



Islamic Republic of Afghanistan
Ministry of Public Works

NATIONAL EMERGENCY RURAL ACCESS PROGRAM

ROAD & BRIDGE REHABILITATION PROJECT

TECHNICAL SPECIFICATION

July 2007

MINISTRY OF PUBLIC WORKS

KABUL, AFGHANISTAN

Table of Contents

- | | |
|--|-----------------------------------|
| 1. Technical Specification Series – 1000 | : Preliminary and Site Facilities |
| 2. Technical Specification Series – 2000 | : Clearing and Earthworks |
| 3. Technical Specification Series – 3000 | : Soil/Aggregate Pavement |
| 4. Technical Specification Series – 4000 | : Bituminous Pavement |
| 5. Technical Specification Series – 5000 | : Miscellaneous Works |
| 6. Technical Specification Series – 6000 | : Concrete Production |
| 7. Technical Specification Series – 7000 | : Concrete Construction |
| 8. Technical Specification Series – 8000 | : Pre-cast Concrete |
| 9. Technical Specification Series – 9000 | : Prestressing |
| 10. Technical Specification Series – 10000 | : Piling Works |
| 11. Technical Specification Series – 11000 | : Metal Work and Structural Steel |
| 12. Technical Specification Series – 12000 | : Bridge Bearing & Deck Joints |

TECHNICAL SPECIFICATION
SERIES-1000
PRELIMINARY AND SITE FACILITIES

Item Number	Page No.
1100 General requirement and Provision	1-5
Scope	1-5
Program of works	1-5
Workman ship and Quality Control	1-5
Measurement and Payment	1-6
Substantial completion of works	1-7
Protection of works	1-7
Remedial works	1-7
Sign board	1-8
Payment and Tolerance	1-8
Photographic record	1-8
Access to site	1-8
Security of works	1-8
Suppression of Noise	1-8
Safety	1-9
Work methodology	1-9
Temporary works	1-9
Provision for Traffic	1-9
Testing materials	1-10
Materials testing by Independent Laboratory	1-11
Special and Additional testing	1-11
Staff for materials testing	1-11
Test results and record	1-12
Measurement and payment	1-12
Approval of source of materials	1-12
Stockpiling of materials	1-12
Control test on materials stock piles	1-13
Compaction equipment	1-13
Compaction	1-13
Compaction trail	1-13
Compaction control	1-13
Mixing and control of moisture	1-14
Drainage during construction	1-14
Protection of existing Embankment	1-14
Disposal of hauling equipment	1-14
Playing Traffic	1-14
Drawing	1-14

1200 Contractor's Establishment	1-15
Scope	1-15
Sitting of construction camp	1-15
Provision of facilities, plant and equipment	1-15
Compliance with condition of contract	1-15
Field office for the Engineer's Facilities	1-15
Sanitation	1-15
Field office for the Engineer and his field staff	1-15
Contractor office equipment	1-16
Survey equipment	1-16
Levels and Levelling Staff	1-16
Theodolites	1-17
Measurement and Payment	1-17
Payment	1- 17
As built drawing	1-17
 1300 Transport for the Engineer	 1-19
General	1-19
Items of Transport	1-19
Operation and Maintenance of vehicle	1-19
Measurement and Payment	1-20
 1400 Environmental and Social Protection	 1-20
1401 General	1-20
1402 Land Acquisition	1-20
1403 Contractor Activities	1-20
1404 Entry upon land with side boundary	1-21
1405 Provision of construction materials	1-21
1406 Construction Camp	1-21
1407 Restoration of construction camp site	1-21
1408 Environmental measure	1-22
1409 Erosion control	1-22
1410 Establishment of vegetable	1-22
1411 Trap, Bench, Toe, and road side diversion	1-22
1412 Silt fences	1-22
1413 Clearing	1-22
1414 Disposal and unsuitable/Excess materials	1-22
1415 Extraction of river gravel	1-23
1416 Protection of vegetable	1-23
1417 Condition of plant and machinery	1-23

1418	Fuel storage and refueling	1-23
1419	Site restoration	1-23
1420	Measurement and Payment	1-23
1500	Setting out Horizontal and Vertical Alignment	1-25
	Scope	1-25
	Construction method	1-27
	Measurement and Payment	1-28
1600	Terms and Definition	1-24
	Terms and definition	1-24
	Other Character	1-27
	Measurement and Payment	1-28
1700	Demining and UXO clearance	1-29
	General	1-29
	Mine clearance Agencies	1-29
	Clearance Agencies	1-29
	Detail Technical survey	1-31
	Clearance	1-31
	Quality Management Plan	1-31
	Liability	1-31
	Demining Facilitator	1-31
	Qualification	1-31
	Duties	1-31
	Responsibilities and Authorities	1-32
	Mine and UXO disposal and clearance Operation	1-32
	Method of Payment	1-32
	Basis of Payment	1-32

Section 1100: General Requirements and Provisions

1101 Scope

This Section covers matters which relate to the construction work as a whole.

1102 Programme of Work

The programme of work required in terms of the General Conditions of Contract shall be submitted to the Engineer not later than 14 days after the Contractor has been issued with the order to commence.

The Programme shall not be in the form of a **bar chart** only, but shall show clearly the anticipated quantities of work to be performed each week/month, (Construction Planning) the resources to be applied to each activity, as well as the anticipated earnings for the various sections of work. If, during the progress of the work, the quantities of work performed per week/month fall below those shown in the programme, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Contractor shall, within one week after being notified by the Engineer, submit a revised programme.

If the programme is to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing the modifications to the original programme necessary to ensure completion of the works or any part thereof within the time for completion or any extended time granted as per the Conditions of Contract. Any proposal to increase the tempo of the work must be accompanied by positive steps to increase production by providing more labour and plant on Site, or by using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to work according to the programme or revised programme shall be sufficient reason for the Employer to take steps as provided for in the Conditions of Contract and shall be construed as not executing the Works in accordance with the Contract.

The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer would be satisfied if the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme, nor shall it limit the right of the Engineer to instruct the Contractor to vary the programme should circumstances make this necessary. The above shall not be taken to limit the right of the Contractor to claim for damages or extension of time to which he may be fairly entitled to in terms of the General Conditions of Contract for delay or disruption of his activities.

Should the Employer request and the Contractor undertake to finish the whole or part of the Works ahead of the time originally required by the Contract, payment for accelerating the work shall only be made if agreed to beforehand in writing and according to the terms of such agreement.

1103 Workmanship and Quality Control

The onus is on the Contractor to produce work which conforms in quality and accuracy of detail to the requirements of the Specifications and/or Drawings, and the Contractor must, at his own expense, institute a quality control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

The cost of all supervision and process control, including testing, so carried out by the Contractor, shall be deemed to be included in the rates tendered for the related items of work except that the cost of certain tests and the provision of certain items of testing and sampling equipment will be paid for separately as provided for in those Sections of the Specifications where this applies.

Unless otherwise instructed by the Engineer, the Contractor shall obtain approval for each layer of the works, in embankments, sub-grade, or any gravel or pavement layers and shall not proceed with subsequent layers until each approval is granted. The Contractor shall be required to give reasonable notice to the Engineer to allow any inspection to be carried out. If any test is required to verify compliance with these specifications, then the Contractor shall plan his Works so as to allow the Engineer sufficient time to carry out such tests. Unless instructed otherwise, the Contractor may proceed with the Works even though the results of tests may not yet be available. However, the Contractor shall be required to re-execute work if tests indicate non-compliance with these Specifications. Any approval given by the Engineer shall not relieve the Contractor of any of his obligations under the Contract.

1104 Measurement and Payment

Bill of Quantities

The quantities set out in the Bill of Quantities are estimated quantities and are used for the comparison of Tenders and awarding the Contract. It must be clearly understood that only the actual quantities of work done or materials supplied will be measured for payment, and that the billed quantities may be increased or decreased as provided for by the General Conditions of Contract.

Contract Rates

In computing the final contract amount, payments shall be based on actual quantities only of authorized work done in accordance with the Specifications and/or Drawings. The tendered rates shall apply, subject to the provisions of the General Conditions of Contract, irrespective of whether the actual quantities are more or less than the billed quantities.

The Contractor shall accept the payment provided in the Contract and represented by the prices tendered by him in the Bill of Quantities, as payment in full for executing and completing the work as specified, for procuring and furnishing all materials, labour, supervision, plant, tools and equipment, for wastage, transport, loading and offloading, handling, maintenance, temporary work, testing, quality control including process control, overheads, profit, risk and other obligations and for all other incidentals necessary for the completion of the work and maintenance during the Period of Maintenance.

In particular the Contractor shall be deemed to have included time related and fixed costs as specified in Section 1200 under the appropriate items in the General and Preliminary Section of the Bill of Quantities and not in rates for work items.

Pay items

The descriptions under the pay items in the various Sections of the Specifications, indicating the work to be allowed for in the tendered prices for such pay items, are for the guidance of the Contractor and do not necessarily repeat all the details of work and materials required by and described in the Specifications.

These descriptions shall be read in conjunction with the relevant Specifications and/or Drawings and the Contractor shall, when tendering, allow for his prices to be inclusive as indicated above.

Materials on Site

Payment for material will be made only for steel delivered at the site as it is separately itemized in the BOQ. Paying for other materials stocked at site will complicate the payment system as they are clubbed into works and not itemized separately. The payment will be made once it tallies with the specification.

Provisional Sums

The Bill of Quantities may contain certain Provisional Sums so designated and entered as a preliminary allowance to cover the cost of work, materials, goods or services to be provided by the Contractor and which have not been fully specified or measured or to cover the cost of unforeseen items of work or contingent expenditure. Work done under a Provisional Sum shall only be executed upon a written order by the Engineer which order shall also specify the method of payment.

The Contractor shall furnish to the Engineer such receipts or other vouchers as may be necessary to prove the amounts paid and, before ordering materials, shall submit to the Engineer quotations for the same for his approval. In respect of such of the works executed on a day works basis, the Contractor shall, during the continuance of such work, deliver each day to the Engineer an exact list of the names, occupation and time of all workmen employed on such work and a statement showing the description and quantity of all materials and equipment used other than the Contractors equipment which is included in the percentage addition in accordance with such day work schedule. Each list and statement will, if correct, or when agreed, be signed by the Engineer and a copy returned to the Contractor.

The Contractor shall not be entitled to any payment unless such lists and statements have been fully and punctually provided. Where the Engineer considers that for any reason the provision of such lists was impracticable he shall nevertheless be entitled to authorize payment for such work provided that, such work or value thereof shall, in his opinion, be fair and reasonable.

1105 Substantial Completion of the Works

The Contractor shall note that the Engineer reserves the right not to certify the Works to be “substantially completed” as required by the General Conditions of the Contract, unless the following portions of the Works are completed according to the Specifications:

- (a) All bituminous seal works or, where a seal is not included, the uppermost gravel layer.
- (b) All drains and drainage structures, for the construction of which timeous instructions were given by the Engineer.
- (c) Finishing of all support or retaining structures.

Opening of individual sections or lots shall not entitle the Contractor to receive a Completion Certificate.

1106 Protection of the Works and Requirements to be met before Construction of New Work on top of Completed Work is Commenced

The Contractor is to provide temporary drainage works such as drains, open channels, banks, etc. and furnish and operate temporary pumps and such other equipment as may be necessary to adequately protect, drain and dewater the works and temporary works. This will be in addition to any permanent drainage works specifically paid for separately. Care shall be exercised to keep all completed layers properly drained, not to cause dumps of material on completed layer work to inhibit surface drainage or to form wet spots under and around dumps, and to protect all parts of the work against erosion by floods and rain.

Material shall not be spread on a layer that is so wet such as to damage underlying layers or prevent adequate compaction of overlying layers. Such wet layers shall be dried and recompacted or removed. Excavations for pipe drains, culverts, sewer drains, water mains, manholes, service ducts and similar structures shall be adequately protected against the possible ingress of water during rainstorms.

All completed layer work shall be protected and maintained until the following layer is applied. Maintenance shall include immediate repairs to any damage or defects which may occur and shall be repeated as often as is necessary to keep the layer continuously intact and in a good condition. Before any completed layer is primed or a succeeding layer constructed thereon, any damage to the existing layer shall be repaired so that after repair or reconstruction if necessary, it will conform in all respects to the requirements specified for that layer. All repair work other than minor surface damage repairs shall be submitted to the Engineer before covering up.

Work performed as part of the above obligations shall not be measured and paid for separately and the cost thereof is to be included in the prices tendered for the various items of work requiring protection and for the Contractor's establishment on Site as specified in Section 1200.

1107 Remedial Work

When any part of the Works or any equipment or material is found upon examination by the Engineer not to conform to the requirements or is at any stage before final acceptance damaged so that it no longer conforms to the requirements of the Specifications, the Engineer may order its complete removal and replacement, at the Contractor's expense, with satisfactory work, equipment or material or he may permit the Contractor to apply remedial measures in order to make good any such defects or damage. The actual remedial measures taken shall at all times be entirely at the Contractor's own initiative, risk and cost, but subject to the Engineer's approval regarding the details thereof.

In particular, remedial measures shall ensure full compliance with the Specifications of the final product, shall not endanger or damage any other part of the Works and shall be carefully controlled.

1108 Sign Boards

The Contractor shall provide identification sign boards. A signboard is to be erected at each end of the works and maintain them in good condition. All information on the signboards will be written in English and Dari/Pashto. The signboards will be positioned as directed by the Engineer. The Contractor shall submit proposals for the materials of the signboards, the text layout and installation of the signboards on Site to the Engineer for approval. Each sign shall show:

Name and Number of Contract

Name of Employer and Employer's Agent

Length of Works

Cost of Works

Date of Commencement and Completion.

1109 Payments and Tolerances

The work specified in the various sections of these Specifications shall comply with the various dimensional and other tolerances specified in each case. Where no tolerances are specified, the standard of workmanship shall be in accordance with normal good practice.

Where the work is not as constructed provided that the dimensions are not so far below the minimum specified that in the Opinion of the Engineer they will not function adequately with the "authorized" dimensions, plus or minus any tolerances allowed, the engineer may nevertheless in his sole discretion accept the work for payment. In such cases no payment will be made in respect of quantities of work or material in excess of those calculated from the "authorized" dimensions and where the actual dimensions are less than the "authorized" dimensions, minus any tolerance allowed, quantities for payment shall be based on the actual dimensions as constructed.

1110 Photographic Records

The Engineer shall make photographs and other records to be agreed with the Contractor of the condition of the surfaces of the site immediately before entering upon them for the purpose of constructing the Works. Each month, the Contractor shall make a set of up to 100 digital colour photographs illustrating progress of the Works, or any other photograph that he may deem necessary for record purposes, and provide these to the Engineer for his records. The copyright of all photographs shall be vested in the Employer and the Contractor shall not use any photograph for any purpose whatsoever without the Engineer's approval.

1111 Access to Site

The Contractor shall make his own arrangements for access to the various parts of the Site where works are to be constructed but all such accesses shall be subject to the approval of the Engineer.

Where the access to the Site proposed to be used by the Contractor lies across the land of any third party the Contractor shall produce to the Engineer the written consent of the owner and the occupier of the land over which the access lies before making use of the same.

The Contractor shall also make a record to be agreed by the Engineer of the conditions of the surfaces of any land (and of any crops on such land) over which access lies before he uses it for access purposes and he shall keep all such surfaces in a reasonable state of repair during the executing of the Works. On the termination of the Contractor's use of such access he shall restore any lands, roads or other property to a condition at least equal to that existing before his first entry upon them.

1112 Security of the Works

Watching of the Works shall be provided by the Contractor at his own expense. If the Engineer considers it necessary he will order in writing that additional watchmen be provided all at the Contractor's expense.

1113 Suppression of Noise

The Contractor shall make every reasonable endeavor both by means of temporary works and by the use of appropriate plant or silencing devices to ensure that the level of noise resulting from the execution of the Works does not constitute a nuisance.

1114 Safety

The Engineer shall be notified by the Contractor immediately any accident occurs whether on Site or off Site in which the Contractor is directly involved which results in any injury to any person whether directly concerned with the Site or whether a third party. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the accident.

Transportation of any material by the Contractor shall be in suitable vehicles which when loaded do not cause spillage and all loads shall be suitably secured. Any vehicle which does not comply with this requirement or any of the local traffic regulations and laws shall be removed from the Site.

1115 Work Methodology

The Contractor shall submit work methodology for his whole work for the [prior](#) approval from the Engineer and adopt a method of working such as to permit the satisfactory and timely completion of the Works and to limit disturbance and damage to a minimum.

The Contractor shall only open up sections of the Works for which his resources are sufficient to maintain continuous and methodical progress. If in the opinion of the Engineer, the Contractor has not complied with the foregoing, he shall be entitled to suspend sections of the works as per the General Conditions of Contract until other sections have been completed to a stage where risk of damage through exposure to traffic and the elements and inconvenience to public traffic has been minimized.

Constructional Plant used in the execution of the Works shall be of a design and used in a manner approved by the Engineer. The Engineer may at any time withdraw his approval for any method of working proposed by the Contractor and the Contractor shall immediately adopt another method of Working. If such change shall be required to achieve satisfactory progress or workmanship, the Contractor shall have no claim against the Employer for costs incurred by him in changing the method of working or in the provision and use of other plant.

1116 Temporary Works

The Contractor shall provide, maintain and remove on completion of the Works all temporary works necessary for the construction of this permanent works. All temporary works shall be properly designed and constructed to carry such loads as may be imposed upon them and shall be safe and suitable in every respect for providing access or carrying plant or for the construction of the Works or other purposes.

1117 Provision for Traffic

The Contractor shall at all times provide for traffic flow along existing roads, rivers and canals. The Contractor shall provide and maintain all detours, temporary roads, temporary bridges, necessary barricades, warning lights and guide signs as well as other equipment at all hours during the day or night.

The Contractor shall submit the plan and section drawings of proposed detours, temporary roads and temporary bridges to the Engineer for approval prior to commence of works.

The width of the pavement diversion shall be 5.0m with 1.0 m shoulders on each side on a compacted soil of 90% of [MOD AASHTO T 180 laboratory](#) compaction covered with a minimum of 300 mm of gravel sub-base with [gravel](#) surfacing laid and well edged. The Contractor shall provide drainage facilities through the diversions.

The Contractor shall in due time and at least one month before any diversion of traffic, submit a detailed stage programme for the Engineer's approval. The programme shall show all arrangements necessary to ensure a smooth traffic flow. Upon completion of the Works, all temporary roads, temporary bridges, barricades, signs and other equipment shall be completely removed, unless otherwise approved in writing by the Engineer.

The Contractor shall so plan his operation so as to maintain the flow of traffic through the Works without disruption or delay. Road closures may be permitted by the Engineer in exceptional circumstances. The Contractor shall give at least 7 days notice of any proposed road closure.

Upon completion of a days work, or if the Works are to be left unattended, the Contractor shall leave the Works in such a condition so as to allow the safe passage of traffic. The Contractor shall be responsible for complying with all regulations relating to the temporary closure of roads in [Afghanistan](#).

Should the road width be restricted or should there be any form of obstruction or danger to traffic, the Contractor shall supply adequate flagmen, signs, barriers, lights, communications and staff to ensure that the traffic is safely conducted through the Works.

1118 Testing of Materials

Contractor's Site Laboratory

The Contractor shall provide and maintain minimum facilities of a site laboratory for the use of the

Contractor and the Engineer including furniture, testing equipment and consumable stores necessary to carry out the tests listed below. The laboratory shall be constructed with a concrete floor and brick walls, shall be watertight and provided with electricity, potable running water and sewerage.

Where necessary independent testing will be undertaken at a laboratory specified by the Engineer for which a provisional Sum is included in the bill of quantities.

The list of the test furnished below may include but not be limited to those required for.

Soil	Classification (Grading, Atterberg limits), Compaction, (AASHTO T180), density, moisture contents, dry density, DCP
Aggregate (Coarse & fine)	Grading (Fineness modulus), Flakiness, density, moisture content,
Cement	Setting time, mortar cube strength
Concrete	Slump
Bricks	Absorption, Unit weight
Bituminous mixture	Temperature, combined gradation.
Pavement Layers	surface tolerance and thickness checking
Pavement Surface	Roughness

A minimum list of lab equipment shall be provided by the Engineer during the period for mobilization. A preliminary list given but not to be limited to those required for.

SI No.	Description of Items	Unit	Qty
	GENERAL ITEMS		
1	Scientific Calculator	no.	1
2	Hammer 1 kg	no.	2
3	Slides callipers		1
	Soils		
4	Particle size analysis of soils.		
	Set consisting of 200mm dia. sieves (11 nos.)	set	1
5	Determining the liquid limit of soils		
	a) Liquid limit device with counter (Casagrade)	no.	1
	b) Spatula 200 mm. blade	no.	1
6	Determining the plastic limit and plasticity index of soils		
	a) Glass plate 30 x 30 x 5 mm. = 1 no.	no.	1
	b) Moisture can	no	30
	c) Spatula 100 and 200 mm. = 2 nos.	no.	1
7	Moisture content determination		1
	c) Gas burner with 2 cylinder	no.	1
	c) Balance 311g x 0.01g	no.	1
8	Density of soil in place by sand cone method		
	a) Sand cone, base plate & plastic bottle	no.	2

	b) Field balance 15 to 20kg capacity	no.	1
9	Plastic graduated cylinder 1000ml	no.	2
10	Galvanize tray		
	a) 0.75x0.75x0.05 m	no.	2
	b) 0.25x0.25x0.03 m	no.	2
11	Soil mortar	no.	1
12	Rubber mallet	no.	1
13	Soil Pestle	no.	1
14	Dynamic Cone Penetrometer (DCP) 8kg TRL/ South African, design complete with carrying box with calibration chart, spare DCP upper shafts, anvils, and harden 60 degree DCP cone	no.	1
	Aggregates		
15	Materials finer than 0.075mm sieve in mineral aggregates by washing		
	a) Washing sieve 300mm dia and 0.075mm mesh	no.	1
16	Sieve analysis of fine & coarse aggregates as per ASTM	set	1
17	Flakiness and elongation	no.	
	a) Flakiness gauge	no.	1
	b) Flakiness sieves (set of 7 pcs)	set	1
	c) Elongation gauge	no.	1
	Bituminous Materials/Asphalt Concrete		
18	l) Dial thermometer 259°C	no.	1
	Concrete		
19	Concrete cylinder mould 150mm dia x 300mm high	no.	6
	Tamping rod, 16mm plain bar 600mm length with round edges		1
21	Slump test device a(slump cone) and tamping rod, base plate	no.	2
	Straight edge/ steel ruler	no.	2

1119 Materials Testing by Independent Laboratories

In addition to the Site testing facilities described in Specification Section 1118, the Contractor shall be responsible for arranging for the field and off-Site laboratory tests listed and all other tests indicated as the responsibility of the Contractor in Sections of Divisions 2 to 5 of the Specifications, to be performed by testing laboratories approved by the Engineer. The Contractor shall be responsible for all attendance on staff from these approved testing laboratories, including if necessary the provision of transport for personnel, equipment and test specimens.

1120 Special and Additional Testing

In addition to the testing described in Specifications here, the Engineer may require further testing to be carried out. Such special and additional testing shall be arranged by the Contractor at approved laboratory at Afghanistan or out-side abroad under the direction of the Engineer.

1121 Staff for Materials Testing

The Contractor shall provide qualified laboratory engineers, technicians, assistants, labourers, etc. to carry out sampling and testing of materials.

1122 Test Results and Records

The Contractor shall maintain complete records of test results which may be inspected by the Engineer at any time. All test results shall be recorded on standard forms approved by the Engineer and shall be signed by the Contractor's engineer or technician in charge of the laboratory. Completed forms shall clearly show the locations of samples, sampling dates and testing dates. Samples shall be numbered serially at the time of sampling. The Engineer may witness any sampling or testing carried out in the laboratory and will have the right to use the facilities and equipment to make his own tests. The Contractor shall have the right to witness any sampling or testing carried out by the Engineer. On completion of the contract the original copies of all tests results shall be handed over to the Employer, via the Engineer. All tests results should be submitted to the Engineer immediately after the test.

1123 Measurement and Payment

The provision of the laboratory, Materials Engineers office, furniture, equipment and services detailed in Specification Section 1118 and the removal from Site of the laboratory, Materials Engineers office, furniture and equipment at the end of the Contract shall be paid for at a lump sum price. Maintenance of the site laboratory, Materials Engineers office, furniture and equipment shall be deemed in unit rate item wise.

The sampling and testing carried out by the Contractor in accordance with Specifications.

Payment for special or additional tests described in Specifications Section 1118, shall be under a provisional sum, unless the costs of such tests are to be borne by the Contractor as per the Conditions of Contract.

Pay items shall be:

11/1	Special or Additional Tests	Provisional Sum
11/2	Soil investigation for confirming the pile length/type of foundation, complete of soil boring geotechnical report as per TOR	Meter

1124 Approval of Sources of Materials

The sources of the materials shall be selected by the Contractor, but approved by the Engineer prior to their incorporation in the Works. For this purpose, the Contractor shall furnish all relevant test data for representative samples from each source area as desired by the Engineer and also afford opportunities for the Engineer to visit the source areas. The number of representative samples to be tested shall not be less than two for each type of material in each source area. Notwithstanding approval of sources of materials, materials as brought to the work site for use in the work shall be subject to acceptance or rejection by the Engineer based on quality control tests to be performed before use in construction.

1125 Stockpiling of Materials

All materials brought to the site shall be stockpiled and stored in a systematic manner so as to prevent deterioration or mixing of materials or intrusion of foreign matter. Preparation and storage of materials along the alignment will not be allowed. The Contractor shall make all arrangements and bear all costs associated with the provision of these storage areas.

The site of stockpile shall be cleared of vegetation and debris, graded and drained. The bottom 50mm layer of aggregate or any contaminated aggregate shall not be used in the work. Materials which have suffered intrusion and deterioration due to improper storage shall not be used in the works.

1126 Control Tests on Material Stockpiles

The Contractor shall use only such materials in construction as conform to the requirements regarding composition, grading, and physical properties and engineering characteristics specified for different kinds of material. For this purpose pre-construction control tests shall be carried out on representative samples collected at random from material brought to the site or at stockpiles. Any stockpile or any material brought to the site found not conforming to the Specification requirements shall be removed promptly.

1127 Compaction Equipment

Mechanical equipment shall be used for compacting materials by rolling, tamping and watering (if needed). For other

Operations such as spreading, mixing and shaping, manually operated tools and equipment is preferred on mechanical equipment alone or a combination of the two shall be used. The choice of equipment and the procedure for their use shall be subject to the approval of the Engineer upon his being satisfied about their effectiveness on the basis of trial compaction.

It shall be understood by the Contractor that different types of material are likely to require different kinds of compaction equipment, including successive applications thereof, to achieve the specified degrees of compaction, and the Contractor shall keep available compaction equipment of the requisite kind, size and number.

For compacting narrow strips and for compaction in restricted areas smaller sized compacting equipment may be required and if so, the same shall be provided for by the Contractor.

1128 Compaction

Compaction of materials shall be done in layers of uniform thickness using approved compaction equipment including combinations thereof if desired by the Engineer.

Compaction with rollers shall commence at the edges and progress towards the centre except in super-elevated and other stretches of unidirectional cross fall, where the rolling shall commence at the lower edge and progress towards the upper edge. When commencing rolling from an edge, rollers shall run forward and backward along the edge several times till the edge strip becomes firm to provide lateral support. The roller shall then move inwards parallel to the centre line of the road in successive passes with the tracks made by successive passes overlapping. Rolling shall continue till the specified degree of compaction is achieved throughout. When rolling is terminated at an edge, the procedure similar to that for commencing rolling at an edge shall be adopted. During rolling, the top of the layer being rolled shall be checked for levels and cross fall and any irregularities in these regards corrected by loosening the material in the affected area and by removing or adding materials and continuing with the rolling until the entire area being rolled has been brought to a state of uniform and desired compaction.

1129 Compaction Trials

To demonstrate the efficiency of mixing and compaction equipment and the working methods proposed to be used by the Contractor for different kinds of materials, the Contractor may be required to carry out compaction trials before starting full-scale construction on the road. Based on results of compaction trials and construction observations, the Engineer may direct the use of particular mixing and compaction equipment and methods and disallow the use of others.

1130 Compaction Control

After the compaction of each layer of material, field density tests shall be done on the compacted material. For locating test points, successive compaction panels covering the entire area of work shall be designated in advance of compaction. The frequency of the tests (in terms of square metres of compacted area of each layer for which minimum one test is to be done) shall be separately specified for different kinds of material. The test locations shall be chosen through random sampling techniques.

For material other than bituminous mixes, the compaction panels in which the compaction work is found as non-acceptable shall be given re-compaction accompanied with scarifying and wetting/drying for the entire thickness of the compacted layer to achieve the specified degree of compaction. In case of bituminous mixes, the compaction panels in which the compaction work is found as non-acceptable shall be stripped off and re-laid with fresh bituminous mix and re-compacted.

1131 Mixing and Control of Moisture Content

Before compaction is taken up (other than for bituminous mixes), each layer of material shall be brought to a state of uniform composition, texture and moisture content by thorough mixing and addition of water or drying as required. The Contractor shall be deemed to have taken account of the fact that the materials encountered may vary widely with respect to their in-situ moisture content and the moisture content at which the materials are to be compacted.

1132 Drainage during Construction

All embankment, sub-grade, shoulder and pavement layers under construction shall be protected from any accumulation of water due to rains or other causes and from erosion. All such layers under construction shall be provided with cross-fall to facilitate surface run-off and, if necessary, the cross-fall shall be supplemented with temporary drains or pumping arrangements to prevent accumulation of water.

1133 Protection to Existing Embankment/Pavement Layers

Excavation for new construction, and placement of materials and their in-situ processing and compaction shall be done in such a manner and with such precautions as not to cause any damage to embankments, sub-grade layers, shoulders and pavement layers in position including those pre-existing and intended to form part of the improved road.

1134 Disposal of Hauling Equipment

Hauling equipment bringing materials to the site of work shall be dispersed uniformly over the surface of the previously constructed layers in order to avoid rutting and uneven compaction. The materials from hauling equipment shall not be dumped in concentrated heaps but deposited as evenly distributed layers.

1135 Plying of Traffic

Layers of embankment, sub-grade, pavement and shoulder during construction shall be protected against the plying of any kind of traffic other than construction equipment, till the new construction has been finally opened to traffic.

1136 Drawings

The drawings referred to in the contract document are the standard cross sections of the road.

Typical Cross Section

The “Standard Cross Sections” given in the drawings are provided as a guide only. The locations and extent of works to be undertaken will be ordered by the Engineer on site.

SECTION 1200: CONTRACTOR'S ESTABLISHMENT

1201 Scope

This Section covers the setting up of the Contractor's establishment on the site, maintenance of the site establishment and the removal thereof after completion, and compliance with the provisions of the contract.

General Requirements

1202 Locating construction camps

The Contractor shall establish his principal construction camp at or near to the site at a location of his choice, subject to the approval of the Engineer. The principal construction camp shall accommodate the Contractor's administrative offices and testing facilities but the Contractor may establish other camps as he may require accommodating stores, plant workshops, casting yards, concrete batching facilities, crushing plant etc. The Contractor shall be solely responsible for the provision of land for construction camps, the cost of which shall be deemed to be included in his tender.

1203 Provision of facilities, plant and equipment

The Contractor shall provide all facilities, personnel, equipment, plant and all other things whether of a permanent or temporary nature required for the execution and maintenance of the .

1204 Compliance with the Conditions of Contract

The Contractor shall be deemed to have examined the documents comprising the contract and to have included in his tender for the cost of complying with the provisions thereof whether itemized in the Bill of Quantities or not.

1205 Field Office for the Engineer and Other Facilities to be provided by the Contractor

1206 Sanitation

The Contractor shall provide adequate water-borne sanitation and refuse collection and disposal, complying with the Laws of Afghanistan and all local By-Laws, and to the satisfaction of the Engineer, for all offices, laboratories, workshops, houses etc. erected on the site.

1207 Field Office for the Engineer and his Staff

An addition to the office space required for his own use, the Contractor shall provide and maintain furnished field office, 30 m2 floor areas for the use of the Engineer and his supervising staff. The field office shall be maintained in a secure and watertight condition by the Contractor until completion of the Works or as otherwise instructed by the Engineer and shall be provided with electricity, running water and sewerage. All doors shall be fitted with approved locks, and windows shall be provided with mosquito screens and blinds and shall have interior locking devices.

The Contractor shall submit for the approval of the Engineer before **construction/hire/rental**, plans and drawings showing proposed details and location for the Field office and site camp, including foundations, access roads, shades, layout of electrical and water supplies and hard standings thereto. The Engineer may require revision of the plans prior to giving approval for construction.

The office/ site camp, complete with furnishings, fittings, access roads and hard standings shall be ready for use by the Engineer's staff within four weeks of the date when the Contractor first occupies the site.

Sl. No.	Description of Furniture	Quantity
1.	Visitor's chairs (steel pipe)	12
2.	Arm chair, Cloth covered	4
3.	Desk, 1500mmx900mm	2
4.	Desk, 1200mmx750mm	2
5.	Stool	2
6.	Book case 1000mmx3 shelves	3
7.	Filing cabinets, 4 drawer, steel, lockable	2
8.	White board 1200mmx750mm	1
9.	Waste baskets	6
10.	Steel cupboard	1
11.	Tea set for 12 persons, China ceramic	1
12.	Emergency charger light	2

The Contractor will provide all necessary MLSS (Members of Lower Service Staff) for the field office, including day and night security guards and a tea boy.

1208 Contractor Office Equipment

The Contractor shall procure and maintain the office equipment such as photocopy machines, desktop computers, printer, UPS, Internet facilities (if available), and Mobile Telephone for their field office.

Equipment List

Sl. No.	Description of equipment	Quantity
1	Latest model new desk computers (Pentium-IV) with all current software needed for the project and laser printer to take A3 size sheets.	1
2	Latest model new laser printer to take A4size sheets.	1
4	Battery operated electrical calculator	4
6	Photo copier(A4 size) with operator	1
7	Heavy duty Stapler	1
8	Heavy duty punch machine	1
9	Electrical wall clocks 250mm dia.	2
10	Desk set of office equipment of each desk (stapler, staple remover, calendar desk tidy, pair of scissors etc.	2
17	Steel and fiber tapes 100m, 30m and 5m	2
18	Note book	24
21	Sprit level	2

1209 Survey Equipment

The Contractor will be required to provide survey equipment for the use of the Contractor's and Engineer's staff as required for the project.

In addition to the survey equipment, the Contractor will procure miscellaneous tools and minor items of survey equipment such as 30 m and 3 m long steel tapes, ranging rods, spirit levels, plumb bobs, umbrellas, hammers, knives, wooden stakes, steel pins, string lines, paint, marking crayons etc. to the Site. These shall be available in reasonable quantities at all times for use by the Contractor's and Engineer's staff. Ranging rods shall be 1.8 m long with alternate red and white painting. They shall be true and straight with a steel pointed tip to one end.

The Contractor shall supply approved chainmen and other artisans to the Engineer to assist with survey and setting out works, as and when required.

1210 Levels and Levelling Staffs

Levels shall be auto set in carrying cases, complete with centering tripods with extension legs, and to the following minimum specifications:

Magnification 32 times	Stadia 1:100
Aperture 40 mm minimum	Resolving power 3" (sec)
Angular field of view 1° 20'	Range of sensitivity ± 15 minutes or less Short Focusing
Distance 1 m	Horizontal circle diameter 75 mm
Addition constant 0 double run	Graduation 10 minutes Accuracy ± 1 mm for 1 km

Staffs shall be telescopic, aluminums with graduations in Metric units.

1211 Theodolites

Theodolites shall be double circle Triangulation with optical Micrometers. The instruments shall be in airtight metal/wooden carrying cases with tool compartments and eyepiece filters complete with centering tripods and extension legs, to the following minimum specifications. One or more Theodolites suitable for the attachment of an EDM may be required.

Objective aperture 45 mm	Addition constant 0
Shortest focusing distance 1.7 m	Sensitivity of collimation of level 20"/2 mm
Multiplication constant 100	Graduations 360°

1212 Measurement and Payment

Supplying materials for and construction/hire/rental of the site camp/field office for the Engineer, including all furniture and fittings, access roads etc., and the provision of water electricity and sewerage facilities, and the removal of the field office for the use of Contractor and Engineers staff, as described in this specification series 1200 shall be paid for at a lump sum price for site mobilization and site facilities.

1213 Payment

Item	Unit
12/1 Mobilization	Lump Sum
12/2 Provision of Engineers site office with furnishing and supplying of office equipment	monthly

Payment for mobilization shall be compensation in full for the cost of establishing plant equipment facilities and personnel upon the site and shall include (but not necessarily be limited to).

- (i) Transport of plant, buildings, temporary facilities to the site.
- (ii) Provision and erection of contractor temporary buildings, office facilities on the site.
- (iii) Provision of access roads, hard standings etc. within construction camps.
- (iv) Airfares, temporary accommodation during the mobilization phase, permits, bonds etc. necessary to establish expatriate supervisory personnel upon the site.
- (v) Establishment of testing and process control facilities on the site.
- (vi) Erection of contract signboards.
- (vii) Provision of transportation facilities for supervisory, administrative and technical personnel.

Payment for mobilization shall be made when the Contractor has established himself upon the site to the satisfaction of the Engineer.

Payment for maintenance of the Contractor's establishment on the site shall be compensation in full for the costs of maintaining offices, supervisory, technical and administrative personnel and facilities both on and off the site and shall include (but not necessarily be limited to).

- (i) Salaries leave fares, gratuities and miscellaneous entitlements of supervisory personnel, technical personnel, surveyors, administrative personnel, security personnel, store men etc.
- (ii) Maintenance of offices, buildings, laboratories and transportation facilities for administrative, supervisory and technical personnel.
- (iii) Communications.
- (iv) Maintenance of housing for administrative, supervisory and technical personnel.
- (v) Overheads off site.
- (vi) Financing charges.
- (vii) Compliance with the provisions of the contract whether specified or implied.

This item shall not include for maintenance or depreciation of plant, the cost of which shall be deemed to be included in the relevant work item.

Payment shall be made at a lump sum rate per week/month in respect of the period commencing from the Engineer's order to commence until the date for completion of the whole of the Works subject to the Contractor having provided an acceptable Performance Bond in accordance with the Conditions of Contract.

Notwithstanding equal monthly payments as aforesaid, in the event that the Contractor shall fail to complete to Works, total payment under this item shall be limited to the sum of all items pertaining to maintenance of the Contractors establishment multiplied by the value of works completed (excluding General and Preliminary items, Day works and Provisional Sums) divided by the total value of the Works (excluding General and Preliminary items, Day works and Provisional Sums) and any over payment shall be recoverable as a debt by the Employer.

In the event that the Contractor shall complete the Works before the date for completion, then the whole of the sum under this item shall become due and payable with the first interim certificate after completion has been certified. Subject to the above provisions relating to failure to complete the whole of the Works, this provision shall apply equally to Sections of the Works defined in the contract.

In the event of an extension of the Contract period being granted by the Engineer (excluding any extension for which the Contractor is not entitled to costs) then payment shall be due at the lump sum rate per week/month for an extension not exceeding three months. Thereafter, costs associated with time extension shall be determined as provided for by the contract.

Item	Unit
12/3 Demobilization	Lump Sum

Payment for demobilization shall be compensation in full for the costs of removing plant, equipment, facilities and personnel from the site and shall include (but not necessarily be limited to).

- (i) Transport of plant, buildings, and temporary facilities from the site and export if required.
- (ii) Dismantling and removal of all temporary facilities on the site.
- (iii) Airfares for repatriation of expatriate personnel.
- (iv) Removal of contract sign boards.
- (v) Restoration of all construction camp areas to a satisfactory condition.

Payment shall be made upon completion of demobilization to the satisfaction of the Engineer. This item shall be payable only in respect of the whole of the Works and shall not apply in cases of sectional completion.

Payment for Performance Bond will be in the form of Bank Guarantee, which is 10 percent of the contract value. The winning contractor will provide the unconditional Bank Guarantee to the Client after the Contractor has been intimated about the award letter by UNOPS (Client). No Contract will be signed before furnishing the Bank Guarantee. The Bank Guarantee shall be returned to the contractor after the work has been completed 100%. The 10% retention money will be the security bond for the work during the defects liability period.

In the event of extensions to the contract period the Contractor will accordingly extend the Bank Guarantee to cover the extended period.

Insuring works are new for Afghanistan. However, if client desires that works of the contractor should be insured, the Contractor will do so as per the instruction received from the Client.

In the event of extensions to the contract period the insurance will also be extended accordingly to cover the time extended.

1214 As –Built Drawings

The Contractor shall furnish sets of as-built Drawings of the Works to the Engineer, showing the permanent works as actually constructed, within 14 days of completion of the Works. Included in the sets of as-built Drawings will be revisions of Tender Drawings and Drawings supplied to the Contractor during the Contract as well as revisions of drawings supplied by the Contractor during the Contract. The as-built drawings submitted by the Contractor will be subject to the approval of the Engineer.

1300 Transports for the Engineer

1301 General

The Contractor shall provide, operate and keep maintained at all times transport for the exclusive use of the Engineer, his representatives and representatives of the Employer.

1302 Items of Transport

Provide and maintain the supplied vehicles:

Road transport, which shall be used both on and off the Site, four wheel drive vehicles Double cab Pickup.

The Bill of Quantities indicates the requirements for road transport. When items of transport are out of use for damage, repairs, servicing etc., equivalent substitutes shall be provided within 24 hours.

Items of transport and drivers considered unsuitable by the Engineer shall be replaced within 24 hours.

1303 Operation and Maintenance of Vehicles

The Contractor shall operate and maintain the vehicles provided by the contractor. Drivers shall be provided by the Contractor for all hours worked by the Engineers staff as directed by the Engineer.

The vehicles shall be kept fuelled with fuel appropriate to the vehicle.

The vehicles shall be regularly cleaned and they shall be properly serviced and maintained following the manufacturer's recommendations. Necessary oils, greases and filters shall be provided as required.

Damaged vehicles shall be promptly repaired and tyres shall be replaced when the tread depth is less than 2 mm.

The Contractor shall ensure the drivers of the vehicles are licensed to drive, competent in English, and have an adequate knowledge of vehicle maintenance and of the traffic regulations in force in Afghanistan.

The Contractor shall pay all drivers' wages, allowances, and overtime and outstation allowances when required by the Engineer to travel away from the Works, including to Kabul, tolls shall be included in the cost of maintaining and operating vehicles.

The Contractor shall consult with the Engineer in preparing his maintenance schedule for vehicles and shall give at least one week's notice of vehicles to be withdrawn for maintenance.

When items of transport are out of use or replacement for accident, damage, repairs, servicing etc., equivalent substitutes shall be provided within 24 hours.

The Contractor shall make re-fuelling arrangements close to the Engineer's site Office or as instructed by the Engineer.

1304 Measurement and Payment

The Contractor's monthly rate for the provision, operate and maintenance of vehicles (Supplied by the contractor) shall include fuel, oil, greases, spare parts and tyres, servicing, maintenance, drivers wages, allowances, per diems and overtime, tolls and taxes, duties, registration, interest, insurance etc., as applicable.

Contractor's monthly rate for operation and maintenance shall include overhaul and refurbishment (tyre, battery, filter, brake shoes, plug, carburetor etc.).

Pay items shall be:

13/1	Provided 4-Wheel Drive (Double cab Pick up) vehicle Supply the Contractor, hire basis	V. Month
------	--	----------

SECTION 1400: ENVIRONMENTAL AND SOCIAL PROTECTION

1401 General

The Contractor shall take all reasonable precautions, whether specified in the contract or not to prevent damage to the natural environment occurring as a result of the execution of the Works and shall strictly observe all regulations procedures etc. in relation to entry upon land, whether within the Site or not.

This Section of the specification shall prevail over any other section in the event of ambiguity or conflict in requirements for environmental protection or treatment of social issues.

1402 Land Acquisition

No land will be made available to the Contractor on the Site or on any other land for which it is the Employer's responsibility before all compensation arrangements have been satisfactorily agreed with a legally binding agreement between the Employer and the landowner. To this end, the Contractor shall comply strictly with specified procedures for obtaining possession of those parts of the Site required for the Works.

1403 Contractor's activities In Respect of Property outside the Site boundary and Services moved, altered or damaged

The Contractor shall seek the prior approval of the Engineer for activities outside of the site boundary prior to commencing negotiations with landowners. The Contractor shall plan such operations in a manner that will minimize inconvenience to local communities (including dust, noise, etc.) and shall undertake to restore the area to an acceptable condition upon completion of his activities in that area. The Contractor shall not enter upon private or government land without written confirmation to the Engineer that:

- (a) In the case of borrow or spoil areas the necessary negotiations with the owner of the property have been concluded and permission is granted for the Contractor to enter upon the land and take or deposit material

(b) In the case of temporary access, bypasses and access roads to borrow areas, the Contractor has complied with the requirements stated below and elsewhere regarding the serving of notice and making detailed arrangements with the owner for access, compensation, reinstatement, etc.

The Contractor shall put in writing all his agreements with owners of property outside the site boundary or of services inside or outside the boundary in respect of the following matters:

- (a) The location, extent and use of borrow pits spoil areas haul roads, construction roads and bypasses outside the site boundary;
- (b) Compensation for land or materials taken or for land temporarily used or occupied;
- (c) Reinstatement of property occupied, used, damaged or destroyed or compensation thereof in lieu of reinstatement;
- (d) The procedure for moving of services and details of how and when this is to be done;
- (e) Any similar matter directly concerned with the Contractor's activities on or in respect of private property or services.

These arrangements shall be signed by all the parties concerned and delivered to the Engineer.

Where, in addition to any agreement with the owner of any property to be entered upon or temporarily occupied or service to be moved, it is understood or required that the Contractor shall serve notice immediately before actually entering or occupying private property or moving a service, proper notice in writing shall be given and the Engineer is to be supplied with a copy of such notice with acknowledgement of receipt.

On completion of his operation the Contractor shall obtain, from the owner concerned, a written statement that either:

- (a) The owner is satisfied that the Contractor has fulfilled his obligations under any written agreement, or in the absence of a written agreement, that
- (b) The owner is satisfied that he has received all the compensation he is entitled to and also is satisfied that all property occupied, including borrow pits spoil areas, haul roads, construction roads, is properly restored and in a satisfactory condition.

If the Contractor fails to compensate the owner, or otherwise fails to properly restore or landscape the area in accordance with any agreement or the Engineer's instructions, the Employer shall be entitled to employ others to carry out such works and to recover the cost thereof from the Contractor.

1404 Entry upon Land within the Site Boundary

The Contractor shall not enter upon any land or commence any work within the site boundary until authorized in writing to do so by the Engineer. At least 7 days prior to commencement of any part of the Works, the Contractor shall give notice to the Engineer to facilitate assessment of compensation in respect of any buildings, crops, trees or other improvements by the Employer.

The Employer shall be responsible for the assessment and payment of compensation in respect of land to be acquired and incorporated in the works within the Site together with all buildings, crops, trees and any other properties so defined on the land.

The Contractor shall be responsible for agreement and payment of compensation and any royalties in respect of land temporarily occupied, spoil areas, working areas, borrow areas, road deviations and sites for Contractor's and Engineer's accommodation, where such land or area is not within the Site.

1405 Provision of Construction Materials

The Contractor will be responsible for all payments in respect of all materials required for use in the Works. The Contractor must fully acquaint himself with required protocol and legislation regarding the sourcing of earthworks and pavement materials. The Contractor shall, unless otherwise stated, be solely responsible for negotiation and payment of all fees, licenses, goodwill, royalty and any other charge in respect of materials obtained from any land.

1406 Construction Camps

Unless otherwise specified the contractor is at liberty to make his own arrangements with land owners to establish construction camps. Prior to the development of such camps the Contractor shall submit to the

engineer the signed authority of the land owner.

1407 Condition of plant and machinery

The Contractor shall ensure that all plant, vehicles and machinery used in relation to gravel extraction works are in good condition with no leaking fuel and/or lubricants including oil and grease and he shall submit to the Engineer a spill contingency action plan and shall have on site at all times an oil spill emergency containment kit.

If any leak of fuel, oil or grease occurs the Contractor shall immediately remove any relevant item of plant, vehicle or machinery from the site of the works and may not return such item to the site until all leaks have been repaired.

1408 Fuel storage and refueling

The Contractor shall ensure that fuel storage areas are located at an elevation above any likely flood level. All fuel storage areas and refueling activity shall be undertaken within a bounded area to prevent the escape of spilled fuel or lubricants. Access to the bounded area shall be protected by an appropriate concrete lined drain which shall discharge through a purpose built oil or grease trap prior to discharge into a grassed swale that shall lead to a natural water course.

1409 Restoration of Construction Camp Sites

At the completion of the construction work the contractor shall dismantle and remove from the site all facilities established within the construction camp including the perimeter fence and lockable gates. The whole of the construction camp site shall be grassed and if trees originally grew on the site they shall be replaced with similar tree species. At the completion of restoration the site shall be in no way inferior to the condition that pertained prior to commencement of the works.

All oil or fuel contaminated soil shall be carefully removed from the site and transported and buried in waste soil disposal areas.

1410 Measurement and Payment

14/1 If there are environmental concerns that need to be mitigated the works should be quantified as much as possible during the survey stage. For example the site requires plantation of XX number of trees, reclaiming X Sq m of degraded area and etc. In the event of environmental damages that came up during the construction period, which was not foreseen initially, the damages will be repaired processing variation order to the Bill of Quantities, which will be initiated by the Contractor and Client Engineer. After the submission of variation order the requirement of mitigation measures both in terms of extent and item shall be verified by the Project Headquarters based upon which approval shall be accorded.

1411 Environmental Measures

1412 Erosion control

The Contractor is required to enter into the spirit of environmental protection and conservation and to construct works in terms of agreed programmes, methods and sequences that will prevent or mitigate against erosion. The Contractor shall employ such temporary measures as are necessary to prevent or mitigate against erosion or siltation of any natural water course in addition to permanent drainage or erosion control systems that are detailed in the contract documents.

The Contractor shall programme the works to demonstrate that the sequence of operations involving drainage installation, earthworks, drainage facilities, erosion protection measures, pavement construction and re-vegetation are implemented to minimize the period over which earth is exposed to the potential for erosion.

1413 Establishment of vegetation

The Contractor shall establish vegetation and erosion protection measures on all cut and fill batters as soon as possible during the construction period. In benched cut batters the establishment of vegetation and erosion protection measures shall be undertaken on the bench and upper batter as soon as it is completed. Such work shall not wait until the completion of the total excavation. The Contractor shall maintain the vegetation and erosion control measures throughout the construction period. The vegetation appropriate for Afghanistan is willows, poplar, and Mulberries.

1414 Traps, bench, toe and roadside drains

The Contractor shall establish all such drains as soon as practicable during the construction of the works and in terms of the programme which has been agreed by the Engineer. Erosion protection and sediment control measures as detailed and specified shall be established as soon as possible to minimize erosion. Outlets to all drains shall be passed through silt traps and or silt ponds prior to their discharge to natural water courses all as detailed and specified.

1415 Silt fences

Throughout the construction of the works the Contractor shall install silt fences in locations as directed by the Engineer. Such fences as are specifically ordered by the Engineer shall be measured and paid from amounts entered as provisional within the Day works Bill Group. No payment shall be due for silt fences required for environmental controls for any of the Contractor's temporary works including campsites, stockpiles, haul roads accesses and the like and the cost of providing these shall be deemed to be included in the rates for associated work items. Silt fences shall be constructed of appropriate materials as instructed by the Engineer.

Silt fences shall be maintained in efficient operating condition throughout the construction of the works. Material periodically cleaned from such drains shall be transported and disposed of in waste disposal areas approved by the Engineer.

1416 Clearing

The Contractor shall only clear vegetation from between the batter limit lines shown in the drawings, the net agreed area for the construction camp and the agreed area of proposed waste material disposal areas. On no account is the Contractor to damage vegetation outside the above areas. Should such damage occur the Contractor shall forthwith take such steps as are necessary to prevent erosion and to re-establish vegetation.

The Contractor shall install such temporary or permanent drainage systems as are required to collect storm water run off from stripped areas. Silt traps or silt retention ponds shall be constructed at appropriate locations in such temporary or permanent drains which traps or ponds shall be maintained in efficient operation throughout the contract period.

1417 Disposal of Unsuitable or Excess Materials

The Contractor shall locate waste excavation disposal areas as agreed with the Engineer. All excavated material which by virtue of its organic content, moisture content, or other characteristics, which is unsuitable for incorporation into embankment construction shall be transported and placed in such waste excavation disposal areas. On no account shall waste excavated material be disposed of by side tipping or flattening of fill batters unless specifically directed by the Engineer.

After agreement with the Engineer on the location of waste excavation disposal areas the Contractor shall strip the topsoil from such sites and stockpile this material for later restoration work. Material excavated to waste shall be placed in such areas and compacted by track rolling, and shaped to conform to the adjacent topography.

Surface water discharged from such areas shall be collected into perimeter drains which shall discharge through silt traps and or silt ponds in order to minimize the discharge of silt laded water to natural water courses. At the completion of use of waste excavation disposal areas they shall be resurfaced with topsoil from previously stripped areas to promote re-vegetation.

The Contractor shall locate topsoil stockpiles clear of future works in locations agreed with the Engineer. They shall be located on terrain which is suited for the construction of toe drains around the topsoil stockpile in order to minimize topsoil laden water discharging directly into natural water courses or onto adjacent land.

After each day's work and before rain the stockpiles shall be smoothed off track rolled with suitable equipment to minimize the amount of loose material on the stockpile at any time.

1418 Extraction of River Gravels

The Contractor shall take due regard of the natural environment and mitigate any adverse affects by addressing the following:

1419 Protection of vegetation

The Contractor shall protect all vegetation from damage or disturbance by gravel extraction works within a 7 meter wide band measured from the river bank. The removal of any trees within the 7 metre wide band is prohibited without the written consent of the Engineer.

1420 Site restoration

The Contractor shall restore the extraction site to an even longitudinal and traverse profile. Any mounds or heaps of gravel within the river shall be spread into diversion channels or otherwise evenly over the river bed. Material from access ramps shall be similarly spread over the river bed

1421 Measurement and Payment

Item	Unit
14/1 Environmental and Social Protection	Lump Sum
14/2 Plantation of sapling/live staking	Number
14/3 Restoration of quarry site	Sq.m

For plantation of sapling, the rate shall include selection of appropriate species to the local conditions and protection fence for each sapling.

Restoration of quarry sites shall include trimming the sites and planting grasses if the original site condition had grasses.

SECTION 1500: Setting Out Horizontal and Vertical Alignment

1501 Scope

Setting out the horizontal alignment and elevation levels shall consist of the provision and placement of ranging rods and profile boards to determine the exact alignment of the road. The ranging rods and profile boards shall be of good quality metal and their finish of such a standard that they can be used for good and correct setting out. The setting out shall include vertical as well as horizontal alignment. The contractor shall ensure that the setting out is maintained for the entire period required to achieve the dimensions of the road according to the drawings.

1502 Construction Method

Setting out of alignment shall be carried out following the instructions of the Engineer. The setting out shall ensure that the dimensions of the road are according to the drawings and shall be maintained by the contractor for the time required to complete the works.

