's price is based on continuous working the Contractor shall indicate in the Bill of Quantities a rate for the cost of delays due to causes beyond the control of the Contractor. A clear indication of the conditions under which the rates for delay will be incurred must be given in a covering letter.

SECTION NO. B.3
VOID FORMERS

1. DESCRIPTION

Void formers are sealed boxes incorporated into bridge decks for the purpose of excluding concrete and thereby reducing the dead load of the superstructure. The exact shape and location of formers is specified on the Drawings.

2. MATERIALS

The materials used in the fabrication of formers shall be approved by the Engineer and shall comply with the following requirements -

- (a) the mass shall not exceed that specified on the Drawings;
- (b) they shall not lose strength when immersed in water;
- (c) they shall not be porous or absorb water from the wet concrete;
- (d) they shall withstand a load of 1 KN spread over an area of 100mm placed at any point on the former;
- (e) the deflection under the above load shall not exceed 5mm.

3. FABRICATION AND INSTALLATION

- 3.1. Formers shall be prefabricated to the dimensions shown in the Drawings.
- 3.2 They may be fabricated in units of any length to achieve the layout shown on the Drawing.
- 3.3 They shall be adequately stiffened to ensure that their shape will be retained during concreting.
- 3.4 All joints and ends shall be sealed to prevent the ingress of cement paste.
- 3.5 Formers shall be accurately positioned in the deck and secured against any possible movement during concreting.

4. MEASUREMENT

The unit of measurement of formers is the number off.

5. PAYMENT

The rate of each former will include full compensation for the fabrication and installation of the former in the structure as specified, and for all work incidental and necessary thereto.

SECTION NO. B.4
STEEL BEARINGS

1. GENERAL

This section covers bearings manufactured from mild steel and cast iron, as detailed on the Drawings.

2. DESCRIPTION

2.1 Rocker Bearings

2.1.1 A rocker bearing consists of a Meehanite or other approved fine grey cast iron plate radiused top and bottom and set between two mild steel contact plates to which is sealed a mild steel bearing plate.

2.1.2 Bearing plates to be embedded in the substructure or in concrete beams have mild steel anchor bars welded to one face as shown on the Drawings.

2.1.3 Bearing plates to be bolted to steel beams have holes drilled in the positions shown on the Drawings.

2.1.4 The contact plates are drilled to accommodate the shear pins which are force-fitted.

2.2 Fixed Bearings

2.2.1 A fixed bearing consists of two mild steel contact plates to which is sealed a mild steel bearing plate.

2.2.2 The bearing plates are provided with anchor bars.

2.2.3 The bottom of the upper contact plate is machined to the radius shown on the Drawings.

2.2.4 The contact plates are drilled to accommodate the shear pins which are force-fitted into the lower contact plates.

3. MATERIALS

3.1. Materials used in the manufacture of bearings shall comply with the latest issue of the following standards:

B.S. 916 Black Bolts, Screws and Nuts
B.S. 4360 Grade 43A Weldable Structural Steel
B.S. 4449 Hot Rolled Steel Bars for the
Reinforcement of Concrete

- 3.2 The rockers of the rocker bearings shall be manufactured in grey cast iron or Meehanite Type GC, with the following characteristics:

Minimum Tensile Strength	280 MPa(=280 N/mm ²)
Modulus of Elasticity	120000 MPa(=120 KN/mm ²)
Minimum Shear Strength	280 MPa(=280 N/mm ²)
Minimum Compressive Strength	1 200 MPA
Specific Gravity	7,25
Brinell Hardness	220

- 3.3 The castings shall be dense, close-grained, free from blow holes, distortion and all surface and other defects. They shall be free from chill and machineable by normal methods.

4. WORKMANSHIP

The workmanship shall be first class in every respect to ensure that all parts fit truly and properly together on erection. Workmanship shall comply with the latest B.S. 5400 (Parts 6 & 9) "Steel, Concrete & Composite Bridges - Part 1" with the following amendments.

4.1 Corresponding Parts

If corresponding parts are not interchangeable matching sets shall be clearly marked.

4.2 Machining

The bearing surfaces of all rockers and plates shall be machined to a tolerance of +/- 100 um.

4.3 Drilling

All holes shall be drilled. Burrs formed on the surfaces of the rockers and bearing plates shall be effectively removed by slightly chamfering the lips of the holes. Punching of holes will not be permitted.

4.4 Construction

4.4.1 The bearings shall be fitted and finished as required for first class work.

4.4.2 Surfaces of the bearings which will not be in contact with any rolling surfaces may be left unmachined.

4.5 Welding

Welding of bearings shall comply with the latest B.S. 5135 "Metal Arc Welding of Carbon and Carbon Manganese Steels".

5. TESTING OF CASTINGS

Iron castings shall be tested in accordance with the latest B.S.1452 "Grey Iron Casting" with the following amendments:

5.1 Test Bars

During casting of rockers three test bars shall be provided with each separate batch cast. The test bars shall be cast separately from the castings to which they are related, but shall be poured at the same time and from the same ladle of molten metal. All test bars shall be marked to identify them with the batch of castings which they represent. The test bars shall be cast in dry sand and shall be of the dimensions shown on the Drawings.

5.2 Acceptance Criteria

The test bars shall be forwarded for testing to the Ministry's Central Laboratory a week before dispatch of the bearings to the site. The failing stress of each bar in tension shall not be less than 280 MPa (= 280 N/mm²). Should two out of the three test bars for any one batch pass the test the batch represented will be deemed to comply with the test requirements. Should two out of the three test bars fail to pass the test, the batch represented will be rejected.

5.3. Examination

Castings shall be inspected as soon as they have been removed from the moulds and have been cleaned and dressed. If the Engineer directs, the castings shall be submitted to radiographic or ultrasonic examination. If upon examination defects are disclosed in a casting it shall be replaced free of charge.

6. TESTING OF WELDING.

All welding any be examined in accordance with the latest issue of the following standards:

B.S. 2600 "Methods for radiographic examination of fusion welded butt joints in steel".

B.S. 3923 "Methods for ultrasonic examination of welds".

7. FABRICATION

7.1 The bearings shall be accurately fabricated to the dimensions shown on the Drawings.

7.2 Bearings surfaces in rolling contact after assembly shall be machined and painted with two coats of an approved lubricant. The second coat shall not be applied within 24 hours of application of the first coat.

7.3 All surfaces which will be exposed after assembly shall be thoroughly cleaned with a stiff wire brush after fabrication and zinc coated to give a minimum thickness of 100 um. The zinc coating shall not be applied to the anchor bars or the surfaces of the bearing plates carrying anchor bars.

7.4 Machined surfaces of the bearings shall be wrapped with a double hessian covering during delivery.

8. INSTALLATION

8.1 The lower bearing plates shall be accurately installed in the substructure as shown on the Drawings, care being taken to ensure that the plates are horizontal and that the lateral axes of the bearings are at right angles to the centreline of the carriageway. The shear pins shall be pushed home in the lower bearing plates before the top bearing plates are assembled and positioned.

8.2 The tapered cavity formed in the substructure above the lower plates of the rocker bearings shall be filled with a straight 180/200 penetration grade bitumen as soon as the rocker has been positioned on the lower bearing plate.

8.3 The top bearing plates shall be set in the underside of the concrete beams or bolted to the steel beams in accordance with the details shown on the Drawings. The greatest care shall be exercised to ensure that each bearing plate is horizontal.

8.4 The Contractor shall ensure that each bearing is soundly assembled, that the working surfaces of the bearings are in continuous contact and that the shear pins are properly pushed home before the concreting of the superstructure commences.

9. MEASUREMENT

The unit of measurement for each type of bearing is the number off.

10. PAYMENT

The rate for each complete bearing assembly will include full compensation for the fabrication and installation of the bearing in the structure as specified and for all work incidental and necessary thereto.

11. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. B.5 RUBBER BEARING PADS

1. GENERAL DESCRIPTION

This section covers rubber bearing pads located as shown on the Drawings.

2. MATERIALS

2.1 Rubber pads shall be made by an approved manufacturer and comply with the following physical requirements when tested in accordance with the latest B.S. 903 - "Methods of testing vulcanised rubber".

Hardness	As shown in the Drawings
Minimum Tensile Strength	18MPa(=18N/mm ²)
Maximum Elongation at breaking	350%
Maximum Compression Set	25%

Maximum changes under accelerated ageing test:

Hardness	0 to + 15 points
Tensile Strength	+/- 15%
Elongation at breaking	- 40%

2.2 The Contractor shall submit to the Engineer the Manufacturer's test certificate of compliance with the specified properties.

3. WORKMANSHIP AND INSTALLATION

3.1 The pads shall be manufactured to the dimensions shown on the Drawings.

3.2 All adjacent planes shall be perpendicular to each other.

3.3 Mild steel shims, when shown on the Drawings, shall be effectively bonded to each layer of rubber and totally enclosed.

3.4 The pads shall be positioned as shown on the Drawings and the Contractor shall ensure that the pads remain square to the longitudinal axis of the deck they support and that they are horizontal.

4. MEASUREMENT

The unit of measurement of the bearing pads is the number off.

5. PAYMENT

The rate for each bearing pad will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply and delivery of the bearing pads as specified;
- (b) provision of recesses where shown on the Drawings;
- (c) installation of pads in place.

SECTION NO. B.6
STEEL EXPANSION JOINTS

1. DESCRIPTION

Expansion joints consist of mild steel nosings to retain rubber seals or mild steel members provided with a sliding steel cover plate across the joint.

2. MATERIALS

Materials used in the fabrication of the steel parts of the expansion joints shall comply with the latest issue of the following standards:

B.S. 4360 Grade 43A Weldable Structural Steel.
B.S. 4449 Hot Rolled Steel Bars for the Reinforcement of Concrete.
B.S. 5315 Metal Arc Welding of carbon and carbon manganese steels.

3. WORKMANSHIP

3.1 Structural Steel

3.1.1 Workmanship shall be of first class quality and shall comply with the latest B.S. 5400 "Steel Concrete and Composite Bridges - Part 6".

3.1.2 If corresponding parts are not interchangeable matching sets shall be clearly marked.

3.1.3 Each component part of the joints shall be examined by the Engineer before it is placed in the structure.

3.1.4 Parts not approved by the Engineer shall be removed from the site.

3.1.5 Steelwork surfaces which will be exposed to the atmosphere after installation in the superstructure shall be given a zinc coating of minimum thickness 100 um.

3.2 Welding

All welding shall be done by skilled welders and the standard of workmanship and materials used shall comply with the requirements of the relevant British Standard Specification listed in paragraph 2 of this section.

3.3 Installation

- 3.3.1 The steel faces which will be in contact with the concrete shall be thoroughly cleaned with a wire brush.
- 3.3.2 Care must be taken during concreting to ensure that the concrete is worked into contact with the steel and that no air pockets or gaps are left between the concrete and the steel.
- 3.3.3 Every precaution must be taken to ensure that each steel member is placed true to line and will remain in its correct position.
- 3.3.4 Where the mild steel nosings are designed to accommodate a rubber seal the width of gap shall conform with the requirements of "Rubber Seals for Expansion Joints" (See section B.7).

4. MEASUREMENT

- 4.1 The unit of measurement for the steel members comprising each complete expansion joint is the number off.
- 4.2 Joints in carriageway and footwalk will be measured separately.

5. PAYMENT

The rate for mild steel members of each complete expansion joint will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply and fabrication of mild steel members;
- (b) delivery to site of mild steel members;
- (c) installation of mild steel members in the deck slab.

SECTION NO. B.7

RUBBER SEALS FOR EXPANSION JOINTS

1. DESCRIPTION

Rubber seals for expansion joints comprise cellular rubber extrusions which are inserted between concrete or steel nosings under precompression.

2. MATERIALS

2.1 The rubber seals shall be manufactured from a rubber compound possessing the following properties when tested in accordance with the latest B.S. 903 "Methods of Testing Vulcanised Rubber".

Hardness	As shown in the Drawings
Minimum Tensile Strength	18 MPa (= 18N/mm ²)
Maximum Elongation at breaking	350%
Maximum Compression Set	25%
Maximum changes under accelerated ageing test:	
Hardness	0 to + 15 points
Tensile Strength	+/- 15%
Elongation at breaking	- 40%

2.2 The rubber seal shall be supplied with a sealed polythene wrapping in which it shall remain during delivery and storage.

2.3 The lubricant adhesive shall be of an approved manufacture.

3. INSTALLATION

3.1 The rubber seal shall be inserted in the gap to a depth of 5 mm below the road surface.

3.2 A lubricant adhesive shall be used to facilitate the insertion of the seal. The recommendations of the manufacturer of the adhesive shall be rigidly followed.

3.3 The width of the gap at the time of fixing the seal in place, shall be within 10 percent of the value obtained from the following formula:

$$g + \frac{(C - 15)L}{100}$$

Where g = gap width (in millimetres) shown on the Drawings
 C = air temperature in degree Celsius at the time of fixing
 L = expansion length of deck (in metres) relevant to the joint under consideration.

4. MEASUREMENT

4.1 The unit of measurement for rubber seals is the metre.

4.2 Each size of seal will be measured separately.

5. PAYMENT

The rate for each metre of rubber seal will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply of rubber seal;
- (b) provision of wrapping for the seal and delivery to site of wrapped seal;
- (c) supply of lubricant adhesive and all materials for installation of the seal;
- (d) installation of the seal as specified.

SECTION NO. B.8
EPOXY NOSINGS, JOINT SEALANTS AND SEATINGS

1. DESCRIPTION

- 1.1 Epoxy nosings are used in conjunction with compressible rubber seals or polysulphide sealants to form a wide range of expansion joints.
- 1.2 Joint sealants are used to span small expansion joints where a compressible rubber seal is not warranted. The sealant may be supported by a joint filler and/ or a waterstop.
- 1.3 Sealants are also used to seal joints in structure when expansion ,movement is not involved.
- 1.4 Seatings are used to support short bridge decks where bearings are not warranted.

2. MATERIALS

2.1 Epoxy Nosing

The composition of and epoxy nosing shall be as specified on the Drawings or as recommended by a specialist supplier. The mix design shall be approved by the Engineer before any work commences.

2.2 Joint Sealant

The composition of the joint sealant shall be as specified on the Drawings or as recommended by a specialist supplier. The sealant shall be approved by the Engineer before any work commences.

2.3 Joint Filler

The composition of the joint filler shall be specified on the Drawings and shall be approved by the Engineer before work commences.

2.4 Waterstop

The composition of the waterstop shall be as specified on the Drawings and shall be approved by the Engineer before work commences.

2.5 Seatings

The composition of the seating shall be as specified on the Drawings and shall be approved by the Engineer before work commences.

3. INSTALLATION

3.1 Epoxy Nosing

The epoxy nosing shall be accurately constructed to the dimensions shown on the Drawings. Any notes on construction procedure shall be rigidly followed. The manufacturer's recommendations for preparation of surfaces to receive an epoxy nosing shall be rigidly followed and the use of any recommended adhesives or primers shall be mandatory.

3.2 Joint Sealant

The joint sealant shall be accurately constructed to the dimensions shown on the Drawings. The manufacturer's recommendations for preparation of surfaces to receive a sealant shall be rigidly followed and the use of any recommended adhesives or primers shall be mandatory.

3.3 Joint Filler and Waterstop

The joint filler or waterstop used to support a joint sealant shall be accurately positioned as shown on the Drawings. All surfaces to receive the joint sealant shall be neatly trimmed to assist in the accuracy of dimensions of the sealant.

3.4 Seatings

The seating shall be accurately positioned as shown on the Drawings and all protruding material shall be neatly trimmed on completion of the deck.

4. MEASUREMENT

4.1 The unit of measurement for epoxy nosings or joint sealants is the linear metre of completed nosing or sealant. Each cross section of nosing or sealant will be measured separately.

4.2 The unit of measurement for joint fillers including waterstops and for seatings is the number off. Each type of joint or seating will be measured separately.

5. PAYMENT

5.1 The rate for each metre of epoxy nosing or joint sealant will include full compensation for the supply of all materials and the construction of the nosing or sealant as specified and for all work incidental and necessary thereto.

- 5.2 The rate for each complete joint filler or seating will include full compensation for the supply of all materials and the construction of the joint or seating as specified and for all work incidental and necessary thereto.

SECTION NO. B.9
STEEL PARAPETS

1. DESCRIPTION

This section covers both tubular steel parapet rails which are set into concrete posts and structural steel parapet members bolted on to the superstructure.

2. MATERIALS

2.1 The materials used in the manufacture of steel parapets shall comply with the latest issue of the following standards:

B.S. 1387 Steel Tubes and Tubulars.
B.S. 4360 Grade 43A Weldable Structural Steel.
B.S. 4449 Hot Rolled Steel Bars for Reinforcement of Concrete.
B.S. 5135 Metal Arc Welding of carbon and carbon manganese steels.

2.2 The structural steel parapet members shall conform to the details given on the Drawings.

2.3 The tubular steel parapet rails shall be black tubes of the diameter and mass detailed on the Drawings.

3. FABRICATION AND ERECTION

3.1 Tubular Steel Rails

3.1.1 The tubes shall be straight and cylindrical. Their surfaces shall be smooth, free of scale, droplets of weld metal, loose rust, or other material.

3.1.2 Butt-welding of the tubes will not be permitted, except where the weld will be contained within the body of a post.

3.1.3 Ancillary parts shall be fabricated as detailed on the Drawings.

3.1.4 All parts of the rails shall fit truly together on erection.

3.1.5 The Contractor must ensure that the tubes are packed so that they will not be damaged or distorted during transport. Any tube which is found to be damaged or distorted will be rejected.

3.1.6 The tubes shall be erected true to line and level and the concrete posts cast around them.

3.2 Structural Steel Members

- 3.2.1 Structural steel parapet members shall be fabricated as specified on the drawings.
- 3.2.2 Welding shall be structurally sound and aesthetically neat and all weld imperfections shall be made smooth.
- 3.2.3 Welding may be examined radiographically or ultrasonically in accordance with the appropriate standards.
- 3.2.4 The completed parapet member shall be straight and true to line as shown on the Drawings.
- 3.2.5 The parapet members shall be bolted to the superstructure as indicated on the Drawings.
- 3.2.6 The erected parapet shall be true to line and level and free from obvious distortion.

4. PAINTING

After erection of the steel parapet all exposed members shall be painted as given in "Painting of Steelwork".

5. MEASUREMENT

5.1 Tubular Rails

- 5.1.1 The unit of measurement for tubular rails is the metre of single tube.
- 5.1.2 Tubes of different diameters and/or mass will be measured separately.
- 5.1.3 The measured length will be calculated as the length of rails fixed in position.

5.2 Structural Steel

- 5.2.1 The unit of measurement for structural steel parapet members is the tonne (1 000 kg).
- 5.2.2 The quantity will be calculated from the actual length of members and nominal mass of 0,00784 kg/mm² of cross section per metre.

6. PAYMENT

6.1 Tubular Rails

The rate for each metre of rail will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply and fabrication of tubular rails, including all ancillary parts;
- (b) delivery to site;
- (c) erection in the parapet;
- (d) painting as specified.

6.2 Structural Steel

The rate for each tonne of structural steel will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) supply of all members;
- (b) fabrication as detailed on the Drawings;
- (c) delivery to site;
- (d) erection of the parapet;
- (e) painting as specified.

SECTION NO. B.10
GUARDRAIL

1. DESCRIPTION

The guardrail consists of "W" section rail elements mounted on steel posts which are embedded in concrete.

2. MATERIALS

2.1 Rail and Terminal Section

The rail shall be manufactured from 2,50 mm thick steel complying with the latest B.S. 4360 "Grade 50B Weldable Structural Steel".

2.2 Posts

The posts shall be mild steel tubes of the dimensions shown on the Drawings and complying with the latest B.S. 1387 "Steel Tubes and Tubulars".

2.3 Bolts

The bolts used shall be mushroom-head bolts of the diameter and length shown on the Drawings and complying with the latest B.S. 916 "Black Bolts, Screws and Nuts".

2.4 Concrete

The concrete used in the erection of the guardrail shall be of the grade shown on the Drawings and comply with the requirements given in "Portland Cement Concrete" (See section C.8).

3. MANUFACTURE

3.1 Any approved method of forming the rail element may be used provided that -

- (a) the thickness of steel after forming does not vary by more than 250 um from the thickness before forming;
- (b) No physical property of the steel after forming varies by more than 5 percent from that physical property before forming.

3.2 The accepted tolerances in the manufacture of the rail elements and terminal sections will be 1 mm on cross sectional dimensions and 5 mm on all other dimensions unless otherwise shown on the Drawings.

- 3.3 All holes shall be drilled and the burrs removed. Punching will not be permitted.
- 3.4 The manufacturer may be called on to supply samples, to be tested in accordance with B.S. 4360.
- 3.5 All metal parts, except bolts, shall be cleaned and shop painted with one coat of an approved brand of rust inhibitive primer.

4. INSTALLATION

- 4.1 The guardrail shall be erected as shown on the Drawings.
- 4.2 Excavation of the holes for the posts shall be to the dimensions of the concrete block. Any excavation in excess of these dimensions shall be backfilled at the Contractor's expense with concrete of the grade used for the blocks.
- 4.3 The rail element shall be lapped in the direction of traffic in the adjacent lane. In the case of a single lane bridge the rail element shall be lapped towards the bridge.
- 4.4 After erection of the guardrail to the written satisfaction of the Engineer all nuts shall be spot welded.
- 4.5 The completed guardrail shall be painted as given in "Painting of Steelwork" (See section B.14).

5. MEASUREMENT

- 5.1 The unit of measurement for guardrail components is the number off.
- 5.2 Posts, rail elements and terminal sections will be measured separately.
- 5.3 Manufacture and delivery will be measured separately from erection

6. PAYMENT

- 6.1 Manufacture and Delivery
 - 6.1.1 The rate for the manufacture and delivery of each guardrail component will include full compensation for the execution of the work as specified and for all work incidental and necessary thereto.
 - 6.1.2 The rate for posts will include the post bolts and nuts.

- 6.1.3 The rate for rail elements and terminal sections will include the splice bolts and nuts.

6.2 Erection

- 6.2.1 The rate for the erection of each guardrail component will include full compensation for the execution of the work as specified and for all work incidental and necessary thereto.
- 6.2.2 The rate for posts will include the excavation for and placing of the concrete surround.
- 6.2.3 The rate for rail elements and terminal sections will include painting and spot welding of nuts.

SECTION NO. B.11
NAME PLATES

1. MATERIALS AND WORKMANSHIP

Name plates shall be manufactured from the materials and to the dimensions specified on the Drawings. The workmanship shall conform to the requirements specified on the Drawings.

2. INSTALLATION

2.1 The name plates shall be installed in the positions shown on the Drawings.

2.2 A plate, bearing the name of the river as shown, shall be placed in each of the nearer end panels on the right, as viewed from the bridge approach.

2.3 If required, a second set of two plates bearing inscriptions to be stipulated by the Engineer, shall be placed in the other two end panels. If this set is not required, recesses of the same overall dimensions as the plates shall be provided instead.

2.4 The name plates shall be firmly attached to the inside faces of the forms of the end panels before concreting.

3. MEASUREMENT

3.1 The unit of measurement for name plates is the number off.

3.2 Manufacture and delivery will be measured separately from installation in the structure.

4. PAYMENT

4.1 Manufacture and delivery

The rate for manufacture and delivery of each name plate will include full compensation for the execution of the work as specified and for all other work incidental and necessary thereto.

4.2 Installation in the structure

The rate for installation of each name plate will include full compensation for the execution of the work as specified and for all other work incidental and necessary thereto.

SECTION NO. B.12 WELDED PLATE GIRDERS

1. GENERAL
 - 1.1 This section covers structural steel welded plate girders used in composite action with a reinforced concrete deck slab.
 - 1.2 Each plate girder comprises a stiffened web plate with dissimilar top and bottom flange plates.
 - 1.3 When it is not possible to transport the entire girder to site each section of girder will be field spliced, as given in "Friction Grip Splices" (See section B.13), to make up the complete girder.
2. DESCRIPTION
 - 2.1 Girders
 - 2.1.1 The mild steel plate girders shall be fabricated in sections as detailed on the Drawings. The web plates shall be cut to shape to give the preset camber detailed on the Drawings.
 - 2.1.2 Web stiffeners shall be welded to the webs and packing plates on the flanges in the position shown.
 - 2.1.3 The stiffener packing plate shall be welded to the flanges by means of fillet welds parallel to the edges of the flange plate.
 - 2.1.4 The webs shall be accurately drilled to accommodate the friction grip bolts and the diaphragm bars, and the bottom flanges shall be accurately drilled and slotted to accommodate the bearing positioning bolts.
 - 2.1.5 The Contractor shall provide adequate assembly jigs and templates, and carry out the positioning and welding of the webs, flanges and stiffeners so as to ensure that the stiffeners are in close contact with the stiffener packing plates, that the alignment of the girders is true and that the flange outstands are truly normal to the axis of the girder.
 - 2.1.6 The greatest care shall be taken during the fabrication and welding of the flanges, by means of accurate assembly, the provision of robust jiggling, and the adoption of a suitable welding sequence, to ensure that the shape is accurately maintained.

2.2 Shear Connectors

2.2.1 Shear Connectors shall be welded to the top flange of the plate girders in the positions shown on the Drawings.

2.2.2 Site welding of shear connectors will only be permitted with the Engineer's written approval.

2.3 Permanent Bracing

2.3.1 Concrete Diaphragms

Threaded round mild steel bars shall be passed through the webs in the positions shown on the Drawings and fitted with bevelled washers, nuts and bearing plates where indicated. The nuts shall be "finger-tight" before the diaphragm bars are spot-welded to the faces of the webs, in readiness for the casting of the concrete diaphragms.

2.3.2 Steel Diaphragms

Structural steel bracing members shall be bolted to the girders in the positions shown on the Drawings. The members shall be located initially by black bolts before site welding as indicated on the Drawings.

2.4 Erection Bracing

The Contractor shall provide adequate erection bracing during the lifting, launching, and seating of the girders, and ensure that lateral deflection of the girders is reduced to avoid buckling of the compression flange.

3. MATERIALS

3.1 Plate Girders

Materials used in the fabrication of the plate girders shall comply with the latest issue of the following standards :

- B.S. 5400 Steel, Concrete & Composite Bridges
- Part 6
- B.S. 4360 Grade 43A Weldable Structural Steel

3.2 Shear Connectors and Bracing

Materials used in the fabrication of shear connectors and bracing members, shall comply with standards given in paragraph 3.1. above

3.3 Structural Members

Structural members shall also comply with the latest issue of the following standards :

B.S. 4 Structural Steel Sections
 B.S. 916 Black Bolts, Screws and Nuts
 B.S. 4449 Hot rolled Steel Bars for the Reinforcement of Concrete.

4. WORKMANSHIP

Workmanship shall be of first class quality and comply with the latest B.S. 5400 "Steel, Concrete & Composite Bridges" - Part 6", with the following amendments :

- (a) Corresponding Parts. Corresponding parts shall be interchangeable throughout.
- (b) Shearing and Machining. The ends of plate girder webs and flanges shall be fitted to a tolerance of 2 mm.
- (c) Drilling. All holes shall be drilled. The edges of holes on outside faces of members shall be slightly chamfered. Punching will not be permitted.

5. WELDING

- 5.1 Welding of plate girders, cross bracing and shear connectors shall comply with the latest B.S. 5135 "Metal Arc Welding of carbon and carbon manganese steels".
- 5.2 Electrodes shall be accompanied by the manufacturer's certificate of compliance with the latest B.S. 639 "Covered Electrodes for the Metal Arc Welding of carbon and carbon manganese steels".
- 5.3 All welding may be examined in accordance with the latest issue of the following standards :

B.S. 2600 "Methods for radiographic examination of fusion welded butt joints in steel".
 B.S. 3923 "Methods for ultrasonic examination of welds".

6. CONSTRUCTION

The construction of steel work shall comply with the latest B.S.5400 "Steel, Concrete & Composite Bridges", Parts 3 & 6.

6.1 Drawings

Before commencing work, the Contractor shall examine the Drawings showing the General Arrangement and scantlings of the steel work with typical details to satisfy himself as to their dimensional accuracy. Any errors or omissions shall be notified by the Contractor to the Engineer and they shall correct the Drawings accordingly. Any extra work required as a result of errors or omissions not so notified shall be done at the Contractor's expense. The whole of the work shall be done strictly in accordance with the dimensions, or modifications as directed by the Engineer. Three copies of all necessary working drawings prepared by the Contractor shall be submitted to the Engineer for his approval, but notwithstanding this, the Contractor shall be entirely responsible for the accuracy of his own drawings and of the work.

6.2 Cleaning

All steel surfaces abutting concrete shall be completely clean and free from grease and paint in order to provide a good bond between steel and concrete.

6.3 Diaphragm Members

The diaphragm shall be fitted as shown on the Drawings. The members shall be adjusted to bring the girders truly vertical and then welded in position as indicated.

7. ERECTION

7.1 Erection of steelwork shall comply with the latest B.S.5400 "Steel, Concrete & Composite Bridges", Part 6.

7.2 The method of erection and equipment used by the Contractor must be approved by the Engineer in writing.

7.3 The girder shall be lifted and launched so that the axis of the web remains appreciably vertical during the whole operation.

7.4 Should girders be lifted at points other than at the ends, the Contractor shall ensure that the free cantilever does not exceed that specified on the Drawings.

7.5 The Contractor shall ensure that loads from struts, ties, poles, stays, etc., comprising the erection gear are effectively anchored and/or distributed.

7.6 The Contractor shall be responsible for the temporary fixing of the rocker bearings during erection and seating, and for

the removal of any drifts and wedges to restore freedom of movement to the rocker bearings after the completion of erection.

- 7.7 The girders shall be seated on the bearings, with the flanges in full face contact with the surfaces of the upper bearing plates.
- 7.8 Care shall be taken during the seating of the girders to avoid upsetting the bearing seating on the lower bearing plates.
- 7.9 The bearing locating bolts shall be inserted through the slots in the bottom flange and threaded into the tapped holes in the upper bearing plates.
- 7.10 The upper bearing plate shall be welded to the bottom flange of the plate girder by means of continuous fillet welds in the position shown on the Drawings.
- 7.11 On completion of the seating operation the top of the vertical axis of the rocker bearing shall be within 2 mm of true vertical.
- 7.12 The permanent bracing shall be fitted immediately after all girders in any span have been launched.

8. PREPARATION OF STRUCTURAL STEELWORK

- 8.1 All structural steelwork shall be delivered and erected unpainted and in a clean condition. On completion of erection the Contractor shall clean all exposed steel surfaces and remove all loose rust, scale, grease and dirt.
- 8.2 Painting shall be as given in "Painting of Steelwork" (See section B.14).

9. MEASUREMENT

- 9.1 Structural Steelwork (Fabrication and Delivery)
 - 9.1.1 The unit of measurement for the supply, fabrication and delivery to site of structural steelwork is the tonne (1 000kg).
 - 9.1.2 The quantity will be calculated from the actual length of members and nominal mass of 0,00784 kg/mm² of cross section per metre run.
 - 9.1.3 Welded plat girders and ancillary steel sections will be measured separately.

9.1.4 All components for friction grip splices will be measured separately as given in "Friction Grip Splices" (See section B13).

9.2 Diaphragm Bars

9.2.1 The unit of measurement for threaded diaphragm bars is the number off.

9.2.2 Each diameter and length will be measured separately.

9.3 Shear Connectors

The unit of measurement for shear connectors is the number off.

9.4 Structural Steelwork (erection)

9.4.1 The unit of measurement for erection of structural steelwork is the number off.

9.4.2 Complete plate girders and complete diaphragm assemblies will be measured separately.

9.5 Painting of Steelwork

The unit of measurement for painting of steelwork is the square metre.

10. PAYMENT

10.1 Structural Steelwork (Fabrication and Delivery)

The rate for the supply, fabrication and delivery of each tonne of structural steelwork will include full compensation for completing each structural member as detailed on the Drawings and for all work incidental and necessary thereto.

10.2 Structural Steelwork (Erection)

The rate for erection of each complete girder of specified length or each complete diaphragm assembly will include full compensation for completing the erection as specified and for all work incidental and necessary thereto.

