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# Background and General Description

In Oct. 2008, the provincial government of Nangarhar submitted a request paper requesting technical assistance and grant aid projects to assist returnees and receiving communities in Nangarhar province to government of Japan. The returnees in this area have increased year by year and now have occupied more than 50% of total population and tormented their lives.

Firstly, the technical assistance project namely Community Development Project for Returnees and Receiving Communities in Nangarhar Province have launched in Jul, 2010 and provided 38 pilot projects (irrigation, roads, foot path, surrounding walls, etc). Secondly, the outline design for grant aid project namely the Project for Rehabilitation of Community Infrastructure for Returnees and Receiving Communities has also launched in May, 2012 utilizing the experiences of technical assistance project. The outline design survey has been approved in the minutes of discussion in Sep. 2012 and exchange of note between government of Japan and the Islamic republic of Afghanistan was also concluded in Dec. 2012. The projects will be implemented under the supervision of UNOPS as implementing agency. The project components consist of ten(10) road, fourteen(14) school, three83) clinic and one(1) box culvert projects.

# Specifications

## Preliminary & Mobilization / Demobilization (Temporary Work)

### Preparation Work

#### Temporary Work Plan

###### The Contractor shall prepare temporary work plan incorporating temporary enclosure, temporary office (including minimum office space (i.e. 20ft. shipping container, desks, chairs, A4 multi-function printer, internet connection, air-conditioner/heater, etc. for minimum 3 UNOPS staff project site office), temporary toilets, workshop, warehouse, approach plan, scaffolding plan, temporary power supply and water supply and drainage systems. Temporary work plan shall be submitted and approved by the Client.

###### In case of existing school/clinic site, temporary work plan shall be explained to the school/clinic by the Client and approved by the representative of the school/clinic.

#### Verification of Site Conditions

###### The Contractor shall verify the site boundaries and the site dimensions, with the design documents and shall report his findings to the Client. In case of site boundaries are unclear or different from the design drawings, the Client shall discuss the matter with the representative of the school/clinic to make a decision on the matter.

###### The Contractor shall verify the site conditions and if any existing constructions, pipes, cables, etc. which is to be removed or demolished to proceed the work, shall report to the Client.

#### Temporary Enclosure

###### Temporary enclosure shall be installed to ensure security around construction area in principle. The area of enclosure shall be decided in consideration with security and activity of the school/clinic, and shall be kept enough space for working and storage of materials and equipment.

###### Temporary enclosure shall be of timber, metal or wire fence with adequate height (2m recommended) to safeguard materials and human resources of Contractor.

#### Inscription Plates

###### Inscription Plates made of bronze and designed as shown below shall be furnished and monumentalized in accordance with the requirements of the Contract at locations as directed by the Consultant.

###### Unless otherwise provided, all requirements imposed by the Inscription Plates and constructed by the Contractor shall be considered incidental to the various contract items and no separate or additional payment shall be made thereof.

**THE PROJECT FOR THE REHABILITATION OF COMMUNITY INFRASTRUCTURE FOR RETURNEES AND RECEIVING COMMUNITIES IN NANGARHAR PROVINCE**

**GRANT AID FROM**

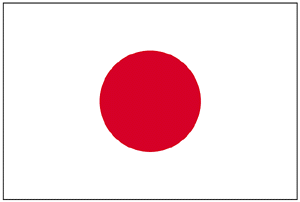
**THE PEOPLE OF JAPAN**

**AS A TOKEN OF FRIENDSHIP AND**

**COOPERATION BETWEEN**

**JAPAN AND THE ISLAMIC OF AFGHANISTAN**

**20\*\***

#### Temporary Offices, Warehouse and Toilets, etc.

###### The Contractor shall set up temporary office, toilet and adequate warehouse for the equipment and materials to be stored at site in accordance with their needs.

###### In the case of the storage of inflammable materials, such as paint and oil, the structure shall be capable of containing a temperature increase inside the warehouse while due attention is paid to ventilation. This type of warehouse shall be lockable and shall have the indications “storage of inflammable materials” and “no fire inside” at the entrance and fire extinguishers shall be provided.

###### A high floor of not less than 300 mm from the ground surface shall be adopted for storing cement as a preparatory measure for inundation and the inner walls of this storage shall be lined with polyethylene film to prevent the entry of moisture from outside.

#### Workshops and Material Yards, etc.

###### The Contractor shall set up such workshops of a suitable size for bending bars, etc. as well as material yards for the storage of reinforcing bars, wood and aggregates, etc. in accordance with their need. All of these workshops and material yards shall have either concrete or mortar floor, shall be covered by sheets or roofed.

###### A job-mixed concrete mixer shall be installed on either the concrete or mortar floor capable of withstanding dead load, dynamic load and vibration of the mixer and shall be roofed.

###### Elevated ground shall be set up for storing reinforcement bars, wood and roofing material so as to prevent them direct contact with the ground. The reinforcing bars, wood and roofing materials shall be covered by sheets or shall be roofed to protect them from rain.

###### In regard to aggregates, fine aggregates and coarse aggregates shall be temporarily stored on either a concrete or mortar floor which has a suitable inclination for water drainage. These temporarily stored aggregates shall be covered by sheets to protect them from rain.

#### Scaffolding

###### Both the external and internal scaffolding shall be steel pipe or timber of Russian which is commonly used in the project area.

###### Both the external and internal scaffolding shall have a stable structure with the suitable use of braces and struts and prevents any collapse. The struts and other members to support the scaffolding shall not be nailed to the exterior concrete blocks or bricks of the building. Neither shall through holes be made in the exterior walls for the purpose of keeping the struts in place.

###### The posts for the external scaffolding shall be rectangular timber of not less than 80 mm x 80 mm and shall be buried at least 300 mm in the ground with backfilling and tamping around each post. The maximum distance between the posts shall be 1.2 m or less and neighbouring posts shall be tightly bound by bridging timber.

###### An access ramp should be introduced from the ground level to the first floor, its gradient shall be approximately 0.3 in height for a horizontal distance of 1. This access ramp shall be provided with a handrail and anti-slip measures shall be applied for its flooring.

###### Both the external and internal scaffolding shall be provided with walkways which do not hinder work safety, handrails to prevent accidental falling and safety signs. The safety signs shall be written in either English or Pashtun or shall use symbols which can be easily understood by workers.

###### The Contractor shall check and confirm the safety and rigidity of both the external and internal scaffolding during and after assembly.

#### Temporary Power Supply

###### The Contractor shall set up a temporary power supply system by connecting city-grid or providing generator to provide power for lighting and power equipment during the construction period at his own expense.

###### On-site electrical wiring and connection works shall be conducted in a manner which prevents an electrical accident during the construction work or rainy weather, and the Contractor shall report the completion of the temporary wiring and connection work to the Client.

#### Temporary Water Supply

###### The Contractor shall supply water for the work by well, city water, tank lorry service or other means at his own expense.

###### The Contractor shall install water reservoir tank on site to serve the construction work. The absence of any rust, dirt, oil or other harmful substance inside the tank shall be checked to ensure the use of clean water for the construction work.

###### The reservoir tank shall, in principle, be made of a 100 mm thick PCC base and 200 mm filled in concrete block or burnt brick rising walls with mortar finish inside and outside. The standard dimensions of this reservoir shall be inner dimensions of 3 m x 3 m and a depth from the crown of the rising walls to the base plate of 1.8 m with the height of the rising walls of not higher than 700 mm from the ground surface. However, the Contractor shall determine the suitable size of the reservoir depending on the scale of the main construction work and shall inform the Consultant of the size. The level of the stored water shall be not higher than 300 mm from the bottom of the rising walls and the reservoir shall always be covered by a wooden lid to shut out direct sunlight. The water in the reservoir shall be completely replaced once a week and no tools, etc. shall be washed in the reservoir. In the case of the use of a steel reservoir, the Contractor shall confirm the absence of any rust or oil inside the reservoir and shall report to the Consultant.