Both alignments shall follow as closely as appropriate to the existing terrain and road lines and they shall be established by pegging the centre line, edge of carriageway and ditch lines. Reference pegs shall be provided at intervals outside the roadway to allow for the reestablishment of the alignment during construction. Chainage shall be clearly marked on pegs at not less than 100 metre intervals.

The Contractor shall set out, using pegs and string lines, the various construction operations in sufficient detail to ensure that the required standards and tolerances are achieved, and in such a way that any task work system adopted may be easily checked by the Engineer.

The limits of the embankments shall be marked by fixing out wooden pegs (at least 50mm dia and 500mm long) at 20m intervals or closer if desired by the Engineer. The pegs shall be fixed at about 0.5m beyond the actual limits of the fill and painted in a distinctive colour.

1503 Measurement and Payment

Item	Unit
15/1 Setting out alignments	metre

The unit of measurement for setting out is metre (m). The quantity shall be measured as the length of the road section where setting out has been carried out for centre line and other edges of the road.

No extra payment shall be made for the re-placement of pegs, profile boards or any other setting out materials which are removed from the site prior to instructions of the Engineer.

SECTION 1600: TERMS AND DEFINITIONS

1601 Terms and Definitions

Fill Materials (also termed as “Fill”): Naturally occurring inorganic soils and soil like materials including sand and crushed rock but excluding individual particles of sizes greater than 75mm.

Ordinary Fill : Fill material to be used for forming the road embankments other than in improved sub-grade and in back fill behind bridge abutments.

Sub-Base : The pavement layer composed of a homogeneous mixture of crushed stone aggregates and local sand and soil lying immediately below the base course.

Base Course : The pavement layer composed lying between the bituminous surfacing at its top and the sub-base course at its bottom and within the carriageway on either side of the center line.

Surfacing : Gravel or stone or bituminous bound layer at the top of the pavement structure extending full width of carriageway only.

Hard Shoulder : Compacted gravel or any hard strips beyond the carriageway of the roadway width, adjacent to the surfacing.

Earth Shoulder : Compacted earth strips protected on top at the extremities of the roadway width, adjacent to the hard shoulders.

Maximum Dry Density (MDD): Maximum dry density as determined in the laboratory using [the Specified method of Test Compaction](#).

Optimum Moisture Content (OMC): Optimum moisture content as determined from moisture-density relationship tests in the laboratory using [the Specified method of Test Compaction](#).

Dynamic Cone Penetrometer (DCP): Device for field checking of in situ CBR.

Boulders : River-borne or blasted hard stone materials of sizes exceeding 100mm.

Atterberg Limits : PI, PL, LL Sand equivalent Test used for evaluating the plastic properties of the sand fraction of aggregate

Application (spread) rate: The rate of spreading chippings or spraying bitumen on the surface.

Wearing Coarse : The surface allowed plying the traffic

Plasticity Limits (PL) : The limits that are used to estimate the engineering behaviour of clayey soils. They include the Liquid Limit and Plastic Limit, which are determined by arbitrary tests on the fine soil fraction passing the 0.42 mm sieve.

Liquid Limit (LL) : The water content of the soil that allows the divided soil sample to flow together after fixed times of applying dynamic force on it.

Plastic Limit (PL) : The water content of the soil when the thread crumbles

Plasticity Index (PI) : The difference between PL and LL

Plasticity Product (PP): The combined product of PI and fine content

California Bearing Ratio (CBR) : Test method to evaluate the bearing capacity of the soil

Speedy Moisture Tester: The speedy moisture tester needs a chemical i.e. Calcium carbide that mixed with a measured amount of moist soil in a closed container. The gas formed by reaction gives the % moisture through a pressure gauge (Calibrated accordingly). The % moisture is found in “Wet weight basis” and this is transformed to “Dry weight basis” using a Conversion curve.

Formation width : Full width of road, including drains and embankments.

- Roadway** : Width of road, including shoulders.
- Carriage way** : Pave width of the road, available for traffic
- Shoulders** : Paved or unpaved width of road next to the edge of the carriage way adjacent to the ditch or embankment slope.
- Camber** : A camber road has a cross-section like a roof on a house, to drain the rainwater away from the carriage way to the side drains.
- Gravel surfacing** : A layer of compacted [gravel](#) which forms the surface (or pavement) of the carriage way
- Embankment** : Compacted earth fills below the roadway.
- Cut** : Excavation in the natural ground on the hill side of the road usually with graded slopes. The material dug out is used to fill the embankment on the valley side of the road.
- Sub grade surface** : Upper layer of the soil (natural material) supporting the roadway including embankment and slopes.
- Side drain** : The side drain runs along the road and collects the water from the carriage way and adjoining land, and transports it to a convenient point of disposal.
- Original ground level** : The natural surface of the cross-section prior to construction.
- Back slope** : The outer slope of the side drain with an appropriate angle to prevent the soil from sliding to the ditch.
- Ditch slope** : Inside slope from the shoulder to the side drain.
- Embankment slope** : Natural material slope on embankment
- Crown** : Peak or highest point of the camber
- Road centre line** : The line running along the centre of the road (important in surveying and setting out the road alignment).
- Chainage** : is a term frequently used for describing distances measured along the centre line of the road.
- High flood level (HFL)** : The highest elevation to which the peak flood waters are expected to rise.
- Miter drains** : Miter drains (or turnout drains) lead the water out of the side drains and safely disperse it on adjoining land. Miter drains should be provided as often as possible so that the accumulated water volume in each drain is not too high and does not cause erosion to the adjoining land
- Catch water drains:** Where the road is situated on a hillside a significant amount of rainwater may flow down the hill towards the road. This may cause damage to the cut face (back slope) of the road and may even cause landslides. Catch water drains intercept or “catch” surface water flowing towards the road from adjacent land, and lead it away.
- Scour checks** : Scour checks prevent erosion in side drains on steep gradients by slowing down the water (steps). Scour checks are usually built using locally available material, such as stones or wooden sticks or [masonry and pre-cast Vee-notch as appropriate](#).
- Culvert** : The culvert is a transverse drain built under the road and its function is to lead water from the upper, uphill side of the road to the lower, valley side. In tropical countries with high rainfalls three or four culverts are required per kilometer. Culvert rings are usually made of concrete or prefabricated corrugated steel rings.
- Head wall** : A wall 300 mm. thick stone masonry constructed perpendicular to the culvert pipes (at the end) to retain backfill material. The headwall shall extend vertically to an elevation of 200mm above the surface of the road.
- Wing wall** : Continuation of headwall at an angle, generally 45 degrees, and shall extend a minimum of 1m out from the pipes, to retain the soil of the road side slope and to allow the free flow of water into and

away from the pipes.

Reinforced concrete pipes: Reinforced concrete pipes prefabricated in a standard steel mould.

Pipe bedding : The foundation on which pipes are laid.

Up stream apron : Part of a culvert at the upstream inlet made of stone/masonry, where water enters into the pipes to prevent any scour or damage to the pipes.

Downstream apron : Part of a culvert at the downstream outlet, where the water goes out at natural water course, to prevent any scour or damage to the pipes.

Cut- off wall : Wall generally constructed at the downstream end of a structure and constructed into the ground, to prevent scouring of the apron, as well as the structure.

Headwall foundation : Headwall foundation provided to the main culvert headwall so that it can retain the earth pressure.

Gravel : Gravel is defined as stones (2-60mm) but for roadwork use, a more useful definition is a mixture of stones (maximum 30mm), sand and clay.

Sand : A coarse-to-fine gritty soil, with grains of size 0.06-2mm. Sand is normally firm when damp.

Silt : A soil with very small particles (0.002-0.06mm), which is powdery when dry but very soft when wet. For a quick test, when you roll a lump of silt between your hands they will not get stained.

Clay : This is a soil with even smaller particles (<0.002mm). It forms hard lumps when dry and the surface is cracked, but is sticky and soft when wet. For a quick test, your hands will be stained if you roll a lump of clay between your hands.

Organic Soil : This is dull and dark in colour, and often has a distinct smell. Topsoil is almost always organic. Swamp soils usually contain remains of plants (fibres, roots, and so on).

Well-graded : Material with a wide range of particle sizes which are well distributed (Note: a mixture of particle sizes means that the soil will be easier to compact)

Poorly-graded : Material with too much of some sizes and too little of others

Uniformly-graded: Material with a limited range of sizes mainly concentrated in one size category.

1602 OTHER CHARACTERISTICS

Cohesive : The particles of a soil stick together (mainly the clay fraction)

Non-cohesive : Does not stick together (mainly sand and gravel)

Coarse-grain soil : Mainly sand and gravel (little or no clay, little or no sand)

Fine-grain soil : Mainly silt and clay.

Soil Conditions

Density : In a dense soil the particles are close together (or well-compacted)

Compaction: The process that packs the particles close together, and so increases the density

Bearing capacity : The strength of the soil (measured by the weight that can be loaded on to a specified area without penetration or the amount of penetration under a certain load on a specified area)

Plasticity : Measures whether soil can be moulded and hold its new shape

Permeability : The degree to which water can penetrate a particular soil

Optimum moisture content: The water content that gives the best effect of soil compaction.

1603 Specifications Standards

The following Specifications issued by widely recognised bodies are referred to in this Specification:

AC	- Asphalt Cement
ACV	- Aggregate Crushing Value
AIV	- Aggregate Impact Value
ASTM	- American Society for Testing and Materials
AASHTO - Officials	American Association of State Highway Transportation
BS	- British Standard
CBR	- California Bearing Ratio
CC	- Cement Concrete
DCP	- Dynamic Cone Penetration
FM	- Fineness Modulus
Gm	- Gram
ISI	- Indian Standard Institution
IRC	- Indian Road Congress
Kg	- Kilogram
Kip	- Kilo-Pound
KN	- Kilo-Newton
KPa	- Kilo Pascal
Lb	- Pound
LL	- Liquid Limit
MC	- Moisture Content
MDD	- Maximum Dry Density
MN	- Mega-Newton
MPa	- Mega-Pascal
OMC	- Optimum Moisture Content
Oz	- Ounce
PL	- Plastic Limit
PI	- Plasticity Index
Psi	- Pound per Square Inch
Psf	- Pound per Square foot
RC	- Rapid Curing
RCC	- Reinforced Cement Concrete
RM	- Running Meter
RRI	- River Research Institute
SC	- Slow Curing
TSF	- Ton per Square Foot

SECTION 1700: DEMINING AND UXO CLEARANCE

1701 General

This work shall consist of the detection and disposal of land mines and UXO that exist within the confines of the site and the certification that the entire site is free from contamination and is safe for all construction operations.

The work shall include the following activities:

Detailed Technical Survey Detection; Detection, Neutralization and Disposal of Mines; Detection, Neutralization and Disposal of UXO;

Certification confirming the site has been checked and cleared.

In this Section of the Specifications the following terms abbreviations are used:

UXO: Unexploded Ordinance

UNMACA: United Nations Mine Action Center for Afghanistan

IMAS International Mine Action Standards

Subcontractor: the Mine Clearance Agency, or Agencies, appointed as a Subcontractor to carry out demining and UXO clearance as part of the Contract

EOD emergency ordinance disposal

1702 Mine Clearance Agencies

Nominated Mine Clearance Agency

The Contractor must propose, in his bid, the Mine Clearance Agency that he will appoint as a Subcontractor under the terms of the Contract to carry out Demining and UXO Clearance activities. The Contractor will propose only Mine Clearance Agencies compliant with AMAS and accredited with the Mine Action Center for Afghanistan (UNMACA) on behalf of the Government of Afghanistan, or capable of being accredited immediately on award of Contract.

Up to three Mine Clearance Agencies may be proposed to jointly carry out the demining and UXO clearance but one agency must be designated as the Lead Mine Clearance Agency and that agency will be responsible, as the Subcontractor, to the Contractor for all demining and UXO clearance. This will not be taken as in any way absolving or reducing the Contractor's ultimate responsibility for all works under the Contract.

The Contractor is required to inform himself of all laws, regulations and other requirements governing demining and UXO clearance activities in Afghanistan, including the requirements of this Specification, prior to bid.

The Contractor shall manage the detection and disposal operations and shall carry out such checks as shall be necessary to enable him to take full responsibility for safety from the risk of mines and UXO over the whole area of the Site and for all construction operations.

1703 Clearance Agencies

The Contractor should make his own investigations as to the clearance agencies available for work in Afghanistan. The following Contact List has been made available for information only and should not be considered as a complete list or an indication of approved agencies.

NGO Contact List for UXO Clearance					
Agency for Rehabilitation and Energy Conservation in Afghanistan (AREA)					
Aminulhaq House Kabul, Afghanistan	No.45, Darulaman	Mayel, Managing Road,	Shura	Director Street	
Tel: +93-20-2501193/+93-70-279382, E-mail: brain.net.pk					
Afghan Technical Consultants (ATC)					
Kefayatullah Wazir Akbar Khan, Kabul, Afghanistan	Eblagh,				Director
Mobile: +93-70-278261/+93-2301390, E-mail: actkabul@apollo.net.pk					
Deming Agency for Afghanistan (DAFA)					
Eng. H# 32 A Jinnah Town Sumanli Road, P.O. Box 548 Quetta, Pakistan	A. Sattar,				Director
Mobile: +92-381-4282983/+92-81-834687/ 825237					
Fax No: +92-81-825247, E-mail: Dafa@qta.infolink.net.pk					
Mine Clearance and Planning Agency (MCPA)					
Eng. Wazir Akbar Khan Mina, Next to Silk Route Guest House	Attiqullah,				Director
Mobile: +93-70-276006/+93-26093					
Mine Detection and Dog Centre (MDC)					
Mr. House No. 271, Street # 14, Wazir Akbar Khan Mina, Kabul, Afghanistan	H. M	Shohab Hakimi,	Director		
Digital: +93-2301201/+93-62612, Sat Phone: +873761623220,					
Mobile No: +93-70-275500, E-mail: MDC@liwal.com					
Organization for Mine clearance and Afghan Rehabilitation (OMAR)					
Fazel House No. 206, Street No. 10 Zall, Wazir Akbar Khan,	Karim				Fazel Khan,
P.O. Box 5885, Kabul, Afghanistan					
Digital Tel: +93-2100833, +93-20760, +93-23520					
Mobile: +93-70-275793/+882-1621131042/+873-763224159					
Fax: +873-763224161, E-mail: omarintl@liwal.com					
Danish Deming Group (DDG)					
Jan House # 131, Beside Military Club, Shash Darak, Kabul, Afghanistan	Ejeklint, Programme				Manager
Mobile: +93-70-274517/+92-300-855-7374					
Office: +92-51-2104632/33/34, Kabul Mobile: +93-70-274675					
Fax No: +92-51-2104635, E-mail: ddg@apollo.net.pk					
HALO Trust (HT)					
Dr. Shar-I-Now, P.O. Box 3036, Kabul, Afghanistan	Farid Homayoun,	Programme			Manager
Sat. Phone: +873-761931 817, Sat. Fax: +873-761931 818					
Digital: +93-2201483, Email: haloafg@liwal.com					

1704 Detailed Technical Survey

The Subcontractor shall carry out a Detailed Technical Survey of all areas required by the Contractor for the execution of the works or for quarries, haul roads, work areas, camps and other facilities which have been identified by a General Survey as potentially containing mines or UXO. The General Survey shall consist of the information available from the UNMACA database.

The Detailed Technical Survey will determine the exact perimeter of areas containing mines or UXOs.

1705 Clearance

The Subcontractor shall ensure the removal and/or destruction of all mine and UXO hazards from the area and depth as specified in the clearance tasking order that will be issued as a result of the Detailed Technical Survey. In the absence of reliable information on the depth of mine and UXO hazards the default shall be 130 mm.

The Subcontractor shall destroy mines and UXO hazards in situ, unless such action would cause damage to buildings or other infrastructure, cause risk to personnel or hinder construction without enhancing safety. In the event the Subcontractor believes it is necessary to remove mines or UXO for destruction, the Demining Facilitator must be consulted and give written approval before any action is taken.

The Subcontractor shall ensure that all mines and munitions are destroyed and that all mines and munitions located during a working day are destroyed on that day whenever possible. If it is not possible to destroy the mines and munitions on that day the Subcontractor is responsible for ensuring that they are not removed from the clearance site by unauthorised persons.

The Subcontractor shall ensure the complete destruction of all mines, munitions and explosive materials using demolition charges in accordance with the IMAS requirements.

1706 Quality Management Plan

The Subcontractor will draw up a Quality Management Plan in accordance with the requirements of UNMACA. The plan will include details of his methods of operation in surveying for, detecting and disposing of mines and UXO, his quality control system, safety and evacuation procedures, methods of certification of clearance, the reporting system to be used to the Contractor, local authorities and UNMACA, the method of handing over cleared areas, and any other matters relevant to his activities or required by UNMACA

1707 Liability

The Subcontractor shall be liable for each area surveyed, cleared and verified up until the time the Quality Assurance Officer signs the Handover Certificate in the Completion Report for each site, recommending acceptance that the site is cleared of landmines and UXO in accordance with the National Safety and Technical Guidelines.

1708 Demining Facilitator

The Contractor shall nominate, for the approval of the Engineer, a Demining Facilitator, who shall be responsible on behalf of the Contractor for overall management of demining and UXO clearance, and shall have the authority to act in all demining and UXO matters for the Contractor.

1709 Qualifications

The Demining Facilitator shall have appropriate practical and academic qualifications, be experienced in the management of demining projects in a variety of environments, including Afghanistan, and be experienced in general project management. He shall be experienced in working with people of varying backgrounds, skills and cultures, be fluent in written and spoken English, and have well-developed written expression skills.

1710 Duties

The duties of the Demining Facilitator shall include, but not be limited to:

Supervise, manage and report on the survey, clearance and disposal operations of the demining subcontractor.

Ensure that the demining programs and actual progress achieved conform to the requirements of the Contractor's construction program.

Liaise daily with the Contractor, the demining subcontractor, the demining QA agency, UNMACA and the Engineer and act as the demining management interface between all parties.

Provide technical advice and support on all demining matters to all concerned parties.

The Demining Facilitator shall be assigned no other duties not related to demining/UXO clearance. The Demining Facilitator shall be on the site at all times during demining and UXO clearance and will be employed by the Contractor.

1711 Responsibilities and Authority

The Demining Facilitator shall report directly to an executive of the Contractor's organization and have equivalent authority and status as the Contractor's Project Manager.

He shall have the responsibility and authority to override the Contractor's Project Manager on all aspects relating to demining and UXO clearance of the Works including the responsibility and authority to stop work which is not in compliance with the Contract.

1712 Mine and UXO Disposal and Clearance Operations

The Contractor will be responsible for the disposal of all mines and UXO recovered. Where collateral property damage is likely to occur as a result of disposal activity, the Contractor must first advise the Engineer before proceeding.

In the course of clearance operations it may be necessary to damage crops, remove fences, etc. The Contractor will be required to notify the Engineer in writing with a copy to the Employer prior to taking any action that may cause damage resulting in demands for compensation being presented.

1713 Method of Measurement

Establishment cost for the Subcontractor shall not be measured for payment but shall be a lump sum payment. Payment shall be made in full when the Contractor has signed an agreement with the Subcontractor which meets with the conditions of this Specification and the Conditions of Contract and the Contractor has appointed a Demining Facilitator approved by the Engineer.

Detailed Technical Survey for minefields shall be measured by the Hectare of area surveyed.

Mine Detection and Disposal (Clearance) shall be measured by the Hectare of site required to be cleared as determined by the results of the Detailed Technical Survey and certified and endorsed as cleared in accordance with the provisions of these Specifications.

UXO Detection and Disposal (Clearance) shall be measured by Hectare of site approved for clearance as determined by the results of the Detailed Technical Survey and certified and endorsed as cleared in accordance with the provisions of these Specifications.

Attendance by the Subcontractor shall not be measured for payment but paid on a monthly basis.

Attendance by Demining Facilitator (to coordinate demining/UXO survey and clearance activities and ensure compliance with construction program) shall not be measured for payment but paid on a monthly basis.

Sites identified for clearance shall be classified as normal or difficult. Normal clearance is defined as the UXO clearance that will be conducted in open rural areas. Difficult clearance is defined as the UXO clearance that will be conducted at bridge and culvert sites and in built-up areas as designated by the Engineer.

1714 Basis of Payment

Payment shall be in accordance with applicable prices included in the Bill of Quantities. Payment shall be full compensation for all labor, equipment, tools, materials and incidentals necessary to complete the work.

Pay Item	Unit
17/1	Demining of Site Lump Sump

TECHNICAL SPECIFICATION

SERIES 2000

CLEARING AND EARTHWORKS

TECHNICAL SPECIFICATION
SERIES 2000 - CLEARING AND EARTHWORKS

TABLE OF CONTENTS

Item Number	<u>Page</u>
2000 General	2 - 4
2001 General Requirements for Earthworks	2 - 4
2002 Compaction Control of Embankment Construction	2 - 4
 2100 Clearing and Grubbing	 2-5
2101 Scope	2 - 5
2102 Description	2 - 5
2103 Requirements	2 - 5
2104 Clearing and Grubbing	2 - 6
2105 Debris Disposal	2 - 6
2106 Individual Trees	2-6
2107 Method of Measurement	2-6
108 Basis of Payment	2 - 6
 2200 Demolition of Structures	 2-6
2201 Description	2 - 6
2202 Methods	2 - 7
2203 Safety Precautions	2 - 7
2204 Ownership of Material	2 - 7
2205 Method of Measurement	2-7
2206 Basis of Payment	2 - 8
 2300 Removal of Existing Pavements	 2 - 8
2301 Description	2 - 9
2302 Removal of Methods	2 - 9
2303 Disposal of Materials	2 - 10
2304 Methods of Measurement	2 - 10
2305 Basis of Payment	2 - 10
 2400 Roadway Excavation	 2 -10
2401 Description	2 - 10
2402 Spoil Material	2 - 10
2403 Removal of Topsoil	2 - 11
2404 Construction Methods	2 -11
2405 Method of Measurement	2-11
2406 Basis of Payment	2 -11

2500	STRUCTURE AND CHANNEL EXCAVATION	2 - 12
2501	Description	2 - 12
2502	Construction Methods	2 - 12
2503	Excavation within enclosures for foundations	2 - 12
2504	Foundation Compaction and Extra Depth of Excavation	2 - 14
2505	Inspection of Excavations	2 - 14
2506	Backfilling and filling	2 - 14
2507	Preservation and Diversion of Channels	2 - 15
2508	Excavation Limits	2 - 15
2509	Measurement	2 - 16
2510	Basis of Payment	2 - 16
2600	BORROW EXCAVATION	2-17
2601	Description	2-17
2602	Method of Measurement	2-17
2603	Basis of Payment	2-18
2700	ROADWAY EMBANKMENT	2-18
2701	Description	2 - 18
2702	Embankment Material	2 - 18
2703	Construction Method	2 - 19
2704	Maintenance and Stability of Embankments	2 - 23
2705	Measurement	2 - 24
2706	Basis of Payment	2 - 25
2800	SUB-GRADE PREPARATION	2-25
2801	Description	2 - 25
2802	Construction Requirements	2 - 25
2803	Proof Rolling	2 - 26
2804	Methods of Measurement	2 - 27
2805	Basis of Payment	2 - 27

2000 GENERAL

2001 General Requirements for Earthworks

The Contractor is required to take particular note of the specifications for the compaction of earthworks. Details of compaction control are discussed in paragraph 2.0.3 below and the testing of embankment earthworks will require particular care.

The UNOPS, Afghanistan, Quality Assurance/Quality Control, Engineering Support Unit, has established soil sampling and test procedures, which are published in "Standard Laboratory Test Procedures for Quality Control Laboratories," referred to herein as "Standard Test Procedures".

In order to achieve the specified compaction, the Contractor shall carefully control the moisture content of the embankment material. For some sections of the works to achieve this end the Contractor may have to construct bunds and carry out dewatering. No separate payment shall be made for such ring bunds or for dewatering or for watering when necessary and the Contractor shall have allowed for the cost thereof by including that cost in the unit rate tendered for roadway embankment.

The Contractor shall programme the works so that existing embankment materials are re-used to the maximum extent possible under the Specifications and the measures necessary to reduce the moisture content of materials with high moisture content values but which are otherwise suitable for incorporation in the embankment shall be included in the tendered rates.

The earthworks quantities given in the Bills-of-Quantities are approximate only and the Contractor shall be paid according to the relevant items of the Bills-of-Quantities for the actual quantities of work performed in accordance with the Specifications.

2002 Compaction Control of Embankment Construction

This paragraph outlines the field and laboratory tests on soil samples that are necessary to ascertain the quality and the degree of compaction of the embankment to be constructed as roadway embankment.

a) Materials

Samples of embankment and sub-grade materials shall be obtained from the newly formed embankment or from those borrow pits along side the existing road, or other borrow pits provided by the Contractor where required, from which materials to be used as embankment construction materials are to be obtained.

b) Testing of Materials

The following tests shall be performed on the soil samples which shall be obtained as required by the Standard Test Procedures, or as stated herein or as directed by the Engineer.

- i. Specification Gravity Test
- ii. Moisture Content Test
- iii. Grading Analysis (by sieve & hydrometer)
- iv. Atterberg Limits (liquid limit & plastic limit)
- v. Field density measurement
- vi. CBR Test
- vii. Compaction Test

All the tests specified herein shall conform to the latest AASHTO standards or other similar standards approved by the Engineer. Testing methods intended to be used by the Contractor shall be approved by the Engineer and the Engineer shall supervise and observe all sampling and testing carried out by the Contractor. Tests shall be conducted by the Contractor in the field laboratory supplied for the use of the Engineer under the Engineers supervision.

The Contractor shall, for the purposes of testing materials and workmanship, employ on the work at least one Civil Engineer qualified by a recognized degree and having at least 5 years experience in soil and materials investigation and testing. The Contractor's Engineer shall be supported by at least two experienced laboratory technicians familiar with soil laboratory test procedures plus labour as required. These staff of the Contractor shall work under the supervision of the Engineers representative.

c) **Method of Measurement and Basis of Payment**

It is the responsibility of the Contractor to perform, record and report to the Engineer all such tests as are required to control adequately the quality of each item of the works in progress and the costs thereof shall be included in the contract price or unit rate for each item in the Bills-of-Quantities.

2100 CLEARING AND GRUBBING

2101 Scope

This Section covers general clearing activities along the roadside and includes cutting back of vegetation and cleaning out existing drains and ditches.

2102 Description

This work shall consist of clearing, grubbing, removing, and disposing of vegetation and debris located within the limits shown on the plans or designated by the Engineer, except such objects as are designated to remain in place or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

Most mature standing trees affecting and required to be removed for the work may have been removed by others under a separate contract with the Department.

2103 Requirements

The Contractor shall preserve all objects designated to remain. Vegetation contiguous to streams, ponds, or lakes shall be preserved and kept safe from injury unless this vegetation is designated to be removed by the Engineer. When vegetation that is to be preserved becomes damaged or is destroyed by the Contractor, it shall be replaced at no cost to the Government and in a manner acceptable to the Engineer.

Minor cuts or scarred surfaces of trees or shrubs selected for retention shall be repaired as directed. Where trees are to be removed by others, the removal will be completed before work under this project begins. Stumps remaining from such removal by others are to be removed under this project Works.

2104 Clearing and Grubbing

All surface objects and all trees, stumps, roots, and other protruding obstructions, not designated to remain, shall be cleared and/or grubbed as required, except as provided below:

- (a) On the slope of an embankment, unless the area is to be benched, undisturbed stumps and roots that do not appear to extend beneath the pavement may remain provided they do not extend more than 150 mm above the ground.
- (b) Grubbing of pits, relocated channels and ditches will be required only to the depth necessitated by the proposed excavation within such areas.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with Section 1128.

All areas, where clearing and grubbing is in progress or has been completed, shall be kept well drained and standing or ponded water will not be permitted.

2105 Debris Disposal

When burning perishable material is permitted, it shall be burned under the constant care of competent watchmen so that surrounding vegetation, other adjacent property, or anything designated to remain on the right-of-way will not be jeopardized. Burning shall be done in accordance with applicable laws, ordinance, and regulations.

Materials and debris may be disposed of by methods and at locations approved by the Engineer, on or off the project. If disposal is by burying, the debris shall be placed in layers with the material so distributed as to avoid formation of cavities. Each layer shall be covered or mixed with earth material to fill all voids. The top layer of material buried shall be covered with at least 300 mm of earth or other approved material and shall be graded, shaped, and compacted to present a pleasing appearance. Materials shall not be buried beneath drainage ditches or in any areas that will be subject to measurable amounts of free flowing water.

If the disposal location is off the project, the Contractor shall make all necessary arrangements in writing with property owners for obtaining suitable disposal locations that are outside the limits of the project. The cost involved shall be included in the contract unit price. A copy of such agreements shall be furnished to the Engineer.

2106 Individual Trees

Where individual trees are designated for removal, such trees shall be clearly marked with paint. If the Contractor wishes to remove trees for his own convenience, he shall clearly mark the trees and obtain the Engineer's approval before proceeding with removal. Only such trees as are clearly marked shall be removed and all others will remain undisturbed.

2107 Method of Measurement

Clearing and grubbing shall be measured as the area in square meter.

2108 Basis of Payment

Item	Unit
21/1 Payment will be made for clearing and grubbing of the measured area at the contract unit rate for Item 21/1	Sq.m
21/2 Clearing and Cleaning drainage path	m

2200 DEMOLITION OF STRUCTURES

2201 Description

This item shall include demolition of bridges, culverts and other structures and buildings within the right-of-way required to complete the works. Demolition, unless otherwise specifically directed by the Engineer, shall be complete including foundations but not including caissons below ground level. No demolition work shall be carried out without the prior written approval of the Engineer.

This item shall consist of performing the following operations in accordance with the Engineering Drawings and other provisions of the Contract and the requirements hereinafter set forth: excavating all materials which must be removed to permit removing the bridge, culvert or other structure; removing, cleaning, transporting and storing the pipe, steel beams or other reusable components; breaking, removing and disposing of bricks, concrete, masonry and other materials in structures, all as approved by the Engineer.

This item shall not include payment for demolition and disposal of site accommodation specified in Part-I of the specifications, payment for which is otherwise provided.

This item also shall not include payments for demolition and disposal of temporary bridges and access roads separately specified in these specifications, payment for which is otherwise provided.

2202 Methods

Demolition and disposal shall be performed according to standard practices approved by the Engineer.

Buildings and appurtenances shall be removed, including removal of foundations and concrete slabs or other types of floors resting upon the ground. The Engineer shall review the Contractor's proposals and appropriately approve or disapprove the Contractor's proposed methods for each building or structure which is to be removed. The Employer reserves the right to eliminate from the work to be done by the Contractor, the removal of any or all of the buildings, structures, etc. shown on the Drawings, if deemed advisable by the Engineer. Such elimination shall not affect the price bid on the remaining buildings, structures, etc. to be removed and the Contractor will not be entitled to any compensation due to such elimination.

Where the Engineering Drawings or Engineer's instructions call for pipe or other structures to be removed for reuse or storage, there shall be removed a section of pipeline or other structure sufficient in length to permit determining the quality of pipe or other structure and the possibility of removing it without damage. If the Engineer determines that the pipe or other structure is worth salvaging and can be salvaged the Contractor shall perform the remainder of the excavation in a manner that will not damage the pipe. Where caving occurs, the caved material shall be excavated before the trench created by the excavation is backfilled.

Pipes, steel beams, or other reusable or salvageable structural components shall be removed in such manner that they will not be damaged. After removal the pipe shall be cleaned and hauled to the location where it will be reused, or to storage. Where pipe is to be stored, storage shall be on the Right-of-Way at locations approved by the Engineer.

The trench resulting from the removal of pipe shall be backfilled in accordance with the provisions for embankment except when the trench lines within the limits of subsequent excavation.

2203 Safety Precautions

The Contractor shall comply with all laws, ordinances and building code regulations. Unless otherwise permitted by the Engineer, the Contractor shall furnish, erect and maintain suitable barricades to prevent personal injury or property damage.

2204 Ownership of Material

All material, except that belonging to public or private utility company, or unless otherwise specified such as a bailey bridge, steel bridge, including joist, screw pile, trough plat, steel etc. or shown on the Drawings shall become the property of the Contractor. Bricks, concrete, masonry and the like may be suitable for processing and re-use as sub-base material as specified herein and the Contractor is expected to take account of this when submitting his Tender.

2205 Method of Measurement

Demolition and removal of structures shall be measured on a lump sum basis for the total project and the price Bid therefore shall be shown in Bill 2 of the Bill of Quantities. Such price will cover all of the work required under this Section.

Demolition of one story buildings, houses, shops etc., will not be measured separately but will be included in the bid under Item 22/1 for the work in general.

Where large structures or groups of structures require special treatments they shall be listed in the appropriate Bill of Quantities and measured on a unit basis.

2206 Basis of Payment

Structures to be demolished in the works generally and not specifically identified shall be paid for by payment of the Contract lump sum price for "Item 2.2/1 Demolition of Structures" in Bill No. 2 of the Bill-of-Quantities. The Engineer shall assess the progress of the works for payment of pro rata amounts of this sum on interim certificates.

Structures or groups of structures identified separately shall be paid for at the Contract Unit Price per structure as shown in the appropriate Bill of the Bill of Quantities. Payment may be for any of the following items as shown in the Bill.

Item 22/1	Demolition of Structures, General	lump sum
Item 22/2	Demolition of Structures, pipe culverts	each
Item 22/3	Demolition of Structures < 10 m	each
Item 22/4	Demolition of Structures > 10 m	each
Item 22/5	Demolition of Structure, Km	lump sum

Type of structure:

For 22/2, Pipe Culverts shall include concrete, steel, circular or oval or any other kind of pipes, singly or in a group of any number of pipes of any size.

For 22/3 and 22/4, Structure shall refer to any kind of concrete, steel, brick or other box culvert, arch culvert, or bridge of any kind. The dimension shall be between the externals of the walls, or spring line of arches or the centre line of bearing of bridge abutments.

Large buildings or other structures shall be included under Item 22/5.

The price and payment shall constitute full compensation for performing all of the requirements of this item including the removal and disposal of pipe headwalls and other structures not otherwise listed on the Engineering Drawings or in the Schedule of Rates for payment, furnishing all necessary materials, labour, tools, equipment, supplies and incidentals.

2300 REMOVAL OF EXISTING PAVEMENTS

2301 Description

This item shall consist of the removal of existing pavement (flexible or rigid) including base course, sub-base and shoulders as applicable and the satisfactory disposal of materials removed.

Since the works to be carried out under the Contract are for the overlay/betterment of the existing road the work under this item shall normally involve only the removal of bituminous wearing/levelling courses and concrete pavement slabs. Removal of other types of pavement and shoulder materials will be required at structures and may be required in areas elsewhere as shown in the Drawings or at the direction of the Engineer.

The existing pavement and shoulders may consist of layers of varying thickness of the following materials:

- blended and natural sands and soil
- brick soling
- broken brick and sand aggregate
- herring-bone brick
- broken stone aggregate, water bound or bitumen penetrated

- broken stone or brick with sand, water bound or bitumen penetrated
- broken stone aggregate/sand bitumen premix
- river gravel/sand bitumen premix
- seal coats with river pebble chipping stone
- seal coats with broken stone chippings
- Portland cement concrete 125 mm thick
- reinforced Portland cement concrete 125 mm thick
- other combinations of bricks, stone, sand and bitumen are also possible

The total thickness of the layers will rarely exceed 600 mm and will normally exceed 300 mm.

In some instances levelling courses or wearing surfaces of hand-mixed and hand-placed bituminous concrete will be found on top of rigid pavement. Rigid pavement usually consists of two layers of Portland cement concrete approximately 125 millimetres in total thickness, in which the coarse aggregate may be brick chips or stone and there may be some reinforcement and dowel bars. Concrete slabs which may have been broken under traffic loads are generally about 3 metres by 6 metres between joints.

Prior to the removal of any existing road pavement the Contractor shall excavate trial pits and trenches as required by the Engineer to ascertain in detail the depth and composition of the pavement and this cost shall be included in the Contractor's rates generally.

All bituminous seal coats, wearing courses and levelling courses shall be removed and if not suitable for use elsewhere shall be disposed of by the Contractor.

All Portland cement concrete slabs, 125 mm thick, whether reinforced or not, shall be removed and the material processed for re-use where approved by the Engineer. Areas of existing pavement at the sites of new structures and at other locations as directed by the Engineer, for instance where the depth of the pavement in strips or localized areas is insufficient to form the sub-base to the new pavement structures or where bitumen has adversely contaminated granular base materials, shall be removed and if unsuitable for re-use shall be disposed of by the Contractor.

All suitable materials for re-use as sub base or other material for the works as approved by the Engineer shall be brought to the Contractor's materials preparation areas for stockpiling and re-use on the works.

The laboratories to establish quality and usage will test the materials.

2302 Removal Methods

The pavement and base course may be removed by either hand or machine provided the methods used do not cause an undue wastage of material. Bituminous concrete overlays on rigid pavement shall be separated from the Portland cement concrete slabs and removed before removal of the rigid pavement slabs.

2303 Disposal of Materials

All recovered pavement material suitable of re-use shall be handled as per the Conditions of Contract. The unsuitable materials shall be disposed of as spoil as instructed by the engineer.

2304 Methods of Measurement

The unit of measurement for the removal of existing pavement materials shall be the Square meter of bituminous wearing / levelling courses, concrete slab, HBB/BFS or full pavement structure removed, as the case may be. Where the full pavement structure is to be removed the measurement shall be of the volume in cubic metres and will not be made of individual pavement layers regardless of the composition and depth of the pavement section removed.

2305 Basis of Payment

These volume measured as provided herein above shall be paid for at the contract unit price for the items shown below which are listed in the Bill of Quantities; which prices and payment shall provide full compensation for removing, separating, loading, transporting and stock-piling or otherwise disposing of all materials, and for all labour, equipment, tools and incidentals necessary to complete this item of the works.

<u>Pay Item</u>	<u>Unit</u>
23/1 - Removal of Bituminous Surfacing	Sq.m
23/2 - Removal of Concrete Pavement	Sq.m
23/3 - Removal of Existing Pavement Structure	Sq.m

2400 Roadway Excavation

2401 Description

This work shall consist of the excavation, and satisfactory disposal of all material excluding materials measured and paid for under Item 2.3 - Excavation of Existing Pavements, encountered within the grade lines shown on the Drawings or approved by the Engineer below the existing ground or surface elevation and above the final sub-grade elevation or final slope line, and the removal and disposal of all unsuitable materials encountered below the final sub-grade elevation, provided that such unsuitable material is deemed by the Engineer to be unsuitable through no fault of the Contractor.

This item shall include all necessary stripping, shaping of the sub-grade, excavation for slopes and ditches, and the formation of berms, inlet, outlet and lateral drainage ditches shown on the Drawings or established by the Engineer.

After completion of clearing and grubbing and the removal of existing pavement as specified and after the slope stakes have been set and approved the Contractor shall excavate materials at such locations and in such sequence as the Engineer may approve.

All suitable material removed from road way excavation shall be used as far as practical in the formation of embankment, sub-grade, shoulders, slopes, bedding, and backfill for structures, and for other purposes shown on the plans or as directed by the Engineer. Unsuitable material shall be disposed of as spoil.

Unsuitable materials encountered below the final sub grade elevation shall be removed to such a depth as the Engineer may stipulate.

Roadway excavation that has become unsuitable attributable to carelessness of the Contractor will be removed and disposed of at the expense of the Contractor.

2402 Spoil Material

Cut to spoil shall be measured as the net difference between the total volume of cut and the net volume of fill. The net volume of fill shall include any fill, sub-base or any other material used elsewhere on the Works, which is measured and paid for as per these specifications under a separate pay item and originated from a cut.

The net volume of fill shall exclude the net volume in place in a fill of material arising from a borrow pit, or excavated from the pavement of the existing road, if such excavation is not within the road prism. No account shall be taken of variations in actual quantities due to bulking.

The tendered rates for cut to spoil shall include full compensation for disposal of surplus materials, including the cost of providing disposal sites outside of the site, shaping compacting, landscaping and draining such sites.

2403 Removal of Topsoil

All topsoil encountered during required excavation shall be removed and stored in stockpiles at locations approved by the Engineer for later use in accordance with the requirements of these specifications. The Engineer may direct that topsoil is not to be removed where he considers that this operation may result in a reduction in shear strength in foundation for embankment.

2404 Construction Methods

After completion of clearing and grubbing and removal of existing pavement as specified and after slope stakes have been set and approved, the Contractor shall excavate material at such locations and in such sequence as the Engineer may approve. All suitable material required to be removed to make way for the Works shall be used in the formation of Roadway Embankment, Bunds, Spur Dikes or otherwise utilised for the works as approved by the Engineer. Unsuitable material shall be disposed of as spoil.

Unsuitable materials (as determined by the Engineer) encountered below final sub-grade elevation shall be removed to such depth as the Engineer may stipulate. After removal of these unsuitable materials and cross-sectioning of the area, the Contractor shall bring the roadway to final sub-grade elevation in accordance with the specifications for the formation of Roadway Embankment.

The sub-grade shall be prepared in accordance with the requirements of sub-grade preparation as herein specified.

Excavation of preloaded embankment material where placed shall not commence without the written approval of the Engineer. The pre-load material may be used in embankment and berm construction where this is approved by the Engineer. If not approved as embankment or berm material, it shall be hauled to disposal areas outside the right-of-way. Removal of the material shall be to average ground level in the area or as otherwise directed or approved by the Engineer.

The final trimmed surface level of the sub-grade at any point shall be within 25 mm of the design level as approved by the Engineer. For any section of finished sub-grade measuring 100 metres along the alignment, the differences between actual and design levels at points checked by the Engineer shall show no departure trend in either direction and areas consistently above the design level shall be trimmed to level.

2405 Method of Measurement

Roadway Excavation to spoil as specified herein shall be measured for direct payment. All required and accepted roadway excavation to spoil shall be measured in its original position and the volume determined in cubic metres by the average end area method as computed from the original and final cross sections of required and completed work.

The volume of suitable material placed in accordance with the requirements of these specifications to replace unsuitable materials (except waste material) ordered by the Engineer to be removed below final sub-grade elevation will be measured by cross-sectioning and computed in cubic metres by the average-end-area method and shall be paid for as embankment material.

2406 Basis of Payment

The quantities of roadway excavation to spoil measured as specified above will be paid for at the Contract unit price per cubic metre shown in the Bill of Quantities for Item 24 - Roadway Excavation to Spoil. Payment shall include for excavation, removal, haulage and satisfactory disposal of all roadway excavation, for shaping, dressing and completion of all surfaces and for furnishing all labour, materials, tools and equipment.

Materials removed in roadway excavation and incorporated in embankment or elsewhere in the works shall be paid for at the contract price for the relevant pay item for that part of the works but shall not be paid for under item 2.4.

Pay Item	Unit
24/1 Road way excavation to spoil materials	
a) Excavation for structure foundation	Cum
b) Excavation in hilly area or along the road	Cum
c) Excavation/cutting hard material	Cum
24/2 Excavation of Hard materials (rock) by blasting	Cum

2500 Structure and Channel Excavation

2501 Description

This item shall consist of the necessary excavation for water channels and for the foundation of bridges, retaining walls, culverts and any other structure not otherwise prescribed.

Excavation for structures and channels shall include the removal of all material from within the excavation limits as shown on the Drawings or hereinafter prescribed or otherwise approved by the Engineer; all clearing and grubbing of the site of the proposed work except as otherwise provided for, the construction, and subsequent removal of all necessary bracing, shoring, sheeting, cribbing, and cofferdams; all pumping, bailing, draining, backfilling, and disposal of surplus or unsuitable material and the excavation of stream channels.

Excavation shall be classified as follows :

a) Unclassified Structure Excavation

This classification shall include all excavation made within the horizontal limits hereinafter prescribed and between the existing ground or embankment surface and the elevation of the bottom of structure as shown on the Drawings or approved by the Engineer.

b) Extra Depth Structure Excavation

This classification shall include all excavation within the horizontal limits and between the elevation of the bottom of structure as defined in (a) and the actual bottom of excavation that becomes necessary by reason of the removal of any unsuitable material below a footing as directed by the Engineer.

c) Unclassified Channel Excavation

This classification shall include all excavation of existing stream channels made within the limits hereinafter prescribed.

2502 Construction Methods

All equipment necessary and required for structure excavation shall be in first-class working condition and approved by the Engineer before excavation will be permitted to begin.

If structure or channel excavation is shown in the Bill of Quantities as a separate bid item, the Contractor shall notify the Engineer a sufficient time in advance of the beginning of the excavation so that the Engineer and the Contractor can jointly agree on a system of survey of the ground before excavation and the necessary cross-sectional elevations and measurements may be taken of the undisturbed ground. Any materials removed or excavated before the measurements have been taken will not be paid for. The ground at the structures site shall not be disturbed without the permission of the Engineer.

The area required for a structure or channel shall be cleared and grubbed as provided in Section 2100.

2503 Excavation within enclosures for foundations

All foundations, where practicable, and in particular all culvert foundations shall be constructed by open excavation and the foundation openings shall be shored as necessary, braced or be protected by cofferdams if necessary in accordance with approved methods. Foundation excavation shall be made and piles, where required, driven or drilled in such sequence that no portion of the structures shall be endangered by reason of subsequent operations. No foundation excavation shall be commenced without the prior approval of the Engineer.

a. Cofferdams

Cofferdams shall be dewatered and foundations placed in the dry except as specified below. When conditions are encountered which, in the Engineer's judgement, render it impracticable to dewater the cofferdams below the level for placing foundations, he may require the placing of underwater concrete of such dimensions or quantities as may be necessary. The cofferdam shall be pumped out and the balance of the foundation placed in the dry. During the placing of underwater concrete the elevation of the water inside the cofferdam shall be controlled and if the cofferdam is to remain in place it shall be vented or ported at low water level.

After each excavation is completed the Contractor shall notify the Engineer, and no further construction work shall be started until the Engineer has approved the depth of the excavation and the character of the foundation material.

i) Construction

Cofferdams, cribs or sheeting for foundation construction shall in general be carried well below the bottom of the footings and shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms if required. Cofferdams or cribs which are tilted or sinking shall be righted and this work shall be at the sole expense of the Contractor.

Cofferdams shall be constructed so as to protect green concrete against damage from a sudden rising of the stream and to prevent damage by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure.

For all foundation work, the Contractor shall submit Drawings showing his proposed method of cofferdam, support, dewatering and other details. The type and clearance of supports and cofferdams, insofar as such details affect the character of the finished work, will be subject to the approval of the Engineer, but other details of design will be left to the Contractor, who is responsible for the successful construction of the work.

ii) Removal

Unless otherwise shown on the Drawings or approved by the Engineer, cofferdams, trench support or cribs with all sheeting and bracing shall be removed by the Contractor after the completion of the substructure and after approval by the Engineer for such removal to be effected. The removal shall be effected in such a manner as not to disturb or mar the finished work. In lieu of

the entire removal of the cofferdams or cribs the Engineer may require the Contractor to remove any portion of the same or to leave them entirely in place.

Cofferdams, cribs, sheeting and bracing left in place by written order of the Engineer shall be paid for in the amount of the actual delivered cost of the material left in place, and no allowance will be made for labour or any other item required for this work.

b) Pumping

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it be done from a suitable sump separated from the concrete work by a water-tight wall.

Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure and in no case less than 7 days or such additional length of time after the sealing of the cofferdams as the Engineer may direct.

2504 Foundation Compaction and Extra Depth of Excavation

The foundations shall be excavated to permit the placing of the full widths and lengths of footings shown on the Drawings with full horizontal or slightly graded beds as specified herein. Special care shall be taken at the bottom of the excavations for foundations for structures to ensure that the foundation material is not disturbed. The foundation excavation shall be completed to within 50 mm of the required underside of the structure, including blinding concrete and improved sub-grade material, and the excavation shall be inspected before any further action is taken. If bottom of the excavation shall be compacted by the use of impact or vibratory compaction equipment to 85% of maximum dry density as determined using AASHTO T180 except where shown on the Drawings or directed by the Engineer, beneath earth retaining structures the compaction of the base of foundation shall be to 90% of maximum dry density as determined using AASHTO T180. The final trim of the foundation shall remove the base of the excavation to the underside of the blinding concrete, which shall be immediately placed thereon.

If the bottom of the excavation is not considered by the Engineer suitable as a foundation, Extra Depth Structure Excavation shall be removed until the material is considered suitable or until the depth is 2 metres below the underside of the concrete foundation. The bottom of the excavation where suitable shall be compacted as above defined. The void excavated for Extra Depth Structure Excavation shall be refilled with river sand suitable for improved sub-grade material as herein defined or by sand embankment material and shall be compacted as specified for Roadway Embankment to 85% of AASHTO T180 maximum dry density. Density tests in accordance with AASHTO T191 shall be made at a rate of one per compacted layer for each discrete excavation or per 100 square metres of compacted surface within an excavation, whichever gives the greater number of tests.

2505 Inspection of Excavations

After each excavation is completed and before the foundation is covered, the Contractor shall notify the Engineer and no material shall be placed until the Engineer has approved the condition of the foundation and its depth and has given permission to proceed.

2506 Backfilling and filling

All material used for backfill shall comply with 2.5.4 or 2.7.2 as applicable and shall be of the type specified or shown on the Drawing or acceptable to the Engineer. All spaces excavated for and not occupied by structures and other permanent work shall be refilled with embankment material, or other specified material, as shown on the Drawings up to the ground surface existing before excavation was made.

Special precautions shall be taken to prevent any wedging action against structures. Fill around culverts, and bridges shall be placed on both sides to approximately the same elevation at the same time. Fill shall be placed simultaneously at both ends of arches and frames in such a manner as to load the structures uniformly and symmetrically.

Adequate provision shall be made for the drainage of all backfilling weep holes, which shall be formed in abutments and retaining walls where specified in these specifications or where shown on the Drawings. Their outlet ends shall be placed where shown on the Drawings or specified herein or approved by the Engineer. The fill side ends of weep holes shall be covered by geo-textile and aggregate seepage drain material as specified in 2.7.2.

Pipe drains shall be provided when called for on the Drawings.

In order to prevent the collection of water in spaces around footings, backfill shall be placed up to existing ground line around abutments, wing walls, retaining walls, end bents and piers as soon as possible after vertical forms have been removed. Backfill around arches and rigid frames shall be placed up to existing ground line as soon as possible after the forms have been removed.

All excavated material used in roadway embankments shall be placed and compacted in accordance with the requirements for embankment.

2507 Preservation and Diversion of Channels

Unless otherwise specified, no excavation shall be made outside the area required for construction of the foundation as shown on the Drawings and the natural stream bed adjacent to the structure shall not be disturbed unless shown on the Drawings or permitted by the Engineer. If any excavation or dredging is made at the site of the structure before cribs or cofferdams are sunk or in place, the Contractor shall, without extra charge, after the foundation base is in place, backfill all such excavations to the original ground surface or river bed with material satisfactory to the Engineer as specified for roadway embankment.

Materials deposited within the stream area from foundation excavation or from filling of cofferdams shall be removed, and the stream left in its original or planned condition, unless otherwise permitted by the Engineer.

The Contractor during excavation of embankment from channel diversions shall maintain channels, or borrow pits in a well drained condition and shall not excavate below the final stream bed level and shall not open the borrow pit or the diversion channel to water flow from the existing stream nor allow flow from an existing stream to enter a diversion channel until the Engineer has approved the Contractor's written proposal to open the excavation to running water.

The Contractor shall make every endeavour to incorporate in the works all material excavated for channels, and shall not commence excavation from borrow pits located in such areas as require channels until he has submitted to the Engineer a detailed written proposal as to his mode of operation for the excavation and the Engineer has approved the proposal.

All such material excavated and incorporated in embankment and approved by the Engineer shall be paid for as embankment material and all such material excavated and ordered by the Engineer to be disposed shall be paid for as spoil material.

2508 Excavation Limits

General

For any class of excavation, only the actual volume of the material excavated to the limits defined shall be measured for payment.

Unclassified Structure Excavation

For purposes of payment, the horizontal limits shall be the neat lines of the footings and to the limit of the free draining backfill, the vertical limits shall include all excavation made between the existing ground surface and the original plan elevation of the bottom of the footing, including blinding concrete and to the limit of free draining backfill.

Extra Depth Structure Excavation

Shall include all excavation directed by the Engineer below the original plan elevation of the underside of the blinding layer.

The horizontal limits of Extra Depth Structure Excavation shall be to the neat lines of footings and to the limit of free draining backfill.

Unclassified Channel Excavation

When shown on the Drawings or specified or directed by the Engineer, channels shall be excavated to the elevation and dimensions called for. The excavated material shall be used to form embankments where suitable and where required, otherwise it shall be disposed of in borrow pits or be used to flatten embankment slopes.

All channels shall be excavated and materials disposed of in a manner satisfactory to the Engineer.

2509 Measurement

If a separate bid item for unclassified structure excavation or other particular classification of excavation is given in the Bill-of-Quantities, the quantity to be paid for under this section shall be the number of cubic metres of all material measured in its original position, which has been excavated in accordance with the requirements of these Specifications from within the limits prescribed herein. The method of average end areas shall be used in computing the volume of excavation except as agreed between the Engineer and the Contractor.

Excavation above original plan elevation of bottom of footing made necessary by increasing the horizontal dimensions of footings over those originally shown on the Drawings or for any other reason, shall be measured as herein before prescribed per cubic metre for Unclassified Structure Excavation.

Measurement for Extra Depth Structure Excavation for the area measured above shall include the cost of any over break, dewatering (if required), shoring and supports and the cost of backfilling as specified including the provision of the backfill materials and for any difficulty of working and compacting in excavations.

The measured area of footings per square metre for Foundation Compaction shall include inspections; compaction of unfilled ground; testing of extra depth refilled foundations and final trimming and preparation prior to the placing of blinding concrete.

Material excavated before the Engineer has made the necessary measurements either at the beginning or during the progress of the work; excavation outside the prescribed limits; material in over breaks and slides, and excavation made necessary by the heaving of a foundation due to the driving of piles, shall not be measured as excavation, nor shall unauthorised voids be measured for roadway embankment.

Rehandled material shall not be measured as excavation, except where a structure, the excavation for which is a pay item, is required to be constructed subsequent to the placing of the roadway fill at the structure site. The excavation (measured in place in the compacted fill) necessary for the construction of the structure in this case shall be included in the measurement for payment.

The area in square metres of the plan area of concrete footings shall be measured net from the approved Drawings for payments for compaction of Structure Foundations.

2510 Basis of Payment

Payment will be made at the Contract Unit Price for the Items listed below which are shown in the Bill of Quantities. Such price will include full compensation for all labour, tools, equipment, supplies, required tests and all other things necessary for the work. Where excavations require shoring, cofferdams or dewatering or the enlargement of existing shorting, cofferdams or dewatering facilities, these shall also be included.

Where a pay item is not included in a Bill of Quantities for a particular structure or group of structures, for example a large bridge or minor structures in general, the work shall be considered as included in the price bid in Bill No. 2 for the works in general and will not be paid separately.