10.3 Shear Connectors and Diaphragm Bars

The rate for each shear connector or diaphragm bar will include full compensation for supply, delivery and erection in the structure as specified and for all work incidental and necessary thereto.

10.4 Painting of Steelwork

The rate for each square metre of painting shall include full compensation for the execution of the work as specified and for all work incidental and necessary thereto.

11. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. B.13 FRICTION GRIP SPLICES

1. GENERAL

This section covers the use of high strength friction grip bolts for the purpose of splicing long plate girders at the bridge site.

2. DESCRIPTION

2.1 Friction grip splices comprise the assembly in the field of sections of plate girders to produce a full length girder for erection in the superstructure.

2.2 Flange splices are normally offset 150mm from the web splice.

2.3 The two sections of girder are lined up in their correct relative positions and bolted together by means of covering splice plates, using high strength friction grip bolts.

3. MATERIALS

3.1 Materials used in fabrication of splice components shall comply with the latest issue of the following standards:

B.S. 5400	Steel, Concrete & Composite Bridges - Parts 1 and 2.
B.S. 1580	Unified Screw Threads
B.S. 3139	High Strength Friction Grip Bolts for Structural Engineering.
B.S. 3294	The use of High Strength Friction Grip Bolts in Structural Steelwork.
B.S. 4360	Grade 43A Weldable Structural Steel.

3.2 High strength friction grip bolts shall carry a manufacturer's written guarantee that the bolts supplied comply with B.S. 3139.

3.3 When tendering, the Contractor will be required to submit full detail of the nuts, bolts, washers, calibrated torque wrench and calibration equipment he proposes to use.

4. WORKMANSHIP

4.1. General

4.1.1 Friction grip joints will only function satisfactorily if the greatest care is exercised in the preparation and assembly of all parts.

4.1.2. The Engineer must be afforded easy access to the workshops when the splices are prepared.

4.1.3. Workmanship shall be of first class quality and shall comply with the latest B.S.5400 "Steel, Concrete & Composite Bridges" - Part 6" with the following amplification -

- (a) site assembly shall only be carried out by skilled steel erectors;
- (b) the field splices shall be made in the positions shown on the Drawings;
- (c) the splice plates and packer plates shall be accurately cut to shape and drilled as detailed on the Drawings to accommodate the friction grip bolts.

4.2. Pre-Assembly Preparation

- (a) The ends of plate girder webs and flanges shall be accurately machined to provide a 2 mm gap at the field splices.
- (b) All holes shall be drilled. Holes in all splices shall be drilled 2 mm oversize to give a clearance of 1 mm.
- (c) All bolts are to fit squarely into holes.
- (d) The practice of reaming at an angle and inserting the bolts askew will not be permitted.
- (e) Any distortions or bumps due to drifting, welding or other causes shall be ground flush.
- (f) All bolts shall be provided with a nut and one case hardened washer.
- (g) Contact surfaces are to be completely free from dirt, oil, paint, loose scale, burrs pits and other defects which would reduce the coefficient of friction, or prevent solid seating of parts.
- (h) Surfaces in contact with case-hardened washers shall provide a solid seating of parts.
- (i) Where flame-cleaning is used the surface temperature shall not exceed 150o Celsius.
- (j) Surfaces cleaned by sand-blasting or wire-brushing shall not be given a polished finish.

- (k) Contact surfaces of splices shall be parallel. The angle between the bolt axis and the surface under the non-moving component shall be between 87° and 93°.

4.3 Assembly

- (a) On assembly, holes shall be correctly aligned using at least two drifts.
- (b) All bolts shall then be inserted and have a loose fit in the holes.
- (c) Surfaces shall be drawn together by tightening the bolts with a ring spanner in a staggered pattern working outwards from the centre of the group. Undue force shall not be used as this tightening is not intended as a corrective for faulty workmanship in the assembled splices.
- (d) After completion of the preliminary tightening of all nuts in a joint, permanent marks shall be made on each nut and the protruding threads of its bolt to record their relative positions. Each nut shall then be finally tightened with the torque wrench until it has turned relative to its bolt by the amount specified, or the corresponding torque specified has been achieved.
- (e) The table below is given as a guide to the specified torque and turn for 20 mm diameter bolts under normal conditions and must be used unless variations thereof are authorised by the Engineer.

Bolt length	Maximum turn	Maximum torque	Minimum torque
Under 80 mm . .	1/3	750 Nm	700 Nm
80 mm to 160 mm (inclusive)	1/2	800 Nm	750 Nm

- (f) The torque wrench shall be calibrated every morning, by means of weights, before work commences, and at any other time if the Engineer considers conditions have materially altered.

- (g) Care shall be taken with the storage of bolts to ensure that at the time of assembly all bolts are at a similar temperature.
- (h) The torque and turn achieved shall be recorded on the forms supplied by the Engineer.
- (i) Bolts which fail to achieve the minimum torque specified at the maximum turn specified shall be discarded and not re-used.
- (j) Where the torque is the limiting criterion the torque wrench shall be returned to tighten up bolts previously tightened which may have lost tension through subsequent tightening of other bolts, until all bolts in the joint are finally tightened to the specified torque.
- (k) Final tightening shall be carried out only in the presence of the Engineer or his representative. If the results of tightening are erratic the criteria specified will be reviewed by the Engineer.
- (l) If after final tightening a nut or bolt is slackened off for any reason, the bolt, nut and washers shall be discarded and not re-used.
- (m) Bolts, nuts and washers which are in any way defective shall not be used.
- (n) The Contractor shall have available on site spare bolts, nuts and washers sufficient for replacement of damaged bolts.
- (o) All friction grip joints shall be assembled by skilled steel erectors.
- (p) Under no circumstances are high preload bolts to be subjected to any form of heat treatment before or after installation.

5. CONSTRUCTION AND ERECTION

- 5.1. The Construction and erection of friction grip splices shall comply with the latest B.S. 5400 "Steel, Concrete & Composite Bridges" Parts 2 and 4. All bolts shall be inserted "finger-tight" in the web and flange splices before preliminary tightening is commenced.
- 5.2. The Engineer may direct the assembly of at least one plate girder splice in the Contractor's yard prior to delivery to the site.

6. MEASUREMENT

6.1 Splice Plates

6.1.1 The unit of measurement for supply and delivery of splice and packer plates is the tonne (1 000 kg.)

6.1.2 The quantity will be calculated from the actual length of plates and nominal mass of 0,00784 kg/mm² of cross section per metre run

6.1.3 No deduction will be made for any holes drilled in this steelwork.

6.2 High Strength Bolts

6.2.1 The unit of measurement for supply and delivery of high strength friction grip bolts is the number off.

6.2.2 Each diameter and length will be measured separately.

6.3 Assembly of Splices

6.3.1 The unit of measurement for the assembly of friction grip field splices is the number off.

6.3.2 One field splice will be construed as all the web and flange splices at any one section.

7. PAYMENT

7.1 Splice Plates

The rate for supply and delivery to site of each tonne of splice and packer plates will include full compensation for fabricating each plate as detailed and for all work incidental and necessary thereto.

7.2 High Strength Bolts

The rate for supply and delivery of each high strength friction grip bolt will include full compensation for each bolt including nut and washer as specified complete in place in the splice. No payment will be made for extra quantities of bolts ordered by the Contractor to cover damaged bolts.

7.3 Assembly of Field Splices

The rate for assembly of each field splice will include full compensation for completing each splice as specified and for all work incidental and necessary thereto.

SECTION NO. B.14 PAINTING OF STRUCTURAL STEELWORK

1. GENERAL

This section covers the surface treatment applicable to mild steel. Only those surfaces of the steelwork which remain exposed after completion of the structure shall be painted.

2. PREPARATION

The exposed surfaces shall be thoroughly cleaned by sandblasting to remove all dirt, rust, scale paint and grease. Where only light cleaning is required the use of approved de-scaling chippers or scrapers and stiff wire brushes may be allowed. The cleaned surfaces must be approved in writing by the Engineer before the application of the prime coat.

3. PROTECTIVE COATINGS

The surfaces to be painted shall be given a prime coat, an undercoat, and a finishing coat as detailed below :

3.1 Prime Coat

3.1.1 The prime coat shall consist of one coat of lead based primer of genuine red lead/linseed oil type and complying with the latest S.A.Z.S. K7 "Red Lead Primer for Iron and Steel".

3.1.2 The primer shall be applied at a rate of 0,07 litre/m² to 0,09 litre/m² and be allowed to dry for 48 hours before the application of the undercoat.

3.2 Undercoat

3.2.1 The undercoat shall consist of a micaceous iron oxide paint, in which the minimum micaceous iron oxide content must be 1 kg/litre of paint, and the binder must be of the linseed/wood oil modified phenolic type.

3.2.2 The shade of the undercoat shall be different from that of the finishing coat, and shall be agreed between Contractor and Engineer before painting starts.

3.2.3 The undercoat shall be applied at a rate of 0,06 litre/m² to 0,08 litre/m², and shall be allowed to dry for 48 hours before the application of the finishing coat.

3.3 Finishing Coat

3.3.1 The finishing coat shall consist of an aluminium paint complying with the latest S.A.Z.S K14 "Ready mixed aluminium finishing paint" using a long drying oil alkyd resin medium.

3.3.2 The finishing coat shall be applied in one full coat at a rate of 0,05 litre/m² to 0,07 litre/m².

3.3.3 Tenderers shall submit with their tender full technical specifications for the undercoat and finishing coat they propose to use.

4. MIXING AND APPLICATION

4.1 The paint shall be thoroughly mixed and stirred immediately before application in order to keep the pigment in uniform suspension.

4.2 The aluminium paint shall be well mixed on the site where it is to be used, and the Contractor shall provide shallow paint pots so that the brush automatically stirs and keeps the aluminium powder in suspension and produces an even and consistent film of paint.

4.3 If it is found necessary in cold weather to thin the paints in order they shall spread more freely, the paint containers shall be heated by immersion in hot water.

4.4 Additional thinners shall not be added for this purpose unless authorised by the Engineer.

4.5 Paint shall be applied with hand brushes.

4.6 The brushes used shall be round, oval or flat, the latter not over 100 mm wide.

4.7 Brushes showing excessive wear shall not be used.

4.8 The coating of paint shall be spread smoothly and uniformly so that excess paint does not collect at any points or run on the vertical surfaces. The paint coat shall be even.

4.9 The paint shall be well worked into corners and crevices.

4.10 Painted areas considered unsatisfactory by the Engineer shall have the paint removed and the metal thoroughly cleaned and be repainted.

4.11 Parts which will be in close contact after assembly shall not be given the undercoat and finishing coat but shall be given two coats of primer, the second coat being applied immediately before final assembly.

5. WEATHER CONDITIONS

5.1 Paint shall not be applied when the air temperature is below 5°C or when the air is misty, or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

5.2 Paint shall not be applied on damp or frosted surfaces, but only on warm dry and clean surfaces.

6. SAMPLING

6.1 The Contractor shall submit, at his cost, samples of the paint he proposes to use.

6.2 Each new batch of paint delivered to the site shall be sampled, and if found to be below standard or defective in any way shall be removed from the site.

7 MEASUREMENT AND PAYMENT

Measurement and payment for painting will only be made as a separate item when so specified elsewhere in these sections.

**SECTION NO. B.15
BRIDGE APPROACHES**

1. DESCRIPTION

NOTE: THIS SECTION IS ONLY APPLICABLE WHERE THE ADJACENT ROAD HAS NOT BEEN DESIGNED

- 1.1 It deals with the minimum earthworks necessary to make the new bridge trafficable,
- 1.2 Earthworks to be included in bridge approaches extend from the toe of the abutment fill to the "Limit of Contract" shown on the Drawings.
- 1.3 The cut and fill for the bridge approaches shall be constructed to the lines, levels and cross-sections shown on the Drawings or as directed by the Engineer.

2. CLEARING

- 2.1 The areas to be cleared will be indicated on the site to the Contractor by the Engineer.
- 2.2 The Contractor shall clear the areas of all timber, brush, grass, roots, debris and other unsuitable material.
- 2.3 The timber cleared shall be corded immediately adjacent to the cleared area.
- 2.4 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All such material not required by the landowner shall be burned at locations indicated by the Engineer.
- 2.5 In the case of borrow pits the overburden shall be placed on the perimeter of the pit, once all material required for construction of the road has been removed, the overburden shall be spread across the site from which it was removed.

3. EXCAVATION

- 3.1 Excavation for bridge approaches is divided into the following three categories in accordance with the method of excavation necessary, notwithstanding the method actually used. Mixed or borderline materials will be divided by the Engineer between the two relevant categories.

3.1.1 Common Excavation

Common excavation is any material which, in the Engineer's opinion, can be excavated without the use of pneumatic tools or explosives.

3.1.2 Hard Excavation

Hard excavation is material which, in the Engineer's opinion requires for its excavation the use of pneumatic tools.

3.1.3 Rock Excavation

Rock excavation is material which, in the Engineer's opinion, requires for its excavation the use of explosives.

3.2 At the conclusion of the excavation for each part of the approaches the Engineer and Contractor shall sign a certificate detailing the quantities of each category of excavation. No claims will be entertained if the certificate has not been completed.

3.3 Excavated material which is not required for fills shall be deposited at sites indicated by the Engineer.

4. FILL MATERIAL

The material for this purpose shall be approved by the Engineer. Such material shall be obtained from the following sources in order of priority -

- (a) excavations for the structure or approaches, if the material is suitable for use in embankments;
- (b) extensions to excavations for approaches, if the material is suitable for use in embankments.
- (c) borrow pits.

5. COMPACTION OF FILLS

5.1 Fill material shall be placed loose in horizontal layers not more than 200 mm thick over the whole area of the fill at that level. Each layer shall be thoroughly compacted as specified on the Drawings by means approved by the Engineer.

5.2 All compaction shall be carried out at a moisture content approved by the Engineer.

5.3 The top surface of the fill shall be graded to line and camber as shown on the Drawings.

6. TESTING OF COMPACTION

6.1 If any defects such as irregularities of shape or texture, laminations or lack of density should develop, they shall be corrected to the satisfaction of the Engineer.

- 6.2 During the progress of the work a minimum of six field density holes shall be made at locations selected at random as being typical of the length and width of the area under test.
- 6.3 If any tests show that the compaction of a layer is not as specified, the Contractor shall take whatever steps are necessary to ensure that the required density is achieved.
- 6.4 The Contractor shall have no claim against the Government for any delay due to testing staff not being immediately available at any particular time.

7. FILL BEHIND ABUTMENTS

- 7.1 Where shown on the Drawings the space behind the abutments shall be filled with a wedge of selected material from a source indicated by the Engineer.
- 7.2 Selected fill shall be laid to the dimensions shown on the Drawings and be compacted in accordance with paragraph 5 of this section.
- 7.3 Where indicated on the Drawings a stabilising agent shall be added to the fill behind abutments and thoroughly mixed.
- 7.4 Density tests on each layer of compaction will be undertaken in accordance with paragraph 6 of this section.

8. WEARING COURSE

- 8.1 Where shown on the Drawings the top of the fill shall be provided with a layer of a selected wearing course material from a source indicated by the Engineer.
- 8.2 The wearing course shall be laid to the width and thickness shown in the Drawings and be compacted in accordance with paragraph 5 of this section.
- 8.3 Where indicated on the Drawings a stabilising agent shall be added to the wearing course and shall be thoroughly mixed.
- 8.4 The wearing course shall be compacted as specified on the Drawings by means approved by the Engineer.
- 8.5 Density tests on each 400 m³ of compaction will be undertaken in accordance with paragraph 6 of this section.

9. TRIMMING OF SLOPES

On completion of the work, the slopes of approaches shall be trimmed to the lines, grades and dimensions shown on the Drawings.

10. SURFACING

- 10.1 Where shown on the Drawings the completed road approaches shall be provided with a bituminous surfacing.
- 10.2 The surfacing shall comprise a surface dressing or bituminous concrete as specified on the Drawings.
- 10.3 The surfacing shall be laid as specified on the Drawings by means approved by the Engineer.
- 10.4 Tolerances on binder content shall be carefully observed and any substandard surfacing shall be removed.

11. EXPLOSIVES REGULATIONS

The Contractor shall take all necessary precautions to safeguard the public and shall in every way comply with the current explosives regulations.

12. MEASUREMENT

12.1 Clearing

- 12.1.1 The unit of measurement for clearing for roads and borrow pits is the hectare.
- 12.1.2 The quantity of clearing will be calculated as the area cleared, as directed by the Engineer, to the nearest 0,1 hectare

12.2 Excavation

- 12.2.1 The unit of measurement for excavation is the cubic metre.
- 12.2.2 The quantity of excavation will be calculated as the volume of material before excavation, using the Method of Average End Areas.

12.3 Compaction

- 12.3.1 The unit of measurement for compaction is the cubic metre.
- 12.3.2 The quantity of compaction will be calculated as the volume of material after compaction, using the Method of Average End Areas.
- 12.3.3 Compaction of fills, selected fill behind abutments and wearing course will be measured separately.

12.4 Surfacing

12.4.1 The unit of measurement for surfacing is the square metre.

12.4.2 No separate measurement will be made for aggregate or binder materials.

12.5 Overhaul

Overhaul will be measured as given in "Haul and Overhaul".

13. PAYMENT

13.1 Clearing

The rate for each hectare of clearing will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) clearing the areas as specified;
- (b) removal of overburden and reinstatement of the areas;
- (c) tidying up the cleared areas

13.2 Excavation

The rate for each cubic metre of excavation will include full compensation for the execution of the following operations and for all work incidental and necessary thereto -

- (a) excavating in the various types of materials as classified in paragraph 2 of this section;
- (b) transporting excavated material (excluding overhaul) and placing in fill or waste as directed by the Engineer.

13.3 Compaction

The rate for each cubic metre of compacted material will be extra over the payment made for excavation of the material and will include fill compensation for the execution of the following operations and for all works incidental and necessary thereto -

- (a) compacting the material as specified;
- (b) providing and transporting water for compaction (excluding overhaul);
- (c) trimming the slopes of the approaches.

13.4 Surfacing

The rate for each square metre of surfacing will include full compensation of the execution of the following operations and for all work incidental and necessary thereto -

- (a) provision of all materials;
- (b) provision of all equipment for laying of surfacing.
- (c) provision of all labour and expertise for laying of surfacing.

13.5 Overhaul

Overhaul will be paid as given in "Haul and Overhaul". See Section C.7).

SECTION NO. R.1

exceed the depth indicated by the design reduction factor.

- 1.2. Where clearing is called for, the width to be cleared will generally extend horizontally for at least 12 metres on each side of the road centreline provided that -
- (a) the Engineer may call for additional clearing on the inside of curves, at intersections or at other places; and
 - (b) if the toes of fills or the tops of cuts extend beyond this width, clearing, if called for, shall be under-taken to just beyond the limits of such fills or cuttings.
- 1.3 The Engineer may require that selected trees or shrubs, within the strip to be cleared, shall not be disturbed.
- 1.4 The degree of clearing shall be diminished outwards from the central 15 metres of the road servitude so as to effect a gradual transition in treatment and avoid a sharp demarcation between the artificial and the natural. Material including boulders which has been windrowed out to the edge of the cleared area shall be removed entirely from the road servitude to an approved spoil area.
- 1.5 Stumps and large roots which will be buried under at least 1,5 metres of fill may be allowed to remain provided that the stumps are cut to within 300mm of the natural ground surface.
- 1.6 The timber cleared shall be corded immediately adjacent to the cleared area.
- 1.7 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All brush, grass, etc., not required by the landowner shall be burned in the centre of the cleared area or at any other location agreed to or directed by the Engineer.

2. MEASUREMENT

- 2.1 Clearing for the road will be measured by the hectare of clearing authorized and completed. For the purpose of measurement, the width cleared will, at any point along the road centreline, be measured at right angles to the centreline and to the limits of the strip cleared, irrespective of whether isolated trees or other growth have been left undisturbed within such width by the direction of the Engineer.
- 2.2 Measurement for clearing will exclude the area of any existing road which has been previously cleared.

3. PAYMENT

- 3.1 The price paid per hectare for clearing and preparing the road reserve will include full compensation for labour, materials, tools, implements, plant and equipment for doing work necessary for the operation as specified.
- 3.2 The Contractor will have no claim for extra payment because he has been required to work round or leave undisturbed any trees or growth in the cleared area.

SECTION NO. R.2
CONSTRUCTION OF PIPE CULVERTS

1. DESCRIPTION OF WORK

- 1.1 The work consists of the construction of pipe culverts which may consist of any of the following:-
- (a) plain concrete pipes with concrete surround;
 - (b) reinforced concrete pipes either haunched or with concrete surrounds;
 - (c) cast in-situ internally formed pipes.
- 1.2 Pipe culverts shall be constructed in accordance with the details shown on the Drawings. The Engineer may in addition order the construction of concrete bedding; haunching, mass or reinforced concrete surrounds, drop inlets, aprons, headwalls and wingwalls.
- 1.3 Culverts shall be placed in the position indicated by the drawings or as directed by the Engineer.

2. MATERIALS

- 2.1 Concrete
- The concrete shall comply with the grade specified on the drawings or as directed by the Engineer.
- 2.2 Reinforced Concrete Pipes
- Reinforced concrete pipes shall comply in all respect with the latest S.A.Z.S. No. A17.
- 2.3 Plain Concrete Pipes
- 2.3.1 Plain concrete pipes shall be manufactured with concrete as specified in "Portland Cement Concrete". (See Section C.8).
 - 2.3.2 Pipe moulds shall be approved by the Engineer.
 - 2.3.3 Concrete pipes shall be smooth, straight, circular, free from cracks, honeycombing or other defects. Plastering of pipes to conceal defects will not be permitted and pipes that have deemed to have been plastered shall be rejected and removed from the site.

- 2.3.4 Plain pipes shall have the minimum shell thickness given in the following table.

INTERNAL DIAMETER mm	MINIMUM SHELL THICKNESS mm
450	40
600	50
750	55

- 2.3.5 The use of plain concrete pipes of nominal internal diameter greater than 750mm is not permitted.

2.4 Internally Formed Pipe Culverts

- 2.4.1 Formers used in the construction of pipe culverts may be inflatable tubing or collapsible metal sheeting.

- 2.4.2 The concrete shall consist of concrete specified in "Portland Cement Concrete" and as shown in the Drawings.

- 2.5 If the Contractor wishes to use an alternative design of pipe culvert he shall submit details of the design and method of construction at the time of tendering.

- 2.6 Steel Reinforcement shall be as specified in "Steel Reinforcement" (Section C.11).

3. CONSTRUCTION

3.1 Trenches

- 3.1.1 Culverts shall be constructed in trenched conditions, except where the Engineer has approved an alternative method.

- 3.1.2 Excavation of culvert trenches for culverts constructed below ground level shall qualify for measurement and payment for the full depth of the excavation below ground level.

- 3.1.3 Where a culvert is designed to be constructed at ground level, or partly below ground level the fill, subgrade and if necessary the base must first be constructed to a level which will provide the minimum cover as specified in paragraph 3.7 of this section. Thereafter excavation of the trench for the culvert may commence.

- 3.1.4 Where fill, subgrade, and base have been placed above the specified minimum cover level for any particular culvert no measurement or payment will be made for such excavation.

3.2 Culvert Foundations

- 3.2.1 The Engineer may direct that subsoil exposed after excavation be watered and compacted by approved methods before concrete is placed. Preparation and treatment of foundations shall be as given in Section C. 6, "Excavation and Backfilling for Structures".
- 3.2.2 Where the bottom of an excavation does not provide suitable foundation for a culvert, the unsuitable material shall be excavated to depths indicated by the Engineer. Such excavation shall be made good with well consolidated approved natural or cement stabilised granular material, or in concrete as shown on the Drawings or as directed by the Engineer.

3.3 Placing of Concrete Pipes

- 3.3.1 All concrete pipes shall be laid on a concrete bed. Pipes shall be uniformly supported throughout their length and laid true to line and grade.
- 3.3.2 Pipes which deform and crack or are damaged before or during the maintenance period shall be removed and replaced by the Contractor at his own expense.

3.4 Internally Formed Concrete Culverts

- 3.4.1 Steel formers and inflatable tubing shall be laid on a concrete invert slab cast to the dimensions shown in the Drawings. The formers shall be correctly aligned and securely anchored to prevent movement during placing of concrete.
- 3.4.2 Formers shall not be deflated or removed from the concrete surround for at least 12 hours after placing concrete.

3.5 Backfilling

- 3.5.1 All excavation backfilling work where required will normally be carried out as given in "Excavation and Backfilling for Structures". (See Section C6).

3.5.2 The fill adjacent to the culvert structure shall be constructed as specified in paragraph 2.4 Section R.6 "Construction of the Subgrade" for culverts not constructed in trench conditions.

3.5.3 Each layer shall be watered, thoroughly mixed and compacted to the satisfaction of the Engineer.

3.5.4 No backfilling shall be placed around a culvert for at least 3 days after placing concrete, or such other period specified by the Engineer.

3.6 End Treatment

3.6.1 Where required, headwalls, including wingwalls, at the inlets and outlets to concrete pipe culverts shall be constructed in vibrated concrete in accordance with the Drawings or as directed by the Engineer.

3.6.2 Where required cladding shall be provided at the inlets and outlets to pipe culverts in accordance with the Drawings or as directed by the Engineer.

3.6.3 Other forms of end treatment such as drop inlets, silt traps, aprons, etc., shall be constructed in accordance with the Drawings or as directed by the Engineer.

3.7 Minimum Cover to Culverts

3.7.1 Minimum cover to culverts shall be 0.3m in respect of all pipe culverts.

3.7.2 Heavy construction equipment with axle loading in excess of the legal limit shall not be allowed to travel over a newly constructed culvert until the concrete has achieved its 28 day cube strength, and, only then when a minimum cover of 1.0m has been provided and shall be removed after use, all at the Contractor's expense.

4. MEASUREMENT

4.1 Excavation

The unit of measurement for the excavation of pipe culverts will be the cubic metre and the method of measurement of excavation as given in "Excavation and Backfilling for Structures". (See Section C6).

4.2 Backfill

The unit of measurement for natural or stabilised backfill in special treatment of foundations will be the cubic metre measurement after compaction.

4.3 Concrete Pipes

Concrete pipes will be measured by the linear metre of pipe in position along the centreline.

4.4 Concrete

4.4.1 The concrete in headwalls, wingwalls, aprons, drop inlets and in the bedding, haunches, and surrounds to pipes will be measured by the cubic metre as given in "Portland Cement Concrete" (See Section C.8)

4.4.2 There will be no separate measurement for formwork to concrete for piped culverts.

4.5 Plain, Wired or Grouted Cladding

Plain, wired and grouted cladding at culvert inlets and outlets, will be measured by the square metre as given in "Slope Protection and Anti-Erosion Works" (See Section C.12).

4.6 Stabilising Agent

The unit of measurement of the stabilising agent is the tonne.

5. PAYMENT

5.1 Excavation

Payment for excavation will be as given in "Excavation and Backfilling for Structures" (See Section C.6).

5.2 Backfill

a) Natural

The rate for each cubic metre of natural backfill under excavations and culvert foundations will be as specified in Excavation and Backfilling for Structure (See Section C.6).

b) Stabilised

The rate for each cubic metre of stabilised backfill under and culvert foundations will be as specified in Excavation and Backfilling for Structure (See Section C.6).

5.3 Concrete Pipes

The rate for each linear metre of pipe in place will include full compensation for all labour and equipment for the supply, loading, transport, and off loading of pipes and materials, and laying the pipes.

5.4 Concrete

The rate for each cubic metre of concrete in headwalls, wingwalls, aprons, drop inlets, concrete bedding, haunching and surrounds to precast pipe culverts and culverts constructed with internal formers will be as given in "Portland Cement Concrete". (See Section C8). There will be no separate payment for formwork to concrete for pipe culverts.

5.5. Stabilising Agent

The rate for each tonne of stabilising agent will be as given in "Excavation and Backfilling For Structures" (see Section C6) and full compensation for the supply and transport of the agent to the point of application.

5.6 Plain, Wired and Grouted Cladding

SECTION NO. R.3 CONSTRUCTION OF BOX CULVERTS

1. DESCRIPTION OF WORK

The work consists of providing materials for, and the construction of reinforced concrete box culverts. together with ancillary works in connection with the culverts, at sites indicated by the Engineer, A box culvert is defined as a structure of rectangular cross-section for conveying water under a road. Culverts shall be constructed in accordance with the design supplied by the Engineer, and will conform to the details shown on the Drawings.

2. MATERIALS, MIXES AND CONSTRUCTION

All materials, concrete mixes and construction processes used shall conform to the requirements specified in the relevant sections.

3. CONSTRUCTION

3.1 Excavation

3.1.1 Excavation for foundations shall be as given in "Excavation and Back filling for Structures". (See Section C.6).

3.1.2 All culverts shall be founded on sound, firm material approved by the Engineer.

3.2 Excavation in soils

Foundation beds in soil shall be watered and compacted by approved means, to the specified density and depths as shown on the Drawings or as directed by the Engineer.

3.3 Excavation in Heaving Soil

Where the culvert is founded on heaving soil the Engineer may order excavation of the unsound material to a depth not less than 1 m below the level of the underside of the foundation slab. Immediately preceding backfilling, the expansive soil in the floor of the excavation shall be heaved by saturating with water. The void formed by excavating expansive soil shall be filled with approved cement stabilised material, The cement content shall be not less than 2 percent by mass of the soil and shall be placed in layers not more than 200 mm thick compacted to the density specified on the Drawings.

3.4 Concrete Substructures

- 3.4.1 Where required on the Drawings, the whole area below the invert slab shall be covered with a 75 mm foundation blinding layer of non-vibrated Grade C.15 concrete before constructing the invert slab.
- 3.4.2 The abutment walls, wingwalls, drop inlets, inverts, etc., where required, shall be constructed of vibrated concrete as specified.
- 3.4.3 Weepholes of 75 mm diameter asbestos cement pipes shall be placed as required, or as shown on the Drawings. They must not be damaged during the placing of the concrete. After the concrete is poured the weepholes shall be inspected and cleared.
- 3.4.4 Construction joints shall be provided as shown on the Drawings.

3.5 Concrete superstructure

- 3.5.1 The deck slabs and parapet walls shall be constructed in vibrated concrete as shown on the Drawings.
- 3.5.2 If the Contractor wishes to use an alternative to the standard deck designs he shall submit full details of the design and method of construction to the Engineer for approval 28 days before he intends to start work on the deck. All designing shall be based on the latest relevant standard, full details of which are available from the Engineer.
- 3.5.3 No traffic shall be allowed over the culvert decks for at least three weeks after completion and not before the 28 day cube strength has been achieved.

3.6 Filter Medium

- 3.6.1 A filter medium shall be placed behind each abutment and wingwall as shown on the Drawings.
- 3.6.2 The filter medium shall be placed to the widths and heights shown on the Drawings or as required by the Engineer.

3.7 Backfilling and Construction of Subgrade adjacent to Box Culverts.

3.7.1 All backfilling of excavations and construction of subgrade adjacent to Box Culverts shall be carried out as given in "Excavation and Backfilling for Structures" and "Construction of the Subgrade" see section C.6 & R.6 respectively.

3.7.2 The construction of the subgrade adjacent to abutment walls or wingwalls shall not commence until at least ten days after the placing of concrete in the walls.

3.8 Formwork and Surface Finish

The formwork and surface finish shall be as given in "Formwork and Surface Finish" (see Section C.10).

3.9 External Loading

No pier, abutment or superstructure shall be subjected to external loads until all the concrete affected by such loading has achieved the specified 28 day cube strength.

3.10 Malthoid Bearings

A double layer of 3 ply malthoid shall be provided as indicated on the drawings.

4. MEASUREMENT

4.1 Excavation

Excavation will be measured as given in "Excavation and Backfilling for Structures" (see Section C.6).

4.2 Mass and Reinforced Concrete

Mass and reinforced concrete will be measured as given in "Portland Cement Concrete" (see Section C.8).

4.3 Formwork and Surface Finish

The measurement for formwork and surface finish will be as given in "Formwork and Surface Finish" (see Section C.10).