#### Curing Water Tank for Test Pieces

###### The Contractor shall set up a curing water tank for concrete test pieces next to the water reservoir tank.

###### Curing water tank shall have a 100 mm thick PCC base and 200 mm thick filled-in concrete block or burnt brick rising walls with mortar finish inside and outside. The standard dimensions of this curing water tank shall be inner dimensions of 3.0 m x 1.0 m with a depth from the crown of the rising walls to the base of 750 mm and a height of the rising walls from the ground surface of not higher than 550 mm. The Contractor shall determine the suitable size of tank depending on the quantity of test pieces and shall inform the Consultant of the size. The level of the stored water shall not be higher than 300 mm from the bottom of the rising walls and the curing water tank shall always be covered by a wooden lid to shut out direct sunlight. The water in the curing water tank shall be completely replaced once a week and no tools, etc. shall be washed in the tank.

#### Temporary Drainage System

###### The Contractor shall install suitable temporary drains and drainage ditches around construction area to intercept or divert, and drain out surface rain water or miscellaneous waste water which may adversely affect work to appropriate place.

#### Removal of Temporary Structures and Systems

###### The Contractor shall remove all the temporary structures, materials used for the temporary power and water supply systems, temporary electricity posts, cables and piping, etc. by the completion of the construction work.

###### Ex-temporary structure sites shall be backfilled leveled and cleaned.

###### The Contractor shall complete all payment of user charges for the temporary power and water supply by the completion of the construction work. Should such payments be delayed until after the completion of the construction work due to the timing of issue of invoices or any other reason, the Contractor shall inform the timing of expected payment and make such payment without fail.

### Profile and Setting Out

#### Profile Work

###### The Contractor shall conduct the profile work in accordance with the design documents to determine the setting out of location and ground floor level of the building.

###### A total station shall be used for the profile work while the steel measuring tape shall have a minimum length of 50m.

###### The collar brace for the profile with its upper end being planned shall be horizontally nailed to the post. The positions of the grid lines of the building shall be marked on the collar brace by nails or others and the names of these grid lines shall be clearly indicated.

###### Upon completion of the profile work, the Contractor shall have the profile inspection and approval of the position, dimensions and ground floor level, etc. of the building by the Client.

#### Benchmark and Setting Out

###### After receiving the profile work inspection and approval, the Contractor shall set the necessary number of benchmarks showing the reference height outside the profile at positions of 1.0 m from the reference grid lines of the building. These benchmarks shall be made of either concrete or concrete blocks so that they do not move.

###### For setting out, off-set lines which are 1.0 m from the grid lines shall be marked in addition to the marking of the grid lines for easier inspection and confirmation. Base lines shall be marked at the walls or columns at 1.0 m above the design floor level.

###### Upon completion of the setting out, the Contractor shall confirm the dimensions and names of the members, etc. and shall have the inspection by the Client.

## Demolition (Removal of Structure and Obstructions)

### Description

This Item shall consist of the removal wholly or in part, and satisfactory disposal of all buildings, fences, structures, old pavements, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the Contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

### Construction Requirements

###### General

The Contractor shall perform the work described above, within and adjacent to the roadway, on Government land or easement, as shown on the Drawings or as directed by the Engineer. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places on the project or as otherwise shown in the Special Provisions. Perishable material shall be handled as designated in Subsection 2.3.1.2-2) Nonperishable material may be disposed of outside the limits of view from the project with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished to the Engineer. Basements or cavities left by the structure removal shall be filled with acceptable material to the level of the surrounding ground and, if within the prism of construction, shall be compacted to the required density.

###### Dismantling of PCC Concrete Structure (existing Head wall, retaining wall and other structures comprising of masonry, PCC cement concrete, wood work, etc)

Unless otherwise provided, all pipes shall be carefully removed and every precaution taken to avoid breakage or damaged. Pipes to be re-laid shall be removed and stored when necessary so that there will be no loss of damage before re-laying. The Contractor shall replace sections lost from storage or damage by negligence, at his own expense.

###### Dismantling of RCC Concrete Structure (Existing Culverts, Bridges, relating Walls and other Structures)

All existing bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic. The removal of existing culverts within embankment areas will be required only as necessary for the installation of new structures. Abandoned culverts shall be broken down, crushed and sealed or plugged. All retrieved culvert for future use as determined by the Engineer shall be carefully removed and all precautions shall be employed to avoid breakage or structural damage to any of its part. All sections of structures removed which are not designated for stockpiling or re-laying shall become the property of the Government and be removed from the project or disposed of in a manner approved by the Engineer.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down to at least 300 mm (12 inches) below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Steel bridges and wood bridges when specified to be salvaged shall be carefully dismantled without damaged. Steel members shall be match marked unless such match marking is waived by the Engineer. All salvaged material shall be stored as specified in Subsection 2.2.2-1).

Structures designated to become the property of the Contractor shall be removed from the right-of-way.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work, unless otherwise provided in the Special Provisions.

###### Removal of Existing Pavement, Sidewalks, Curbs, etc.

All concrete pavement, base course, sidewalks, curbs, gutters, etc., designated for removal, shall be:

Broken into pieces and used for riprap on the project, or

Broken into pieces, the size of which shall not exceed 300 mm (12 inches) in any dimension and stockpiled at designated locations on the project for use by the Government, or

Otherwise demolished and disposed of as directed by the Engineer. When specified, ballast, gravel, bituminous materials or other surfacing or pavement materials shall be removed and stockpiled as required in Subsection 2.2.2-1), otherwise such materials shall be disposed of as directed.

There will be no separate payment for excavating for removal of structures and obstructions or for backfilling or for compacting remaining cavity.

## Earth Work

### Clearing and Grubbing

#### Description

This item shall consist of clearing, grubbing, removing and disposing all vegetation and debris as designated in the Contract, except those objects that are designated to remain in place or are to be removed in consonance with other provisions of this Specification. The work shall also include the preservation from injury or defacement of all objects designated to remain.

#### Construction Requirements

###### General

The Engineer will establish the limits of work and designate all trees, shrubs, plants and other things to remain. The Contractor shall preserve all objects designated to remain. Paint required for cut or scarred surface of trees or shrubs selected for retention shall be an approved asphalt base paint prepared especially for tree surgery.

Clearing shall extend one (1) meter beyond the toe of the fill slopes or beyond rounding of cut slopes as the case maybe for the entire length of the project unless otherwise shown on the Drawings or as directed by the Engineer.

###### 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, including mowing as required, except as provided below:

Removal of undisturbed stumps and roots and nonperishable solid objects with a minimum depth of one (1) meter below subgrade or slope of embankment will not be required.

In areas outside of the grading limits of cut and embankment areas, stumps and nonperishable solid objects shall be cut off not more than 150 mm (6 inches) above the ground line or low water level.

In areas to be rounded at the top of cut slopes, stumps shall be cut off flush with or below the surface of the final slope line.

Grubbing of pits, channel changes and ditches will be required only to the depth necessitated by the proposed excavation within such areas.

In areas covered by wild grass and other vegetation, top soil shall be cut to a maximum depth of 150 mm below the original ground surface or as designated by the Engineer, and disposed outside the clearing and grubbing limits as indicated in the typical roadway section.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted to the required density.