<u>Pay Item</u>	<u>Unit</u>
25/1 Unclassified Structural Excavation	
(a) Soft materials	cum
(b) Hard materials excavation	cum
25/2 Extra Depth Excavation	cum
25/3 Unclassified Channel Excavation	cum
25/4 Compaction of Structure Foundations	sqm
25/5 Embankment backfill behind the structure, compaction in layers (Layer not more than 200 mm)	cum

Backfilling around structures above the elevation of the ground line existing before excavation was made shall, unless otherwise specified on the Drawings or in the special Provisions, be done by the Contractor and the entire cost of same shall be included in the contract unit prices bid per cubic metre for Embankment as specified herein.

2600 Borrow Excavation

2601 Description

This item shall include excavation of roadside borrow from within the limits of the right-of-way including redundant existing road embankment or from borrow pits provided by the Contractor outside the right-of-way and placing in the embankment according to embankment specifications.

Construction Methods

During the time that any borrow pit is in use as a source of embankment material for any portion of the works:

- a) It shall be kept drained, if necessary by the excavation of a sump or sumps as well points and the installation and maintenance of mechanical pumping equipment;
- b) Development of the excavation of any borrow pit shall have the approval of the Engineer. Borrow pits shall not be developed any closer to the roadway than as shown on the Drawings or as instructed by the Engineer, and under no circumstances shall any longitudinal edge of any borrow pit be within 5 metres of the toe of any roadway embankment or private land.

c) Where a variety of materials are available on any land to be the site of a borrow pit, the Contractor shall adopt excavation methods designed to mix the different material from the pit so as to yield a consistent product when delivered to the embankment.

The overburden in the borrow pits shall be stripped and be disposed of if it contains materials not suitable for embankment construction. Disposal shall consist of burning and/or spreading the unsuitable materials in sections of the borrow pits where excavation has been completed as approved by the Engineer.

Excavated material which is not suitable for embankment construction shall be wasted or stockpiled for use in flattening of slopes or in backfilling ditches or for other use, as directed by the Engineer.

Any method of excavation may be used that will leave the borrow pits in a neat, smooth condition after excavation is completed.

If slopes at the edge of borrow pits are shown on the Drawings, the actual slopes may be flatter than shown on the Drawings, but in no case shall they be steeper or steeper than roadway embankment. Except as limited in regard to having the edges of borrow pits the required minimum distance from toe to embankment or right-of-way lines, borrow pits shall be excavated to cover the entire borrow pit area, with the depth being varied if approved to provide the required orphan amount of embankment.

When any borrow pit is no longer required as a source of embankment material, as certified by the Engineer, the lines of the excavation shall be trimmed to neat, regular faces as directed by the Engineer, prior to the carrying out of soil conservation measures if required by the Contract.

2602 Method of Measurement

Borrow shall not be measured for payment.

(c)	From borrow	m^3
-----	-------------	-------

2603 Basis of Payment

The work in this item will be paid for payment as cum under the contract unit price bid for Roadway Embankment or Miscellaneous Embankment or other pay items as specified herein.

2700 ROADWAY EMBANKMENT

2701 Description

This work covered by this item shall consist of the construction of embankment, including preloaded embankment, and berms and backfill not specified elsewhere, by furnishing, placing, compacting and shaping material or materials as specified herein below, obtained from approved sources, to the lines, levels, grades, dimensions and cross-sections shown on the Drawings or as directed by the Engineer.

This item shall consist of placing in roadway embankments suitable material excavated as roadway excavation, structure excavation or borrow excavation, all in accordance with these Specifications and in conformity with the lines, grades and typical cross-sections shown on the Drawings or established by the Engineer.

Under this Contract most embankment construction will involve the widening of existing road embankment in accordance with Conditions of Contract. The precise extent of the work will be advised after the determination of the new road alignment and may involve widening relatively short, intermittent lengths of the existing embankment. Embankment construction shall include the preparation of the areas upon which the embankment is to be constructed; the selection and preparation of materials; the formation, compaction and stabilisation of the embankment; and the disposal of surplus and unsuitable material.

2702 Embankment Material

Only suitable materials shall be used in the construction of roadway embankment and backfills. Brush, roots, rubbish, sods, weeds, logs, stumps, heavy vegetation or other organic or deleterious material, shall be deemed unsuitable and shall not be incorporated or placed in the embankments.

The top 500 mm of any roadway embankment shall not contain any material larger than will pass a 100 mm sieve. Grading and excavating operations in Roadway, Structure and Channel Excavation shall be so conducted that all suitable material shall be used where required for the formation of embankments, sub grade, shoulders, approaches, intersections and for backfilling around structures. The work shall be done in such a manner and sequence that the most suitable soil shall be reserved for the top 500 mm of the roadway embankment in so far as is practical.

Aggregate seepage drains shall be over burnt brick aggregate of 20 mm nominal size.

Sand for free draining backfill, where specified, shall have not more than 10% smaller than the 0.075 mm sieve.

Materials for sand embankment and bedding sand shall be river sands and have a portion passing the 0.075 mm sieve not greater than 20 percent.

Materials for sand working platform where permitted, shall have portion passing the 0.075 mm sieve not greater than 25 percent.

Preloaded embankment and berms shall be constructed of materials which meet the requirements for embankments, and when compacted shall have a unit mass (in situ moist density) of at least 1.75 t/cu.m.

At least 20 (twenty) days prior to the scheduled commencement of any embankment placement, the Contractor shall submit to the Engineer samples of any material or materials intended for use. The samples shall be accompanied by a written description stating the source of the material and if it is sand, whether it is natural sand or includes blended fractions. The description shall also indicate the section of embankment wherein it is proposed to use the sampled material.

No material shall be incorporated in the works prior to the written approval of the Engineer.

2703 Construction Method

a) Preparation for Embankment

Prior to placing any embankment upon any area, all clearing and grubbing operations shall have been completed in accordance with Section 2100 hereof.

The height of an embankment at any point is measured from the finished centreline of pavement or shoulder level (whichever is the lower) to the level of the natural surface after grubbing in accordance with Section 2100.

In areas where embankment 2 metres or more in height is to be placed the surface of the ground shall be broken so that the embankment will bind with the original ground.

In areas where roadway embankment less than 2 metres is to be placed, the exposed surface shall be ploughed or otherwise loosened to a depth of at least 200 mm and compacted according to the density requirements hereinafter specified. The top 150 mm of the residual mineral soil shall be processed as necessary and compacted to 90% of the maximum dry density as determined by AASHTO test method T-180 Method D. The Engineer may direct that the original ground surface is to be disturbed as little as possible where he considers that the operations will result in a reduction in the shear strength of the foundation for the embankment. The Engineer may notify the Contractor of areas where top soil may not be removed prior to his inspection of the operation. The Contractor will take care to grade and drain the

embankment foundation at all time during the preparation for fill placement. No payment will be made for foundation excavation or backfill when, in the opinion of the Engineer the requirement for these operations results from the Contractor's neglect of grading and drainage.

In sections of the road embankment so designated or so shown on the Engineering Drawings or so directed by the Engineer, sand embankment material shall be placed as a filter layer or zone of minimum thickness 500 mm compacted on the cleared and grubbed in-situ soil before roadway embankment itself is placed. Where the embankment height does not provide sufficient space for 500 mm of sand embankment free draining improved sub-grade may be used instead of sand embankment material.

b) Incorporation of Existing Embankment in the Works

Where existing embankments, road, or parts thereof, after recovery of the pavement materials as specified, are to be modified to form the embankment, the top, to the extent to be reconstructed, and one or both slopes of the old embankment shall be stripped of vegetation and roots and the embankment shall be removed to proposed finished sub-grade elevation. Steps with horizontal and vertical faces shall be cut in the existing slopes to provide a key between the old and the new embankment.

The top of the embankment after removal of existing pavement layers if it is to be raised shall be treated as the foundation of a new embankment as specified herein.

The top of the embankment where it is not to be raised more than 300 mm shall be compacted as sub-grade otherwise it shall be compacted as embankment. The embankment material immediately (down to 500 mm) below sub-grade level is not suitable for sub-grade material if its soaked CBR is less than 5%, in which case the unsuitable sub-grade shall be excavated and used for embankment below sub-grade and suitable sub-grade material shall be filled thereon as specified. The excavated volume shall only be measured for payment if the material is unsuitable for use in the embankment and it is spoiled with the Engineer's written approval.

A widened embankment shall be constructed as for new embankment.

Where embankments are to be constructed on or placed against existing embankment the slopes of which are 1 on 3 or steeper, the slope shall be benched as the fill is constructed. The width and depth of the benches shall be as shown on the Drawings or as directed by the Engineer. Suitable materials from the benches shall be re-compacted in the new fill. The volume of the benches shall not be measured and no extra payment will be allowed for this excavation or embankment.

When embankment are made on hillsides or slopes flatter than 1 on 3, the slopes of the original ground shall be loosened or ploughed to a minimum depth of 150 mm. No extra payment will be allowed for this excavation.

When the widened embankment has been filled to the underside of sub-grade, the sub-grade on the existing embankment and the new sub-grade shall be filled and compacted at the same time.

After the existing embankment has been lowered the amount sufficient to provide for the widening or other incorporation described above, the exposed surface shall be compacted as specified herein for embankment material in the sub-grade zone.

The soil removed, if suitable, shall be used as roadway embankment for widening or for new embankment. After completion of these preparatory works, borrowed or transported embankment material may be placed if required and compacted to final elevation as directed by the Engineer.

c) Embankment Formation

In embankment construction, the materials shall be deposited and spread in successive uniform layers shaped to drain. Each layer of the embankment, before starting the next, shall be thoroughly compacted by approved mechanical compaction equipment. Hauling shall be distributed over the width of the

embankment being filled and in no case will deep ruts be allowed to form during the construction of the embankment.

Where embankments are to be constructed across ground which will not support the weight of trucks or other hauling equipment, the first layer of the fill may be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the trucks or hauling equipment while placing subsequent layers. The remainder of such fills shall then be constructed in layers as above specified.

The Contractor shall make suitable allowance for consolidation of the material in the construction of embankments.

Embankments over and around pipes, culverts, arches, bridges and other structures shall be embankment material or free draining embankment material shown on the Drawings placed and thoroughly tamped in a manner that will avoid unbalanced loading and will not cause movement or place undue strain on any structure. Embankments placed against or adjacent to bridge abutments, retaining wing walls open end bents, culverts and around pipes, shall be placed in horizontal layers not exceeding 225 mm loose and must be thoroughly compacted by means of an approved vibrating or mechanical tamper capable of achieving the specified density throughout the layer. Each layer shall be compacted thoroughly before the next layer is placed thereon. The volume of embankment around structures that cannot be rolled with a power vibrating roller or a tamping roller shall be mechanically tamped to the same density as the adjacent portion of the embankment. Filling and tamping around structures shall be carried on simultaneously on both sides to prevent undue strain to the structure. An aggregate seepage drain shall be placed between all structure walls and the embankment for the full height of the walls or as shown on the Drawings. No embankment shall be placed against any structure or culvert until permission has been given by the Engineer and in no case until the concrete has been in place and has reached a strength at which it is capable of withstanding the loads of the backfill.

At sections along the alignment where the toe of the new embankment is in water and, in the opinion of the Engineer, it is impracticable to drain the water prior to placement of the fill, and where construction equipment like bulldozers with low contact pressure cannot in the opinion of the Engineer be used the Contractor may place a sand working platform provided that:

- i. Prior to any placement of sand, the foundation shall be cleared of water logged vegetable matter and organic soil;
- ii. The total compacted depth of the sand shall not exceed 1 metre unless otherwise approved by the Engineer.
- d) Except as otherwise directed by the Engineer, the embankment shall be constructed in layers of uniform thickness approximately parallel to the finished grade of the road bed with compaction by approved mechanical compaction equipment proceeding in the direction of the alignment and gradually covering the width of the embankment or part embankment by overlapping passes. Successive layers of the embankment shall be graded with power graders or by other means in conjunction with the compaction operation. All the time during compaction of any section of embankment, a smooth surface grade having an adequate crown slope or cross-fall shall be maintained to provide for rainfall runoff. The Contractor shall take particular care to drain that portion of any new embankment where it abuts an existing road embankment. Surface water must on no account be permitted to concentrate at the joint between an existing and a new embankment.

The Contractor shall ensure that the compactive effort is uniformly spread over the layer. over the layer. Concentrated compaction by construction traffic will not be permitted.

Materials approved for use in the embankment from whatever source, shall be uniform when run out in loads on the road bed. If, in the opinion of the Engineer, unacceptable non-uniformity exists in the delivered materials either within individual loads or between successive loads, the Contractor may be directed to suspend the compaction whilst the non-uniform material is blended

on the road bed with power graders or by approved labour methods. The Contractor, may also be directed to suspend the delivery of further material whilst blending of non-uniform material is proceeding. If, in the opinion of the Engineer, a uniform embankment material will not result from blending by power grader on the road bed, the non-uniform material shall be rejected and must thereupon be removed from the works to approved disposal. The Contractor shall be entitled to no additional compensation for:

- i. blending of non-uniform material on the road bed as directed by the Engineer;
- ii. down time in the event of the suspension of the compaction as directed by the Engineer;
- iii. down time in the event of the suspension of the delivery of material as directed by the Engineer;
- iv. Removal of any rejected material to disposal in pursuance of the foregoing.

The Contractor will make his own arrangements for watering of the soil when required for effective compaction and shall do so by providing sufficient water tankers or tanker trucks and shall provide sufficient water pumps on site for filling trucks and for dewatering the works as necessary in accordance with the contract.

The Contractor shall provide on site for the cutting, moving, dewatering, transporting, spreading, mixing, drying and watering and compaction of soil, at least that equipment nominated in the contract and any other equipment required completing the work as specified and in the time allowed.

The type of compaction plant in use on embankment sections shall be of sufficient capacity to produce the specified standard of compaction within a reasonable number of passes so as not to delay production.

Prior to the commencement of the compaction of any layer of embankment on the road the material shall be worked to distribute moisture evenly. Compaction shall be undertaken at moisture content close to the optimum moisture content determined for the material in accordance with AASHTO T-180 Method D for the degree of compaction required.

The Contractor shall at all times have on the embankment works, a sufficient number of mobile water tankers to water the embankment material at the required rate and to control dust loss to the satisfaction of the Engineer. Where clean sand is used, the material may be saturated with water during compaction. When dewatering may be required the Contractor shall ensure that sufficient pumps are available to enable the works to proceed without damage or delay due to unnecessary or prolonged inundation.

The number of items of compaction plant in use on any embankment section shall at all times be compatible with the rate of delivery of materials to the road bed. The Engineer may direct a decrease in the delivery rate or a total suspension of deliveries, if in his opinion, the compaction or watering or mixing operations cannot handle the volume of material. The Contractor will have no right to additional compensation or extension of time in such circumstances.

e) Compaction Trials

If requested by the Contractor, and at his expense, the Contractor shall perform a field compaction test of his compaction plant on any material approved for use as embankment fill. The Engineer will supervise and test the results of such full scale field test and may, depending upon his interpretation of the result, and without waiving any requirement of the Contract:

- i. approve a standard thickness of uncompacted layers placed in the embankment for a given type of compaction equipment, and
- ii. Approve compaction of material in the embankment within a range of moisture contents different from that specified.

f) **Standard of Compaction**

The standard of compaction achieved on all embankments shall be as follows:

All tests shall achieve 90% or more of the maximum dry density as determined by AASHTO test method T-180 Method D for all layers of the embankment constructed of approved materials, except as prescribed otherwise hereinafter or in the proceeding passages or in the Drawings.

The layers of embankments below 500 mm below sub-grade elevation shall be compacted to the above density and for the top 500 mm of the embankment all tests shall achieve 95% or more of maximum dry density quoted above. The moisture content of the sample material will be at the optimum estimated by the Engineer for proper compaction. The in-place density determination will be made according to standard procedures approved by the Engineer.

Unless the material at the time of compaction has the proper moisture content, it shall be allowed to dry if too wet; or mixed with water if too dry, until the material contains the proper amount of moisture for compaction.

The embankment material shall be tested by the Contractor under the supervision of the Engineer at every change in the observable characteristics of the material or at least every 500 metres to determine its compaction characteristics and CBR value.

The laboratory CBR is to be tested in the soaked or un-soaked condition or at any moisture content which the Engineer may deem relevant to the long term characteristics of the embankments.

The Contractor shall make a field density test under the supervision of the Engineer on the compacted embankment layers by AASHTO Test Method T-191 or other approved test for at least each 250 sq.m of each layer of embankment compacted. If the results of the tests made at representative locations in any layer, when interpreted by the Engineer, shown that the specified density has not been obtained, reworking of the layer will be directed. Reworking includes but is not necessarily limited to, scarification of the full depth of layer; windrowing by power grader of the loosened material; drying out or watering of the material, whichever is appropriate; and re-compaction. Further field tests will follow the reworking of any layer.

Other types of field density test or penetrometer test may be used for rapid assessment or measurement of field compacting during placement, after a correlation with the results of AASHTO test method T191 or other approved test has been established to the satisfaction of the Engineer.

2704 Maintenance and Stability of Embankments

a) **Embankments to be free draining and maintained in shape.**

The top of the embankment shall be maintained with adequate compaction, camber and shape at all times to withstand rain and flood waters.

Following damage by traffic, weather or flood the Contractor shall strip and re-compact the top 300 mm of the embankment over the full length unprotected by a seal in order to achieve satisfactory compaction of the surface to the approval of the Engineer. No extra payment shall be made therefore.

The Contractor shall be responsible until final acceptance for the stability of all embankments made under the Contract and shall replace at his own expense any portion which, in the opinion of the Engineer, has become displaced or damaged prior to final acceptance of the Project.

Embankments shall be maintained to the grade and cross-section shown on the Drawings, or established by the Engineer, until the completion and acceptance of the works.

b) **General Construction Procedures**

When there is difficulty in the movement of hauling equipment over a constructed or partly constructed embankment, the Contractor may be permitted to place a blinding layer consisting of dense graded sand to a maximum depth of 100 mm, over any layer in the embankment. The blinding material must be approved by the Engineer. Payment for the blinding layer will not be made separately, but the material shall be included and measured as part of the embankment material in place.

Embankment shall be constructed to the required grade and completed embankment shall correspond to the shape of the typical sections shown on the Drawings. The final trimmed surface of the embankment at sub-grade level shall be, at any point, within 25 mm of the design level. For any section of finished embankment measuring 100 metres along the alignment, the differences between actual and design levels at points checked by the Engineer shall show no trend in either direction.

Where the existing ground is in the water or is affected by tidal inundation, the Contractor shall construct closures and ring bunds and trenches so that inundation of the right-of-way is prevented.

Embankment shall be constructed in successive layers for the full width of the layer. Prior to compaction the layers shall not exceed the depth which the compaction equipment is capable of compacting as specified herein.

The Contractor shall programme his embankment construction so that any constructed embankment will not be overtopped by floodwaters during the construction period.

When constructing on soft ground the Engineer may direct the actual rate of raising the height of embankment to minimise possible soil failure. If soil failure does occur, or is expected during construction, the Engineer shall suspend embankment construction in the area of failure, until corrective measures can be determined.

An extension in the Contract time caused by a delay due to soil failure may be granted in accordance with the Conditions of Contract.

2705 Measurement

At sections where a new embankment abuts upon an existing road embankment or natural slope, the area of the cross section used in the quantity computation will be based on the joint between the new embankment and existing soil cross section surveyed after grubbing as shown on the Drawings or directed by the Engineer.

The units of measurement shall be the volume in cubic metres of Roadway Embankment and Miscellaneous Embankment completed and accepted and the volume in cubic metres of soils excavated and spoiled where they are unsuitable for use in embankment or they are surplus to the requirement for the construction of Roadway Embankment or Miscellaneous Embankments.

The volume shall be measured by surveyed cross sections measured after clearing and grubbing and the design cross section to sub-grade elevation as accepted by the Engineer.

The average area of added embankment in two adjacent cross sections shall be multiplied by the distance between them to obtain the volume of Roadway Embankment. The horizontal distance between cross sections shall be mutually agreed between the Engineer and the Contractor and may be varied according to the variability of the cross sections. No allowance will be made for settlement.

If the volume of roadway excavation as measured by the cross sections above, less the volume of recovered pavement materials measured separately, less the volume of Miscellaneous Embankment, less the volume classified by the Engineer as unsuitable due to organic matter, or materials unable to attain minimum CBR of 3% at 90% MDD for the whole of the Works exceed the volume of Roadway Embankment as measured above then the additional excavation shall be paid as Roadway Excavation to Spoil.

Where the Contractor is required to excavate unsuitable material from below the ground level, the volume of replacement material will be measured for payment by the Engineer using a method, in his opinion, suitable to the conditions. Where the Contractor excavates material from below ground level under the embankment or anywhere beneath the finished sub-grade level and, in the opinion of the Engineer, the need to excavate such material results from careless working of the embankment foundation, the volume of backfill will not be measured for payment.

2706 Basis of Payment

This work measured as provided above shall be paid for at the Contract unit prices as detailed below. Payment shall be full compensation for performing the work, furnishing the specified materials from whatever approved source, disposing of waste and spoil and providing all labour, plant, equipment, tools and incidentals necessary to do the work. The payment shall be full compensation for excavation (except if otherwise paid for as specified herein above) and hauling; formation and compaction of embankments; testing, refilling around structures; removal and disposal of all roots, stumps, logs and other debris; clearing and grubbing; completion of sub-grade, shoulders and slopes; and the furnishing of all labour, equipment, tools and incidentals necessary to complete the work. Payment for Sand Embankment shall be measured only for the location and cross-section to volumes approved by the Engineer.

Payment for Roadway Embankment will be at the price for pay Item 2.7/1 regardless of the source of the material.

Payment for sand working platform shall be paid as roadway embankment.

Payment for backfill where unsuitable material has been excavated will be made at the price for Roadway Embankment, unless otherwise approved in specific cases by the Engineer.

<u>Pay Item</u>	<u>Unit</u>
27/1 Roadway Embankment	cum
27/2 Sand Embankment	cum
27/3 Aggregate Drain Backfill	
a) Crushed aggregate	cum
b) Natural aggregate	cum

2800 Sub-Grade Preparation

2801. Description

This work will consist of the preparation of the top surface of the embankment to accommodate the placement of the pavement structure, shoulders and other cross-section features in accordance with these Specifications and in conformity to the lines, grades, and width shown on the Drawings and cross sections or as directed by the Engineer.

2802 Construction Requirements

The existing embankment shall be scarified (at least 100 mm), bladed, and shaped to conform to the line, grade, and cross-section shown on the Drawings or as established by the Engineer. Any high place in the embankment shall be cut to grade and scarified; the resulting material hauled and deposited on low areas or on fill slopes as directed by the Engineer. All depressions shall be filled with approved material so as to bring the surface of the sub-grade to the elevation shown on the Drawings or approved by the Engineer.

All soft and yielding material, other than material that would be satisfactory but for its high moisture content, boulders and loose stones, or any other objectionable materials in the sub-grade, shall be removed and replaced with suitable material, which shall be thoroughly compacted. Large rocks, stones, boulders or soil lumps greater than 100 mm shall be removed for a depth of 300 mm below sub-grade

elevation. All buried roots, stumps, or other perishable matter encountered in the preparation of the sub-grade shall be removed to a depth of not less than 600 mm below sub-grade elevation.

The sub-grade for all pavements shall be compacted at close to optimum moisture content for AASHTO Test T 180 Method D and shall be compacted to not less than 95% of maximum dry density. At least one density test shall be performed for each 250 square metres of finished sub-grade surface. Any portion of the sub-grade inaccessible to the roller shall be thoroughly compacted in thin layers with approved mechanical tampers. The sub-grade for pavement widening shall be compacted by rolling with an approved heavy vibrating compactor or tamper.

Should the sub-grade become baked and hardened before laying a sub-base it shall be scarified, moistened and thoroughly compacted.

The sub-grade shall be in a final condition for receiving sub-base, base course or surface course material for a distance of at least 200 metres in advance of placing of such materials, forms, etc. No materials, forms, etc., shall be placed until the sub-grade has been approved.

No vehicle, the gross mass of which exceeds 10 kilograms per millimetre width of tyre shall be permitted on the sub-grade. If the sub-grade is in such condition that vehicles cause excessive rutting, either lighter vehicles shall be used or suitable runways provided.

2803 Proof Rolling

Prior to the placement of the pavement if directed by the Engineer, the Contractor shall furnish and operate at the direction of the Engineer heavy pneumatic-tyred compaction or other approved equipment for compacting and for testing for stability of the sub-grade.

The sub-grade and base course shall be prepared and compacted in accordance with their respective Specification requirements and shall be further compacted and tested with a heavy pneumatic-tyred roller if required by the Engineer.

The sub-grade, prior to proof-rolling with a heavy pneumatic-tyred roller, shall be prepared and compacted in accordance with the requirements for Roadway Embankment in these Specifications. The sub-grade shall then be compacted and tested with two or more coverage's as directed by the Engineer, of a proof roller meeting the requirements of the Engineer. Coverage is considered to be that stage in the rolling procedure when the entire width of the section designated has been in contact with the pneumatic tyres of the roller at least once.

The roller shall be operated in a systematic manner at a speed no greater than six kilo meters per hour so that the number of coverage over all areas designated can be readily determined and recorded.

Where the operation of the proof roller shows the sub-grade to be unstable or to have non-uniform stability, the Contractor shall correct the unstable areas by one of the following methods:

- i. If the quality of the soil is acceptable and the instability of the sub-grade is due to high moisture content, the soil shall be dried by aeration or other means, and then compacted and tested with the heavy pneumatic-tyred roller. No payment will be made for drying the soil.
- ii. If the Contractor has not incorporated unsuitable material, as defined herein above, in the sub-grade and the soil is inherently incapable of being stable, the unsuitable material shall be removed to a depth not exceeding 600 mm below the top of sub-grade levels, and it shall be replaced with material that is satisfactory and workable. The corrected sub-grade shall be then be compacted and tested with the proof roller. The material removed will be paid for under Roadway Excavation, if confirmed as unsuitable, or as otherwise approved by the Engineer and the material used for replacement will be paid for as Embankment material or as otherwise approved by the Engineer. The sub-grade shall then be checked for line and grade and any deviations corrected. All materials authorized for removal due to unsatisfactory conditions or high moisture contents shall be reused for embankments after drying and there shall be no payment for excavation to spoil unless the Engineer confirms the materials as unsuitable after laboratory verifications.

In a manner similar to that described above for the sub-grade, and as directed by the Engineer, the sub-base and base course shall in turn be compacted and tested by proof roller, and areas found deficient in stability shall be corrected to a condition of uniform and satisfactory stability, and shaped to plan line and grade.

Proof-rolling shall be done only in the presence of the Engineer, who will approve or disapprove the stability of the sub-grade, sub-base and base course and supervise the correction of the unstable areas.

Proof-rolling done in the absence of the Engineer or Engineer's Representative will not be accepted.

2804 Method of Measurement

Sub-grade preparation shall be measured as the area in square metres of sub-grade compacted to the specified density and accepted within the limits shown on the Drawings. No measurement shall be made for additional sub-grade material required to compensate for loss of volume due to re-compaction.

Unsuitable or unsatisfactory embankment removed and replaced shall be measured by cross-sectioning prior to and subsequent to removal of unsatisfactory or unsuitable material and subsequent to the replacement of satisfactory material. The average end area method of computation shall be used. The material measured as unsuitable shall be paid as spoil. Unsatisfactory material dried and reused in embankment shall be paid for as embankment material from borrow, and the replacement material shall be paid for as embankment material from borrow.

2805 Basis of Payment

The work in this item performed on roadway embankment and sub-grades shall be paid for by payment of the measured area at the contract unit rate for Item - 28. Sub-grade Preparation which price and payment shall be full compensation for removing or adding materials, the shaping, dressing, compacting, and completing of the sub-grade and shoulders in accordance with the Specifications and Drawings.

For removal and replacement of unsatisfactory or unsuitable material, as directed by the Engineer, the volume measured as provided herein above shall be paid for at the contract unit price per cubic metre of road way excavation to spoil unless the material is suitable for embankment in which case it shall not be measured as excavation. The material used to replace the unsatisfactory or unsuitable material shall be measured and paid as roadway embankment - Item 27/1, also where the pavement is to be constructed over a newly constructed embankment, the sub-grade preparation shall not be paid separately, but only under Item 27/1, which prices shall be full compensation for the excavation, hauling, disposal of surplus material, formation and compaction of embankment, completion of sub-grade, and the furnishing of all labour, equipment, tools, materials, and incidentals necessary to complete this work.

<u>Pay Item</u>	<u>Unit</u>
28/1 Sub-grade Preparation	Sq.m

TECHNICAL SPECIFICATION

SERIES 3000

SOIL/AGGREGATE PAVEMENT

TECHNICAL SPECIFICATION

PART 3000 - SOIL/AGGREGATE PAVEMENT**TABLE OF CONTENTS**

<u>Item Number</u>	<u>Page</u>
3000 General	3 - 4
3001 Description	3 - 4
3100 Improved Sub-Grade	3 - 4
3101 Description	3 - 4
3102 Materials	3 - 4
3103 Construction Method	3 - 4
3104 Testing	3 - 5
3105 Measurement	3 - 5
3106 Basis of Payment	3 - 5
3200 Aggregate Sub-base for Pavements and Shoulders	3 - 5
3201 Description	3 - 5
3202 Materials	3 - 6
3203 Construction Methods	3 - 7
3204 Testing	3 - 9
3205 Method of Measurement	3 - 9
3206 Basis of Payment	3 - 9
3300 Aggregate Base Course	3 - 10
3301 Description	3 - 10
3302 Materials	3 - 10
3303 Construction Method	3 - 11
3304 Testing	3 - 13
3305 Method of Measurement	3 - 13
3306 Basis of Payment	3 - 13
3400 Stone Base Course	3 - 14
3401 Description	3 - 14
3402 Materials	3 - 14
3403 Construction Method	3 - 25
3404 Testing	3 - 17
3505 Method of Measurement	3 - 17
3406 Basis of Payment	3 - 17
3500 Preparation of Existing Pavement	3 - 18
3501 Description	3 - 18
3502 Construction Method	3 - 18
3503 Method of Measurement	3 - 18
3504 Basis of Payment	3 - 18

3000 GENERAL

3001 Description

Payment for the items covered in this Specification shall be for the finished compacted quantities approved by the Engineer.

Improved sub-grade shall be placed beneath roadway pavement or other structures in accordance with the Engineering Drawings and the Specifications therefore or as directed by the Engineer.

Where the Contract involves widening of the existing pavement materials, including improved subgrade, subbase and base course will have to be placed and compacted in narrow widths.

Aggregate base course material will be placed in a variable thickness layer to provide a levelling course for the pavement in addition to the function as a base course.

3100 IMPROVED SUB GRADE

3101 Description

This item consists of the furnishing, hauling from outside the right of way if required, placing, shaping, compacting and testing of soil, sand or soil aggregate mixtures above the compacted subgrade to form the lowest layer of the pavement in accordance with these specifications and to the lines, grades and thickness and in the locations shown on the Drawings or approved by the Engineer.

3102 Material

Improved sub-grade shall be any natural soil or sand or any blend or mixture of soils, sands (natural or manufactured), broken brick or aggregate having a maximum particle size of 37 mm, a plasticity index of less than 6%, a minimum of 12% and maximum of 25% finer than 0.075 mm sieve and must have a minimum CBR value of 10 percent when compacted to 95% of the maximum dry density from AASHTO (Test Method T 180 Method D) and soaked for four days. A surcharge load of at least 10 kg or the pavement load shall be applied in the CBR test.

3103 Construction Method

The improved sub-grade shall be placed in uniform layers on the top of compacted subgrade shaped as required to camber or cross-falls. Blends of materials preferably shall be mixed off site by approved methods but if sufficient labour or equipment capable of mixing materials in place are provided then the materials may be laid loose in uniform layers of thickness appropriate to the required final proportions and the layers shall be thoroughly and evenly mixed together to a uniform colour and texture in a dry state. Prior to compaction the materials shall be remixed with water to near the optimum moisture content and only then shall be compacted to a density of not less than 95% of the maximum dry density AASHTO (Test Method T-180 Method D).

Whichever method is adopted prior to placing any materials, the Contractor shall demonstrate by providing samples to the Engineer and by laboratory test results that the proposed material or materials meet the requirements, and if mixing is required shall have determined appropriate mix proportions and mixing procedure.

The materials in place shall be compacted to the specified density at moisture content close to the optimum. The compacted layer shall be of the thickness shown on the Drawings within

a tolerance of -15 mm to +10 mm. the average of at least 3 depths measured over any 100 metre length shall be within a 5 mm variation from the required depth.

Any deficiencies in material shall be made up by scarifying the material and adding and mixing in new material as required and re-compacting as specified, except that deficiencies may be made up with material of the next layer above but at the Contractor's expense.

Excess material shall be trimmed off and disposed of in the borrow pits and shall not be paid for.

When the improved subgrade cannot be extended to the surface of an embankment or to the slope of a side drain for example, in urban areas, it shall be drained by a system of sand drains to the approval of the Engineer.

3104 Testing

The layer depth shall be tested in at least 3 places for each 600 sq.m of work.

The density shall be tested at last three times for every 600 sq.m of completed work. Samples shall be removed from the pavement and shall be tested for grading, compaction and CBR once for each one kilometre. Where the material does not meet the requirements of the Specification at the conclusion of two additional tests, the material shall be removed and replaced as specified or the faults shall be corrected by methods approved by the Engineer at the Contractor's expense.

3105 Measurement

Measurement shall be the volume in cubic metres computed from plan lines or field measurements of widths and depths provided that the maximum depth to be paid for shall be the compacted depth of material required or instructed by the Engineer.

3106 Basis of Payment

The volume measured shall be paid for at the contract unit price per cubic metre for "Item 31/1 - Improved subgrade" which price shall be full compensation for providing soils, sands and aggregates, mixing, watering, trimming to shape, compacting, testing, trimming and re-compacting and removing if necessary.

Item	Unit
31/1 Improved Sub-grade	Cum

3200 Aggregate Sub-Base (Gravel Sub-Base) for Pavements and Shoulders

3201 Description

This item shall consist of a compacted aggregate sub-base and shoulder material constructed in accordance with the requirements hereinafter set forth and in conformity with the lines, grades and cross sections shown on the Drawings or approved by the Engineer. This item shall be compensation for aggregate subbase constructed with materials from outside the ROW provided by the Contractor and with materials recovered from structures and the old pavement in the right-of-way.

3202 Materials

a) Aggregate Components

Materials for this course shall be sound, durable crushed rock, slag, gravel, concrete, or fused clay aggregate as specified herein below. The characteristics of these materials shall be such that they will compact to the density and stability established as satisfactory by the Engineer. Materials shall be processed from recovered structures and pavement materials or shall be provided by the Contractor as necessary.

The material shall be clean, sound, and durable, of uniform quality, and free from thin, elongated, flaky or brittle pieces.

The percentage of deleterious substances shall not exceed the following values:

<u>Deleterious Material</u>	<u>Percent by weight</u>
Coal	1.0
Clay Lumps	0.25
Soft Fragments	3.0
Shale and other deleterious substances (such as alkali, friable or laminated pieces, limonitic concretions and chert) which will readily disintegrate	2.5

In addition to meeting the above requirements, for the component coarser than the 4.75 mm (no. 4) sieve at least 90 percent by weight must have at least two fractured faces and at least 98% by weight must have at least one fractured face.

The abrasion resistance of coarse aggregates passing 37.5 mm shall be measured by the Los Angeles Abrasion Test (AASHTO Test Method T-96). In the case of aggregate having a bulk specific gravity, saturated surface dry condition (SSD) less than 2.55 the standard test procedure shall be modified by decreasing the weight of material charged into the L A Abrasion machine. The weight of material charged shall be a fraction of the standard weight which fraction shall be the bulk specific gravity saturated surface dry condition of the material to be tested divided by 2.65.

These aggregates shall have a Los Angeles Abrasion loss of not more than 50% percent.

- b) The aggregate shall be well graded evenly within the following grading distribution limits. Material meeting the following requirements may be obtained by blending if approved by the Engineer.

Table 3-1

	Total Per cent Passing					
Sieve Size	50 mm	25 mm	19 mm	4.75 mm	0.425 mm	0.075 mm
Percent passing	100	70-90	50-85	25-60	10-30	0-15

Alternatively any of grading A to F (C to F for the top surface of shoulders where required) inclusive, of AASHTO standard Specification M 147, with the fraction passing the 0.075 mm sieve not greater than two thirds of the fraction passing the 0.425 mm sieve.

AASHTO**Standard Specification Designation M 147****Table 3-2**

Sieve Designation mm	Percentage by mass passing square mesh sieve					
	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
50	100	100				
25		75-95	100	100	100	100
9.5	30-65	40-75	50-85	60-100		
4.75	25-55	30-60	35-65	50-85	55-100	70-100
2.0	15-40	20-45	25-50	40-70	40-100	55-100
0.425	8-20	15-30	15-30	25-45	20-50	30-70
0.075	2-8	5-20	5-15	5-20	6-20	8-25

The material shall have 4 days soaked CBR value of not less than 30% when tested at the density and moisture conditions approved by the Engineer to best simulate service conditions. The fraction of the material passing a 0.425 mm (No. 40) sieve shall have a liquid limit not greater than 30 and a plasticity index of not more than 6.

In the top 150 mm of unsealed shoulders the plasticity index shall be in the range 4 to 9, the grading shall be C, D, E or F and a minimum of 8% shall pass the 0.075 mm sieve.

3203 Construction Methods

Any ruts, holes, defects or soft yielding places which occur in the subgrade or other underlaying course by reason of any improper drainage conditions, traffic or hauling over the same, or for any other causes, shall be corrected and compacted to required density and stability and shall comply with the smoothness requirement of the Specifications before aggregate subbase is placed thereon. Stockpiling and loading methods shall be such as to permit ready identification of the materials to be used and shall be approved by the Engineer. Sites for stockpiles shall be clean prior to storing materials. The stock piles shall be built up in layers not to exceed 1 metre height, and each layer shall

be completely in place before the next layer is started. Aggregates shall not be removed from stockpiles within 200 mm of the ground until final clean up of the site of the work and no material which has become mixed with foreign matter or other sizes or grades of aggregates shall be used.

Coarse aggregates shall be placed in stockpiles in units of not less than 200 cubic metres at least seven days prior to their anticipated use in the work. The Engineer will sample each stockpile or each 200 cubic metres of stockpile to determine the quality of the material and assess it for approval for use in the various types of construction.

In the following paragraphs machine-intensive construction methods are specified. Labour-intensive methods may be used with the prior approval of the Engineer.

Aggregate subbase materials shall be evenly spread on the subgrade, or other underlaying course, by the use of approved, self-propelled spreading machines capable of placing the materials true to line and grade without damage to the subgrade or other course. Aggregate subbase materials shall be at or near optimum moisture content at the time of loading for transportation to the site, during and on completion of compaction.

The aggregate subbase materials shall be spread in courses of not less than 75 mm compact thickness or of a greater depth up to that depth capable of being compacted as specified by the available equipment. It is expected that smooth wheel vibrating rollers of a minimum mass of 10 tonnes will be required to achieve the compaction standard.

Compaction of the layer shall immediately follow the spreading operation and rolling or compacting shall begin at one edge of the course (the low edge on superelevated sections). Water in the amount that is necessary for compaction shall be added before and during rolling.

Any irregularities that develop in the surface of the aggregate subbase course during compaction shall be corrected by loosening the surface, adding or removing material and re-compacting until the surface presents a smooth regular appearance. The finished surface of the course shall conform so nearly to that indicated on the Drawings or approved by the Engineer that it will nowhere vary more than 10 mm from a straight edge, 3 metres long, applied to the surface parallel to the centreline of the pavement, nor more than 12 mm from a template conforming with the cross sections shown on the Drawings. The Contractor shall furnish all the straight edges, full width templates and other devices necessary to control construction of aggregate subbase course to these surface tolerances. The finished subbase course shall not be used for the carriage of through traffic but may be used for the carriage of local traffic only. Any damage which is done to the finished aggregate subbase course by traffic shall be repaired by loosening, reshaping, re-compacting, use of necessary water and the addition of more aggregate subbase course material if necessary. Reshaping and re-compacting operations shall be done at the expense of the Contractor.

The surface of the finished layer shall be within +10 mm or -15 mm of the elevation shown on the Drawings or instructed by the Engineer. The depth over each 100 metres shall be measured in at least 3 places and the mean depth shall not be less than the required depth. Deficiency in depth shall be corrected or made up in the next layer above at the Contractor's expense.

In the case where the course is allowed to stand more than 24 hours before the application of a prime coat or the placing of a subsequent course, the Contractor shall regularly sprinkle the surface of the course with water, at his own expense, so that the course is prevented from drying out through its depth.

Preparation of existing crushed brick or whole brick shall be shaped and re-compacted to the lines,

grades and cross-sections shown on the drawing or approved by the Engineer. The compaction requirement for crushed bricks shall be 98% of the maximum dry density determined by the Engineer in accordance with AASHTO T180 (Method D) or as approved by the Engineer.

3204 Testing

Before commencing the work, the Contractor shall furnish to the Engineer, a sufficient quantity of the materials intended for use in order that the Engineer can determine the maximum dry density in accordance with AASHTO T-180 (Method D). The density requirement for the project shall be at least 98% of the maximum dry density determined by the Engineer. During the construction, the grading shall be checked on samples from each 50 cubic metres of stockpiled aggregate and if there is an appreciable change in grading or shape of the aggregate, or a change of source of aggregate, the Contractor shall furnish sufficient samples to the Engineer in order to establish a new value for the density requirements. Field test for moisture content and dry density shall be in accordance with AASHTO T-191 or other method approved by the Engineer. At least one test shall be carried out for each 300 square metres of completed subbase course.

3205 Method of Measurement

The quantity of aggregate subbase course to be paid for under this item shall be the number of cubic metres computed from plan lines of approved aggregate subbase course and shoulder surface material compacted in conformity with the lines, grades and cross sections shown on the Drawings or agreed field measurements of width and depth or as approved by the Engineer.

3206 Basis of Payment

The quantity measured as above specified shall be paid for at the contract unit price bid per cubic metre for "Item 3.2 – Aggregate Sub-base" which price and payment shall constitute full compensation for providing aggregates and water for the subbase, hauling, placing, mixing, compaction, manipulating and re-compaction where necessary, proof-rolling if required and for furnishing all labour, equipment tools and incidentals necessary to complete this item.

Aggregates source may be from brick fields or material salvaged from the existing road or structures and payment will be considered full compensation for the aggregate regardless of source.

Pay Item	Unit
32/1 Aggregate Sub-Base (natural River gravel)	Cum
32/2 Aggregate Sub-base (crushed and graded agg.)	Cum

3300: AGGREGATE BASE COURSE

3301 Description

This item shall consist of a compacted aggregate base course constructed in accordance with the requirements hereinafter set forth and in conformity with the lines, grades and cross sections shown on the Drawings and approved by the Engineer.

Finished base course levels shall be determined following the choice of horizontal and vertical alignments for the new road pavement. The base course shall be constructed, with variable thickness where necessary, to the lines and levels directed by the Engineer.

3302 Materials

Materials for this course shall be sound, durable crushed rock, crushed slag, crushed boulder, as specified in Section 3200 for aggregate sub-base, except as otherwise specified herein below. The characteristics of these materials shall be such that they will compact to the density and stability established as satisfactory by the Engineer.

Coarse and fine aggregate materials may be mixed to obtain the required specifications as set out below. Fine aggregate material passing the 2.00 mm sieve shall consist of crushed stone screenings, natural sand, and non-plastic soil binder passing the 0.425 mm sieve.

The materials shall be uniformly blended by mixing predetermined quantities of coarse and fine aggregate and at the time of compaction the moisture content shall be plus or minus two percent of the optimum moisture content. The aggregate shall meet the grading B, C or D of AASHTO standard Specification M147-65. The fraction passing the 0.075 mm sieve shall be not more than one thirds of the fraction passing the 0.425 mm sieve.

AASHTO Standard Specification Designation M147-65

Table 3-3

Sieve Designation mm	Percentage by mass passing square mesh sieve					
	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
50	100	100				
25		75-95	100	100	100	100
9.5	30-65	40-75	50-85	60-100		
4.75	25-55	30-60	35-65	50-85	55-100	70-100
2.0	15-40	20-45	25-50	40-70	40-100	55-100
0.425	8-20	15-30	15-30	25-45	20-50	30-7-
0.075	2-8	5-20	5-15	5-20	6-20	8-25

The fraction of the material passing a 0.425 mm sieve shall have a liquid limit not greater than 30 and a plasticity index of not more than 6.

Coarse aggregate sizes shall have at least 90 percent by weight of pieces with two fractured faces and at least 98 percent by weight shall have at least one fractured faces. Thin flat flaky or over sized aggregate detrimental to compaction and effective choking shall not be used. The flakiness index as determined in accordance with BS 812 shall be not greater than 35%.

When tested in accordance with the Method of Test of Soundness of Aggregates by use of Sodium Sulphate, AASHTO Test Method T-104, and the weighted average loss in five cycles shall not exceed 15% by weight. The aggregates shall have a Los Angeles Abrasion loss of not more than 30 percent.

The California Bearing Ratio (CBR) value of this material compacted and tested at the approved density and moisture content shall be not less than 80%.

3303 Construction Method

Any ruts, holes, defects or soft yielding places which occur in the subbase by reason of any improper drainage condition, traffic or hauling over the same, or for any other cause, shall be corrected and compacted to required density and stability and shall comply with the smoothness requirements of the Specification before aggregate base course is placed thereon.

Plant: The processing and mixing plant and its operation shall be approved prior to the start of the work. The coarse and fine materials shall be measured separately and accurately by either volume or weight and shall be fed to the pug mill or other approved type of mixer in their proper proportions and at a rate to ensure correct blending in the mixer. Added water shall be measured accurately by weight, volume, or an approved metering device, and shall be uniformly distributed in the mix.

All mixing plants shall be equipped with automatic cut-off devices which will stop the feed to the mixer if the delivery of any component of the mix should fail.

Means shall be provided for checking and verifying the accuracy of all proportioning and measuring devices.

Stockpiling aggregates for proportioning by any method approved by the Engineer shall be accomplished in a manner that will ensure separation of different sized aggregates and prevent segregation and degradation of the aggregates.

Weight proportioning plants shall be equipped with separate bins for each size of coarse and fine materials.

Delivery: The mixture shall be handled and transported without segregation or loss of moisture. The vehicles used for hauling shall be clean and free of all harmful material. To prevent loss of moisture during transportation, the mixture shall be covered with tarpaulins or other suitable covers, if necessary, until it is deposited in the spreader. Frequent moisture control tests will be made at the point of delivery on the project, as directed by the Engineer. Aggregate base materials shall be at or near optimum moisture content at the time of loading for transportation to the Project site.

Aggregate base materials shall be evenly spread on the subbase or lower base course by the use of approved, self-propelled spreading machines or power graders capable of placing the materials true to line and grade without damage to the subbase or lower base course or by approved labour intensive methods.

The aggregate base materials shall be spread in courses of not under 75 mm compacted thickness. Compaction shall be carried out using heavy vibrating power rollers, heavy rubber tyred rollers or plate compactors for small widths.

Labour-intensive placing, spreading and levelling methods may be used with the prior approval of the Engineer.

Base course shall be compacted to the full width shown on the Drawings. Either shoulder material or extra base material shall be placed and compacted with the base to provide edge support and to allow full compaction. Base course material only will be paid for to the limits of the lines shown on the Drawings.

Compaction of the course shall immediately follow the spreading operation and compaction shall begin at the edges of the course. When the shoulder backing is firmly compacted, the rolling shall proceed inward until the crown part is reached. In the case of superelevated curves the compaction shall be from the low side to the high side, in the manner described above, until the shoulder backing at the high side is firmly compacted. Water in the amount that is necessary for compaction shall be added during rolling.

In narrow base widening, inaccessible to the main compaction equipment, the compaction may be performed with approved reciprocating or vibratory tampers or other methods approved by the Engineer. Unless the excavation is performed accurately by cutting to neat lines, the requirement for backing up the edge as stated above will apply for each course. The same density requirement as stated herein shall be followed.

Any irregularities that develop in the surface of the aggregate base course during compaction shall be corrected by loosening the surface, adding or removing material and re-compacting until the surface presents a smooth regular appearance. The finished surface of the course shall conform closely to that indicated on the Drawings or approved by the Engineer so that it will nowhere vary more than 10 mm from a straight edge 3 metres long applied to the surface parallel to the centreline of the pavement, nor more than 12 mm from a template conforming with the cross sections shown on the Drawings. The Contractor shall furnish all the straight edges, full width templates and other devices necessary to control construction of aggregate base course to these surface tolerances.

The upper surface of the base course in no place shall be more than 6 mm above the planned elevation nor more than 10 mm below the planned elevation and the mean of five measurements of thickness taken in any 200 metre long section by digging holes shall be at least equal to the required base course thickness.

For construction of wide roads, the finished base course shall not be used for the maintenance of through traffic but may be used for the maintenance of local traffic only. Any damage which is done to the finished aggregate base course by traffic shall be repaired by loosening, reshaping, re-compacting watering as required and the addition of more aggregate base course material, if necessary. Repair operations shall be done at the expense of the Contractor. When a section has been completed as described above it shall be allowed to surface dry before the application of a bituminous prime coat. If a prime coat is not provided, a base course of another type may be placed immediately. In case the application of a prime coat or the placing of subsequent course, the Contractor shall sprinkle the surface of the course with water, at his own expense, so that the course is prevented from drying out through its depth.

3304 Testing

Before commencing the work, the Contractor shall furnish to the Engineer a sufficient quantity of the materials intended for use in order that the Engineer can determine the density requirements in accordance with AASHTO T-180 (Method D) and the CBR of the material. Course aggregate shall be placed in stockpiles in units of not less than 200 cubic metres at least seven days prior to their anticipated use in the work. The Engineer will sample each stockpile or each 200 cubic metres of stockpile to determine the quality of the material and assess it for approval for use in the various types of construction. The density requirements for the project shall be at least 98 percent of the dry density determined by the Engineer. During construction, grading shall be checked on samples from each 50 cubic metres of stockpile. If there is an appreciable change in grading of the aggregate from stockpiled samples or from samples in place and compacted on the roadbed, as determined by the

Engineer, or a change of source of aggregate, the Contractor shall furnish sufficient samples to the Engineer in order to establish a new density for the density requirements.

Field test for density shall be in accordance with AASHTO T-191 or as otherwise approved by the Engineer and shall be carried out by the Contractor at a rate of at least one per 250 sq. metres of compacted base course.

3305 Method of Measurement

The quantity of Aggregate Base Course to be paid for shall be the number of cubic metres, computed from plan lines, of approved aggregate base course material compacted in conformity with the lines, grades and cross sections shown on the Drawings or agreed field measurements of width and depth or as approved by the Engineer.

3306 Basis of Payment

The quantity measured as provided above shall be paid for at the contract unit price per cubic metre bid for "Item 33/1 Aggregate Base Course which price and payment shall constitute full compensation for providing aggregate and water for the base, crushing, screening, stockpiling, testing, hauling, placing, compacting, manipulating and preparation and re-compaction where necessary, providing all labour, equipment, tools, and incidentals necessary to complete this item.

The unit price shall cover all operations defined above whether the base material has been provided by the Contractor from outside the right of way or from materials recovered from structures and existing pavement as provided for in Part II of this Technical Specification.

Item	Unit
33/1 Aggregate Base-Course	Cum

3400 PREPARATION OF EXISTING PAVEMENT

3401 Description

This work shall consist of preparation of existing subbase/base by scarifying, reshaping, and re-compacting to the lines and grades shown on the drawings or approved by the Engineer.

3203 Construction Method

After scarifying the existing gravel sub-base or removal of existing bituminous layer minimum 150 mm top of the existing subbase / base course to be scarified and reshaped to proper grade and camber as shown on the drawing. The scarified materials then shall be watered as required and re-compacted. Maximum dry density of top material shall be determined by the Engineer in accordance with AASHTO T180 (Method D). The density requirement shall be at least 98% of the maximum dry density so determined. At least one density test shall be carried out for each 300 square metres of compacted existing aggregate sub-base/base.

3403 Method of Measurement

The unit of measurement for preparation of existing brick aggregate subbase /base shall be the area in square metres of the horizontal surface area of the existing pavement scarified, reshaped and re-compacted to the specified density.

3404 Basis of Payment

The work in this item performed on preparation of existing stone aggregate shall be paid for by payment of the measured area at the contract unit rate for Item – 35 preparation of existing stone aggregate which price and payment shall be full compensation for removing or adding materials, the shaping, dressing, compacting, and completing of the preparation of existing stone aggregate sub-grade and shoulders in accordance with the Specifications and Drawings.

Pay Item	Unit
34/1 Preparation of existing stone-aggregate surface	Sq.m

3500: GRAVEL WEARING COURSE

3501 SCOPE

This section covers the provision and construction of a gravel wearing course to unsealed roads.

3502 MATERIALS

Gravel Wearing Course material shall be obtained from sources located by the Contractor and approved by the Engineer. The completed layer shall contain no material having a maximum dimension exceeding two-thirds of the compacted layer thickness, or 50 mm whichever is the lesser. Unless otherwise authorized material shall conform to the following requirements.

Table 3-5

	Total Percent Passing					
Sieve Size	50 mm	25 mm	19 mm	4.75 mm	0.425 mm	0.075 mm
Percent passing	100	70-90	50-85	25-60	10-30	0-15

Plasticity Index

The plasticity index shall be in the range of 6 to 12.

California Bearing Ratio (CBR)

The minimum CBR of material shall be 30% at the specified in situ density after soaking for 4 days.

Compaction Requirements

Where the nominal thickness of the Gravel Wearing Course is 150mm or less, it shall be compacted by a minimum of 8 passes of a vibrating roller with a static mass of at least 5000kg per metre width. If the layer thickness is greater than 150mm, the material shall be laid in two layers of approximately equal thickness and each layer shall be compacted as for a layer of less than 150mm thickness.

3503 CONSTRUCTION METHODS

The Gravel Wearing Course shall only be constructed provided that the underlying sub-grade layers conform to the requirements specified or preparation has been completed to the satisfaction of the Engineer.

Immediately before placing the material, the sub-grade shall be checked by the Contractor for any damage or deficiencies which shall be made good as directed by the Engineer. Oversize material shall be removed by appropriate screening methods from the Gravel Wearing Course before transportation to the placement area. The Gravel Wearing Course shall be placed, spread, watered, compacted and shaped to provide a surface free of irregularities which could cause the ponding of water.

The Contractor shall protect and maintain the completed Gravel Wearing Course at his own expense. Maintenance shall include immediate repairs of any damage or defects which may occur and shall be repeated as often as is necessary to keep the Gravel Wearing Course continuously intact until the Works or section of the Works have been completed and handed over. Repairs shall be made in a manner that will ensure restoration to an even and uniform surface.

The Gravel Wearing Course shall be finished to give a hard dense surface throughout and free from irregularities of any kind. No specific tolerances shall apply to Gravel Wearing Course except that it shall be nowhere more than 15mm thinner than the nominal thickness shown on the drawings or instructed by the Engineer.

3504 INSPECTION AND TESTING

Routine inspection and testing will be carried out by the Engineer to test the quality of materials and workmanship for compliance with the requirements of this Section. The density requirements specified in Section 3202 for compaction of Gravel Wearing Course shall be deemed to have been complied with if the minimum number of passes of the roller of the weight specified has been applied in the presence of the Engineer.