4.4 Steel Reinforcement

Steel reinforcement will be measured as given in "Steel Reinforcement" (see Section C.11).

4.5 Filter medium behind Abutments and Wingwalls

The unit of measurement for filter medium is the cubic metre.

4.6 Cement Stabilised Backfill in Heaving Soils.

The unit of measurement for the cement stabilised backfill to replace the excavated heaving soil underlying the culvert foundations slab will be as given in the "Excavation and Backfilling for Structures" (see Section C.6).

4.7 Stabilising Agent

The unit of measurement will be the Tonne.

4.8 Overhaul

Overhaul will be as specified in "Haul and Overhaul" (See section C.7).

5. PAYMENT

5.1 Excavation

Payment will be as given in "Excavation and Backfilling for Structures". (See section C.6)

5.2 Mass and Reinforced Concrete

Payment for each cubic metre of mass and reinforced concrete will be given in "Portland Cement Concrete" (see Section C.8).

5.3 Formwork and Surface Finish

Payment for formwork and surface finish will be as given in "Formwork and Surface Finish" (see Section C.10).

5.4 Steel Reinforcement

Payment for reinforcing steel will be as given in "Steel Reinforcement" (see Section C.11).

5.5 Filter Medium behind Abutments and Wingwalls

The rate for each cubic metre of filter medium will include full compensation for labour and equipment, supply and transport to the site of all material, mixing, shuttering and placing of the membrane as specified.

5.6 Cement Stabilised Backfilling in Heaving Soils

The rate for each cubic metre of cement stabilised material used to replace the excavated heaving soil underlying the foundation slab will be as given in "Excavation and Backfilling for Structures" (See section C.6).

5.7 Stabilising Agent

The rate for each Tonne of stabilising agent will include full compensation for the supply and transport of the material to the point of application.

5.8 Overhaul

Payment of overhaul of backfill material, including water for compaction and preheaving purposes shall be as given in "Haul and Overhaul" (see Section C.7).

**SECTION NO. R.4
CONSTRUCTION OF PRECAST ARCHED CULVERTS**

1. DESCRIPTION OF WORK

1.1 The work consists of providing materials for, and the construction of culverts using precast arched panels, together with relevant ancillary works, at sites indicated by the Engineer.

"Shelverts" or similar approved panels can be defined as structures having an arch type cross-section for conveying water under a road. Construction shall be in accordance with the design supplied by the Engineer, and will conform to the details shown on the drawings.

1.2 The following sections specifically cover shelverts and alternative designs must be approved by the Engineer.

2. MATERIALS, MIXES AND CONSTRUCTION

All materials, concrete mixes and construction processes used shall conform to the requirements specified in the relevant sections. This includes the shelvert panels which are half-arch sections in precast concrete.

3. CONSTRUCTION

3.1 Excavation

Excavation to founding level shall be as given in "Excavation and Backfilling for Structures" (See Section C6).

3.2 Preparation of Foundation

3.2.1 Founding materials having Dynamic Cone Penetrometer (DCP) values equal to or less than 10 mm/blow are satisfactory.

3.2.2 Compaction of the foundation material to a density of 95% Mod. AASHTO in the top 150 mm must be carried out by vibratory rollers in the areas shown on the drawings.

3.2.3 The uncompacted mid portion as shown in the drawing must be ripped to a depth of 100 mm and must remain uncompacted.

3.2.4 Material at founding level having DCP values greater than 10 mm/blow shall be treated as follows:

- a) Excavation to a uniform depth below invert level
- b) Backfill with a non-plastic granular class 3.3 material stabilised with 3% cement and compacted to 95% Mod. AASHTO.

3.3 Concrete Substructure

- 3.3.1 The invert slab and upstands shall be constructed of vibrated concrete to the dimensions and details as shown on the drawings.
- 3.3.2 The invert and upstands must be cast in one operation.
- 3.3.3 The recess in the upstands must be cast with a smooth and even bedding for the precast shelvert panels.
- 3.3.4 The concrete shall be grade C 25.
- 3.3.5 Steel mesh must be placed as shown on the drawings.

3.4 Concrete Superstructure

- 3.4.1 The precast shelvert panels must be placed in position as shown on the drawings and grouted as specified after placing.
- 3.4.2 Steel pins must be inserted in the transverse holes at the top of the precast panels as detailed on the drawings.
- 3.4.3 C.30 concrete infill surrounding a 12mm nominal size square twisted bar running the full length of the spinal grove must be placed as detailed on the drawings.
- 3.4.4 For fills over 4 metres in height a minimum of 150 mm of C.25 concrete surround is to be placed on all shelverts as detailed on the drawing.

3.5 Backfilling of Excavations

Backfilling work to excavations where required will be carried out as given in "Excavation and Backfilling of Structures" (See section C.6)

3.6 Subgrade Fill Adjacent to Structure

The subgrade fill adjacent to the shelvert must be carried out as given in "Construction of the Subgrade" (See section

R.6 paragraph 2.4). The level of the material on either side of the structure must be brought up evenly.

3.7 Formwork and Surface Finish

The formwork and surface finish shall be as given in "Formwork and Surface Finish" (See section C.10).

3.8 External Loads

The invert slab and superstructure shall not be subjected to external loads until all the concrete affected by such loading has achieved the specified 28 day cube strength.

3.9 End Treatment

3.9.1 Where required retaining walls shall be provided at the inlets and outlets to the shelverts. They shall be constructed in stone masonry in accordance with the drawings or as directed by the Engineer.

3.9.2 In addition cladding of the fill slope will be carried out as shown on the drawings or as directed by the Engineer.

3.9.3 Other forms of end treatment such as drop inlets silt traps, aprons, etc shall be constructed in accordance with the drawings or as directed by the Engineer.

3.10 Minimum Cover

Minimum cover to the crown of shelverts shall be 500 mm.

4. MEASUREMENT

4.1 Excavation

Excavation will be measured as given in "Excavation and Backfilling for Structures" (See section C.6).

4.2 Mass and Reinforced Concrete

Mass and reinforced concrete will be measured as given in "Portland Cement Concrete" (See section C.8).

4.3 Formwork and Surface Finish

The measurement for formwork and surface finish will be as given in "Formwork and Surface Finish" (See section C.10).

4.4 Steel Reinforcement

Steel reinforcement will be measured as given in "Steel Reinforcement" (See section C.11).

4.5 Cement Stabilised Backfill

The unit of measurement for the cement stabilised backfill in the foundation will be as given in "Excavation and Backfill for Structures" (See section C.6).

4.6 Stabilising Agent

The unit of measurement will be the Tonne.

4.7 Overhaul

Overhaul will be as specified in "Haul and Overhaul" (See section C.7).

4.8 Shelvert Precast Panels

Shelvert Precast Panels will be the number off in place.

4.9 Fill Adjacent to Shelvert

This will be measured as given in "Construction of the Subgrade" (See Section R.6).

4.10 Stone Masonry (Grouted Stonework)

The unit of measurement will be as given in "Slope Protection and Anti-Erosion Works" (See section C.12).

4.11 Stone Cladding

The unit of measurement will be as given in "Slope Protection and Anti-Erosion Works" (See section C.12).

5. PAYMENT

5.1 Excavation

Payment for excavation will be as given in "Excavation and Backfilling for Structures". (See section C.6)

5.2 Mass and Reinforced Concrete

Payment for each cubic metre of mass and reinforced concrete will be as given in "Portland Cement Concrete" (See section C.8).

5.3 Formwork and Surface Finish

Payment for formwork and surface finish will be as given in "Formwork and Surface Finish" (See section C.10).

5.4 Steel Reinforcement

Payment for reinforcing steel will be as given in "Steel Reinforcement" (See section C.11).

5.5 Cement Stabilised Backfill

The rate for each cubic metre of stabilised backfill will be as given in "Excavation and Backfilling for Structures" (see section C.6).

5.6 Stabilising Agent

The rate for each tonne of stabilising agent will be as given in "Excavation and Backfilling for Structures" (see section C.6).

5.7 Overhaul

Overhaul will be paid as given in "Haul and Overhaul" (See section C.7).

5.8 Shelvert Precast Panels

The rate for the supply and placing of each panel in position will include full compensation for the execution of the work as specified and for all work and materials incidental and necessary thereto. It will not include the rate for concrete surround to shelverts in fills over 4 metres in height.

5.9 Fill Adjacent to Shelvert

The rate for each cubic metre of fill will be as given in "Construction of the Subgrade" (See section R.6).

5.10 Stone Masonry (Grouted Stonework)

The rate for each cubic metre of stone masonry will be as given in "Slope Protection and Anti-Erosion Works" (See section C.12).

5.11 Stone Cladding

The rate for each square metre of stone cladding will be as given in "Slope Protection and Anti-Erosion Works" (See section C.12).

SECTION NO. R.5
PREPARATION OF ROADBED

1. DESCRIPTION OF WORK

- 1.1 The roadbed is that part of the ground surface uncovered by clearing the site, completion of cuts, excavations and removal of unsuitable material, including topsoil below the depth indicated by the reduction factor, as required, on which the road structure rests.
- 1.2 Where the roadbed is rock no preparation is necessary. Otherwise it shall be scarified to a depth of 150 mm and compacted with four passes of 50 tonne single axle supercompactor.
- 1.3 One pass of a supercompactor means that the whole area to be compacted has been covered without overlapping.
- 1.4 The Engineer will instruct in writing where roadbed preparation is to be carried out.
- 1.5 Additional rolling and/or watering of the roadbed may be ordered by the Engineer in writing.
- 1.6 The Contractor shall remove unsuitable material and drain water-logged areas before roadbed preparation is undertaken. Drainage of waterlogged areas is generally achieved by the installation of temporary open drains. Where the open drains are not successful the Engineer may direct that permanent sub-soil drains be installed or alternatively, where deemed physically possible, order the removal of the waterlogged material.
- 1.7 It shall be the Contractor's responsibility to identify to the Engineer areas of water-logged material requiring treatment sufficiently in advance of earthworks operations and/or roadbed preparation to suit his works programme. Any delays to the earthworks operation occasioned by the Contractor's failure to notify the Engineer of any water-logged material shall be the Contractor's responsibility.

2. MEASUREMENT

2.1 Preparation of Roadbed

The unit of measurement is the hectare of roadbed prepared, calculated by measuring the area on which the road structure rests.

2.2 Watering

Watering is measured in cubic metres of water applied where directed.

2.3 Overhaul of Water

Overhaul of water is measured as given in "Haul and Overhaul" (see Section C.7).

2.4 Additional Rolling

Additional rolling ordered by the Engineer will be measured as plant hire and daywork.

2.5 Removal of Unsuitable Material

Measurement shall be as given in "Construction of the Subgrade" (see section R.6).

3. PAYMENT

3.1 Preparation of roadbed

The rate for each hectare of roadbed prepared will include scarifying, forming, shaping and rolling of the roadbed.

3.2 Water

The rate for every cubic metre of water will include full compensation for the provision, pumping, hauling and distribution of the water.

3.3 Overhaul of Water

Overhaul will be paid for as given in "Haul and Overhaul" (see Section C.7).

3.4 Additional Rolling

Payment for any additional rolling ordered by the Engineer will be as plant hire and daywork.

3.5 Removal of Unsuitable Material

Payment for excavation of unsuitable material will be as given in "Construction of the Subgrade" (See section R.6.)

SECTION NO. R.6 CONSTRUCTION OF THE SUBGRADE

1. DESCRIPTION OF WORK

- 1.1 The subgrade comprises all materials, up to the underside of the pavement placed on the roadbed and built into the road structure as specified. If no such materials have to be placed on the roadbed, the top 150 mm of the roadbed will be referred to as the subgrade.
- 1.2 This section deals with the excavation and removal of material from cuttings, borrow pits, side drains, mitre drains, catch drains, culvert outlets, etc, and the disposal of or, if suitable, the placing of this material on the road and compaction of the material to the density specified on the Drawings.
- 1.3 The Engineer may instruct the Contractor to route his earthmoving equipment over fill areas in order to obtain the maximum compactive effort.

2. CONSTRUCTION

2.1 Cuts

- 2.1.1 Cuts shall be finished true to the profiles, slopes, widths and levels required by the Engineer who shall advise the Contractor of his requirements by means of plans or sections or in some other suitable and recorded manner. All rocks shall be removed to a depth of 150 mm below the specified level of the upper surface of the sub-grade, or to a greater depth if required by the Engineer.
- 2.1.2 Materials occurring within the road structure which are unsuitable for road construction shall be removed to waste. Some materials classified as unsuitable for the subgrade are: antheap, topsoil below the depth indicated by the reduction factor, dispersive soil, some rock, some hard and water-logged materials, and all materials with a soaked CBR of less than 3.

The extent of excavation of material to waste shall be agreed by the Engineer before the work commences. All waste material shall be neatly dumped and spread to the satisfaction of the Engineer.

2.1.3 Where, for any reason save by direction of the Engineer, excavation is carried deeper or beyond the limits specified the levels, cross-sections, etc, shall be restored to the satisfaction of the Engineer at the Contractor's expense. Material from excavations shall not be wasted indiscriminately.

2.1.4 Where reasonable and practicable the Engineer will indicate where material of varying quality will be placed in fills and embankments. No extra payment will be made for such procedure unless double handling or overhaul of material is involved and authorized by the Engineer.

2.1.5 Any anthills and termite workings encountered shall be excavated to the extent and depth required by the Engineer and the material so excavated shall not be used in any part of the road structure unless instructed by the Engineer. All material brought in to fill and make good such excavation will be deemed to be subgrade and shall be compacted by the use of approved equipment. It will be measured and paid for as subgrade.

After excavation of anthills and termite workings termite poison approved by the Engineer shall be applied over the affected area at the rates and method recommended by the manufacturer.

2.1.6 Any deviation to the agreed disposal of the subgrade as indicated on the mass-haul curve must be with the approval of the Engineer.

2.2 Subgrade Borrow Areas

2.2.1 Where it is necessary to borrow material for the construction of the subgrade, the site of the borrow area and the material to be borrowed must be approved by the Engineer, who may also direct where any particular material is to be used in the subgrade. The Contractor shall clear the area of all timber, bush, grass, roots, debris and other unsuitable material.

2.2.2 The timber cleared shall be corded immediately adjacent to the cleared area.

2.2.3 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All brush, grass, etc., not required by the landowner shall be burned in the centre of the cleared area or at any other location agreed to or directed by the Engineer.

- 2.2.4 All borrow pits must be carefully cross-sectioned before and after excavation in order to determine the quantity of earth excavated.
- 2.2.5 After removal of material for use in the road subgrade the working area must be reinstated by the Contractor so that it will not prove a hazard to man or beast, or a source of erosion. The sides of the excavation must first be sloped and then any previously stock-piled topsoil spread as far as possible over the whole area in order to encourage regrowth of the natural vegetation.
- 2.2.6 The Engineer will indicate the route to be followed by the Contractor who will be responsible for providing access roads to the borrow areas. Once removal of material from the borrow areas has been completed these access roads must be reinstated. They must be ripped and an attempt made to restore the land to its original condition. Windrows on each side must be flattened and where necessary anti-erosion measures must be taken.
- 2.2.7 All reinstatement of borrow areas and access roads will be to the satisfaction of the Engineer.

2.3 Embankments

- 2.3.1 Embankments forming the subgrade shall be completed true to line and level in conformity with the details shown on the Drawings, the Construction Print-out Sheets or as directed by the Engineer. Such details may include benching of the roadbed, construction of subsoil drainage works, etc.
- 2.3.2 Suitable material from road cuttings or other excavations which is available within an economic haul will be used as provided in paragraphs 2.1.4 and 2.1.6, for the construction of fills and embankments before opening up borrow pits.
- 2.3.3 Stumps, trees, brush, grass, and other unsuitable material shall under no circumstances be incorporated in the subgrade.

- 2.3.4 When embankments contain broken rock or boulders, the larger stones shall be distributed and filled around with smaller and finer material to produce a dense compact embankment. Stones more than 150 mm in any dimension shall not be left within 300 mm of the upper surface of the subgrade. The subgrade will normally be constructed by importing material in loose layers not more than 200 mm thick. If this is not possible because of the size of stones in an essentially rockfill then the layers are to be as thin as possible but not more than 450 mm thick. Where sandy soils are used, the Engineer may direct that the material is to be placed in loose layers between 200 mm and 300 mm thick.
- 2.3.5 For 7 on 7 roads (viz 7 metre surfacing on a 7 metre formation width), it will be necessary to compact an additional 150mm on each side of the width specified to ensure compaction to the full width of the layers. The additional compaction shall not be paid for separately and shall be allowed for in the rates for base compaction. Such additional material shall not be removed but shall be trimmed to shape with tolerances to slope and drain width as determined by the Engineer.
- 2.3.6 The top layer of the subgrade shall be compacted as given in "Controlled Compaction" (See Section R.11) and all the underlining layers as given in "Semi-Controlled Compaction" (See Section R.10)
- 2.3.7 Any damage caused to the completed subgrade by the Contractor's equipment and vehicles shall be restored at his expense.
- 2.4 Construction of the Subgrade adjacent to Structures (Wedge Treatment)
- 2.4.1 All fills adjacent to the concrete face of a structure shall be constructed in horizontal layers of not more than 200 mm thickness compacted to a specified density using approved material for the full height of the embankment to top of subgrade. The compaction of the approved filling shall be as given in "Controlled Compaction" (See section R.11). Where indicated on the drawings or directed by the Engineer, the fill shall be constructed in equal lifts on both sides of the structure.

- 2.4.2 The dimensions of the fill wedge shall be two metres wide at the top of subgrade level sloping down to ground level at a grade of 1 : 2 parallel to the road centreline unless otherwise shown on the Drawings.
- 2.4.3 The Engineer may specify that all or part of the wedge of subgrade material shall be stabilised with cement or lime.
- 2.4.4 Where spill-through abutments are shown on the Drawings, the whole of the spill-through portion of the subgrade as well as the subgrade behind the structure shall be compacted as specified above.
- 2.4.5 Subgrade material shall not be placed behind the walls of concrete box culverts until the top slab is placed and cured, unless authorized by the Engineer.
- 2.4.6 Subgrade material shall not be placed against concrete faces or over the top of structures until such time as the concrete has attained sufficient strength to withstand the applied loading as authorized by the Engineer.

2.5 Controlled Compaction of the Subgrade

Where indicated on the Drawings, or directed by the Engineer, the Contractor shall compact any layer of the subgrade, as given in "Controlled Compaction" (see Section R.11).

2.6 Finish to the Subgrade: Allowable Variations

The finished subgrade shall normally conform to the lines, grades and dimensions shown on the Drawings. Variations from the Drawings will only be accepted if the levels for the upper surface of the finished subgrade are within 20 mm below or above those specified on the Drawings or by the Engineer. The top of the subgrade must be free from any rutting and/or depressions which may hold water.

2.7 Stabilisation of the Subgrade

Where indicated on the Drawings or directed by the Engineer any layer of the subgrade shall be stabilised as given in "Stabilisation with Lime or Cement" (see Section R.12).

2.8 Blasting

- 2.8.1 No blasting shall be carried out without the approval of the Engineer. The Engineer may forbid blasting altogether if, for example, he considers it dangerous to any structure, service or facility.
- 2.8.2 The Contractor shall at all times strictly observe Government explosive regulations.
- 2.8.3 When blasting, the Contractor shall take steps, to the satisfaction of the Engineer, to prevent injury or damage to persons and property. The approval of the Engineer shall not relieve the Contractor of his liabilities in respect of any injury or damage whatsoever caused by blasting or attributable thereto.
- 2.8.4 If any habitations are within 200 metres of any blasting operation, the Contractor shall notify the Engineer at least 24 hours in advance that blasting will be taking place in that area. He shall obtain instructions from the Engineer about the hours during which blasting may take place, and about any special arrangements required by him.
- 2.8.5 The Contractor shall arrange with the appropriate authority for the protection of traffic on all roads passing within two hundred metres of blasting operations, and shall comply with any instructions, such authority shall issue.

3. MEASUREMENT

3.1 Classes of Excavation

The excavation of material from cut or borrow shall be classified as follows:

3.1.1 Rock Excavation

Rock is material which requires the extensive use of explosives to remove it. Soft rock which can be efficiently ripped by a crawler tractor of 200 kw power output at the flywheel and fitted with matched hydraulic ripping and bulldozing attachment shall not be classified as Rock. For clarification this definition covers tractors in the Caterpillar D8H range.

3.1.2 Hard Excavation

Material which is not classified as Rock but cannot be efficiently removed by a crawler tractor of less power output at the flywheel than 135 kw equipment with matched hydraulic ripping and bulldozing attachments. For clarification this definition covers tractors in the Caterpillar D7F range.

3.1.2.1 Boulder material consisting of boulders of 0.25 cubic metres or more in size interspersed with finer and/or smaller material shall be classified as Hard Excavation when 75 percent or more of any excavation consists of boulders.

Individual boulders larger than 3,0 cubic metres shall be classified as Rock Excavation.

3.1.3 Common Excavation

All material other than ROCK and HARD excavation is classified as Common Excavation. Where less than 75 percent of any excavation consists of boulder material, the excavation will be classified as Common Excavation.

3.2 Method of classifying

3.2.1 The Contractor shall advise the Engineer when an excavation is ready for classifying. It will be satisfactory in the first instance for the classification to be based on an inspection of the material to be excavated.

3.2.2 In the event of disagreement between the Contractor and the Engineer, after his initial assessment of the classification, the Contractor shall notify the Engineer immediately before commencing further excavation, in order that the class of material can be established using the equipment specified in paragraphs 3.1.1 and 3.1.2. If appropriate equipment is not available the Engineer will classify the material by assessment from the power and performance of the machines actually on site. Materials which would normally qualify for common or hard excavation under dry conditions shall not be re-classified because of saturated ground conditions.

- 3.2.3 The Contractor shall be at liberty to select the method of excavation; however, the method selected shall not dictate the classification of the material for payment purposes.

3.3 Methods of Measurement

- 3.3.1 The volumes included in the Bill of Quantities have been calculated using the Ministry of Transport's Road Earthworks Programme. The User Manual for this Road Earthworks Computer Programme can be obtained on application to the Engineer.
- 3.3.2 Volumes of excavation will be accepted as calculated by the Ministry of Transport's Road Earthworks Programme unless at the time of tendering the Contractor states that he wishes to produce his own measurement. A copy of the Design and Construction Printout will be supplied to the successful tenderer on award of the contract. Ground Level Data Sheets can be supplied to the successful tenderer on request.
- 3.3.3 The earthworks quantities take into consideration the loss due to initial clearing and roadbed compaction. Acceptance of these quantities will be assumed unless the Contractor carries out his own check.
- 3.3.4 Earthworks quantities shown on the computer printout will be used for measurement purposes with the following adjustments:-
- a) Excavation of material to waste (other than expansive material allowed for in the road Earthworks Programme) will be calculated by taking accurate "before and after" cross sections from which volumes will be computed using the method of Average End Areas.
 - b) Where rock or waste material fall within the cut volumes calculated by the Ministry of Transport's REWP these volumes should be calculated and deducted from the total cut values.
 - c) Excavation of material in borrow pits will be calculated by taking accurate "before and after" cross section on the ground line after clearing from which volumes will be computed using the method of Average End Areas.

- d) The design report gives accurate values for cut and fill for the majority of the road length. However, at each major culvert site and anthill the quantities are to be agreed on site and substituted for the computerised figures.
- 3.3.5 Excavation of material for the construction of intersections, lay-bys, culvert outlets, catchwater drains, mitre drains and other features not included in the normal road cross section will be measured by appropriate methods and included in the total earthworks quantities.
 - 3.3.6 Where material is excavated outside designed lines and levels or in excess of the required volumes it will neither be measured nor paid for.
 - 3.3.7 The volume of each class of excavation will be determined separately, the unit of measurement being the cubic metre of material before excavation.
 - 3.3.8 The following categories of excavation will normally be measured separately:
 - a) Common excavation for use in fill
 - b) Hard excavation "extra over" item a and e.
 - c) Rock excavation "extra over" item a and e.
 - d) Common excavation of material from borrow pits
 - e) Common excavation to waste.
 - f) Anthill excavation to waste.
 - g) Rock excavation to waste for a distance of 75 m.
 - h) Extra over item g. for removal up to 1 000 m.
 - i) Extra over item g. for burying rock.
 - j) Excavation of rejected materials (CBR<C3) to waste.
 - k) Excavation of Water-logged materials.

3.4 Clearing and Reinstatement of Borrow Areas

Clearing and Reinstatement of the borrow area will be measured by the Hectare of clearing authorised by the Engineer.

3.5 Overhaul of Rock, Hard, Boulder and Common Excavation

Overhaul will be measured as given in "Haul and Overhaul".

3.6 Controlled Compaction of the Subgrade

The unit of measurement is the cubic metre of material compacted as given in "Controlled Compaction"(see Section R.11).

3.7 Stabilised Subgrade

3.7.1 Stabilising Agent

The unit of measurement of the stabilising agent is the tonne.

3.7.2 Stabilised Subgrade

The unit of measurement of the stabilised subgrade is the cubic metre of subgrade measured after stabilisation and compaction.

3.8 Subgrade Adjacent to Structure (Wedge Treatment)

The unit of measurement for material placed in the subgrade adjacent to structures is the cubic metre. Separate measurements will be made for material stabilised and unstabilised.

4. PAYMENT

4.1 Excavation

4.1.1 The rate for each cubic metre of excavation for the construction of the subgrade will include full compensation for excavation on the road as well as in borrow areas and will include the provision and reinstatement of access roads to borrow areas. It will also include the construction shaping and finishing of the subgrade and forming benches, etc., as specified, the moving or transporting of excavated material to embankment, stockpile or waste. When overhaul is involved, this will be paid for separately.

- 4.1.2 The rate for excavation placed in embankments will include full compensation for semi-controlled compaction to a relative density of $L S = 89\%$ Mod. AASHTO.
- 4.1.3 The rate will also include full compensation for all supervision, labour, equipment, explosives and other materials and incidentals required to complete the work, and for construction, maintenance and tidying up on completion of all access and other haul roads.
- 4.1.4 Subsoil drains placed beneath or into subgrade material shall be paid for as given in "Drains" (See Section R.9).
- 4.1.5 The rate of hard excavation will be paid as "extra over" the rate for common excavation and will provide full compensation for the additional effort involved.
- 4.1.6 The rate for rock excavation will include full compensation for blasting to a size suitable for removal by a bulldozer of 200 kW rating and removal from the road structure for a distance of 75 m as directed by the Engineer.

An "extra over" item for removal of rock to a distance of 1 000 m will include full compensation for additional costs of blasting to a size suitable for loading into trucks and transporting within the free haul distance.

An "extra over" item for burying of rock will include full compensation for additional costs of burying the rock including excavation and reinstatement of the area in which the rock is buried.

4.2 Clearing and Reinstatement of Borrow Areas

The rate for each hectare cleared will include full compensation for labour, materials, tools, implements, plant and equipment for doing all work, including the clearing, removal of overburden to the perimeter of the area, reinstatement work and incidental work necessary to the operations as specified.

4.3 Overhaul of Material

Payment of overhaul of Rock, Hard, Boulder and Common Excavation will be as given in "Haul and Overhaul".

- 4.4 Water
- 4.4.1 Semi-controlled Compacted Subgrade
- Payment for water used in the semi-controlled compaction of subgrade will be as given in "Semi-controlled Compaction" (see Section R.10).
- 4.4.2 Control-Compacted Subgrade
- Payment for water used in the controlled compaction of subgrade will be as given in "Control-Compacted Subgrade" (see Section R.11).
- 4.5 Controlled Compaction of Subgrade
- Payment for each cubic metre of subgrade material that has been compacted to the specified density will be as given in "Controlled Compaction" (see Section R.11).
- 4.6 Stabilised Subgrade
- 4.6.1 Stabilising Agent
- The rate for each tonne of stabilising agent will include full compensation for supply to the point of application.
- 4.6.2 Stabilised Subgrade
- The rate for each cubic metre of stabilised subgrade will include full compensation for off-loading, spreading, mixing and any additional work or operation necessitated by the addition of the stabilising agent to the subgrade, as given in "Stabilisation with Lime or Cement" (see Section R.12). It will also include full compensation for compacting the material to a specified density.
- 4.7 Subgrade to Structures (Wedge Treatment)
- The rate for each cubic metre of subgrade material placed adjacent to structure will include full compensation for supervision, labour, plant, equipment and materials necessary for the execution of the work.
- 4.8 Stabilised Subgrade to Structures
- The rate for each cubic metre of stabilised subgrade to structures will additionally include full compensation for off-loading, spreading, mixing and other additional work or operation necessitated by the addition of the stabilising agent.

SECTION NO. R.7 EXPANSIVE SOILS

1. DESCRIPTION

- 1.1 This section deals with work which shall be performed when the road is located on soils which have expansive and heaving qualities.
- 1.2 Expansive soils are those materials which experience large volumetric changes with changes in moisture content, thereby causing a destructive effect on the road structure.

2. LOCATION

The Contractor will be advised by drawings or by written instructions where remedial action over expansive soils should be undertaken.

3. CONSTRUCTION

- 3.1 Generally the method of preparing the roadbed for the road structure on expansive soils is to remove the expansive soil to a depth below ground level where equilibrium moisture conditions exist and to backfill the excavation with non-expansive but impermeable material.
- 3.2 The expansive material shall be excavated to a depth and width indicated on the drawings. Over fill sections only it shall be placed conveniently on each side of the road.

In cut areas i.e. where side drains are to be constructed, the expansive material excavated shall be cut to waste.
- 3.3 The Engineer may direct that the roadbed shall be watered prior to the backfilling of the excavation.
- 3.4 Backfilling shall take place using approved material as for an embankment construction in "Construction of the Subgrade" (see Section R.6).
- 3.5 After construction of the subgrade the expansive material excavated and placed alongside the road shall be placed against the side slopes to form a smooth cladding as shown on the drawings or as directed by the Engineer.

4. MEASUREMENT

4.1 Excavation

The measurement of expansive material shall be the net volume of in-situ material in cubic metres before excavation. The volume shall be calculated from the dimensions shown on the drawings or as directed by the Engineer.

No measurement shall be made for material excavated outside the specified dimensions.

No adjustment shall be made to the volume resulting from changes in moisture content.

No adjustment shall be made for the consistency or composition of the expansive material due to moisture content.

4.2 Water

Water used in "flooding" the roadbed after excavation and in the backfilling operation shall be measured as given in "Semi-controlled Compaction" (see Section R.10).

4.3 Backfill

The backfill to the excavation shall be measured as given in "Construction of the Subgrade" (see Section R.6).

4.4 Cladding of Slopes

There will be no separate measurement for the work involved in placing the excavated expansive material against the side slopes after completion of the subgrade.

5. PAYMENT

5.1 Excavation

Separate payment for the excavation of expansive material shall be made for each cubic metre of expansive material excavated to waste and excavated to cladding.

5.2 Water

Payment for water used in "flooding" the roadbed after excavation and for the backfilling operation will be as given in "Semi -controlled Compaction" (see Section R.10).

5.3 Backfill

Payment for backfilling shall be as given in "Construction of the Subgrade" (see Section R.6).

5.4 Cladding of Slopes

There will be no separate payment for the cladding of slopes using the expansive materials excavated. The cost of the work involved shall be included in the price for the excavation of expansive material.

**SECTION NO. R.8
COLLAPSING SOILS**

1. DESCRIPTION

- 1.1 This section deals with the work which shall be performed when the road is located on soils which have collapsing qualities.
- 1.2 Soil collapse leads to sudden settlement and to consolidation of the pavement structure and results in a loss of ride in pavements even though bases may be both quantitatively and qualitatively adequate.

2. LOCATION

The Contractor will be advised by drawings or by written instructions where remedial action over collapsing soils should be undertaken.

3. CONSTRUCTION

- 3.1 The method of preparing the roadbed for the road structure on collapsing soils is to preconsolidate the soils when wet by means of impact or heavy vibratory rollers or single axle super compactors. Because of the depths involved (0,5-1,0m) it is uneconomical to use artificial wetting and therefore rolling should be undertaken during or immediately after a rainy season.
- 3.2 The roadbed shall be compacted to relative density of 89% modified AASHTO from 0 - 0,5 metre depth and 84% from 0,5-1,0 metre depth.
- 3.3 The densities specified in 3.2 above can be achieved, using the types of rollers as listed in paragraph 3.1 above, provided the preconsolidation is carried out when the moisture content over the specified one metre depth is adequate for compaction purposes.
- 3.4 Preconsolidation in the dry shall be achieved by excavating the material to the specified depth then replacing it in 200mm layers, watering to optimum moisture content and finally compacting each layer to the specified density.