If perishable material is burned, it shall be burned under the constant care of component watchmen at such times and in such a manner that the surrounding vegetation, other adjacent property, or anything designated to remain on the right of way will not be jeopardized. If permitted, burning shall be done in accordance with applicable laws, ordinances, and regulation.

The Contractor shall use high intensity burning procedures, (i.e., incinerators, high stacking or pit and ditch burning with forced air supplements) that produce intense burning with little or no visible smoke emission during the burning process. At the conclusion of each burning session, the fire shall be completely extinguished so that no smoldering debris remains.

In the event that the Contractor is directed by the Engineer not to start burning operations or to suspend such operations because of hazardous weather conditions, material to be burned which interferes with subsequent construction operations shall be moved by the Contractor to temporary locations clear of construction operations and later, if directed by the Engineer, shall be placed on a designated spot and burned.

Materials and debris which cannot be burned and perishable materials 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 disturbed to avoid nesting. Each layer shall be covered or mixed with earth material by the land-fill method to fill all voids. The top layer of material buried shall be covered with at least 300 mm (12 inches) of earth or other approved material and shall be graded, shaped and compacted to present a pleasing appearance. If the disposal location is off the project, the Contractor shall make all necessary arrangements with property owners in writing for obtaining suitable disposal locations which are outside the limits of view from the project. The cost involved shall be included in the unit bid price. A copy of such agreement shall be furnished to the Engineer. The disposal areas shall be seeded, fertilized and mulched at the Contractor’s expense.

Woody material may be disposed of by chipping. The wood chips may be used for mulch, slope erosion control or may be uniformly spread over selected areas as directed by the Engineer. Wood chips used as mulch for slope erosion control shall have a maximum thickness of 12 mm (1/2 inch) and faces not exceeding 3900 mm2 (6 square inches) on any individual surface area. Wood chips not designated for use under other sections shall be spread over the designated areas in layers not to exceed 75 mm (3 inches) loose thickness. Diseased trees shall be buried or disposed of as directed by the Engineer.

All merchantable timber in the clearing area which has not been removed from the right of way prior to the beginning of construction, shall become the property of the Contractor, unless otherwise provided.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be trimmed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 6 m (20 feet) above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

Timber cut inside the area staked for clearing shall be felled within the area to be cleared.

###### Individual Removal of Trees or Stumps

Individual trees or stumps designated by the Engineer for removal and located in areas other than those established for clearing and grubbing and roadside cleanup shall be removed and disposed of as specified under Subsection 2.2.2 except trees removed shall be cut as nearly flush with the ground as practicable without removing stumps.

### Excavation

#### Description

This Item shall consist of roadway and drainage and borrow excavation and the disposal of material in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Drawings or established by the Engineer.

###### Roadway Excavation

Roadway excavation will include excavation and hauling of 1km and grading for roadways, parking areas, intersections, approaches, slope rounding, benching, waterways and ditches; removal of unsuitable material from the roadbed and beneath embankment areas; and excavating selected material found in the roadway as ordered by the Engineer for specific use in the improvement. Roadway excavation will be classified as “unclassified excavation”, “rock excavation”, “common excavation”, or “muck excavation” as indicated in the Bill of Quantities and hereinafter described.

Unclassified Excavation(Excavation of soft soil) Unclassified excavation shall consist of the excavation and disposal of all materials regardless of its nature, not classified and included in the Bill of Quantities under other pay items.

Rock Excavation. Rock excavation shall consist of igneous, sedimentary and metamorphic rock which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones each having a volume of 1 cubic meter or more as determined by physical measurements or visually by the Engineer.

Common Excavation. Common excavations shall consist of all excavation not included in the Bill of Quantities under “rock excavation” or other pay items.

Muck Excavation. Muck excavation shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

###### Borrow Excavation

Borrow excavation shall consist of the excavation and utilization of approved material required for the construction of embankments or for other portions of the work, and shall be obtained from approved sources, in accordance with the following:

Borrow, Case 1: Borrow Case 1 will consist of material obtained from sources designated on the Drawings or in the Special Provisions.

Borrow, Case 2: Borrow Case 2 will consist of material obtained from sources provided by the Contractor.

The material shall meet the quality requirements determined by the Engineer unless otherwise provided in the Contract.

#### Construction Requirements

###### General

When there is evidence of discrepancies on the actual elevations and that shown on the Drawings, a pre-construction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the excavated materials.

All excavations shall be finished to reasonably smooth and uniform surfaces. No materials shall be wasted without authority of the Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to excavation, all necessary clearing and grubbing in that area shall have been performed in accordance with 2.3.1, Clearing and Grubbing.

###### Conservation of Topsoil

Where provided for on the Drawings or in the Special Provisions, suitable topsoil encountered in excavation and on areas where embankment is to be placed shall be removed to such extent and to such depth as the Engineer may direct. The removed topsoil shall be transported and deposited in storage piles at locations approved by the Engineer. The topsoil shall be completely removed to the required depth from any designated area prior to the beginning of regular excavation or embankment work in the area and shall be kept separate from other excavated materials for later use.

###### Utilization of Excavated Materials

All suitable material removed from the excavation shall be used in the formation of the embankment, subgrade, shoulders, slopes, bedding, and backfill for structures, and for other purposes shown on the Drawings or as directed.

The Engineer will designate as unsuitable those soils that cannot be properly compacted in embankments. All unsuitable material shall be disposed of as shown on the Drawings or as directed without delay to the Contractor.

Only approved materials shall be used in the construction of embankments and backfills.

All excess material, including rock and boulders that cannot be used in embankments shall be disposed of as directed.

Material encountered in the excavation and determined by the Engineer as suitable for topping, road finishing, slope protection, or other purposes shall be conserved and utilized as directed by the Engineer.

Borrow material shall not be placed until after the readily accessible roadway excavation has been placed in the fill, unless otherwise permitted or directed by the Engineer. If the Contractor places more borrow than is required and thereby causes a waste of excavation, the amount of such waste will be deducted from the borrow volume.

###### Prewatering

Excavation areas and borrow pits may be prewatered before excavating the material. When prewatering is used, the areas to be excavated shall be moistened to the full depth, from the surface to the bottom of the excavation. The water shall be controlled so that the excavated material will contain the proper moisture to permit compaction to the specified density with the use of standard compacting equipment. Prewatering shall be supplemented where necessary, by truck watering units, to ensure that the embankment material contains the proper moisture at the time of compaction.

The Contractor shall provide drilling equipment capable of suitably checking the moisture penetration to the full depth of the excavation.

###### Presplitting

Unless otherwise provided in the Contract, rock excavation which requires drilling and shooting shall be presplit.

Presplitting to obtain faces in the rock and shale formations shall be performed by: (1) drilling holes at uniform intervals along the slope lines, (2) loading and stemming the holes with appropriate explosives and stemming material, and (3) detonating the holes simultaneously.

Prior to starting drilling operations for presplitting, the Contractor shall furnish the Engineer a plan outlining the position of all drill holes, depth of drilling, type of explosives to be used, loading pattern and sequence of firing. The drilling and blasting plan is for record purposes only and will not absolve the Contractor of his responsibility for using proper drilling and blasting procedures. Controlled blasting shall begin with a short test section of a length approved by the Engineer. The test section shall be presplit, production drilled and blasted and sufficient material excavated whereby the Engineer can determine if the Contractor’s methods are satisfactory. The Engineer may order discontinuance of the presplitting when he determines that the materials encountered have become unsuitable for being presplit.