3505 MEASUREMENT AND PAYMENT

Pay Item	Unit
35/1 Gravel Wearing Course....	Cum

The unit of measurement shall be the cubic metre of material, measured in the final position after compaction and the quantity shall be calculated as the product of the nominal depth, the required surface plan width and the required length of gravel wearing course measured horizontally along the centre line.

The tendered rate shall include full compensation for procuring, including royalties, furnishing, screening (if required) and placing all materials, including transporting and the removal of all oversize material and for protecting and maintaining the work specified in this Section.

3600: Dressed Stone Pavement

3601 SCOPE

This work shall consist of the supply, shaping, packing and compaction of a pavement course composed of dressed stone blocks packed on a prepared sub-grade and within prepared and compacted shoulders with the Specifications and to the lines, levels, dimensions and cross-falls shown on the Drawings or as directed by the Engineer.

3602 MATERIALS

a) Dressed Stone Blocks : The stone blocks shall be hand broken blocks. The blocks shall be cubical in shape and shall be hard and durable to serve as ideal material for dressed stone pavement. The faces of the blocks shall form 90° angles with one face being relatively level to provide a good riding surface. The blocks shall be free from vegetation, soft particles and excess clay or any other substance, which is considered deleterious. The size of the block shall be according to the drawings with the tolerances of ± 25 mm

The stone blocks shall comply with the following requirements:

Water absorption shall not exceed 2%.

Los Angeles Abrasion value shall be not more than 30 (BS 812) or as directed by the Engineer.

Specific Gravity not less than 2.0

Plasticity Index of binding materials shall not more than 6.

F.M. of sand shall not be less than 2.0 and shall be free from deleterious materials.

Crushed stones: Coarse aggregate to pack the blocks shall be of the same material as stone blocks.

Screening materials: Screenings to fill voids shall be consists of coarse sand. The liquid limit and plasticity index shall be 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 5%.

b) Shoulders material:

The shoulders shall be constructed from naturally occurring gravels, crushed rock or stabilised gravel from sources approved by the Engineer. The material shall consist of stone and finer particles and the Engineer may require samples to be tested at the Ministry of Public Works and Transport Laboratory before the material is used in the works.

Naturally occurring gravels shall comply with the following:

Table 3-6

Sieve Size (mm)	Percentage Passing by (Mass)		
	37.5mm	20mm	10mm
50	100	-	-
37.5	80-100	100	-
20	60-80	80-100	100
10	45-65	55-80	80-100
5	30-50	40-60	50-70
2.36	20-40	30-50	35-50
0.425	10-25	12-27	12-30
0.075	5-15	5-15	5-15

For the material passing the 0.425 mm sieve,

Liquid Limit shall not exceed 35%,
Plasticity Index in the range 8-20%,
Soaked CBR of not less than 35%

Where testing facilities are not conveniently available the Contractor shall submit samples to the Engineer for approval.

- c) Cushion material: Materials for the sand cushion shall consist of coarse sand of FM (Fineness Modulus) not less than 2.0. The liquid limit and plasticity index shall be 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 5%.

3603 Construction Methods

Preparation of foundation:

The sub base to receive the sand cushion shall be prepared to the grade and camber and cleaned of all dust, dirt and other extraneous matter. Weak places shall be strengthened, corrugation removed, depressions and pot holes made good with suitable materials before spreading the sand.

Shoulders construction:

Side shoulders shall be constructed in advance to a thickness corresponding to the compacted layer of the dressed stone pavement and according to the drawings. The shoulders material shall be spread with a thickness not exceeding 150mm. In case of using heavier compaction methods, thicker layers can be specified by the engineer. The shoulder shall then be watered to the Optimum Moisture Content and compacted with proper compaction equipment. The shoulders shall be compacted to a dry density of at least 95% MDD (AASHTO, Modified Proctor). The second layer of the material shall be spread and compacted in a similar manner. After the shoulders are ready, their inside edges shall be trimmed vertical and the included area to be cleaned.

Spreading of sand cushion:

The coarse sand shall be spread uniformly upon the prepared sub grade in such quantities that the thickness of compacted layer is 50 mm. The loose layer is consolidated to 85% thickness. In no cases shall these be dumped in heaps directly on the area where these are to be laid. The relationship between the loose thickness and compacted thickness shall be determined from field trials and used in controlling the loose thickness at the time of spreading the materials.

Compaction:

Immediately following the spreading of coarse sand, it is first rolled dry with aid of vibrating roller. The rolling shall begin from edges with roller running forward and backward, parallel to the centre line of the road until the layer has been firmly compacted. Slightly sprinkling of water may be done during rolling, if required. Rolling should not be done if the sub base is soft or yielding. The rolled surface shall be checked transversely and longitudinally with templates and if the irregularities exceed 12 mm, the surface should be loosened and aggregate added or removed before rolling again. In no case shall the use of screenings be permitted to make up depressions.

Filter Drains:

The drains shall be continuous, rectangular and 200mm deep on both sides of the road's cross section under the side edges of the sub grade and the road shoulders. The drain shall be between 1 and 1.5m long depending on the width of the shoulders and the drain's longitudinal slope, which shall vary between 2-5%.

The drain shall be excavated to a suitable depth (200-300mm) under the subgrade, with the filter shoulders reaching the side of the embankment. Dry compaction by hand rammer shall be carried out. The drain shall be watered and compacted again.

The box shall then be filled with a 100mm layer of broken stone and sand (1:1) to reach the level of the sub-grade according to drawings. Watering and hand compaction shall be carried out to assure a dense mixture of stones and sand.

Cross Drains:

See Filter Drain above

3604 Placing and Packing Stones:

Before placing the stones, string lines shall be placed using metal pegs made of reinforced steel. The peg interval shall be 5 metres. Lines shall be placed longitudinally and along the cross section of the road to indicate the desired camber.

The kerb stones shall be laid first, followed by the rest of the. Stones shall be placed from the edges of the road to the centerlines. Stones should be laid so that each block settled on the sand cushion without any support from the blocks nearby and with an average space of 5-15mm between blocks. The voids between the stones shall then be filled with broken stones packed in with proper tools. A regular top surface should be achieved during the laying operation. A camber board shall be used longitudinally and across the section to assure an even surface.

Compaction:

A vibrating roller or a plate compactor shall be used, static weight compactors are not recommended for this operation. Compaction should be carried out to level the height of the stone blocks, providing a smoother running surface on the carriageway. Compacting shall be carried out from the edge to the centreline of the road to avoid extra stress on the shoulders.

Quality Control of Materials and Work:

The Engineer shall exercise control over quality of the materials incorporated and works performed through quality control tests carried out to the frequencies indicated hereinunder. The frequencies are the minimum, and the Engineer shall have the authority to have these tests at more frequent intervals where quality of a material or work is in doubt.

Materials

Table 3-7

Material	Type of Test	Frequency of Test
Aggregate	Los Angeles Abrasion Value	One per 1.0km (more frequently if material character changes)
	Water Absorption	-do-
Sand	F.M.	-do-
Mixed Material	Gradation	One per 500m (more frequently if material character changes)
	Atterberg Limits	-do-
	CBR (set of 3 specimens)	One per 1.0km (more frequently if material character changes)
	Moisture-Density	-do-

3605 Joint filing:

The joint filling materials shall be confirmed according to the drawings.

Granular joint filling: The granular materials shall fill the interstices between the blocks.

Bitumen-Sand Sealing of Joints: Sealing of joints in Dressed Stone Surfacing with 100/80 grade bitumen and blinding with coarse sand. The hot bitumen shall be spread evenly into all joints, ensuring an adequate amount of bitumen is placed in each joint, using a watering can or funnel device. Immediately after placement of the bitumen the joints shall be covered with a layer of coarse sand such that the joints are filled to the road surface level.

3606 Measurement and Payment

Pay Item	Unit
36/1 Dressed Stone Road Pavement	Square metre
36/2 Sand Cushion	Cubic metre

This work shall be measured as the area in Square metres of Dressed Stone road pavement compacted and accepted. Area shall be computed from field measurement of the width of the base course at its top surface and the nominal depth as shown in the Drawing or as ordered by the Engineer.

The work as measured shall be paid for at the Contract unit price shown in the Bill of Quantities. Payment shall be full compensation for performing the work including supplying the all materials, and providing all labour, tools, equipment, joint filling and incidentals necessary.

TECHNICAL SPECIFICATION

SERIES 4000

BITUMINOUS PAVEMENT

TECHNICAL SPECIFICATION

PART 4000: BITUMINOUS PAVEMENT

TABLE OF CONTENTS

<u>Item Number</u>	<u>Page</u>
4000 GENERAL	4 – 4
4001 Materials	4 - 4
4002 Bituminous Materials	4 - 4
a) Penetration Grades Bitumen	4 - 4
b) Bituminous Emulsions	4 - 7
4003 Application Temperatures of Bituminous Binder Materials	4 - 8
a) Penetration Grades	4 - 7
b) Bituminous Emulsion	4 - 7
c) Cut-back Bitumen	4 - 7
4004 Measurement	4 - 7
4100 Asphalt Mix Course	4 – 8
4101 Asphalt Concrete Surface Course	4 - 8
4102 Asphalt Concrete Binder Course	4 – 8
4103 Asphalt Concrete Base Course	4 – 9
4104 Asphalt Layer Thickness and Surface Tolerances	4 - 9
4200 Bituminous Macadam Base Course (Penetration Method)	4 – 9
4201 Description	4 - 9
4202 Bituminous Material	4 - 9
4203 Aggregates	4 - 10
4204 Construction Methods	4 - 11
4205 Method of Measurement	4 - 14
4206 Basis of Payment	4 - 14
4300 Bituminous Prime Coat and Tack Coat	4 – 14
4301 Description	4 - 14
4302 Materials	4 - 14
4303 Construction Methods	4 - 15
4304 Method of Measurement	4 - 16
4305 Basis of Payment	4 - 16
4400 Bituminous Premix Surface Course	4 – 16
4401 Description	4 - 16
4402 Materials	4 - 16
4403 Job Mix Formula	4 - 18
4404 Mix Design	4 - 19
4405 Plant	4 - 20
4406 General Requirements	4 - 23
4407 Construction Methods	4 - 23
4408 Method of Measurement	4 - 27
4409 Basis of Payment	4 - 28

<u>Item Number</u>	<u>Page</u>
4500 Cold Mix Asphalt	4- 29
4501 Scope	4 - 29
4502 Materials	4 - 29
4503 Mixes	4 - 30
4504 Plant and Equipment	4 - 30
4505 Mixing of Aggregate and Bitumen	4 - 30
4506 Placing and Compaction	4 - 31
4507 Measurement and Payment	4 - 31
4600 Bituminous Surface Treatment	4 – 31
4601 Description	4 - 31
4602 Binder	4 - 32
4603 Additives	4 - 32
4604 Aggregate	4 - 32
4605 Precoating Chips	4 - 33
4606 Distributor	4 - 34
4607 Preparation of Surface	4 - 35
4608 Protection of road furniture	4 - 35
4609 Start and End of spray operation	4 - 35
4610 Pattern of Operation	4 - 35
4611 Spreading of Chips	4 - 36
4612 Application Rate	4 –36
4613 Rolling	4 - 37
4614 Maintenance	4 - 37
4615 Traffic Control	4– 38
4616 Locking Coat	4 – 38
4617 No fouling of Treated Surface	4 – 38
4618 Intersecting Public Roads	4 – 38
4619 Measurement	4 – 39
4620 Payment	4 – 39
4700 Premix Bituminous Carpeting (manual method)	4– 40
4701 General	4 – 40
4702 Composition	4 – 40
4703 Materials	4 – 41
4704 Bituminous Materials	4 – 41
4705 Coarse Mineral Aggregate	4 – 41
4706 Fine Mineral Aggregate	4 – 41
4707 Mixture	4 – 41
4708 Construction Methods	4 – 41
4709 Preparation of Bituminous Material	4 – 42
4710 Preparation of Mineral Aggregate	4 – 43
4711 Preparation of Mixture	4 – 43
4712 Spreading	4 – 43
4713 Joints	4 – 44
4714 Edge Treatment	4 - 44
4715 Protection of the Pavement	4 – 44
4716 Pavements Samples	4 - 44
4717 Surface Texture	4 – 44
4718 Measurement	4 – 44
4719 Payment	4 – 45

4800	Premix Bituminous Seal Coat (manual method)	4 – 46
4801	Description	4 – 46
4802	Materials	4 – 46
4803	Bituminous Materials	4 – 46
4804	Mineral Aggregate	4 – 47
4805	Mixture	4 – 47
4806	Construction	4 – 48
4807	Preparation of Bituminous Material	4 – 48
4808	Preparation of Mineral Aggregate	4 – 48
4809	Preparation of Premix Seal Coat	4 – 48
4810	Spreading and Compaction	4 – 48
4811	Joints	4 – 49
4812	Edge Treatment	4 – 49
4813	Protection of the Pavement	4 – 49
4814	Surface Texture	4 - 49
4815	Measurement	4 - 50
4816	Payment	

4000 GENERAL

4001 Materials

All materials shall be tested by the Contractor in the presence of the Engineer's representative at the Site except where manufacturer's test certificates are supplied and accepted.

Unless otherwise specified, all tests shall be carried out in accordance with the document "Standard Laboratory Test Procedures for Quality Control Laboratories" (referred to in this document as Standard Test Procedures) published by United Nations Office for Project Services, Engineering Section, Afghanistan, 2004.

If the quality of the sample from any stockpile or consignment after test is found to be inferior to that required by the specifications the material of that consignment will not be accepted and the Contractor shall remove such rejected materials from site.

The Contractor may arrange for testing to be carried out at his own cost prior to delivery of materials to site but this shall in no way affect the Engineer's right to carry out tests and reject defective materials at the Works.

4002 Bituminous Materials

a) Penetration Grade Bitumen

Sampling: Bitumen shall be sampled in accordance with AASHTO T40. Samples thus sampled will be tested for penetration, specific gravity, softening point, loss on heating, flash point and solubility.

Packing: Bitumen shall be supplied in bulk in appropriate road tankers or be packed in securely sealed brand new steel drums.

Penetration: The penetration shall be not less than 80 and not more than 100, or as otherwise directed by the Engineer. Penetration shall be determined in accordance with AASHTO T49 at 25°C.

Specific Gravity: Specific gravity shall be determined in accordance with AASHTO T228.

Specific gravity at 25°C shall be not less than 1.00 and not more than 1.05.

Softening Point: Softening point shall be determined in accordance with AASHTO T53.

The softening point shall be not less than 43°C and not more than 54°C.

Loss on Heating: Loss on heating shall be determined in accordance with AASHTO T47.

Loss on heating shall not exceed 1%.

Flash Point: Flash point shall be determined in accordance with Cleveland Open Cup method AASHTO T48.

The flash point shall be not less than 230°C.

Solubility: Solubility shall be determined in accordance with AASHTO T44.

The solubility shall be not less than 99.0%.

General Requirements: The bitumen shall be homogeneous, free from water and shall not foam when heated to 180°C.

b) Bitumen Emulsion

General: Bitumen emulsion shall be a mixture of penetration grade bitumen, water and an emulsifying agent. Bitumen emulsion deteriorates on storage and always should be used as soon as possible after manufacture. Drums should be rolled for several minutes before use to remove any sediment. Testing generally should be in accordance with AASHTO T59.

Sampling: Bitumen emulsion shall be sampled shortly before use, sampling shall be in accordance with AASHTO T40. Samples thus sampled shall be tested for bitumen content, viscosity, residue on sieving etc.

Packing: Bitumen emulsion shall be packed in clean steel drums of the type and quality used for fuel oil deliveries. Drums shall be fitted with a watertight screwed stopper.

Bitumen Content: The percentage of bitumen by weight retained after distillation in accordance with BS434 Appendix-E shall be not less than 57%.

Viscosity: The viscosity of the bitumen emulsion shall be between 6 and 9 degrees Engler at 20°C as determined in accordance with BS434 Appendix-F.

Residue: The percentage of residue by weight as determined in accordance with BS434 Appendix-C shall not be greater than 0.05% on the 0.710 mm sieve or 0.15% on the 0.150 mm sieve.

Coagulation: There shall be no coagulation of the emulsion at low temperature as determined in accordance with BS434 Appendix-G.

Cut-back Bitumen

General: Cut-back bitumen is a mixture of penetration grade bitumen and kerosene. Cut-back bitumen is not manufactured commercially in Bangladesh at the present time but may be mixed on site for immediate use. The Engineer will direct the mix proportions to be adopted for a particular application but the following will indicate the range of likely mixtures.

Grades

- (a) Fluid - 80/100 bitumen mixed with 20% - 40% kerosene by volume.
- (b) Medium - 80/100 bitumen mixed with 10% kerosene by volume. (Suitable for use in penetration grouting etc.)
- (c) Viscous - 80/100 bitumen mixed with 5% kerosene by volume. (Suitable for surface dressing work etc.)

Constituents: The 80/100 bitumen used for making cut-back bitumen must conform in all respects to the relevant Specification. The cutting oil shall be normal commercially available kerosene free from any dirt or other impurities.

Mixing: The bituminous binder shall be penetration grade 80/100 bitumen cut-back with kerosene so that the total diluent content of the binder is in accordance with Table 4.1. Binder which is sprayed while the shade air temperature of the site is rising shall be blended in accordance with the maximum expected temperature on the day. The maximum temperature shall be estimated by the Contractor and approved by the Engineer. Binder sprayed while the shade air temperature is falling shall be blended in accordance with the shade air temperature measured at the time of spraying. Interpolation may be used to obtain intermediate values from Table 4.1. The formulations may be used over a range of $\pm 3^{\circ}\text{C}$ from the specified temperatures except that where no kerosene is required the upper temperature limit shall

not apply. Binder not complying with this specification shall not be used without re-blending.

Table 4-1
Total dilutents (diesel, kerosene) for 80/100 penetration grade bitumen

Shade air Temperature °C	Parts per hundred parts of bitumen binder at 15°C
12.5	16
15.0	14
17.5	12
20.0	10
22.5	8
25.0	6
27.5	4
30.0	2
32.5	
and over	0

Blending: The total quantity of each component incorporated into the bituminous binder shall be accurately measured by a volume metering or weighing device. The binder shall be thoroughly mixed before use. The minimum acceptable degree of mixing shall be such that the concentration of any component in any part shall not differ by more than 15% from the concentration calculated assuming that the binder is perfectly mixed. All plant and methods used to be blend the binder shall be approved by the Engineer.

The Engineer may by specific direction require that cutback and/or flux oil to be blended either at a central blending plant or on site. When blending is done in a central blending plant, the Contractor shall provide a blending certificate with each load of binder. The certificate shall list the following:

Time and date of blending,
Temperature of bitumen when blended,
Grade of bitumen,
Number of parts of diesel per 100 of bitumen,
Number of parts of kerosene per 100 parts of bitumen,
Type and quantity of other additives (in parts per 100 parts of bitumen) as well as the quantity in either kilograms or litres at 15°C.

If the Contractor fails to provide the specified blend or to provide accurate delivery certificates, the Engineer will require the Contractor to blend only in the presence of and at times and locations previously approved by the Engineer.

4003 Application temperatures of bituminous binder materials

Where the binder, or its bitumen component, is to be stored for a period exceeding one week, it shall be stored at a temperature not exceeding 150°C. The quantity of bituminous binder or bitumen raised above this temperature in any one day should not exceed that which is to be sprayed on that day.

Where binder which has been heated to spraying temperatures must be stored for more than one day, thermostatic heaters shall be used to maintain the binder temperature not higher than 50°C below the appropriate spraying temperature listed in Table 4-2, except with the specific approval of the Engineer.

Any binder which has been heated to a temperature in excess of 30°C above that specified in Table 4.2 for any period, or which has been held in storage at temperatures above those permitted in this specification, shall not be used until it has been re-tested for compliance with these specifications.

a) Penetration Grades

Penetration grade bitumen will be sprayed at the highest temperature possible to gain time for spreading and rolling of chips. However, in no case may the temperature at any time exceed 180°C.

b) Bituminous Emulsions

Emulsified bitumen shall not be reheated above a temperature of 90°C nor stored in such as to allow deterioration of its properties. Emulsified bitumen shall be continuously circulated to ensure a uniform temperature throughout. Any emulsified bitumen showing lack of uniformity will be condemned and shall immediately be removed from the site of the works.

The emulsified bitumen may be sprayed at the temperature at which it is received from the manufacturing plant except that no emulsified bitumen shall be sprayed at a temperature in excess of 90°C or below 20°C.

c) Cut-back bitumen

The binder, according to its composition, shall be sprayed at a spraying temperature within the limits defined in Table 4-2.

Precautions: Kerosene is highly inflammable and care must be taken at all times to prevent fire. Kerosene should be stored in sealed metal drums away from naked flames. Mixing shall be carried out away from fires or other naked flames and fire fighting appliances shall be located within 30 metres ready for use.

Table 4-2
Spraying temperatures for cut-back bitumen based on 80/100 penetration grade bitumen

Total Diluent	Temperature °C	Total Diluent	Temperature °C
0	185	11	157
1	182	12	154
2	180	13	151
3	177	14	148
4	175	15	146
5	172	16	144
6	170	17	141
7	167	18	139
8	164	19	136
9	162	20	133
10	150	--	--

- Notes:
1. Total diluent refers to the total quantity of diluents expressed as parts per hundred parts of bitumen (measurement by volume at 15°C).
 2. Binder may be sprayed at temperatures varying not more than 10°C from these tabulated values.
 3. This table does not apply to binders containing diluents other than those listed in note 1.

4004 Measurement

Bituminous materials shall be measured by volume at 15°C for payment. The following table shall be used for computing volumes of materials stored or used at other temperatures:

Volume Correction Table 4-3
(Multipliers for reducing the volume of hot bitumen to the equivalent volume at 15°C)

Observed Temperature					
(°C)	Multiplier	(°C)	Multiplier	(°C)	Multiplier
15	1.000	81	0.959	147	0.920
18	0.998	84	0.957	150	0.918
21	0.996	87	0.956	153	0.916
24	0.994	90	0.954	156	0.914
27	0.993	93	0.952	159	0.913
30	0.991	96	0.950	162	0.911
33	0.989	99	0.948	165	0.909
36	0.987	102	0.946	168	0.907
39	0.985	105	0.945	171	0.905
42	0.983	108	0.943	174	0.904
45	0.981	111	0.941	177	0.902
48	0.979	114	0.939	180	0.900
51	0.978	117	0.937	183	0.899
54	0.976	120	0.936	186	0.897
57	0.974	123	0.934	189	0.895
60	0.972	126	0.932	192	0.893
63	0.970	129	0.930	195	0.892
66	0.968	132	0.928	198	0.890
69	0.967	135	0.927	201	0.888
72	0.965	138	0.925	204	0.886
75	0.963	141	0.923		
78	0.961	144	0.921		

4100 Asphalt Mix Types

The type of hot (or cold for patches) asphalt mixes shall be as indicated on the Drawings or as directed by the Engineer.

4101 Asphalt Concrete Surface Course

Asphalt Concrete Surface Course is intended as the top layer of pavement that is exposed to the traffic. It is placed on a binder or leveling course, or existing asphalt surface, the surface of which has been prepared with a Tack coat.

4102 Asphalt Concrete Binder Course

Asphalt Concrete Binder Course, when required by drawings, is intended as the layer of pavement immediately below the Asphalt Concrete Surface Course. It is placed on a base course, the surface of which has been prepared with a Prime Coat if the base material is unbound crushed stone or Tack Coat if the base material is an asphalt base course.

4103 Asphalt Concrete Base Course

Asphalt Concrete Base Course (Also referred to as asphalt treated base course (ATB)), when required by drawings, is intended as the layer of pavement immediately below the Asphalt Concrete Binder Course. It is intended to be placed directly on a prepared sub-grade or sub-base material in substitution for unbound base and sub-base materials. Asphalt Concrete Binder Course may be substituted for the material specified herein as Asphalt Concrete Base Course, with the Engineer's authorization.

4104 ASPHALT layer Thickness and Surface Tolerances

The thickness of asphalt concrete laid shall be monitored by pavement cores taken by the Contractor under the supervision of the Engineer. 100mm cores shall be taken for both compaction and thickness checked at 100m intervals on alternate sides of each paved area, 0.5 m from the edges. Repeat cores shall be taken 1m on either side of failure cores, until the extent of the affected area is known.

The actual thickness of asphalt concrete placed over any given section of the Works shall be defined per lot in accordance with requirements and procedures noted in this specification.

The pavement must conform to the designed finished grade shown on the Drawings. The finished surface levels of the asphalt surfacing shall conform to the design finish grade at all points.

The variation of the finished surface of asphalt mixes used as binder courses from a 3 m straightedge shall not exceed 7 mm at any point and 13 mm for asphalt base courses.

The variation of the finished surface of asphalt wearing courses from a 3 m-straightedge shall not exceed 5 mm at any point.

The tolerance accepted for the final level on the wearing course from the specified design levels shall be – 0 mm, + 5 mm.

4200 BITUMINOUS MACADAM BASE COURSE (Penetration Method)**4201 Description**

This item shall consist of a base course of bituminous macadam composed of crushed stone aggregate and bituminous material applied by penetration methods, and shall be constructed on completed and accepted aggregate base course, sub-base or existing pavement with a tack coat in accordance with these Specifications and in conformity with the lines, grades, and typical cross-sections shown on the Drawings and approved by the Engineer.

4202 Bituminous Material

Bituminous material for the asphalt concrete base course shall be AC-20 grade asphalt cement, conforming to the requirements of AASHTO M 226. Bituminous material conforming to the requirements of 60/70 Penetration Grade will be accepted as equivalent to AC-20 grade asphalt cement. Bituminous material for the asphalt concrete surface course shall be AC-20 grade asphalt cement, conforming to the requirements of AASHTO M 226.

Bituminous material conforming to the requirements of 60/70 Penetration Grade will be accepted as equivalent to AC-20 grade asphalt cement.

Other grades of Asphalt will be permitted only with the prior approval of the Engineer. Any and all deliveries of bitumen to site shall be sampled and tested with at least 4 samples being taken or as directed by the Engineer. At least 4 separate sub-samples will be taken for each sample.

4203 Aggregates

a) Coarse Aggregates

The coarse aggregates shall be well graded broken stone and meet the requirements of Section 3302 Aggregate base, for crushed stone except as otherwise specified herein or approved by the Engineer. Coarse aggregate sizes shall have at least 90 percent by weight of pieces with two fractured faces and at least 98 per cent by weight shall have at least one fractured face. Thin flat flaky or over sized aggregate detrimental to compaction and effective choking shall not be used. The flakiness index as determined in accordance with BS812 shall be not greater than 30%.

Permissible variations in the grading of coarse aggregates are shown below.

Aggregates may be mixed or blended to achieve the grading if approved by the Engineer.

Permissible Gradation of Coarse Aggregates

Table 4-4

Sieve Size mm	Percentage Passing by mass	
	75 mm layer	63 mm layer
50	100	
37.5	90 - 100	100
19	30 - 65	80 - 100
12.5		30 - 70
9.5	0 - 20	0 - 30
4.75	0 - 5	0 - 5

The abrasion resistance of coarse aggregates shall be measured by the Los Angeles Abrasion Test (AASHTO Test Method T-96). The maximum allowable abrasion loss for bituminous macadam coarse aggregate shall be 35% by weight.

When tested in accordance with the Method of Test for Soundness of Aggregates by use of Sodium Sulphate, AASHTO Test Method T-104, the weighted average loss in five cycles shall not exceed 15% by weight.

b) Choke Aggregate

The fine or choke aggregate for bituminous macadam shall comply with one of the following gradings as approved by the Engineer.

Permissible Gradations of Choke Aggregate

Table-4-5

Sieve Size mm	Total Percent Passing by Mass		
	Type A	Type B	Type C
19	100	100	
12.5	90 - 100	90 - 100	100
9.5	40 - 70		95 - 100

6.3	0 - 15	10 - 35	60 - 90
4.75		0 - 5	0 - 10
2.36	0 - 5		0 - 5
1.18			

The fine aggregate or sand used as choke aggregate shall be either a natural or manufactured product, which must be dust free and meeting above gradation sizes except as otherwise specified herein.

4204 Construction Methods

a) Application of Materials

Bituminous macadam base course shall be laid in layers of compacted thickness as specified on the Drawings. The materials shall be placed to the satisfaction of the Engineer. For 75 mm macadam base course thickness bitumen shall be placed in two applications, as specified herein, at maximum application rates of 7.6 litres/sq. metre in the first and a maximum of 5.4 litres/sq. metre in the second application. A total of not less than 10.4 litres/sq. metre and not more than 13 litres/sq. metre bitumen shall be applied in the two applications. Both above application rates shall be reduced proportionately for thicknesses less than 75 mm (by 1/6 for 63 mm). The application of materials for penetration macadam may be performed by approved labour-intensive methods.

b) Spreading Coarse Aggregate

The coarse aggregate as specified herein shall comprise not less than 85% by volume of the aggregate applied in this course.

The base course or other underlying course or existing pavement upon which this course is to be constructed shall be swept thoroughly clean. When constructed upon an aggregate base course, the sweeping shall be done in such manner as to expose the coarse aggregate to a depth of not more than 5 mm. The sweeping shall be done immediately in advance of spreading the aggregate for this course.

A tack coat shall be applied to the underlying layer if directed by the Engineer. Spreader boxes of an approved design or self propelled spreading and levelling devices or approved hand methods of spreading and levelling will be required. Where curbs or approved spreading and levelling machines are not used, side forms having a base width of not less than 40 mm and of the height of the loose material, and securely fastened together at their ends will be required. The forms shall be securely staked in such manner that there will be no deviation greater than 5 mm vertically or 12 mm horizontally from the grade and line shown on the Drawings. A template cut to the crown or cross-fall as required of the finished course and resting on the side forms is required to fix the depth of the loose material. The side forms shall be backed with sub-base material of the shoulder of the proper moisture content for compaction, to a width of not less than 300 mm and to such a height, that after being thoroughly compacted, the surface of the backing will conform to the surface of the compacted course.

After the aggregate has been spread and checked with the template and straight edge for conformance to crown and profile, and before rolling is started, the side forms shall be removed and the space occupied by the forms shall be filled with sub-base (shoulder) material to such a height that it will compact to the final height of the course. Except in narrow base widening (2000 mm and under) when the compaction of the shoulder back up is completed to the height of the surface of the course, the remainder of the shoulder shall have sufficient slope to the side ditches or edge of formation that surface drainage of the course is continuous through the section or sections under construction.

In lieu of forms, the backing of the shoulder material as specified above for forms shall be placed as near as possible to its final position before aggregate is spread. The backing with the proper moisture content for compaction shall be in the final position, as specified for forms, prior to rolling. Before rolling starts the spread aggregate shall be checked for conformance to crown (or cross-fall) and profile with a template cut to the cross section of the finished course and the ends of the template shall be supported by a suitable device in proper reference to tightly stretched grade lines offset at the edge of the course. Checking of the spread aggregate, where either forms/or backing are used, shall be done by the

Contractor and no work shall be allowed to begin until the template and necessary straightedge are on the Works.

Thin, flat or oversized aggregate detrimental to compacting and choking of the course shall be removed. The aggregate shall have a uniform distribution of size and all patches or areas of fine or undersized material shall be removed and replaced before any rolling starts. Aggregate for filling or choking the course shall be applied with approved mechanical chip spreaders or approved hand methods.

c) Rollers

All rollers for this item shall meet the requirements of the Engineer and shall be at least 10 tonnes mass static/vibrating rollers with smooth steel wheels.

A sufficient number of rollers shall be used to perform the required rolling for the programmed rate of completion without exceeding the total combined rolling capacity of the rollers used. The total amount of rolling required shall be divided among the operations of preliminary rolling, and first and second penetration rolling as hereinafter specified.

d) Preliminary Rolling

The coarse aggregate shall be rolled until it is compacted so that the surface is smooth and conforms to the established profile grade and cross sections. Rolling shall begin at the edges of the course, and when the course is not being built between curbs, the roller shall extend over the shoulder backing and shall be run forward and backward along the edges until the backing and the edges of the course are firmly bound together. The rolling then shall progress gradually toward the centre until the entire course has been thoroughly compacted. However, on superelevated pavements after the edges of the course and the backing have been firmly bound together, the rolling shall then be continued from the inner edge of the curve to the outer edge, instead of from the edges to the centre. The preliminary rolling shall stop when the surface of the course will support the pressure distributor, bitumen sprayer, water tanker or other heavy construction equipment without appreciable deformation. The surface of the course shall then be checked for conformance to the profile grade and cross section. Any irregularities shall be loosened and reshaped and again rolled as required above.

Aggregate that crushes under the roller so as to prevent the free and uniform penetration of bituminous material shall be removed and replaced by suitable aggregate.

e) Applying Bituminous Material

No bituminous material shall be applied when the temperature of the atmosphere on the work is below 5°C nor when the aggregate in the course is damp or wet. Without disturbing the rolled aggregate course, the bituminous material shall be uniformly applied by means of pressure distributors or other means approved by the Engineer. Hand pouring pots of known volume or single hand spray nozzles may be used with the approval of the Engineer if the surface is marked out in equal areas of a convenient size to be covered by whole container loads of bitumen.

The total amount of bituminous material approved by the Engineer for the penetration of the course shall be proportioned to the first and second penetration as determined by the Engineer.

The bituminous material shall be heated in a suitable appliance so designed as to heat the entire mass evenly with an efficient and positive control of the heat at all times. The application temperatures and temperatures during heating shall be in accordance with Section 4003.

f) First Penetration, Filling and Rolling

Immediately after the bituminous material is applied Type A or B size choke aggregate shall be evenly spread over that area of the course. The specific size to be determined by the Engineer and shall be applied at the rate approved by the Engineer. All choke aggregate shall be spread with approved mechanical spreaders or in areas inaccessible to such spreaders or otherwise approved by the Engineer,

manually with square ended shovels. Following the application of the choke aggregate, the surface of the course shall be dragged with an approved fibre broom drag so designed as to secure even distribution of the aggregate.

The course shall then be thoroughly rolled with steel wheeled rollers and vibrated. At least two rollers will be required on each portion of the work where bituminous material has been applied. The rolling shall be started before the bituminous material stiffens enough to prevent the choke aggregate from being readily incorporated. Low atmospheric temperature will necessitate the early completion of rolling after the application of bituminous material.

g) Second Penetration, Filling and Rolling

Following the completion of the work described under Section (f) above the bituminous material for the second penetration of the base course shall be applied and before it has cooled Type B or C size choke aggregate shall be spread at the rate approved by the Engineer.

The surface of the course shall then be broom dragged and rolled in the same manner as after the first application of bituminous materials. The dragging and rolling shall be continued until the required rolling is completed and all surface voids in the base course are filled.

The surface of the course shall be tested with a straight edge 3000 mm long applied parallel to the centreline of the pavement, and any irregularities, 10 mm or more, shall be corrected as directed. Upon completion of this operation and before any surface course material is placed all loose aggregate shall be swept from the surface of the base course.

h) Protection of Structures from Bituminous Material

When bituminous material is being applied, the surface of all structures shall be protected by a satisfactory method or device to prevent their surface from becoming marred by the operation.

i) Surface Tolerance

The final surface shall not vary more than 10 mm from a template cut to the cross section of the surface of the course nor 10 mm from a 3000 mm straight edge applied parallel to the centreline of the course.

Irregularities which may develop after the initial rolling shall be corrected by loosening the surface and adding new material or removing material to bring areas of such irregularities to the surface tolerance required above. All areas of the course that are defective in composition and that in any other respect do not comply with the requirements of the specifications shall be replaced or adjusted with suitable material in such a manner that compliance with the Specifications is secured.

The Contractor shall provide competent workmen who are capable of performing the work incidental to checking the surface of the course with templates and straightedge and properly performing the correction of all irregularities of the surface of the course that may be found.

j) Small Tools and Portable Equipment

The Contractor shall provide all necessary tools such as rakes, forks, hand sprays, paint brushes, templates, straightedges, tamps etc. which shall be kept in first class workable condition.

k) Testing

To determine the compliance with the Specification the Contractor shall cut out core samples of the freshly completed work at random locations selected by the Engineer. These locations shall not be more than 200 lane metres apart. Samples shall be checked for gradation, bitumen content and thickness generally as provided for in Section 4001 of this Specification.

4205 Method of Measurement

The area to be paid for under this item shall be the number of square metres of bituminous macadam base course of specified materials and thickness, in place, completed and accepted. Unless otherwise specified or approved by the Engineer the minimum thickness of bituminous macadam base-course shall be either 75 mm or 63 mm and each shall be measured separately.

4206 Basis of Payment

The area determined as above provided shall be paid for at the contract unit price per square metre bid for "Item 42/1 - Bituminous Macadam 75 mm" and "Item 42/2 - Bituminous Macadam 63 mm" which payment shall constitute full compensation for the base course complete in place, and including the furnishing of aggregate, bitumen, cutback and all other materials, labour, equipment, tools and incidentals necessary to complete and to test and measure this item.

Item No.	Unit
42/1 Bituminous Macadam 75 mm	Sq.m
42/2 Bituminous Macadam 63 mm	Sq.m

4300 BITUMINOUS PRIME COAT AND TACK COAT

4301 Description

This item shall consist of the careful cleaning of a base, wearing course or an existing road surface and the application of a prime coat or tack coat of bituminous material as described in these Specifications.

4302 Materials

a) Prime Coat

The primer seal or prime coat shall be 80/100 bitumen mixed with 30%-35% kerosene by volume or alternative primer of a grade approved by the Engineer.

The primer application rate shall nominally be 1.0 litres per sq.m (residual bitumen) but shall be within the range 0.80 - 1.40 litres per sq.m as directed by the Engineer.

When specifically approved by the Engineer bitumen without kerosene may be used.

b) Tack Coat

A tack coat shall be applied where directed to bond a new bituminous surface to an older bituminous surface. A tack coat shall comprise a light application of bituminous material in a similar manner to the prime coat. The tack coat shall be 80/100 bitumen mixed with 0% - 5% kerosene by volume.

Spray rates (for residual bitumen) shall nominally be 0.2 litres per sq. metre but shall be in the range 0.1 to 0.5 litres per sq. metre as required for the existing surface and ordered by the Engineer.

Where a tack coat is required in the Engineers opinion only to overcome a delay or damage to a bitumen surface, which could have been reasonably prevented by the Contractor, then the tack coat shall be applied at the Contractor's expense and shall not be measured for payment.

c) Primer seal Aggregate

Sand for primer seal aggregate shall meet the requirements of chokes aggregate Type C or as approved by the Engineer.

The application rate for the aggregate shall be within the range 0.007 - 0.012 cum per sq. metre to the approval of the Engineer.

4303 Construction Methods

a) Cleaning Surface

Surface to be tacked or primed shall be thoroughly cleaned to remove all mud, earth, dust, animal droppings and other foreign material.

The sweeping on a water bound surface shall be just sufficient to expose the pattern of the coarse aggregate.

Special care shall be taken to clean the edges of the road to be primed in order to ensure uniform application of the bituminous material directly on the existing base or pavement material.

Material cleared from the surface shall be removed and disposed of as directed by the Engineer.

b) Protection of Structures from Bituminous Material

When bituminous material is being applied, the surfaces of all structures shall be protected by a satisfactory method or device to prevent their surface from being marred or defaced by the operation.

c) Applying Bituminous Material

- i. After the surface has been cleaned as described above and when in a dry condition, the bituminous material, except as noted below, shall be uniformly applied by means of heating and distributing equipment conforming to the requirements of Section 4400.
- ii. Prior to commencing bitumen application for the Works, the Contractor at his own cost shall demonstrate to the Engineer by means of trial sections the method he proposes to use for bitumen application. This method must be approved by the Engineer before the Contractor shall be permitted to commence bitumen application.
- iii. In irregular areas, such as driveways and intersections, the method of application shall be that approved by the Engineer. Dry spots shall be retreated and excess pools of bituminous material shall be removed from the surface.
- iv. The temperature of the cut back bitumen at the time of application shall be within the range 110°C - 135°C, unless the Engineer approves or directs that application be carried out at a lower temperature.

Tack coats shall not be applied when the shade air temperature is under 5°C. Prime coats shall not be applied when the shade air temperature is below 0°C nor when the air temperature within the proceeding 24 hours has been 5°C or lower. Prime coats on new macadam, and stabilised and granular base courses may be applied when the shade air temperature is not less than 5°C.

d) Tack Coat

Tack coats shall be provided only where directed by the Engineer. When a tack coat is to be provided it shall not precede the work of placing the subsequent course to such an extent that the treated surface may be damaged.

e) **Prime Coat**

Primer shall be applied in one or more applications if directed by the Engineer except that the Engineer may vary the rate of application depending upon the condition of the surface being primed. A prime coat shall not be applied when the surface of the course is wet or if it is dusty. The bituminous material shall not be applied at such a rate as will cause it to flow off the course or road surface. The area primed shall be closed to traffic for a period sufficient to allow for proper penetration and curing. Any primed area shall be allowed to fully cure for not less than 24 hours before placing of subsequent layers unless otherwise directed by the Engineer.

f) **Primer sealing**

For Bituminous Surface Course primer seal shall be applied in the same manner of Prime Coat and after which primer seal aggregate shall be applied at the rate given in Section 4200. After primer sealing area shall be closed to traffic for a period sufficient to allow penetration and curing. Then traffic to be allowed to run on the primer sealing surface for a minimum period of 2 weeks before the surface dressing is applied in accordance with Section 4.4 of these specifications.

4304 Method of Measurement

The quantity of primer seal, prime or tack coat used as directed shall be measured in accordance with Section 4.0.5. The volume measured shall exclude kerosene where cut back bitumen is used.

4305 Basis of Payment

The quantities measured as above provided shall be paid for at the contract unit price bid per litre for “Item 4.2/1 -Bituminous Prime Coat” or “Item 4.2/2 - Bituminous Tack Coat” or “Item 4.2/3 - Bituminous Primer sealing” which price and payment shall constitute full compensation for cleaning of the surface, furnishing and applying all materials, including sand or aggregate for primer seal where called for by the Engineer and for all labour, equipment, tools and incidentals necessary to complete this item.

Item No.	Unit
43/1 -Bituminous Prime Coat	Litres
43/2 - Bituminous Tack Coat	Litres
43/3 - Bituminous Primer sealing	Sq.m

4400 BITUMINOUS PREMIX SURFACE COURSE (HOT ROLLED ASPHALT)

d) **Description**

This item shall consist of one or more courses of compacted bituminous premix constructed on the prepared base, or existing pavement, in accordance with these Specifications and in conformity with the lines, grades, designed thickness, typical cross sections and other details shown on the Drawings or approved by the Engineer.

The bituminous premix shall be composed of a mixture of coarse and fine aggregate, approved mineral filler and bitumen. The mix shall be nominal 20 mm maximum size unless the Engineer directs that a mix of 10 mm nominal maximum size be used in locations where minor correction layers are required.

4402 Materials

a) Binder

Unless otherwise noted on the Drawings or in the Special Provisions the binder used shall have penetration grade bitumen meeting the requirements of Section 4202. It shall not be cut back.

d) Coarse Aggregate

Coarse aggregate (material retained on the 2.36 mm Sieve), shall be crushed stone, crushed slag or crushed gravel. The sodium sulphate soundness loss shall not exceed 9 percent and the magnesium sulphate loss shall not exceed 12 percent when tested in accordance with AASHTO T104. All crushed aggregate shall be produced by means of a Cone Crusher unless otherwise directed by the Engineer.

The abrasion resistance of coarse aggregates shall be measured by the Los Angeles Abrasion Test (AASHTO Designation T-96). The maximum allowable abrasion loss for bituminous premix coarse aggregate shall be 30% by weight.

When crushed gravel is used not less than 95 percent by weight of the particles retained on the 4.75 mm sieve shall have less than two fractured faces.

The coarse aggregate shall be of such gradation that when combined with the other aggregate fractions in proper proportion the resultant mixture will meet the gradation required under the composition of the mixture for the specific type under contract.

d) Fine Aggregate

The fine aggregate shall be defined as material passing the 2.36 mm sieve and shall be either a natural or manufactured product, the surface of which shall be clean and free from clay and any deleterious coatings. The Plasticity Index of the material passing the 0.425 mm sieve shall not exceed 4 and shall have a sand equivalent not less than 50 as determined by the Sand Equivalent Test AASHTO T176.

The material shall be graded uniformly from coarse to fine and may be supplied as two or more components capable of being combined with the coarse aggregates to produce a satisfactory overall combined grading.

d) Mineral Filler

Mineral filler shall consist of rock dust, hydrated lime or Portland cement. It shall be dry and free from lumps and shall meet the following grading requirements:

Table 4-6

Particle Size	Percentage by Mass Passing (AASHTO T-11 and T-27)
0.6 mm	100
0.18 mm	95 - 100
0.075 mm	65 - 100

e) Sampling, Testing and Approval of Materials

Prior to the delivery of any mineral aggregate or mineral filler, the Contractor shall furnish and test samples under the supervision of the Engineer. At the completion of the tests the Engineer

will inform the Contractor if such materials as represented by the samples conform to the requirements of the Specifications. Permission to use a material shall not be construed as an approval of the source of supply of this material.

Upon the initial delivery or manufacture of the materials and during subsequent deliveries and manufacture, samples will be taken and tested to determine that the materials being furnished conform to the original samples and also to the requirements of these Specifications. For each day of production the Contractor shall test at least two samples of all materials entering into uncompacted pavement. All tests will be performed by the Contractor under the supervision of the Engineer unless the Engineer chooses to separately test the samples.

The test procedures to be used are as listed below although the Engineer may specify other tests should these be required.

Table 4-7

Characteristic	Method of Test	
	AASHTO	ASTM
Materials Finer than 0.075 mm sieve	T 11	C 117
Unit Weight of Aggregate	T 19	C 29
Sieve analysis of Fine and Coarse Aggregates	T 27	C 136
Sieve Analysis of Mineral filler	T 37	C 546
Resistance to Abrasion of Coarse Aggregate using Los Angeles Machine	T 96	C 131
Soundness of Aggregates by use of Sodium Sulphate	T 104	C 88
Plastic Fines in Graded Aggregates and Soil by use of the Sand Equivalent Test	T 176	-
Asphalt Content by Quantities Extraction	T164	D2172
Mechanical Analysis of Extracted Aggregate	T30	-

4403 Job Mix Formula

The table following gives the composition limits within which the Job Mix Formula will be set by the Engineer. After examination of the materials that the Contractor proposes to use, and following tests of trial mixes by the Contractor, the Engineer shall establish the Job Mix Formula. Should the Contractor at any time propose to change the source or processing of the materials, sufficient notice shall be given the Engineer before such change is made. Samples shall be provided and tested by the Contractor supervised by the Engineer so that the mix design may be checked and the Job Mix Formula amended as necessary.

The Engineer may vary the Job Mix Formula to suit changing materials or to improve workability but no change shall be made unless authorised by the Engineer.

Aggregate Gradation for Hot Asphalt mixes (Ref.- Asphalt Institute MS-22, 2nd Edition)

Table 4-8

Sieve Size mm	% Passing by Weight of Total Aggregate in mix	
	Asphalt concrete Binder course (19 mm)	Asphalt Surface Course (12.5 mm)
25	100	
19	90 - 100	
12.5	-	90-100
9.5	56 - 80	-
6.7	-	-
4.75	35- 65	44-74
2.36	23 - 49	28-58

1.18	-	-
0.300	05 - 19	5-21
0.075	3 – 8	3-8
Asphaltic Cement by weight of total mix %	4.0-5.0	4.5-6.0

4404 Mix Design

The mix design shall comply with the following tables which show the composition limits within which the mixes will be approved by the Engineer. After examination of the materials that the Contractor proposes to use, the Contractor, supervised by the Engineer will establish a mix that will produce the required density and stability which shall be determined by conducting Marshall Test on trial mixes. Should the Contractor at any time propose to change the source for processing of material, sufficient notice shall be given to the Engineer before such change is made. Samples shall be provided by the Contractor so that the mix design may be checked by the Contractor supervised by the Engineer. In no instance shall coarse aggregates of widely different absorption characteristics be blended.

The Engineer may approve changes in the Job Mix Formula because of changing materials or to improve workability but no change shall be made unless authorised by the Engineer.

The Engineer shall require trial mix designs to be prepared and tested in the laboratory not less than 30 days prior to the scheduled commencement of paving. The trials shall be performed by the Contractor under the supervision of the Engineer.

The cost of such tests shall be included in the rates for bituminous premix course.

The laboratory trials will be directed toward determining the optimum mix design for the material samples submitted. Should the materials actually used in construction deviate from the samples submitted further laboratory trials may be required at the discretion of the Engineer to allow modification, if necessary, of the Job Mix Formula.

The optimum mix design will be selected according to the stability, flexibility and flow desired and achievable with the available materials while maintaining bitumen and void contents at the level indicated herein.

Marshall Test procedures shall be followed, and the following parameters shall be adopted:

Table- 4-9
Mix property requirement

Mix Properties	Asphalt Concrete Binder Course	Asphalt Surface Course
Specimen compaction	75	75 blows
Stability (minimum)	6000 N	6000 N
Flow	2-5 mm	2 - 5 mm
Air voids %	3-5 mm	3-5 mm
Voids in mineral aggregate % (minimum)	13	14
Retained Marshall Stability %(minimum)	70%	70%

Once the Job Mix Formula is set by the Engineer, field quality control shall be achieved by

control of the aggregate content and grading, bitumen content and the compacted density. The Engineer shall also require checks on mix properties by means of Marshall Tests on two samples from each day's production.

The limits, relative to the Job Mix Formula, within which aggregate gradation and bitumen contents, determined by the field quality control and checks on mix properties, shall lie within the following, provided the aggregate grading is within the gradation envelope specified in Section 4403.

Table 4-10

Passing Sieve	Percent
4.75 mm and larger	± 5
0.150 mm - 2.36 mm	± 4
0.075 mm	± 2
Bitumen	± 0.3

Any variation from these tolerances shall be sufficient cause for the Engineer to discontinue production until the cause of the variation has been corrected. The Contractor shall take and analyse pavement samples of the materials in question either before or after incorporation in the pavement and if laboratory analysis of those samples confirms the Engineer's analysis the Engineer may require the Contractor to remove and replace the material exceeding these variations in composition. No compensation shall be paid to the Contractor for samples taken by himself or by the Engineer and the material removed shall not be measured for payment.

4405 Plant

The Contractor shall submit at the time of tender details of the plant he proposes to use for the production of bituminous premix. The Contractor shall demonstrate that the plant proposed is capable of supplying premix materials at a rate which is adequate to meet the requirements of the Contractual Programme.

The Contractor shall further submit to the Engineer at least 60 days before paving is scheduled to commence full details of the plant and, where the items are already operating in Bangladesh, arrange for the Engineer to inspect them.

On the basis of the details submitted and the outcome of the field inspection where held the Engineer shall either accept or reject the equipment. Acceptance however shall not relieve the Contractor of his responsibility to produce, transport and pave material conforming in all respects to the requirements of this Specification.

For the Engineer to provide this initial acceptance the various plant items must have the following minimum attributes.

- a) Batch Plant
 - i) Mixing plants shall be of sufficient capacity to adequately handle the proposed bituminous construction in a smooth continuous operation.
 - ii) Cold Feed System. The plant shall have not less than 4 cold feed bins of a width sufficient to ensure that, with the loading equipment proposed by the Contractor, each bin can be charged without spill or overflow into adjacent bins.

The cold feed bins shall be fitted with an adjustable feed mechanism which shall be in good working order.

- iii) Dryer. The dryer shall be of a capacity suitable for the rated output of the plant. Its burner or burners shall be oil fired and controlled automatically by sensors to ensure the aggregate temperature remains reasonably uniform. The burners shall be in good condition and capable of

producing a clean flame without leaving a residue of soot or unburnt fuel on the surface of the aggregate.

- iv) Dust extractor. The plant shall be fitted with an efficient dust extractor with water sprinkler, automatic damper control, adjustable venturi and centrifugal separator and fan which shall remove the maximum possible amount of fine material from the exhaust gases. The extractor system shall have the capability of returning some or all of the extracted fine material to the hot elevator or to spoil as required.
- v) Hot elevator. The hot elevator shall be enclosed and fitted with an accurate temperature sensing device, the output from which shall be displayed in the plant's control room.
- vi) Screens. The vibrating screens shall be in good condition and of mesh sizes suitable for producing the specified mix. The screens shall be replaced if openings are larger than the nominal size due to wear.
- vii) Hot aggregate bins. There shall minimum of four hot bins, each of sufficient capacity to allow continuous operation of the plant at its rated capacity. Each bin is to be fitted with a contents indicator and a temperature sensing device, each displaying its output in the plant control cabin. A suitable sampling gate shall be provided at the base of each bin. The hot bin gates shall be mechanically operated, quick acting and tight fitting.
- viii) Filler feed. The plant shall be fitted with separate filler feed and weighing arrangement which feeds directly into the pugmill.
- ix) Weigh box. The weigh box shall have a capacity greater than the rated batch size and shall be capable of being calibrated by the sequential addition of standard weights. The Contractor shall make available at all times at the plant site a range of such weights, of sizes directed by the Engineer, to enable the calibration to be checked. The output from weigh box scales shall be displayed in the control cabin.
- x) Binder proportioning device. Binder shall be fed into the mix by means of a spray bar fed from the plant's binder metering device. This device shall be capable of adding binder to an accuracy of within 1 kg of the required amount. It shall be capable of being calibrated and shall display its output in the control cabin. A temperature sensor shall be fitted in the binder feed line adjacent to the metering device and its output shall also be displayed in the control cabin.
- xi) Pug mill: The pug mill shall have a minimum rated capacity of 1000 kg of mix. It shall be of the double shaft type and its paddles, paddle tips and liners shall not be significantly worn. The clear gap between paddle tip and liner at any point shall not be more than half the maximum aggregate size in the mix. Where this limit is exceeded the paddle tips and pug mill liners shall be replaced.

The discharge gates shall be mechanically operated, quick acting and not subject to leaks.

A batch counter shall be provided which displays its output in the control cabin.

- xii) Controls. The plant shall be fitted with fully functional automatic mixing controls. As a minimum the process from discharge of aggregates into the weigh hopper and subsequent discharge of the mix into a truck shall be controlled to preset requirements, which shall include mix proportions and mixing time. Manual operation for other than plant checking or start up shall not be permitted.

Control cabin. The control cabin shall be an air-conditioned room separate from but having a full view of the plant. It shall contain all necessary devices to monitor all aspects of the plant from cold feed bin contents through to discharge of the mix into the truck. Where the Contractor provides his own weigh bridge to weigh trucks it shall be installed adjacent to this control cabin.

b) Bituminous Pavers.

Bituminous pavers shall be self-contained, power-propelled units, provided with an adjustable activated screeder strike-off assembly, heated and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thicknesses shown on the plans.

Pavers shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms which independently control the elevation of each end of the screed from reference lines or surfaces.

The controls shall be capable of working in conjunction with any of the following attachments:

- i) Ski-type device of not less than 9 m in length or as directed by the Engineer.
- ii) Taut stringline (wire) set to grade.
- iii) Short ski or shoe.