4.0 MEASUREMENTS

- 4.1 Method 1 - in the wet.

The unit of measurement is the hectare of roadbed prepared, calculated by measuring the area on which the road structure rests.

4.2 Method 2 - in the dry.

The unit of measurement covering preconsolidation of the roadbed, using the method described in 3.4, shall be as given in the "Construction of the Subgrade" (See Section R.6).

Where necessary excavation of the collapsible material will be treated initially as "cut to waste" followed thereafter by "cut to fill". Any shortfalls of material shall be made up by "borrow to fill".

4.3 Watering

Water will be measured by the cubic metre of water applied. Each unit will be paid for at the appropriate rate in the Bill of Quantities.

4.4 Overhaul of Water

Overhaul of water will be measured as given in "Haul and Overhaul" (See Section C.7).

5.0 PAYMENT

5.1 Method 1.

The rate for each hectare of roadbed prepared will include for forming, shaping and all rolling necessary to achieve the densities specified.

5.2 Method 2.

Payment for this work as described in paragraph 3.4 will be as given in "Construction of the Subgrade" (See Section R.6).

5.3 Water

The rate for each cubic metre of water applied will include full compensation for the provision, pumping and distribution of the water and for hauling. The Engineer retains the right to curtail wasteful watering of material.

5.4 Overhaul of Water

Overhaul of water will be paid for as given in "Haul and Overhaul" (See Section C.7).

**SECTION NO. R.9
DRAINS**

1. DESCRIPTION OF WORK

1.1 Permanent Drains

This work comprises the construction of permanent drainage works as shown on the Drawings or as required by the Engineer.

1.2 Temporary Drains

These works involve the construction of all temporary drainage works needed to protect and or aid the construction of the permanent works. Such drainage work are the responsibility of the Contractor who will bear the full cost of the construction and if necessary of the dismantling. The Engineer may direct that temporary drains be constructed at any stage of the works. The Contractor is responsible for protecting the works and Government will entertain no claim arising from damage caused by water.

2. DEFINITIONS

2.1 Side Drains

Side drains are drains approximately parallel and adjacent to the course of the road.

2.2 Catchwater Drains

Catchwater drains are constructed clear of the road so as to intercept water before it reaches the road or side drain. Catch water drains will be constructed approximately on contour at such grades as to pass water without causing silting or erosion.

2.3 Mitre Drains

Mitre drains are drains at an angle to the course of the road to lead water away from the road side drains and/or catchwater drains.

2.4 Subsoil Drains

Subsoil drains are underground drains designed to lower the level of the water below the road structure.

2.5 Culvert Inlet or Outlet Drains

Culvert inlet or outlet drains are channels leading water into or away from a culvert.

3. CONSTRUCTION

3.1 General

3.1.1 Drains will be constructed to line, level and cross-section as shown on the Drawings, or as directed by the Engineer.

3.1.2 Drainage of surface water from the road will normally be by side and mitre drains, If the subgrade material is suitable, excavation form the drains shall be incorporated into the road subgrade. Surplus or unsuitable material shall be spoiled at sites approved by the Engineer.

3.2 Side Drains

3.2.1 Side drains shall be constructed as shown on the Drawings or as directed by the Engineer.

3.2.2 The outlets of side drains shall not discharge water down embankments. The discharge from such drains shall be on to undisturbed ground which may require protection from erosion.

3.3 Catchwater Drains

Catchwater drains will be placed so as to intercept all surface water flowing towards the road. They shall discharge either into the adjacent side drain, contour drains or into culverts which disperse water beneath and through the road structure.

3.4 Mitre Drains

Mitre drains will be constructed in conjunction with the side and catchwater drains; their size, shape and position shall be as indicated by the Engineer. Drain grades shall be such as to pass water without causing silting or erosion.

3.5 Subsoil Drains

3.5.1 Subsoil drains shall be provided as directed by the Engineer. They shall be constructed in accordance with the drawings and may incorporate porous or other types of collector pipes and approved designed filter material.

3.5.2 Where porous or other types of collector pipes are installed the outlet end of the pipes will be plugged with no-fines concrete.

3.6 Culvert Inlet and Outlet Drains

Culvert inlet and outlet drains shall be provided where required and shall normally be trapezoidal in shape except where the Engineer directs otherwise.

3.7 Anti-erosion and Protection Works

The Engineer may order the construction of protection and anti-erosion works to be carried out where he considers them necessary.

3.8 Paved Drains, Grouted Paved Drains and Cement Stabilised Paved Drains

These may be called for by the Engineer and details of their construction will be shown on Drawings which will be supplied.

4. MEASUREMENT

4.1 Drains

4.1.1 The unit of measurement is the cubic metre of material measured before excavation.

4.1.2 The classification of materials and method of measurement is given in "Construction of the Subgrade" (see Section R.6).

4.2 Excavation for Subsoil Drains

The measurement of material excavated to provide for a subsoil drain is given in "Excavation and Backfilling for Structures" (see Section C.6).

4.3 Filter Material

The unit of measurement of the filter material is the cubic metre of material measured placed.

4.4 Piped Subsoil Drains

The unit of measurement shall be the linear metre of pipes used.

4.5 Anti-erosion Works

The measurement of the construction of anti-erosion works will be as given in relevant sections.

4.6 Paving to Drains

The unit of measurement is the square metre of surface of completed paving.

4.7 Grouting Paved Drains

The unit of measurement is the square metre of surface of drain grouted.

4.8 Cement Stabilised Paved Drains

The unit of measurement is the cubic metre of soil cement material in place.

5. PAYMENT

5.1 Drains

Payment for each cubic metre of material excavated for the construction of drains, except sub-soil drains, shall be as given in "Construction of the Subgrade" (see Section R.10). It will also include full compensation for removing all obstructions from drains and clearing them.

5.2 Excavation for Sub-soil drains

Payment for each cubic metre of material excavated for the construction of sub-soil drains shall be as given in "Excavation and Backfilling for Structures" (see Section C.6). It will also include full compensation for removing and spoiling all unwanted excavation.

5.3 Filter Material

The rate for each cubic metre of filter material will include supply on site, handling, transport and placing.

5.4 Pipes For Subsoil Drains

The rate paid for each linear metre of pipe will include full compensation for supply on site, handling, transport and laying complete with No- fines concrete plug at the outlets.

5.5 Anti-erosion Works

Payment for the construction of anti-erosion works will be as plant hire and daywork only when payment by unit is not possible.

5.6 Paving to Drains

The rate for each square metre of paved drain will include full compensation for preparing the bed, supplying and placing the material, finishing true to line and grade, filling spaces and any incidental work.

5.7 Grouting of Paved Drains

The rate for grouting each square metre of paved drain will include full compensation for supplying and placing all materials and any incidental work.

5.8 Cement Stabilised Paved Drains

The rate for each cubic metre of material placed will include full compensation for the supply of cement, the excavation of the in situ material, the mixing and placing of the soil-cement mixture true to line and grade, and for all work incidental and necessary thereto.

SECTION NO. R.10 SEMI-CONTROLLED COMPACTION

1. DESCRIPTION

- 1.1 Semi-controlled compaction is the process whereby the material making the road structure is compacted uniformly by mechanical means to a specified density.
- 1.2 Uniformity of density is to be achieved even though high density may not be specified.
- 1.3 Material in the fill slopes must be given the same degree of compaction as the fill under the carriageway.
- 1.4 Embankments and fills will be compacted to the full width of the road as specified. It will be necessary to place fill to a greater width than that shown on the drawings to ensure adequate compaction of the fill slopes. Such additional material will be trimmed off and used elsewhere in the earthworks and not wasted. No payment will be made for the extra work required for this operation.
- 1.5 For 7 on 7 roads (viz 7 metre surfacing on a 7 metre formation width) it will be necessary to compact an additional 150mm on either side of the embankment width for the layer in question to ensure compaction to the full width of the layers. The additional compaction and material shall not be paid for separately and shall be allowed for in the rates. Such additional material shall not be removed but shall be trimmed to shape with tolerance to slope and drain width as determined by the Engineer.
- 1.6 Fill shall be compacted at a moisture content at which it is possible to achieve the density specified. Where water is applied to the fill the material will be thoroughly mixed to achieve a uniform moisture content.
- 1.7 All embankments shall be compacted to a relative density of LS = 89% Mod. AASHTO by the method outlined in this section.

2. DESCRIPTION OF THE WORK

- 2.1 Semi-controlled compaction involves the use of compaction equipment such as vibratory, pneumatic, grid or flat rollers. The Engineer may specify the use of a single axle pneumatic roller in the 30-50 tonnes range.

Watering and rolling will be continued until the Engineer is satisfied that the required density has been obtained. The Contractor shall facilitate the testing of the compacted fill and shall have no claim against the Government for any delay due to density testing.

- 2.2 Testing will be as specified in "Controlled Compaction" (see Clause 2.3 of Section R.11).

3. MEASUREMENT AND PAYMENT

- 3.1 Semi-controlled Compaction

No separate measurement will be made for semi-controlled compaction.

- 3.2 Watering

Watering will be measured by the cubic metre of water applied. Each unit will be paid or at the appropriate rate quoted in the Bill of Approximate Quantities. This price will include full compensation for the provision, pumping and distribution of the water and for hauling. The Engineer retains the right to curtail wasteful watering of material.

- 3.3 Overhaul of Water

Overhaul will be measured and paid for as given in "Haul and Overhaul" (see Section C.7).

- 3.4 Rolling

No separate measurement will be made for the use of compaction equipment. The cost of this work will be covered under other priced items.

4. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. R.11 CONTROLLED COMPACTION

1. DEFINITION

Controlled compaction is the process whereby material is compacted to specified densities by the combined process of watering, mixing and rolling carried out with mechanical compaction equipment.

2. DESCRIPTION OF WORK

2.1 Spreading, Watering and Mixing

2.1.1 Materials shall be dumped and spread in loose layers so as to achieve the compacted width and thickness specified. The Contractor shall avoid any undue and unnecessary waste of the pavement materials.

2.1.2 For 7 on 7 road (viz 7 metre surfacing on a 7 metre formation width) it will be necessary to compact an additional 150mm on either side of the width specified for the layer in question to ensure compaction to the full width of the layers. The additional compaction and material shall not be paid for separately and shall be allowed for in the rates. Such additional material shall not be removed but shall be trimmed to shape with tolerances to slope and drain width as determined by the Engineer.

2.1.3 Material which is oversize and would produce a rough surface after compaction may at the discretion of the Engineer be rejected from the layer or be reduced to acceptable dimensions by knapping. After knapping the material shall be thoroughly mixed.

2.1.4 Water shall be added as necessary to achieve and maintain the optimum moisture content. The material shall be further mixed to achieve uniformity of distribution of moisture throughout the layer.

2.1.5 When the material has been thoroughly mixed it shall be spread to give the required thickness.

2.1.6 Mixing of material from more than one source of supply shall be carried out in the proportions and by a method approved by the Engineer.

2.2 Compaction

- 2.2.1 Immediately after the final spreading of each layer the material shall be compacted by means of rollers over the full width. Rolling shall progress gradually from the sides towards the centre of the road and parallel to the centreline of the road.
- 2.2.2 If any defects such as irregularities of shape or texture, laminations or lack of density should develop, they shall be corrected to the satisfaction of the Engineer.
- 2.2.3 During the progress of the work a minimum of six field density test holes shall be made at locations selected at random as being typical of the length and width of the area under test.
- 2.2.4 If any tests show that the compaction of a layer is not as specified, the Contractor shall take whatever steps are necessary to ensure that the required density is achieved.
- 2.2.5 The Contractor shall have no claim against the Government for any delay due to testing.

2.3 Testing

The testing of all compacted layers will be undertaken in accordance with the relevant Standard of the Standards Association of Zimbabwe and internal Ministry test procedures.

2.4 Acceptance Criteria

The rate of testing any compacted layer will be a minimum of 6 density tests for each 3 000 square metres of compaction or part thereof in any day's work.

Compliance with the density specification requirements will be judged on the basis of the statistical quality control acceptance scheme outlined in "Statistical Control" (see Section C.13).

3. MEASUREMENT

3.1 Controlled compaction of Subgrade and Pavement

The unit of measurement is the cubic metre of material measured on the road after compaction. The thickness measured is that specified on the Drawings or ordered by the Engineer.

3.2 Rejected Material

Material rejected shall be measured in cubic metres.

3.3 Knapped Material

There shall be no measurement of knapping oversize material

3.4 Watering

3.4.1 The Engineer will determine the laboratory optimum moisture content of each type of material, and its actual moisture content before watering for compaction.

3.4.2 The difference between the two moisture contents will be used to determine the theoretical quantity of water required for compaction, and this quantity will be measured and paid for irrespective of the actual quantity used.

3.5 Overhaul of Water and Rejected Material

Overhaul will be measured as given in "Haul and Overhaul" (see Section C.7).

4. PAYMENT

4.1 Controlled Compaction

The rate for the controlled compaction of each cubic metre of material will include full compensation for all labour, plant and equipment for scarifying, mixing, shaping and compacting in accordance with this specification.

4.2 Rejected Material

The rate per cubic metre of rejected material shall include full compensation for work necessary and incidental to discarding the material from the pavement, loading and hauling within the free haul distance to a dumping site approved by the Engineer.

4.3 Knapped Material

Payment for the operation of knapping oversize material shall be paid at plant hire and daywork rates.

4.4 Water

4.4.1 Water shall be paid for in units of cubic metres. The price will include full compensation for the provision, pumping, hauling and application of the water.

4.4.2 Payment will only be made for the calculated theoretical quantity of water. No extra water added will be paid for.

4.5 Overhaul of Water and Rejected Material

Overhaul of water and rejected material in cubic metre-kilometre units will be paid for as given in "Haul and Overhaul". (See Section C.7).

5. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. R.12
STABILISATION WITH LIME OR CEMENT

1. DESCRIPTION

Stabilisation of pavement and subgrade materials with lime and/or cement is the mixing of lime or cement with them to improve their quality.

Alternative stabilising agents may be used subject to the approval of the Engineer.

2. MATERIALS

2.1 Lime

Lime for stabilisation will be hydrated lime complying with the latest S.A.Z.S. No. A19. Any variation must be authorized in writing by the Engineer.

2.2 Cement

Cement for stabilisation will normally be Portland Blast Furnace Cement, but the use of other cement types may be directed or authorized by the Engineer in writing. All cement used shall comply with the latest S.A.Z.S. No. A46.

3. CONSTRUCTION

3.1 The material to be stabilised shall be spread, mixed and shaped before the distribution by approved means of the specific quantity of dry powdered stabiliser over the prepared layer.

3.2 The stabiliser shall be uniformly mixed with the natural material to the depth and width specified.

3.3 Water shall be added to the mixture to achieve optimum moisture content and thoroughly mixed.

3.4 Where the pavement material has a high plasticity the Engineer may direct that following the preparation of the layer and the mixing of the stabiliser, usually lime, as given in clauses 3.1 to 3.3., the prepared layer shall be allowed to stand for a period of 24 hours before the compaction process takes place. In this case the mixed layer shall be shaped and sealed by giving two passes with the pneumatic tyred roller.

3.5 Compaction shall be carried out as given in "Controlled Compaction" (see Section R.11).

- 3.6 Where the stabilising agent is cement all compaction and finishing shall be completed within six hours of the commencement of hydration of the cement.
- 3.7 Where the stabilising agent is lime all compaction and finishing shall be completed within 48 hours of the addition of lime.
- 3.8 On completion of compaction of the stabilised layer the surface shall be kept damp for a period of five days by the regular application of water.
 - (i) Lower pavement layers shall be covered by the next layer of spread material immediately after the five-day curing period.
 - (ii) Base pavement layers shall be kept damp until sealed as given in "Prime Coat" (see Section R.16). The prime coat shall be applied not sooner than 24 hours nor later than seven days following the curing process.
- 3.9 Construction traffic, except that essential for curing the layer, shall not travel on any stabilised layer within five days of completing compaction. No traffic shall be allowed on the uppermost stabilised base layer until it has been surfaced except necessary construction traffic.
- 3.10 The Engineer may direct that the Contractor shall make good any stabilised section which fails in either density or tolerance by re-working that section with the addition of a quantity of fresh stabiliser being not less than 50 percent of the quantity originally specified.
- 3.11 The Contractor shall have no claim against the Government for any delay due to testing.

4. MEASUREMENT AND PAYMENT

Measurement and payment will be as given in the Sections dealing with the construction layers being stabilised.

SECTION NO. R.13 GRAVEL CRUSHING

1. DESCRIPTION

This specification covers the loading of gravel from stockpile, hauling to crusher, crushing, hauling and re-stockpiling the crushed gravel.

2. PROGRAMME

The Contractor shall maintain an average output of sufficient material throughout the period of the contract to ensure completion by due date.

3. CRUSHING PLANT

3.1 The plant shall consist of a portable crushing and screening combination capable of providing the required output.

3.2 The crushing and screening shall be a continuous process providing a uniform product without segregation.

4. STOCKPILING

The gravel to be crushed will have been stockpiled. The Contractor shall only use such portions of the stockpiles as directed by the Engineer.

5. FEEDING, CRUSHING AND STOCKPILING

5.1 The gravel shall be fed through the crushing plant and loaded directly into tippers, or other hauling plant, hauled and off-loaded into stockpiles as directed by the Engineer. Alternative methods of stockpiling and hauling the crushed gravel will be considered by the Engineer.

5.2 All the crushed gravel shall be passed through a 25 mm square mesh screen which shall be erected at the point of discharge from the crusher.

5.3 Oversized material retained on the final 25 mm screen shall be returned to the crusher unit in a continuous process for re-crushing.

5.4 If the Contractor screens out the minus 25 mm material it is to be recombined with the crushed materials in the same proportions and in a continuous process; all the combined materials passing the 25 mm mesh screen. The combined materials shall then be discharged directly into hauling plant.

5.5 Segregation of the gravel during stockpiling shall be avoided.

5.6 The stockpiles of crushed gravel shall be sited and shaped as directed by the Engineer. They will generally be rectangular in plan with the tops levelled off to facilitate measurement, having a minimum height of two metres and a maximum of 3 metres.

5.7 Once gravel has been placed in stockpile it shall only be removed on instructions from the Engineer.

6. MEASUREMENT

6.1 Clearing

Clearing the site for stockpile areas will be by plant hire and daywork.

6.2 Crushing and Re-stockpiling

The unit of measurement shall be the cubic metre of crushed material in stockpile.

7. PAYMENT

7.1 Stockpile Sites

Payment for clearing sites for stockpiling crushed gravel shall be paid for as plant hire and daywork.

7.2 Crushing and Re-stockpiling

The price per cubic metre measured shall include full compensation for all operations involved in feeding, crushing, screening, loading, hauling and re-stockpiling of gravel, and for all work incidental and necessary thereto.

SECTION NO. R.14
THE SUPPLY OF MATERIALS FOR USE IN THE
CONSTRUCTION OF THE PAVEMENT

1. DESCRIPTION

1.1 Definition of Pavement

The pavement is that part of the road structure above the subgrade. It comprises selected materials which may be required to be placed in specified thicknesses and positions within the pavement structure.

1.2 General

1.2.1 The work covered by the section consists of providing access to deposits of selected materials, clearing all growth and over burden from the deposits and the stockpiling of selected material.

1.2.2 The sites are listed in the Schedule of Gravel Areas and are shown on the Site Plan. The information provided may, however, be modified by the Engineer.

1.2.3 Stockpiling of the materials for the pavement shall be completed at least three months before being placed on the road, unless otherwise authorised by the Engineer.

1.3 Access Roads

Suitable access roads shall be constructed to the material deposits and water points on a route and alignment and to a specification approved by the Engineer in writing. Should sections of these roads fall on Public roads, the Engineer reserves the right to indicate the level of maintenance on these sections.

1.4 Clearing the area of the deposit and removal of overburden.

1.4.1 The area to be cleared at each deposit will be indicated on the site to the Contractor by the Engineer.

1.4.2 The Contractor shall clear the area of all timber, brush, grass, roots, debris and other material.

1.4.3 The timber cleared shall be corded immediately adjacent to the cleared area.

1.4.4 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All brush, grass, etc., not required by the landowner shall be burned in the centre of the cleared area or at any other location agreed to or directed by the Engineer.

1.4.5 The overburden shall be placed outside the perimeter of the deposit in stockpiles in such a way as to permit adequate drainage through the area of deposit.

1.5 Stockpiling of Material

1.5.1 The information given to the Contractor on the availability of the material in the deposits has been obtained from investigations at selected points.

1.5.2 The Contractor must take such measures as he considers necessary to satisfy himself that suitable material exists and can be won.

1.5.3 All stockpiles shall be the size and shape required by the Engineer (generally rectangular and of a uniform height of not more than 3 metres and volume not exceeding 4000/m³). When stockpiling no material of inferior quality shall be incorporated and the Engineer will take tests to determine that all material is suitable for the purpose for which it was intended. If it is found to be unsuitable, it may be used for other purposes determined by the Engineer and notified in writing to the Contractor, or, it may be rejected.

1.5.4 The Contractor will be expected to carry out the mechanical operations normally associated with the winning of gravel, and this is to include ripping. Where other methods are required or proposed they are to be approved by the Engineer.

1.6 Rehabilitation of the Deposit Area

1.6.1 After removal of the material for use in the road the working area must be reinstated so that it will not prove a hazard to man or beast, or a source of erosion. The sides of the excavation must be sloped and the overburden and topsoil previously removed before stockpiling the gravel, must be replaced over the entire area in order to assist in re-establishing grass cover.

- 1.6.2 All access roads to deposit areas, constructed by the Contractor must, after removal of the material for road purposes has been completed, be reinstated. They must be ripped, and an attempt made to restore the land to its original condition by flattening all windrows left along the side of the road and where necessary anti-erosion measures must be taken.
- 1.6.3 The rehabilitation of both gravel areas and access roads must be carried out to the satisfaction of the Engineer.

2. MEASUREMENT

2.1 Access Roads

The construction, maintenance and rehabilitation of approved access roads will be measured by the hectare of road constructed as approved by the Engineer.

2.2 Clearing and Rehabilitation of Deposit Areas

The unit of measurement is the hectare of area cleared. No measurement will be made outside the limits of the area defined to the Contractor by the Engineer.

2.3 Removal of Overburden

The unit of measurement is the cubic metre of overburden measured before excavation.

2.4 Stockpiling

The unit of measurement of stockpile material will be the cubic metre of material measured in completed stockpiles. There shall be no measurement whatsoever of material rejected by the Engineer.

2.5 There shall be no measurement of material ripped.

3. PAYMENT

3.1 Access Roads

The rate per hectare for the construction, maintenance and rehabilitation of access roads will include full compensation for all incidental and necessary thereto.

3.2 Clearing and Rehabilitation of Deposit Areas

The rate per hectare will include full compensation for clearing and rehabilitation of the defined area as specified and all work involved in stacking of timber and the burning of other material not required.

3.3 Removal of Overburden

The rate per cubic metre of overburden will include full compensation for all work involved in removing the overburden to the perimeter of the area and for all work incidental and necessary thereto.

3.4 Stockpiling

The rate per cubic metre of material stockpiled shall include full compensation for all work involved in excavation and placing material in stockpiles and all work involved in shaping and tidying stockpiles to the requirements of the Engineer. There shall be no payment for material stockpiled but rejected by the Engineer.

SECTION R.15 CONSTRUCTION OF THE PAVEMENT

1. DESCRIPTION OF THE WORK

This section deals with the loading from stockpile, hauling and placing of one or more layers of the selected material comprising the pavement on the road in its natural, crushed or stabilised state, and control compacting the material to the density specified on the drawings or as required by the Engineer.

2. MATERIAL

2.1 All materials used for the pavement will conform to the latest relevant standards and must be approved by the Engineer.

2.2 Stockpiling of the materials for the pavement shall be completed at least three months before being placed on the road, unless otherwise authorised by the Engineer.

2.3 Stabilising agents will conform to the requirements given in "Stabilisation with Lime or Cement" (see Section R.12) and they shall be used as specified on the drawings and as directed by the Engineer.

3. CONSTRUCTION

3.1 Location of Work

The Engineer may decide where and when the Contractor shall proceed with any of the layers comprising the pavement.

3.2 Provision of Materials in Pavement

All material shall be loaded from previously prepared stockpiles as given in "The Supply of Materials for Use in the Construction of the Pavement", unless the Engineer directs otherwise.

The Contractor shall avoid any undue and unnecessary waste of the pavement materials. Any materials in excess of 5% of the compacted volume specified by the Engineer which has been left in windrows shall be recovered for reuse at no extra cost to Government failing which the Contractor shall be required to fully compensate Government for such wastage.

3.3 Restoration of the Dumping Surface

Any deterioration of the surface of the underlying layer by construction traffic shall be restored in every way to the satisfaction of the Engineer before any pavement layer is placed on it.

3.4 Spreading, Watering, Mixing and Compacting

These operations shall be undertaken as described in "Controlled Compaction". (See Section R.11).

3.5 Rejected Material

Rejected material shall be handled as given in "Controlled Compaction". (See Section R.11).

3.6 Knapped Material

Knapped material shall be handled as given in "Controlled Compaction". (See Section R.11).

3.7 Stabilisation

3.7.1 Where indicated on the Drawings, or directed by the Engineer, any layer of the Pavement shall be stabilised with lime or cement as specified in "Stabilisation with Lime or Cement" (See Section R.12)

3.7.2 Stabilised gravel shall be compacted to the full width of the layer being processed. No longitudinal construction joints will be accepted.

3.7.3 The physical amount of stabilising agent to be added to the gravel will be specified by the Engineer. The stabilising agent shall be spread uniformly over the prepared gravel by approved means.

3.7.4 Sixteen random samples shall be taken of the upper half of the layer and sixteen random samples of the lower half of the layer of the compacted stabilised gravel and the stabilising agent content determined for each sample. The coefficient of variation for the samples in the upper half shall not be greater than 25% and for the lower layer not greater than 35%.

3.7.5 Transverse joints shall be given special attention and will require ripping into adjacent compacted layers. The additional cement required at the transverse joints will be paid for but no payment shall be made for the additional compaction required at the transverse joints which shall be constructed to the Engineer's satisfaction.

3.7.6 Time limits for stabilised compaction using lime or cement will be as given in "Stabilisation with Lime or Cement" (see Section R.12).

3.7.7 Layers of Gravel requiring stabilisation with:-

- a. Cement -The Contractor shall use fresh cement. However stock 1 to 2 months of age may be used provided the cement content is increased by 12% at no extra cost to Government.
- b. Lime - Hydrated Lime complying with S.A.Z.S. A.19 shall be used. Stocks over 6 months of age should be tested before use. Ministry of Transport will carry out these tests free of charge.
- c. Other Stabilising Agents - As instructed by the Engineer.

3.7.8 Stabilised layers shall be cured as given in "Stabilisation with Lime or Cement". (See Section R.12).

3.8 Finish of the Pavement Layers and Allowable Variations

3.8.1 General

Each layer shall be within the tolerances given below and to the lines, grades, cross-sections and dimensions shown on the Drawings. All tolerances specified are subject to the finished layer being free from rutting and/or depressions which may hold water and from any compaction layering caused by bad grading techniques.

The surface texture of the Base 1 layer shall be approved by the Engineer who may direct special techniques to be followed to achieve an acceptable surface finish.

For 7 on 7 roads (viz 7 metre surfacing on a 7 metre formation width), it will be necessary to compact an additional 150mm on each side of the width specified to ensure compaction to the full width of the layers. The additional compaction shall not be paid for separately and shall be allowed for in the rates for base compaction. Such additional material shall not be removed but shall be trimmed to shape with tolerances to slope and drain width as determined by the Engineer.

3.8.2 Tolerances

The allowable tolerances for the various layers of the pavement shall be according to the table on the following page:

	BASE I	BASE II	BASE III	BASE IV	S.G.
(a) The compacted thickness may vary from the specified thickness by not more than	+20mm -15mm	+20mm -20mm	+20mm -20mm	+20mm -20mm	N.A.
(b) The level of any point on the finished surface may vary from the level as given or calculated from the details given on the drawings by no more than	+/-20mm	+/-20mm	+/-20mm	+/-20mm	+/-20mm
(c) The maximum gap between the finished surface and a straight edge when placed on or parallel to the road centre-line shall be for:					
i) a 3 metre straight edge	10mm	12mm	14mm	16mm	16mm
ii) a 1 metre straight edge	7mm	9mm	10mm	12mm	12mm

3.9 Use of Pavement by Traffic

Traffic shall not use any layer of the pavement except on the Engineer's written authority, which will only be given when, because of weather or other conditions outside the control of the Contractor, it is not possible to maintain the detour in a satisfactory condition. In such cases the Contractor shall make good any damage and shall restore the pavement layer to its original line, shape, level, thickness and density to the satisfaction of the Engineer.

4. MEASUREMENT

4.1 Pavement Material

4.1.1 The unit of measurement is the cubic metre of material measured on the road after compaction; thickness being that specified on the Drawings or by the Engineer.

4.1.1.1 No adjustments in the quantity will be made for densities higher than those specified. Any pavement layer constructed outside the limits and tolerances specified will not be measured.

4.1.2 There will be separate measurement for each pavement layer constructed from materials stockpiled as given in "Supply of Materials for Use in the Construction of the Pavement".

4.1.3 In each case unstabilised material and material stabilised with lime, cement or any other specified stabilising agent will be measured separately.

4.1.4 Oversize material rejected from the pavement layers shall be measured as given in "Controlled Compaction". (See Section R.11).

4.1.5 Knapped material shall be measured as given in "Controlled Compaction". (See Section R.11).

4.2 Stabilising Agent

The unit of measurement of the stabilising agent is the tonne.

4.3 Overhaul

The unit of measurement for overhaul of pavement and reject materials is the cubic metre-kilometre calculated as given in "Haul and Overhaul". There is no measurement of overhaul for the stabilising agent.

5. PAYMENT

5.1 Pavement Material

5.1.1 Separate rates will be paid for constructed pavement as detailed in paragraphs 4.1.2 and 4.1.3.

5.1.2 The rates will include full compensation for all the work, given in "Controlled Compaction", (see Section R.11), and for the preparation of the surface of the underlying layer, the supply, loading of the material, transporting, off loading and spreading of the materials, and finishing of

the layer as specified and including all necessary for the compaction of the additional width as outlined in paragraph 3.8.1. The rates will cover labour, plant, materials, etc., and the restoration of the underlying layer as detailed in paragraph 3.3.

5.1.3 Payment for removal of oversize material from the pavement plus the loading and removing to an approved dumping site shall be as given in "Controlled Compaction". (See Section R.11).

5.1.4 Knapped Material

Payment for knapping oversize material shall be as given in "Controlled Compaction". (See Section R.11).

5.2 Stabilised Pavement

Separate rates will be paid for stabilising the pavement layers constructed from each of the different classes of selected materials set out in paragraph 1 and will include full compensation for the offloading, spreading and any other additional work or operation necessitated by the addition of the stabilising agent.

5.3 Stabilising Agent

The rate for each tonne of stabilising agent will include full compensation for the supply and transport of the agent to the point of application.

5.4 Overhaul

5.4.1 Payment for overhaul will be as given in "Haul and Overhaul".

5.4.2 There will be no payment for overhaul of the stabilising agents.

5.5 Restoration of the Pavement

Payment for the restoration of the Pavement, where it has been used by traffic on the authority of the Engineer, as detailed in paragraph 3.9, will be as plant hire and daywork.

SECTION NO. R.16 PRIME COAT

1. DESCRIPTION

This work consists of providing and applying bituminous material on a prepared base in accordance with the specifications and to the width shown on the Drawings or as directed by the Engineer.

2. MATERIALS

2.1 Bitumen

Bitumen prime will be medium curing cutback bitumen grade M.C. 30 conforming to the latest S.A.Z.S. No. 145.