The holes shall be charged with explosives of the size, kind, strength, and at the spacing suitable for the formations being presplit, and with stemming material which passes a 9.5 mm (3/8 inch) standard sieve and which has the qualities for proper confinement of the explosives.

The finished presplit slope shall be reasonably uniform and free of loose rock. Variance from the true plane of the excavated back slope shall not exceed 300 mm (12 inches); however, localized irregularities or surface variations that do not constitute a safety hazard or an impairment to drainage courses or facilities will be permitted.

A maximum offset of 600 mm (24 inches) will be permitted for a construction working bench at the bottom of each lift for use in drilling the next lower presplitting pattern.

###### Excavation of Slopes, Ditches, Gutters, etc.

All materials excavated from side ditches and gutters, channel changes, irrigation ditches, inlet and outlet ditches, toe ditchers, furrow ditches, and such other ditches as may be designated on the Drawings or staked by the Engineer, shall be utilized as provided in Subsection 2.3.2.2-3).

Slopes, Ditches shall conform to the slope, grade, and shape of the required cross-section, with no projections of roots, stumps, rock, or similar matter. The Contractor shall maintain and keep open all ditches dug by him until final acceptance of the work and shall be free from leaves, sticks, and other debris.

Furrow ditches shall be formed by plowing a continuous furrow along the line staked by the Engineer. Methods other than plowing may be used if acceptable to the Engineer. The ditches shall be cleaned out by hand shovel work, by ditcher, or by some other suitable method, throwing all loose materials on the downhill side so that the bottom of the finished ditch shall be approximately 450 mm (18 inches) below the crest of the loose material piled on the downhill side. Hand finish will not be required, but the flow lines shall be in satisfactory shape to provide drainage without overflow.

###### Excavation of Roadbed Level

Rock shall be excavated to a depth of 150 mm (6 inches) below subgrade within the limits of the roadbed, and the excavation backfilled with material designated on the Drawings or approved by the Engineer and compacted to the required density.

When excavation methods employed by the Contractor leave undrained pockets in the rock surface, the Contractor shall at his own expense, properly drain such depressions or when permitted by the Engineer fill the depressions with approved impermeable material.

Material below subgrade, other than solid rock shall be thoroughly scarified to a depth of 150 mm (6 inches) and the moisture content increased or reduced, as necessary, to bring the material throughout this 150 mm layer to the moisture content suitable for maximum compaction. This layer shall then be compacted in accordance with Subsection 2.3.4.3-3).

###### Borrow Areas

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross-section elevations and measurements of the ground surface after stripping may be taken, and the borrow material can be tested before being used. Sufficient time for testing the borrow material shall be allowed.

All borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavation has been completed. The Contractor shall not excavate beyond the dimensions and elevations established, and no material shall be removed prior to the staking out and cross-sectioning of the site. The finished borrow areas shall be approximately true to line and grade established and specified. When necessary to remove fencing, the fencing shall be replaced in at least as good condition as it was originally. The Contractor shall be responsible for the confinement of livestock when a portion of the fence is removed.

###### Removal of Unsuitable Material

Where the Drawings show the top portion of the roadbed to be selected topping, all unsuitable materials shall be excavated to the depth necessary for replacement of the selected topping to the required compacted thickness.

Where excavation to the finished graded section results in a subgrade or slopes of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable material and to backfill to the finished graded section with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary cross-sectional measurements before the backfill is placed.

The excavation of muck shall be handled in a manner that will not permit the entrapment of muck within the backfill. The material used for backfilling up to the ground line or water level, whichever is higher, shall be rock or other suitable granular material selected from the roadway excavation, if available. If not available, suitable material shall be obtained from other approved sources. Unsuitable material removed shall be disposed of in designated areas shown on the Drawings or approved by the Engineer.

### Structure Excavation

#### Description

This Item shall consist of the necessary excavation for foundation of bridges, culverts, under drains, and other structures not otherwise provided for in the Specifications. Except as otherwise provided for pipe culverts, the backfilling of completed structures and the disposal of all excavated surplus materials, shall be in accordance with these Specifications and in reasonably close conformity with the Drawings or as established by the Engineer.

This Item shall include necessary diverting of existing streams, bailing, pumping, draining, sheeting, bracing, and the necessary construction of cribs and cofferdams, and furnishing the materials therefore, and the subsequent removal of cribs and cofferdams and the placing of all necessary backfill.

It shall also include the furnishing and placing of approved foundation fill material to replace unsuitable material encountered below the foundation elevation of structures.

No allowance will be made for classification of different types of material encountered.

#### Construction Requirements

###### Clearing and Grubbing

Prior to starting excavation operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with 2.3.1, Clearing and Grubbing.

###### Excavation

General, all structures. The Contractor shall notify the Engineer sufficiently in advance of the beginning of any excavation so that cross-sectional elevations and measurements may be taken on the undisturbed ground. The natural ground adjacent to the structure shall not be disturbed without permission of the Engineer.

Trenches or foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the Drawings or as staked by the Engineer. They shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown. The elevations of the bottoms of footings, as shown on the Drawings, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary, to secure a satisfactory foundation.

Boulders, logs, and other objectionable materials encountered in excavation shall be removed.

After each excavation is completed, the Contractor shall notify the Engineer to that effect and no footing, bedding material or pipe culvert shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

Structures other than pipe culverts. All loose materials in rock or other hard foundation shall be cleaned and cut to a firm surface, either level, stepped, or serrated as directed by the Engineer. All seams or crevices shall be cleaned and grouted. All loose and disintegrated rocks and thin strata shall be removed. When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to be placed. When the foundation material is soft or mucky or otherwise unsuitable, as determined by the Engineer, the Contractor shall remove the unsuitable material and backfill with approved granular material. This foundation fill shall be placed and compacted in 150 mm (6 inches) layers up to the foundation elevation.

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven and any placing of foundation fill shall be done after the piles are driven. After the driving is completed, all loose and displaced materials shall be removed, leaving a smooth, solid bed to receive the footing.

Pipe Culverts. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 300 mm or 4 mm for each 100 mm of fill over the top of pipe, whichever is greater, but not to exceed three-quarters of the vertical inside diameter of the pipe. The width of the excavation shall be at least 300 mm (12 inches) greater than the horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 150 mm (6 inches) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed to the depth directed by the Engineer and replaced with approved granular foundation fill material properly compacted to provide adequate support for the pipe, unless other special construction methods are called for on the Drawings.

The foundation surface shall provide a firm foundation of uniform density throughout the length of the culvert and, if directed by the Engineer, shall be cambered in the direction parallel to the pipe centerline.

Where pipe culverts are to be placed in trenches excavated in embankments, the excavation of each trench shall be performed after the embankment has been constructed to a plane parallel to the proposed profile grade and to such height above the bottom of the pipe as shown on the Drawings or directed by the Engineer.

Utilization of Excavated Materials

All excavated materials, so far as suitable, shall be utilized as backfill or embankment. The surplus materials shall be disposed of in such a manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure. No excavated materials shall be deposited at any time so as to endanger the partly finished structure.

Cofferdams

Suitable and practically watertight cofferdams shall be used wherever water-bearing strata are encountered above the elevation of the bottom of the excavation. If requested, the Contractor shall submit drawings showing his proposed method of cofferdam construction, as directed by the Engineer.