The Contractor shall furnish the long ski, the short ski or shoe and furnish and install all required stakes and wire for a taut stringline.

Should the automatic control system become inoperative during the day's work, the Contractor will be permitted to finish the day's work using manual controls, however, work shall not be resumed thereafter until the automatic control system has been made operative.

The Contractor shall provide and have ready for use at all times enough tarpaulins or covers, as may be necessary, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may have been dumped and not spread.

4406 General Requirements

a) Field Laboratory

The Contractor shall provide a suitable field laboratory meeting the requirements as set forth in this Specification and required by the Engineer to perform the specified tests on aggregates, mixes and cores.

b) Preparation of Mixtures

The exact proportions, within the limits specified for each type of mix, shall be regulated so as to produce a satisfactory mixture with all particles coated with bitumen. To ensure this is achieved the Contractor shall calibrate the aggregate and binder proportioning devices in the presence of the Engineer prior to the commencement of mixing and at such other times as the Engineer may require.

The aggregates shall be mixed dry for a minimum of 15 seconds; the binder shall then be added in an evenly spread sheet over the full length of the mixer. The mixing shall be continued for a minimum of 30 seconds. The total time of mixing shall be the interval of time between the opening of the weigh box gate and the opening of the mixer gate. The Engineer may vary the length of the dry and wet mixing periods, but under no circumstances shall the total mixing time

be less than neither 45 seconds nor more than 60 seconds.

Continuous mixing may only be used if specifically approved by the Engineer. When continuous mixing is approved by the Engineer, the plant shall conform where applicable to the requirements of Section 4303. The dry aggregates shall be thoroughly mixed before the addition of the binder. The binder shall then be added in an evenly spread sheet over the full width of the mixer. The mixing shall be continued for a period of not less than 30 seconds. The total time of mixing shall be the ratio of the dead load of the mixer to the mass per minute delivered. The mass per minute delivered shall be determined by timing and weighing a load of mixed materials. The dead load shall be determined by weighing the mixer's full load of material. The dry mixing time shall be the product of the total mixing time and the ratio of dry mixer length to the total mixer length. The Engineer may vary the length of the dry and wet mixing periods, but under no circumstances shall the total mixing time be less than neither 45 seconds nor more than 60 seconds.

The mixture shall be loaded into the trucks in such a manner that segregation will not occur.

c) Temperature Control

Temperature shall be controlled within the following limits.

Binder	135 - 160°C
Aggregate (ex-dryer)	150 - 180°C
Mix (pugmill)	135 - 170°C
Delivery (paver)	130°C minimum
Rolling (initial)	110°C minimum

4407 Construction Methods

a) Cleaning of Base of Old Pavement

Immediately prior to the arrival of the mix at the paving site, the base, levelling course or old pavement to be surfaced shall have been thoroughly cleaned of all soil or foreign materials. Unstable or fatty patches of surplus bituminous material shall be removed from the old pavement and be replaced where necessary with suitable material, before spreading of any of the bituminous mixtures.

The cost of such cleaning and preparation shall be included in the price bid for bituminous premix.

b) Transportation and Placing of Mixtures

Mixtures shall be transported to the work in trucks having tight, clean and smooth metal beds that have been sprayed or painted with a minimum amount of soapy water to prevent mixture from adhering to the beds. No load shall leave the plant that is not thoroughly protected by a waterproof canvas cover. Any truck causing excessive segregation of materials by its spring suspension or other contributing factors, or that shows oil leaks of any magnitude, or that causes undue delays, shall upon the direction of the Engineer be discharged from the work until such conditions are corrected.

Recording of Truck Weights - A digital recorder shall be installed as part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process. In addition, the system shall be so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately weigh the heaviest loaded trucks or tractor trailers that are used for the delivery of the bituminous concrete

from that plant.

When any mixtures are being transported at shade air temperatures below 10°C or when the length of haul exceeds 10 kilometres, all truck beds shall be insulated to maintain workable temperature of the mixture. The maximum distance mixtures may be transported from mixing plant to paving site shall not exceed 30 kilometres except by specific permission of the Engineer.

Mix shall be dumped into the hoppers of the spreading and finishing machines hereinafter described in Section 4407.

Alternative labour - intensive spreading and finishing methods will require the prior approval of the Engineer, and will only be permitted for small irregular areas of work.

Except as specified below, no loads of mix shall be despatched from the plant so late in the day that they cannot be spread, compacted and completed in daylight. The Engineer may permit the surface course to be constructed after daylight hours, provided sufficient artificial illumination is available and that the work performed complies in every respect to this Specification.

No mix shall be spread when the base or supporting course is wet or when other conditions prevent proper spreading, finishing or compacting.

c) Spreading and Finishing

Bituminous premix shall be spread by self-powered pavers, which shall be capable of spreading and finishing the mixtures true to the line, grade and crown shown on the Drawings or set by the Engineer, without the use of forms or side supports.

No mix shall be placed when weather conditions are such that proper spreading, finishing, compaction and bonding may not be obtained.

A longitudinal joint when adjoining lane is not placed the same day or has become distorted by traffic or other means, shall be carefully trimmed to line and shall have a near vertical face. The face shall be coated with a thin layer of seal coat before placing the abutting material.

Transverse joint shall be constructed and compacted to provide a smooth riding surface. The joints should be straight and be trimmed to a near vertical face and coated with a thin layer of seal coat prior to the placing of fresh material adjacent to the joint.

Faces of castings, kerbs, gutters, concrete pavement etc. against which the mix is to be placed shall be painted or sealed with bituminous material as specified in Section 4303. The cost of the painting or sealing shall be included in the price bid for bituminous premix and no separate payment shall be made therefore.

Immediately after any course is screeded and before compaction has commenced, the surface shall be checked, any irregularities adjusted, all foreign material removed by a rake or hoe and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the rolling of the edge is performed.

The Contractor shall provide competent workmen who are capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given to the straight edging of each course immediately following the initial rolling.

Any areas such as intersections, turnouts or driveways that are impracticable to be constructed by machine intensive methods shall be spread and finished by acceptable hand methods.

d) Compaction

After spreading, the mixture shall be thoroughly and uniformly compacted. The density of the completed pavement shall be in accordance with the requirements specified below.

Steel wheel rollers shall be tandem static/vibratory rollers unless otherwise approved by the Engineer. Pneumatic tyred rollers shall have a minimum of 7 wheels and be capable of adjusting tyre pressure while moving.

Rolling shall be carried out in three sequences:

- * Breakdown rolling by steel wheel roller at a temperature not less than 110°C
- * Secondary rolling by pneumatic tyred roller
- * Finish rolling, by smooth wheel vibrating or static rollers at a temperature not less than 70°C.

The number of rollers used shall be sufficient to compact at a rate not less than the rate of paving, making due allowance for rapid cooling at low temperature. At all times, the motion of the rollers shall be slow enough to avoid displacement of the mix. Rolling shall commence as close behind the paver as is practicable and shall be continued until all roller marks are eliminated and no further compaction is possible. The initial pass of the roller over the uncompacted surface shall be with the powered drive wheel towards the paver.

To prevent the adhesion of mix the roller drums and tyres shall be kept moist for their full width, but an excess of water will not be permitted.

In general, rolling shall begin at the sides and shall progress toward the centre, parallel to the centreline of the roadway. Successive passes of the roller shall uniformly lap the previous passes. On superelevated curves, rolling shall start at the low side and progress to the high side as above described. Where a longitudinal joint is being made, the joint shall be thoroughly rolled before starting at the edge to roll inward. Alternate passes of the roller shall be terminated in steps at least 1 metre distant from any preceding stop, and such stops shall be so regulated as to preclude the trapping of any water on the rolled surface. Other rolling procedures may be approved or directed by the Engineer as conditions require.

In areas adjacent to kerbs, compaction shall be performed with a reciprocating tamper or trench roller, or other method, to the approval of the Engineer. In other areas inaccessible to any roller the required density shall be secured by the use of tampers or other compaction equipment meeting the approval of the Engineer.

The Contractor shall employ only bituminous surfacing skilled operators, supervisors and drivers who are capable of adjusting their operations to the observed conditions.

Where the paving and rolling of the surfacing is not carried out in a workmanlike manner the Engineer may suspend surfacing operations until suitably skilled workmen and operators are provided by the Contractor.

e) Small Tools and Portable Equipment

The Contractor shall provide all necessary tools and keep them in first-class condition. Sufficient number of standard 3000 mm straight edges or surface testers for bituminous pavements and standard templates constructed to the true cross section of the road shall be provided by the Contractor and shall be available at all times at all individual work sites where they may be required to be used. This provision shall be complied with before work is started.

f) Surface Tolerances

The finished surface shall not vary more than 3 mm from a template cut to the cross section of

the course, nor more than 3 mm from a 3000 mm edge applied parallel to the centreline of the pavement nor shall any portion be more than 3 mm below or above the finished level shown on the Drawings or instructed by the Engineer.

Portions of the completed pavement that do not comply with the requirements of the Specifications shall be taken up, removed and replaced or otherwise corrected in a manner satisfactory to the Engineer. These corrections shall be made at the Contractor's cost.

g) Protection of Wearing Course

After the completion of the wearing course, no vehicular traffic shall be allowed on the pavement until it has so cooled that its surface will not glaze or flush. Upon completion of the final rolling, suitable barricades shall be placed on the surface of the course at such intervals as will keep vehicular traffic off the course. The minimum period of protection shall be 6 hours after placing and when the shade air temperature is above 30°C the protection shall be lengthened by the Engineer as required but in no case shall this exceed 10 hours.

h) Plant Tickets

When batch mixers are used, the number of batches and total net weight of all loads of mix shall be recorded in triplicate upon Engineer's Plant Ticket forms by an authorised representative of the Engineer. The Contractor shall install and regularly calibrate an acceptable weigh bridge to weigh the mix transporting vehicles and shall provide suitable plant tickets to the Engineer's requirements. Installation of a weigh bridge is a mandatory requirement for this contract.

With each load delivered to the Work, the driver shall present one copy of the plant ticket to the Engineer's representative and another to the authorised representative of the Contractor. The plant inspector shall keep the third copy until the completion of the Work and then forward it to the Engineer. Any changes in the amounts set forth on the tickets, necessitated by the rejection of any material or in the designation as to where material is used, shall be noted by the Engineer's representative upon all copies, and a reason stated for such rejection. At any time during the delivery of material for the purpose of checking the operation and weighing equipment of the plant, the Engineer may direct the Contractor to weigh or cause to be weighed, on tested and approved scales at the Contractor's expense, any truck either full or empty engaged in delivery of mix to the Works.

i) Sampling Pavement

For the determination of thickness and density of the compacted mix, the Contractor under the supervision of the Engineer will take core samples of the pavement. These cores shall be a minimum 75 mm diameter and taken at intervals of not more than 200 lane metres or 2 per day whichever gives the greater number of samples.

If the bulk density of the compacted mix determined from these cores is less than 95 percent of the design density of the mix, such additional rolling or modification of rolling shall be initiated at once as will secure this result. This rolling shall be carried out when the ambient temperature is high and shall employ pneumatic tyred rollers at maximum tyre pressure. Steel wheeled rollers shall not be used. Upon completion of rolling, further cores will be taken and tested as above. If the results remain less than the required value, the Engineer may direct that the mix represented by this core be removed from the works and replaced at the Contractor's expense.

j) Thickness

The total thickness of bituminous premix courses determined as herein specified, shall be not less than the design thickness, and shall not be more than 6 mm greater. When the total thickness is less than the minimum specified, the deficient area shall be corrected at the Contractor's expense either by an overlay course, or by removal and replacement of the

unsatisfactory thickness. The corrective measures will be subject to the approval of the Engineer.

k) Acceptance Sampling and Testing of Bituminous Mixture

The mean and range of the density of the pavement will be calculated from the results of all tests run on randomly selected sites each two production days. Regardless of the quantity of pavement placed, no less than ten tests will be run. The compaction of the lot will be considered acceptable when the average of all test results for two production days is equal to or greater than 95% of the target density plus 0.35 times the range (the difference between the largest and smallest test result).

In addition to the tests which are run on randomly selected sites, the Engineer reserves the right to test any area which appears defective and to require further compaction of areas that do not have at least 95 percent of target density.

The in-situ and target densities shall be measured in terms of "Bulk Specific Gravity" as determined by AASHTO T166. The target density test specimen shall be determined using the procedure for test specimen preparation including mixing, moulding and curing described in AASHTO T167. (Compressive Strength of Bituminous Mixtures')

When the thickness of a sample is found to be less than the minimum permissible pavement thickness, two additional samples shall be cut at locations 2 m longitudinally in both directions from the location of the deficient sample. If both of these samples give thicknesses more than the design thickness, the represented shall be considered satisfactory and no correction shall be required. If either or both of these samples are deficient in thickness, additional samples shall be taken in the direction or directions of deficiency indicated, at intervals of 30 metres measured longitudinally from the location of the first deficient sample, until a pavement thickness within the specified tolerance limits is found.

If an overlay is used for correction it shall be placed for the full width of the pavement over the entire area of deficiency and shall have butt joints at the ends. A tack coat meeting the requirements of the Contract Specification shall be applied at the expense of the Contractor.

The overlay course shall be not less than a 20 mm thickness of 10 mm mix or 40 mm of 20 mm mix and it shall not be measured for payment.

If the deficient area in a lane is removed and replaced, the courses shall be stepped into adjoining pavement for a distance of 500 mm at the ends and 300 mm at the edges. The area of deficiency in this case need not extend to the limiting sample locations described above, but shall extend to the point where the thickness of the exposed edge of bituminous premix remaining is found to be of satisfactory thickness. The supporting base course shall be regarded and recompacted if necessary, and the various courses replaced. The overall thickness of the replaced courses shall be within the tolerances specified.

4408 Method of measurement

Measurement for bituminous premix surface course of the various thicknesses specified shall be made in cu.m accepted with no deduction made for the mass of bitumen in the mixture. The material shall be weighed after mixing when placed in the delivery trucks, each of which shall have a tare mass certified to the satisfaction of the Engineer. Loaded trucks shall be weighed as herein before specified.

The summation of certified delivered masses shall be the basis for payment of this item after due allowance has been made for any wasted material and any material rejected by the Engineer for non compliance with any of the specified requirements and subject to the limitation set out in the next paragraph.

The Contractor shall cooperate with the Engineer in establishing, by field trial on the Works, the rate of spread (tonnes per square metre) for the bituminous premix surface course.

Thereafter, the payment mass for surface course, as determined by weighbridge docket, after adjustment as provided for herein above, must be within 7 percent of the rate computed using the rate of spread determined by field trial, the comparison being on a daily basis.

Payment will not be made for any mass determined by weighbridge docket which is more than 7 percent below the mass computed by rate of spread, pending investigation by the Engineer and the carrying out, at the Contractor's expense, of any repairs to the affected area deemed necessary by the Engineer.

Bitumen used in the mix shall be deemed to be included and shall not be measured separately irrespective of its quantity. No price adjustment shall be made in case the quantity of bitumen used becomes more or less because of change in job mix formula during the process of the works.

4409 Basis of Payment

The quantities measured as provided above shall be paid for at the Contract unit price per cu.m bid for:

Item	Unit
44/1 - Bituminous Premix Binder Course 60 mm.	Cum
44/2 - Bituminous Premix Binder Course 75 mm	Cum.
44/3 - Bituminous Asphalt Concrete surface Course 40 mm	Cum.
44/4 - Bituminous Asphalt Concrete surface Course 50 mm	Cum.

Which prices and payment shall constitute full compensation for the Bituminous Premix Surface Course complete in place and includes the furnishing of all materials, labour, equipment, tools, sampling, field trials testing and incidentals necessary to complete this item.'

Bitumen used in the mix shall be deemed to be included and shall not be paid separately

SECTION 4500: COLD MIX ASPHALT

4501 SCOPE

This section covers the supply and furnishing of materials, methods of construction and requirements for the construction of a bituminous surface treatment using cold mix asphalt. The contractor may adopt alternative types of construction provided details of construction methods / specifications etc. are first provided to, and approved by, the Engineer.

4502 MATERIALS

Aggregates

The aggregate shall consist of approved crushed stone, free from all clay and organic material, and which complies with the following requirements:

(i) Grading Percentage by weight passing

Table 4-11

Sieve Size (mm)	Coarse aggregate 9mm	Coarse aggregate 19mm	Fine aggregate
20	100	100	
12.7	100	30 – 100	
9.5	85 – 100	0 – 55	100
4.75	20 – 45	0 – 10	90 – 100
2.36			80 – 100
0.6			25 – 100
0.075	0 - 5	0 - 1	3 – 11

(ii) Shape, strength, abrasion and durability

The following limits are set for coarse aggregates

Flakiness Index	< 45
Aggregate Crushing Value	< 25
Aggregate Impact Value	< 25
Los Angeles Abrasion	< 30
Aggregate Abrasion Value	< 15
Polished Stone Value	>50
Soundness	<12
Water absorption	<2

Crushed gravels shall have at least two fractured faces.

Bitumen

The bitumen content shall be MC 800 cut back bitumen to AASHTO M 82-75 unless otherwise approved by the Engineer. A bitumen certificate shall be provided for all material delivered to the site.

4503 MIXES

The asphaltic mixture shall be composed basically of aggregate and bituminous material. Before starting work the Contractor shall submit to the Engineer, for his approval, a mix design for the material that he proposes to use. This will include details of material type and source, nominal particle sizes, combined percentages, total and effective bitumen contents. The contractor shall demonstrate the suitability of all proposed aggregates and proposed mix by making and testing trial mixes in the laboratory and also by field testing using his proposed procedure for production and placement. Permanent paving works shall not commence until a satisfactory trial has been placed and approved by the Engineer.

The following mix composition is provided as a guide to property requirements for cold mix patching materials.

Table 4-12

MIX CLASS	C/10	C/20
Nominal particle size (mm)	9	19
Nominal minimum layer thickness (mm)	20	40
Percentage by mass passing (mm)		
19.0	100	95 – 100
9.5	85 – 100	60 – 75
2.36	15 – 25	15 – 25
0.075	3 - 5	3 – 5
Residual bitumen (% by mass of total)	5.5	5.0
Min ^m effective bitumen (% by mass)	5	4.5

All material delivered to the site shall conform to the approved mix design within the following tolerances :

Aggregate passing		
9.5mm sieve	-	± 7 % (by weight of total mix)
2.36mm sieve	-	± 5 %
75 micron sieve	-	± 1.5 %
<u>Bitumen content</u>	-	+ 0.5 %
		- 0.0 %

4504 PLANT AND EQUIPMENT

All plant and equipment shall be in accordance with this Specification except where the Engineer determines that works are of a 'minor' nature.

In such instances mixing may be carried out using a mechanical concrete mixer of at least 200 litres capacity – alternative methods may be allowed by the Engineer provided the contractor can demonstrate its suitability. The equipment must be capable of producing a homogeneous, fully and uniformly coated material. Spreading and compacting the material using hand methods will require hand tools such as lutes, shovels, tampers (min^m 4kg) and brooms.

4505 Mixing of Aggregates and Bitumen

Aggregates shall be as dry as possible and shall have no surface moisture. Aggregates shall be combined in the mixer in the proportion of each fraction required. When batched by hand, proportions shall be measured by weight or volume using correctly calibrated containers. After adding the bitumen mixing shall continue until the aggregate is fully and uniformly coated and a homogeneous material is produced.

4506 Placing and Compaction

The bituminous mix shall be kept free of contamination and segregation during transportation. If required each load shall be covered with canvas or similar covering to protect it from the weather and dust.

Immediately before placing the material the existing surface shall be cleaned of all loose or deleterious material by sweeping with a power broom, supplemented with hand brooming if necessary. After the surface has been prepared and approved a tack coat shall be applied in accordance with section 4300 to completely and uniformly coat all surfaces against which the cold mix is to be placed. The bituminous mixture shall then be spread to line and level by the laying equipment without segregation and dragging. Immediately after the bituminous mixture has been spread, it shall be thoroughly and uniformly compacted by rolling as per Section 4712.

For minor works hand methods may be adopted. Areas of less than 1m² may be compacted using a hand tamper, larger areas shall be compacted using a mechanical roller or vibrating plate compactor. Cold mix shall be compacted in layers not exceeding twice the nominal thickness. Deeper patches must be filled using multiple layers.

4507 MEASUREMENT AND PAYMENT

Item	Unit
45/1 Cold mix asphalt in minor works	Cum
45/2 For resurfacing large areas	Sq.m

For minor works the unit of measurement shall be the compacted volume of material laid and compacted on the road calculated on the basis of the approved surface area and thickness for each repair.

For resurfacing works the unit of measurement shall be the square meter of material laid and compacted on the road calculated as the product of the length instructed to be laid and the net width as shown on the Drawings or instructed by the Engineer.

No measurement or payment shall be made for alternative mixes proposed and/or adopted by the contractor nor for bituminous mixes laid in excess of the authorized dimensions. Payment shall include for the cost of all preparatory works; provision, storage and transportation of all materials; hauling, laying and compacting the bituminous mixture and all other incidentals that are necessary for the proper execution of the works.

4600: BITUMINOUS SURFACE TREATMENT

4601 Description

This work shall consist of a single or multiple course bituminous treatment in accordance with these Specifications and in reasonably close conformity with the line shown on the Drawings or established by the Engineer.

As used herein, a surface treatment may be applied to an earlier bituminous or concrete surface after suitable surface preparation or to an aggregate surface, which has been suitably prepared and primed in accordance with Section 4303 of these Specifications.

For general guidance, refer to the current edition of 'A Guide to Surface Dressing in Tropical and Sub tropical Countries' Overseas Road Note 3 of the Transport and Road Research Laboratory (U.K.), and BS-434 parts 1 and 2.

4602 Binder

The binder shall be penetration grade bitumen, cutback bitumen or bitumen emulsion as described in Section 4002 and shown in the Drawings or directed by the Engineer.

4603 Additives

If directed by the Engineer, binder shall contain, at the time of application to the surface, the required percentage of an approved adhesion agent.

4604 Aggregate

Aggregates shall be hard, durable and clean and shall conform to the requirements listed below:

a) Gradation

The gradation shall be within the following limits:

Table 4-13

Sieve Size (mm) Grading	Percentage by weight passing for the following nominal sizes			
	20 mm A	14 mm B	10 mm C	5 mm D
25	100			

19	95-100	100		
13.2	0-20	90-100	100	
9.5	0-5	0-30	95-100	
6.3		0-5	0-40	100
4.75			0-5	5-100
2.36				0-40
0.600	0-1	0-1	0-2	0-5

b) Cleanliness

The surface of the aggregate particles shall be clean and free of dust. The Contractor shall arrange for the aggregate to be washed if necessary to achieve this requirement.

c) Resistance to wear

The Los Angeles Abrasion result of the aggregate when tested in accordance with Los Angeles Abrasion Test AASHTO T96 shall be not greater than 30%.

d) Shape

The aggregates shall have a flakiness index in accordance with BS 812 not greater than 30%.

e) Affinity for bitumen

The Contractor shall present results of adhesion tests in accordance with Appendix 3 of Overseas Road Note No. 3 to the Engineer. These tests shall be carried out on samples of aggregates approved for use in the works in a laboratory acceptable to the Engineer. On the basis of these tests the Engineer may direct that a suitable adhesion agent be added to the binder.

f) Moisture Content

Chips which are sufficiently dry to adhere to the binder without applied pressure within one minute of being spread over the binder shall be considered satisfactory. The above standard of dryness of chips shall be adopted without variation.

g) Stockpiles

The Contractor shall supply the sealing chips and shall be responsible for arranging his stockpile sites locations to be approved as suitable by the Engineer. The Contractor shall inform the Engineer immediately each stockpile is completed and allow 14 days for the Engineer to test it for approval. The Contractor shall not add any further material to any stockpile from the time that he notifies the Engineer that it is completed until its use on the Contract is ended. No chips shall be used from an unapproved stockpile.

The chips used to seal any section shall generally be drawn from the stockpile appropriate for that section. Where the Contractor wishes to use chips of the same grade from an alternative tested and approved stockpile, he shall submit such alternate proposal to the Engineer a minimum of two days before the proposed use of those chips. Approval of any such proposal will be accompanied by amendment or confirmation of the required binder application rate, and may require that such alternate chips be not mixed with that from another stockpile.

4605 Pre-coating chips

The Engineer may direct that the sealing chips be pre-coated prior to application by spreading.

a) Dryness of chips prior to pre-coating

The chips shall be reasonably dry prior to pre-coating. The minimum degree of dryness acceptable is such that if the chips are spread one layer thick on a flat surface, they shall be completely surface dry within five minutes. This requirement will not apply to chips which are pre-coated with cationic emulsion or the cut-back bitumen which incorporates an approved adhesion agent.

b) Pre-coating material

The pre-coating material used shall be a bituminous material. The pre-coating material shall comply in all respects which the following requirements.

The bituminous material shall be either:

- (1) a cationic emulsified bitumen,
- (2) a cut-back bitumen produced by thoroughly blending 180/200 penetration grade bitumen with 70% by volume of lighting kerosene. If the cut-back bitumen is to be used to pre-coat chips which do not comply with the requirements of Section 4002 of this Specification for dryness, then an approved adhesion agent shall be added to the cut-back. If 80/100 penetration grade bitumen is used, fluxing have to be done with 5% diesel oil and then have to cut-back with 65% kerosene.

c) Application of the pre-coating material

The rate of application of pre-coating material shall be between 4 to 5 litres per cubic metre of aggregate.

All particles of aggregate must be thinly coated by means of a line pressure spray on a moving stream of aggregate or by mechanical mixing. If the chips need to be heated prior to pre-coating, they shall not be heated beyond 45°C. The cut-back bitumen shall not be heated to more than 45°C at time of coating.

d) Stockpiling

The chips shall be coated not more than one week prior to being spread on the road. Measures shall be taken to ensure that the pre-coated aggregate is not contaminated by dust or other deleterious matter prior to use. This shall be done by locating the stockpile or stockpiles on prepared sites remote from sources of contamination and by covering the stockpile or stockpiles where necessary.

e) Condition of pre-coated chips prior to being spread on the road

All particles of aggregate must be thinly and uniformly coated with the pre-coating material. The standard of pre-coating shall be such that from any representative sample of 100 chips :

- i. not more than two chips shall have no pre-coating;
- ii. not more than 5 chips shall have less than 50% of the surface area pre-coated and
- iii. the remainder of the 100 chips shall have not less than 75% of the surface area pre-coated.

4606 Distributor

The distributor shall be truck mounted in good condition and shall incorporate the following as a minimum:

- * A means for measuring distance and speed (low range) to an acceptable accuracy
- * A means of heating the binder in the distributor tank and a means of indicating the temperature of the binder

- * A means of accurately determining the volume of binder in the tank
- * A pump for distributing the binder onto the road surface, recirculating binder through the tank when spraying is not taking place and for filling the distributor
- * A recirculating type spray bar of sufficient width to apply binder to one full lane width in a single pass. The spray jets both individually and in groups shall be capable of being cut off as needed to enable narrow and odd shaped areas to be sprayed
- * A suitable hand spray device
- * Suitable fire extinguishers and other safety equipment.

Prior to use on the work the distributor shall be calibrated in the presence of and to the satisfaction of the Engineer and calibration charts produced. The specific items to be calibrated and the required tolerances where applicable are listed below:

Velocity and distance accurate to $\pm 2\%$.

Temperature measuring device accurate to $\pm 5^{\circ}\text{C}$.

Dipstick or other volume measuring device accurate to $\pm 1\%$.

d) Spray bar

- * Transverse distribution. Applications over 100 mm intervals across the width of the spray bar to be within 10% of required application rate. The test is to be carried out using the method described in Appendix 6 of Overseas Road Note No. 3.
- * Overall application to be within $\pm 5\%$ of that specified.

4607 Preparation of Surface

Before spraying of the binder is commenced, any necessary preliminary patching of the surface of the road shall have been completed, the surface as a whole shall be generally dry and any damp areas shall be completely free of standing water. The road surface shall be broomed immediately before sealing with special attention to remove dried mud and animal dung. The Engineer shall approve the surface condition before sealing begins.

4608 Protection of road furniture

Before any binder is sprayed, the Contractor shall install offset marks to identify the positions of all service covers, railway crossing rails in the surface, and bridge expansion joints, so that they can readily be located afterwards, and shall cover them adequately to protect them from spray. Once spraying and chip spreading is completed the covers shall be cleaned off.

Kerb and channel, marker and sign posts, and other road furniture adjacent to the surface to be sealed shall be adequately protected against over-sprayed binder and from roller or other damage. Any blemish or damage so caused shall be made good at the Contractor's expense and to the satisfaction of the Engineer.

4609 Start and End of Spray Operation

In order to ensure that the required rate of application is obtained at the commencement of the spray and that a sharp and even joint is obtained at the finish of the spray, 1 metre minimum width of non-porous paper or fabric shall be placed across the pavement where each run of the spray starts and finishes. The Contractor shall take adequate measures to secure the paper against lifting by wind or traffic. Soil shall not be used for that

purpose. Bituminous binder shall be circulated through the spray bar until the bar is fully heated before spraying is commenced.

The bitumen distributor shall start moving not less than 5 metre in advance of the area to be sprayed so as to be travelling at the correct speed when the spray bar reaches the paper strip. Spraying shall start and stop within the paper strips.

No spray work shall be authorised when strong wind interferes with the fans of bitumen spray from the spray bar causing uneven distribution.

4610 Pattern of Operations

The positions of transverses and longitudinal joints between adjacent spray runs and the position and extent of hand spray work shall be subject to approval by the Engineer.

The minimum width of spray shall be half width of the carriageway except that for roads less than 3.6 metres wide, the full width of roadway shall be sprayed. Generally the Engineer will not approve a spray pattern, which provides for a joint along a normal wheel path for heavy vehicles.

Where a longitudinal joint occurs, a strip about 150 mm wide of the first sprayed area shall be left uncapped to allow effective jointing with the next pass of the sprayer and the next spray run shall overlap to the extent approved by the Engineer. No lap shall be left uncompleted at the end of any day's sealing. Unless otherwise approved by the Engineer, laps within traffic lanes, or within 600 mm of them, shall be completed within 30 minutes of the first side being sprayed. No normal road traffic shall be allowed to cross uncovered binder.

For roads 3.6 metre wide or less, the road shall be sprayed full width before any section is open to traffic, irrespective of the method of application of binder. The Contractor shall provide diversions where required during the work.

4611 Spreading of Chips

After the spraying of the binder, the spreading of cover chips shall commence promptly. All binder sprayed shall be covered with chips across the full sprayed width, apart from necessary longitudinal laps, within two (2) minutes of spraying.

Before commencing any sprayer run, sufficient loaded trucks or other approved conveyances shall be at the site to provide the full chip cover for the area of road surface to be sprayed.

The load of sealing chips in each truck shall be levelled and trimmed to a loading line approved by the Engineer. Chips shall be spread using either tail-gate mounted fantail spreaders or other approved chip spreaders. All types of chip spreader shall have provision to block off chutes to vary the width of spread and the discharge rate shall be controlled by an experienced operator who shall be positioned at the rear of the vehicle with a clear view of the spread chip surface. Operations will be conducted so that sprayed areas of bitumen will be covered with chips before the truck wheels pass over them.

Workmen with hand brooms shall be stationed to ensure that the area of binder is evenly covered by sealing chip. The Contractor may also use sheeting and drag brooming to evenly distribute the chips.

The spread rate of the chips shall be such that when fully rolled it will be one stone thick, closely packed shoulder to shoulder, with the individual stones lying flat. The Contractor shall be responsible to obtain the chip spread rate as directed by the Engineer which may be tested for "take" of chips at the end of the protection period. The initial spread rate shall be not more than 5% above the rate directed by the Engineer for both labour intensive and mechanical spreading.

4612 Application Rate

The rates for application of bitumen and aggregate will be within the ranges specified below:

Table 4.14

Aggregate Grading	DESIGNATION			
	80/100 Bitumen		Emulsified Asphalt	
	DBST-1	DBST-2	DBST-3	DBST-4
<u>First Course</u>				
Bituminous Material (litre/sq.m)	1.0-1.3	1.35-1.7	1.14-1.6	1.6-1.8
Aggregate (kg/sq.m):				
Grading A 20	--	20 -23	--	20-23
Grading B 14	16-19	--	16-19	--
<u>Second Course</u>				
Bituminous Material (litre/sq.m)	0.7-1.0	1.0-1.3	1.8-2.0	2.0-2.2
Aggregate (kg/sq.m.):				
Grading C 10	--	12-15	--	12-15
Grading D 5	6-9	--	6-9	--
TOTALS:				
Bit. Material (litre/sq.m)	1.7-2.3	2.35-3.0	3.2-3.6	3.6-4.0
Aggregate (kg/sq.m)	22-28	32-38	22-28	32-38

The aggregate spread rate is based on materials having a specific gravity of 2.65. For materials, having specific gravities of less than 2.55 or greater than 2.75 appropriate adjustments will be made. For two course surface treatments, the nominal aggregate size for the upper course shall be approximately half of the size selected for the lower course.

Where a single surface treatment is specified, the application rates for the second course indicated above or as decided by the Engineer shall be used.

Before beginning general production, a trial section of approximately 100 metres length shall be sealed by the contractor, at his own expense on trial areas other than the project road surface. The Engineer shall evaluate the performance and then shall establish the distribution rates within the above ranges as necessary.

The Contractor under the supervision of the Engineer shall carry out tests during the execution of the Works in order to verify that the actual rate of application of aggregates and bituminous material complies with that fixed rate during trials and / or as per the Engineer's instructions. If the measured application rates vary within $\pm 10\%$ of the rates ordered and or fixed the work will be accepted. For regular checking of the application rate of stone, it is **mandatory** to install a weighbridge and calibrate it prior to commencement of work at site.

New trial sections will be made whenever the nature of the surface being treated changes, or whenever the Engineer may direct for the purposes of adjusting the distribution rates.

The distribution rate for aggregate and bitumen shall be tested by placing flat pans approximately 1/4 square metre in area in the path of the distributor or aggregate spreader and weighting the amount deposited thereon. Results of this method will be compared with results of dipstick and other measurements to determine the spread rate.

4613 Rolling

Rolling shall be classified as initial rolling (which is half the total rolling requirement), and finish rolling. Initial rolling in association with light blooming shall be applied immediately after the application of chips and shall consist of at least three passes of an approved pneumatic tyre roller over the whole of the area sprayed.

During the initial rolling other plant or traffic shall not be permitted on the new seal. The entire sealed surface must be rolled, and areas outside normal traffic wheel tracks should receive additional rolling.

Finish rolling, comprising the balance of the total rolling requirement, shall be completed on the day of sealing before removal of the rollers from the site.

4614 Maintenance

Where more than one course of sealing is to be applied and cut-back or emulsified bitumens are used, at least 24 hours shall pass between applications of bitumen unless otherwise approved by the Engineer. Where penetration grade bitumen is used, the bitumen shall be fully cooled and all rolling completed before the application of subsequent courses.

The aggregate surface shall be lightly broomed or otherwise maintained for a period of 4 days or as directed. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free asphalt material and cover any areas deficient in aggregate. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept from the entire surface. The surface shall be swept at the time determined by the Engineer and brooming shall not be so forceful that aggregate is displaced.

The standard of protection shall be such that area covered by chips in close contact shall not be less than 98% of the total area being considered. When testing for the "take" of chips, the minimum area to be considered shall be a square having 300 mm sides.

The Engineer will inspect the seal coat immediately prior to the removal of the temporary speed restriction and after final surplus chip removal is completed. Provided the requirements of this Specification have been complied with and the binder is completely bonded to the sealing chips, the Contractor shall not be required to carry out any further works or maintenance with respect to that section of seal coat.

4615 Traffic Control

On each section of seal coat constructed within a period of one day, the Contractor shall be entirely responsible for the control of traffic, both for the safety of the travelling public and for the prevention of damage to the road surface, from the time that work commences until his obligations as per the Conditions of Contract are discharged.

All traffic control shall be carried out to the requirements of Section 1117 of this Specification. Unless otherwise specified or authorised by the Engineer, the temporary speed restriction used shall be 25 km/h applied for 48 hours after the completion of rolling where penetration grade or emulsified bitumen binder is used and 10 days where cut-back bitumen binder is used.

The Contractor shall carefully control the speed of traffic through the work area and shall keep all traffic off newly furnished work until the initial rolling is completed, or longer if so directed by the Engineer. The Engineer may direct that the Contractor use flagmen and pilot cars to control traffic. Provision for flagmen and pilot cars are included in the amount bid under item 1.1/1 of Bill No.1 of the Bill of Quantities.

The Contractor shall maintain the required road signs for this period. In the event of adverse weather or traffic conditions within this period, it shall be the responsibility of the Contractor to implement supplementary traffic control measures which may include barriers and/or the use of pilot vehicles in order to protect the new seal coat.

The Engineer may require the Contractor to take such measures should the Engineer consider that there is a risk of the seal being damaged due to the Contractor's lack of effective action.

4616 Locking Coat

The Contractor shall apply a grit or sand locking coat to sections of new surface dressing at sections where there are bus stops or as directed by the Engineer. This locking coat shall be applied after completion of the rolling and within 24 hours of such completion or as specified by the Engineer.

The locking coat includes the supply of 3 mm nominal maximum size chip and uniform spreading at an application rate of 260 square metres per cubic metre plus or minus 10% over the entire area of the specified sections of surface dressing. Drag-brooming or hand-brooming may be required to obtain a sufficiently uniform spread.

4617 No Fouling of Treated Surface

The sealed surface shall not be fouled by soil, water, oil, petrol or other droppings. The movement of plant and traffic onto the new seal and into and out of stockpile areas shall be controlled to prevent the carrying of deleterious material onto the seal by vehicle tyres.

4618 Intersecting Public Roads

Unless otherwise specified all sealed intersecting public roads shall be resealed to the reserve boundary of the road being sealed.

4619 Measurement

Bituminous Surface Treatment of the type stated in the Bill of Quantities shall be measured by the area in square metres satisfying the approved rate of application through weighbridge for the surface completed and accepted.

Bitumen used in the works shall be deemed to be included and shall not be measured separately irrespective of its quantity. No price adjustment shall be made in case the quantity of bitumen used becomes more or less because of change in job mix formula during the process of the works.

Pre-coating of chips and locking coat sand or chips will not be measured for payment.

4620 Payment

Payment for the measured and accepted Bituminous Surface Treatment shall be at the Contract Unit price for the items listed below and shown in the Bill of Quantities.

Item	Unit
46/1 Double Bituminous Surface Treatment (20 mm size followed by 10 mm size aggregate)	sq.m.
46/2 Single Bituminous Surface Treatment (14 mm size aggregate)	sq.m.

Payment shall be compensation for the provision of all materials, labour and equipment and all other things including trial sections required to complete the work as specified.

Bitumen used in the works shall be deemed to be included and shall not be paid separately

Pre coating of chips, the use of adhesive and anti stripping agent bitumen will not be paid for separately, the relevant charges being included in the rates for the pay items for bituminous surface treatment.

4700: Premix Bituminous CARPETING (manual method)**Description****4701 General**

This work shall consist of a surfacing of bituminous material, constructed on a prepared base in accordance with these Specifications, to the lines, levels, grades, dimensions and cross sections shown on the Drawings and as required by the Engineer.

The provisions of Section 4400, "BITUMINOUS PREMIX SURFACE COURSE" shall form a part of these Specifications except that the requirements for plant mixing and laying by paving machine may be relaxed provided the Contractor proposes and demonstrates effective alternative manual methods or by using mini asphalt plant to the full satisfaction of the Engineer. Such methods shall take account of the total quantity of material to be mixed and laid within the stipulated programme. Any alternative methods shall only be employed after receipt of written approval from the Engineer. Such approval may be withdrawn at any time if the work is found to be unsatisfactory.

Bituminous carpeting shall consist of one or two layers of binder course of the total thickness shown or as directed by the Engineer. The upper layer shall be given a premixed seal coat as specified in Section 4400 to provide a close textured surface finish.

4702 General Composition of the Mixture

The mixture shall consist of mineral aggregate and filler if needed, coated with bitumen. The total mineral aggregate shall have a job-mix grading within the limits set by Table 4.5-1.

When the total thickness of bituminous binder course exceeds 50 mm, the material shall be laid in two layers. The material shall be within the limits set by mix classification 1 in Table 4.5-1.

In certain cases the Engineer's approval may be given to gradings outside the limits specified in Table 4.5-1.

The selected job-mixes shall conform to Table 4.5-1 below.

Table 4-15

Mix classification	1	2
Course	Binder	Binder
Thickness (mm)	25	38 or 50
Sieve Size (mm)	Total % by weight passing	
25	100	100
20	100	75-100
16	100	-
12.5	75-100	60-80
10	60-80	-
4.75	35-55	35-55
2.4	20-35	20-38
0.6	10-20	6-18
0.075	2-8	2-8
Bitumen Content % by weight of total mixture.	5.5% ± 0.3% (5.2% - 5.8%)	5.2% ± 0.3% (4.9% - 5.5%)

The Contractor shall furnish samples of crushed coarse and fine mineral aggregate not less than 10 days prior to commencement of bitumen work for the approval of the Engineer. After approval of the aggregate, the Contractor shall propose job-mix formulae for the binder course, prepared on the basis of several placement trials, testing within the limits of Table 4.5-1 to obtain optimum quality. The job-mix formulae and samples shall be submitted to the Engineer for approval and possible changes in grading or bitumen contents or both.

Such adjustments shall be considered incidental to the work and allowed for in the tender prices.

4703 Materials

The materials shall conform to Section 4200 of this Specifications with the additional requirements noted below.

4704 Bituminous Materials

These materials shall conform to the requirements of Section 4200 or as Engineer may direct.

A sample of the bituminous material shall be furnished by the Contractor prior to establishing job-mix formula.

4705 Coarse Mineral Aggregate

The portion of the aggregate retained on the 5 mm sieve shall be known as coarse aggregate and shall be crushed stone, or crushed gravel, or blended combinations of both.

Crushed stone, and crushed gravel shall consist of clean, tough, durable material free from vegetable matter, soft particles, and other objectionable matter, and the abrasion resistance of coarse aggregates shall be measured by the Loss Angles Abrasion Test (AASHTO Designation T – 96). The maximum allowable abrasion loss for bituminous premix coarse aggregate shall be 30% by weight.

When crushed gravel is used, not less than 75% by weight of the particles retained on a 5 mm sieve shall have at least two fractured faces.

Water absorption shall be not greater than 2%.

Bulk specific gravity shall be not less than 2.50.

The flakiness index as determined in accordance with STP T7.1.3 shall not exceed 30%.

Weight loss shall be not more than 12% when subjected to 5 alternations of the sodium sulphate soundness test, AASHTO: T.104

4706 Fine Mineral Aggregate

The portion of the aggregate passing a 5 mm sieve shall be known as fine mineral aggregate, and shall consist of natural sand, stone screenings, or a combination of both. Fine aggregate shall be composed of clean, hard durable particles, rough surfaced and angular, free from vegetable matter, soft particles, clay balls or other objectionable material.

The PI for material passing the 0.425 mm sieve shall be less than 4.

4707 Mixture

The Contractor shall carry out regular checks at frequency to be determined by the Engineer on the composition of the mixed material and shall submit results to the Engineer within 3 days of sampling.

4708 Construction Methods **General**

A prime coat shall be applied to the surface of the granular base material in accordance with Section 4300 before spreading the bituminous carpet.

A tack coat shall be applied to an existing bituminous surface in accordance with section 4.2 before spreading the bituminous carpet.

Construction methods shall conform to the general requirements of Section 4407 of this Specification subject to the following modifications.

The method described in the following paragraphs has been used successfully, and should form the basis of the method to be used by the contractor.

The Contractor shall submit his full method statement for the Engineer's approval, which shall be given in writing. No surfacing works will be permitted until such approval has been granted.

Prior to commencing contract surfacing the contractor is required to bring his labour, plant, equipment and materials to site. Using the information on mix design agreed with the Engineer, short, half width (3.75m), trials of approximately 10 metres length shall be carried out to demonstrate to the contractor, his labour force and the supervision staff exactly what is required to produce the quality of works specified. The trials will also be used to fine tune the mix design if required.

When the trials have satisfied the Engineer that the contractor and the laying staff understand, and can apply the specification correctly to the works, the Method Statement is filled in and signed by the contractor. Only then are contract works permitted to commence.

It is expected that method statements will be approved after only one short trial, although trials will continue until the Engineer is satisfied that the Contractor will produce quality work on a consistent basis. If the trial works are suitable, they may be accepted in the contract works. If the trial work has to be rejected, they can be permitted to remain in the works until replacement near the end of the contract, so that unspecified work can be monitored and used to demonstrate to other contractors and supervision staff the defects that will manifest themselves if work is carried out using unspecified materials, workmanship or methodology.

The Contractor shall furnish a thermometer at each mixing unit to ensure that temperature of bitumen mineral aggregates and bituminous mixture shall be within the specified ranges stipulated in 47.. through 47....

4709 Preparation of Bituminous Material

Bitumen shall be heated to a temperature between 121°C and 163°C. This must be carried out in a tar boiler/mini asphalt plant. Locally produced, wood fired boilers are satisfactory, and at the ambient temperatures experienced in Bangladesh the 80/100 penetration grade bitumen required under the specification can be poured (albeit slowly) into the tar boiler. When the boiler is approximately 30% full the fire box is filled with wood and the wood ignited. In practice the boilers are generally kept over 50% full during operation by allowing up to two drums of bitumen to drain down through a manhole, on top of the boiler, into the main heating tank at all times.

The temperature control at the boiler is critical to the success of this methodology. When the thermometer within the mass of bitumen in the main tank reaches 150°C the fire box must be emptied or the fire extinguished. The residual heat within the tar boiler will continue to heat the bitumen to the required maximum temperature of 163°C. When the temperature starts to drop below 155°C - 160°C the fire box should be refilled with wood and re-ignited as the temperature will soon fall below 150°C. The operation is repeated as the temperature again regains 150°C. With experience the operator can soon judge how much firewood is required to achieve and maintain the specified temperatures.

4710 Preparation of Mineral Aggregate

The contractor shall submit the material tests results of the crushed stone proposed for Bituminous carpeting, together with the proportion of each size of aggregate required to provide the optimum gradation and the quantity of each size required per batch. Gauging boxes shall be constructed to the required size which, when filled and struck off level, deliver the desired volume for that size of stone.

The stone is batched into a rectangular steel pan with handles at each corner and heated on top of a metal frame under which heating is provided by firewood and sawdust. The aggregates are continually raked to

ensure thorough mixing and even heating. The temperature of the aggregate at this stage is not critical provided it is above the maximum mixing temperature required by the specification. The pan and overheated aggregate is then transferred to an unheated frame where the raking continues until the aggregate temperature has reduced to the maximum temperature permitted in the specification (163°C).

4711 Preparation of Mixture

The heated bitumen is drawn off from the tar boiler, decanted into gauge tins and added to the aggregate in the pan on the unheated frame. As the two ingredients are at approximately the same temperature there is no risk of fire, overheating or the clouds of black smoke (indicating hot bitumen being applied to very hot aggregates) associated with other manual methods. The mixing is carried out on the unheated frame and, when satisfactorily completed, the pan is carried to the adjacent work head for placing.

The mixture shall after mixing be at a temperature within the absolute limits of 135°C and 163°C even for tolerances. The Contractor shall submit the measured temperatures for the Engineer's approval.

4712 Spreading and Compaction

To avoid traffic disruption, the spreading and compaction is carried out over half the road width only.

Unless the bituminous premix is laid directly onto a clean prime coat, a tack coat shall be applied in accordance with Section 4400 to the underlying surface prior to spreading the binder course.

The depth of the finished surfacing, and the density of the material after compaction, is controlled by using mild steel angles as side shutters (32 × 32 mm for a finished 25 mm surfacing, 50 × 50 mm for a finished 38 mm thick surfacing, and 65 × 65 mm for a finished 50 mm surfacing) and marking on the prime coat with chalk the area that each pan of mixed material should cover. The cross-fall or super elevation is controlled in a similar way using 32 mm rods for 25 mm surfacing and 50 × 6 mm steel plate for 38 mm thick surfacing, and 65 × 6 mm steel plate for 50 mm surfacing at intermediate points between the edge of the road and the crown of the road.

If the Contractor is using a 3.5 tonne vibrating roller the initial pass shall be with NO vibration. The side and intermediate shutters are then moved to their next location while the vibrating roller, with vibration ON, completes the compaction process. Trial and error will provide the information regarding the number of passes required without and with vibration for each type of roller used and relative to the thickness of the surfacing provided and the ambient temperature.

Static tandem steel wheel rollers will require trials to assess the number of passes to achieve full compaction. Compaction is generally achieved when all roller marks have been removed.

For regulation courses the thickness of a compacted layer shall not be less than twice the maximum grain size.

Rollers shall not be allowed to stand on newly laid material that may be deformed thereby. Sections of newly laid base course and binder course shall be kept clean prior to laying the surface course.

No traffic except in connection with laying the surface course shall be permitted on the prepared base course or binder course.

The mixture shall be compacted at a temperature within the absolute limits of 107°C and 135°C.

Unless the Engineer directs otherwise the seal coat specified in Section 4800 shall be applied immediately after laying of the carpet course and the seal coat and carpet course shall be rolled together. The combined thickness of the two layers shall not be less than the sum of the two specified layer thicknesses.

4713 Joints

The work shall be organized so that transverse joints only occur at specified positions (i.e. bridges etc.). Should other transverse joints be inevitable, the edges shall be cut vertically and painted with bitumen before continuing the pavement.

To attain a strong and even connection in the longitudinal direction, joints shall be pre-heated and painted with bitumen in front of the laying of the adjacent bitumen concrete lane.

4714 Edge Treatment

On 38 mm Bituminous Carpeting works the mix at the edge of the road may be open textured after compaction and chippings can be displaced by traffic during the initial maturing period (four to eight weeks). This will be overcome by placing a narrow strip of pea-gravel bitumen seal (approximately 75 mm wide) against the shoulder side steel angle prior to the placing of the Bituminous Carpeting. This, when compacted along with the Bituminous Carpeting, will provide a dense, true edge to the road and will minimize ragged edges.

4715 Protection of the Pavement

Sections of the newly finished work shall be protected from traffic of any kind until the mixture has cooled to approximately ambient air temperature. Traffic shall not normally be permitted on the newly laid surface less than 6 hours after completion of the pavement, except with the approval of the Engineer.

4716 Pavement Samples

The Contractor shall, after final rolling and before opening the surface to traffic, cut samples from the finished work for testing. Samples shall be cores with diameters of 100 or 150 mm as directed, and cut by an approved coring machine. Samples shall be taken of the mixture for the full depth of the course from the locations directed by the Engineer.

At least one sample for density and thickness measurement shall be taken for each 50 m of completed surfacing.

Samples for analysis and other tests shall be taken from the surfacing when the Engineer so directs and shall in any case be taken whenever a substantial change is made in the job-mix formula.

Where samples have been taken from the surface course, fresh material shall be placed, thoroughly compacted and finished to the satisfaction of the Engineer.

4717 Surface Texture

The surface finish of the finished surfacing shall be close and tight.

4718 Measurement

The quantity of bituminous carpeting measured for payment shall be the number of cubic metres completed to the width and thickness shown on the Drawings and accepted in the completed surfacing. Bitumen used in the mix shall be deemed to be included and shall not be measured separately irrespective of its quantity. No price adjustment shall be made in case the quantity of bitumen used becomes more or less because of change in job mix formula during the process of the works.

The bituminous carpeting shall be measured as the net dimensions of the top surface of each course and the Contractor will make allowance in this rates for additional material used for forming sloping edges and over spill.

4719 Payment

The quantities measured as provided above, shall be paid for at the Contract unit price per unit of measurement

respectively, for each of the particular items that is shown in the Bill of Quantities or on the Drawings. The prices and payments shall be full compensation for furnishing and placing all materials including all labour, equipment, tools, trails, preparation of job-mix formulas, testing, making good test holes, and incidentals necessary to complete the work.

Bitumen used in the mix shall be deemed to be included and shall not be paid separately

Pay items shall be:

Pay Item	Unit
47/1 Premix Bituminous Carpeting (Manual method)	Cum

4800: PREMIX BITUMINOUS SEAL COAT (MANUAL METHOD)

4801 Description

This work shall consist of a premix bituminous seal coat applied to newly laid binder course of the bituminous carpeting or a prepared and primed granular base course or existing bituminous surface in accordance with these Specifications, to the lines, levels, grades, dimensions and cross sections shown on the Drawings and as required by the Engineer. The thickness of the premix bituminous seal coat shall be 7 mm, 12 mm or 15 mm as directed.

The provisions of Section 4400, "BITUMINOUS PREMIX SURFACE COURSE" shall form a part of these Specifications except that the requirements for plant mixing and laying by paving machine may be relaxed provided the Contractor proposes and demonstrates effective alternative methods to the full satisfaction of the Engineer. Such methods shall take account of the total quantity of material to be mixed and laid within the stipulated programme. Any alternative methods shall only be employed after receipt of written approval from the Engineer. Such approval may be withdrawn at any time if the work is found to be unsatisfactory.

The Contractor shall submit the material tests together with the samples of aggregate and sand not less than 10 days prior to use of them for the approval of the Engineer. After approval of the aggregate and sand, the Contractor shall propose job-mix formulae for the seal coat, prepared on the basis of testing several aggregate grading within the limits of Table 4.6 -1 to obtain optimum quality. The job-mix formulae together with supporting tests results shall be submitted to the Engineer for approval and possible changes in grading. Such adjustments shall be considered incidental to the work and allowed for in the tender prices.

Table 4-16

Mix classification Course Compacted Thickness (mm)	1 Seal Coat 7	2 Seal Coat 12 or 15
Sieve Size (mm)	Total % by weight passing	
10	-	100
6.3	100	80-100
4.75	80-100	70-95
2.4	70-95	20-50
0.6	20-50	5-15
0.075	5-15	2-10

4802 Materials

General

The materials shall conform to Section 4001 of this Specification with the additional requirements noted below.

4803 Bituminous Materials

These materials shall conform to the requirements of Section 4002. The bituminous material shall be 60/70 or 80/100 penetration grade or as may be directed by the engineer.

A sample of the bituminous material shall be furnished by the Contractor prior to establishing job-mix formula.

4804 Mineral Aggregate

Aggregates shall consist of 6.3mm or 10mm down graded pea gravel free from any organic matter, clay and any other objectionable matter.

Where required to achieve the specified grading the aggregate shall be mixed with natural sand. Sand shall be non-plastic, clean and free from any deleterious substances. The minimum FM of sand for the sealing premix shall be between 2.00 to 2.50 and that of sand to be spread over the seal coat as blotting material shall be between 0.80 to 1.00.

The mix of the aggregates and sand combined shall comply with the following grading given in Table 4.6 -1.

4805 Mixture

The Contractor shall carry out regular checks at frequency to be determined by the Engineer on the composition of the mixed material and shall submit results to the Engineer within 3 days of sampling.

4806 Construction Methods

General

A prime coat shall be applied to a surface of granular base material, or a tack coat to an existing bituminous surface, in accordance with Section 4400 before spreading the premixed seal coat.

Construction methods shall conform to the general requirements of Section 4407 of this Specifications subject to the following modifications..

The method described in the following paragraphs has been used successfully, and should form the basis of the method to be used by the contractor.