2.2 Tar

Tar prime will be refined tar having an equiviscous temperature of between 5°C and 9°C and conforming to the latest S.A.Z.S. No. 105.

2.3 Samples

The Contractor shall supply the Engineer, free of charge, with samples of materials intended for use.

3. CONSTRUCTION

3.1 Location of the Work

The Engineer may decide where and when the Contractor shall proceed with the application of the prime.

3.2 Weather Limitations

Prime will not be applied -

- (a) when the air (shade) temperature is -
 - (i) rising and less than 18°C;
 - (ii) falling and less than 21°C;
- (b) during wet or foggy weather.

3.3 Equipment

3.3.1 Distributors must comply with the latest B.S. 1707 for mobile tank spraying units. They must -

- (a) be pressure fed, closed tank type;
- (b) have a capacity greater than 3 000 litres;
- (c) be fitted with hand-spray apparatus;
- (d) be capable of spraying a minimum width of 3,75m.

3.3.2 The Contractor shall deliver his distributors for testing by the Engineer before the commencement of the contract, and at such other times during the period of the contract as the Engineer may require. All costs connected with such testings will be borne by the Contractor.

3.3.3 The fact that such tests have been carried out satisfactorily will not absolve the Contractor from his responsibilities of ensuring that applications of prime comply with specifications.

3.4 Cleaning Surface

3.4.1 Immediately before the prime is applied all loose material shall be removed from the surface by power brooms, or other approved means.

3.4.2 If the surface is dry, a light application of water shall be given just before the application of the prime.

3.4.3 The finished surface shall be free from ruts or depressions which may hold water.

3.5 Application of Prime

3.5.1 Prime shall normally be applied by distributor at a rate of 0,80 litres/square metre. The optimum rate of application is the maximum that the base can completely absorb within three days.

3.5.2 Any order for an application rate above or below 0,80 litres per square metre will be given to the Contractor in writing.

3.5.3 The rate of application for the prime shall not vary by more than +/- 0,05 litres per square metre from that specified or authorized by the Engineer.

3.5.4 The temperature of application shall be 30°C to 55°C for M.C. 30 and 50°C to 70°C for tar prime.

3.6 Application of Sand Cover

3.6.1 A sand cover will not be required if the prime is entirely absorbed by the base course.

3.6.2 If the prime has not been absorbed within seven days, the Engineer may order that the Contractor apply sufficient sand cover to blot up the excess.

- 3.6.3 All loose and excess sand must be removed from the primed surface to the satisfaction of the Engineer before further surfacing is constructed.

3.7 Correction of Defects

- 3.7.1 All defects in the prime coat shall be made good to the Engineer's satisfaction.
- 3.7.2 Streaking shall be corrected by hand spray. Depressions, holes or other irregularities shall be filled with suitably graded bituminous concrete as approved by the Engineer and rolled or rammed.
- 3.7.3 The bitumen content and grading of the bituminous concrete must be approved by the Engineer.
- 3.7.4 The aggregate used in the bituminous concrete is normally - 6,7 mm + 1,18 mm crushed stone.

3.8 Use by Traffic

Traffic must not use the primed surface of the road except on the Engineer's written authority which will only be given in emergency.

4. MEASUREMENT

4.1 General

- 4.1.1 Quantities of bituminous material must be recorded separately for every area sprayed.
- 4.1.2 Signed agreement on quantities sprayed must be agreed daily by the Engineer and Contractor.
- 4.1.3 Unless and until agreement is reached work will not proceed.

4.2 Prime

- 4.2.1 The unit of measurement for the primed surface is the litre of prime sprayed.
- 4.2.2 No measurement will be made in respect of bituminous material applied in excess of the widths and tolerances specified.

5. PAYMENT

5.1 The rate for each litre of bituminous material sprayed will include provision for all work incidental and necessary thereto, and full compensation for -

- (a) the supply and application of prime at the rate specified;
- (b) the preparation of the surface including the provision and application of the required quantity of water;
- (c) the setting out of the area to be primed;
- (d) the provision of supervision, labour and equipment necessary for loading, transporting, heating and spraying prime at specified rates and temperatures;
- (e) the correcting of defects in the primed surface.

5.2 Sand Cover

Payment for the application of a sand cover and the subsequent removal of excess sand will be paid for as Dayworks.

5.3 Payment will not be made for any cost accruing to the Contractor as a result of a failure to agree in terms of paragraph 4.1.

5.4 There will be a reduction in the payment for any applications which do not meet specifications as follows:

For up to 3 times the permitted variance only 80% payment will be made;
For more than 3 times the permitted variance only 60% payment will be made.

Irrespective of the above the Engineer reserves the right to direct the Contractor to redo all of the work, at the Contractor's expense, should the specification not be met.

SECTION NO. R.17 SURFACE TREATMENT

1. DESCRIPTION

- 1.1 This work consists of laying a bituminous surface on the primed base, or directly on the base if priming is not called for, or its omission is directed by the Engineer.
- 1.2 The bituminous surfacing consists of one or more separate coats applied as directed by the Engineer.
- 1.3 The widths of the completed surfacing will be as shown on the Drawings or as required by the Engineer.
- 1.4 PVC/Tar or other approved binders may be considered by the Engineer.

2. MATERIALS

- 2.1 Bituminous materials used will be specified by the Engineer but generally will be 150/200 penetration bitumen conforming to the latest S.A.Z.S. No. 144.
- 2.2 Aggregate will be stone from approved sources complying with the latest S.A.Z.S. No. 232.
 - (a) for the tack coat -
 - (i) -19 mm + 13,2 mm;
 - (ii) -13,2 mm + 6,7 mm;
 - (b) for the grit seal -
 - (i) -6,7 mm + 1,18 mm;
 - (ii) coarse, clean river sand approved by the Engineer may be used instead of -6,7 mm + 1,18 mm stone aggregate (in exceptional circumstances only).

2.3 Samples

The Contractor shall supply the Engineer free of charge with samples of materials intended for use.

3. CONSTRUCTION

3.1 Location of the Work

The Engineer may decide where and when the Contractor shall proceed with surface treatment.

3.2 Weather Limitations

Bituminous material will not be applied -

- (a) when the air (shade) temperature is -
 - (i) rising and less than 18°C;
 - (ii) falling and less than 21°C;
- (b) during wet or foggy weather;
- (c) if the surface to be sprayed is wet;
- (d) if in the opinion of the Engineer a rainstorm is imminent.

3.3 Equipment

The Contractor's equipment must include power brooms, boilers for heating bituminous materials, self-propelled pressure distributors, steel-wheeled and pneumatic-tyred rollers, drag-brooms and aggregate spreaders.

3.3.1 Distributors must comply with the latest B.S. 1707 for mobile tank spraying units. They must -

- (a) be pressure-fed, closed tank type;
- (b) have a capacity greater than 3 000 litres;
- (c) be fitted with hand-spray apparatus;
- (d) be capable of spraying a minimum width of 3,75 metres.

3.3.2 The Contractor shall deliver his distributors for testing by the Engineer before the commencement of the contract, and at such other times during the period of the contract as the Engineer may require. All costs connected with such testings will be borne by the Contractor.

3.3.3 The fact that such tests have been carried out satisfactorily will not absolve the Contractor from his responsibility of ensuring that applications of bituminous material comply with specification.

3.3.4 Steel wheel rollers must be of self-propelled tandem type, that transmit through each wheel a pressure of 20-30 kilo Newtons per metre width of wheel. A roller rated at 6-8 tonnes will generally comply with this requirement when unballasted.

3.3.5 Pneumatic tyred rollers shall be self-propelled and of 10 to 15 tonnes mass. They will have two rows of pneumatic tyred wheels so mounted that any gaps between wheels in the front row are covered by a wheel in the rear. The roller shall be capable of producing a working tyre pressure of two to four bars.

3.4 Cleaning of Surface

The Engineer must approve the surface before bituminous material is applied and may direct it to be cleaned by power operated brooms and/or by hand.

3.5 Sequence of Operations

- 3.5.1 Immediately after the application of bituminous material for the tack coat to the width of the carriageway the aggregate for the tack coat shall be spread, rolled and broomed. All excess tack stone shall be removed to the satisfaction of the Engineer, leaving a single layer of stone only.
- 3.5.2 The bituminous material for the grit seal shall be applied on top of the prepared tack coat and the primed shoulders after which the aggregate for the grit seal shall be spread, broomed and rolled.

3.6 Application of Bituminous Material

- 3.6.1 The application of bituminous material shall be at the rates specified by the Engineer; the following table provides an indication of the general requirements:

Traffic vehicles per day per lane	Total rate both layers	Binder application rate for two coat surface treatment (litres per square metre, hot)	
		Tack coat	Seal coat
19 mm stone			
Under 125	2,89	1,56	1,33
125-500	2,72	1,47	1,25
500-1 000	2,45	1,32	1,13
13 mm stone			
Under 125	1,95	1,05	0,90
125-500	1,66	0,89	0,77
500-1 000	13 mm stone not permitted		

- 3.6.1.1 The seal coat binder application rate shall normally be the difference between the total specified rate and the actual tack coat binder rate obtained.

- 3.6.2 The given quantities are those measured at the temperature of application which will be 150 - 170°C for 150/200 penetration bitumen.
- 3.6.3 The binders shall not be kept at specified temperature for more than three hours before application. Accurate thermometers shall be fitted to the heating and distributing equipment.
- 3.6.4 No bituminous material shall be applied until enough aggregate to cover it is available at the site of the spraying.
- 3.6.5 Bituminous material shall be applied uniformly over the area treated and applications shall not overlap.
- 3.6.6 The rate of application may not vary by more than +/- 0.05 litres per square metre from that specified or authorized by the Engineer.
- 3.6.7 If the rate of application achieved is outside specification the Engineer may direct that corrective measures be taken before further applications are carried out. This will be at the Contractors expense.
- 3.6.8 Each run must start and end on a mask to ensure clean transverse joints and the edge of the surfacing must be quite clean.

3.7 Application of Aggregate

- 3.7.1 The aggregate for any coat must be spread, by mechanical means, to cover the bituminous material with an even layer one stone thick immediately behind the spraying. The application of aggregate shall be at the rates specified by the Engineer. These will approximate to -
 - (a) 13,0 x 10⁻³ cubic metres per square metre where nominal 19 mm stone is used for the tack coat;
 - (b) 9,0 x 10⁻³ cubic metres per square metre where nominal 13 mm stone is used for the tack coat;
 - (c) 7,0 x 10⁻³ cubic metres per square metre where nominal 7 mm stone is used for the grit seal;
 - (d) 5 x 10⁻³ cubic metres per square metre where sand is used for the grit seal.

3.7.2 The application rate of the aggregate shall not vary from that specified or authorized by the Engineer by more than $2,0 \times 10^{-3}$ cubic metres per square metre for the tack coat and $1,0 \times 10^{-3}$ cubic metres per square metre for the grit seal.

3.7.3 The aggregate shall be dry and free from dust before it is spread.

3.8 Rolling

3.8.1 Rolling of each coat shall begin as soon as the aggregate has been spread. It will continue until the aggregate is uniformly and thoroughly bonded over the full width of the sprayed area.

3.8.2 The tack coat may be given one or two passes of a steel wheeled tandem roller of maximum mass of eight tonnes. It is obligatory that four covering passes of a pneumatic tyred roller as specified in clause 3.3.2.1 shall be given.

3.8.3 The grit seal will be given a minimum of four covering passes of a pneumatic tyred roller.

3.8.4 For the purpose of this section, one pass of a roller in relation to any point on the surface means one movement of the roller over that point.

3.9 Brooming

3.9.1 The Engineer may require the tack coat to be broomed with a drag broom, after the first pass of the steel wheel roller. The brooming must not disturb the aggregate adhering to the bituminous material.

3.9.2 For the first two weeks after the road is opened to traffic, loose grit aggregate disturbed or displaced by traffic shall be respread evenly over the road surface and rolled in with a pneumatic roller.

3.10 Opening to Traffic

3.10.1 Normally the tack coat will not be used by traffic.

3.10.2 Under special circumstances traffic may be permitted to use the completed surface immediately after specified rolling but its speed must be controlled for one week by means acceptable to the Engineer.

3.11 Finish of the Completed Bituminous Surface

The finished surface shall be free from rutting or any irregularities which may hold water.

4. MEASUREMENT

4.1 General

4.1.1 Quantities and application rates for bituminous material and aggregates used must be recorded separately for every area surfaced.

4.1.2 Signed agreement on quantities must be agreed daily by the Engineer and Contractor.

4.1.3 Unless and until agreement is reached, work will not proceed.

4.2 Completed Bituminous Surfacing

4.2.1 The unit of measurement is the square metre of bituminous surfacing completed.

4.2.2 No surfacing outside the limits shown on the Drawings or required by the Engineer will be measured.

4.3 Bituminous Materials

4.3.1 The unit of measurement for bituminous materials shall be the litre of material sprayed, measured at application temperature.

4.3.2 No measurement shall be made for bituminous materials sprayed in excess of the specified tolerances and widths.

4.4 Stone Aggregate and Sand

4.4.1 There will be no measurement of these materials for payment purposes unless the Engineer directs application in excess of those specified in Clause 3.7.1.

5. PAYMENT

5.1 Bituminous Surfacing

- 5.1.1 The rate for each square metre of bituminous surfacing will include full compensation for -
- (a) all plant, labour and equipment required for cleaning the surface prior to application of the surfacing specified and for all work incidental and necessary thereto;
 - (b) supply, transport (irrespective of haul) and spreading the aggregate at application rates not greater than that specified in Clause 3.7.1. and for all work incidental and necessary thereto;
 - (c) supervision, labour and all processes necessary for completing the bituminous surface.
- 5.1.2 The rate does not include the supply and application of bituminous materials.

5.2 Bituminous Materials

- 5.2.1 The rate per litre of bituminous materials will include full compensation for -
- (a) their supply at site of the works;
 - (b) all plant, equipment and transport (irrespective of haul) necessary for handling, heating and applying them at the specified rates, and for all work incidental and necessary thereto.
- 5.2.2 Payment will not be made for materials applied in excess of the application rates specified or ordered by the Engineer.
- 5.2.3 An adjustment shall be made for binder sprayed at rates below that Specified in Clauses 3.6.1 and 3.6.6 during sealing.
- 5.2.4 Should the overall binder applied (for both tack and seal coats) not be to specification then there will be a reduction in the payment as follows:
- For up to 2 times the permitted variance only 80% payment will be made;
 For more than 2 times the permitted variance only 60% payment will be made.
- Irrespective of the above the Engineer reserves the right to direct the Contractor to redo all of the work, at the Contractor's expense, should the specification not be met.

5.3 Payment will not be made for any cost accruing to the Contractor as a result of a failure to agree in terms of paragraph 4.1.

5.4 Additional Aggregate

The rate per cubic metre for extra stone aggregate or sand directed in terms of paragraph 4.4 will include full compensation for the provision, crushing, loading, transport (irrespective of haul), off-loading and the spreading of the material in place where required for all work incidental and necessary thereto. Payment will only be made for additional aggregate ordered in writing by the Engineer.

5.5 Aggregate for Correcting Defects

No payment will be made for aggregate used for correcting defects.

SECTION NO. R.18 RESEALING

1. DESCRIPTION

- 1.1 This work consists of laying a bituminous surface on an existing surface.
- 1.2 The bituminous surface generally consists of a single coat applied as directed by the Engineer.
- 1.3 The width of the reseal is dependent on the existing surface being sealed.
- 1.4 Repair to potholes plus the taking out of slacks ruts and depressions must first be carried out before applying the seal coat.

2. MATERIALS

- 2.1 Bituminous material used will be specified by the Engineer but generally will be 150/200 penetration bitumen conforming to the latest S.A.Z.S. No. 144 or MC 3000 cut back bitumen as an alternative during periods of low ambient temperatures. PVC/Tar or other approved binders may be considered by the Engineer.
- 2.2 Where a nominal 10 mm or greater size aggregate is used a cationic antistripping agent Polyram L200 will be added to the bitumen.
- 2.3 Aggregate will be stone from approved sources complying with the latest S.A.Z.S. No. 232.
 - 13,2 mm + 6,7 mm
 - or -10,0 mm + 3,35 mm
 - or - 6,7 mm + 2,36 mm
 The Engineer shall direct the size to be used.
- 2.4 Samples

The Contractor shall supply the Engineer free of charge with samples of materials intended for use.

3. CONSTRUCTION

- 3.1 The Engineer may decide where and when the Contractor shall proceed with the reseal.
- 3.2 Weather Limitations

The weather limitations as given in "Surface Treatment" (see Section R.17) shall apply.

3.3 Equipment

Equipment as specified in "Surface Treatment" (see Section R.17) shall apply.

3.4 Preparing Existing Surface

3.4.1 Repair of potholes and taking out of slacks, ruts and depressions over 10 mm and less than 40 mm in depth when measured as outlined in para 3.8.2 c(i) of Section R15 "Construction of the Pavement", shall be carried out using premix as directed by the Engineer. As a general guide premix must not be laid in layers thicker than twice the size of the coarsest aggregate used in the mix. Where the underlying surface is very smooth it is usual to indent it with a pick so as to provide an improved mechanical bond. The outline of the premix patch may be cut with a vertical face or groove to assist in laying a straight tidy edge. A tack coat shall be applied over the full area using bitumen emulsion applied at between 0.5 over 0.8 litres/m². The premix patch shall be compacted with a vibrating plate or roller or as directed by the Engineer.

3.4.2 Repair of serious failures, large potholes and severe slacks greater than 40 mm deep shall be carried out using a cement stabilised gravel patch as directed by the Engineer. As a general guide the operation is carried out as follows:

The surfacing shall be excavated over the whole area of the patch and put separately on one side. Patches should be diamond or rectangular in shape.

In the case of certain slacks the base thus exposed may be sound and need only be trimmed to a flat bed with vertical side walls. In other cases the base shall next be excavated and placed in a separate pile to one side. Excavation shall continue in layers, each extending well in to good material on every side, until a sound foundation material is reached. Excavation shall not exceed 300 mm until consideration is given to drainage. Given satisfactory drainage conditions it should seldom be necessary to excavate down as far as 500 mm to reach a firm foundation. The foundation shall be compacted by a vibrating plate or by hand punner. The surfacing removed from the patch may be placed at the bottom, broken into small pieces and compacted. Good granular base gravel shall be brought in and shall be mixed at visual optimum moisture content with 4% cement (roughly one shovel full of cement to one wheelbarrow load of

gravel). The material shall be placed in the excavation and compacted in 50-80 mm layers using a vibratory plate or hand punners. The surface shall be finished proud of the adjacent road surface by 10mm, primed with bitumen emulsion or MC30 cutback bitumen or TP7 tar prime and sanded over before opening to traffic. After 7 days, or such other period as directed by the Engineer, resealing may commence.

3.4.3 Repair of edges of the mat

In the case of settlement, fretting, ravelling or breaking of the edge of the bituminous surface, care shall be taken to finish off the patch with a neat straight edge or as directed by the Engineer.

3.5 Antistripping Agent

3.5.1 Addition of the antistripping agent Polyram L200 into the bitumen shall be carried out as follows:- The bitumen in the bitumen distributor shall be heated to the spraying temperature and the Polyram L200 then added from the top. For 13 mm nominal size aggregate 0, 4% of the chemical by volume of bitumen shall be added while for 10 mm nominal size aggregate 0.3% is the required concentration.

These figures represent a concentration of antistripping agent of 3.5 kg/tonne of bitumen and 2.6 kg/tonne of bitumen respectively for 13 mm and 10 mm nominal size aggregate. The table below shows examples of the volumes of antistripping agent required for given volumes of bitumen at spraying temperature.

Volume of hot bitumen Litres	Volume of Polyram L200 (litres)	
	10mm aggregate	13mm aggregate
1 000	3.0	4.0
1 500	4.5	6.0
2 000	6.0	8.0
3 000	9.0	12.0
4 000	12.0	16.0
4 500	13.5	18.0
5 000	15.0	20.0
6 000	18.0	24.0
7 000	21.0	28.0
8 000	24.0	32.0
9 000	27.0	36.0
10 000	30.0	40.0

It is recommended that the antistripping agent be measured in a precalibrated plastic container. (A 10-litre or 20-litre container precalibrated at 1 litre intervals using a 1-litre measuring cylinder should be suitable).

3.5.2 Circulation in the bitumen

The antistripping agent shall be allowed to circulate and mix with the bitumen for at least 30 minutes using the pump outfit on the bitumen distributor for this purpose. Normal sealing operations shall then proceed. It shall be noted that the stability of the antistripping agent in bitumen is maintained for at least 72 hours at spraying temperature. If more than 72 hours have passed since addition of the chemical to bitumen fresh antistripping agent shall be added as given in the table (i) above.

3.5.3 Precautions

Antistripping agents are organic amines which are caustic. Goggles, overalls, gloves and other protective clothing shall be worn when handling these chemicals.

3.6 Precoating of aggregate

3.6.1 General

For aggregate of nominal size 10 mm or greater use of an antistripping agent in the bitumen is recommended. However the alternative of precoating the aggregate before use shall be resorted to in exceptional circumstances as directed by the Engineer. The precoating of the stone shall be carried out as directed by the Engineer but will generally be as described below:

3.6.2 Precoating

Precoating can be carried out using concrete mixers. The precoating binders shall be a TP7 tar prime or MC 30 cutback bitumen or bitumen emulsion. The application rate of binder shall be in the range 5 to 10 litres per cubic metre of aggregate depending on the type and size of stone. Initial 80% coverage is adequate and any over application shall be corrected by adding clean dry aggregate to the stockpile. Aggregate shall be precoated 2 to 4 weeks before use to provide time for the volatile components to evaporate.

3.6.3 Protection of precoated stone

The area on which the precoated aggregate is stockpiled shall initially be levelled and compacted, then either treated with prime, covered with metal sheets or reject quality polythene sheeting. The stockpile of precoated aggregate shall also be protected by a covering.

3.7 Sequence of Operations

3.7.1 The bituminous material for the reseal shall be applied on top of the prepared old surface only when approved by the Engineer.

3.7.2 Immediately after the application of the bituminous material for the reseal the aggregate for the reseal coat shall be spread, rolled and broomed. All excess reseal stone shall be removed to the satisfaction of the Engineer, leaving a single layer of stone only.

3.8 Application of the Bituminous Material

3.8.1 The application of bituminous material shall be at the rate specified by the Engineer. The following table provides an indication of the general requirements.

Nominal Aggregate Size (mm)	150/200 bitumen (litre/m ²)	MC 3000 cutback (litre/m ²)
13	1.30-1.50	1.35-1.60
10	1.20-1.40	1.25-1.45
7	1.00-1.20	1.05-1.25

3.8.2 The given quantities are those measured at the temperature of application which will be 150o-170⁰C for 150/200 penetration bitumen.

3.8.3 The binder shall not be kept at specified temperature for more than three hours before application. Accurate thermometers shall be fitted to the heating and distributing equipment.

3.8.4 No bituminous material shall be applied until enough aggregate to cover it is available at the site of the spraying.

3.8.5 Bituminous material shall be applied uniformly over the area treated and applications shall not overlap.

3.8.6 The rate of application may not vary by more than $\pm 0,05$ litre per square metre from that specified or authorised by the Engineer.

3.8.7 Each run must start and end on a mask to ensure clean transverse joints and the edge of the surfacing must be clean.

3.9 Application of Aggregate

3.9.1 The application for the seal coat must be spread by mechanical means, to cover the bituminous material with an even layer one stone thick immediately behind the spraying. The application of the aggregate shall be at the rate specified by the Engineer. This will approximate to -
 8×10^{-3} cubic metres per square metre where nominal 10 mm stone is used for the reseal.

3.9.2 The application rate of the aggregate shall not vary from that specified or authorised by the Engineer by more than $1,0 \times 10^{-3}$ cubic metres per square metre for the reseal coat.

3.9.3 The aggregate shall be dry and free from dust before it is spread.

3.10 Sweeping and Rolling

One pass only of a 6-8 Tonne tandem roller may be made immediately after the aggregate has been laid and then considerable pneumatic rolling by a self-propelled roller shall be carried out. A minimum of four passes is necessary.

In the early morning of the following day, the surface shall be drag-broomed, followed by further pneumatic rolling.

3.11 Traffic Control

Traffic speeds shall be kept low during resealing and for about 3 days thereafter. Traffic shall be encouraged to make use of the full width of the surface.

3.12 Finish of Completed Bituminous Surface

The finished surface shall be free from rutting, or any irregularities which may hold water.

4. MEASUREMENT

4.1 General

- 4.1.1 Quantities and application rates for bituminous material and aggregates used must be recorded separately for every area surfaced.
- 4.1.2 Signed agreement on quantities must be agreed daily by the Engineer and Contractor.
- 4.1.3 Unless and until agreement is reached, work will not proceed.

4.2 Completed Bituminous Surfacing

- 4.2.1 The unit of measurement is the square metre of bituminous surfacing completed.
- 4.2.2 No surfacing outside the limits shown on the Drawings or required by the Engineer will be measured.

4.3 Bituminous Materials

- 4.3.1 The unit of measurement for bituminous materials shall be the litre of material sprayed, measured at application temperature.
- 4.3.2 No measurement shall be made for bituminous materials sprayed in excess of the specified tolerances and widths.

4.4 Stone Aggregate and Sand

- 4.4.1 There will be no measurement of these materials for payment purposes unless the Engineer directs application in excess of those specified in Clause 3.7.1.

5. PAYMENT

5.1 Bituminous Surfacing

- 5.1.1 The rate for each square metre of bituminous surfacing will include full compensation for -
 - (a) all plant, labour and equipment required for the repairing existing surface prior to the application of the reseal and for all work incidental and necessary thereto;

- (b) supply, transport (irrespective of haul) the aggregate at application rates not greater than that specified in Clause 3.9.1 and for all work incidental and necessary thereto;
- (c) supervision, labour and all processes necessary for completing the bituminous surface.

5.1.2 The rate does not include the supply and application of bituminous materials.

5.2 Bituminous Materials

5.2.1 The rate per litre of bituminous materials and antistripping agent (where applicable) will include full compensation for -

- (a) their supply at site of the works;
- (b) all plant, equipment and transport (irrespective of haul) necessary for handling, heating and applying them at the specified rates, and for all work incidental and necessary thereto.

5.2.2 Payment will not be made for materials applied in excess of the application rates specified or ordered by the Engineer.

5.2.3 There will be a reduction in the payment for any applications which do not meet specifications as follows:

For up to 2 times the permitted variance only 80% payment will be made;

For more than 2 times the permitted variance only 60% payment will be made.

Irrespective of the above the Engineer reserves the right to direct the Contractor to redo all of the work, at the Contractor's expense, should the specification not be met.

5.3 Payment will not be made for any cost accruing to the Contractor as a result of a failure to agree in terms of paragraph 4.1.

5.4 Additional Aggregate

The rate per cubic metre for extra stone aggregate or sand directed in terms of paragraph 4.4 will include full compensation for the provision, crushing, loading, transport (irrespective of haul), off-loading and the spreading of the material in place where required and for all work incidental

and necessary thereto. Payment will only be made for additional aggregate ordered in writing by the Engineer.

5.5 Aggregate for Correcting Defects

No payment will be made for aggregate used for correcting defects.

SECTION NO. R.19
EMULSION SLURRY

1. DESCRIPTION

- 1.1 This specification covers the requirements for the supply and laying of a bituminous emulsion slurry, applied directly on to a previously prepared surface which may consist of -
- (a) a primed surface as described in "Prime Coat";
 - (b) a tack coat as described in "Surface Treatment";
 - (c) an old bituminous surface requiring a seal.
- 1.2 The emulsion slurry may be applied in one or two layers. Where the emulsion slurry seal is applied in two layers, the specified rate shall be the total or combined application of the two layers.
- 1.3 The width of the completed surface will be as shown on the Drawings or as directed by the Engineer.

2. MATERIALS

2.1 Binder

The binder shall be a stable slow breaking Class 3 Bitumen Emulsion containing a minimum of 60 percent bitumen and complying with the latest issue of B.S. 434.

2.2 Aggregate

2.2.1 All aggregate shall be from approved sources and complying with the latest S.A.Z.S. No. 232.

2.2.2 The aggregate shall be free of organic matter, clay or other material which would adversely affect the slurry coat.

2.2.3 The aggregate shall be a crusher dust with the grading shown in the following table:

B.S. sieve mm	Percentage passing			
	Coarse	Grading	Fine	Grading
6,7	100	100	-	-
4,75	70	100	100	100
2,36	45	90	80	100
1,18	30	70	55	95
0,60	20	50	35	70
0,30	12	30	20	50
0,15	7	20	10	30
0,075	5	15	5	15

2.2.4 Neither pit sand nor river sand shall be added to the crusher dust to improve the grading.

2.3 Filler

The filler shall consist of 1 percent to 2 percent by mass of the aggregate of Portland Cement.

2.4 Emulsion Slurry

2.4.1 The composition of the slurry shall be as follows:

Materials	Per cent by mass		
Aggregate	82	-	84
Cement	1	-	2
Emulsion	15	-	16

2.4.2 The residual bitumen content shall be between 10,5 and 11,5 percent by mass of the dry aggregate.

2.4.3 The consistency of the emulsion slurry, when measured with the "Colas Viscometer", shall be between six and seven. To obtain the specified consistency approximately 160 litres of water per cubic metre of dry aggregate is required.

2.5 Samples

The Contractor shall supply the Engineer free of charge with samples of materials intended for use.

3. CONSTRUCTION

3.1 Location of the Work

The Engineer may decide where and when the Contractor shall proceed with the Slurry Seal.

3.2 Weather Limitations

Slurry shall not be applied -

- (i) during wet or foggy weather;
- (ii) if the surface is wet;
- (iii) if in the opinion of the Engineer a rainstorm is imminent.

3.3 Application of the Slurry

3.3.1 The emulsion slurry shall be applied in one or two layers at the specified application rate expressed as a rate of spread of the dry aggregate. Where the emulsion slurry is applied in two layers, the specified rate shall be the total or combined application of the two layers.

3.3.2 The application of the emulsion slurry shall be at the rates shown in the table:

Type of surface	Application rate m ³ /m ²
Prime	0,0065 to 0,0055
Existing bituminous surface	0,005 to 0,0045
-13,2 mm + 6,7 mm tack	0,0055 to 0,005
-19,0 mm + 13,2 mm tack	0,007 to 0,0065

3.3.3 Laps of joints shall be minimal, neat and water tight.

3.3.4 Each application of slurry shall be "dragged" with wet hessian to produce a smooth finish.

3.3.5 Areas of excess or deficiency of slurry shall be corrected by hand immediately behind the spreader box.

3.3.6 Where slurry is applied in two layers to a new tack surface the following is specified:

- (a) The first layer of slurry shall be applied sufficiently to fill the voids in the stone layer to leave the tops of the stone particles just visible.
- (b) The second layer shall be applied not less than 24 hours and not more than 72 hours after the first layer has been applied.
- (c) The second layer of emulsion shall be applied so as to ensure that all interstices of the aggregate are completely filled and the slurry after compaction shall be level with the tops of the aggregate.

3.4 Equipment

The equipment shall be an approved self-propelled machine, capable of delivering the requisite materials accurately in pre-determined proportions, of mixing the materials thoroughly into a slurry, and of spreading the slurry at the specified rate on the road surface in a continuous flow.

3.5 Preparation of Surface

3.5.1 The Contractor shall satisfy himself that the road surface has been satisfactorily prepared for the slurry application.

3.5.2 All loose stones and surplus aggregate chips shall be removed by brooming, before application of the slurry.

3.5.3 The road surface shall be cleaned of all soil, mud, animal droppings, twigs, leaves and any other foreign matter likely to adversely affect the adhesion and performance of the slurry coat.

3.5.4 The surface shall be lightly watered immediately ahead of the application of the first application of slurry.

3.6 Curing and Compaction

3.6.1 The slurry shall be allowed to cure for approximately four hours during which time vehicles or pedestrians shall not be allowed on the surface.

3.6.2 As soon as the surface is dry enough for a pneumatic tyred roller to compact the slurry without "picking up", the slurry shall be given a minimum of six passes of a self-propelled pneumatic roller of 12 to 15 tonne mass and tyre pressures of three to four bars.