Cofferdams or cribs for foundation construction shall in general, be carried well below the bottoms of the footings and shall be well braced and as nearly watertight as practicable. In general, the interior dimensions of cofferdams 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. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

When conditions are encountered which, as determined by the Engineer, render it impracticable to dewater the foundation before placing the footing, the Engineer may require the construction of a concrete foundation seal of such dimensions as he may consider necessary, and of such thickness as to resist any possible uplift. The concrete for such seal shall be placed as shown on the Drawings or directed by the Engineer. The foundation shall then be dewatered and the footing placed. When weighted cribs are employed and the mass is utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire mass of the crib to the foundation seal. When a foundation seal is placed under water, the cofferdams shall be vented or ported at low water level as directed.

Cofferdams shall be constructed so as to protect green concrete against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into substructure masonry, without written permission from the Engineer.

Any pumping that may be permitted 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 material being carried away. Any pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall be done from a suitable sump located outside the concrete forms. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing involved therewith, shall be removed by the Contractor after the completion of the substructure. Removal shall be affected in such manner as not to disturb or mar finished masonry.

Preservation of Channel

Unless otherwise permitted, no excavation shall be made outside of caissons, cribs, cofferdams, or sheet piling, and the natural stream bed adjacent to structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is made at the side of the structure before caissons, cribs, or cofferdams are sunk in place, the Contractor shall, after the foundation base is in place, backfill all such excavations to the original ground surface or stream bed with material satisfactory to the Engineer.

Backfill and Embankment for Structures Other Than Pipe Culverts

Excavated areas around structures shall be backfilled with free draining granular material approved by the Engineer and placed in horizontal layers not over 150 mm (6 inches) in thickness, to the level of the original ground surface. Each layer shall be moistened or dried as required and thoroughly compacted with mechanical tampers.

In placing backfills or embankment, the material shall be placed simultaneously in so far as possible to approximately the same elevation on both sides of an abutment, pier, or wall. If conditions require placing backfill or embankment appreciably higher on one side than on the opposite side, the additional material on the higher side shall not be placed until the masonry has been in place for 14 days, or until tests made by the laboratory under the supervision of the Engineer establishes that the masonry has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor.

Backfill or embankment shall not be placed behind the walls of concrete culverts or abutments or rigid frame structures until the top slab is placed and cured. Backfill and embankment behind abutments held at the top by the superstructure, and behind the sidewalls of culverts, shall be carried up simultaneously behind opposite abutments or sidewalls.

All embankments adjacent to structures shall be constructed in horizontal layers and compacted as prescribed in Subsection 2.3.4.3-3) except that mechanical tampers may be used for the required compaction. Special care shall be taken to prevent any wedging action against the structure and slopes bounding or within the areas to be filled shall be benched or serrated to prevent wedge action. The placing of embankment and the benching of slopes shall continue in such a manner that at all times there will be horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to the backfilled against except insofar as undisturbed material obtrudes upon the area.

Broken rock or coarse sand and gravel shall be provided for a drainage filter at weepholes as shown on the Drawings.

### Embankment

#### Description

This Item shall consist of the construction of embankment in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Drawings or established by the Engineer.

#### Material Requirements

Embankments shall be constructed of suitable materials, in consonance with the following definitions:

###### Suitable Material – Material which is acceptable in accordance with the Contract and which can be compacted in the manner specified in this Item. It can be common material or rock.

Selected Borrow, for topping - soil of such gradation that all particles will pass a sieve with 75 mm (3 inches) square openings and not more than 15 mass percent will pass the 0.075 mm (No. 200) sieve, as determined by AASHTO T 11. The material shall have a plasticity index of not more than 30 as determined by ASSHTO T 90.

###### Unsuitable Material – Material other than suitable materials such as:

Materials containing detrimental quantities of organic materials, such as grass, roots and sewerage,

Organic soils such as peat and muck.

Soils with liquid limit exceeding 80 and / or plasticity index exceeding 55.

Soils with a natural water content exceeding 100%.

Soils with very low natural density, 800 kg/m3 or lower

Soils that cannot be properly compacted as determined by the Engineer

#### Construction Requirements

###### General

Prior to construction of embankment, all necessary clearing and grubbing in that area shall have been performed in conformity with 2.3.1, Clearing and Grubbing.

Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or adjacent to the roadway; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the roadway area.

Embankments and backfills shall contain no muck, peat, sod, roots or other deleterious matter. Rocks, broken concrete or other solid, bulky materials shall not be placed in embankment areas where piling is to be placed or driven.

Where shown on the Drawings or directed by the Engineer, the surface of the existing ground shall be compacted to a depth of 150 mm (6 inches) and to the specified requirements of this Item.

Where provided on the Drawings and Bill of Quantities the top portions of the roadbed in both cuts and embankments, as indicated, shall consist of selected borrow for topping from excavations.

###### Methods of Construction

Where there is evidence of discrepancies on the actual elevations and that shown on the Drawings, a preconstruction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the embankment materials and shall be reflected in the bidding document.

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half width at a time, the existing slopes that are steeper than 3:1 when measured at right angles to the roadway shall be continuously benched over those areas as the work is brought up in layers. Benching will be subject to the Engineer’s approval and shall be of sufficient width to permit operation of placement and compaction equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus excavated shall be placed and compacted along with the embankment material in accordance with the procedure described in this Section.

Unless shown otherwise on the Drawings or special Provisions, where an embankment of less than 1.2 m (4 feet) below subgrade is to be made, all sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surfaced shall be completely broken up by plowing, scarifying, or steeping to a minimum depth of 150 mm except as provided in Subsection 2.3.2.2-2). This area shall then be compacted as provided in Subsection 2.3.4.3-3). Sod not required to be removed shall be thoroughly disc harrowed or scarified before construction of embankment. Wherever a compacted road surface containing granular materials lies within 900 mm (36 inches) of the subgrade, such old road surface shall be scarified to a depth of at least 150 mm (6 inches) whenever directed by the Engineer. These scarified materials shall then be compacted as provided in Subsection 2.3.4.3-3).

When shoulder excavation is specified, the roadway shoulders shall be excavated to the depth and width shown on the Drawings. The shoulder material shall be removed without disturbing the adjacent existing base course material, and all excess excavated materials shall be disposed of as provided in Subsection 2.3.2.2-3). If necessary, the areas shall be compacted before being backfilled.

Roadway embankment of earth material shall be placed in horizontal layers not exceeding 200 mm (8 inches), loose measurement, and shall be compacted as specified before the next layer is placed. However, thicker layer maybe placed if vibratory roller with high compactive effort is used provided that density requirement is attained and as approved by the Engineer. Trial section to this effect must be conducted and approved by the Engineer. Effective spreading equipment shall be used on each lift to obtain uniform thickness as determined in the trial section prior to compaction. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Removal of water shall be accomplished through aeration by plowing, blading, discing, or other methods satisfactory to the Engineer.

Where embankment is to be constructed across low swampy ground that will not support the mass of trucks or other hauling equipment, the lower part of the fill may be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers.

When excavated material contains more than 25 mass percent of rock larger than 150 mm in greatest diameter and cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces resulting from excavation methods, such materials may be placed on the embankment in layers not exceeding in thickness the approximate average size of the larger rocks, but not greater than 600 mm (24 inches).

Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 600 mm in diameter will be permitted provided that when placed, they do not exceed 1200 mm (48 inches) in height and provided they are carefully distributed, with the interstices filled with finer material to form a dense and compact mass.

Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. Lifts of material containing more than 25 mass percent of rock larger than 150 mm in greatest dimensions shall not be constructed above an elevation 300 mm (12 inches) below the finished subgrade. The balance of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 200 mm (8 inches) in loose thickness and compacted as specified for embankments.

Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction complies with the requirements of Subsection 2.3.4.3-3).

Hauling and leveling equipment shall be so routed and distributed over each layer of the fill in such a manner as to make use of compaction effort afforded thereby and to minimize rutting and uneven compaction.