The Contractor shall submit his full method statement for the Engineer's approval, which shall be given in writing. No surfacing works will be permitted until such approval has been granted.

Prior to commencing contract surfacing the contractor is required to bring his labour, plant, equipment and materials to site. Using the information on mix design agreed with the Engineer, short, half width (3.75m), trials of approximately 10 metres length shall be carried out to demonstrate to the contractor, his labour force and the supervision staff exactly what is required to produce the quality of works specified. The trials will also be used to fine tune the mix design if required.

When the trials have satisfied the Engineer that the contractor and the laying staff understand, and can apply the specification correctly to the works, the Method Statement is filled in and signed by the contractor. Only then are contract works permitted to commence.

It is expected that method statements will be approved after only one short trial, although trials will continue until the Engineer is satisfied that the Contractor will produce quality work on a consistent basis. If the trial works are suitable, they may be accepted in the contract works. If the trial work has to be rejected, they can be permitted to remain in the works until replacement near the end of the contract, so that unspecified work can be monitored and used to demonstrate to other contractors and supervision staff the defects that will manifest themselves if work is carried out using unspecified materials, workmanship or methodology.

The Contractor shall furnish a thermometer at each mixing unit to ensure that temperature of bitumen, mineral aggregates and bituminous mixture shall be within the specified ranges stipulated in 4.6.3.2 through 4.6.3.5.

4807 Preparation of Bituminous Material

Bitumen shall be heated to a temperature between 121°C and 163°C. This must be carried out in a tar boiler. Locally produced, wood fired boilers are satisfactory, and at the ambient temperatures experienced in Bangladesh the 80/100 penetration grade bitumen required under the specification can be poured (albeit slowly) into the tar boiler. When the boiler is approximately 30% full the fire box is filled with wood and the wood ignited. In practice the boilers are generally kept over 50% full during operation by allowing up to two drums of bitumen to drain down through a manhole, on top of the boiler, into the main heating tank at all times.

The temperature control at the boiler is critical to the success of this methodology. When the thermometer within the mass of bitumen in the main tank reaches 150°C the fire box must be emptied or the fire extinguished. The residual heat within the tar boiler will continue to heat the bitumen to the required maximum temperature of 163°C. When the temperature starts to drop below 155°C - 160°C the fire box should be refilled with wood and re-ignited as the temperature will soon fall below 150°C. The operation is repeated as the temperature again regains 150°C. With experience the operator can soon judge how much firewood is required to achieve and maintain the specified temperatures.

4808 Preparation of Mineral Aggregate

The contractor shall submit the materials tests results of the pea gravel and sand proposed for seal coat, together with the proportion of each required to provide the optimum gradation and the quantity of each size required per batch. Gauging boxes shall be constructed to the required size which, when filled and struck off level, deliver the desired volume for that size of stone.

The pea gravel and sand are batched into a rectangular steel pan with handles at each corner and heated on top of a metal frame under which heating is provided by firewood and sawdust. The mixture is continually raked to ensure thorough mixing and even heating. The temperature of the mixture at this stage is not critical provided it is above the maximum mixing temperature required by the specification. The pan and overheated mixture is then transferred to an unheated frame where the raking continues until the mixture temperature has reduced to the maximum temperature permitted in the specification (163°C).

4809 Preparation of Premix Seal Coat

The mixture shall after mixing be at a temperature within the absolute limits of 135°C and 163°C even for tolerances. The Contractor shall submit the measured temperatures for the Engineer's approval.

4810 Spreading and Compaction

To avoid traffic disruption, the spreading and compaction is carried out over half the road width only.

The mixed bituminous seal coat shall be placed and spread over the granular base course or bituminous carpeting to a uniform thickness which shall be a minimum of 25% greater than the specified compacted thickness, and immediately compacted fully with a power driven road roller to the satisfaction of the Engineer.

Static tandem steel wheel rollers will require trials to assess the number of passes to achieve full compaction. Compaction is generally achieved when all roller marks have been removed.

Rollers shall not be allowed to stand on newly laid material that may be deformed thereby. Sections of newly laid base course and binder course shall be kept clean prior to laying the surface course.

The mixture shall be compacted at a temperature within the absolute limits of 107°C and 135°C.

Unless the Engineer directs otherwise the seal coat where specified shall be applied immediately after laying of the bituminous carpeting and the seal coat and bituminous carpeting shall be rolled together. The combined thickness of the two layers shall not be less than the sum of the two specified layer thicknesses.

4811 Joints

The work shall be organized so that transverse joints only occur at specified positions (i.e. bridges etc.). Should other transverse joints be inevitable, the edges shall be cut vertically and painted with bitumen before continuing the pavement.

To attain a strong and even connection in the longitudinal direction, joints shall be pre-heated and painted with bitumen in front of the laying of the adjacent bitumen concrete lane.

4812 Edge Treatment

4813 Protection of the Pavement

Sections of the newly finished work shall be protected from traffic of any kind until the mixture has cooled to approximately ambient air temperature. Traffic shall not normally be permitted on the newly laid surface less than 6 hours after completion of the pavement, except with the approval of the Engineer.

Pavement Samples

The Contractor shall, after final rolling and before opening the surface to traffic, cut samples from the finished work for testing. Samples shall be cores with diameters of 100 or 150 mm as directed, and cut by an approved coring machine. Samples shall be taken of the mixture for the full depth of the course from the locations directed by the Engineer.

At least one sample for density and thickness measurement shall be taken for each 50 m of completed surfacing.

Samples for analysis and other tests shall be taken from the surfacing when the Engineer so directs and shall in any case be taken whenever a substantial change is made in the job-mix formula.

Where samples have been taken from the surface course, fresh material shall be placed, thoroughly compacted and finished to the satisfaction of the Engineer.

4814 Surface Texture

The surface finish of the finished surfacing shall be close and tight.

4815 Measurement

The quantity of bituminous seal coat measured for payment shall be the number of square meters completed to the thickness shown on the Drawings or as directed by the Engineer and accepted in the completed surfacing. Bitumen used in the mix shall be deemed to be included and shall not be measured separately irrespective of its quantity. No price adjustment shall be made in case the quantity of bitumen used becomes more or less because of change in job mix formula during the process of the works.

4816 Payment

The quantities measured as provided above, shall be paid for at the Contract unit price per unit of measurement respectively, for each of the particular items that is shown in the Bill of Quantities or on the Drawings. The prices and payments shall be full compensation for furnishing and placing all materials including all labour equipment, tools, trails, preparation of job-mix formulas, testing, making good test holes, and incidentals necessary to complete the work.

Pay items shall be:

Item	Unit
48/1 7mm Compacted Premix Bituminous Seal Coat	Sq.m
48/2 12mm Compacted Premix Bituminous Seal Coat	Sq.m
48/3 15mm Compacted Premix Bituminous Seal Coat	Sq.m

TECHNICAL SPECIFICATION

SERIES 5000

MISCELLANEOUS WORKS

TECHNICAL SPECIFICATION
SERIES 5000 - MISCELLANEOUS WORKS

TABLE OF CONTENTS

<u>Item Number</u>	<u>Page</u>
5000 GENERAL	5 - 3
5100 Pitching and stone work	5 - 3
5101 Scope	5 - 3
5102 Materials	5 - 3
5103 Stone Pitching	5 - 3
5104 Riprap	5 - 4
5105 Stone Masonry Walls	5 - 4
5106 Measurement and payment	5 - 5
5200 Kerbs and foot path	5 - 6
5201 Concrete Kerbs and Footways	5 - 6
5202 Concrete Kerbs and Footway	5 - 6
5203 Method of Measurement	5 - 8
5204 Basis of Payment	5 - 8
5300 Road Signs and Road Appurtenance	5 - 8
5301 Description	5 - 8
5302 Sizes and Colours	5 - 8
5303 Fabrication of Signs	5 - 8
5304 Erection of Signs	5 - 9
5305 Method of Measurement	5 - 9
5306 Basis of Payment	5 - 9
5307 KILOMETRE POSTS	5 - 10
5308 Letters and Figures	5 - 10
5309 Erection	5 - 10
5310 Method of Measurement	5 - 10
5311 Basis of payment	5 - 10
5312 CONCRETE GUARD POSTS	5 - 11
5313 Materials	5 - 11
5314 Construction Methods	5 - 11
5315 Measurements	5 - 11
5316 Payment	5 - 11
5400 PAVEMENT MARKING	5 - 11
5401 Description	5 - 11
5402 Materials	5 - 11
5403 Longitudinal Lines	5 - 12
5404 Transverse Lines	5 - 13
5405 Pavement Lettering and Symbols	5 - 13
5406 Method of Measurement	5 - 13
5407 Basis of Payment	5 - 13

5500	BRICK AND BRICKWORK	5 - 14
5501	General	5 - 13
5502	Sampling	5 - 13
5503	Dimension	5 - 13
5504	Appearance	5 - 14
5505	Unit Weight	5 - 14
5506	Crushing Strength	5 - 14
5507	Water Absorption	5 - 14
5508	Bricks for Brick Masonry Construction	5 - 15
5509	Bricks Face work Fixed to concrete	5 - 15
5600	Gabions	5 - 16
5601	Scope	5 - 16
5602	Materials	5 - 16
5603	Forming the Gabion Cages	5 - 17
5604	Construction of Gabions	5 - 18
5605	Measurement and Payment	5 - 18
5700	Sub Grade Drains	5 - 19
5701	General	5 - 9
5702	Materials	5 - 19
5703	Construction Methods	5 - 20
5704	Measurement	5 - 20
5705	Payment	5 - 20
5800	Tree Plantation	5 - 20
5801	Scope	5 - 20
5802	Construction Method	5 - 20
5803	Measurement and Payment	5 - 21
5900	Road side Drainages - Lined	5 - 21
5901	Scope	5 - 21
5902	Materials	5 - 21
5903	Preparation of Sand Bedding	5 - 21
5904	Plastering side Drain in Cement Mortar	5 - 21
5905	Net Cement Finishing	5 - 21
5906	Backfilling	5 - 21
5907	Pre- Cast Concrete side Drains	5 - 21
5908	Placing side drains	5 - 21
5909	Measurement	5 - 22

5000 General

5100: Pitching and Stonework

5101 Scope

This section covers the furnishing of materials and construction of a protective covering in stone pitching, or cast in situ concrete pitching on exposed surfaces such as earth slopes, drains and stream beds, as well as heavier protection in the form of riprap and stone masonry retaining walls all as shown on the Drawings or ordered by the Engineer.

5102 Materials

Stone

Stone for pitching and masonry shall be sound, tough and durable, with no stone less than 200 mm in minimum dimension, except that smaller pieces or spells may be used for filling spaces between the larger stones. Rocks or stone shall be of such a shape as to form a stable protection structure of the required section. Rounded boulders or cobbles shall not be used on slopes steeper than 2:1 unless grouted. All stone intended for use on any particular pitching or masonry job shall receive the prior approval of the Engineer.

Stone for riprap shall be hard field or quarry stone not susceptible to disintegration or excessive weathering on exposure to the atmosphere or water. It shall be free from soft material such as sand, clay, shale or organic material and shall not contain an excessive amount of elongated stone. The required size of stone will be determined by the "critical mass" specified. At least 50% of the material comprising the riprap shall consist of stones having a mass heavier than the critical mass and not more than 10% by mass of the material shall consist of stone having a mass of less than 10% of the critical mass or more than 5 times the critical mass.

Cement

Cement shall be ordinary Portland cement complying with the requirements of BS 12 Part 2.

Sand

Sand for the cement mortar shall comply with the requirements of BS 882.

Concrete

Concrete works shall be carried out in accordance with the provisions of Section 7300.

5103 STONE PITCHING

a) Plain stone pitching

The area shall be prepared by excavating, shaping and trimming to accommodate the stone work and shall be thoroughly compacted by hand-ramming to minimize subsequent settlement. A trench shall be excavated as directed by the Engineer along the toe of any slope to be pitched or along the unprotected edge of the pitching in the beds of stream.

Commencing at the bottom of the trench, the stone shall be laid and firmly bedded into the slope and against adjoining stones. The stones shall be laid with their longitudinal axes at right angles to the slope and with their surfaces in contact so as to break joint. The stones shall be well rammed into the bank or surface to be protected and the spaces between the larger stones shall be filled with fragments of approved pitching stone securely rammed into place. Placing of rock by dumping shall not be allowed.

The finished surface of the pitching shall present an even, tight and neat appearance with no stones varying by more than 25 mm from specified surface grades or lines. The thickness of the pitching, measured at right

angles to the surface, shall not be less than 200 mm, or as indicated on the drawings.

b) Grouted stone pitching

This work shall be done in accordance with all the requirements specified for plain pitching described above, except that the spaces between the stones shall be filled with cement mortar composed of one part of cement to three parts of sand. Before the mortar is applied the surfaces of the stones shall be thoroughly cleaned of adhering dirt and clay then moistened.

The mortar shall be placed in a continuous operation for any day's run at any one location. The mortar shall be worked into the pitching so as to ensure that all spaces or voids between the stones are completely filled with mortar, and to the depth of stone pitching. After the grout has been placed, the stones shall be thoroughly brushed so that their top surfaces are exposed. The grouted pitching shall be cured for a period of not less than four days after grouting with wet sacking or other approved wet cover, and shall not be subjected to loading until adequate strength has been developed. Where required, weep holes shall be formed in the pitching.

5104 Riprap

Riprap shall consist of a course or courses of large rock placed on bank slopes and toes, river and stream beds and other localities where protection of this type may be required. Two types of riprap are specified, one type where the rocks are individually packed, designated as packed riprap and another type where the stone is dumped and then spread by machines, designated as dumped riprap.

The surface of areas to receive riprap shall be neatly trimmed to line and level and all loose material compacted. The perimeters of riprap shall be protected by the construction of either rock-filled trenches, walls or other structures as may be required. Perimeter trenches shall normally be backfilled with rock of the same size and quality as used in the construction of the riprap it adjoins but any cavities shall be filled with smaller material and the whole backfill well consolidated.

5105 Stone Masonry Walls

Stone masonry walls may be plain with dry joints or constructed with stones set in cement mortar as indicated on the Drawings, specified or ordered. The minimum mass of stone shall be 10 kg. The minimum dimension of stone shall be 75 mm.

Plain stone masonry walls

A foundation trench shall be excavated down to rock, or to material of adequate bearing capacity at a minimum depth of 300 mm below ground level. Large selected stones shall be laid with the largest dimension in the horizontal plane. Stones shall be individually placed to break joints and to provide a minimum of voids, and shall be firmly bedded against adjoining stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The larger stones shall not bear on the spalls used to fill the voids. The top and ends of the wall shall be neatly finished with selected coping stones. The resulting appearance of the wall shall present an even, tight surface.

Cement mortared stone masonry walls

The walling shall be constructed as for plain walls above, with the exception that the stones shall be wetted and set in a 3:1 sand: cement mortar. Exposed stones on the wall faces shall be cleaned of mortar by washing or wire brushing. The mortar shall be flush pointed to the approval of the Engineer who may require a capping and end treatment in the same mortar. Weep holes shall be provided as ordered and shall be cleaned of mortar and any other clogging material that may have entered during construction. The walling shall be protected from the elements and kept moist for a minimum period of four days after completion.

5106 MEASUREMENT AND PAYMENT

Pat Item	Unit
----------	------

Stone Pitching:

51/1	Plain pitching.....	Sq.m
51/2	Grouted pitching.....	Sq.m

The unit of measurement for pitching shall be the square metre of each type of pitching in place.

The tendered rate for each type of stone pitching shall include full compensation for furnishing all materials, excavations excluding trench and bulk excavations, compaction and trimming of excavated areas, forming and cleaning of weepholes, placing of stones, grouting where applicable; and for all other work necessary to complete the pitching as specified.

Excavations for foundation trenches and edge beams and the construction of edge beams will be paid for separately.

Pay Item	Unit
----------	------

Riprap

51/3	Packed riprap (Critical mass of stone indicated).....	Cum
51/4	Dumped riprap (critical mass of stone indicated)....	Cum

The unit of measurement for riprap shall be the cubic metre of riprap in place including rock in trench backfill.

The rates tendered shall include full compensation for the preparation of surfaces, including excavation but excluding excavation for trenches and bulk excavations and for the furnishing, transporting, handling and placing of riprap. Collectively the rates shall also include full compensation for all other incidentals necessary for completing the work as specified.

Pay Item	Unit
----------	------

Stone masonry walls:

51/5	Plain.....	Cum
51/6	Cement-mortared.....	Cum

The unit of measurement for stone masonry walls shall be the cubic metre of actual walling constructed and accepted.

The tendered rate for each type shall include full compensation for furnishing all materials, trimming of areas, placing of stones and cement-mortar where necessary and all other work necessary to complete the walls as specified. Excavation of foundation trenches will be paid separately.

5200 KERBS AND FOOTWAYS

5201 Description

This item shall consist of cement rendered brick kerb, concrete cast-in-place or precast kerb, combination of kerb and gutter, header kerb and/or footway composed of Portland cement concrete or other approved material constructed in accordance with these Specifications at the location and to the dimensions, lines and grades shown on the Drawings. The concrete shall be composed of coarse aggregate, fine aggregate, Portland cement and water in accordance with the Specifications for concrete given herein. The brickwork shall comply with the Specifications given herein for brickwork structures.

5202 Concrete Kerbs and Footway

a) Description

This item shall consist of concrete kerb or kerb and gutter as specified herein and shown on the Drawings. Kerbs may be precast or in-situ concrete at the Contractor's choice and with the approval of the Engineer.

b) Precast Concrete Sections

Unless otherwise described in the Contract, or approved by the Engineer, precast concrete slabs or precast concrete flags shall be hydraulically pressed or cast in such other manner as is approved by the Engineer. The flags shall be about 63 mm thick and except where cutting is necessary, of a uniform width of about 650 mm, a minimum length of 500 mm and maximum length of 900 mm.

Precast concrete sections shall be constructed of Class C structural concrete as provided in Section 6.02 except as otherwise specified herein or approved by the Engineer.

Precast concrete kerbs, edging and quadrants shall comply with and shall be laid and bedded in a layer of mortar not less than 12 mm and not more than 40 mm thick laid on 150 mm Class E concrete foundation or alternatively on pavement base course at least 150 thick. Kerbs shall be backed with Class E concrete.

Any unit of kerb, channel edging and quadrant deviating more than 4 mm in 2 m from line and level shall be made good by lifting and relaying.

c) In-situ Concrete Kerbs

In-situ concrete kerbs shall be laid by approved methods. The kerbs shall be dense with regular sides, arises and chamfers finished to a fine surface free from blow holes and dragging and to dimensions described in the Contract. The kerbs shall be formed in concrete Class C structural concrete as specified in Section 6.02.

Kerbs shall be cut whilst the concrete is green to form expansion joints and contraction joints at not more than 3 m centres and the cut shall be grooved with a 3 mm radius grooving tool.

Expansion joints shall be filled and sealed with materials complying with the requirements of the Engineer for expansion joint filler in such cases.

The vertical alignment of the finished kerb shall not depart from the true level more than ± 6 mm and, at any point, the maximum deviation of the top of the kerb under a straight edge shall be not greater than 4 mm in 2 m.

The horizontal alignment shall not depart from that shown in the contract by comply with the requirements given herein above for precast sections and shall be laid in conformity therewith except as otherwise specified herein.

d) Footways (Concrete Paved)

Precast concrete flags (slabs) for footway sidewalks or footpaths shall comply with the requirements given

herein above for precast sections and shall be laid in conformity therewith except as otherwise specified herein.

Flags shall be laid to the required cross falls, unless otherwise specified, with a 3% downgrade in the direction away from the road centreline, and bedded using 5 parts of cement mortar not less than 150 mm in diameter for each slab. The flags shall be laid to a 150 mm minimum bond or as described in the Contract with joints at right angles to the kerb.

On circular work where the radius is 12 metres or less all flags shall be radially cut on both edges to the required line.

Concrete or concrete footway and steps shall be Class C in accordance with the Specifications except as otherwise specified herein below or approved by the Engineer.

Forms for concrete footway cast in place shall be of wood not less than 50 mm nominal thickness or of steel of equal rigidity. Flexible strips shall be used on curves. The form shall be securely held to line and grade and shall at no time deviate more than 6 mm from an accurate template 30 m in length. Forms shall be cleaned and oiled after each use.

Transverse expansion joints shall be 6 mm to 10 mm wide and shall be placed in such manner that the joint will be filled to within 12 mm of the surface of the walk and shall be constructed at intervals of not more than 8 metres, unless otherwise ordered by the Engineer. They shall be placed at the grooved division line and shall be truly normal to the grade. Wherever concrete footway abuts other walks, steps, kerbs, manholes, catch basins, or adjacent building foundations, expansion joints 12 mm thick or joint composed of two thicknesses of 6 mm material shall be provided. At the expansion end of a bridge, an approach walk shall be effectively separated. All concrete shall be cleaned from the top of the pre-moulded joints.

Footway and steps shall be placed and finished by the following methods.

The base course shall be adequately moistened just before the concrete is placed. The concrete shall be deposited and compacted in a single layer to the thickness indicated on the Drawings and the minimum layer thickness shall be 75 mm. It shall be struck off with a template and smoothed with a float to produce a sandy texture. The edge shall be rounded to 6 mm radius.

The surfaces of footway shall be divided into blocks by the use of a grooving tool. The grooves shall be spaced equally at approximately 2 metre intervals to form rectangular blocks, unless otherwise ordered by the Engineer. Grooves in the surface of footway reinforced for beam action shall not be placed where the full thickness of concrete is required for strength. During the setting and before the removal of forms, no loading shall be placed upon the concrete. Footway forms shall not be removed within 24 hours after the concrete is placed. Immediately after the forms are removed any concrete that is unsatisfactory in appearance or density shall be replaced or repaired in a manner that is satisfactory to the Engineer.

Treads of steps shall be finished to produce a sandy texture. The forms on faces of steps or integral walls which will be exposed to view shall be removed as soon as the concrete is hardened sufficiently that it will not be injured, in order to facilitate surface finishing. Any small cavities or openings in the surface shall be neatly painted with cement mortar of the same proportions as used in the original mixture. All exposed surfaces of integral walls and steps, except treads, shall be rubbed with a float until all projections and form marks are removed. The material which, in the above process, is being ground to paste, shall then be brushed "thinly and uniformly over the entire surface and allowed to reset.

Within 15 days from this time, the final finish shall be attained by a thorough rubbing with a fine silicon carbide or other equally good abrasive. The rubbing, using clear water, shall continue until the entire surface is of a smooth texture and uniform colour.

No heavy loads shall be permitted on the footway or steps at any time. Concrete footway and steps shall be protected, cured and opened for use as specified herein under Part 7, Concrete Construction.

5203 Method of Measurement

The length to be paid for kerb shall be the measured linear metres of each type of concrete or brick kerb measured along the back of the kerb.

The area of footway to be paid for shall be the actual number of square metres of footway of the specified thickness, in place, completed and accepted.

5204 Basis of Payment

Payment will be made at the Contract Unit Price for the items listed below which are shown in the Bill of Quantities.

<u>Pay Item</u>	<u>Unit</u>
52/1 – Pre-cast Concrete Footway	sq.m.
52/2 - In-situ Concrete Footway	sq.m.
52/3 - Concrete Kerb Type A	lin m
52/4 - Concrete Kerb Type B	lin m

Payment shall constitute full compensation for necessary excavation and backfill, the removal and disposal of all surplus excavation and discarded material, furnishing, preparing and placing all material, including expansion joints, cement, reinforcing steel, sub grade material, drainage outlet for sub grade material, and for all labor, equipment, tools and incidentals necessary to complete this item.

Where kerb or combination kerb and gutter is used to form medians or islands, the cost of backfilling of earth inside the medians or island with falls to the top of the kerb and the furnishing and placing of drainage pipe through the kerb and median is included in the price per metre bid under the respective bid items above.

5300: Road Signs and Road Appurtenance

5301 Description

This item shall consists of the provision and installation of road signs of approved material constructed in accordance with these Specifications and fixed at the location and to the dimensions and lines shown on the Engineering Drawings or as directed.

The item shall not include project signs, temporary signs and barricades installed in accordance with Part 1 of these Specifications for Provision for Traffic except in so far as the requirements for such temporary signs and barricades specifically require.

5302 Sizes and Colours

All signs shall be the sizes, colours and shapes shown on the Drawings and as directed.

5303 Fabrication of Signs

Sign supports shall be fabricated of mild steel and the posts shall be retained in the ground with concrete Class E, using steel and concrete as specified in these Specifications, and as shown on the Drawings. Signboards shall be fabricated from aluminium sheet of thickness not less than 10 gauge.

Tubular steel supports shall be a minimum of 70 mm outside diameter or as required to resist wind loads of 2.5 kPa with only minor deflections and shall be galvanized.

Cleaning and finishing shall conform generally to BS 7079. The top two coats of paint shall be horizontal black and white strips commencing with black at ground level.

Sign faces shall be braced with aluminium sections affixed to sign with suitable rivets as necessary and shall be firmly fixed to the support and prevented from rotating.

The Contractor shall provide detailed Drawings and load and stress calculations of the signs to be provided showing the fabrication of the sign faces and their connection to the supports. The sign face material shall be of "Plastic Sheeting". Plastic sheeting shall be Scotch lite High Intensity Grade Reflective Sheeting or equivalent. Reflective sheeting shall be fixed to the sign plate with heat activated adhesive using a heat vacuum applicator. The High Intensity Reflective Sheeting materials shall be applied on treated aluminium by heat vacuum treatment. The surface of the sheeting shall be smooth and flexible. Reflective materials shall have high durability under all weather conditions, heat and moisture.

The minimum retro reflective values will remain effective for its intended use and the stated minimum retro reflective value.

Minimum Coefficient of Retro reflection

Candle Per Sq.Ft. (.2 deg observation and -4 deg entrance)

Sheeting Colour	Coefficient of Retro reflection	Initial	Minimum after (7 Years)
White	250		200
Yellow	170		136
Red	45		36
Green	45		36
Blue	20		16

The expected service life of plastic sheeting should not be less than 5 years.

With his tender the Contractor shall indicate his proposed road sign, its manufacture, sign facing and Specifications.

At least sixty days before the erection of any sign the Contractor shall supply detailed Drawings and Specifications and a sample sign for the Engineers approval. The signs supplied and erected shall be equal to or better than the approved sample and shall conform to the drawing and Specification.

5304 Erection of signs

Signs shall be erected in the manner and at the locations and be of the types shown on the Drawings or as directed by the Engineer. Where the indicated position of a sign is obstructed, the sign shall be located as directed by the Engineer. The Contractor and the Engineer shall inspect all sign locations prior to erection. No payment will be made for relocating a sign erected without the Engineer's prior approval.

5305 Method of Measurement

Signs on a single post, shall be measured by the number of signs supplied, erected and accepted.

Signs supported on more than one post shall be measured by the area in square metres of the sign facing.

5306 Basis of Payment

Payment for each sign supported on a single post at the unit rate in the Bill-of-Quantities of item 5.3/1. "Road Signs on Single Posts" and for the measured face area of signs supported on more than one post at the unit rate per square metre in Item 5.3/2 "Road Signs on Multiple Supports".

Pay Item

Unit

53/1	Road Signs on Single Posts	each
53/2	Road Signs on Multiple Supports	sq.m.

Signs shall only be measured for payment after they are completed in place and accepted by the Engineer. Payment shall be full compensation for excavating foundations, supplying and placing concrete backfill, manufacture, design, supply and erection of signs including all labor, equipment and tools required to complete the work.

5307 Kilometre Posts

General

This item shall consist of the supply and erection of reinforced concrete kilometre posts as shown on the Drawings. The concrete and reinforcement shall be as specified for precast concrete.

If required, the kilometre posts shall be set in a concrete foundation as shown in the drawings.

5308 Letters and Figure

Letter and figures as directed shall be inset 5 mm deep in the face of the concrete pillar during casting or, for kilometre posts, in a plaster coating applied to the roughened surface of the precast concrete tablet, or as shown on the Drawings. For kilometre posts the letters and figures shall be painted black and the background shall be yellow, all in approved paint supplied in new sealed drums and from a reputable manufacturer.

5309 Erection

Posts shall be erected truly vertical to the depth shown and at the position marked on the Drawings and as directed.

Kilometre posts shall be erected in such a manner that, as the post is approached, the letters and figures seen on the visible face of the post will be those referring to the name of, and the distance to the town towards which the traveller is proceeding. No part of the post or foundation shall be closer to the edge of the pavement than 2.5 m.

5310 Method of Measurement

For kilometre posts the number of posts to be paid for shall be the actual number of posts installed, completed and accepted.

5311 Basis of Payment

The number of kilometre posts measured as described above shall be paid for at the contract unit rate for "Item 5.4/1 - Kilometre posts".

<u>Pay Item</u>	<u>Unit</u>
53/3 Kilometre Posts	each

Payment shall constitute full compensation for excavation and backfill, the removal and disposal of all surplus excavation material and discard material, furnishing preparing and placing all material including all concrete, mortar, paint, reinforcement, and for all labour, equipment, tools and incidentals necessary to complete the item.

5312 Concrete Guard Posts

General

This work shall consist of furnishing and installation of concrete guard posts as detailed on the drawings and at locations indicated on the drawings or as directed by the Engineer.

5313 Materials

Concrete guard posts shall be pre cast using concrete and reinforcement conforming to the requirements of specific Part of the specification. Paint, if indicated on the drawings, shall be of the appropriate type and colours and approval of the Engineer.

5314 Construction Methods

Construction, fabrication and installation of concrete guard posts shall be as shown on the drawings.

5315 Measurements

The quantity measured for payment shall be the actual number of concrete guard posts placed and accepted.

5316 Payment

This work measured as provided above shall be paid for at the contract rate for each concrete guard post. The price and payment shall be full compensation for the furnishing and placing, painting, including all materials, labour, equipment, tools and incidental necessary to complete the work.

The number of concrete guard posts made and installed shall be paid for at the contract unit rate of "Item 53/4- concrete guard posts."

<u>Pay Item</u>	<u>Unit</u>
53/4 Concrete guard post	each

5400 PAVEMENT MARKINGS

5401 Description

This item shall consist of the supply of materials for and the placing of all lines, symbols, patterns, work messages and numerals or other devices set in the surface of, applied upon or attached to the pavement or kerb for the purpose of regulating, warning or guiding traffic as specified herein, shown on the Drawing or instructed by the Engineer.

Lines shall be applied to mark the division of carriageway lanes and unless otherwise specified shall be 100 mm wide between lanes and 150 mm wide at the edges of lanes and as shown on the Drawings.

Islands, refuges, dead areas of pavement and tapers shall be marked as shown and as directed.

5402 Materials

All paints shall be road marking paint conforming to AASHTO M248 Type F and made by an approved manufacturer and suitable for application, by the means proposed, to the road surfaces laid by the Contractor. Samples of materials to be used shall be demonstrated to the Engineer at least 60 days before the first application. Once approved the paint supplied shall be equal to or better than the approved sample.

The markings shall, where shown on the Drawings or required by the Engineer, be non-reflectorised.

The drying time of the paint shall not exceed five (5) minutes.

The paint shall be applied evenly to the road surface at the thickness recommended by the manufacturer and not less than 0.3 mm. The finished work shall be true to line and have sharp edges.

White paint shall be coloured by not less than 48% pigment of which about 35% shall be titanium dioxide.

Yellow paint shall be coloured by not less than 48% of a suitable yellow pigment giving standard colour BS 381C No. 355 except where an alternative shade has been approved.

The paint shall be supplied fresh in sealed containers and shall be applied without thinners or other additives at the covering rate recommended by the manufacturer or as approved by the Engineer to give a clear, well formed solidly coloured line or mark.

5403 Longitudinal Lines

Separation and Barrier Line (Centre line)

Separation and barrier lines shall be used to define the portion of roadway to be used by opposing streams of traffic. The separation line shall be a single broken line. The width of the line shall be 100 mm. The length of breaks and length of line shall be as shown on the Drawings or as directed. The barrier line shall be a combination of two lines, one broken and one continuous or both continuous. Unless otherwise specified, the barrier line (no crossing) shall consist of two continuous lines. The width of each line shall be 100 mm and the clear separation between lines shall be 100 mm. The broken line shall be formed as specified for separation line and is to indicate that the barrier line may be crossed from that side only.

The middle of the line width or the middle of the line spacing in case of two lines shall coincide with the middle of the roadway width unless otherwise specified or approved by the Engineer.

Lane Line

Lane lines indicate those portions of the travelled roadway assigned to single lanes of traffic.

The lane line shall be 100 mm wide and shall be as specified herein above for separation lines unless otherwise directed by the Engineer.

Transition Line

Transition line shall be 100 mm wide and shall be as specified for separation lines unless otherwise approved.

Turning and Continuity Lines

Turning and continuity lines shall be 800 mm long dash lines 100 mm wide with 1500 mm between them but otherwise shall comply with the requirements for separation lines unless otherwise approved.

Edge Lines

Edge lines shall be 150 mm wide continuous lines marking the outer edge of the carriageway.

5404 Transverse Line

Stop Line

Stop line shall be a continuous line extending the full width of a lane.

Pedestrian Crossings

The marking shall comprise white stripes each up to 4 metres long and 600 mm wide with a 600 mm gap in between stripes. The markings shall be parallel to the centre line of the roadway or 45° to the centre line as directed by the Engineer.

5405 Pavement Lettering and Symbols

The types and dimensions of lettering and symbols shall comply in all respects with that specified or shown on the Drawings or approved by the Engineer.

5406 Method of Measurement

The area of a pavement marking to be paid for shall be that area, being the product of the specified width of each line and the specified centre line length thereof, actually installed in accordance with these Specifications and the Drawings and as directed, finished in place, completed and accepted. The measurement of irregular areas shall be as directed by the Engineer.

5407 Basis of Payment

Payment shall be at the contract unit price for the items listed below which are shown in the bill of quantities.

<u>Pay Item</u>	<u>Unit</u>
54/1 - Road Marking, Reflectorised	sq. m.
54/2 - Road Marking, Non Reflectorised	sq. m.

Payment shall be full compensation for furnishing all labour, materials, equipment and incidentals and for doing all work necessary to prepare the road surface and to paint pavement marking onto the roads at the locations shown on the Drawings and as specified herein or directed by the Engineer and including making good or repainting those areas where the surfacing peels or loses balloting and is deficient in appearance.

5500 BRICK AND BRICKWORK

5501 General

This section specifies whole bricks for use in the Works and specifies brickwork construction using whole bricks and mortar.

5502 Sampling

Whole bricks shall be sampled in accordance with standard test procedures. Samples thus collected will be tested for crushing strength, unit weight and water absorption. Samples shall be collected from each batch of 10,000 bricks supplied.

5503 Dimension

First Class Bricks should have the following dimensions after burning: 250 mm x 120 mm x 70 mm. Picked Jhama (PJ) Bricks may have dimensions slightly below those for other brick but not less than 235 mm x 110 mm x 70 mm.

5504 Appearance

Bricks shall be uniform in size and colour and shall have a clear metallic sound when struck. They should have an even surface without cracks. When scratched by steel nails these should leave no permanent mark on the surface.

5505 Unit Weight

Bricks shall be broken by hand or machine to the sizes shown below in order to determine the unit weight.

Sieve Sizes (mm)		Percentage of Sample	Min. Weight Reqd. Grams
Passing	Retained		
38	25	25	1500
25	19	25	1500
19	12.5	25	1500
12.5	9.5	25	1500

The unit mass shall determined in accordance with Standard Test Procedures Test 7.3 (Compacted).

The unit mass of First Class bricks shall be not less than 1100 kg/cu.m.

The unit mass of Picked Jhama bricks shall not less than 1200 kg/cu.m.

5506 Crushing Strength

The crushing strength of bricks shall be tested in accordance with Standard Test Procedures Test 7.9.

The average crushing strength of First Class bricks shall be not less than 17 MPa.

The average crushing strength of Picked Jhama bricks shall be not less than 20 MPa.

5507 Water Absorption

Bricks shall be broken by hand or machine to the sizes shown below in order to determine the water absorption.

Table 5-1

Sieve Sizes (mm)		Percentage of sample	Min. Weight Reqd. Grams
Passing	Retained		
38	25	25	750
25	19	25	750
19	12.5	25	750
12.5	9.5	25	750

The water absorption shall be determined in accordance with Standard Test Procedures Test 7.2 for Material between 38 mm and 10 mm.

The water absorption as a percentage of the dry weight shall not exceed 20% for First Class bricks.

The water absorption as a percentage of the dry weight shall not exceed 15% for Picked Jhama bricks.

5508 Bricks for Brick Masonry construction

Only First Class bricks shall be used in brick masonry construction.

Bricks shall be laid to the specified bond or as directed on a full bed of the mortar described in the contract and single frogged bricks shall be laid with the frog uppermost. Perpend between bricks shall be filled with mortar before the next mortar bed is laid. Whole bricks shall be used except where necessary for closers or where expressly authorized. Exposed joints shall be treated as specified herein below. Brickwork shall be built uniformly; corners and other advanced work shall be racked back and not raised above the general level more

than one metre. Courses shall be kept horizontal and matching perpends shall be in vertical alignment.

Unless agreed by the Engineer, overhead work shall not be permitted.

Immediately after laying and for 3 days thereafter, brick work shall be protected against harmful effects of weather. The upper surface of newly laid brickwork shall continue to be protected against rain as the work proceeds by covering with approved waterproof sheets until such time as the brickwork is completed and the upper damp course, coping or other finishing feature is laid.

All visible brickwork and any surface below the brickwork which is visible at the completion of the Works shall be clean and free from damage. All purpose made open joints shall be free from debris of any description.

Fabric reinforcement shall be completely embedded in the mortar joint if specified.

Brick reinforcement shall be completely embedded in the mortar joints, shall be sufficiently thick to prevent stone-to-stone or brick contact and shall be completely filled with mortar.

The joints shall be raked out to a depth of 12 mm and after the completion of the entire face work, pointed in weather struck cement mortar as described in the Contract. All joints shall be pointed except where otherwise specified or approved.

The mortar for joints which are not to be pointed, shall extend slightly beyond the full width of the beds and shall then be struck off flush as the work proceeds.

5509 Brick Face work Fixed to Concrete

Any loose material shall be removed from the concrete, and its surface washed with clean water before any bricks are laid.

The proportion of fixing ties projecting from the concrete shall be completely embedded in the mortar of the face work and shall be kept back a minimum of 30 mm from the face of the brickwork.

The cavity between brick face work and concrete shall be completely filled as the work proceeds with mortar of the same mix as that specified for the face work.

5600: GABIONS

5601 SCOPE

This section covers the construction of gabion walls and aprons for the construction of retaining walls, lining of channels, revetments and other anti-erosion structures.

5602 MATERIALS

Rocks used as filling for cages shall be clean, hard, sound, durable and unweathered boulders or rock fragments. No rock particles shall exceed the maximum size given below and at least 85% of the rocks shall have a size equal to or above minimum size given below:

Depth of cage (m)	Rock size according to largest dimension of the rock	
	Minimum (mm)	Maximum (mm)
0.2	75*	125
0.3	95**	125
0.5	100	250
1.0	100	300

* Using 60 x 80 mm mesh ** Using 80 x 100 mm mesh

All wire used in the fabrication of the gabions and in the wire operations during construction shall be to BS 1052, having a tensile strength of not less than 350 MPa. All wire used in the fabrication of gabions shall be galvanized in accordance with the provisions of BS 729 for Class A heavy galvanized mild steel wire. The minimum mass of the zinc-coating shall be according to the figures shown in the table below:

Table 5-3

Nominal diameter of coated wire (mm)	Mass of coating (g/m ²) surface area
3.7 - 4.0	290
3.0 - 3.6	275
2.2 - 2.9	260
Below 2.2	245

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns round a mandrel of four times the diameter of the wire, it shall not flake nor crack to such an extent that any zinc can be removed by rubbing with the bare fingers.

Wire mesh shall be hexagonal-woven mesh wherein the joints are formed by twisting each pair of wires through the three half turns. The tightness of the twisted joints shall be such that a force of not less than 1, 7 kN is required when pulling on one wire in order to separate it from the other wire provided each wire is prevented from turning and the applied forces and the wire are all kept in the same plane. The diameter of the wire and the size of mesh used shall be as follows:

Table 5-4

Depth of gabion	Mesh size (mm)	Wire diameter (mm)
0.5m and over	80 x 100	2.5
	100 x 120	2.7
0.2m - 0.3m	80 x 100	2.2
	60 x 80	2.0

The shorter dimensions of the mesh shall be taken from centre to centre of the twisted joints, and the larger dimensions shall be between the inside ends of twisted joints.

Where indicated on the drawings or ordered by the Engineer, one layer of geo-textile filter fabric shall be paced on the prepared surface prior to the placing of gabions. The material shall be placed as directed in vertical strips with a minimum overlap of 300 mm, and shall be properly fastened to prevent any movement or slipping during the placing of gabions.

5603 FORMING THE GABION CAGES

Gabion cages shall be fabricated of wire mesh of the size and type and selvedge as specified below. The cages shall be sub-divided into cells by wire mesh diaphragms and will be of two types:

Boxes : which are generally used for the construction of gabion walls. Boxes are sub-divided into cells by diaphragms spaced at 1.0 interval.

Mattresses : which are generally used as single layer aprons only in revetments, channel linings, etc., and in which the maximum width shall be 2.0 m, the maximum depth shall be 0.5m. Mattresses shall be sub-divided by diaphragms into cells having a width of 600 mm or 1.0 m as specified in the Bill of Quantities.

Standard sizes of boxes and mattresses as follows:

Boxes:	Lengths:	1, 2, 3 and 4 metres
	Width:	1 m
	Depths	0.3 m, 0.5 m and 1.0 m
	Diaphragm spacing:	1.0 metre
Mattresses:	Lengths:	6 m
	Widths:	2 m
	Depths:	0.2 m, 0.3 m and 0.5 m
	Diaphragm spacing:	600 mm or 1.0 m as directed.

Other gabions may be supplied, provided the Engineer's approval is obtained beforehand.

The cut edges of all mesh used in the construction of gabions, except the bottom edge of diaphragms and end panels, shall be selvedge with wire of at least twice the diameter of the mesh wire diameter. Where the selvedge is not woven integrally with the mesh but has to be fastened to the cut ends of the mesh, it must be attached by finding the cut ends of the mesh, about it so that a force of not less than 8.5 KN applied in the same panel as the mesh, at a point on the selvedge of a mesh sample 1 m long, is required to separate it from the mesh.

The diaphragms and end-panels shall be selvedge on the top and vertical sides only. The end-panels shall be attached by twisting the cut ends of the mesh wires at the bottom of the panel about the selvedge on the base of gabions. Similarly, the diaphragms shall be attached by twisting the cut ends of the mesh to the twisted joints of the mesh of the base of the gabion. In each case the force required to separate the panels from the base should not be less than that required to break the mesh over the same length.

Sufficient binding and connecting wire must be supplied with the gabion cages to perform all the wiring operations to be carried out in the construction of the gabion work specified in section 6204 below. The diameter of wire shall be 2.0 mm. A tolerance on the specified diameters of all wire of $\pm 2\%$ shall be permitted. The length of the cages is subject to a tolerance of $\pm 3\%$ and the width of cages is subject to a tolerance of $\pm 3\%$ up to a maximum of 25 mm.

5604 CONSTRUCTION OF GABIONS

The bed, on which the gabion cages are to be laid prior to filling, has to be levelled to a depth as shown on the drawings or as directed by the Engineer so as to present an even surface. If necessary, cavities between rock protrusions shall be filled with material similar to that specified in Sub-section 6202. Where required, a foundation trench along the toe of the revetment or wall shall be excavated to the dimensions shown on the drawings or indicated by the Engineer.

The methods of erection, stretching, aligning, wiring and filling the gabions shall generally be in accordance with the manufacturer's instructions as approved by the Engineer but, nevertheless, sufficient connecting wire braces shall be provided and tensioned between the vertical sides of each of the outer visible cells to prevent the deformation of boxes as they are being filled with stone.

It is essential that the corners of gabion cages be securely wired together to provide a uniform surface and ensure that the structure does not appear as a series of posts or panels. Consecutive courses of boxes should preferably be 'bonded' as in brickwork to avoid the coincidence of vertical joints.

Particular care shall be exercised in filling visible faces of gabion boxes where only selected stone of adequate size shall be used and repacked to obtain a fair faced finish. The filling of boxes shall be done in stages in

order to prevent deformation and bulging. Boxes shall be filled to just below the level of the wire braces after which the braces shall be twisted to provide tension. Care must be taken to ensure that consecutive layers of cages being filled are filled evenly to a level surface ready to receive the next course.

The filling of the 0.3 m and 0.5 m gabion mattresses forming aprons and revetments has to be carried out by spreading random stones on the first layer and using selected stones for the top layer so as to present a dry stone-pitched surface.

5605 MEASUREMENT AND PAYMENT

Pay Item	Unit
Foundation trench excavation	
56/1 In hard material	Cum
56/2 In all other classes of material.	Cum

The unit of measurement shall be the cubic metre of each class of excavation made in accordance with the authorized dimensions.

The tendered rates shall include full compensation for excavating in each class of material including for unavoidable over-break, for trimming trenches and compacting trench inverts, for backfilling and consolidating backfill, and for disposal of surplus excavated material.

Pay Item	Unit
56/3 Surface preparation for gabions	square metre (sq m)

The unit of measurement for the levelling and preparation of areas to receive gabions shall be the square metre to the neat dimensions of wall foundations, revetments or aprons.

The tendered rate shall include full compensation for the excavation, filling cavities with rock; for levelling the ground surface ready to receive gabion cages in retaining walls, aprons and revetments.

Pay Item	Unit
56/4 Gabion boxes (size of box and mesh indicated).	Cum
56/5 Gabion mattresses (depth of mattresses, mesh size and diaphragm spacing indicated).	Cum

The unit of measurement shall be the cubic metre of the rock-filled cages and the quantity shall be calculated from the dimensions of the gabions indicated on the drawings or ordered by the Engineer, irrespective of any deformation or bulging of gabions as constructed.

The tendered rate shall include full compensation for the supply of all materials including rock fill, wire mesh cages, binders, connectors; for loading, transporting and offloading; for the assembly and filling of the cages and for any other work necessary for the construction of the gabions.

Pay Item	Unit
56/6 Filter fabric.	square metre (sq m)

The unit of measurement shall be the square metre area covered with filter fabric placed in position.

The tendered rate shall include full compensation for the supply of the filter fabric, cutting, waste, placing, joining, overlapping, and fastening the material in position.

5700: SUBGRADE DRAINS

5701 General

This work shall consist of excavating, furnishing materials, backfilling and finishing drains in accordance these Specifications and the dimensions and cross sections shown or Drawings or instructed by the Engineer.

5702 Materials

The material for backfilling of sub grade drains shall be clean, free draining gravel, free from any vegetable matter, soft particles, silt or clay.

The grading of the material shall conform to the grading shown in Table 5.13

Grading requirements of Drain Backfill Materials

Table 5-13

Sieve	% Passing by Weight
10 mm	10
4.8 mm	80 – 100
2.4 mm	65 – 95
1.2 mm	50 –80
600 micron	25 –50
300 micron	10 –20
150 micron	0 – 10
75 micron	0 – 2

5703 CONSTRUCTION METHODS

Sub grade drains shall be excavated neatly in the prepared sub grade to the dimensions and grades shown on the Drawings or as directed by the Engineer.

Drains shall be constructed at the intervals shown on the Drawings. Drains on opposite sides of the road shall be staggered.

Geo-textile material shall be placed in the excavation and wrapped around the backfill in accordance to the drawing.

The excavation shall be backfilled with material in accordance with section 5.13.2.

The backfill shall be compacted by hand and struck off level with, or slightly above, the finished sub grade level.

Shoulder and pavement materials over the drains and geofabric shall be placed carefully by hand for a depth of not less than 100mm prior to placing and rolling of the general shoulder and pavement materials.

5704 MEASUREMENT

Sub-grade drains shall be measured in linear meters of drain completed and accepted. Drains shall extend from a point vertically below the outer edge of the carriageway surfacing layer to the finished face of the embankment, or side ditch, side slope. In the event that the Contractor constructs the embankment to dimensions in excess as those shown on the plans and sections the Contractor shall extend the sub-grade drains to the embankment face at his own expense.

5705 PAYMENT

The work measured as provided above shall be paid at the Contract unit rate per linear metre. Payment shall be full compensation for performing the work including excavation, filling and providing all labour, equipment, materials, tools and incidentals necessary to complete the works.

Pay item:	Unit
57/1 Sub-grade drains	Linear Meter.

5800: TREE PLANTATION

5801 SCOPE

This work shall consist of planting tree seedlings at the base of embankment and side slope fills to prevent erosion of the material in which it is planted.

5802 CONSTRUCTION METHODS

The planting shall be carried out at intervals and locations as directed by the Engineer. The tree seedlings shall be planted with their root system substantially undamaged, well buried in firm material, and packed around with moist earth in which they have grown.

Tree seedlings shall be planted at such a time and the work shall be done in such a way that at the time of the final construction inspection all seedlings are well established, firmly rooted and the planted area is free from erosion channels.

The Contractor shall maintain the seedlings at his expense until the issuance of the Practical Completion Certificate. Maintenance shall consist of preserving, protecting, watering and replacing seedlings and such other work as may be necessary to keep them in a healthy condition.

5803 MEASUREMENT AND PAYMENT

Pay Item	Unit
58/1 Tree plantation	Numbers

The unit of measurement shall be the Number of planted trees and accepted.

The tendered rate shall include full compensation for the supply of all materials including trees, watering regularly, and cage protecting the trees from animals.

5900: Road Side Drainages-Lined

Masonry Road Side Drain

5901 Scope

As shown on the drawing, side drains should be constructed in stone or brick masonry works with cement mortar. The Specification of cement and sand should comply with the standards specified in respective sections.

5902 Materials

The materials shall be dressed stone or bricks comply with the specifications in section 5700 and 8200

5903 Preparation of Sand Bedding

A layer of sand as shown in the drawing should be placed over the excavated side drain prior construction of lined drain. Sand should be spread in uniform thickness, brought up to the optimum moisture content and compacted with proper equipment such as vibrating plate compactor.

5904 Plastering Side Drain in Cement Mortar

All brick works should plaster in cement mortar (1:3). The plaster should be even and smooth. No cracking is allowed.

5905 Net Cement Finishing

The internal sides of the drains shall be plastered with net cement finishing. The layer should be even and smooth.

5906 Backfilling

All spaces which have been excavated shall be backfilled and compacted with material as shown in the drawing. The layers shall not be more than 250mm in depth and shall be compacted to a density comparable with the adjacent undisturbed material.

5907 Pre-Cast Concrete and cast in-situ Side Drains

This work consists of supply and installation of pre-cast or in-situ concrete side drains.

5908 Placing Side Drains

The pre-cast concrete drains shall be placed according to the drawings or as instructed by the engineer. Care has to taken to maintain the alignment specified in the drawings.

The drains shall be connected by both mechanical and plaster joints.

5909 Measurement and Payment

Pay Item	Unit
59/1 Masonry lined concrete drain	linear metre
59/2 Masonry lined Pre-cast or in-situ road side drain	linear metre

The unit of measure shall be in linear metres according to the drawings and accepted.

The tendered rate shall include full compensation for the supply of all materials including excavation, backfilling, loading, transporting and offloading, plastering, neat cement finishing, sand cushions, lean concrete, tools, local haulage etc complete. No extra item shall be measured.

TECHNICAL SPECIFICATION

SERIES 6000

CONCRETE PRODUCTION

TECHNICAL SPECIFICATION

SERIES 6000 - CONCRETE PRODUCTION

TABLE OF CONTENTS

<u>Item Number</u>	<u>Page</u>
6100 CONTRACTOR'S PLANT, EQUIPMENT AND CONSTRUCTION FACILITIES	6-3
6101. General	6-3
6102. Transporting and Handling Equipment	6-3
6103. Payment	6-3
6200 COMPOSITION	6-4
6201. General	6-4
6202. Maximum Size Aggregate	6-4
6203. Responsibility for Mix Design	6-4
6204. Criteria for Designing Mixes	6-4
6205. Approval of Mix Design	6- 5
6300 CONCRETE	6-6
6301. Required properties of Concrete	6- 6
6302. Water	6-7
6303. Regulation of Water Content	6- 7
6400 CEMENT	6-8
6401. Type of Cement	6-8
6402. Testing Cement	6-8
6403. Maximum Storage Period	6-8
6404. Cement Containers	6-8
6405. Delivery of Bulk Cement	6-8
6406. Delivery of Bagged Cement	6-9
6407. Storage and Handling of Cement	6-9
6408. Temperature of cement	6-10
6409 Rejection	6-10
6410 Payment	6-10
6500 ADMIXTURES	6-10
1. General	6-10
2. Air-Entraining Agent	6-10
3. Water-Reducing, Set-Retarding Agent	6-10
4. Non-Permissible Admixtures	6-10
5. Payment	6-11

<u>Item Number</u>	<u>Page</u>
6600 AGGREGATES	6-11
6601. General	6-11
6602. Test	6-11
6603. Deleterious Substances	6-12
6604. Particle Shape	6-12
6605. Grading of Fine Aggregate	6-12
6606. Normal Size and Grading of Coarse Aggregate	6-12
6607. Other Properties	6-13
6608. Processing	6-14
6609. Payment	6-14
6700 BATCHING AND MIXING	6-14
6701. Plant	6-14
6702. Measuring and Tolerances	6-14
6703. Calibration	6-15
6704. Batching and Weighing Equipment	6-16
6705. Vibrating Screens	6-16
6706. Records	6-16
6707. Mixing Equipment	6-17
6708. Batch Mixer	6-17
6709. Truck-Mounted Mixer and agitation Units	6-17
6710. Mixing Time	6-17
6711. Charging Sequence	6-18
6712. Mixing and Transporting	6-18
6713. Discharging Period	6-19
6714. Mixer Performance	6-19
6715. Delivery Docket	6-19
6716. Payment	6-19
6800 TEMPERATURE OF CONCRETE	6-19
6801. Placing Temperature	6-19
6802. Cooling Plastic Concrete	6-19
6803. Payment	6-20
6900 SAMPLING AND TESTING	6-20
6901. Testing Facilities	6-20
6902. Standards	6-20
6903. Testing Cement at Source	6-21
6904. Testing Cement Elsewhere	6-22
6905. Testing aggregate	6-22
6906. Sampling and testing plastic Concrete	6-22
6907. Rejection of plastic Concrete	6-23
6908. Testing Cylinders	6-23
6909. Testing Hardened Concrete in Structures	6-24
6910. Payment	6-24

6100: Contractor's Plant, Equipment and Construction Facilities**6101 General****Mixing of Concrete:**

All concrete shall be machine mixed at the site. Concrete shall be thoroughly mixed in a batch mixer of an approved size and type which will ensure a uniform distribution of the materials throughout the mass. No mixer having a rated capacity of less than one bag of cement shall be used nor shall a mixer be charged in excess of its rated capacity.

The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. Upon cessation of mixing for a considerable period, the mixer shall be thoroughly cleaned.

Containers for measuring aggregates, sand, water and cement shall be approved by the Engineer.

When mixing coarse aggregates shall be fed first, then sand and then cement. These materials shall be mixed dry before water is added.