3.6.3 The first and second application of slurry shall each be compacted with a minimum of six passes of the pneumatic tyred roller.

3.6.4 All loose stone shall be brushed off before the application of the second layer of slurry.

3.7 Finish of the Completed Surface

The finished surface shall be free from rutting or any irregularities which may hold water. The edges shall be trimmed neatly to the correct width specified and all waste material shall be taken away to a waste dump as directed by the Engineer.

4. QUALITY CONTROL

4.1 The Contractor shall provide a fully equipped laboratory with facilities to control the proportions of the slurry mixture at all stages of the work. The Engineer shall have access to the laboratory at all reasonable times for the purpose of checking testing procedure.

4.2 The Contractor shall take and test representative samples of slurry from the spreader box from at least every 20 tonne of dry aggregate mixed or part thereof. A duplicate of each sample so taken shall be submitted to the Engineer.

4.3 The Contractor shall ensure by regular testing and by regular adjustment of the mix proportions if necessary, that the slurry mixture complies with the specification.

4.4 The Contractor shall provide the Engineer with all reasonable facilities to sample the slurry mixture from the spreader box whenever he so requires it.

5. MEASUREMENT

5.1 General

5.1.1 Quantities and application rates for emulsion and aggregates used must be recorded separately for every batch.

5.1.2 The quantities of materials used to manufacture slurry and the measurement of slurry laid shall be recorded, agreed and signed by the Contractor and the Engineer in respect of each batch of slurry mixed and laid.

5.1.3 Unless and until agreement is reached, work will not proceed.

5.2 Completed Slurry Seal

5.2.1 The unit of measurement is the square metre of slurry seal completed.

5.2.2 No surfacing outside the limits shown on the Drawings or required by the Engineer will be measured.

5.3 Emulsion

5.3.1 The emulsion used will be measured at ambient temperature, the unit being the litre.

5.3.2 The quantities of emulsion used shall be recorded separately for each batch.

5.4 Aggregate

The quantities of aggregate used shall be recorded separately for each batch. The unit of measurement is the cubic metre of dry aggregate.

6. PAYMENT

6.1 Slurry Seal

6.1.1 The rate for each square metre of slurry seal completed will include full compensation for -

- (a) all plant, labour and equipment required for the preparation of the road surface prior to application of the slurry as specified and for all work incidental and necessary thereto;
- (b) supply and transport (irrespective of haul) of all materials comprising the slurry and of laying the slurry seal to the specified application rates and of all work incidental and necessary thereto;
- (c) supervision, labour and all processes necessary for completing the slurry seal.

6.1.2 No payment shall be made for slurry laid thicker than that specified.

6.1.3 A proportional reduction in the unit rate will be made in respect of slurry laid thinner than that specified.

Irrespective of the above the Engineer reserves the right to direct the Contractor to redo all of the work, at the Contractor's expense, should the specification not be met.

6.2 Payment will not be made for any cost accruing to the Contractor as a result of failure to agree in terms of paragraph 5.1.

SECTION NO. R.20 BITUMINOUS CONCRETE

1. DESCRIPTION

- 1.1 This specification covers the design, supply and placing of bituminous concrete.
- 1.2 Bituminous concrete is defined as a homogenous mixture of aggregate and bituminous binder. The bituminous binder may consist of either bitumen or tar.
- 1.3 The bituminous concrete may be applied to -
 - (a) a prepared base course which has been primed as given in "Controlled Compaction" and "Prime Coat" (see Sections R.11 and R.16 respectively);
 - (b) an existing bituminous surfacing requiring levelling or strengthening;
 - (c) the decks of a reinforced concrete bridge.
- 1.4 The bituminous concrete shall be laid in conformity with the lines, levels, grades, dimensions and typical cross section shown on the Drawings or as directed by the Engineer.

2. MATERIALS

The Contractor shall be responsible for procuring all materials required for the manufacture of the bituminous concrete and shall, at all times, ensure that these materials comply with the specifications outlined hereunder. Prior to, and during, mixing the Contractor shall permit regular sampling of all materials by the Engineer. This practice in no way removes the responsibility from the Contractor for ensuring that quality control is maintained at all times.

2.1 Bituminous Materials

2.1.1 Bitumen

The bitumen used shall be 60/70 or 80/100 penetration grade conforming to S.A.Z.S. 144 as directed by the Engineer. Other grades may be specified by the Engineer.

2.1.2 Tar

The tar used shall be a Road Tar Type C with an E.V.T. value ranging from 53°C to 57°C and shall comply with S.A.Z.S. 105.

2.1.3 Prime Coat

Where specified the prime coat shall be applied in accordance with "Prime Coat" (see Section R.16).

2.1.4 Tack Coat - Fog-spray

Where specified, the tack coat shall consist of an approved bitumen emulsion complying with the latest issue of B.S. 434.

2.2 Aggregates

2.2.1 Aggregates shall be free from vegetable or organic matter and other deleterious material which could prevent thorough coating by the binder, or adversely affect the strength or durability of the bituminous concrete.

2.2.2 The aggregate shall not be excessively absorbent nor include any soft weathered or decomposed material which would be liable to breakdown under traffic.

2.2.3 The aggregate shall be stored so that it remains clean and free from contamination by deleterious material from any source.

2.2.4 Aggregates shall be stored separately by grading and source. All necessary precautions shall be taken to ensure that graded aggregates do not become segregated.

2.2.5 All aggregates shall be stockpiled to achieve consistency and uniformity in a manner approved by the Engineer. Stockpiles of aggregate shall not exceed 1,5 m in height.

2.2.6 Coarse aggregate, defined as that material retained on the 4,75 mm sieve, shall consist of clean, hard, durable, angular, crushed rock with the following properties -
 (a) 10 percent. Fine Aggregate Crushing Test (10 per cent F.A.C.T.) - not less than 100 KN;
 (b) Flakiness Index - not more than 30 percent.

2.2.7 Fine aggregate, defined as that fraction passing the 4,75 mm sieve, shall consist of approved quarry dust. If sufficient quarry dust is not available, the addition of a small quantity of approved pit sand may be permitted. In extreme circumstances where little or no quarry dust is available the use of naturally occurring sands may be authorized. The fine aggregate shall consist of hard grains and shall be free from decomposed or weathered material, clay and other undesirable material.

2.3 Filler

- 2.3.1 Filler is defined as that portion of the total aggregate mineral matter passing the 75 um sieve, and may include natural dust in the aggregate, approved inert mineral dust and cement.
- 2.3.2 Unless otherwise directed by the Engineer two per cent by mass of the total aggregate will consist of an approved Portland Cement and will be added to the mix separately as part of the filler.
- 2.3.3 Filler shall be thoroughly dry and free from lumps.
- 2.3.4 At least 60 percent by mass of the aggregates shown in the grading specifications in 3.1.1 as passing the 75 um sieve shall be added to the mix separately as filler.

3. BITUMINOUS CONCRETE MIX SPECIFICATION

- 3.1 The following grading specifications and Marshall design criteria shall apply for continuously graded mixes.

3.1.1 Laboratory Design Mix Grading Specifications

B.S. sieve size (mm)	Consolidated thicknesses (mm)			
	40-75	25-50	20-40	10-20
	% Passing	% Passing	% Passing	% Passing
26,5	100			
19,0	80-100	100		
13,2	70- 90	80-100	100	
9,5	62- 82	70- 95	80-100	100
4,75	48- 64	54- 73	60- 80	83-95
2,36	36- 52	40- 56	44- 60	66-86
1,18	27- 39	29- 44	31- 45	48-68
600 um	20- 30	19- 31	20- 32	30-50
300 um	12- 22	12- 22	12- 22	18-36
150 um	7- 16	7- 16	7- 16	11-25
75 um	4- 9	4- 9	4- 9	5-12

Note: The above gradings are a guide only and may be adjusted to provide the required design criteria.

3.1.2 Marshall Design Criteria

Number of compaction blows each end of specimen	Roads		Aerodromes	
	75		75	
	Min.	Max.	Min.	Max.
Flow (mm)	2,0	4,0	2,0	4,0
Air voids (%)	3,0	5,0	2,0	4,0
Immersion index %	75	-	75	-
Film thickness (u) (min.)	5		6	

Maximum aggregate size (mm)	Minimum voids in mineral aggregate (VMA) %
19,0	14,0
13,2	15,0
9,5	16,0

3.1.3 The binder content shall be expressed as a percentage of the total dry aggregate.

3.2 The Tenderer shall use a binder content of 6 percent for the purpose of pricing the Bill of Approximate Quantities for all mixes.

4. MIX DESIGN

4.1 Laboratory Design Mix

4.1.1 The Contractor shall design the mix to comply with the specification given in paragraph 3, and for the purpose of tendering this mix shall be called the "Laboratory Design Mix".

4.1.2 The Contractor shall submit the proposed design, together with 40 kg samples of all aggregates and fillers, and 10 litres of the binder to be used in the mix, to the Engineer for approval before plant mixing takes place.

4.2 Job Standard Mix

- 4.2.1 The Contractor shall produce bituminous concrete complying with the approved "Laboratory Design Mix" using his own mixing plant.
- 4.2.2 The grading and mix proportions may be modified to produce a mix giving acceptable surface finish with satisfactory workability as determined from the laying of a Trial Area as described in paragraph 4.4.
- 4.2.3 All modifications of the "Laboratory Design Mix" shall be called the "Job Standard Mix" which will not be altered without prior approval.

4.3 Plant Mixes

- 4.3.1 Samples of the mix taken from the mixing plant during production will be called "Plant Mixes".
- 4.3.2 The following are the permissible variations of "Plant Mixes" from the "Job Standard Mix":

Sieve size (mm)	Permissible variation (% passing)
26,5 - 4,75	+/- 6,0
2,36	+/- 4,0
600 um	+/- 4,0
75 um	+/- 2,0
Binder content %	+/- 0,6

4.4 Trial Area

The Contractor shall lay a trial area of at least 200 m² immediately prior to commencement of the work for approval by the Engineer. The standards for this trial area shall be those called for in this specification or as offered. If these standards are not met a new trial area shall be ordered and there will be no payment for material already laid. After acceptance of the trial area the standards of the work shall not be lower than those of the trial area.

- 4.5 For any change in the type, nature, source or other variation in the constituents of the mix, the Contractor shall submit a new design mix in accordance with the foregoing paragraphs.

5. EQUIPMENT

5.1 General

All equipment used shall be of adequate rating for the work specified and in good mechanical condition.

5.2 Bitumen Distributor (Sprayer)

Bitumen sprayers shall comply with B.S. 3136. "Cold Emulsion Spraying Machines for Roads."

5.3 Mixing Plant

5.3.1 The mixing plant shall be of an approved type capable of producing designed mixes at the rate which shall be specified.

5.3.2 All weighing or other measuring devices used to proportion the various constituents of the mix shall be checked daily by the Contractor and shall be accurate to +/- 2 percent.

5.3.3 The plant shall be capable of measuring the binder by mass for each batch, or by accurate metering pump.

5.3.4 The plant shall have provision for adding all or part of the filler separately, and efficient means of showing the temperature of the aggregate in the hot bins.

5.4 Spreading Machines

5.4.1 Spreading machines shall be mechanical self-powered pavers of approved type capable of spreading the mix accurately to line, level and grade.

5.4.2 The paver shall lay the mix without segregation, dragging, burning or other surface defects.

5.5 Bitumen Heaters

5.5.1 Bitumen heaters shall be of an approved type efficiently insulated and capable of heating the binder uniformly throughout the tank without overheating and damaging the binder.

5.5.2 The heaters shall be fitted with accurate thermometers positioned to show the maximum temperature of the binder.

- 5.5.3 Sufficient binder shall be stored on site to keep the mixing plant supplied with binder at the correct temperature and operating at full capacity for 10 hours.

5.6 Rollers

- 5.6.1 Steel wheel rollers must be of the self-propelled tandem type in the 8-12 tonne range. The rolling surfacing of the wheels shall be free of indentations and grooves and they shall be fitted with effective scrapers and an efficient means of keeping the wheels moist.

- 5.6.2 Pneumatic tyred rollers shall be self propelled and in the 12-20 tonne range. They shall have two rows of smooth tread pneumatic tyred wheels so mounted that any gap between wheels in the front row is covered by a wheel in the rear. The tyres shall be capable of working to inflation pressures of 5 to 7,5 bars and be fitted with effective scrapers and an efficient means of keeping the wheels moist.

- 5.6.3 Vibratory rollers may not be used without prior approval of the Engineer. This will be dependent upon lift thickness and roller characteristics.

6. MANUFACTURE OF BITUMINOUS CONCRETE

6.1 Sampling

The Contractor shall permit frequent sampling by the Engineer of all materials to be used before, during and after mixing. This practice in no way removes the responsibility from the Contractor for maintaining quality control at all times.

6.2 Mixing Temperature

- 6.2.1 The following are the permissible temperature limits:

Binder	Grade	Max. storage temp. °C	Mixing temp °C		Max. agg. °C temperature
			Min.	Max.	
Bitumen	60/70 Pen	130	140	165	175
	80/100	130	135	165	170
Tar	RT 55C	80	90	100	100

Note: The binder shall not exceed the maximum mixing temperature nor be held at this level for excessive periods before use.

6.2.2 The temperature of the mix on completion of the mixing operation shall be:

Binder	Mix temperature °C	
	Min.	Max.
Bitumen	135	165
Tar	70	90

6.3 Mixing Time

The mixing cycle shall consist of a period of dry mixing followed after the addition of binder by a period of wet mixing. The dry mix time shall be between five and 15 seconds and the wet mix between 30 and 60 seconds. Both the dry and wet mix times shall be the minimum necessary to obtain a uniform and completely coated mix.

7. CONSTRUCTION

7.1 Prime

Where specified the surface shall be primed as given in "Prime Coat".

7.2 Preparation of Surface

Immediately before any bituminous material is applied all loose and foreign material shall be removed from the surface by approved means and to the Engineer's satisfaction. The Engineer may, at his discretion, direct that certain areas be roughened by hand pick marking with approximately 100 indentations/m² with an approved impact head. This will be measured per square metre finished and cleaned as specified before the application of the fog spray.

7.3 Tack Coat - Fog-spray

A tack coat may be required on the prime or existing surface immediately before laying bituminous concrete. This shall be a stable grade bitumen emulsion diluted with water and sprayed to give approximately 0,2 litre/square metre residual bitumen, or as varied by the Engineer.

7.4 Transportation

7.4.1 The mix shall be transported from the mixing plant to site in suitable vehicles and at a delivery rate not less than the production rate specified in terms of paragraph 5 of this Section.

7.4.2 Where necessary the vehicles shall have suitable covers fitted to prevent the mix from losing excessive heat or being damaged by rain.

7.5 Laying

7.5.1 The temperature of the mix on laying shall be not less than 120°C for a mix using bitumen and not less than 70°C for a mix using tar.

7.5.2 The mix shall be laid in the number of lifts or at the spread rates ordered by the Engineer to provide the compacted thickness shown on the drawings or otherwise specified, and true to line, level and grade.

7.5.3 The mix shall be laid without segregation, dragging, burning or other surface defects.

7.5.4 Back casting will not normally be permitted.

7.5.5 The mix shall be laid in the lane order specified or directed by the Engineer.

7.6 Joints

7.6.1 Joints shall be either at right angles to, or parallel with the direction of paving.

7.6.2 All joints between sections shall be cut back to a vertical face, loose material removed and the face painted with a thin coat of bitumen emulsion immediately before the adjacent section is laid.

7.6.3 Transverse and longitudinal joints in succeeding layers shall be offset by at least 200 mm.

7.6.4 Joints shall be accurately constructed so that the surface is uniform and true.

7.6.5 Where a longitudinal lane edge is true to line and the adjacent lane is placed on the same day, the Engineer may omit the treatment given in paragraph 7.6.2 or authorize the use of an approved joint heater as an alternative.

- 7.6.6 The outside edge of a completed layer shall be trimmed to line to give the specified finished width in relation to the carriageway or runway centreline.

7.7 Rolling

- 7.7.1 Each completed layer shall have a relative Compaction of not less than the following percentages of the maximum Marshall density determined for the mix:

Roads	Aerodromes
96%	98%

- 7.7.2 The rolling technique shall be in accordance with current accepted good practice for the rolling of bituminous concrete surfacing with particular attention paid to the correct sequence of rolling edges, and the rolling of joints.
- 7.7.3 The sequence of rollers used shall be at the discretion of the Contractor but the Engineer shall have the right to order any alternative sequence to that used by the Contractor.
- 7.7.4 All necessary steps shall be taken to prevent the adhesion of mix to the roller wheels. The use of additives in systems for moistening roller wheels is subject to approval by the Engineer.
- 7.7.5 The Engineer may order the laying of bituminous concrete to cease if there are insufficient rollers available to compact the layer at the rate at which it is being laid.

8. QUALITY CONTROL

- 8.1 The Contractor shall provide a fully equipped laboratory with facilities to control the proportions of the mix at all stages of the work. The Engineer shall have access to the laboratory at all reasonable times for the purpose of checking testing procedures.
- 8.2 The Contractor shall take and test representative samples from the mixing plant from at least every 100 tonne mixed. A duplicate of each sample so taken shall be submitted to the Engineer.
- 8.3 The Contractor shall ensure by regular testing and by regular adjustment of the mix proportions if necessary that the mix complies with the "Job Standard Mix" tolerances at all times.

- 8.4 At least one density, binder content and grading test shall be carried out by the Contractor on every day's production.

9. TOLERANCES

- 9.1 The bituminous concrete shall conform closely with the lines, grades, cross-sections and dimension shown on the Drawings. Deviations from the Drawings will only be accepted if they are the specified tolerances.
- 9.2 The finished surface shall be free from rutting or any irregularities which may hold water.
- 9.3 The level of any point on the finished surface of the bituminous concrete shall be within 10 mm of the level specified on, or calculated from the Drawings or by the Engineer.
- 9.4 When a 3 metre long straight edge is placed on any part of the surface, so as to be on or parallel to the centreline any gap between the contact edge and the finished surface shall not be more than 5 mm.

10. WEATHER LIMITATIONS

Bituminous concrete shall not be laid -

- (a) when the air temperature is below 15°C;
- (b) during wet or foggy weather;
- (c) if the surface is wet.

11. CORRECTION OF DEFECTS

When any bituminous concrete is not to specification the Engineer may instruct the Contractor to remove and replace it. The cost to be borne by the Contractor.

12. MEASUREMENT

12.1 Prime

Prime will be measured as given in "Prime Coat" (see Section R.16).

12.2 Tack coat - Fog-Spray

The unit of measurement shall be the quantity of 60 percent bituminous emulsion used in the fog-spray in litres.

12.3 Bituminous Concrete

The unit of measurement shall be the metric tonne of bituminous concrete permanently incorporated in the works. There shall be separate measurement for different courses and different binders.

12.4 Bituminous Binder Variations

The unit of measurement of bituminous binder for increases or decreases in the specified percentage or rates of application shall be the litre calculated at a temperature of 25°C.

13. PAYMENT

13.1 Prime shall be paid for as given in "Prime Coat" (see Section R.16).

13.2 Fog Spray

The rate per litre of 60 percent bituminous emulsion shall include full compensation for supplying, transporting, heating if necessary, and applying the fog spray.

13.3 Bituminous Concrete

13.3.1 The rate per tonne of bituminous concrete shall include full compensation for -

- (a) supplying and transporting all materials;
- (b) screening aggregate;
- (c) heating the binder where necessary;
- (d) mixing, spreading and rolling the concrete;
- (e) finishing the concreting surface defects;
- (f) providing all supervision, labour, materials, transport, plant and equipment, and other incidentals necessary to construct, protect and maintain the specified work;
- (g) cutting of longitudinal and transverse joints and painting with emulsion.

13.3.2 The different courses shall be paid for separately.

13.4 Bituminous Binder Variations

13.4.1 The price rate per litre of binder used over and above the specified quantity shall include full compensation for supplying, transporting, heating and mixing the binder. Binder used in excess of the specified quantities shall only be paid for if it has been ordered in writing by the Engineer.

13.4.2 The Government shall be refunded the value of any decreases in the specified percentage at the same price per litre as tendered by the Contractor for the supply and use of additional bituminous binder.

**SECTION NO. R.21
SPALLING AND CRUSHING STONE**

1. DESCRIPTION

1.1 This specification covers the quarrying, spalling and subsequent crushing of spalls to produce the required quantities of graded stone for use in concrete and surfacing.

1.2 The following sizes may be required:

(a) Concrete Stone to S.A.Z.S. 233:
40 mm (37,5 mm single sized)
20 mm (19,0 mm single sized)
10 mm (9,5 mm single sized)

(b) Surfacing Stone to S.A.Z.S. 232:
19 mm (-19,0 + 13,2)
13 mm (-13,2 + 6,7)
10 mm (- 9,5 + 3,35)
7 mm (- 6,7 + 2,36)
7 mm (- 6,7 + 1,18)

1.3 No separate payment will be made for spalls or unscreened crusher dust. The -1,18 mm product will nevertheless remain the property of Government.

1.4 Crusher dust conforming to the grading requirements of S.A.Z.S. 232 will be regarded as surfacing stone and appropriate payment made.

2. PROVISIONS OF SPALLS

2.1 The suggested quarry site is shown on the Site Plan.

2.2 In the event of a tenderer wishing to propose alternatives, details and samples must be submitted to the Engineer at least 48 hours before the date of the site visit.

3. ACCESS ROADS TO QUARRY SITE

Access roads to the quarry site shall be dealt with as given in "The supply of materials in the construction of the pavement" (see Section R.14).

4. CLEARING AND REMOVING OF OVERBURDEN

4.1 The Contractor shall clear the area of all timber, brush, grass, roots, debris and other unsuitable material.

4.2 The timber cleared shall be corded immediately adjacent to the cleared area.

4.3 It is drawn to the Contractor's attention that the ownership of all timber and grass growing on the area rests with the landowner. All brush, grass, etc., not required by the landowner shall be burned in the centre of the cleared area or at any other location agreed to or directed by the Engineer.

4.4 The overburden shall be placed on the perimeter of the deposit. If instructed by the Engineer it will be spread over the area when all stone required has been removed.

5. EXPLOSIVES REGULATIONS

The Contractor shall take all necessary precautions to safeguard the public and shall in every way comply with the current explosives regulations.

6. CLOSING OF UNSUITABLE QUARRIES

The Engineer has the right to order the cessation of quarrying of the whole or any part of a quarry if the stone is found to be unsuitable.

7. QUALITY OF STONE

7.1 Surfacing Stone

The stone shall comply with the latest S.A.Z.S. No. 232 "Single-sized Roadstone for Surface Dressing". It is the Contractor's responsibility to ensure that all stone complies to these standards both for shape and grading.

7.2 Concreting Stone

Concreting stone shall comply with the latest S.A.Z.S. No. 233 "Aggregates from Natural Sources for Concrete" unless otherwise authorized in writing by the Engineer.

7.3 Rejects

The Engineer shall have the right to reject stone which does not comply with specification.

7.4 Sampling

The Engineer shall have the right to require the Contractor at any time to draw samples of aggregates from stockpiles on the site, or any other locations to be indicated by the Engineer. The samples shall be drawn and tested by the Roads Laboratory according to the appropriate clauses of the latest S.A.Z.S. No. 190.

8. STOCKPILE SITES

- 8.1 The Contractor shall make his own arrangements for clearing adequate sites for the stockpiling of spalls.
- 8.2 The clearing of sites selected for stockpiling crushed stone shall be as directed by the Engineer.

9. STONE STOCKPILES

- 9.1 The various sizes of crushed stone and the waste crusher dust shall be stockpiled into separate stockpiles in such a manner that the piles shall not be contaminated in any way. The stockpiles shall be rectangular in plan and the height shall be in multiples of 0,5 m, but having a maximum height of 3,0 m except in respect of crusher run or graded concrete aggregate which shall not be stockpiled to a greater height than 2,0 m.
- 9.2 Once stone has been placed in the stockpile, it shall be removed only on instructions from the Engineer.

10. MEASUREMENT

10.1 General

There will be no separate measurement for spalls, -1,18 mm to dust, clearing overburden and clearing sites for stockpiles of spalls.

10.2 Crushed Stone

The unit of measurement will be the cubic metre of approved stone measured in stockpile.

11. PAYMENT

- 11.1 There will be no separate payment for provision of spalls, -1,18 mm to dust, clearing overburden, and clearing sites for stockpiling spalls.
- 11.2 Payment for clearing sites for the stockpiling of crushed stone will be paid for as plant hire and daywork.
- 11.3 The price tendered and paid for each cubic metre of graded crushed stone will include all costs for quarrying, loading, hauling and stockpiling spalls, re-loading spalls, hauling to crusher, feeding, crushing, screening and delivery to stockpile of graded crushed stone, provision of explosives, safety precautions, warning notices and any operation necessary for the efficient running of the quarry and crusher, and for all work incidental and necessary thereto.

SECTION NO. R.22
FENCING

1. DESCRIPTION OF WORK

This work consists of supplying, erecting and straining temporary or permanent fencing along the road as directed by the Engineer.

2. MATERIALS

2.1 Barbed Wire

Barbed wire for permanent fencing shall be as given in the latest S.A.Z.S. 284. It shall be made up of two strands of wire, each wire shall be 2,5 mm nominal diameter.

Barbed wire for temporary fencing shall be as given in the latest S.A.Z.S. 284. It shall be a single strand of wire, 2,95 mm nominal diameter.

In either case the barbs shall be as given in the latest S.A.Z.S. 284.

2.2 Straining posts

Straining posts shall be as given in the latest S.A.Z.S. 284 or S.A.Z.S. 07; as applicable. In the latter case they shall be impregnated with creosote.

2.3 Standards

The standards shall be as given in the latest S.A.Z.S. 284 or S.A.Z.S. 07; as applicable. In the latter case they shall be impregnated with creosote.

2.4 Droppers

The droppers shall be as given in the latest S.A.Z.S. 284 or S.A.Z.S. 07; as applicable. In the latter case they shall be impregnated with creosote.

2.5 Tying Wire

The tying wire shall be not less than 2,65 mm diameter plain galvanized steel wire as given in the latest S.A.Z.S. 284.

2.6 Anchor Wire for Straining Posts

The anchor wire shall be not less than 4,00 mm diameter plain galvanized steel wire as given in the latest S.A.Z.S. 284. Anchors shall be at least four-ply.

2.7 Gates

All gates shall be as described in the latest S.A.Z.S. 284.

2.8 Gate Posts

The gate posts shall be as given in the latest S.A.Z.S. 284 or S.A.Z.S. 07; as applicable. In the latter case they shall be impregnated with creosote.

3. CONSTRUCTION

3.1 General

3.1.1 Fences both temporary and permanent shall be erected in a workmanlike manner and shall on completion be on the lines as indicated by the Engineer.

3.1.2 Fences will consist of not less than four strands, the top strand being 1,2 metres above the ground, each strand shall be strained tightly to the satisfaction of the Engineer.

3.1.3 Each strand shall be firmly tied to standards and droppers, the ends of the tying wire being wound round the strand and left flush.

3.1.4 Strands shall be placed at the following centres, measured from the top of each standard. 40 mm, 345 mm, 595 mm, 790 mm.

3.2 Straining Posts

Straining posts shall be firmly embedded and anchored not more than 400 metres apart and at all points of change of direction of the fence line. They shall be drilled, or in the case of wooden posts notched, to correspond to the required strand spacings.

3.3 Standards

Standards shall be firmly fixed not more than 14 metres apart and drilled, or in the case of wooden standards notched, to correspond to the required strand spacings.

3.4 Droppers

Three droppers, equally spaced shall be inserted between each pair of standards for permanent fencing; in the case of temporary fence only two droppers are required. They shall be drilled, crimped or in the case of wooden droppers notched to correspond to the required strand spacings.

3.5 Gates

Gates shall be erected where indicated by the Engineer and shall -

- (a) have a clear opening of not less than 4,25 metres unless the Engineer authorizes to the contrary;
- (b) not be hung on straining posts;
- (c) be constructed so as to swing clear of the road
- (d) have a balanced catch or other fastening approved by the Engineer;
- (e) in addition to the above, where the gate is across a public road, it shall be fitted with a disc or other device easily visible at night, as detailed by the Engineer.

3.6 Gate Posts

Gate posts shall be secured either -

- (a) in a concrete block of not less than 400 mm by 400 mm x 300 mm deep, which will not protrude above ground level; or
- (b) on a base plate of a surface area of not less than 400 mm x 400 mm, such plate to be set not less than 500 mm below ground level.

3.7 Pedestrian Openings

Where pedestrian openings are required they will be constructed as detailed by the Engineer who will provide a Drawing detailing the construction of the openings.

3.8 Game Fencing

Where Game Fencing is required it will be covered by the special specifications.

3.9 On the completion of the work all temporary fencing shall become the property of the Government.

4. MEASUREMENTS

4.1 Fencing

The unit of measurement is the kilometre of single fence erected.

4.2 Gates

The unit of measurement is the number of gates erected. Main gates and pedestrian gates or openings will be measured separately.

4.3 Additional Straining Posts

The unit of measurement is the number of straining posts additional to those required for a 400 metre spacing.

4.4 Additional Strands

The unit of measurement is the length in kilometres of wire additional to that required for a four strand fence.

5. PAYMENT

5.1 Fencing

The rate for a kilometre of single fence will include full compensation for the supply of all materials on site and all labour and equipment required for the erection of fences as specified and for all work incidental and necessary thereto.

The rate per kilometre for temporary fencing will also include full compensation for both erection and dismantling of the fence.

5.2 Gates

The rate for each gate will include full compensation for the supply of the gate, gate posts and all other materials on site and all labour and equipment required for the erection of the gates as specified and for all work incidental and necessary thereto.

5.3 Pedestrian Openings

The rate for each opening constructed as shown on the Drawing supplied will be for the number off. The rate shall include full compensation for the supply of the posts, wire and other materials, labour and equipment required for the erection of each pedestrian opening and for all work incidental and necessary thereto.

5.4 Additional Straining Posts

The rate for each additional post will include full compensation for the supply of the posts and other material, labour and equipment required for the erection of the posts as directed and for all work incidental and necessary thereto.

5.5 Additional Strands

The rate for each additional kilometre of wire used will include full compensation for the supply of the wire, labour and equipment required for the erection as specified and for all work incidental and necessary thereto.

SECTION NO. R.23
CATTLE GRIDS

1. DESCRIPTION

- 1.1 The work consists of the construction of cattle grids where indicated by the Engineer.
- 1.2 A cattle grid is a structure constructed across a road which is designed to prevent the passage of cattle while permitting other traffic to pass. The work shall conform to the details shown on the Drawings, or as supplied by the Engineer. Connecting fences and swinging gates are as given in "Fencing" (see Section R.22).

2. MATERIALS

2.1 Concrete

The materials used for concrete will be as given in "Portland Cement Concrete" (see Section C.8).

2.2 End Posts

End posts shown on the Drawings shall be made of 75 mm internal diameter galvanized iron pipe.

3. CONSTRUCTION

3.1 Excavation

Excavation for cattle grids shall be made large enough to permit construction of the base slab to the dimensions on the Drawings.

3.2 Concrete

3.2.1 Base slabs and walls of cattle grids shall be constructed in concrete as shown on the Drawings. end posts will be placed in position during the casting of the side walls.

3.2.2 Pre-stressed concrete grid ribs shall be made in accordance with the details shown on the Drawings. The ribs shall be bedded on 1:3 cement mortar on the walls so that the top edge of each rib is in line with the finished road surface. The ribs will be held in place by raising the walls between the ribs, in concrete to the height shown on the Drawings.

3.2.3 For cast-in-situ cattle grids construction will be in accordance with the details as shown on the Drawings.

3.2.4 Concrete mixes and processes of construction shall conform to requirements of the relevant sections.

3.3 Drains

An outlet drain pipe shall be cast into the sidewalls in accordance with the Drawings. From this pipe a drain shall be constructed to the size and dimensions indicated by the Engineer.

3.4 Cattle Grid Markers

Cattle grid markers, supplied by the Government, shall be erected and barbed wire strands placed as shown on the Drawings.