###### Compaction

**Compaction Trials**

Before commencing the formation of embankments, the Contractor shall submit in writing to the Engineer for approval his proposals for the compaction of each type of fill material to be used in the works. The proposals shall include the relationship between the types of compaction equipment, and the number of passes required and the method of adjusting moisture content. The Contractor shall carry out full scale compaction trials on areas not less than 10 m wide and 50 m long as required by the Engineer and using his proposed procedures or such amendments thereto as may be found necessary to satisfy the Engineer that all the specified requirements regarding compaction can be consistently achieved. Compaction trials with the main types of fill material to be used in the works shall be completed before work with the corresponding materials will be allowed to commence.

Throughout the periods when compaction of earthwork is in progress, the Contractor shall adhere to the compaction procedures found from compaction trials for each type of material being compacted, each type of compaction equipment employed and each degree of compaction specified.

**Earth**

The Contractor shall compact the material placed in all embankment layers and the material scarified to the designated depth below subgrade in cut sections, until a uniform density of not less than 95 mass percent of the maximum dry density determined by AASHTO T 99 Method C, is attained, at a moisture content determined by Engineer to be suitable for such density. Acceptance of compaction may be based on adherence to an approved roller pattern developed as set forth in **Subsection 2.3.5**, Compaction Equipment and Density Control Strips.

The Engineer shall during progress of the Work, make density tests of compacted material in accordance with AASHTO T 191, T 205, or other approved field density tests, including the use of properly calibrated nuclear testing devices. A correction for coarse particles may be made in accordance with AASHTO T 224. If, by such tests, the Engineer determines that the specified density and moisture conditions have not been attained, the Contractor shall perform additional work as may be necessary to attain the specified conditions.

At least one set of three in-situ density tests shall be carried out for each 500 m of each layer of compacted fill.

**Rock**

Density requirements will not apply to portions of embankments constructed of materials which cannot be tested in accordance with approved methods.

Embankment materials classified as rock shall be deposited, spread and leveled the full width of the fill with sufficient earth or other fine material so deposited to fill the interstices to produce a dense compact embankment. In addition, one of the rollers, vibrators, or compactors meeting the requirements set forth in Subsection 2.3.5.2-1), Compaction Equipment, shall compact the embankment full width with a minimum of three complete passes for each layer of embankment.

###### Protection of Roadbed During Construction

During the construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments or otherwise shall be so constructed as to avoid damage to embankments by erosion.

###### Protection of Structure

If embankment can be deposited on one side only of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of, or excessive pressure against the structure. When noted on the Drawings, the fill adjacent to the end bent of a bridge shall not be placed higher than the bottom of the backfill of the bent until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

###### Rounding and Warping Slopes

Rounding: Except in solid rock, the tops and bottoms of all slopes including the slopes of drainage ditches shall be rounded as indicated on the Drawings. A layer of earth overlaying rock shall be rounded above the rock as done in earth slopes.

Warping: Adjustments in slopes shall be made to avoid injury in standing trees or marring of weathered rock, or to harmonize with existing landscape features, and the transition to such adjusted slopes shall be gradual. At intersections of cuts and fills, slopes shall be adjusted and warped to flow into each other or into the natural ground surfaces without noticeable break.

###### Finishing Roadbed and Slopes

After the roadbed has been substantially completed, the full width shall be conditioned by removing any soft or other unstable material that will not compact properly or serve the intended purpose. The resulting areas and all other low sections, holes of depressions shall be brought to grade with suitable selected material. Scarifying, blading, dragging, rolling, or other methods of work shall be performed or used as necessary to provide a thoroughly compacted roadbed shaped to the grades and cross-sections shown on the Drawings or as staked by the Engineer.

All earth slopes shall be left with roughened surfaces but shall be reasonably uniform, without any noticeable break, and in reasonably close conformity with the Drawings or other surfaces indicated on the Drawings or as staked by the Engineer, with no variations therefrom readily discernible as viewed from the road.

###### Serrated Slopes

Cut slopes in rippable material (soft rock) having slope ratios between 0.75:1 and 2:1 shall be constructed so that the final slope line shall consist of a series of small horizontal steps. The step rise and tread dimensions shall be shown on the Drawings. No scaling shall be performed on the stepped slopes except for removal of large rocks which will obviously be a safety hazard if they fall into the ditch line or roadway.

###### Earth Berms

When called for in the Contract, permanent earth berms shall be constructed of well graded materials with no rocks having a diameter greater than 0.25 the height of the berm. When local material is not acceptable, acceptable material shall be imported, as directed by the Engineer.

###### Compacted Berm

Compacted berm construction shall consist of moistening or drying and placing material as necessary in locations shown on the drawings or as established by the Engineer. Material shall contain no frozen material, roots, sod, or other deleterious materials. Contractor shall take precaution to prevent material from escaping over the embankment slope. Shoulder surface beneath berm will be roughened to provide a bond between the berm and shoulder when completed. The Contractor shall compact the material placed until at least 90 mass percent of the maximum density is obtained as determined by AASHTO T 99, Method C. The cross-section of the finished compacted berm shall reasonably conform to the typical cross-section as shown on the Drawings.

###### Uncompacted Berm

Uncompacted berm construction shall consist of drying, if necessary and placing material in locations shown on the Drawings or as established by the Engineer. Material shall contain no frozen material, roots, sod or other deleterious materials. Contractor shall take precautions to prevent material from escaping over the embankment slope.

### Compaction Equipment and Density Control Strips

#### Description

When specified, this procedure will be used to determine density requirements of selected embankments, subgrade, bases, and bituminous concrete. The procedure will consist of control strip construction to establish target densities for the specified course plus use of sand-cone method of density testing equipment to determine in-place densities obtained during the construction process.

#### Construction Requirements

###### Compaction Equipment

Compaction equipment shall be capable of obtaining compaction requirements without detrimentally affecting the compacted material. The equipment shall be modern, efficient compacting units approved by the Engineer. The compacting units may be of any type, provided they are capable of compacting each lift of material as specified and meet the minimum requirements as contained herein. Minimum requirements for rollers are as follows:

Sheepsfoot, tamping or grid rollers shall be capable of exerting a force of 45 Newton per millimeter (250 pounds per inch) of length of roller drum.

Steel-wheel rollers other than vibratory shall be capable of exerting a force of not less than 45 Newton per millimeter of width of the compression roll or rolls.

Vibratory steel-wheel rollers shall have a minimum mass of 6 tonnes. The compactor shall be equipped with amplitude and frequency controls and specifically designed to compact the material on which it is used.

Pneumatic-tire rollers shall have smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 550 kpa (80 pounds per square inch).

Heavier compacting unit may be required to achieve the specified density of the embankment.

###### Construction of Control Strips and Determination of Target Density

To determine target density, a control strip shall be constructed at the beginning of work each course of material to be compacted. Each control strip, constructed to acceptable density and surface tolerances shall remain in place and become a section of the completed roadway. Unacceptable control strip shall be corrected or removed and replaced at the Contractor’s expense. A control strip shall have an area of approximately 335 square meters and shall be of the same depth specified for the construction of the course which it represents.

The materials used in the construction of the control strip shall conform to the specification requirements. They shall be furnished from the same source and shall be of the same type to be used in the remainder of the course represented by the control strip. The underlying grade or pavement structure upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer and shall be of the same type and mass to be used on the remainder of the course represented by the control strip.

Compaction of control strips shall commence immediately after the course has been placed to the specified thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no discernible increase in density can be obtained by additional compactive effort.