All concrete shall be mixed for not less than 2 minutes after all materials, including water, are in the mixer. Every batch shall be mixed until a uniform consistency of the mixture is obtained. The entire contents of the mixer shall be removed from the drum before mixing of the next batch commences.

Concrete shall be placed and compacted within 30 minutes of batching. Concrete which has experienced initial set shall not be used. Remixing of concrete is not permitted.

6102 Handling and Placing of Concrete:

Concrete shall not be placed until the reinforcement and the forms have been inspected and approved by the Engineer.

Before placing of concrete all sawdust, wood chips and other construction debris and extraneous matter shall be removed from the interior of the forms, the reinforcement shall be thoroughly cleaned; and the forms and reinforcement shall be thoroughly wetted.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs and chutes requires the permission of the Engineer. The chutes or troughs shall be kept clean and free from hardened concrete.

Concrete to be placed from a height of more than 1.5m shall be poured through troughs/tremie pipes, or as directed by the Engineer.

Struts, stays and braces serving temporarily to hold the forms in correct position pending the placing of concrete shall be removed when the concrete has reached an elevation rendering their service unnecessary. They shall not be buried in the concrete.

Concrete shall be laid in layers of 150mm to 300mm in thickness and each layer shall be properly vibrated before laying the next one.

6103 Payment

The Contractor shall not be entitled to any additional payment over the rates and lump sums tendered in the priced Bill-of-Quantities for concrete by reason of any limitations in the batching, mixing, transporting and placing of concrete required under the provisions of this Specification.

6200 Composition of Concrete**6201 General**

- a) Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified, all well mixed and brought to the proper consistency.
- b) The source and type of ingredients used in the concrete shall not be varied without approval.
- c) All sieve sizes referred to in this Section refer to the aperture dimensions in millimetres to sieves conforming to ASTM E11, ASTM E323 and AASHTO M92.
- d) All concrete and its constituent materials and all methods and procedures shall conform to an internationally recognised standard approved by the Engineer. Standards of the American Association of State Highways and Transportation Officials hereinafter referred to as AASHTO, the American Society for Testing of Materials (ASTM), and British Standards (BS) have been quoted herein.

6202 Maximum Size Aggregate

- a) Unless otherwise approve or directed, the nominal maximum size aggregate used in concrete shall be in accordance with Table 6.02. (6) - Part A.
- b) In heavily reinforced sections and in walls less than 275 mm in thickness, the Engineer may direct the use of a smaller maximum size aggregate.

6203 Responsibility for Mix Design

The Contractor shall be responsible for the design of concrete mixes, and for ensuring that all concrete placed in the works meets the requirements of the Specification.

Notwithstanding any other provisions contained herein the Contractor will not be permitted to employ volume batching procedures for concrete classes A to E inclusive (Table 6.02 (6) Part A) unless specifically authorised by the Engineer.

6204 Criteria for Designing Mixes

- a) General
 - i. All mixes shall be designed so that the amount of cement and fine aggregate are the minimum necessary to obtain concrete having approved workability, density, permeability, resistance to abrasion, durability, low shrinkage and meeting the requirements as mentioned in this specification.
 - ii. Concrete mix proportions, including water-cement ratio, shall be established on the basis of field experience and/or trial mixes with the proposed concrete materials.
 - iii. Strengths of concrete shall be determined by testing cylinders at 28 days made and tested in accordance with the standard testing procedure.
- b) Where a concrete production facility has test records, a standard deviation for concrete strength shall be established. Test records from which a standard deviation is calculated:
 - shall represent materials, quality control procedures, and conditions similar to those expected and changes in materials and proportions within the test records shall not have been more restricted than those for the proposed works.
 - shall represent concrete produced to meet the same 28 day strength.
 - shall consist of at least 30 consecutive tests that span a period of not less than 45 days.

c) Average Strength of Trial Mixes

- i. Where a standard deviation has been established, the required average 28 day compressive strength of trial mixes shall be not less than the strength specified in Table 6.02 (6) - Part A plus the following factor times the standard deviation, depending on the method of measuring concrete batch ingredients, adopted by the Contractor.

<u>Batch Measurement</u>	<u>Factor</u>
i. by weight	1.65
ii. by volume	2.15

- ii. When no or insufficient test records are available for a standard deviation to be established, the required average 28 day compressive strengths of trial mixes for concrete of the specified strengths in Table 6. 02 (6) - Part A, depending on the method of measuring concrete batch ingredients, shall be as given in Table 6.02(4).

Table 6-1: Trial Mix Strengths

Specified Strength MPa	Trial Mix; Required Average Strength	
	Batched by weight	Batched by volume
35	44	47
30	39	41
25	33	35
15	21	23

6205 Approval of Mix Design

- a) At least 60 days before placing any concrete in the Works, the Contractor shall submit, for approval, details of his proposed mixes for the various classes of concrete specified.
- b) When test records are used to demonstrate that proposed concrete mixes will produce the required average strengths, such records shall represent materials and conditions similar to those expected. Changes in materials, conditions, and proportions within the test records shall not have been more restricted than those for the proposed works, Test records consisting of less than 30 consecutive tests shall not be permitted.
- c) Before approving the proposed mixes, the Engineer may require the Contractor to prepare, in the Engineer's presence, trial mixes of the proposed mixes which will then be sampled and tested in accordance with test procedure to verify their compliance with the Specification. The Engineer may require trial mixes to be laboratory sized batches and/or full production size batches using the Contractor's batching plant.
- d) During the course of the contract, the Engineer may approve variations to the mix design to take account of the standard deviation achieved in the tested samples.

6300: Properties of Concrete**6301 Required Properties of Concrete**

- a) The class of concrete and properties applicable to the concrete in various structures shall be as specified in Table 6.02 (6) - part A. The Contractor shall design mixes to satisfy the properties specified in this table. The mix design shall be subject to approval in accordance with this specification.

Table 6-2 - part A - Standard Classes of Concrete

Class of concrete	Maximum size of aggregate (mm)	Maximum Water-cement ratio by mass	Minimum cement content (Kg/cum)	Maximum Slump (mm)	28 day cylinder strength (MPa)
A	20	0.45	360	75	35
B	20	0.45	360	75	30
C	10	0.50	410	60	25
D	20	0.50	360	75	25
E	20	0.55	290	75	15
F	20	0.70	220	75	15

The maximum cement content in any mix shall not exceed 510 kilograms per cubic metre.

- b) The various classes of concrete shall be placed in the location specified in Table 6.02(6) - Part B and elsewhere as directed.

Table 6-3 Part B - Type of Mix to be used in Structure

Class of Concrete	Location
A	Precast prestressed beams
B	Precast beams Precast piles Bridge deck slabs Diaphragms Bridge parapet (barrier type) Pier columns and crossheads
C	Bridge railings and posts Concrete pipes
D	Bored piles Pile caps Abutment back walls, sidewalls and wing walls, Box culvert base slab, top slab, walls, head walls, wing walls and aprons Concrete repairs Temporary works
E	Pipe culvert headwalls Miscellaneous concrete
F	Blinding concrete

- c) The Engineer may direct the use of a slump less than that specified in Table 6.02 (6) - part A whenever concrete of such lesser slump can be consolidated or compacted into place by means of the vibration specified in section 7.9.
- d) Where grade C-25 concrete is shown on the Drawings, Class B, concrete shall be supplied.

6302 WATER

The water used in concrete, grout and mortar, for washing aggregate and for curing concrete, shall be subject to approval and shall be free from objectionable quantities of suspended material, organic matter, acid, alkali, salts, sugar and other impurities.

Surface and groundwater in the vicinity of the works may not meet the above requirements without prior treatment.

- a) Water used for concrete work will be tested by the Contractor prior to use in concrete and in the presence of the Engineer in accordance with the requirements of AASHTO T26. The water shall meet the following requirements:
 - i. The total percentage of solids by mass shall not exceed 2.25 per cent.
 - ii. For reinforced concrete construction the concentration of chloride ions shall not exceed 1000 ppm.
 - iii. For prestressed concrete construction the concentration of chloride ions shall not exceed 200 ppm.
- b) Water which fails to meet the requirements shall not be used and the Contractor shall treat the water to conform to the Specification or shall supply suitable approved water from another source. Concrete made with water not meeting the requirements specified herein may be rejected for inclusion in the Works.

6303 Regulation of Water Content

- a) During batching, the Contractor shall regularly measure the moisture content of aggregates by moisture metre or other appropriate and approved procedure in accordance with AASHTO T217, T255 or T265.
- b) The amount of water used in the concrete shall be regulated to adjust for any variation of the moisture content or grading of the aggregates as they enter the mixer as follows:
 - i. Weight Batching

Direct adjustment shall be made to weighed quantities of aggregates and the volume of water added shall be corrected for the water in aggregates.
 - ii. Volume batching

The batched volume of damp fine aggregate should be adjusted to give the required equivalent volume of dry aggregate. The volume of moisture in the aggregates shall be deducted from the free water to be added to the mix.
- c) To expedite the adjustment of the damp fine aggregate volume in sub-section 7.b. ii a "bulking curve" showing the relation between moisture content and increase over dry volume shall be prepared in advance by tests on the fine aggregate to be used.
- d) Addition of water to overcome stiffening of the concrete before placing will not be permitted.
- e) Concrete shall have uniform consistency from batch to batch.
- f) Aggregate shall not be batched for concrete or mortar when free water is dripping from the aggregate.
- g) Payment for all testing will be in accordance with section 6.9.

6400: CEMENT

6401 Type of Cement

- a) i. Cement for concrete, mortar and grout shall be from an approved source and shall conform to the requirements of AASHTO M85 for Type I cement. Cement shall have low alkali content with a sodium oxide equivalent of less than 0.6%.
- ii. For surfaces exposed to public view, where colour of the finished concrete is important, all cement shall be of the same type and colour and from one source.

6402 Testing Cement

Cement shall be tested in accordance with section 6.9.

6403 Maximum Storage period

Cement that has not been used within 6 months from its date of initial testing at its source in accordance with section 6.9, or has been stored on site throughout a monsoon period, shall not be used in the Works unless it has been retested and approved. Such retesting shall be at the expense of the Contractor.

6404 Cement Containers

The Contractor shall deliver cement to the Works in bulk or bags.

6405 Delivery of Bulk Cement

Where cement is supplied in bulk containers, the following requirements shall apply :

- a) All containers shall be completely weatherproof and maintained in good order and condition.
- b) All apertures in the containers shall be fitted with completely watertight closures and shall be sealed after filling. Depending on the transportation methods adopted, the Engineer may require to be present at any subsequent transfer or delivery point when these seals are to be broken.
- c) All containers shall be filled as completely as possible.
- d) All containers shall be completely cleaned out at each transfer or delivery point after each and every use and before being returned for refilling.
- e) Each and every container dispatched from the manufacturer's works or any intermediate transfer point shall be accompanied by a delivery docket signed by a responsible person which shall clearly show the brand and type of cement, and identification number of numbers relating to the testing and certification of the cement, the date of the testing and certification of the cement, the date of filling the container and the net mass of the cement in the container. This docket shall be carried in a suitable fashion inside the sealed container and shall be handed over to the Engineer at any subsequent transfer or delivery point.
- f) Cement supplied in bulk shall not be re-bagged for use in the works without approval.

6406 Delivery of Bagged Cement

Where cement is supplied in bags the following requirements shall apply:

- a) Cement shall be delivered in sound undamaged bags uncontaminated by moisture, oil or any other substance.
- b) The nominal mass of a bag of cement shall be 50 kg. Where cement is batched by bag, individual bags which vary by more than 5 per cent from the nominal mass shall be rejected. Where the average

mass of 50 bags taken at random from any one consignment is less than the nominal mass, the whole consignment shall be rejected.

- c) Every bag shall be marked with the manufacturer's brand, the type of cement, identification number or numbers and the date the bag were filled.
- d) The contents of broken or damaged bags shall not be rebagged.

6407 Storage and Handling of Cement

The following requirements shall apply to the storage and handling of cement at site or at any intermediate transfer or storage point :

- a) All methods for transporting, handling and storing bulk and bagged cement shall be designed, constructed and arranged to ensure the use or transfer of cement in the approximate chronological order of manufacture.
- b) All storage bins and cement handling equipment shall be completely weatherproof and substantially dust-free to the satisfaction of the Engineer and shall be designed and constructed to ensure that there will be no dead storage of cement.
- c) Batches of cement procured at different times shall be stored separately and shall not be mixed.
- d) All loading and unloading facilities for cement shall be under cover and weatherproof to the satisfaction of the Engineer.
- e) All storage bins and silos shall be drawn down to be substantially empty at least once every 3 months.
- f) Where cement is handled by pneumatic means which involve contact of compressed air with the cement, the temperature of air in contact with the cement shall not at any time exceed 38 °C. Where necessary, after-coolers or other means shall be provided to cool the compressed air. All compressed air supplies, where the air may come in contact with the cement, shall be fitted with filters for the removal of moisture, oil or any other contaminating substances. Such filters shall be regularly inspected and maintained by the Contractor.
- g) All bagged cement shall be stored at all times up to its use in the Works in completely weatherproof structures which shall include a timber floor raised not less than 300 mm above the surrounding ground and be adequately ventilated to prevent the accumulation of moisture.
- h) All storage of bagged cement shall be arranged to permit easy access for inspection and definite identification of all cement in the storage.

6408 Temperature of Cement

The temperature of the cement at any time shall not exceed 60 °C.

6409 Rejection

Cement not conforming to the requirements of this specification shall not be used in the Works.

6410 Payment

- a) Direct payment will not be made for cement used in concrete, mortar, dry-pack or grout.
- b) The cost for cement shall be included in the rates tendered in the priced Bill of Quantities for the various items of concrete construction in which the cement is used.

6500 ADMIXTURES

6501 General

Only approved admixtures shall be used in the concrete, grout or mortar for the works. When more than one admixture is to be used, each admixture shall be batched in its own batcher and added to the mixing water separately before discharge into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification. All admixtures shall be prevented, by an approved method, from segregating before batching.

6502 Air - Entraining Agent

- a) The Engineer may direct or approve use of a neutralized, vinsolresin, air-entraining agent conforming to the requirements of AASHTO M154 in any concrete. Where the Contractor wishes to use an alternative air-entraining agent, he shall demonstrate, to the satisfaction of the Engineer, its compliance with AASHTO M154 when tested with the cement, aggregates and other admixtures approved for use in the Works.

6503 Water-Reducing, Set-Retarding Agent

- a) The Contractor may propose and the Engineer may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an admixture may not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to extend the finishing time of concrete, or to overcome unusual circumstances and placing conditions.
- b) The water-reducing set-retarding admixture shall be an approved brand of ligno-sulphonate type admixture conforming to the requirements of Type D admixture as defined in AASHTO M194 and shall be compatible with the other ingredients of the mix as demonstrated by tests carried out on site by the Contractor in the presence of the Engineer at least 30 days before it is proposed to use the agent.
- c) All aspects of the use of such a water-reducing set-retarding admixture, including, but not limited to, the quantity of admixture, the method of introducing the admixture into the concrete, the transporting, handling, forming, finishing and curing of such concrete, shall at all times be subject to approval.
- d) The specified limits in respect of maximum slump, slump loss during transit and the time allowed for concrete to remain in the mixer may be changed by the Engineer when approval to use the agent is given.

6504 Non-permissible Admixture

Fly ash or calcium chloride shall not be used as an admixture in any concrete, mortar or grout.

6505 Sulphate Resistant

In the event the sub-soil investigation report reveals that soil contains sulphate, then the contractor will arrange sulphate resistant ad-mixture or use cement that is resistant to sulphate.

6506 Payment

All concrete admixtures shall be furnished by the Contractor and the cost of these materials and all costs

incidental to their use shall be included in the rates tendered in the priced Bill of Quantities for the various items of concrete construction.

6600 AGGREGATES

6601 General

- a) Fine and coarse aggregates shall conform to AASHTO M6 and M80 respectively, and to the requirements of this Specification.
- b)
 - i. The term 'fine aggregate' is used to designate aggregate in which the maximum size of particles is 4.75 mm. Fine aggregate for concrete, mortar and grout shall be furnished by the Contractor and shall be a blend of natural sands or a blend of natural and manufactured sands.
 - ii. The term 'Coarse aggregate' is used to designate aggregate in which the minimum nominal size is 4.75 mm and which is reasonably well graded from 4.75 mm to the largest size required in the work in which the material is being used. Coarse aggregate for concrete shall be furnished by the Contractor and shall consist of natural gravel, a mixture of natural and crushed oversize gravel or manufactured aggregate.
- c) At least 90 days before placing any concrete the Contractor shall submit, for approval, representative samples of the proposed aggregates from the source proposed by the Contractor in his Tender and approved in the Letter of Acceptance.

6602 Tests

Aggregate will be tested in accordance with section 6.9.

6603 Deleterious Substances

- a) Aggregates shall consist of hard, dense, durable, uncoated crushed stone or gravel particles, and shall be free from organic matter and the amounts of dust, clay lumps, soft or flaky particles, shale, salt, mica, alkali, loam and other substances considered deleterious by the Engineer shall not exceed the values given in AASHTO M80 and AASHTO M6 and Table 6.06 (3).
- b) Aggregate for concrete made from over burned bricks will not be permitted.

Table 6-4 Maximum amount of deleterious substances

Item	Maximum Percentage by Mass	
	Fine Aggregate	Coarse Aggregate
- Material passing 0.075 mm sieve	2.0	1.0
- Lightweight material	2.0	3.0
- Clay lumps	1.0	0.5
- Other deleterious substances Such as shale, alkali, mica, soft and flaky particles	3.0	3.0

- c) The sum of the percentage of all deleterious substances in aggregate as delivered to the mixer shall not exceed 3 per cent for fine aggregate and 3 per cent for coarse aggregate.
- d) The fine aggregate shall not contain deleterious organic impurities when tested in accordance with

AASHTO T21.

6604 Particle Shape

The aggregate shall consist substantially of particles of satisfactory shape having a maximum dimension not greater than 1.8 times the sieve size of the particle and a minimum dimension not less than 0.6 times the sieve size of the particle.

6605 Grading of Fine Aggregate

- a. The fine aggregate as batched shall be well graded and when tested shall conform to the limits specified in Table 6.06 (5).
- b. The fineness modulus of the fine aggregate is defined as the sum of the cumulative percentages retained on the sieves 4.75 mm to 0.15 mm inclusive and divided by 100 and shall be as shown in Table 6.06 (7).
- c. The grading of the fine aggregate shall be so controlled that at any time the fineness module of at least 9 out of 10 consecutive test samples of finished fine aggregate will not vary more than 0.20 from the average fineness modulus of the 10 test samples.

Where fine aggregates from different sources are being used at the one batching plant, or mixing site at the same time, they shall be so blended to ensure uniform grading and colour in successive batches.

Table 6-5 Grading of Fine Aggregate

Sieve size (mm)	Percentage of total mass passing sieve
9.5	100
4.75	95-100
2.3	85-100
1.19	50-85
0.600	25-60
0.300	10-30
0.150	2-10
pan	2-5

6606 Normal size and Grading of Coarse Aggregate

The coarse aggregate as batched shall be separated into normal sizes in accordance with AASHTO T27 and shall be well graded conforming to Table 6.06 (6).

Table 6-6 - Nominal size and grading of coarse aggregate

Nominal size (mm)	Percentage of total mass passing sieve	
	Normal size 10 mm	Normal size 20 mm
25	-	100
19	100	90 - 100
12.5	90 - 100	
9.5	40 - 70	20 - 55

4.75	0 - 15	0 - 10
2.36	0 - 5	0 - 5

6607 Other Properties

Aggregate which does not comply with Table 6-7 may be rejected.

Table 6-7 required properties of aggregate

	Fine Aggregate	Coarse Aggregate
i. Minimum specific gravity (dry basis).(AASHTO T84, T85)	2.56	2.56
ii. Maximum weight loss of portion retained on a 0.300 mm sieve when subject to 5 cycles of sodium sulphate test. (AASHTO T104)	8% by mass	10% by mass
iii. Maximum loss in Los Angeles Abrasion Test at 500 revolutions. (AASHTO T96)	Not Applicable	30%
iv. Maximum sum of flakiness and elongation indices. (BS 812)	Not Applicable	60%
v. Minimum Fineness modulus.		
vi. Maximum fineness modulus	2.10	Not Applicable
• natural sand		
• manufactured fine aggregate		
• Mixture of natural sand and manufactured fine aggregate	3.10 2.80 a proportional value between 3.10 and 2.80	Not Applicable Not Applicable Not Applicable

6608 Processing

- Aggregates shall be screened and washed. Processing of the raw materials may include crushing, milling and blending to produce fine and coarse aggregates meeting the requirements of this specification and shall be done at an approved location and in an approved manner.
- Water used for washing aggregate shall comply with section 6.5.
- After washing, fine aggregate shall be stored in stockpiles for at least 72 hours and shall be subsequently handled to ensure that sand delivered to the batching plant has uniform and stable moisture content.
- Where the surface of stockpiles from which fine aggregate is being delivered directly to the batching plant is substantially drier or wetter than the bulk of fine aggregate in the pile, handling shall be such as to exclude this surface material from the batching plant.
- The mixing of different kinds or sizes of aggregate, or aggregate from different sources in one

- stockpile will not be permitted.
- f) Different kinds or sizes of aggregates shall be measured separately and kept clean.
- g) Stockpiles shall be placed on concrete, sheet metal, wood planks or other approved foundation.

6609 Payment

- a) Direct payment will not be made for fine and coarse aggregate used in concrete, mortar or grout.
- b) The cost of producing or furnishing aggregates required under this Specification shall be included in the rates tendered in the priced Bill of Quantities for the various items of concrete construction in which the aggregate is used. Such rates shall also include all expenses of the Contractor in testing, winning, handling, processing, transporting and storing the materials.
- c) The Contractor will not be entitled to any additional payment for materials wasted from deposits, including crusher fines, excess material of any of the sizes into which the aggregates are required to be separated by the Contractor, and materials which have been discarded by reasons of being above the maximum sizes specified for use.

6700 Batching and Mixing**6701 Plant**

- a) If the Contractor installs at an approved central location a batch plant, it shall be constructed and operate in accordance with AASHTO M157 and this Specification. The batch plant shall be an approved, efficient and dependable, automatically or semi-automatically controlled batching plant.
- b) The equipment shall be capable of controlling the delivery of each size of aggregate to the mixer within the tolerances specified herein.

6702 Measuring and Tolerances

- a) Cement, fine aggregate and each size of coarse aggregate shall all be weighed separately on an individual scale. Water shall be weighed separately on an individual scale or may be measured by volume. Liquid admixtures may be measured by mass or volume. If water is measured by volume, two (2) flow meters shall be installed in parallel so that no delay shall result from faulty operation of one of the metres.
- b) The equipment shall be capable of controlling the delivery of each size of aggregate to the mixer within the tolerances specified herein.
- c) Volume measurement may be used as approved by the Engineer in accordance with AASHTO M241 and the requirements of this specification.

6703 Calibration

- a) The construction and accuracy of the weighing and measuring equipment shall be such that the equipment will maintain accuracy within 0.4 per cent of the scale capacity. The equipment shall be capable of ready adjustment for compensating for the varying weight of any moisture contained in the aggregates and for effecting changes in concrete mix proportions. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1.0 per cent of the desired amount.
- b) The Contractor shall provide standard certified test weights and any other auxiliary equipment required for checking the accuracy of each measuring device.
- c) The Contractor shall calibrate each measuring device in the presence of the Engineer when and as directed. Such tests shall be made at least once every 4 week in the case of equipment for measuring

aggregates and at least once every week in the case of equipment for measuring cement, water and admixtures.

- d) The Contractor shall furnish copies of the complete results of all calibrations to the Engineer and shall adjust, repair or replace any measuring device which does not meet the requirements for accuracy

6704 Batching and Weighing Equipment

- a) Where bagged cement is used, the quantities of aggregates for each batch shall be exactly sufficient for one or more complete bags. No batch requiring part bags of cement will be permitted.
- b) Materials shall be weighed individually and each weighing device shall be equipped with a visible springless dial which shall register the scale load at any stage of the weighing operation.
- c) The Contractor shall provide all necessary facilities for obtaining representative samples of aggregates and cement from the discharge streams between the bins and weigh-hoppers or between weigh-hoppers and the mixers.
- d) All gates and closing devices shall be positive in action and shall prevent leakage of materials when in the closed position.
- e) Batching equipment shall be interlocked so that:
 - i. A new weighing cycle cannot be started until all weigh-hoppers are completely emptied and the discharge gates closed;
 - ii. The discharge-gates of the weigh-hoppers cannot be opened until the correct masses of materials are in and the scales in balance;
 - iii. The discharge-gates cannot be closed until all materials are entirely discharged and the scales are back in balance;
 - iv. The discharge-valve of the water-measuring device cannot be opened until the filling-valve is closed; and
 - v. Accidental over batching of admixtures is prevented.
- f) The batch bins shall be constructed to be self-cleaning during draw-down and the bins shall be drawn down until they are practically empty at least once per week. Materials shall be deposited in the batch bins directly over the discharge gates. The coarse aggregate shall be deposited in the batch bins through effective rock ladders when the distance through which the aggregate would fall is greater than 1.0 m. Equipment for conveying batched materials from the batchers or hoppers to and into the mixer shall be so constructed, maintained and operated that there will be no spillage or contamination of the batched materials or overlap of batches. Equipment that fails to conform to this requirement shall be effectively repaired, modified or replaced to the satisfaction of the Engineer.
- g) When cement and aggregates are hauled from a central batching plant to the mixer, the cement for each batch shall be placed in an individual converted watertight compartment which, during transit, will prevent the cement from intermixing with the aggregates and will prevent loss or contamination of cement. Aggregates shall be covered to prevent changes in moisture content during transit. Each batch compartment shall be of sufficient capacity to prevent loss in transit and to prevent spilling and intermingling of batches as compartments are being emptied. Surface haulage of batched aggregates from a central batching plant to mixers will not be permitted, if when so hauled, the change in moisture content of the fine aggregate between batching plant and mixer exceeds 1%.

6705 Vibrating Screens

- a) Coarse aggregate shall be finish-screened over vibrating screens mounted on the batching plant or, at the option of the Contractor; the screens may be mounted on the ground adjacent to the batching plant. The finish-screens shall be so mounted that the vibrations of the screens will not affect the accuracy of the batching scales. The finished products shall pass directly to the batching plant bins.
- b) Separation of the coarse aggregate into the specified sizes after finish-screening shall be such that the aggregate shall meet the requirements of section 6.6, and in particular Table 6.06(6)

6706 Records

Where a batch plant is set up by the Contractor, records shall be made by the Contractor for each batch, of the measurement of each separate concrete ingredient, including all water and admixtures. The records shall be available for inspection by the Engineer at all times and copies of the records shall be furnished to the Engineer at the completion of each day's production.

6707 Mixing Equipment

- a) In addition to the requirements of sub-section 1 of this section, the mixing equipment shall be as specified herein.
- b) A metal plate shall be attached to all mixing equipment, including agitators, on which is plainly marked the capacity in terms of volume of mixed concrete, and the manufacturer's recommendations for speed of rotation for mixing and for agitation.
- c) When loaded to their rated capacity, mixers shall be capable of combining the ingredients within the time specified in sub-section 10 of this section and of discharging the concrete with a degree of uniformity such that, when samples taken at the one-quarter and three-quarter points of the batch volume are tested for slump, the difference between the two slumps shall not exceed one half of the average of the two slumps.
- d) All equipment shall be in sound mechanical condition and the interior of the drum or pan and mixing blades shall be kept thoroughly clean and free of hardened concrete or mortar by cleaning at frequent intervals as directed by the Engineer, and, in any case, before the commencement of or after a break in mixing operations.

6708 Batch Mixer

- a) The concrete ingredients shall be mixed thoroughly in stationary mechanically operated batch-mixers of the type and size specified in this section, which is so designed as to ensure uniform distribution of all the component materials throughout the mass at the end of the mixing period.
- b) The size of the mixer required shall be determined from the amount of concrete to be placed in a continuous operation. For each 25 cubic metres to be so placed in an 8-hour period the mixer or mixers to be used shall have a capacity of at least a one bag batch. The mixer shall be equipped with suitable devices, accurate to within 1 per cent, for automatically measuring the proper amount of water and for automatically timing each batch of concrete, so that all the ingredients will be mixed together for at least the minimum time required. Such devices shall be easily regulated and controlled to meet the variable conditions encountered.
- c) The drum of the mixer shall revolve at a speed not less than 14 nor more than 20 revolutions per minute.

6709 Truck- Mounted Mixer and Agitation Units

- a) Where the use of truck-mounted mixer and agitator units is approved, the Contractor shall maintain at the Site an up-to-date list of the approved truck-mounted mixer and agitator units and shall ensure that only approved units are allowed to be used for the Works.
- b) Truck-mounted mixer and agitator units and the mixing and transporting of concrete in such units shall be in accordance with the requirements of an internationally recognised standard Specification and applicable to tropical conditions and as specified in this section. Each unit shall be fitted with an approved mixer drum revolution recording counter which can be manually reset to zero, but shall not be capable of being advanced.
- c) Truck-mounted mixer and agitator units will be approved for use only when the units and their operations are such that they conform to the requirements of this section over the full range of slumps and aggregate sizes of concrete for which they are used.

6710 Mixing Time

- a) Unless otherwise directed or approved, the mixing of each batch shall continue for not less than the number of minutes stated in the following table after all materials are in the mixer.

Capacity of mixer (Cubic metre)	Minimum time of mixing (minutes)
1	1.5
2	2.0
3	2.5
4	2.75
5	3.0

- b) The minimum mixing periods specified are conditional on the materials being fed into the mixer in a manner which will facilitate efficient mixing and on operation of the mixer at its designed speed.

6711 Charging Sequence

- a) The Engineer reserves the right to vary the mixing time or to limit the batch size when the charging and mixing operations fail to produce a batch of concrete that conforms with the foregoing requirements with respect to adequacy of mixing. The concrete of a given composition, as discharged from the mixer, shall be uniform in composition and consistency within batches and from batch to batch.
- b) The first batch of concrete materials placed in the mixer shall contain a sufficient excess of cement, sand, and water to coat the inside of the drum without reducing the required mortar content of the mix.
- c) Water shall be added before, during and following the mixer-charging operations. Excessive over-mixing, requiring addition of water to preserve the required concrete consistency, will not be permitted.

6712 Mixing and Transporting

- a) Notwithstanding other requirements of this , mixing and transporting of batched concrete shall be in accordance with any of the following methods:

i. Method 1 - Transit mixing

The concrete shall be mixed in a truck mixer. In general the water and cement shall be charged into the truck mixer at the batch plant with the fine and coarse aggregate. If proper control of the air content, consistency or mixing is not obtained, the time of charging the cement and water shall be as directed by the Engineer.

Immediately after all ingredients are in the mixer, mixing shall be started and continued until discharged. In the case of a truck mixer loaded to its maximum capacity not less than 70 revolutions of the drum or blades at mixing speed shall be required after all of the ingredients including water are in the mixer. If the batch is at least 0.5 cubic metres less than the maximum capacity, the minimum number of revolutions shall be 50 instead of 70. Not more than 100 revolutions of the drum or blades shall be at the rate of rotation stated by the manufacture as mixing speed. Additional mixing, if any, shall be at a slow speed stated by the manufacture as agitation speed.

ii. Method 2 - Stage (Shrink) mixing

All materials including water shall be partially mixed in a stationary mixer for at least 30 seconds and the mixing completed in truck mixer with not less than 50 revolutions or more than 100 revolutions of the drum or blades at mixing speed. Additional mixing, if any, shall be at agitation speed.

iii. Method 3- Central mixing and agitation hauling

The concrete shall be mixed in a stationary mixer for not less than 1.5 minutes after all materials are in the drum. The concrete shall be discharged into truck mixers or truck agitators and the mixing continued at agitation speed until it is discharged at the work.

iv. Method 4- Central mixing and truck hauling

The concrete shall be mixed in a stationary mixer for not less than 1.5 minutes after all materials are in the drum. The concrete shall be discharged into trucks equipped with special bodies and hauled by these trucks to the works where it is to be discharged.

- b) Watertight covers shall be used to protect the concrete being hauled when it is raining or when the shade air temperature is 30°C or higher.

6713 Discharging Period

Unless otherwise approved, concrete shall be completely discharged from the mixers or agitator drums within 40 minutes after the mixing water has been added to the dry ingredients. During weather not conducive to quick stiffening of concrete, this period may, if approved by the Engineer, be extended to not more than 90 minutes. Any concrete which requires additional water to be added to permit satisfactory discharge or placing will not be accepted regardless of the time which has elapsed since the mixing water has been added. Such rejected concrete shall be removed from the Works with the least possible delay.

6714 Mixer performance

- a) Any mixer that at any time does not meet the requirements of this shall be repaired promptly and effectively or shall be replaced. Mixers shall be loaded to their rated capacity or to such batch sizes as determined in accordance with the provisions of sub 8. of this except where mixing mortar or concrete is for the concluding phase of concrete placement. Mixers shall not be loaded in excess of their rated capacity unless otherwise approved, but in no case shall mixers be overloaded by more

than 10 per cent of their rated capacity. Each stationary mixer shall be equipped with a mechanically operated timing and signalling device which will indicate and ensure the completion of the required mixing period and will count the batches.

- b) The Contractor shall check, once each month, for each mixer in use, the actual volume of concrete mixed in each batch against the theoretical volume of concrete mixed in each batch. Such checks shall be carried out in the presence of the Engineer.

6715 Delivery Docket

At the point of delivery or placing, the Contractor shall furnish the Engineer with a delivery docket stating the batch number, the time of batching, class of concrete and volume of concrete delivered.

6716 Payment

Separate payment will not be made for complying with the requirements of this and all costs shall be deemed to be included in the rates tendered in the priced Bill of Quantities for the various items of concrete construction.

6800: Temperature of Concrete

6801 Placing Temperature

The temperature of all concrete when it is placed shall not exceed 30°C nor shall concreting be commenced where it appears likely that the temperature of the concrete may exceed 30°C. Precautions to be taken for concreting during hot weather are specified in 7.9.

6802 Cooling Plastic Concrete

The Contractor shall, where necessary, employ effective means such as precooling the aggregates, refrigerating the mixing water, adding chipped or flaked ice to the mixing water, placing at night or a combination of these or other approved methods to ensure that the concrete does not exceed the temperatures specified in sub 1 of this. The method of cooling shall be in accordance with methods approved by the Engineer.

6803 Payment

The Contractor shall not be entitled to any additional compensation on account of the requirements of this .

6900: Sampling and Testing

6901 Testing Facilities

- a) The Contractor will provide, in accordance with 1.3, a laboratory and all equipment required for testing concrete and materials for concrete in accordance with this.
- b) At any centrally located batch plants, the Contractor shall provide and maintain a lock-up weatherproof dustproof soundproof room for use by the Engineer. The room shall have a minimum area of 7 square metres with a 2.8 m high ceiling and shall be located immediately adjacent to and on the same level as the operations console of the plant. Each room shall be furnished with a bench 3 m long by 0.6 m wide, fitted with a sink connected to drainage, an overhead water supply, electricity power points and fluorescent lights. The design, layout and location of each room shall be submitted for approval, and all costs associated with the provision of these rooms shall be included in the rates for concrete.

6902 Standards

- a) Unless otherwise approved, sampling and testing of concrete materials, plastic concrete and hardened concrete will be in accordance with the testing methods and recommended practices of the American Association of State Highway and Transportation Officials, (AASHTO). Where an AASHTO Standard is not available, testing will be in accordance with the relevant standard of the American Society for Testing and Materials, (ASTM).

Tests on materials for concrete, plastic concrete and hardened concrete will include, but not necessarily be restricted to, those listed in the various parts of Table 6. 09 (2).

Table 6-8- Part 1 - Standards for testing concrete

Test	Standard
- Sampling	AASHTO T141
- Compressive strength	AASHTO T22, T23 and T126
- Slump	AASHTO T119
- Air content	AASHTO T152
- Unit weight	AASHTO T121

- c) All sieve sieves referred to in this Section refer to the aperture dimensions in millimetres of sieves conforming to AASHTO M92. At least 90 days before placing any concrete, the Contractor shall submit, for approval, representative samples of the proposed aggregates.
- d) In checking the grading of aggregate and other materials, imperial size sieves shall be related to specified metric sizes in accordance with Table 6.09 9(2) - Part 2.

Table 6-9 - Part 2 - Relationship between imperial and metric sieves

Specified metric size (mm)	Imperial Sieve Size
150	6 inch
100	4 inch
75	3 inch
37.5	1.5 inch
25	1 inch
19	3/4 inch
9.5	3/8 inch
4.75	No. 4
2.36	No. 8
1.18	No. 16
0.600	No. 30
0.300	No. 50
0.150	No. 100
0.075	No. 200

Table 6-10 - Part 3- Standards for testing aggregate

Test	Designation No.	Sampling/Testing Frequency (Per cubic metre)
Sampling	ASTM Manual of concrete testing	*
Clay and friable particles	AASHTO T112	*
Material finer than 0.075 mm	AASHTO T11	*
Light weight particles	AASHTO T113	*
Organic impurities	AASHTO T71	*
Soundness	AASHTO T104	*
Sieve analysis	AASHTO T27	*
Los Angeles abrasion	AASHTO T96	*
Unit Weight	AASHTO T19	*
Specific gravity and absorption	AASHTO T84, T85	*
Moisture content	AASHTO T255	as directed

* As recommended by AASHTO or ASTM.

6903 Testing Cement at Source

- a) Cement shall be sampled at the source and tested by the manufacturer and certified as conforming to the requirements of this Specification before being dispatched from the factory of the cement manufacturer. The date of any testing shall be noted in any certification of the cement.
- b) Bulk or bagged cement used for concrete, mortar or grout shall be sampled by taking one grab sample representing not more than 100 tonnes of cement manufactured in an uninterrupted process and stored in one silo. The sample shall be tested for all the requirements given in AASHTO M85 by the methods given in that standard.
- c) Cement used for prestressed concrete grouting shall be additionally sampled by taking one grab sample (usually one integral bag), representing not more than 100 bags filled with cement manufactured in an uninterrupted process and delivered to the Site in one consignment. This sample shall be tested for fineness (Specific surface) in accordance with AASHTO M85, 100 per cent of the cement shall pass a 0.150 mm sieve and not less than 90 percent shall pass a 0.075 mm sieve.
- d) Test results shall be forwarded to the Engineer, within a specified time following testing, as determined by the Engineer.

6904 Testing Cement Elsewhere

- a) The Contractor in the presence of the Engineer, shall take from any bulk or bagged storage, transfer point or cement usage point, samples of cement which appear to have deteriorated through age, damage to containers, improper storage or for any other reason and arrange for testing. The Contractor shall provide all facilities, labour and materials, including the actual cement, necessary to obtain and test these samples at no cost to the Employer.
- b) In the event of any sample being found not to comply with this Specification, the whole consignment from which the sample comes shall be rejected and removed from the site immediately.

notwithstanding any previous acceptance on the basis of the manufacturer's certificate. The Engineer may require the removal of any concrete, mortar or concrete produced with cement not complying with the requirements of this Specification.

6905 Testing Aggregate

The Contractor, in the presence of the Engineer, will sample and test aggregate at the frequency shown in Table 6.09 (2) Part 3, or as directed by the Engineer.

6906 Sampling and Testing Plastic Concrete

- a)
 - i. The Contractor in the presence of the Engineer will sample concrete for testing, in accordance with sub 2 of this, from the batching and mixing plant, delivery trucks, at the forms or elsewhere where concrete is being handled or placed. Samples will be obtained at uniform intervals throughout the production or delivery of concrete for a given placement.
 - ii. Where the concrete is deposited into the forms directly from an agitator truck chute, sampling shall be from the discharge chute and the sampling procedure will be as in AASHTO T141.
 - iii. A placement shall be considered as an operation involving the continuous placing of concrete as follows for:
 - In- situ concrete between construction joints
 - Precast concrete each unit or batch of units.
 - iv. In general, the frequency of sampling of a class of concrete in any one placement will be in accordance with Table 6.09 (4).

Table 6. 09 (4) - Frequency of sampling concrete

Size of Placement	Number of Samples
Up to 10 cubic metres	1
Up to 20 cubic metres	2
Up to 40 cubic metres	3
Each additional 20 cubic metres,	1 additional

- v. In general, two specimen cylinders for testing at 28 days, plus as many specimens as required for other testing, will be made from every sample. For precast units, a third specimen cylinder shall be taken from every sample, for testing prior to removal of the forms.
- vi. The Contractor shall provide the required quantity of concrete for sampling and testing and shall include the cost of this concrete and any concrete required separately by the Engineer for his own tests, and the necessary tests in the rates bid therefore in the priced Bill of Quantities for the various items of concrete construction.
- vii. The Contractor has the right to be present at any sampling or testing conducted by the Engineer but such right shall not operate to restrict in any way the right of the Engineer to take samples or make tests at any time.
- viii. The Contractor, in the presence of the Engineer will test the plastic concrete in accordance with sub 2 of this to determine its compliance with 6.2.
- ix. The number and frequency of the sampling and tests on plastic concrete will be in accordance with

Table 6.09(4) but in general shall not be less than four samples for each eight hours of concrete production.

- x. More frequent testing of plastic concrete will be directed under certain circumstances, such as, but not limited to times when the fine aggregate moisture content is fluctuating, and the Contractor shall not be entitled to any additional compensation because of any additional sampling or testing of plastic concrete at any location directed by the Engineer.

6907 Rejection of Plastic Concrete

- a) Concrete shall be liable to rejection if:
 - i. after the concrete has been discharged at the placing point and before it has been consolidated the slump, measured to the nearest 5 mm, is not within ± 10 mm of the slump specified in Table 6.02 (6) - Part A or the slump directed in accordance with paragraph c of 6.2.6.
 - ii. The water/cement ratio is not as specified in Table 6.02 (6) part A of this Section.
 - iii. The amounts of admixtures, if used, are not within approved limits.
- b) Plastic concrete which has been rejected shall be removed from the Works with the least possible delay.

6908 Testing Cylinders

The compressive strength of the concrete will be determined by tests on 150 mm diameter by 300 mm long cylinders. Concrete containing aggregate coarser than 37.5 mm shall be sieved to remove all larger particles before the cylinders are made.

Required properties of hardened concrete

- a) The test strength of a sample will be the average strength of the two cylinders made from a sample and tested at 28 days.
- b) Hardened concrete shall be liable to rejection if:
 - i. the average compressive strength of any 3 consecutive samples representing each class of concrete is less than the specified 28 day cylinder strength for that class of concrete; or
 - ii. the strength of a sample is more than 3.4 MPa below the specified 28 day cylinder strength.

6909 Testing Hardened Concrete in Structures

- a) If approved by the Engineer on each specific occasion, and at the Contractor's expense, hardened concrete liable to rejection may be tested for compressive strength in accordance with AASHTO T24. Unless otherwise directed, core specimens shall be 150 mm in diameter. At least 3 specimens shall be tested and the points from which the specimens are obtained shall be as directed by the Engineer.
- b) If the average compressive strength of the core specimens so obtained is equal to or greater than the specified 28 day cylinder strength for that section of the Works, then the concrete represented by the core specimens shall be considered to be structurally satisfactory.
- c) If the concrete is considered to be structurally satisfactory then the holes left by the removal of the test cores shall be repaired as specified in 7. 13. Unless otherwise directed, concrete which fails to

meet the requirements of this shall be removed and replaced in an approved manner.

6910 Payment

- a) The entire cost of all sampling and testing shall be included in the rates bid therefore in the Bill of Quantities for the various items of concrete construction in the works.
- b) The entire cost of securing and testing core specimens of hardened concrete and of removing and replacing rejected concrete shall be borne by the Contractor.

Payment for a laboratory and all equipment required for testing concrete is provided under Bill No. 1 of the Bill of Quantities.

TECHNICAL SPECIFICATION

SERIES 7000

CONCRETE CONSTRUCTION

TECHNICAL SPECIFICATION
SERIES 7000 - CONCRETE CONSTRUCTION MINOR STRUCTURES
TABLE OF CONTENTS

<u>Item</u> <u>Number</u>	<u>Page</u>
7000 Concrete construction	7-3
7001 Concrete Construction - General	7-3
7002 Accessories	7-3
7003 Change to Dimension	7-3
7004 Change in color	7-3
7005 Application of Loads	7-3
7006 Joint Filler and sealant	7-3
7020: Construction and Construction joint	7-3
7021 Construction Joints	7-3
7022 Contraction Joints	7-4
7023 Payment	7-4
7030: Bituminous and Fibber Sheet	7-4
7031 General	7-4
7032 Materials	7-4
7033 Installation	7-4
7034 Payment	7-4
7040: Water proof and sealant for joint	7-5
7041 General	7-5
7042 Materials	7-5
7043 Construction	7-5
7044 Payment	7-5
7050: Form Work	7-5
7051 General	7-5
7052 Architectural requirement	7-6
7053 Shop Drawing	7-6
7054 Forms Ties	7-6
7055 Treatment of forms	7-6
7056 Removal of forms	7-6
7057 Payment	7-7
7100: Tolerance of Concrete Construction	7-7
7101 General	7-7
7102 In-situ Concrete	7-7
7103 Tolerance in reinforcement	7-8
7104 Embedded Metal Work	7-8
7200: Reinforcement	7-9
7201 General	7-9
7202 Material	7-9
7203 Drawing	7-9
7204 Reinforcement Schedule	7-9
7205 Placing reinforcement	7-10

7206	Joining and placing reinforcement	7-10
7207	Measurement	7-11
7208	Payment	7-11
7300:	Preparation for placing concrete	7-12
7301	General	7-12
7302	Cleaning foundation	7-12
7303	Excavation of foundation	7-12
7304	Blinding Concrete	7-12
7305	Clearing previous concrete surfaces	7-13
7306:	Placing of Concrete	7-13
7306	General	7-13
7307	Concrete during hot weather	7-13
7308	Depositing Concrete	7-13
7309	Concrete place in Horizontal layers	7-14
7310	Consolidation	7-14
7311:	Finish and Finishing	7-15
7311	General	7-15
7312	Class of finished for formed concrete	7-15
7313	Class of Finish for Unformed Concrete	7-16
7314	Sprinkling with Cement	7-16
7315	Curing of concrete	7-17
7315	General	7-17
7316	Water curing	7-17
7317	Membrane curing	7-17
7318	Steam curing	7-18
7400:	Repair of Concrete	7-19
7401	General	7-19
7402	Dry Pack	7-19
7403	Mortar	7-20
7404	Concrete	7-20
7605	Epoxy Resin	7-20
7406	Staining Concrete	7-20
7407	Plugging form-tie holes	7-20
7408	Materials used in repair	7-21
7409	Payment	7-21
7500:	Construction of Box Culvert	7-21
7501	Requirement	7-21
7502	Materials	7-21
7503	Clearing and Grubbing	7-22
7504	Excavation	7-22
7505	Construction sequence	7-22
7506	Back filling	7-22
7507	Traffic diversion	7-22
7508	Measurement and Payment	7-22

7600: Construction of Pipe Culvert 7-24

7601	General	7-24
7602	Materials	7-24
7603	Excavation	7-24
7604	Installation	7-24
7605	Jointing	7-24
7606	Back filling	7-24
7607	Construction Equipment	7-25
7608	Measurement and Payment	7-25

7700: Concrete in major structures

7701.	Concrete in Pile Caps	7-26
7702.	Concrete in Abutment	7-26
7703.	Concrete in Piers	7-26
7704.	Concrete in bridge decks	7-26
7705.	Concrete in Parapets and Barrier walls	7-26
7706.	Measurement	7-26
7707.	Payment	7-27

7810: Rain water down pipe 7-26

7811	General	7-26
7812	Payment	7-26

7900: Aggregate drainage layer 7-26

7901	General	7-26
7902	Payment	7-26

7000: Concrete Construction**7001 General**

All concrete construction shall conform to the requirements of this section and the detailed requirements of section 7.2 to 7.12 inclusive. All structures shall be built in a workmanlike manner to the lines, grades and dimensions shown on the drawing or directed.

7002 Accessories

The Contractor shall place and attach to each structure all timber, metal or other accessories necessary for its completion, as shown on the Drawings or directed. The cost of such work, for which specific Items are not provided in the Bill of Quantities, shall be deemed to be included in the rates tendered in the priced Bill of Quantities for the work to which they are appurtenant.

7003 Changes to Dimension

The dimensions of each structure shown on the Drawings will be subject to such changes as may be found necessary by the Engineer to adapt the structures to the conditions disclosed by the excavation.

7004 Changes in Colour

Abrupt changes in colour of external concrete surfaces exposed to public view will not be permitted. The Contractor shall ensure that as far as possible this surface shall be of uniform or well graded colour and shall use a consistent approved mix.

7005 Application of Loads

Loads shall not be applied to concrete placed in the permanent works without prior approval of the Engineer.

7006 Joint Fillers and sealants

At least 60 days before their proposed use, the Contractor shall submit, for approval, samples of the proposed joint fillers and sealants specified in sections 7300 and 7400 together with the manufacturer's technical data and the details of the recommended method of application.

7020: CONSTRUCTION AND CONTRACTION JOINTS**7021 Construction Joints**

- a) Concrete surfaces, upon or against which concrete is to be placed and to which new concrete is to adhere, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints.
- b)
 - i. The location of and details of required shapes for construction joints are shown on the Drawings and the reinforcement schedules shall be detailed on this basis.
 - ii. Subject to approval, and excepting joints placed for architectural or other purposes which shall not be changed, the Contractor may vary the location of construction joints and sequence of concrete placements, provided that the Contractor shall make all necessary adjustments to the reinforcement to the satisfaction of the Engineer and without cost to the Employer.
 - iii. Unless otherwise shown in the Drawings or approved the maximum spacing between construction joints measured along the structure or element of the structure shall be 10 metres.
 - iv. The Contractor shall submit, for approval, Drawings showing his proposed location of construction joints and sequence of concrete pours not less than 30 days before placing concrete in each structure.
- c) Joints shown on the Drawings as compulsory construction joints shall not be altered and no concrete shall be placed adjacent to the joint for at least 7 days for features up to 1 m in thickness and for at least 10 days where the thickness exceeds 1 m.
- d) Construction joints shall be horizontal or vertical unless otherwise shown on the Drawings or directed and shall be given the prescribed shape by the use of forms, where required, or by other approved means that will ensure suitable jointing with subsequent work. Unless shown on the Drawings, keyways will not be required at construction joints. All intersections of construction joints with concrete surfaces which will be exposed to view shall be made straight and level or plumb and leak proof by the use of 25 mm by 18 mm timber or approved inserts in the corner of the formwork.

7022 Contraction Joints

Contraction joints shall be located and constructed as shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. Unless otherwise shown or specified, the surface of the concrete first placed at contraction joints shall be coated with a colourless grease to break the bond before the concrete on the other side of the joint is placed.

7023 Payment

The cost of construction and contraction joints shall be included in the rates tendered in the priced Bill of Quantities for the concrete in which the joints are required.

7030: Bituminous Fibre Sheet for Contraction Joints**7031 General**

The Contractor shall furnish and install bituminous fibre sheet in contraction joints in box culverts as shown on the Drawing or directed.

7032 Materials

The bituminous fibre sheet shall be about 12 mm thick sheet specifically manufactured for concrete joints complying with AASHTO M33 and conforming to samples and Specification submitted by the Contractor and approved by the Engineer.

7033 Installation

- a) Exposed edges of the bituminous fibre sheet shall be installed flush with either the back of the recess formed by chamfers on the corners of the concrete or the finished concrete surface as shown on the Drawings or as directed.
- b) Joints in the bituminous fibre sheets shall be scarfed as recommended by the manufacturer and to the approval of the Engineer. The number of field joints shall be kept to a minimum and where possible joints shall be factory produced.

7034 Payment

Separate payment will not be made for bituminous fibre sheet joint filler and all costs associated with meeting the requirements of this section shall be included in the rates bid in the priced bill of quantities for the concrete between which the joints are installed.

7040: Waterproof Sealant for Joints**7041 General**

The Contractor shall construct waterproof seals in butt joints as shown on the Drawings or as directed.

7042 Materials

- a) Waterproof joint seals shall be bitumen or rubber-bitumen or other compounds manufactured specifically for filling and waterproofing horizontal and vertical joints in concrete meeting the requirements of an appropriate international standard and as approved by the Engineer.
- b) The Contractor shall submit to the Engineer not less than 45 days prior to the filling of any joint, samples, Specifications and manufacturer's instructions of the materials he proposes to use.

7043 Construction

- a) Bituminous or other waterproofing seals shall be prepared and formed in accordance with the manufacturer's instructions as approved by the Engineer.
- b) Seals shall be placed after curing of mortar in joints. The joint shall be raked with an approved tool to a depth of 10 mm and the joint cleared of all loose material and thoroughly dried by compressed air jet or other approved means.
- c) The seal shall then be placed to completely fill the prepared joint as shown on the Drawings, or directed by the Engineer.

7044 Payment

Separate payment will not be made for waterproof seals for joints and all costs associated with meeting the requirements of this section shall be included in the rates bid in the priced Bill of Quantities for installing the precast concrete units between which the seals are installed.

7050: FORMWORK

7051 General

Concrete shall not be placed until the reinforcement and the forms have been inspected and approved by the Engineer.

Before placing of concrete all sawdust, wood chips and other construction debris and extraneous matter shall be removed from the interior of the forms, the reinforcement shall be thoroughly cleaned; and the forms and reinforcement shall be thoroughly wetted.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs and chutes requires the permission of the Engineer. The chutes or troughs shall be kept clean and free from hardened concrete.

Concrete to be placed from a height of more than 1.5m shall be poured through troughs/tremie pipes, or as directed by the Engineer.

Plastic cone snap ties are preferred with the formwork for wing walls, abutments and other vertical members. Metal ties or anchorages within the forms shall be constructed as to permit their removal to a depth of at least 25mm from the face without injury to the concrete. Ordinary wire ties may be used only when the concrete will not be exposed to view and sulfates. Upon removal of the forms, shall be cut back at least 7mm from the face of concrete with chisels or nippers. Fittings for metal ties shall be such design that upon their removal, the cavities that are left will be of the smallest possible size. The cavities shall be filled with cement mortar and surface left sound smooth, even and uniform color.

Concrete shall be laid in layers of 150mm to 300mm in thickness and each layer shall be properly vibrated before laying the next one.

- a) Forms shall be used to confine the concrete and shape it to the required lines.
- b) Unless otherwise approved, forms shall be designed and constructed by the Contractor and shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete without excessive deflection of any part of surface and shall be maintained rigidly in position.
- c) Forms shall be of wood, metal or other approved material. Forms for exposed surfaces shall be lined with metal or plywood, or other approved material.
- d) Forms shall be sufficiently tight to prevent loss of mortar from the concrete.
- e) Unless otherwise shown on the Drawings, moulding strips shall be placed in the corners of forms to produce bevelled edges on permanently exposed concrete surfaces. Interior angles on such surfaces and edges at formed joints will not require bevelling unless the requirement for bevelling is shown on the Drawings.
- f) The Engineer shall be informed before the Contractor strips any formwork.
- g) The Contractor shall remain fully responsible for the safety of structures from which he removes formwork.