4. MEASUREMENT

The unit of measurement is the number of cattle grids constructed.

5. PAYMENT

5.1 The rate per cattle grid will include full compensation for the supply and delivery to site of all materials necessary for the construction of the cattle grid, except cattle grid markers which will be supplied free on site to the Contractor.

5.2 It will also include all labour, equipment and for all work incidental and necessary to construct the cattle grid and drainage as specified and shown on the Drawings.

SECTION NO. R.24
SUPPLY AND PLACING OF PRECAST CHANNELS, FLUMES,
KERB BLOCKS, GUIDESTONES AND GUARDPOSTS, KILOMETRE MARKERS

1. DESCRIPTION OF WORK

- 1.1 The works consists of supplying and placing to line, level and position precast channels, flumes, kerb blocks, guidestones and guardposts or any other specified precast units plus the construction of certain minor associated "cast-in-situ" structures.
- 1.2 All the work carried out must conform to the details shown on the drawings or as indicated by the Engineer.

2. MATERIALS

- 2.1 All materials necessary and incidental to the supply and placing of the precast products and for the construction of any in-situ item as specified shall be provided by the Contractor.
- 2.2 Plain Concrete

Cement sand and stone for concrete shall be as given in "Portland Cement Concrete" (see Section C.8).

3. PORTLAND CEMENT CONCRETE

- 3.1 General

The specification for the concrete shall be as given in "Portland Cement Concrete" (see Section C.8).
- 3.2 Aggregate

The aggregate for precast units will comply with the grading specification for 10 mm single sized stone.
- 3.3 Concrete

The concrete for precast units shall be grade C.25.
- 3.4 The in-situ concrete shall be grade C.20.

4. CURING PRECAST UNITS

- 4.1 As soon as possible after casting the precast item, the concrete shall be protected from the drying effects of sun and wind by covering with hessian kept in a damp condition or any other method approved by the Engineer.

4.2 Immediately after the precast products have been struck from the mould, usually after 24 hours, they shall be cured under water for six days.

4.3 The approval of the Engineer shall be sought should the Contractor wish to strike moulds earlier than 24 hours after pouring. Approval will only be given provided that no damage is likely to occur to the green concrete.

5. MEASUREMENT

The unit of measurement shall be the number off. Cast-in-situ concrete associated with laying of precast units shall neither be measured nor paid for separately.

6. PAYMENT

6.1 The rate for the supply and placing of each channel, flume, guidestone, kerb block and guardpost will include full compensation for the execution of the work as specified and for all work and materials incidental and necessary thereto.

6.2 The rate for each unit will include the supply, transportation and placing. The placing includes the excavation, grouting and backfilling as specified on the Drawings and as directed by the Engineer.

SECTION NO. R.25 ALLOWANCE FOR EXTRA WORK

1. DESCRIPTION

This deals with the provision of labour, materials and plant for extra work ordered by the Engineer. The description of work, quality of materials and standard of workmanship are described in the specifications and schedule of daywork rates.

2. MEASUREMENT

2.1 Labour

The unit of measurement is the working hour.

2.2 Materials

The unit of measurement is that in the specification and schedule of daywork rates.

2.3 Plant

2.3.1 The unit of measurement is that in the schedule of daywork rates.

2.3.2 "Hour" means the working hour measured by clock not meter.

2.3.3 "Kilometre" means odometer kilometre.

2.3.4 "Tonne-kilometre" means rated net loaded capacity per 1 000 kg multiplied by odometer kilometres.

2.3.5 "Rated Cubic metre-kilometre" means rated capacity in cubic metre units multiplied by odometer kilometre

2.3.6 "Struck Cubic metre-kilometre" means struck capacity in cubic metres multiplied by odometer kilometre.

3. PAYMENT

Payment will be according to rates in the schedule of daywork rates.

3.1 Labour

The rates will be for straight time only. No overtime will be paid unless specifically directed by the Engineer.

3.2 Materials

The rates will be in respect of supply and delivery to the usual point at which materials are received on the site. There will be no payment for delivery to individual sites where work is in progress.

3.3 Plant

The rates will cover necessary insurances, maintenance, supervision, overhead charges, profits, wages of operators and assistants where necessary, fuels, repairs and stores.

SECTION R.26 CARRIAGEWAY MARKINGS

1. General

- 1.1 This section covers the application of painted carriageway markings to the bituminous surface of the road.
- 1.2 Carriageway markings shall in all cases comply with the current Roads and Road Traffic (Traffic Signs and Signals) Regulations. [Publication RGN573 of 1973 and Manual Part K (Traffic B)].
- 1.3 The markings to be applied to the road surface shall be as indicated on the drawings or as directed by the Engineer.
- 1.4 On new surfacing the paint will be applied in two coats, first an undercoat or prime coat and second a reflectorised paint in white or yellow dependent on the type of marking being applied.

When repainting existing markings, the reflective coat only shall be applied.
- 1.5 Reflectorised markings can be obtained using non-reflectorised Road marking paint for use with drop-on beads or by using a base paint premixed with glass spheres.

2. MATERIALS

- 2.1 The road marking paints and reflectorised road marking paints and complementary thinners to be used in the exercise shall conform in every respect with S.A.Z.S. No. K20:1970, or S.A.Z.S. 155:1975.
- 2.2 Road marking paint which gives equal or better performance to that specified above may be used in the works subject to the following:

Before use in the works the Contractor must submit complete technical details such as the specification by which the paint can be assessed mixing proportions of paint and solvent, rates of application in litres per square metre, performance and foreign currency content as compared with road marking paints conforming to the specification stated above.

3. WEATHER LIMITATIONS

Road marking paint shall not be applied to a damp surface or when the relative humidity exceeds 80%, or at temperatures lower than 10 degrees centigrade.

4. SAMPLE AND TESTING

- 4.1 Before any materials are used in the works samples of those materials in the following list which are applicable shall be tested for compliance with S.A.Z.S. K20 or S.A.Z.S. 155:1975. (If testing to these standards does not apply to the paint materials, then testing shall be in accordance with the specification given by the manufacturer).
- (i) Road marking paint - non reflectorised.
 - (ii) Road marking paint - non reflectorised, for use with drop-on beads marking paint.
 - (iii) Base paint of premixed reflectorised road marking paint.
 - (iv) Gloss spheres to be used with (ii) or (iii) above.
 - (v) Thinners.
- 4.2 Report on the testing of these samples shall be submitted to the Engineer.
- 4.3 No samples are required for those materials listed in 4.1 above for which the S.A.Z.S. K.20 or S.A.Z.S. 155:1975 has been awarded and is currently valid. Proof of the validity of the S.A.Z.S. mark shall be supplied to the Engineer upon request.
- 4.4 At any time during the period of the works the Engineer reserves the right to sample for the purpose of determination of quantity and quality, any or all the materials supplied for the works.
- 4.5 With each new batch of premix - white or yellow reflectorised paint supplied, a sample of the base paint used (in the quantity specified by S.A.Z.S. 155:1975) shall be submitted to the Engineer.

5. SUBMISSION OF SAMPLES

- 5.1 All samples shall be submitted in the quantity specified by S.A.Z.S. K.20 or S.A.Z.S. 155:1975.
- 5.2 Glass spheres shall be supplied in the quantity specified in S.A.Z.S. 155:1975.
- 5.3 Samples shall be clearly marked with the contract number, colour description of contents, batch number and date supplied.

6. TESTING OF SAMPLES

All samples obtained may be tested by either the Engineer or the Standards Association of Zimbabwe in accordance with S.A.Z.S. K.20 or S.A.Z.S. 155:1975 as appropriate. (If the testing to S.A.Z.S. K20 and S.A.Z.S. 155:1975 does not apply to the paint described in Clause 2 or this specification then testing shall be in accordance with the specification given by the Manufacturer)

7. WORKMANSHIP AND TOLERANCES

- 7.1 Paint, mixed with thinners if necessary, shall be applied to give a minimum wet thickness of 0,5 mm for each coat.
- 7.2 The completed markings shall comply with the following tolerances unless specified otherwise by the Engineer -
- not less than the specified dimensions
 - width tolerance +5mm
 - length tolerance +50mm
- 7.3 The completed markings shall be inspected by the Engineer during the hours of darkness and will only be accepted if the visibility is deemed to be satisfactory under dry night conditions.

8. EQUIPMENT

The road markings may be hand painted or machine applied. Where a mechanical road marking machine is used it shall be capable of applying the paint to a uniform film thickness at the rates of application specified. The machine shall be so designed that it will be capable of painting the traffic markings to a uniform width with sides within the tolerances specified above, without the paint running or splashing. The machine shall further be capable of painting lines of different widths by adjustment to the spray jets on the machine.

Hand application by spray gun or brush must be carried out using templates made to suit the specified markings. In addition to the above all additional hand operated equipment necessary to complete the work as specified must be provided.

9. SURFACE PREPARATION

Traffic markings shall be applied to bituminous surfaces only after sufficient time has elapsed to ensure that damage will not be caused to painted surface by volatile substances evaporating from the bituminous surfacing. In no case shall traffic markings be applied until at least 48 hours after the completion of the bituminous surfacing.

Before the paint is applied the surface shall be clean and dry and completely free from any soil, grease, oil, acid or any other material which will be detrimental to the bond between the paint and the surface. The portions of the surface where the paint is to be applied shall be properly cleaned by means of brooms or compressed air if required.

10. SETTING OUT OF TRAFFIC MARKINGS

The lines, symbols, figures or marks shall be set out by means of paint spots of the same colour as the proposed final lines and marks. The spot marks shall be at such intervals as to ensure that the traffic markings can be accurately applied and in no case shall they be more than 1,5m from each other.

The Contractor shall provide sufficient experienced personnel to ensure that the position, layout and dimensions of the markings, and application of the paint is carried out correctly.

11. APPLICATION OF PAINT

The paint shall be applied as figures, signs, letters, symbols, broken or unbroken lines or other marks as shown on the drawings or directed by the Engineer.

Where the paint is machine applied each coat shall be applied in one application or layer. Before the machine is used on the permanent works it shall be tested on a suitable site which is not part of the permanent works. Any necessary adjustments to the machine shall be made and the machine re-tested. Only when the machine is spraying at the specified application rate will the machine be used on the permanent work or as directed by the Engineer. Any newly sprayed undercoat must be thoroughly dry before the top coat is applied.

12. APPLICATION OF REFLECTIVE BEADS

Where reflectivity is to be obtained using drop-on beads the reflecting glass beads shall be applied by means of a suitable machine immediately after the application of the paint in one continuous operation. The rate of application of the reflecting beads shall be 0,8 kilogram per litre of paint or such other rate as may be indicated by the Engineer.

13. PROTECTION

After the application of paint, the traffic markings shall be protected against damage by traffic or other causes. The Contractor is responsible for the erection, placing and removal of all warning boards, flags, barricades and other protective measures which may be necessary.

14. MEASUREMENT

- 14.1 The unit of measurement for road lines of constant thickness is the square metre.
- 14.2 The unit of measurement of specific insignia is the number off.
- 14.3 The following items will be measured separately:
 - a. Each width of road line.
 - b. Each colour of paint.
 - c. Top coat and undercoat.
 - d. Drop-on beads or premixed reflectorised paint coat.
 - e. Specific Insignia.

15. PAYMENT

The rate for each square metre of paint or each insignia will include full compensation for the execution of the following operations and for all work incidental and necessary thereto.

- a. Supply and delivery of all material.
- b. Supply of all plant, labour and equipment for application of the paint marking on the carriageway.

16. TESTING

Testing shall be in terms of Section C14 - Testing.

SECTION NO. R.27 TRAFFIC SIGNS

1. DESCRIPTION

- 1.1 This section covers the provision and mounting of signs on steel or concrete posts plus their permanent erection in positions on the road for the control guidance and information of road users.
- 1.2 All signs shall be in the form prescribed in the Roads and Road Traffic (Traffic Signs & Signals) Regulations. [Publication RGN573 of 1973 and Manual Part K (Traffic B)]. Upon request the Contractor will be supplied with the name and address of the firm that is the supplier to the Ministry at the time. The Contractor will be required to supply all signs needed on the Contract to the same standard as supplied to the Ministry.

2. ERECTION

- 2.1 Road signs shall be erected in the positions shown on the drawings or as directed by the Engineer and shall be erected in accordance with the relevant sections of the Roads and Road Traffic (Traffic Signs & Signals) Regulations.
- 2.2 For the erection of small signs such as speed limits and lay-by signs, the post hole should not be less than 600 mm deep. For larger signs and signs erected in soft ground the depth of the hole should be increased to a depth as directed by the Engineer.

The backfill material may be wholly or partly stabilised with cement as directed by the Engineer.
- 2.3 As the bottom of the lowest sign must be a prescribed height above the ground any sign post being erected shall be checked for the prescribed height before any backfilling commences.
- 2.4 All places where paintwork has been damaged during erection shall be made good by the Contractor at his own cost to the Engineer's satisfaction.

3. PROTECTION AND MAINTENANCE

The Contractor shall protect the completed signs against all damage until it is finally accepted by the Engineer and he shall maintain the road signs until the maintenance certificate is issued. Damage or defects caused by faulty workmanship or negligence shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.

4. MEASUREMENT

Measurement will be the number off.

5. PAYMENT

All signs supplied by the Contractor for permanent use on the road will be paid for as given in "Accommodation & Equipment" (Section C2).

Payment will include full compensation for the supply, delivery and erection of the signs as specified.

MODIFICATIONS TO THE STANDARD SPECIFICATIONS,

- NOTE:
1. ALTERATIONS FROM THE ORIGINAL VERSION OF JANUARY, 1980 ARE INDICATED IN LIGHT PRINTING BELOW.
 2. ALTERATIONS FROM THE JAN. '89 VERSION MADE AT MEETING (2 & 3/3/89) INDICATED IN BOLD PRINTING BELOW.
 3. ALTERATIONS SUBSEQUENT TO MEETING 1 & 2.3.89 INDICATED BY UNDERLINING IN PRINTING BELOW.
 4. ALTERATIONS INSTRUCTED BY YAMOA/RANALLI 28/3/89 INDICATED BY UPPER CASE LETTERING.

GENERALLY

1. Steel, Concrete & Composite Bridges" instead of "Steel Girder Bridges" inserted where appropriate throughout Std. Specs.
2. All sectional headings centralised.
3. Index numbering finalised.

SECTIONS COMMON TO BOTH BRIDGES AND ROAD WORKS

SECTION C1: ESTABLISHMENT & GENERAL

- Points: 3 Establishment on Site (b) added, "at the campsite" after sanitary facilities.
- Points: 5.1 Word "interim" spelling not clear
No change

SECTION C2: ACCOMMODATION & EQUIPMENT

TITLE WAS CHANGED TO "ACCOMMODATION, VEHICLES AND EQUIPMENT".

- Points: 2 TITLE CHANGED TO "VEHICLES AND EQUIPMENT".
- 2.1 "VEHICLES AND" INSERTED PRIOR TO "EQUIPMENT".
- 3.1 ",VEHICLES" INSERTED AFTER "ACCOMMODATION".
- 3.6 "VEHICLES AND" INSERTED AFTER "ALL"
- 4.2 "VEHICLES AND" INSERTED BEFORE "EQUIPMENT"
- 4.2.1 "VEHICLES AND" INSERTED BEFORE "EQUIPMENT"
- 4.2.3 ",VEHICLES" INSERTED AFTER "EQUIPMENT"
- 4.3 "IN THE CASE OF EQUIPMENT" INSERTED AT BEGINNING OF PARA.1.
SECOND PARA INSERTED "IN THE CASE OF VEHICLES ALL WORK... PAID FOR BY THE KILOMETRE RECORDED, PROVIDED..".

SECTION C3: CONSTRUCTION OF DETOURS

Formerly this section was entitled ACCOMMODATION OF PUBLIC TRAFFIC DURING CONSTRUCTION.

- Points: 2.4 about width of clearing (minimum 10m);
- 2.5 about width of formation (minimum 7m), materials, water and culverting;
- 2.6 about gravelling, including compaction to sufficient density. Insert the words "to the road surface" after undue wear and tear;
- 2.7 surfacing, if necessary as per Special Specifications in contract documents, was added.

- 3.1 was added, concerning the general obligation to construct barricades and sign;
- 3.2 is as former point 3.1. Last sentence - after the word "Construction" insert "or public". Then add the following "It is the contractors responsibility to take adequate precaution to prevent the access of all such traffic to the road under construction".
- 3.3 and 3.4 are as former points 3.2 & 3.3;
- 3.5 is as former point 7.1. Insert the word "supply" in place of purchase; delete the words "from the nominated supplier and";
- Points: 3.6 is as former point 7.2.
- 4.2 was added, indicating maintenance to be as agreed with Engineer.
- 5 the restoration to be at Contractor's cost if restoration is due to unauthorised use of a completed layer. At the end of the paragraph add by the Contractor or the Public;
- 6.1 was added, describing the obligation to avoid disturbance to land owners and to install gates at fences cut. At the end add "Siting of all such access roads to be to the satisfaction of the Engineer";
- 7 (7.1 & 7.2) is cancelled, contents are in 3.5 and 3.6. The new point 7 is REHABILITATION. The content is completely new, and indicates how the detours must be disposed of at completion. Number the 4 paragraphs in this as 7.1 - 7.4. In the last paragraph after "requests" substitute "any" for "the" and before the first appearance of the word "road" add the word "old" and after "road" insert "or detour". In the last paragraph substitute the word "Provincial" for "Regional". Number the three sections: 7.1, 7.2, 7.3;
- 8 is completely new (MEASUREMENT). It describes the unit of measurement for = 8.1 Clearing, 8.2 Construction of Detours, 8.3 Temporary Pipe Culverts, 8.4 Graveling, 8.5 Grading of Detours, 8.6 Watering, 8.7 Barricades and Signs, 8.8 Overhaul and 8.9 Rehabilitation.
- 8.2 after "measurement" insert the words "of the formation width";
- 8.5 Change title to "Maintenance grading of detours";
- 8.6 The word metre is mis-spelt;
- 8.8 "FOR GRAVEL & WATER" INSERTED AFTER "OVERHAUL";
- 9 is completely re-written (PAYMENT) and the rates are described for each of the operations at point 8 above.
- 9.5 Change title to Maintenance grading of detours.
- 9.6 The word metre is mis-spelt;

SECTION C4: PROVISION OF WATER

- Points: 1.1 2nd paragraph add "the" before Water Court and "adequate" before "public" and at the end of sentence add "for the needs of the contract";
- 1.2 Replace with the 2nd paragraph but change the first word "However" to "The";
- 1.6 delete "before water is drawn" and insert the word "prior" before approval;
- 2.3 Add "shall" before "remain";
- 3.2 the words "See section C7" were added.
- 3.4 the words "See section C2" were added.

- 3.5 measurement to be as in Section C3 and no more as plant hire and dayworks. The same applies for payment. "AS OUTLINED IN SECTION R14, "THE SUPPLY OF MATERIALS FOR THE CONSTRUCTION OF THE PAVEMENT";
- 3.6 is completely new and states that test samples are to be supplied for free by the Contractor. Deleted entirely & replaced with Point 4: TESTING. "Testing shall be in terms of Section C14 - Testing".
- 5 "MEASUREMENTS" changed to "MEASUREMENT"

SECTION C5: REMOVAL OF EXISTING STRUCTURES

Formerly C5 was EXCAVATION AND BACKFILLING FOR STRUCTURES which is now C6. Consequently, all section numbers in SECTIONS COMMON TO BOTH BRIDGE AND ROADWORKS are increased by one numeral. The text of C5 REMOVAL OF EXISTING STRUCTURES is taken from former section B2 = REMOVAL OF EXISTING STRUCTURES that was in the bridge sections, with the following changes:

- Points:
- 1 "the bridge site" is replaced with "any road or bridge construction site".
 - 2.1 insert "comma" after salvageable;
 - 4.1 "the banks of the river" is replaced with "the site" and the trimming can be as indicated in the General Arrangements Drawings or, as now added, as instructed by the Engineer.
 - 5.0 Add para 5. MEASUREMENT as follows: The unit of measurement will be the lump sum;
 - 6.0 Change para 5 Payment to Para 6.

SECTION C6: EXCAVATION AND BACKFILLING FOR STRUCTURES

This Section was formerly numbered C5 (see Section C5 above)

- Points:
- 8 was added as follows Point 8.1 covers the case of unsuitable foundation material;
 - 8.2 the case of rock;
 - 8.3 the case of part rock and part soil;
 - 8.4 the case of steep gradients. At end of paragraph add "as directed by the Engineer";
 - 11 the words "see section C8" were added after Portland Cement Concrete;
 - 12 the words "Construction as per paragraph 2.8 section R6 shall be complied with", were added.
 - 14.7 was added, covering the measurement of Special Treatment to Foundations;
 - 14.8 was added, covering the measurement of the Stabilising Agent;
 - 15.2 was added, covering the payment of the Special Treatment to Foundations = Point 15.2.1 for Natural Backfill and Point 15.2.2 for Stabilised Backfill;
 - 15.3 was added, covering the payment of the Stabilising Agent;
 - 17 the words "See section C7" were added.

SECTION C7: HAUL & OVERHAUL

This section was formerly numbered C6, see above.

- Points: 2.5.4 was added, for the case when the haul road straddle the road under construction;
- 2.6.1 references to section R5, R10, R11 were added as applicable. INSERTION OF "CONSTRUCTION OF DETOURS (SEE SECTION C.3), "SLOPE PROTECTION AND ANTI EROSION WORKS" (SEE SECTION C.12)" INSERTED AFTER "UNDER SECTIONS".

SECTION C8: PORTLAND CEMENT CONCRETE

This Section was formerly numbered C7 see above.

- Points: 1.2 the characteristic strength is that below which 5% (not 50%) of the population falls. The strength is given in MPa, in brackets N/mm. "Per cent" to be "percent";
- 1.3 deleted "Rhodesia"- Table now 8.1 not 7.1;
- 2.1 CAS No A46 was replaced with S.A.Z.S No A46;
- 2.3 CAS 2.3.3 was replaced with S.A.Z.S. Z33;
- 4.1.3 a sample of 1 sack (50kg) is now required, instead of the Engineer being advised of the proposed source of supply;
- 4.2 the words "see section C4" was added;
- 5.1 Remove "Provincial road";
- 5.2 Table No now 8.2;
- 5.3 Table No now 8.3;
- 6.2.2 Changed to "Curing temperatures for concrete cubes will be appropriate to tropical conditions and shall be between 26 and 29 degree's Celsius".
- 6.4.1 & 6.4.2. MPa replace N/mm². N/mm² is still shown in brackets. The same applies to Point 6.6.;
- 7.1.1 Delete 7th & 8th lines of this paragraph;
- 7.1.2 Delete wording from "or volume" up to and inclusive of "by volume". Then insert before words "the aggregate" the following "Where the Engineer approves batching by volume";
- 7.2.4. added at the end "However the mixing times shall not be so long as to cause segregation of the concrete constituents;
- 7.4.3. is deleted. It dealt with wet and dry epoxy adhesive for construction joints, when the older concrete has set;
- 7.9.3 To be checked with Chinsen of M.O.T.; "Dry" corrected to "dry".
- 12.2(b) added "for precast units";
- 13 Completely deleted & replaced with: Point 13.1: "Testing shall be in terms of Section C14 - Testing" & Point 13.2: "The costs of the mix design proposals outlined in 5.1 above will be borne by the Contractor in terms of Section C14, Testing";
- 13.3 was added concerning the cost of mix design proposals; The word "outline" should be "outlined";
- 13.4 was added "Tests failing see G.C.C."
- 7.1 Table No now 8.1 - all strengths in MPa, Grade C35 added;
- 7.2 Table No now 8.2 - all strengths in MPa.
- 7.3 Table No now 8.3.
- 7.9.3 "OTHER METHODS MAY BE USED AS DIRECTED BY THE ENGINEER" INSERTED AT END OF PARA.
- 11.2 "(EXCEPT FOR PIPE CULVERTS WHICH WILL BE IN ACCORDANCE

WITH SECTION R.2 - CONSTRUCTION OF PIPE CULVERTS)"
INSERTED AT END OF PARA.

SECTION C9: NO FINES CONCRETE
Section C9 was formerly numbered C8.

Points: 2.2 & 2.3 added "see Section C8".

SECTION C10: FORMWORK AND SURFACE FINISH
Section C10 was formerly numbered C9.

Points: Diagram page 52 Table No's changed to 10.2 & 10.3.

SECTION C11: STEEL REINFORCEMENT
This section was formally numbered C10.

Points: 1.2 the words in brackets were added "(but not including etc)";
1.3 "SABS CSK 158" replaced with "SABS 1024";
1.7.5 the words "regardless of whether, etc." were added;
2.1 the last sentence was added "When bars are lapped etc";
4.0 DEFINITIONS: To be revised to agreed with Chinsen's table from Bridge Design Manual;
4.3 "actual" inserted after "The"; "round" inserted after "available". "Part B" inserted after Table 11.1. Next sentence reads as "The Nominal cross-sectional area & actual mass per metre run of available square twisted bars is given in Table 11.1, Part B at the end of this Section";
4.3.2 the definition of the nominal size was changed;
4.4 Table number now 11.1;
5.2.2. SABS CSK 158 was replaced with SABS 1024.
7. "Testing shall be in terms of Section C14 - Testing";
11.1 "Actual" inserted above "Cross-sectional" & above "Mass Per"; "Nominal" inserted above "Cross-sectional" & "Actual" inserted above "Mass Per"; Underneath both tables inserted: "NOTE: ABOVE FIGURES SUPPLIED BY QUALITY CONTROL DEPARTMENT, ZISCO".

SECTION C12: SLOPE PROTECTION AND ANTI-EROSION WORKS
This section was formerly numbered C11 and entitled SLOPE PROTECTION.

Points: 1 the following words were added "installation of L-channels and flumes", "in situ concrete", "or bolsters" where applicable. The last sentence was added concerning the topsoil and grass;
2.1 the last sentence was added, concerning natural rock;
2.2 SABS CKS 158 was replaced with SABS 1024;
2.3 CAS N5 was replaced with SAZS 284;
2.4 added words "see Section C8";
2.5 (a) CAS 119 was replaced with SAZS 119;
2.6 is added, concerning Plain Concrete;
2.7 is added, concerning topsoil. Add "Approved" before topsoil. Comma after "natural";
3.1 (b). After drawings add "or as directed by the Engineer";
3.2 (a) added "(as specified etc)", added "topsoil importation and grass planting";

- 3.3 the first sentence in the former specifications was replaced with the first two sentences in the new specifications; in order to accommodate excavation after slope preparation;
- Points: 3.6 is now "Plain Concrete Cladding", while "Concrete Interlocking Blocks" becomes 3.7. Subsequently Points 3.8, 3.9, 3.10 and 3.11 were added covering: Bolsters - Importation of Topsoil - Grass Seeding - Grass Planting. All these items were not in the old Specifications. At end add last sentence as in Para 3.5;
- 3.8 Delete "Trenches for the" in third para.;
- 3.11 "smoother" replaced with "smother";
- 4.1 the words "see Section C6" were added at the end;
- 4.4 the words "for each size" were added at the end;
- 4.5 to 4.12 were added, covering measurement for: No fines concrete in bolster; Grouted Stonework in Bolster; Topsoil Importation; Grass Plantings; Grass Seeding; Grass Seeds; Fertilizer & Water, respectively;
- 5.1 is reworded adding "in toe and bolster trenches" and "(see section C6)" at the end;
- 5.2 the words "specified excavations" were added;
- 5.4 (b) the words "and place" were added;
- 5.5 to 5.13 were added covering payment for: No-Fines Concrete in Bolsters; Grouted Stonework in Bolsters; Topsoil Importation; Grass Planting; Grass Seeding; Grass Seeds; Fertilizer; Water and Overhaul of Water.

SECTION C13: STATISTICAL CONTROL

This Section was formerly numbered C12. The text is completely new, from "Annexure C12/1 of Rds 14 of 85, Statistical Control of Compaction".

- Points: 1 In Para 3 delete letter "F" from fused and also delete the last sentence;
2. Table 2: "CBR 3" changed to "CBR < 3" (referred from Tender RDS 34 of 1983 p.73);
- 2.1 "Day's" not "days";
- 2.3 Correct formula;
- 2.4 Correct formula;
- 2.10 Correct formula.
- 3.3 (a) "Ls 93" now "Ls > 93"; "Ls 91" now "Ls < 91"
 (b) " " " " " "
 (c) " " " " " "
 Moved above the table.
- 3.4 (a) "Ls 93" now "Ls > 93"; "Ls 91" now "Ls < 91"
 (b) " " " " " "
 (a) " " " " " "

SECTION C14: NEW SECTION "TESTING"

Reads as follows "All testing shall be in terms of Clause 44...of the GCC"

SECTIONS ON BRIDGE CONSTRUCTION

SECTION B1: CLEARING OF BRIDGE SITE

This section was formerly entitled: "SITE ACCESS AND CLEARING OF BRIDGE SITE".

Points: 3 is now "MEASUREMENT" while "PAYMENT" becomes Point 4.;
3 is new. At point 4 the words: as outlined in Section C3, "Construction of Detours" were added;

SECTION B2: PILED FOUNDATIONS

Formerly, Section B2 was "REMOVAL OF EXISTING STRUCTURE", which is now in Section C5, see above. Consequently, the subsequent Sections on Bridge Construction are re-numbered;

Points: 1.1.1 "and driven precast piles".;
4.5 is added altogether, covering Driven Precast Piles. 3rd paragraph. After the word strength insert "Piles will be stacked and transported in a manner approved by the Engineer. "Car" should be "care"; 3rd para. "mpa" corrected to "MPa"
5 onwards, the numbering is corrected. Point 5 is CONSTRUCTION;
5.2.2 "Cast in-situ" is introduced before "Piling" at the beginning;
5.6.2 "Cast in-situ" is introduced before "Piles" at the beginning;
5.6.3 is added as a new point, covering Precast Piles;
10 is now rearranged in two subsections: 10.1 Cast-in-situ Piles and 10.2 Precast Piles;
10.1 = 10.1.1 Transport of Equipments is added. The remaining is unaltered from the old Specifications;
10.2 this is a new subsection altogether, with a next text;
11 is now rearranged in two subsections = 11.1 Cast-in-situ Piles and 11.2 Precast Piles. Point 11.1 is unaltered. Point 11.2 is a new subsection altogether, with a new text.
11.2.3 "carefull" now "careful"
11.2.6 Typing error "level" is spelt incorrectly where it first appears.

SECTION B3: VOID FORMERS

This section was formerly numbered B4.

SECTION B4: STEEL BEARINGS

Points: 2.1.1 "welded: is replaced with "sealed";
3.2 MPa is used instead of N/mm2.
4 BS153 was replaced with BS 5400 (Parts 6 &9);
11 the last sentence was added covering delivery of testing materials.

SECTION B5: RUBBER BEARING PADS

This section was formerly numbered B6.

Points: 2.1 Against "minimum tensile strength": question marks are now shown, instead of the old figure of 18N/mm2. Central lab. has come back with a new figure of 60 MPa. "60" should read "18" MPa and followed by 18 N/mm2 in brackets.

SECTION B6: STEEL EXPANSION JOINTS

This Section was formerly numbered B7.

Points: 3.1.1 BS153 was replaced with BS5400;
3.3.4 the words "(See section B7)" were added to the end.

SECTION B7: RUBBER SEALS FOR EXPANSION JOINTS

This Section was formerly numbered B8.

Points: 2.1 MPa is now used.
3.3 "per cent" to be "percent". "Meters" to be "metres";
4.1 "meters" to be "metres";

SECTION B8: EPOXY NOSINGS, JOINT SEALANTS AND SEATINGS

This section was formerly numbered B9.

Points: 3 the title is now INSTALLATION, instead of CONSTRUCTION;

SECTION B9: STEEL PARAPETS

This section was formerly numbered B10.

Points: 5.1.1 "of single tube" added at the end.

SECTION B10: GUARDRAIL

This section was formerly numbered B11.

Points: 2.4 the words "(See section C8)" were added at the end;
4.5 the words "(See section B14)" were added at the end.

SECTION B11: NAME PLATES

This section was formerly numbered B12.