Upon completion of the compaction, the mean density of the control strip will be determined by averaging the results of ten in-place density tests taken at randomly selected sites within the control strip. The mean density of the control strip shall be the target density for the remainder of the course which it represents.

If the mean density of the control strip is less than 85 percent of the density of laboratory compacted specimens as determined by testing procedures appropriate for the material being placed, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer or requested by the Contractor when:

A change in the material or job-mix formula is made.

Ten days of production have been accepted without construction of a new control strip.

There is reason to believe that a control strip density is not representative of the material being placed.

### Forming Earth Slopes in Cut

The work shall be executed in accordance with subsection 2.3.2.2 6).

### Forming Earth Slopes in Embankment

The work shall be executed in accordance with subsection 2.3.4.3 7).

## Drainages

### Stone Masonry (Ditch)

#### Description

This Item shall consist of stone masonry in minor structures, in headwalls for culverts, riprap ditches, in retaining walls at the toes of slopes, and at other places called for on the Plans, constructed on the prepared foundation bed, in accordance with this Specification and in conformity with the lines, grades, sections, and dimensions shown on the Plans or as ordered in writing by the Engineer.

#### Material Requirements

##### Stone

The stone shall be clean, hard, and durable and shall be subject to the Engineer’s approval. Adobe stone shall not be used unless otherwise specified.

Sizes and Shapes – Unless other sizes are shown on the Plans, stones have a thickness of not less than 150 mm, and widths of not less than one and one-half times their respective thickness, and lengths of not less than one and one half times their respective widths. Each stone shall be of good shape and be free of depressions and projections that might weaken or prevent it from being properly bedded.

Dressing – The stone shall be dressed to remove any thin or weak portions. Face stones shall be dressed to provide bed and joint lines that do not vary more than 20 mm from the true lines and to ensure the meeting of bed and joint lines without the rounding of corners of the stones in excess of 30 mm in radius. Bed surfaces of the face stones shall be approximately normal to the face of the stones for about 80 mm and from this point may depart from a normal plane not to exceed 50 mm in 300 mm.

Finish for Exposed Faces – Face stones shall be pitched to the line along the beds and joints. The maximum projection of rock faces beyond the pitch lines shall not be more than 50 mm.

##### Mortar

This work shall conform to subsection 2.6.3.

#### Construction Requirement

##### Selection and Placing

When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the Engineer before any stone is placed.

Care shall be taken to prevent the bunching of small stone or stones of the same size. Large stones shall be used in the corners.

All stones shall be cleaned thoroughly and wetted immediately before being set, and the bed which is to receive them shall be cleaned and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar, and the joints shall be flushed with mortar.

The exposed faces of individual stones shall be parallel to the faces of the walls in which the stones are set.

The stones shall be so handled as not to jar displace the stones already set. Suitable equipment shall be provided for setting stones larger than those that can be handled by two men. The rolling or turning of stones on the walls will not be permitted. If a stone is loosened after the mortar has taken initial set, it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

##### Bed and Joints

Beds for face stones may vary from 20 mm to 50 mm in thickness. They shall not extend an unbroken line through more than 5 stones. Joints may vary from 20 mm to 50 mm in thickness. They shall not extend in an unbroken line through more than two stones. They may be at angles with the vertical from 00 to 450. Face stone shall bond at least 150 mm longitudinally and 50 mm vertically. At no place shall corners of four stones be adjacent to each other.

Cross beds for vertical faced walls shall be level, and for battered walls may vary from level to normal to the batter line of the face of the wall.

##### Headers

Headers shall be distributed uniformly throughout the walls of the structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend from the front face of the wall into the backing of at least 300 mm. When a wall is 450 mm or less in thickness, the headers shall extend entirely from front to back face.

##### Backing.

Backing shall be built mostly of large stones as shown in the approved Plans or as directed by the Engineer. The individual stones composing the backing and hearting shall be well bonded with the stones in the face wall and with each other. All openings and interstices in the backing shall be filled completely with mortar or with spalls surrounded completely by mortar.

##### Pointing

Both bed and vertical joints shall be finished as shown on the Plans or as directed by the Engineer. The mortar in joints on top of surface of masonry shall be crowned slightly at the center of the masonry to provide drainage.

##### Coping

Copings, if called for, shall be finished as shown on the Plans. Where copings are not called for, the top of the wall shall be finished with stones wide enough to cover the top of the wall from 450 mm to 1000 mm in length, and of random heights, with a minimum height of 150 mm. Stone shall be laid in such a manner that the top course is an integral part of the wall. The tops of top course of stone shall be pitched to line, in both vertical and horizontal planes.

##### Weepholes

All walls and abutments shall be provided with weepholes. Unless otherwise shown on the Plans or directed by the Engineer, the weepholes shall be placed horizontally at the lowest points where free outlets for water can be obtained and shall be spaced at not more than 2 m center to center in a staggered manner. The length of the weepholes shall not be less than the thickness of the walls of the abutment and shall be at least 50 mm diameter PVC or other pipe materials accepted by the Engineer. Weepholes must be provided with filter bags as specified in special provision or as directed by the Engineer.

##### Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all face stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

##### Curing

In hot or dry weather, the masonry shall be satisfactory protected from the sun and shall be kept wet for a period of at least three days after completion.

### Earth Ditch

#### Description

This work shall be executed in accordance with subsection 2.2.3.2.

### Pipe Culverts

#### Description

This item shall consist of the construction or reconstruction of pipe culverts and storm drains, hereinafter referred to as “conduit” in accordance with this Specification and in conformity with the lines and grades shown on the Plans or as established by the Engineer.

#### Construction Requirements

##### Trenches Excavation

Trenches shall be excavated in accordance with the requirement of subsection 2.3.3, Structure Excavation, to a width sufficient to allow for proper jointing of the conduit and thorough compaction of the bedding and backfill materials under and around the conduit. Where feasible, trench wall shall be vertical.

The completed trench bottom shall be firm for its full length and width. Where required, in the case of crop drains, the trench shall have a longitudinal camber of the magnitude specified.

When so specified on the Plans, the excavation for conduits placed in embankment fill, shall be made after the embankment has been completed to the specified or directed height above the designed grade of the conduit.

##### Bedding

The bedding shall conform to one of the classes specified. When no bedding class is specified, the requirements for Class C bedding shall apply.

Class A bedding shall consist of a continuous concrete cradle conforming to the plan details.

Class B bedding shall consist of bedding the conduit to a depth of not less than 30 percent of the vertical outside diameter of the conduit. The minimum thickness of bedding material beneath the pipe shall be 100 mm. The bedding material shall be sand or selected sandy soil all of which passes a 9.5 mm sieve and not more than 10 percent of which passes a 0.075 mm sieve. The layer of the bedding material shall be shaped to fit the conduit for at least 15 percent of its total height. Recesses in the trench bottom shall be shaped to accommodate the bell when bell and spigot type conduit is used.

Class C bedding shall consist of bedding the conduit to a depth of not less than 10 percent of its total height. The foundation surface, completed in accordance with subsection 2.3.3, Structure Excavation, shall be shaped to fit the conduit and shall have recesses shaped to receive the bells, if any.

For flexible pipe, the bed shall be roughly shaped and a bedding blanket of sand or fine granular material as specified above shall be provided as follows:

|  |  |
| --- | --- |
| Pipe Corrugation Depth | Minimum Bedding Depth |
| 10 mm | 25 mm |
| 25 mm | 50 mm |
| 50 mm | 75 mm |

For large diameter structural plate pipes the shaped bed need not exceed the width of bottom plate.