7052 Architectural Requirements

- a)
 - i. Form-lining shall be continuous for the full height of the form.
 - ii. Vertical joints in form-lining shall be equally spaced along the length of the form for exposed concrete surfaces. The spacing shall be identical in succeeding wall placements.
 - iii. All edges of lining shall be straight plumb and true to level.

- b) Form-ties shall have a regular set - out in relation to the whole form and to each piece of form-lining.

7053 Shop Drawings

- a) The Contractor shall submit, for approval, Drawings showing details of the formwork and its supports, including adjustments provided and provisions for stripping. The Drawings shall be accompanied by design calculations sufficiently detailed to allow easy checking showing the stresses and deflections in the form surfaces, members and supports. The Drawings and calculations shall be certified by the qualified civil engineer. Approval of these Drawings by the Engineer shall not relieve the Contractor of any of his responsibilities under the contract.
- b) The Drawings shall show the proposed locations of joints in the form lining and the positions of any form ties.

7054 Form-Ties

- a) Embedded ties for holding forms shall remain embedded not less than two diameters or twice the minimum dimension of the tie or 1 mm, whichever is the greater, from the formed faces of the concrete.
- b) The ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete.
- c) Recesses resulting from removal of form-ties shall be repaired in accordance with section 7.13.

7055 Treatment of Forms

Before forms are erected the surface of the forms shall be coated with an approved form-oil that will effectively prevent sticking and will not stain the concrete surface. The Contractor shall submit for approval at least 2 litres of the proposed form-oil at least 30 days before its use is required. When concrete is placed, the surfaces of the forms shall be free from encrustation of mortar, grout, or other foreign material.

7056 Removal of Forms

- a) Forms shall be removed carefully as soon as the concrete has hardened sufficiently to prevent damage in order to facilitate satisfactory progress with the specified curing and enable the earliest practicable repair to imperfections in the surface of the concrete in accordance with section 7.13.
- b) Concrete shall be cured immediately the forms have been removed and curing only temporarily stopped in the actual locations where repairs are being carried out.
- c) Forms on upper sloping faces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once.
- d) In order to avoid excessive stresses in the concrete that might result from swelling of the forms, timber forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete. Forms for the openings shall be constructed so as to facilitate such loosening.
- e) Immediately after stripping, the concrete forms to be reused shall be cleaned, their surface shall be repaired as necessary and oiled with form-oil and the form shall be carefully stored in its true shape.

7057 Payment

The cost of all labour, equipment and materials for forms and their support, handling and maintenance and for any necessary treatment or coating of forms shall be included in the rates tendered for the concrete for which the forms are used.

7100 TOLERANCE FOR CONCRETE CONSTRUCTION

7101 General

- a) Allowable deviations from plumb or level and from the alignment, profile, grades and dimensions shown on the Drawings are defined as 'tolerances'. Tolerances shall be inclusive of surface irregularities as defined in section 7.11. The intent of this section is to establish tolerances that are consistent with modern construction practice, yet governed by the effect that permissible deviations will have upon the structural action or operational function of the structure. Deviations from the established lines, grades and dimensions will be permitted to the extent set forth in this section; provided that the Engineer may reduce the tolerance set forth in this section if such tolerances impair the structural action or operational function of a structure or item.
- b) Where tolerances are not stated in the Specification or shown on the Drawings for any individual structure or feature thereof, permissible deviations will be interpreted in conformity with the provisions of this section. Notations on the Drawings or included in this Specification of specific tolerance in connection with any dimensions, shall be considered as supplementary to the tolerances specified in this section.
- c) The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits and shall ensure that the work is completed within the tolerances specified in this section. Concrete work that exceeds the tolerance limits specified in this section shall be remedied or removed and replaced by and at the expense of the Contractor.

7102 In-situ Concrete

Tolerances for reinforced concrete structures shall be in accordance with the requirements as specified below, except where such tolerances are reduced by the Engineer.

i. Variation from the plumb:

In the lines and surfaces of	In 3 m	5 mm
columns, piers, walls,	In 6 m	8 mm
railing posts	In 12 m or more	16 mm

ii. Variations from the level or from the grades indicated on the Drawings:

Concrete railings	6 mm
-------------------	------

In slab	In 3 m	5 mm
and beam soffits	In any bay	8 mm
In 6 m		8 mm
In 12 m or more		16 mm
Other		12 mm

iii. Variation from indicated position in plan

iv. Variation in bridge deck slab thickness	plus	5 mm
	minus	3 mm

v. Variation in cross-sectional	plus	12 mm
dimensions of columns, beams	minus	5 mm
and in the thickness of slabs (other than in iv) and walls		

vi. Footings; the following apply to concrete only, not to reinforcing bars:

	variations in dimensions in plan	plus minus	50 mm 12 mm
Misplacement or eccentricity	2 per cent of the footing width in the direction of misplacement but not more than 50 mm.		

7103 Tolerance in Reinforcement

Tolerances for reinforcing steel:

- | | | |
|------|---|------------------|
| i. | Length of splice | - 25 mm |
| ii. | Variation of protective cover | ±5 mm |
| iii. | Variation in indicated position of reinforcement: | |
| | . Starter bars | one bar diameter |
| | . Slabs and walls indicated spacing | 0.25 times the |
| | . Beams and columns | ±5 mm |
| iv. | Dimensions of bent bars: | |
| | . Stirrups and ties | ±5 mm |
| | . Other bars | ±10 mm |

Provided the number of bars required by the specified spacing is not varied and provided the specified minimum cover to reinforcement is maintained.

7104 Embedded Metalwork

Tolerances for placing embedded metalwork ±5 mm

7200: REINFORCEMENT**7201 General**

The Contractor shall furnish and install all steel reinforcing bar, wire or fabric, hereinafter referred to as reinforcement, required for execution of the works as specified herein, or as shown on the Drawings or directed.

7202 Material

Mild steel Reinforcing bars shall be Grade SK-30 deformed bars produced by any Steel Mills, and generally complying with AASHTO M42/M 42M-92 and or approved equivalent, and having minimum yield strength not less than 275 MPa.

High yield reinforcing steel bars shall be deformed bars with a yield stress not less than 413 Mpa and shall complying with ASTM A 615 or the latest such equivalent standard or specification in force that is considered by the Engineer to apply.

The use of cold twisted bars is not permitted. Steel for all bars shall be produced by open hearth, basic oxygen or electric arc furnace methods, unless otherwise called for on the Drawings or in special provisions.

Plain round bars will be permitted only on the written approval of the Engineer.

Reinforcing wire or fabric shall comply with AASHTO M32, M55, M225 or M221 as appropriate.

The Contractor shall state in his Tender his proposed source, and grades of reinforcement and shall furnish Certificates of Compliance from the manufacturer of the reinforcing bars, wire or fabric that the proposed materials comply with this Specification.

At least 45 days before using any reinforcement in the Works, the Contractor shall submit, for approval, representative samples of the proposed reinforcement to the Engineer.

The Engineer may test, from time to time throughout the execution of the Works, further samples of the reinforcement for testing to check compliance with this Specification.

The Contractor shall not change his source of supply of reinforcement without prior written approval by the Engineer.

7203 Drawings

Steel reinforcing bars shall be placed in concrete where shown in the Drawings or as directed.

7204 Reinforcement Schedules

The Contractor shall prepare detailed and complete bar lists and bending diagrams hereinafter referred to reinforcement schedules, from the reinforcement details shown on the Drawings. The schedules shall use the standard bar shapes and reinforcement schedule pro-forma as shown on the Drawings included with this Specification. Bending of reinforcement shall comply with the requirements of the AASHTO Standard Specification for Highway Bridges.

The Contractor shall submit to the Engineer for approval, at least 30 days before placing reinforcement, 2 copies and 1 transparency of the reinforcement schedules, together with 2 copies and 1 transparency of the reinforcement Drawings marked up with his proposed location of any construction joints additional to those shown on the Drawings. The approval of reinforcement schedules shall in no way relieve the Contractor of responsibility for the correctness of such schedules.

7205 Placing Reinforcement

- a) The Contractor shall be responsible for the accuracy of the cutting, bending and placing of the reinforcement. Reinforcement will be inspected for compliance with the requirements as to grade, size, shape, length, slicing locations, position and amount after it has been placed.
- b) Before the reinforcement is placed, the surfaces of the bars or fabric and the surfaces of any metal bar supports shall be cleaned of heavy rust, loose mill scale, dirt, grease and other objectionable foreign substances. Heavy flaky rust which can be removed by firm rubbing with rough cloth or equivalent treatment is considered objectionable. After being placed, the reinforcing bars or fabric shall be maintained in a clean condition until they are completely embedded in the concrete.
- c) Reinforcement shall be accurately placed in the position shown on the Drawings and shall be securely held by blocking from the forms, by supporting on concrete or on approved metal or plastic chairs or by using metal hangers and by wiring together at intersections using annealed wire of diameter not less than 1.2 mm with the ends turned into the main body of concrete. Bars shall be tied at all intersections except where the spacing in any direction is less than 300 mm when alternate intersections shall be tied.
- d) Reinforcement supports shall be strong enough to withstand the imposed loads without movement of the reinforcement. They shall be positively attached to the reinforcement and of such size and number as to maintain the specified cover.
- e) There shall be a clear distance of at least 25 mm between the bars and any adjacent embedded metalwork. The Contractor shall ensure that there is no disturbance of the reinforcing bars or fabric in concrete that has already been placed.
- f) Chairs, hangers, spacers and other approved metal, plastic or concrete supports may be furnished and used by the Contractor for supporting reinforcing bars. Concrete supports where used shall be made for the same materials and of the same proportions of sand and cement as that of the concrete in which they are to be used. They shall be cast and cured for at least 7 days before used and shall have wire or

other approved device cast into each support for the purpose of attaching them positively to the reinforcement. If metal supports are used, the portion which extends to the surface of the concrete shall be galvanized or plastic coated and shall be of such shape that they will be easily enveloped by the concrete.

7206 Joining and Splicing Reinforcement

- a) Joints or splices in reinforcing bars shall generally be made at the positions shown on the Drawings, but the Contractor will be permitted to make joints or splices at positions other than those shown on the Drawings, provided that such positions are approved by the Engineer and that the joints and splices in adjacent bars are staggered as directed by the Engineer. Approval of such additional splices will generally be restricted to splices not closer than 8 m in horizontal bars, or 4 m in vertical bars measured between the mid point of laps. The number of splices shall be kept to a minimum.
- b) If cold worked reinforcing bars are used, welding will be permitted only if and when approval has been given by the Engineer for that particular case or application.
- c) Welded splices of mild steel reinforcement shall only be permitted at those locations shown on the Drawings or directed by the Engineer.
- d) All welding of reinforcement for splices shall generally be in accordance with the latest edition of the American Welding Society (AWS) publication "Structural Welding Code-Reinforcing Steel".
- e) Only approved and experienced welders shall be permitted to make welded splices. Each welder shall make, for testing and approval purposes, in the presence of the Engineer, and using the equipment and welding materials proposed for use in the works, 3 welded splices using bar sizes and welding positions as directed by the Engineer.
- f) A full welded splice shall have bars lapped or butted, and welded to develop in tension at least 125 per cent of the specified minimum yield strength of the bar.
- g) Splices in reinforcement in concrete piles where unavoidable shall only be made by butt welding. Lap splices in concrete piles shall not be permitted.
- h) If the Contractor proposes to use mechanical couplings for reinforcing bars, he shall submit, for approval, samples of the proposed coupling not less than 60 days before their proposed use.

7207 Measurement

- a) Measurement, for payment, of furnishing and placing reinforcing bars shall be made only of the calculated mass of the bars placed in the concrete as shown on the Drawings or directed. The calculated mass for reinforcing bars shall be based on the mass per metre given in Table 7.06 (1) or such other table as may be approved by the Engineer in the Letter of Acceptance. No allowance shall be made for rolling margin.
- b) Wire or bar mesh used for reinforcement having wire or bars 5 mm or less in diameter will be measured by the net square metre complete, in place and accepted not including overlaps. Mesh having bar diameters greater than 5 mm will be measured as provided for bars.

Table 7-1 Mass of Reinforcing Bars

Bar Diameter (mm)	Mass (kg/m)
10	0.617
12	0.888
16	1.578
19	2.466
22	2.984

25	3.853
28	4.833
32	6.313

- c) All joints or splices shown on the Drawings, or directed, or approved shall be measured for payment as laps. Additional joints or splices will not be measured for payment. No separate payment will be made for welding splices.
- d) Reinforcement used in miscellaneous precast concrete units will not be measured for payment.

7208 Payment

- a) Payment will be made at the Contract Unit Price for the items listed below which are included in the Bill of Quantities. These rates shall include the cost of furnishing and attaching wire ties and metal, concrete or other supports, scheduling, furnishing, cutting, bending, cleaning, securing and maintaining in position all reinforcing bars.

<u>Pay Item</u>	<u>Unit</u>
72/1 - Furnish and Place Mild steel deformed Reinforcing Bars 40-grade	Tonne
72/2-Furnish and Place High yield steel deformed Reinforcing Bars 60-grade	Tonne
72/3 - Furnish and Place Reinforcing Mesh	sq. m.

7300: PREPARATION FOR PLACING CONCRETE, FINISHING, CURING

7301 General

- a) Concrete shall not be placed until all construction of formwork, installation of reinforcement and parts to be embedded, preparation of surfaces, methods and equipment for transporting, handling, placing and finishing concrete, the number of vibrators and method of consolidating the concrete and the method of curing the concrete have been approved for concrete in a nominated section of work.
- b) Concrete shall not be placed in water.
- c) All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed, shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.
- d) The Contractor shall notify the Engineer verbally and in writing, at least 48 hours in advance of the Contractor's intention to place concrete.
- e) The Contractor shall have adequate and operable, as determined by the Engineer, mixers, vibrators, scales, measuring devices, materials and tools, prior to the Engineer approving starting of a concreting operation.
- f) In order that concrete can be properly finished, when the amount of concrete to be placed continuously is such that it cannot be finished before the end of the regular working day, the time of starting the concreting operations shall be subject to the approval of the Engineer.
- g) The Contractor shall furnish assurance to the Engineer of an adequate and uniform source of supply of concrete to permit proper placing and finishing before work will be permitted to start.
- h) The Engineer under certain conditions will permit night work if requested and if an adequate system of lighting is provided by the Contractor and approved by the Engineer.

7302 Cleaning Foundations

- a) Immediately before placing concrete, all surfaces of foundations upon or against which the concrete is to be placed shall be free from standing water, mud, debris, oil, objectionable coatings and loose, semi-detached or unsound fragments. Where directed surfaces of foundations shall be cleaned with air-water jets.
- b) The surfaces of absorptive a foundation against which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete.

7303 Excavation for foundations

The Contractor shall notify the Engineer before commencing excavation of foundations so that the cross-section, elevations and measurements of the undisturbed ground may taken.

Foundations for structures shall be excavated to the lines, grades and elevations shown on the Drawings or as directed by the Engineer. The elevations of the bottom of the foundations shown on the Drawings are approximate only, and the Engineer may order such changes as are deemed necessary to provide a secure foundation.

Special care shall be taken not to disturb the bottom of the excavation, and final removal of the foundation material to grade shall not be made until just before the footing is to be placed.

Where the material below the bottom of footings not supported by piles has been disturbed, it shall be removed and the entire space filled with concrete not less than 15 MPa at the contractor's expense. Under footings supported on piles, the over-excavation on disturbed volumes shall be replaced and compacted as directed by engineer.

The excavation shall be sufficiently large to provide for the necessary working space, shuttering and any other Temporary Works.

Boulders, roots and any other objectionable material encountered in excavation shall be removed. The excavated foundation shall be cleared of all loose material and cut to a firm surface.

The final 100mm of excavation under footings or abutments shall be deferred so that the foundation bottom is not exposed until just before brickwork or concrete work begins.

The Contractor shall be solely responsible for the safety and stability of the excavation and shall provide all protective supports, bracing and shoring as required.

Excavated material classified as suitable for fill shall be stockpiled. Waste material, and suitable fill material in excess of requirements, shall be disposed by the Contractor outside the limits of the Site.

No footings, bedding material or structure shall be placed in any foundation until the Engineer has inspected and approved the depth of excavation and the foundation material.

7304 Blinding Concrete

- a) Unless otherwise shown on the Drawings, or approved in each specific case, all foundation surfaces against which concrete is to be placed shall be covered with a layer of blinding concrete approximately 50 mm thick.
- b) The class of concrete used for blinding concrete shall be as specified in Table 6.02 (6) - Part B.
- c) The blinding concrete shall be spread and shall be worked thoroughly into all irregularities of the surface.
- d) Concrete shall not be placed upon blinding concrete which has become contaminated by water, debris or other deleterious material. Blinding concrete which has been so contaminated shall be removed from the surface of the foundation, the surface shall be recleaned and a fresh layer of blinding concrete

deposited on the surface before concrete is placed against the surface.

7305 Cleaning Previously Placed Concrete Surfaces

- a) The surface of construction joints, as defined in section 7.2 shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of the removal of all latency, loose or defective concrete, coatings, sand, curing compound if used, and other foreign material to the satisfaction of the Engineer.
- b) The surface of block outs against which concrete is to be placed shall be roughened by scabbling.
- c) The surface of all construction joints, including surfaces of block outs, shall be washed thoroughly with air-water jets immediately before placing adjoining concrete. All pools of water shall be removed from the surfaces of construction joints before new concrete is placed.
- d) The surface of all contraction joint as defined in section 7.2 shall be cleaned thoroughly of accretions of concrete or other foreign material by scraping, chipping, or by other approved means.

7306: PLACING CONCRETE

General

The Contractor shall advise the Engineer when concrete will be placed and concrete shall only be placed in the presence of the Engineer.

7307 Concreting During Hot Weather

- a) No concrete shall be place when the shade air temperature is above 35 °C. Under no circumstances will concrete be accepted if the temperature of the concrete as deposited into the formwork exceeds 30°C.

It may be necessary for the Contractor to provide for the cooling of mixing water and for the efficient insulation of any storage tanks and pipe lines for mixing water to achieve the placing temperature specified in paragraph (a) above.

- c) Aggregate bins, batching and mixing equipment shall be painted white and, if directed stock piles shall be sprinkled with water.
- d) Appropriate measures shall be taken with respect to transporting and placing the concrete to control the temperature of concrete. Stockpiles, mixers and transported fresh concrete shall be kept shaded. Pipe lines for conveying concrete shall be shaded and insulated or painted white; the elapsed time from mixing to placing shall be minimized. Concrete shall be placed promptly when delivered and finishing operation shall not be delayed; concrete surfaces shall be protected from wind and sun if directed during placing, finishing or curing operations.
- e) The cost of all materials, labour and equipment required as specified in this section shall be included in the rates tendered in the priced Bill of Quantities for concrete.

7308 Depositing Concrete

- a) The Engineer may direct that structural concrete placement in formed work shall be started with an approved over sanded mix containing 20 mm maximum size aggregate, a maximum water-cement ratio of 0.47 by mass, and having a maximum slump of 100 mm, placed about 40 mm deep on the joint at the bottom of the placement to minimise honeycombing.
- b) Whenever practicable, concrete shall be deposited directly in its final position and shall not be dropped, chute or caused to flow in a manner to permit or cause segregation. Methods and equipment employed in depositing concrete in forms shall be such as will not result in clusters or group of coarse aggregate being separated from the mass. The movement of concrete within the forms by use of

vibrators will not be permitted.

- c) Unless otherwise agreed by the Engineer, concrete shall not be dropped into place from a height exceeding 2 metres.
- d) The Contractor shall provide approved chutes and baffles to confine and control falling concrete. Open troughs, chutes or pipes shall be metal or metal lined and shall be kept clean and free from coatings of hardened concrete. Water used for flushing shall be discharged clear of the structure.
- e) In the event of continuous placing being interrupted for any reason, the Contractor shall thoroughly consolidate the concrete at such joints to a reasonable uniform and stable slope while the concrete is plastic and any concrete which is unconsolidated and no longer plastic shall be removed by the Contractor at his own expense. The concrete at the surface of such cold joints shall be clean and damp when covered with fresh concrete.

7309 Concrete Placed in Horizontal Layers

Except as intercepted by joints, all formed concrete shall be placed in continuous approximately horizontal layers, the depths of which generally shall not exceed 300 mm. The Engineer may direct thinner layers where concrete in 300 mm layers cannot be placed in accordance with the requirements of this Specification.

7310 Consolidation

- a) Concrete shall be consolidated to the maximum practicable density in such a manner that it is free from pockets of coarse aggregate and closes snugly against all surfaces of forms and embedded materials.
- b) Whenever practicable, concrete shall be consolidated by approved immersion type vibrators operated in accordance with the manufacturer's recommendations. Form vibrators, or impact hammers applied to the forms, shall be used wherever internal vibration is not possible or would be inadequate. Where the use of mechanical vibration is not possible or would be inadequate, concrete shall be consolidated thoroughly by hand.
- c) In consolidating each layer of concrete, the immersion type vibrator shall be operated in near vertical position and the vibrating head shall be allowed to penetrate and revibrate the concrete in the upper portion of the underlying layer. In the area where newly placed concrete in each layer joins previously placed concrete in the same layer, more than usual vibration shall be performed, the vibrator penetrating deeply at close intervals over the areas of contact of these layers. Layers of concrete shall not be placed until layers previously placed have been vibrated thoroughly as specified. Contact of the vibrating head with surfaces of the forms shall be avoided. Direct vibration of the reinforcement will not be permitted.
- d) The total consolidating capacity in cubic metres of concrete per hour of all vibrators in effective operating condition, and employed on concrete compaction in the Works, shall be based on a rated capacity of 70 per cent of the manufacturer's recommendation of each type of vibrator in operation and the total compacting capacity so computed shall be not less than the maximum rate at which concrete is placed in the Works. For every 3 vibrators in use on a concrete placement, the Contractor shall provide one additional standby vibrator of similar compacting capacity in good working order.

7311: FINISHES AND FINISHING

General

- a)
 - i. Irregularities to finish as described herein are to be distinguished from tolerances as pacified in section 7.6.
 - ii. Finishing of concrete surfaces shall be performed by skilled workmen.

- b)
 - i. The Contractor shall inform the Engineer when concrete will be finished.
 - ii. Unless inspection is waived by the Engineer in each specific case, finishing of concrete shall be performed only in the presence of the Engineer.
 - iii. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the specified limits.
- c)
 - i. Surface irregularities are classified as 'abrupt' or 'gradual'.
 - ii. Offsets caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots or otherwise defective form timber will be considered as 'abrupt' irregularities, and will be tested by direct measurements.
 - iii. All other irregularities will be considered as 'gradual' irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 1.5 m for testing of formed surfaces, and 3 m for testing of unformed surfaces.
- d) Grinding and bush-hammering will not be required on formed surfaces, but, unless waived by the Engineer in each specific case, grinding will be required for the repair of surface imperfections or for the removal of concrete which is outside specified tolerances.

7312 Class of Finish for Formed Concrete

- a) All formed concrete surfaces shall be given Class 1, Ordinary Surface Finish, and in addition, if further finishing is required, shall be given a Class 2, Rubbed Finish.
- b)
 - i. Exposed surfaces of all formed concrete surfaces including precast concrete shall generally be given Class 2, Rubbed Finish except in the following specific locations, or as directed by the Engineer:

tops and bottoms of bridge deck slabs.

- ii. Class 2 finish shall be continued not less than 300 mm below the level of any subsequent backfilling.
 - iii. When forms lined with metal or plywood are used, the requirement for a Class 2, Rubbed Finish may be waived by the Engineer except for the surfaces of posts and railings on bridges.
- c)
 - i. Ordinary Surface Finish (Class 1)

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed. On all surfaces, the cavities produced by form ties and all other holes, honeycombs, broken corners or edges and other defects shall be repaired in accordance with section 7.13.

The concrete shall then be rubbed if required or cured in accordance 7.12.

The resulting surfaces shall be true and uniform. Surface irregularities shall not exceed 10 mm. All surfaces which cannot be repaired to the satisfaction of the Engineer shall be "rubbed" as specified for Class 2, Rubbed Finish.

- ii. Rubbed Finish (Class 2)

After removal of forms, rubbing of concrete shall start as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water for a minimum period of three hours. Sufficient time shall have elapsed before the wetting down to allow the material used in any concrete repairs, in accordance with section 7.13 to thoroughly set.

Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on the faces. The mortar shall be composed of cement and fine aggregate mixed in the proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections and excessive surface irregularities have been removed, all voids filled and a uniform surface has been obtained. Surface irregularities shall not exceed 5 mm. The paste produced by this rubbing shall be left in place at this time.

After all concrete above the surface being treated has been cast the final finish shall be obtained by rubbing with a fine carborundum stone and water. The rubbing shall continue until the entire surface is of a smooth texture and uniform colour.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

7313 Class of Finish for Unformed Concrete

- a) The classes of finish for unformed concrete surfaces are designated by the symbols U1 and U2. Interior surfaces shall be sloped for drainage where shown on the Drawings or directed. Surfaces which will be exposed to the weather and which are nominally level shall be sloped for drainage at approximately two per cent unless the use of other slopes or level surfaces are shown on the Drawings, or directed. Unless otherwise specified or shown on the Drawings, these classes of finish shall apply as follows:
 - i. U1 - Finish U1 (screeded finish) applies to unformed surfaces that will be covered by fill material or by concrete. Finish U1 is also used as the first stage of finish U2. The surfaces shall be levelled and screeded sufficiently to produce even, uniform surfaces. Surface irregularities shall not exceed 10 mm.
 - ii. U2 - Finish U2 (floated finish) applies to unformed surfaces not permanently concealed by fill material or concrete, or not required to receive finish U1. Floating may be performed by use of hand or power-driven equipment. Floating shall be delayed until the screeded surface has stiffened sufficiently to prevent the formation of latency, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 5 mm. Joints and edges shall be tooled down where shown on the Drawings or directed.
- b) Unformed surfaces of bridge parapet posts and railings shall be given a Class 2, Rubbed Finish.

7314 Sprinkling with Cement

Sprinkling of the surfaces with dry cement or any other material during finishing operations for drying off the concrete, to facilitate trowelling or for any other purpose will not be approved.

7315: CURING OF CONCRETE

General

- a) All concrete shall be cured using water, in accordance with this section, except for surfaces which do not require a rubbed finish in accordance with section 7.11 for which membrane curing may be approved. Membrane curing will not be approved for construction joints.
- b) Curing of concrete shall start immediately after the forms are removed and the necessary finishing has been done, except where the formwork is maintained in position in a wet condition.
- c) The surfaces of construction joints shall be moistened by covering with water-saturated material or by other approved means as soon as the concrete has hardened sufficiently to prevent damage by water. The surfaces shall be kept completely and continuously moist, before and during form removal, by

water applied on these surfaces.

- d) All precast concrete may be cured by steam curing in accordance with this section.
- e) Water used for curing shall meet the requirements of this Specification for water used in concrete, but with the additional requirement that the water shall not contain any chemicals or other substances that will cause staining of concrete surfaces.

7316 Water Curing

- a) At least 14 days before placing concrete in any structure to be water cured, the Contractor shall submit, for approval, details of the equipment and methods he proposes to use for water curing. After the initial placement of concrete in any structure, subsequent placements will not be permitted until equipment for curing has been satisfactorily installed and is operating on all previous placements in the structure.
- b) All unformed surfaces shall be protected with two thicknesses of wet coarse heavy fabric which have been spot stitched, wet jute cotton mats or by other approved effective means, as soon as the concrete has hardened sufficiently to prevent damage by water. These surfaces shall be kept completely and continuously moist, prior to and during form removal. This procedure shall be followed by the specified water curing or membrane curing.
- c) Concrete to be water cured shall be cured for at least 7 days immediately following placement of the concrete, or until covered with fresh concrete, by keeping all surfaces continuously wet and avoiding cycles of being wet and then dry.
- d) Water curing shall be accomplished by one or more of the following methods or any approved or directed by the Engineer.
 - i. maintaining the formwork in position in a wet condition.
 - ii. Ponding of water on the surface.
 - iii. Covering with coarse heavy fabric, Hessian, jute felt cotton mats, cotton mats, burlap or similar approved material maintained in a damp condition.
 - iv. Covering with at least 25 mm thickness of sand maintained in a damp condition.
 - v. Continuously sprinkling with water.
 - vi. Impervious burlap backed paper or plastic coverings placed and kept in contact with a thoroughly wetted surface.
- e) Sheet materials for curing concrete and burlap shall comply with AASHTO M171 and M182 respectively.

7317 Membrane Curing

- a) Membrane curing, if approved, shall be by application of an approved type of curing compound complying with AASHTO M148 which forms a water retaining membrane on the surface of the concrete surface by spraying on one coat or, where approved, by brushing or rolling on two coats, to provide a continuous uniform membrane over all areas, with a maximum coverage per litre, as directed, according to the roughness of the surface to be covered. If necessary to adequately cover the surface, as determined by the Engineer, an additional coat of curing compound shall be applied.
- b) When curing compound is to be used on unformed concrete surfaces, application of the compound shall commence immediately after the finishing operations are completed.
- c) When curing compound is to be used on formed concrete surfaces, the surface shall be moistened with

a light spray of water immediately after the forms are removed, and shall be kept wet until the surface will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the curing compound shall be applied. There shall be ample coverage with the compound at edges, corners and blow-holes of formed surfaces. After application of the curing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with curing compound in accordance with the foregoing requirements.

- d) Equipment for applying curing compound and the method of application shall comply with the American Concrete Institute (ACI) Manual of Concrete Practice.
- e) Traffic and other operations by the Contractor shall be such as to avoid damage to coatings of curing compound for a period of not less than 28 days after application of the curing compound. Where it is impossible because of construction operations to avoid traffic over surfaces coated with curing compound, the membrane shall be protected by a covering of sand not less than 50 mm in thickness or by other effective means. The protective covering shall not be placed until the sealing membrane is completely dry. The Contractor shall remove all sand covering after completion of the curing period. Any sealing membrane that is damaged or that peels from concrete surfaces within 28 days after application, shall be required without delay.
- f) At least 30 days before using curing compound, the Contractor shall submit, for approval, details of the proposed compound. Such details shall be accompanied by test certificates to show that the compound will give satisfactory results for the proposed application.
- g) Curing compound shall be delivered to the site in suitable labelled containers to enable identification of the batch number and date of manufacture.

7318 Steam Curing

- a) Concrete may be steam cured for the purpose of obtaining high early strength. No admixtures shall be used in conjunction with steam cured concrete without prior approval from the Engineer.
- b) At least 14 days before the Contractor proposes to commence steam curing, he shall submit to the Engineer the following details:
 - i. The duration of the presetting period (i.e., the interval between placing the last concrete batched and the commencement of steam curing). If a retarding admixture is used in the concrete mix this period shall not be less than 4 hours, otherwise this period shall not be less than two hours.
 - ii. The rate at which the temperature of the air space surrounding the units will be raised or lowered. (This rate shall not exceed 15 °C per hour).
 - iii. The maximum temperature of the surrounding air space during the application of the steam. (At no time will a temperature exceeding 75 °C be permitted).
- c) Steam curing operations shall not commence without the written approval of the Engineer. Once approved, no alteration shall be made in the curing method without the written consent of the Engineer.
- d) The Contractor shall provide adequate approved means of measuring the temperature at any point on the concrete. The Contractor shall record the maximum temperature at points as directed and shall keep a continuous record of the temperature by an approved thermograph located to the approval of the Engineer. Temperature variations throughout the steam chamber at any time shall not be more than 5°C. Steam shall not be applied to the member in any way which will cause uneven heating.
- e) On completion of the curing, the steam supply shall be cut off and the member shall be allowed to cool gradually and evenly. Rain shall be prevented from falling on the concrete during the cooling period. Steam covers shall not be removed or disturbed in any way until the temperature at the surface of the concrete mass has fallen to within 20°C of the ambient temperature.

7400: REPAIR OF CONCRETE**7401 General**

- a) Repair of concrete shall be performed by skilled workmen. The Contractor shall inform the Engineer when concrete will be repaired. Unless inspection is waived by the Engineer, in each specific case repair of concrete shall be performed only in the presence of the Engineer.
- b) The Contractor shall correct all imperfections on the concrete surfaces as necessary to produce surfaces that conform to section 7.11. For formed concrete, where the forms are removed within three days and repair of imperfections completed within 24 hours after removal of forms, or for unformed concrete where repairs are completed within 24 hours after the placing of the concrete, repairs shall be dry-pack, mortar or concrete repairs, Otherwise repairs shall be epoxy resin repairs.
- c) Concrete that is damaged from any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which is rejected because of excessive surface depressions, shall be removed and built up with dry-pack, mortar, or concrete, as hereinafter specified, to bring the surface to the prescribed lines. Where bulges and abrupt irregularities protrude outside the limits specified in section 7.11 on which Class 2, Rubbed

Finish is required, the protrusions shall be reduced by bush hammering and grinding so that the surfaces are within the specified limits. After the dressing, the irregularities shall not exceed the limits specified in section 7.11.

7402 Dry-Pack

- a) Dry-pack shall be used for filling holes having a depth greater than the least surface dimension; for narrow slots cut for repair of cracks; and for tie-rod fastener recesses as specified. Dry-pack shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section.
- b) Dry-pack shall be composed of a mix of 1 part of cement, by volume, to 2.5 parts, by volume, of fine aggregate passing a 1.18 mm sieve, together with enough water to produce a mortar which will just stick together when moulded into a ball by a light pressure of the hands and will not exude water, but will leave the hands damp.
- c) Dry-pack shall be placed and packed into under-cut holes in layers each having a thickness of approximately 10 mm. packing shall be carried out with a hardwood stick struck with a hammer to compress the dry-pack thoroughly into contact with the surfaces of the hole.

7403 Mortar

Mortar-filling, placed under impact by use of a mortar gun, shall be used for repairing defects which are too wide for dry-pack fillings and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface.

7404 Concrete

- a) Concrete-filling shall be used for holes extending entirely through concrete sections, for holes which are greater in area than 0.10 square metres and deeper than 80 mm, and for holes in reinforced concrete which are greater in area than 0.05 square metres and which extend beyond the reinforcement that is nearest the surface.
- b) Concrete used for repairs shall be of the same class as the concrete in the location at which the repair is being made.

7405 Epoxy Resin

- a) Epoxy resin repairs shall be used where approved. Epoxy resin repairs shall not be made until 28 days after the concrete has been placed, unless earlier repairs are approved, and shall be completed within 60 days after the concrete has been placed. All materials used for epoxy resin repairs shall be subject to approval and the repairs shall use an unfilled epoxy resin as the bonding medium between old concrete and the repair material, which can be dry-pack, mortar or concrete.
- b) Epoxy resin repairs shall be carried out as follows:
 - i. All imperfections to be repaired with epoxy resin shall be chipped back to sound concrete and the edges of the holes trimmed square for a minimum depth of 3 mm.
 - ii. Immediately before performing a repair, the surface of the concrete to be repaired shall be free of all contaminants by grit blasting or scabbling, and shall present a clean, sound, dry, roughened and dust-free surface with the surface temperature not less than 15°C and not more than the temperature of the surrounding concrete.
- c) After preparation, the surface of the area to be repaired shall be covered with a thick coat of an approved unfilled, solvent less epoxy resin, prepared, batched and mixed in accordance with the manufacturer's instructions and thoroughly brushed into the surface. Immediately and before the resin becomes 'tacky' the repair material shall be placed and finished to the required standard. Curing of the repair shall be performed in accordance with section 7.12 with the additional requirement that the repair is to be maintained at a temperature not less than 20°C for a period of 24 hours, without allowing heat to be directed onto the repair and cause excessive drying of the repair material. Epoxy resin which has become 'tacky' before the repair material has been placed against it, shall be removed and the surface again prepared to the satisfaction of the Engineer.
- d) Unused epoxy resin, shall be wasted when it loses its plastic condition. Excess or spilled resin on surfaces for which a Class 2, Rubbed Finish is specified shall be cleaned immediately and while the resin is in a plastic state.
- e) Should it be necessary to form an epoxy filled repair, either the forms shall be incompatible with the resin or the form shall be coated with a special release agent.
- f) The finished surface of the epoxy resin repairs shall comply with Section 7.11. Any grinding required on epoxy filled repairs shall be performed using a silicon-carbide or other suitable abrasive and preferably under water.

7406 Staining of concrete

For exposed concrete surfaces care shall be taken that accumulation of foreign materials or staining due to any cause does not occur on the finished surface. Any accumulation or staining shall be cleaned off by the Contractor using an approved method.

7407 Plugging form-tie holes

In formed concrete, surface holes remaining after dismantling form-ties shall be cleaned out and neatly plugged with dry pack as previously specified. The dry-pack shall be colour matched with surrounding concrete.

7408 Materials used in repairs

All materials used in the repair of concrete shall conform to the requirements of this Specification, the ACI Manual of Concrete Practice and the Engineer. All fillings shall be bonded tightly to the surface of the holes and shall be sound and free from shrinkage cracks and "drummy" areas after the fillings have been cured and have dried.

7409 Payment

All materials, labour and equipment required for the repair of concrete or removal of stains shall be provided at the expense of the Contractor.

7500: CONSTRUCTION OF BOX CULVERTS**7501 Requirement**

The Contractor shall construct box culverts in accordance with this section where shown on the Drawings or directed.

Construction of each box culvert includes the followings:

- i. demolition and disposal of existing structures where shown on the Drawings;
- ii. provision and removal of cofferdams and dewatering if required;
- iii. Temporary diversion of traffic;
- iv. Clearing and grubbing of the sites and excavation for culvert, slabs, apron slabs and wing walls and grading of the finished surface adjacent to apron slab;
- v. construction of cast in-situ concrete, slabs, walls, apron slabs, wing walls and headwalls;
- vi. Backfilling and construction of road embankment around abed above the culverts; and
- vii. Construction of brick pitching, slope and scour protection.

7502 Materials

- a) Materials and construction shall be in accordance with their respective parts of this Specification as follows:

<u>Section</u>	
• Clearing and grubbing	2.1
• Excavation for structures	2.5
• Improved sub-grade material	2.9
• Aggregate drain	2.7
• Free draining backfill	2.7
• Concrete	Part 6 and Part 7

- b) Foundation material for culverts shall consist of sound natural soil and road sub grade material.

7503 Clearing and Grubbing

Clearing and grubbing shall be carried out within 5 m of any structure.

7504 Excavation

Excavation and preparation of foundations shall be in accordance with Part 2 of this Specification to the dimensions shown on the Drawings, care being taken to avoid disturbing material below this level except as provided for in this Section.

7505 Construction sequence

- a) The construction of the box culverts shall be carried out in the following sequence, unless otherwise approved or directed:

- i. Wing walls shall be constructed and back-filled to at least the level of the wall construction joint as shown on the Drawings, before any construction of the culvert Base Slabs or Apron Slabs in the vicinity of a wing wall shall be permitted.
- ii. The Cut-off wall part of the Apron slab shall then be constructed and backfilled.
- iii. The order of construction of the remainder of the works shall be as determined by the Contractor.

7506 Backfilling

- a) Backfilling and compaction shall be carried out in accordance with Part 2 and the particular requirements of this subsection.
- b) All bracing, formwork etc. shall be removed prior to backfilling.
- c) Prior to any construction plant or diverted traffic being permitted on the culverts and after all construction is approved by the Engineer a minimum of 300 mm of fill shall be placed over the culvert.

7507 Traffic Diversion

To allow the earliest possible diversion of traffic onto the culverts, the Contractor may construct the culverts to approximately half width and divert traffic prior to completing the remainder of the works but only with the prior approval of the Engineer. All provisions for traffic and temporary traffic diversion works shall be in accordance with Section 1.1 of this Specification.

7508 Measurement and payment

- a) General

Unless otherwise specified, payment will be made in accordance with the following sections:

Section

Provisions for traffic	1.1
Clearing and grubbing	2.1
Demolition of Box Culverts	2.2
Excavation for structures	2.5
Compaction of foundations	2.5
Free-draining backfill	2.7
Aggregate drain material	2.7
Reinforcement in structures	7.7
Concrete in structures	Part 7

Pay items

unit

75/1	Construct and remove temporary Constructions to provide for traffic flow at structures	Each
75/2	Maintain temporary constructions and equipment	Each Month
75/3	Demolition of box culverts	Each
75/4	Unclassified Structure Excavation	Cum
75/5	Extra Depth Excavation	Cum
75/6	Unclassified channel Excavation	Cum
75/7	Compaction of structure foundations	Sqm
75/8	Sand Embankment	Cum
75/9	Blinding Concrete	Cum
75/9 a	Plain concrete (1:2:4)	Cum
75/10	Concrete in Culvert base slab/apron slab	Cum
75/11	Concrete in culverts walls, roof slab and wing walls	Cum

7600: Construction of Pipe Culverts/ Prefabricated Culverts**7601 General**

The Contractor shall construct pipe culverts comprising jointed precast concrete pipes and in-situ concrete head walls to the lines grades and dimensions shown on the Drawings or directed by the Engineer and in accordance with this section.

7602 Materials

Materials for and manufacture of pipe culverts shall comply with Parts 6 & 7 of this Specification and the requirements of the following:

- | | | |
|------|-----------------------------|---------------|
| i. | Precast concrete pipe | Section 9.3 |
| ii. | Sand bedding | Section 2.7.2 |
| iii. | Improved sub grade material | Section 3.1 |

7603 Excavation

- a) After preparation of the embankment foundation in accordance with Section 2.2 is complete, further local excavation for trenches may be required and shall be in accordance with Section 2.5 and the particular requirements of this Section. Compressible and other unsatisfactory material on the bottom of trenches shall be removed as directed before laying the pipes. Rock, boulders or other unsuitable material shall be removed to not less than 150 mm below the pipe.
- b) Trenches shall have vertical walls, or be as near to vertical as is practicable.

7604 Installation

- a) The pipes shall be bedded on sand bedding complying with Section 2.7.2 to provide class B type bedding complying with the AASHTO Standard Specifications for Highway Bridges; and shall be installed in accordance with this Section, and as shown on the Drawings, unless otherwise directed or approved.
- b) Pipes shall be bedded on a 100 mm thick layer of sand bedding compacted by hand held mechanical compaction equipment complying with Part 2 to provide a firm and uniform bed for the pipe.
- c) Culvert length shall be directed by the Engineer and shall be no less length than will conform to the cross sections shown on the Drawings, provided that culverts may be extended to use whole pipe lengths. Any adjustment of earthworks required to ensure burial of the pipe shall not be measured for payment but the cost shall be included in the Contractors rates generally. The Contractor may cut culverts to suit the correct length required by the cross section.
- d) The pipes shall be laid starting at the lowest end with the bell end laid upgrade, and with the invert of the pipes conforming to the grade line all as shown on the Drawings or directed by the Engineer. The minimum grade of a culvert shall be 0.5 per cent even if flow may be two-way.

7605 Jointing

- a) Joints in pipes shall be of the bell and spigot type unless otherwise directed or approved by the Engineer.
- b) All joints shall be sealed and made waterproof.
- c) Rubber ring joints should be used and fitted in accordance with the manufacturers instructions.
- d) Where a rubber ring joint is not used the joints shall be totally filled with mortar made of three parts of clean fine sand to one part of cement.
- e) The faces of the pipes to be joined shall be thoroughly wetted, then butted as tightly as possible against each other. The space between the abutting ends of the pipes shall not exceed 0.5 per cent of

the diameter of the pipe. The joint shall be completely filled with mortar, both on the inside and outside of the pipe, to give neat and smooth surfaces uniform with the inside and outside surfaces of the pipe, respectively.

- f) In all cases care shall be taken that the interior of the pipe is cleaned of any excess mortar after jointing.
- g) Mortar joints shall be protected from the sun, and if necessary covered with sand or wet bags to prevent rapid drying of the mortar for at least 48 hours after placing.
- h) Where possible, in order to minimize the effect of disturbance during the construction of headwalls, the joint between the end pipe and the remainder of the pipe line should not be filled with mortar until after the headwall has been constructed.

7606 Backfilling

- a) After the pipes have been bedded, laid, jointed and approved, backfill material shall be placed about the pipes.
- b) The backfill shall be selected sand bedding and improved sub grade material, conforming to the requirements of section 3.1. The fill material shall be brought up evenly and simultaneously on both sides of the pipe, ensuring it is in contact with the underside of the pipe, to a height of 300 mm above the pipe.

7607 Construction equipment

Heavy earth-moving and compaction equipment shall not be operated closer than 1.2 m to the pipe until a cover of 0.3 m has been placed and compacted over the top of the pipe.

7608 Measurement and payment

- a) Measurement, for payment, for furnishing and installing of concrete pipes shall be made of the length of pipe measured along the centreline of the pipes in place, with no allowance for lap at joints.
- b) Payment will be made at the Contract Unit Price for each of the items listed below which is shown in the Bill of Quantities. Such payment shall include furnishing, placement, joint sealing materials and reinforcement in the pipes, back filling and all other tools, materials and tests necessary for the works except as noted below.

<u>Pay Item</u>	<u>Unit</u>
76/1 - Furnish and Install Concrete Pipe 300 mm, Class-I	m
76/2 - Furnish and Install Concrete Pipe 600 mm, Class-I	m
76/3 - Furnish and Install Concrete Pipe 600 mm, Class-II	m
76/4 - Furnish and Install Concrete Pipe 915 mm, Class-I	m
76/5 - Furnish and Install Concrete Pipe 915 mm, Class-II	m
76/6 - Furnish and Install Concrete Pipe 915 mm, Class-III	m

- c) Payment for excavation of trenches will make in accordance with Section 2.5.
- d) Payment for blinding concrete, concrete in pipe culvert headwalls and reinforcement will be made in accordance with Sections 83, 88 & 77 respectively.

Payment for improved sub-grade material bedding and back filling up to 300 mm above the pipe will be made under Item 27/1.

7700: Concrete in Major structures**7701 Concrete in Pile Caps**

1. The item in the Bill of Quantities for Concrete in Pile Caps (Item 8.09) includes all required concrete in the pile caps for abutments and piers for bridges as shown on the Drawings or directed by the Engineer, but excluding concrete in piles.
2. The concrete for pile caps shall be deemed to be mass concrete and the requirements of sub-section 5 of Section 7.09 shall apply.

7702 Concrete in Abutments

The item in the Bill of Quantities for Concrete in Abutments (Item 81/6) includes all required concrete in the curtain walls and wing walls above the pile caps for bridges including run-on slabs, but excluding concrete in parapets as shown on the Drawings or directed by the Engineer.

7703 Concrete in Piers

The Item in the Bill of Quantities for Concrete in Piers include all required concrete in the bridge piers above the pile caps, including columns and crossheads, as shown on the Drawings or directed by the Engineer.

7704 Concrete in Bridge Girder

The Item in the Bill of Quantities for Concrete in girders, cross-beams includes all required concrete in above the pile caps, as shown on the Drawings or directed by the Engineer.

7705 Concrete in Bridge Decks

The item in the Bill of Quantities for Concrete in Bridge Decks (Item 8.12) includes all required concrete in bridge decks for bridges including diaphragms, kerbs and edge beams as shown on the Drawings or directed by the Engineer, but excluding concrete in parapets.

7706 Concrete in Parapets and Barrier Wall

The item in the Bill of Quantities for Concrete in Parapets and Barrier walls (Item 8.13) includes all required concrete in parapets, including parapet posts and rails and end posts, above wing walls of abutments and above edge beams of bridge decks, as shown on the Drawings or directed by the Engineer.

7707 Measurement

1. General

Measurement, for payment, for concrete in structures shall be made to the neat lines of the structures unless otherwise specified.

2. Deductions

In measuring concrete for payment, deductions shall be made for:

- a) The volume of all ducts, embedded pipes and metalwork, and other block outs having a cross-sectional area larger than 0.10 sq.m as measured at right angles to their longitudinal axis; and
- b) All openings, recesses and block outs with cross sectional areas less than 0.10 square metres but which have an individual volume larger than 0.5 cubic metres.

3. Over-breakage

Measurement will not be made for concrete required to be placed outside specified or approved excavation pay lines, excess excavation or wasted concrete, or for any other reason.

7708 Payment

1. Concrete in Structures

Payment for concrete in the various parts of the Works will be made at the applicable price per cubic metre tendered in the priced Bill of Quantities for the following items:

<u>Pay Item</u>	<u>Unit</u>
77/1 Concrete in Pile Caps	cubic meter
77/2 Concrete in Abutments	cubic meter
77/3 Concrete in Piers	cubic meter
77/4 Concrete in Bridge Girder & Diaphragm	cubic meter
77/5 Concrete in Bridge Decks	cubic meter
77/6 Concrete in Parapets	cubic meter
77/7 Concrete wearing Course	cubic meter.

7800: Bamboo reinforcement slab

7801 Scope

This section covers the furnishing and placing of bamboo reinforcement in concrete pavement slabs on grade.

7802 Materials

Bamboo: is to be provided to site in mature poles. The bamboo should not be less than three years old, have a brown colour and a straight profile. All green bamboo poles are to be rejected. All bamboo is to be inspected for approval by the Engineer prior to delivery to site. All bamboo is to be stored by standing against a wall in a vertical position. Bamboo that has been stored on its side on uncovered ground will be rejected by the Engineer. The bamboo should be matured for a minimum of 3 years, free from rot or infestation, solid and straight in shape. In any case green bamboo shall not be accepted.

Cover and spacer blocks required to support the reinforcement shall be as small as possible consistent with their use and be of approved design and material. Cover blocks or spacers required for ensuring that the specified cover is obtained shall be of a material, shape and design acceptable to the Engineer.

Concrete: See Section

Binding Wire:

Bamboo reinforcement binding wire shall be best black annealed mild steel wire, approximately 1.6 mm in diameter.

7803 Splicing and Tying

Each bamboo pole is to be spliced to form uniform 15mm width x 10 mm thickness bamboo splints. Splints are to be made by splitting the bamboo pole with a blunt edge, NOY by cutting the poles with a saw or sharp edged blade. All notches are NOT to be removed from the splints. The splits shall be tied together using steel wire to form a mesh of 200mm x 200mm. Where possible the concave side of the bamboo splint shall be faced upwards to avoid air voids forming upon compaction.

Immediately before the concrete is placed around the reinforcement, the reinforcement shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance that can have an adverse chemical effect on the steel or concrete, or reduce the bond.

7804 Placing, Fixing and Cover

Immediately before the concrete is placed around the reinforcement, the reinforcement shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance that can have an adverse chemical effect on the steel or concrete, or reduce the bond. Reinforcement shall be positioned as shown on the Drawings and accurately secured in these positions by tying with annealed wire or by the use of suitable clips or, where permitted by the Engineer, by tack welding. Projecting ends of ties or clips shall not encroach into the concrete cover.

Where protruding bars/splints are exposed to the elements for an indefinite period the bars/splints shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.

The term "cover" in this context shall mean the minimum clear thickness of concrete between the surface of the reinforcement and face of the concrete. The minimum cover shall be as shown on the Drawings.

7805 Quality Control

Strength of concrete: The strength of the concrete shall be 25 Mpa cylinder strength at 28 days and shall be tested in the laboratory. If average strength of the concrete does not comply with specifications, contractors shall re-concrete on his own expenses.

Water/Cement Ratio: The ratio of free water to cement when using saturated surface dry aggregate shall be as low as possible and may vary between 0.45 to 0.50 by weight for all concrete unless otherwise stated.

Workability: The concrete shall be of suitable workability to obtain full compaction. Slumps measured shall not exceed 75mm+/-25mm unless otherwise directed or approved by the Engineer. Slump tests shall be carried out regularly during any concreting operations. The minimum frequency should be one slump test at the beginning of each casting and one each time test specimens are taken.

Sampling and Testing of Concrete: The Contractor shall take samples of the concrete for testing. The number, frequency and location shall be decided by the Engineer. A minimum of 3 concrete cubes/cylinders should be taken for each days of casting, or every 15 m³ of concrete cast in larger pours, and tested at 28 days.

Formwork: Formwork shall include all temporary or permanent moulds for forming the concrete. All formwork shall be of wood or metal and shall be built mortar tight and rigid enough to maintain the concrete in position during placing, compacting, setting and hardening. All forms shall be set and maintained true to the line designed until the concrete is sufficiently hardened and shall remain in place as required by Engineer. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer may order the work stopped until the defects are corrected. If requested, the Contractor shall submit to the Engineer working drawings of the forms. The shape, strength, rigidity, water tightness and surface smoothness of reused formwork shall be maintained at all times. Any warped or bulged timber must be resized before being reused. Formwork that is unsatisfactory in any respect shall not be reused.

Mixing, Handling and Placing Concrete: Mixers at local site shall be approved drum-type capable of combining the aggregate, cement and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Suitable equipment for discharging the concrete shall be provided. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity. Retempering concrete by adding water or by other means shall not be permitted. Concrete which is not of the required consistency at the time of placement shall not be used.

Concrete which does not reach its final position in the forms within 10 minutes of completion of mixing shall not be used. When placing operations would involve dropping the concrete more than 1.5m, it shall be deposited through sheet metal or other approved pipes.

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer which has not taken initial set.

7806 Finishing of Concrete Surfaces:

Immediately after placing concrete, concrete slabs shall be struck off using templates to provide proper crowns and shall be finished to the correct levels. Finish shall be slightly rough but uniformly roughened by brooming or steel racket. The finished surface shall not vary by more than 10 mm from a 3 metre straight edge placed in any direction on the roadway. Deviation from the grade line shall not be more than +/- 30 mm in any 20 m length.

7807 Contraction and Expansion Joints

All contraction and expansion joints shall be made only where shown on the drawings or in the casting schedule by using removable cock sheets or any other materials unless otherwise approved by the Engineer. All joints shall be sealed by bitumen/sand mix neatly and scrap the excess materials from the top of the pavement surface.

7808 Curing of Concrete:

All concrete surfaces shall be kept thoroughly wet by moisten the surface covering by sand appropriate clay/lean mortared bund for at least 7 days after placing. After a period of 7 days, the concrete shall be watered daily at certain intervals approved by the Engineer to avoid drying out of the surface. This shall take place during the following 2 weeks.

Removal of Formwork:

Forms shall not be removed without the approval of the Engineer. Forms used on exposed vertical faces shall remain in place for periods which shall be determined by the Engineer and normally not less than 3 days.

Cleaning Up:

Upon completion of roadwork and before final acceptance, the Contractor shall remove all forms. Excavated or useless materials, rubbish etc, shall be removed from the site and the site shall be left in a neat and tidy condition, satisfactory to the Engineer.

7809 Measurement and Payment

Pay Item	Unit
78/1 Bamboo Reinforced Concrete Pavement	Square metre

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, welding, placing and fixing of the bamboo reinforcement concrete pavement, including all concreting, plant and equipments and hand tools, tying wire, spacers, stools, supports and waste, all types of joints, and services pipes under the pavement.

7900: RAIN WATER DOWN PIPE**7901 General**

- a) The Contractor shall form rain water down pipes having a minimum diameter of 50 mm through box culvert top slab where and as shown on the Drawings or directed.
- b) Rain water down pipes which become obstructed shall be cleaned out to their full depth in an approved manner or shall be replaced by and at the expense of the Contractor.

7902 Payment

- a) The payment will be made for forming rain water down pipes and all such costs shall be measured and paid in the rates bid in the priced Bill of Quantities as linear meter

Pay Item	Unit
79/1 Supply and Installation of rain water down pipes/weep holes	linear meter