SECTION B12: WELDED PLATE GIRDERS

This section was formerly numbered B13.

Points: 1.3 the words "(See section B13)" were added;
3.1 BS 153 is replaced with BS 5400 - Part 6;
4 "Part I" is replaced with "Part 6";
6 BS 153 is replaced with BS 5400, Parts 3 & 6;
7.1 BS 153, Part 2 is replaced with BS 5400, Part 6;

Points: 8.2 the words "(see Section B14)" were added;
 9.1.2 "noinal" now "nominal"
 9.14 the words "(see Section B13)" were added;
 10.5 was added altogether. Insert "in" after "given";
 deleted and replaced with Point 11: "Testing". "Testing
 shall be in terms of Section C14 - Testing".

SECTION B13: FRICTION GRIP SPLICES

This section was formerly numbered B14.

Points: 3.1 BS153 was replaced with BS 5400 Parts 1 & 2;
 4.1.2 "plies" is replaced with "splices";
 4.1.3 BS 153 was replaced with BS 5400 - Part 6.
 5.1 "BS 153" should be "BS 5400"

SECTION B14: PAINTING OF STRUCTURAL STEELWORK

This section was formerly numbered B15.

Point: 3.1.1 C.A.S. No K7 was replaced with S.A.Z.S. K7.

SECTION B15: BRIDGE APPROACHES

This section was formerly numbered B16.

Points: 6.3 "shown" to read "show";
 7.4 200m3 of compaction is replaced with 200m2 - Bicon
 thinks m2 - Central Lab to confirm. Replace "200m2"
 with the word "layer"
 13.5 "(See section C7)" was added at the end.

SECTIONS ON ROAD CONSTRUCTION

SECTION R1: CLEARING FOR THE ROAD

Points: 1.1 After the word "growth", insert "topsoil containing"
 and at end of paragraph add "Soil removed during these
 operations shall not exceed the depth indicated by the
 design reduction factor"; insertion of "decayed" after
 "containing";
 Points: 2 Measurement was split into 2.1 and 2.2. Point 2.2 is
 an addition that excludes from measurement all areas of
 roads previously cleared.

SECTION R2: CONSTRUCTION OF PIPE CULVERTS

Points: 2.1 "recommended" was replaced with "specified";
 2.2 CAS No. A17 was replaced with S.A.Z.S. No A17. delete
 "shall comply";
 2.3.1 "(see Section C8)" was added at the end;
 2.6 concerning the Steel Reinforcement, was added;
 3.1.3 was re-written, to include subgrade and base, if
 necessary, and the minimum cover, and to exclude
 measurement and payment;
 3.1.4 was re-written to be in context with 3.1.3;
 3.2.1 the last sentence was added; "CLAUSE" REPLACED "PARA";
 3.2.2 "cement stabilised gravel" was replaced with "natural
 or cement stabilised granular material";
 3.5.1 "(see Section C6)" was added at the end;

3.5.2 was re-written referring to section R6;
 3.7.2 "Construction Traffic" was replaced with "Heavy...legal limit". "them" after only should read "then";
 4.1 "(see Section C6)" was added. "i" to be "in";
 4.2 was added altogether; AFTER "BACKFILL" "IN SPECIAL TREATMENT OF FOUNDATIONS" WAS INSERTED;
 4.3 is now "Concrete Pipes". It was "Pipes" before;
 4.4 is as 4.3 before, "(see Section C8)" is added at the end of 4.4.1;
 4.5 is as 4.4 before. "(see Section C12): is added at the end;
 4.6 was added altogether;
 5 "(see Section C6)" was added at 5.1, 5.2;
 5.2 this is an addition altogether;
 5.3 is now "Concrete Pipes". It was "Pipes" before. The last sentence was deleted, which dealt with the preparation of subsoil;
 5.4 was numbered 5.3 before. "(see Section C8)" was added;
 5.5 was added altogether;
 5.6 was 5.4 before, "(see Section C12)" was added.
 5.7 was added altogether.

SECTION R3: CONSTRUCTION OF BOX CULVERTS

Points: 3.11 "(see Section C6)" was added;
 3.3 "soil-cement" was replaced with "cement stabilised";
 "." removed after "percent".
 3.7.1 "see Section C6 & R6 respectively" was added;
 Points: 3.5.2 Remove "precast design" to be "designs";
 3.8 "(see Section C10)" was added;
 4.1 "(see Section C6)" was added;
 4.2 "(see Section C8)" was added;
 4.3 "(See Section C10)" was added;
 4.4 "(see Section C11)" was added;
 4.6 was rewritten, with reference to Section C6. "lab" to be "slab";
 4.7 & 4.8 were added altogether;
 5.1 "(see Section C6)" was added;
 5.2 was re-written, with references to Section C8;
 5.3 "(see Section C10)" was added;
 5.4 "(see Section C10)" was added;
 5.6 was re-written to be consistent with 4.6;
 5.7 was added altogether;
 5.8 "(see Section C7)" was added;

SECTION R4: CONSTRUCTION OF SHELVERTS

This section is a completely new addition to the Specifications. Section R4 was previously PREPARATION OF ROADBED, which is now R5. All subsequent numbering of sections was consequently increased by one numeral. Title should read "CONSTRUCTION OF PRECAST ARCHED CULVERTS".

Points: 1.1 Where the word shelvert first appears substitute "arched" in its place;
 Delete "The completed structure is known as a shelvert"
 Substitute: "Shelverts or similar approved panels can be defined as structures having...drawings"
 Full stop after the word "road"

In the last sentence delete "Shelverts" and substitute "Construction" and delete the word "Constructed";

1.2 Add para 1.2 as follows:

"The following sections specifically covers shelverts and alternative designs must be approved by the Engineer"

SECTION R5: PREPARING OF ROADBED

This section was formerly numbered R4.

Points: 1.1 AFTER "MATERIAL" ", INCLUDING TOPSOIL BELOW THE DEPTH INDICATED BY THE REDUCTION FACTOR," WAS INSERTED;
1.6 & 1.7 were added;
2.3 "(see Section C7)" was added;
2.5 was added altogether;
3.3 "(see Section C7)" was added;
3.5 was added altogether. Delete the words "Page 4" at end of paragraph.

SECTION R6: CONSTRUCTION OF THE SUBGRADE

This section was formerly numbered R5.

Points: 2.1.2 was completely re-worded in much greater detail; "TOPSOIL BELOW THE DEPTH INDICATED BY THE REDUCTION FACTOR," INSERTED AFTER "ANTHEAP";
2.1.5 the second paragraph was added, about termite poison;
2.2.4 & 2.2.5 are completely new. Former point 2.2.4 is now 2.2.6. Thereafter, 2.2.7 is added as a new point;
2.2.6 is completely re-worded from former point 2.2.4;
2.3.2 "b" to be "be";
2.3.5 "(see Section R10)" was added. Delete & replace with: "The top layer of the subgrade shall be compacted as given in "Controlled Compaction (See Section R.11) and all the underlying layers as given in "Semi Controlled Compaction"; deleted entirely & corrected numbering thereafter. Viz no longer reference to additional 150mm of compacted width. RETURNED AS ORIGINALLY DECIDED AND FOLLOWING NUMBERING CHANGED ACCORDINGLY "AT LEAST" WAS DELETED;
2.3.7 was added altogether. Repeat para. from Pg 188 starting with "It will be necessary...the Engineer";
2.3.8 delete & substitute: It will be necessary to compact at least an additional 150mm on each side of the embankment width specified to ensure compaction to the full width of each layer of embankment. The additional compaction shall not be paid for separately and shall be allowed for in the rate for excavation for construction of the subgrade;
2.4 "(Wedge Treatment)" was added to the title;
2.4.1 "(see Section R11)" was added. Delete the word "granular" (This is to allow the use of sand). Add "Where indicated on the drawing or directed by the Engineer the fill shall be constructed in equal lifts on both sides of the structure";
2.4.2 the words "or such other dimensions....indicate" were deleted. The grade is now 1 = 2 instead of 1 = 4;
2.5 "(see Section R11)" was added;
2.7 "(see Section R12)" was added;

- 2.8 Blasting, was added as a new point;
- 3.3.1 to 3.3.8 were completely re-worded;
- 3.4 the second sentence was deleted;
- 3.3.4 (c)change "from" to "form"; (A) "EXPENSIVE " CHANGED TO "EXPANSIVE";
- 3.3.8 (C) "ITEM A" CHANGED TO "ITEM A AND E".
- (J) "REJECTED MATERIALS (CBR C3) TO WASTE" REPLACED "EXPANSIVE CLAYS";
- 3.6 "(see Section R11)" was added;
- 3.7.1 "STONE" CHANGED TO "TONNE";
- 3.8 "(Wedge Treatment)" was added to the title;
- 4.1.2 to 4.1.6 were completely re-written from the original 4.1.2 to 4.1.4;
- 4.1.3 "FILL" CHANGED TO "FULL";
- 4.2 "reinstatement work" was replaced with "clearing, removal....reinstatement work";
- 4.4.1 "(see Section R10)" was added;
- 4.4.2 "(see Section R11)" was added, the same for point 4.5;
- 4.6.2 "(see Section R12)" was added;
- 4.7 "(Wedge Treatment)" was added to the title.

SECTION R7: EXPANSIVE SOILS

This section was formerly numbered R6.

- Points:
- 3.1 Insert "Generally" at beginning of paragraph. "Back" to be "backfilled";
 - 3.2 the second sentence is a re-wording. The second paragraph is an addition;
 - 3.4 "(see Section R6)" was added;
 - 3.5 slightly reworded. Change "dozed" to "placed";
 - 4.2 "(see Section R10)" was added;
 - 4.3 "(see Section R6)" was added;
 - 5.1 was changed to differentiate excavation to waste from excavation to cladding;
 - 5.2 "(see Section R10)" was added;
 - 5.3 "(see Section R6)" was added.

SECTION R8

- Points:
- 3.1 Delete "quantatively or uneconomically impossible";
 - 3.2 Replace "must" with "shall";
 - 3.3 Delete "during the wet season i.e.";
 - 3.4 Delete 1st sentence. Delete "must then" and replace with "shall". "too" should be "to";
 - 4.1 Delete all from "the unit...". Replace with para 21 from Pg 147.;
 - 4.2 Delete "excavate and...the dry season" and replace", with method described in 3.4";
 - 5.1 Delete and replace with "The rate for each hectare of road bed prepared will include for forming, shaping and all rolling necessary to achieve the densities specified";
 - 5.2 "3.5" should be "3.4".

SECTION R9: DRAINS

This section was formerly numbered R7. In fact one Section COLLAPSING SOILS R8, is missing as yet and will be produced at a later stage by the Consultants (has been inserted for proof-reading & discussion).

- Points:
- 3.5 is split into 3.5.1. and 3.5.2, the latter being an addition;

- 4.1.2 "see Section C6 was added;
- 4.2 "Excavation for...." added to the title. "(see Section C6): added;
- 4.4 "Piped..." was added to the title;
- 5.1 "(see Section R10)" was added;
- 5.2 "Excavation for..." was added to the title, "see Section C6" was added ;
- 5.4 "Pipes for..." added to the title.

SECTION R10: SEMI CONTROLLED COMPACTION

This section was formerly numbered R8.

- Points:
- 1.4 "lopes" corrected to "slopes";
 - 1.5 deleted entirely & numbered appropriately. Viz no longer reference to additional 150mm of compacted width; RETURNED TO WHAT ORIGINALLY THERE AND RENUMBERED ACCORDINGLY "AT LEAST" WAS DELETED.
 - 1.6 the density is now specified as 89% Mod AASHTO.
 - 2.1 the second sentence is an addition.
 - 2.2 is an addition altogether;
 - 3.3 "(see Section C7)" was added
 - 4 Inserted & reads as "Testing shall be in terms of Section C14 - Testing".

SECTION R11: CONTROLLED COMPACTION

This section was formerly numbered R9.

- Points:
- 2.1.1 the second sentence was added. "bumped" to "dumped"
 - 2.1.2 was completely re-worded; Deleted entirely & numbered appropriately; CHANGED AS ORIGINALLY AGREED UPON AND NUMBERING CHANGED ACCORDINGLY, "AT LEAST" WAS DELETED;
 - 2.2.3 "test" inserted before "holes";
 - 2.3 & 2.4 were added altogether. "Central African Standards" to "S.A.Z.S."; changed to "relevant Standard of the Standards Association...";
 - 3.2 & 3.3 were added;
 - 3.4 was Point 3.2 before and was not altered. Change word before material to "of" and add "watering" before "compaction";
 - 3.5 "...and Reject Material: was added to the title, "(see Section C7)" was added;
 - 4.2 & 4.3 were added. Consequently former Point 4.2 was renumbered 4.4;
 - 4.5 "...and Rejected Material" was added to the title, "(see Section C7)" was added.
 - 5. Added, reads as "Testing shall be in terms of Section C14 - Testing";

SECTION R12: STABILISATION WITH LIME OR CEMENT

This section was formerly numbered R10.

- Points:
- 1 the second paragraph was added;
 - 2.1 C.A.S. No A19 was replaced with S.A.Z.S. No A19;
 - 2.2 C.A.S. No A46 was replaced with S.A.Z.S. No A46;
 - 3.5 "(see Section R11)" was added;
 - 3.6 delete all sentence after "six hours of the" and

- 3.7 substitute "commencement of hydration of the cement";
delete everything after word "addition" and add "of lime";
- 3.8 (ii) "(see Section R16)" was added.
- 3.11 NUMBERING CORRECTED "3.11" CHANGED TO "3.12"

SECTION R13: GRAVEL CRUSHING

This section was formerly numbered R12. Former Section R11 GRAVEL STOCKPILING is cancelled and its contents are incorporated in the new Section R14 THE SUPPLY OF MATERIALS FOR USE IN THE CONSTRUCTION OF THE PAVEMENT.

- Points:
- 5.1 Add 2nd paragraph as follows:
Alternative methods for hauling and stockpiling of ormsbed gravel will be considered by the Engineer;
 - 5.2 after the word "through" add "an appropriately sized square mesh screen to achieve the grading specified" deleting the words "a 25mm";
 - 5.6 Place a comma after measurement. Delete next sentence up to "metre" and substitute and a maximum height of 3 metres.

SECTION R14: THE SUPPLY OF MATERIALS FOR USE IN THE CONSTRUCTION OF THE PAVEMENT

This section was formerly numbered R13.

- Points:
- 1.2.2 this point was re-worded;
 - 1.2.3 was added;
 - 1.3 "AND WATER POINTS" INSERTED AFTER DEPOSITS AND "AND TO A SPECIFICATION" INSERTED AFTER ALIGNMENT;
 - 1.5 "Excavation and..." was omitted in the title;
 - 1.5.3 "(generally rectangular and...not exceeding 4000m3)" was added;
 - 1.5.4 was added;
 - 1.6 it is now entitled "Rehabilitation of the Deposit Area" and no more "Reject Material", the content of the latter is not included in the next text;
 - 1.6.1 1.6.2 & 1.6.3 were added;
 - 2.1 "... as Plant hire and dayworks: is replaced with "...as given in Construction of Detours (see Section C3)"; AFTER "MEASURED" EVERYTHING DELETED AND REPLACED WITH "BY THE HECTARE OF ROAD CONSTRUCTED AS APPROVED BY THE ENGINEER";
 - 2.2 the title was only "Clearing" the rest is added;
 - 2.3 typed twice & incomplete - remove 1st attempt;
 - 2.4 & 2.5 replace former points, 2.4 Excavation, 2.5 Rejected Material, 2.6 Knapped material, 2.7 Rehabilitation;
 - 3.1 "...or as plant hire and dayworks" was replaced with "...as given in Construction of Detours (see Section C3)"; "PAYMENT" DELETED AND REPLACED WITH "THE RATE PER HECTARE", AFTER ROADS EVERYTHING DELETED AND REPLACED WITH "WILL INCLUDE FULL COMPENSATION FOR ALL INDICIDENTAL AND NECESSARY THERETO";
 - 3.2 ,3.3 & 3.4 are now made consistent with 2.3, 2.4 & 2.5.

SECTION R15: CONSTRUCTION OF THE PAVEMENT

This section was formerly numbered R14.

- Points: 1 "...placing..." was replaced with "loading from stockpile, hauling and placing.";
- 2.3 "(see Section R12)" was added;
- 3.2 Section added (ex old R14 Clause 3.2) on Provision of Materials in Pavement. Section on waste minimisation also incorporated;
- 3.4 "(see Section R11)" was added;
- Points: 3.5 & 3.6 were added;
- 3.7 Stabilisation, and all sub-points, replaces 3.5 Stabilisation, in the old version of the Blue Book. The content of former 3.5 is the same as the new point 3.7.1, with the addition of "(see Section R12)". The remaining points are new;
- 3.8 is the same as former point 3.6, except that:
- 3.8.1 the second & third paragraphs are added; 3rd para removed entirely. Viz no additional 150mm of compacted width required; THIRD PARAGRAPH REINTRODUCED AND "AT LEAST" DELETED;
- 3.8.2 table-the column for Base IV was added; changed to "to the table on the following page";
- 3.9 is the same as former point 3.7;
- 4.1.4 "...the cubic metres hauled away" was replaced with "...be measured as given in Controlled Compaction (see Section R11)";
- 4.1.5 was added;
- 5.1.2 "(see Section R11)" was added; and extended to make allowance for the additional material for the extra width of pavement to allow compaction;
- 5.1.3. was completely re-worded;
- 5.1.4 was added;
- 5.5 reference to paragraph 3.7 was correctly amended to 3.9, in the new text.

SECTION R16: PRIME COAT

This section was formerly numbered R15.

- Points: 2.1 CAS No 145 was replaced with S.A.Z.S. No 145;
- 2.2 CAS No 105 was replaced with S.A.Z.S. No 105.
- 5.4 Added to allow for partial payment for variations outside specifications. "Time" becomes "times". At beginning of last sentence add the word "For". Add the following "Irrespective of the above the Engineer may direct that corrective measures be taken at the Contractors expense".

SECTION R17: SURFACE TREATMENT

This section was formerly numbered R16.

- Points: 1.4 Add para 1.4 P.V.C./Tar or other approved binders may be considered by the Engineer;

- 2.1 only 150/200 penetration bitumen is retained, conforming to S.A.Z.S. No 144 instead of CAS No 144, both for the tack and the seal coat. R.T. is cancelled;
- 2.2 CAS No 232 was replaced with S.A.Z.S. No 232;
- 3.3.2 Change to 3.3.1.4;
- 3.3.2.1 Change to 3.3.1.5 - numbering thereafter changed;
- 3.5.1 "... to the width of the carriageway..." was added;
- 3.5.2 "... and the primed shoulders...road formation..."was added;
- 3.5.3 was cancelled as it is already contained in 3.5;
- Points: 3.6.1 table: the last line was cancelled;
- 3.6.2 table: is cancelled and only the data for the bitumen is retained (the TARS are cancelled);
- 3.6.7 was added;
- 3.6.8 is the same as former point 3.6.7;
- 3.7.1 "...within 15 minutes of spraying..." was replaced with "...immediately behind the spraying...";
- 3.8.4 reads like former point 3.8.5, while former point 3.8.4 was cancelled.
- 5.2.4 add new para: During sealing should the overall binder applied not be according to specification there will be a reduction in payment as follows:
For up to 3 times the permitted variance only 80% payment will be made.
For more than 3 times the permitted variance only 60% payment will be made.
Irrespective of the above the Engineer may direct that corrective measures be taken at the Contractors expense. "than" changed to "there".

SECTION R18: RESEALING

This is a completely new section. In the old version of the Blue Book, R18 was entitled BITUMINOUS CONCRETE, which is now the title of the new Section R20.

- Points: 2.1 Added "PVC/Tar or other approved binders may be considered by the Engineer";
- 3.4.1 Add after "depth" when measured with a 3 metre straight edge as outlined in paragraph 3.8.2 C.1 of Section R.15;
- 3.4.2 Add: Patches should be rectangular or diamond in shape;
- 5.2.3 delete and substitute.
There will be a reduction in the payment for any applications which do not meet specifications as follows:

For up to 2 times the permitted variance only 80% payment will be made.
For more than 2 times the permitted variance only 60% payment will be made. Irrespective of the above the Engineer may direct that corrective measures be taken at the Contractors expense.

SECTION R19: EMULSION SLURRY

This section was formerly numbered R17.

- Points: 2.2.1 CAS No 232 was replaced with S.A.Z.S. No 232;

- 6.1.3 After "A" add "proportional"
Add new paragraph "Irrespective of above the Engineer reserves the right to direct that corrective measures be taken at the Contractor's expense".

SECTION R20: BITUMINOUS CONCRETE

This section was formerly numbered R18.

- Points:
- 1.2.3 added onto "concrete" "permanently incorporated in the works";
 - 1.3 (a) "(See Section R11 and R16 respectively)" was added;
 - 2.1.1 "60/70" was added, as well as the last sentence. CAS 144 was replaced with S.A.Z.S. 144;
 - 2.1.2 CAS 105 was replaced with S.A.Z.S. 105;
 - 2.1.3 "(see Section R16)" was added;
 - 2.1.4 Tack Coat" add "Fog-spray" after;
 - 2.2.6 "10 tonne" was replaced with "100 KN";
 - 2.3.1 "um" corrected;
 - 2.3.4 "um" corrected;
 - 3 "ROAD" INSERTED AFTER "ACCESS"; AFTER "IN" "THE SUPPLY OF MATERIALS FOR USE IN THE CONSTRUCTION OF THE PAVEMENT" (SEE SECTION R.14)" WAS INSERTED;
 - 3.1.1 "um" corrected;
 - 4.3.2 "um" corrected;
 - 7.3 Tack Coat" add "Fog-spray" after;
 - 12.1 "(see Section R16)" was added;
 - 12.3 Insert after "concrete" - "permanently incorporated in the works";
 - 13.1 "(see Section R16)" was added;
 - 13.3.1 delete paragraph as written and substitute Paragraph 2 of 13.4.2.;
 - 13.3.2 was cancelled;
 - 13.4 (1 and 2) was added.

SECTION R21: SPALLING AND CRUSHING STONE

This section was formerly numbered R19.

- Points:
- 1.2 new gradings introduced. Standards S.A.Z.S. 233 and S.A.Z.S. 232 were introduced;
 - 1.3 "...or dust." was replaced with "...or unscreened crusher dust";
 - 1.4 was added altogether;
 - 3 "Accommodation of Public Traffic during Construction was replaced with "Construction of Detours" (see Section C3)";
 - 7.1 CAS No 232 was replaced with S.A.Z.S. No 232;
 - 7.2 CAS No 233 was replaced with S.A.Z.S. No 233;
 - 7.4 CAS No 233 was replaced with S.A.Z.S. No 190.

SECTION R22: FENCING

This section was formerly numbered R20.

- Points:
- 1 "...temporary or permanent..." was added;
 - 2.1 Barbed wire for permanent and temporary fencing has been altered to comply with S.A.Z.S. 284;
 - 2.2 CAS No 5 Part 2 and No. 07 were replaced with S.A.Z.S. 284 and S.A.Z.S. 07.
 - 2.3 & 2.4 CAS No N5 Part 2 (and 3) and N0 07 were replaced

- 2.5 with S.A.Z.S. 184 and S.A.Z.S. 07;
& 2.6 CAS No N5 Part 4 was replaced with S.A.Z.S. 284;
- Points: 2.7 CAS No N5 Part 6 was replaced with S.A.Z.S. 284;
- 2.8 CAS No N5 Part 5 and No 07 were replaced with S.A.Z.S. 284 and S.A.Z.S. 07.
- 3.1.1 "...both temporary and permanent..." was added;
- 3.4 the case of temporary fencing (2 droppers) was added;
- 3.8 & 3.9 were added altogether;
- 5.1 the second paragraph was added.

SECTION R23: CATTLE GRIDS

This section was formerly numbered R21.

- Points: 1.2 "(see Section R22)" was added;
- 2.1 "(see Section C8)" was added.

SECTION R24: SUPPLY & PLACING OF PRECAST CHANNELS, FLUMES, KERB BLOCKS, GUIDESTONES AND GUARDPOSTS, KILOMETRE MARKERS

This section was formerly numbered R22.

- Points: 1.1 was re-worded;
- 1.2 "The work shall..." was replaced with "All the work carried out must..";
- 2.1 "...and for the construction of any in-situ item as specified..." was added;
- 2.2 was added;
- 3.1 "(see Section C8)" was added;
- 3.2 "...for precast units..." was added;
- 3.4 was added;
- 5 the second sentence was added.

SECTION R25: ALLOWANCE FOR EXTRA WORK

This section was formerly numbered R23.

- Points: 3.1 "...unless specifically directed by the Engineer" was added.

SECTION R26: CARRIAGE WAY MARKERS

This section is an addition altogether.

- Points: 1.2 added on end "[Publication RGN573 of 1973 and Manual Part K (Traffic B)]";
- 6.0 Substitute Manufacturer for the word Contractor.
- 15 (b) deleted - numbering changed accordingly;
- 16 Added TESTING: "Testing shall be in terms of Section C14 - Testing".

SECTION R27: TRAFFIC SIGNS

This section is an addition altogether.

Points: 1.2 enlarge by adding. "Upon request the Contractor will be supplied with the name and address of the firm that is the supplier to the Ministry at the time. The Contractor will be required to supply all signs needed on the Contract to the same standard as supplied to the Ministry". After "Regulations" added "[Publication RGN573 of 1973 and Manual Part K (Traffic B)]";

5.0 After "Accomma & Equip" add (See section C.2).

* * * * *

INDEX

A

Access Roads..... 20, 185, 187
ACCOMMODATION..... 7, i
Additives 31
ADJACENT OWNERS..... 12
Aggregates..... 31, 32, 223, 235
antheps 27
Anti Erosion Works..... 28

B

Backfill 26, 140, 145, 148, 150, 151, 167, iii
BACKFILL 24, x
BACKFILLING 22, iii
BARRICADES..... 11
Barricades & Signs 13
Bituminous Concrete..... 4, 232, 233
Bolsters 64, 66, 67, vi
BOND..... 5
BORING..... 26
Box Culverts..... 3, 144
BOX CULVERTS..... 141, x

C

Cattle Grids..... 4
Cement.. 2, 3, 24, 30, 31, 32, 35, 43, 45, 49, 61, 62,
83, 109, 136, 137, 140, 141, 144, 145, 146, 149,
150, 151, 158, 165, 172, 173, 174, 181, 189,
190, 191, 217, 224, 241, 243, iii
CEMENT..... 30, 43, 181, 243, iv, xiii
Clearing 2, 3, 12, 13, 78, 79, 131, 132, 135, 163,
164, 184, 185, 187, 188, ii, xiv
CLEARING..... 21, 78, 128, 234, vii, ix
Collapsing Soils..... 3
Compaction .. 3, 28, 38, 75, 76, 131, 132, 147, 157,
158, 163, 165, 167, 176, 178, 179, 181, 190,
193, 194, 219, 222, 231, vi, xi, xv
Concrete
in-situ..... 41, 42
precast..... 41, 42
CONCRETE 30, 43, 51, 52, 222, 224, 228, 243, iv,
v, xvi, xvii
no-fines 45
Concrete Interlocking Blocks 64
Concrete Mixes..... 30
Concrete Sampling 34
Construction Joints 39
Control Tests 38

CURING..... 40, 243

D

DEMOLISHED MATERIALS 21
Detours 2, 10, 13, 14, 28, ii, vii, xiv, xvii
DETOURS 10, 11, i, iv
Drains 3, 164, 170, 171, 172, 173, 174, 242

E

Earthworks 27, 128, 161
Emulsion Slurry..... 4, 217
Engineer's accommodation..... 7
Equipment 2, 8, 19, 46, 86, 87, 88, 90, 195, 200,
208, 219, 253
EQUIPMENT..... 7, 227, 249, i
ESTABLISHMENT 5, i
Excavation.... 2, 22, 25, 66, 67, 110, 128, 129, 131,
132, 137, 138, 139, 140, 141, 142, 144, 145,
146, 147, 148, 149, 150, 151, 159, 160, 161,
162, 163, 164, 166, 167, 172, 173, 208, 241, xiii,
xiv
EXCAVATION..... 22, 24, 128, iii
existing structure 21
EXISTING STRUCTURE vii
EXISTING STRUCTURES 21, iii
expansive material..... 26, 27, 166, 167
Expansive Soils 3
EXPLOSIVES..... 24, 131, 235

F

FAILURE
cubes..... 40
Fencing..... 4, 61, 239, 240, 241
Formwork
defective 50
FORMWORK 46, 47, 48, 51, v
FOUNDATIONS 23, 80, vii, x

G

Gabions 62
GENERAL COSTS..... 5
Grass Seeding..... 65, 66, 68
Gravel 3, 28, 185, 191
Gravel for Roads 28
Gravelling..... 10, 13, 14, ii
Grout 61
GUARDRAIL 109, viii

H

Haul .. 2, 13, 14, 19, 26, 27, 68, 132, 133, 145, 146,
150, 151, 153, 163, 164, 169, 176, 179, 180,
193, 194
HAUL 27, iv

I

INSPECTION 23
Insurance 6
INSURANCE 5

M

MEASUREMENT 12, 19, 21, 24, 27, 41, 45, 50,
57, 66, 78, 86, 92, 96, 97, 100, 102, 104, 107,
110, 112, 117, 124, 127, 131, 135, 139, 144,
149, 152, 159, 166, 172, 176, 178, 182, 184,
187, 192, 197, 204, 213, 220, 232, 236, 242,
244, 245, 251, 253, ii, iii, vii
MIX DESIGN PROPOSALS 33

O

Overhaul 2, 13, 14, 19, 26, 27, 28, 29, 68, 132, 133,
145, 146, 150, 151, 153, 163, 164, 169, 176,
179, 180, 193, 194, ii, vi
OVERHAUL 26, 27, ii, iv

P

PAYMENT . 6, 8, 13, 19, 21, 25, 29, 42, 45, 50, 58,
67, 79, 88, 92, 96, 98, 100, 102, 104, 108, 110,
112, 118, 124, 127, 132, 135, 140, 145, 150,
153, 163, 167, 169, 173, 176, 179, 182, 184,
187, 193, 198, 205, 213, 221, 233, 236, 240,
242, 244, 245, 251, vi, ii, vii, xiv
Pipe Culverts 3, 13, 14, 137, ii
PIPE CULVERTS 136, iv, ix
Plums 31
PRECAST ARCHED CULVERTS 147
Preparation of Roadbed 3, 152
Prime Coat 4, 125, 216, 222, 229, 232
PUMPING 24

R

Ready Mix Concrete 38
Rehabilitation 12, 13, 15, 186, 187, 188, ii, xiv

REHABILITATION 12, ii
Resealing 4
Rock 22, 25, 61, 63, 82, 87, 88, 129, 159, 160, 162,
163, 164

S

SAFETY 24
SALVAGEABLE MATERIAL 21
Slope Protection 2, 28, 151
SLOPE PROTECTION 61, iv, v
Spalling & Crushing Stone 4
Special Treatment to Foundations 25, 26
Stabilising ... 25, 140, 141, 145, 146, 150, 151, 163,
165, 189, 191, 193, 194, iii
Stabilising Agent 26
Steel Fabric 54, 61
STEEL REINFORCEMENT 54, v
SUBSOIL 22
SURETY 5
Surface Treatment 4, 207, 208, 216

T

Tender 5, vi
Testing .. 2, 20, 33, 34, 42, 54, 56, 59, 96, 101, 119,
176, 178, 180, 251, iii, iv, v, ix, xiii, xviii
TESTING ... 20, 59, 77, 95, 96, 119, 129, 176, 180,
248, 249, 251, iii, vi, xviii
TESTS 42
TOLERANCES 50, 51, 52, 232, 249
Topsoil 62, 64, 66, 68, vi
Traffic Signs 4, 11, 247, 252
TREATMENT 23, 199, x, xv

V

VEHICLES 7, i

W

Water 2, 18, 19, 28, 31, 33, 36, 67, 68, 153, 162,
165, 167, 169, 176, 177, 179, 180, 181, ii, vi
WATER 18, 43, ii, xiv
Watering 13, 14, 153, 169, 175, 176, 177, 179, 190,
ii
WORKS STRENGTH TESTS 33