##### Laying Conduit

The conduit laying shall begin at the downstream end of the conduit line. The lower segment of the conduit shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream. Flexible conduit shall be placed with longitudinal laps or seams at the sides.

Paved or partially-lined conduit shall be laid such that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced conduits shall be placed with the major axis within 5 degrees of a vertical plane through the longitudinal axis of the conduit.

##### Jointing Conduit

Rigid conduits may either be of bell and spigot or tongue and groove design unless another type is specified. The method of joining conduit sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be made with (a) Portland Cement mortar, (b) Portland Cement grout, (c) rubber gaskets, (d) oakum and mortar, (e) oakum and joint compound, (f) plastic sealing compound, or by a combination of these types, or any other type, as may be specified. Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the conduit and finished smooth on the inside. For grouted joints, molds or runners shall be used to retain the poured grout. Rubber ring gaskets shall be installed so as to form a flexible water-tight seal. Where oakum is used, the joint shall be called with this material and then sealed with the specified material.

When Portland Cement mixtures are used, the completed joints shall be protected against rapid drying by any suitable covering material.

Flexible conduits shall be firmly joined by coupling bands.

Conduits shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be taken up and re-laid or replaced.

##### Field Strutting

When required by the Plans, vertical diameter of round flexible conduit shall be increased 5 percent by shop elongation or by means of jacks applied after the entire line of conduit has been installed on the bending but before backfilling. The vertical elongation shall be maintained by means of sills and struts or by horizontal ties shall be used on paved invert pipe.

Ties and struts shall be 300 mm in place until the embankment is completed and compacted, unless otherwise shown on the Plans.

These construction specifications shall also apply in the case of re-laid conduits. In addition, all conduits salvaged for relaying shall be cleaned of all foreign materials prior to reinstallation.

##### Backfilling

Materials for backfilling on each side of the conduit for the full trench width and to an elevation of 300 mm above the top of the conduit shall be fine, readily compactible soil or granular material selected from excavation or from a source of the Contractor’s choice, and shall not contain stones that would be retained on a 50 mm sieve, chunks of highly plastic clay, or other objectionable material. Granular backfill material shall have not less than 95 percent passing a 12.5 mm sieve and not less than 95 percent retained on a 4.75 mm sieve. Oversized material, if present, shall be removed at the source of the material, except as directed by the Engineer.

When the top of the conduit is flushed with or below the top of the trench, backfill material shall be placed at or near optimum moisture content and compacted in layers not exceeding 150 mm (compacted) on both sides to an elevation 300 mm above the top of the conduit. Care shall be exercised to thoroughly compact the backfill under the haunches of the conduit. The backfill shall be brought up evenly on both sides of the conduit for the full required length. Except where negative projecting embankment-type installation is specified, the backfill material shall be placed and compacted for the full depth of the trench.

When the top of the conduit is above the top of the trench, backfill shall be placed at or near optimum moisture content and compacted in layers not exceeding 300 mm (compacted) and shall be brought up evenly on both sides of the conduit for its full length to an elevation 300 mm above the top of the conduit. The width of the backfill on each side of the conduit for the portion above the top of the trench shall be equal to twice the diameter of the conduit or 3.5 m, whichever is less. The backfill material used in the trench section and the portion above the top of the trench for a distance on each side of the conduit equal to the horizontal inside diameter and to 300 mm above the top of the conduit shall conform to the requirements for backfill materials in this Subsection. The remainder of the backfill shall consist of materials from excavation and borrow that is suitable for embankment construction.

Compaction to the density specified in subsection 2.3.4, Embankment, shall be achieved by use of mechanical tampers or by rolling.

All conduits after being bedded and backfill as specified in this Subsection shall be protected by one metre cover of fill before heavy equipment is permitted to cross during construction of the roadway.

##### Imperfect Trench

Under this method, for rigid conduit, the embankment shall be completed as described in Subsection 2.4.3.2.6, Backfilling, to a height above the conduit equal to the vertical outside diameter of the conduit plus 300 mm. A trench equal in width to the outside horizontal diameter of the conduit and to the length shown on the plans or as directed by the Engineer shall then be excavated to within 300 mm of the top of the conduit, trench walls being as nearly vertical as possible. The trench shall be loosely filled with highly compressible soil. Construction of embankment above shall then proceed in a normal manner.

### Box Culvert

This work shall be executed in compliance with subsection 2.4.1 & 2.6.

### Inlet / Outlet Head Wall

This work shall be executed in compliance with subsection 2.4.1 & 2.6.

## Structures

### Box Culvert

This work shall be executed in compliance with subsection 2.4.1 & 2.6.

### Wet Masonry Retaining Wall H max 3.0m

This work shall be executed in compliance with subsection 2.4.1.

### Riprap Retaining Wall H max 8.0m

#### Description

This Item shall consist of the furnishing and placing of riprap with or without grout as the case may be, with or without filter backing, furnished and constructed in accordance with this Specification and to the lines and grades and dimensions shown on the Plans.

#### Material Requirements

##### Stones

Stones for riprap shall consist of rock as nearly as rectangular in section as is practical, except that riprap of Class A may consist of round natural stones. The stones shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended.

Stones for riprap shall be one of the following classes as shown on the Plans or determined by the Engineer.

|  |  |
| --- | --- |
| Class A - | Stones ranging from a minimum of 15kg to a maximum of 25kg with at least 50 percent of the stones weighing more than 20kg |
| Class B - | Stones ranging from minimum of 30kg to a maximum of 70kg with at least 50 percent of the stones weighing more than 50kg |
| Class C - | Stones ranging from minimum of 60kg to a maximum of 100kg with at least 50 percent of the stones weighing more than 80kg |
| Class D - | Stones ranging from minimum of 100kg to a maximum of 200kg with at least 50 percent of the stones weighing more than 150kg |

Sound pieces of broken concrete obtained from the removal of bridges, culverts and other structures may be substituted for stone with the approval of the Engineer.

##### Mortar

This work shall be executed in compliance with subsection 2.6.3.

#### Construction Requirements

##### Excavation

The bed for riprap shall be excavated to the required depths and properly compacted, trimmed and shaped.

The riprap shall be founded in a toe trench dug below the depth of scour as shown on the Plans or as ordered by the Engineer. The toe trench shall be filled with stone of the same class as that specified for the riprap, unless otherwise specified.

##### Placing

Stones placed below the water line shall be distributed so that the minimum thickness of the riprap is not less than that specified.

Stones above the water line shall be placed by hand or individually by machines. They shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. Each stone shall be laid with its longest axis perpendicular to the slope in close contact with each adjacent stone. The riprap shall be thoroughly rammed into place as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be filled with small broken fragments firmly rammed into place.

Unless otherwise provided, riprap shall have the following minimum thickness, measured perpendicular to the slope:

Class A – 300 mm

Class B – 500 mm

Class C – 600 mm

Class D – 800 mm

The surface of riprap shall not vary from the theoretical surface by more than 100 mm at any point.

##### Grouting

When grouted riprap is specified, stones shall be placed by hand, or individually by machine as specified for riprap placed above the water line. The spaces between the stones shall then be filled with cement mortar throughout the thickness of the riprap as specified in Subsection 2.6.3, mortar. Sufficient mortar shall be used to completely fill all voids, except that the face surface of the stones shall be left exposed.

Grout shall be placed from bottom to top of the surface swept with a stiff broom. After grouting is completed, the surface shall be cured as specified in subsection 2.6, Structural Concrete for a period of at least three days.

The stones shall also be laid in a manner that the vertical and horizontal alignments of the exposed face shall, as possible be maintained in a straight line.

##### Weepholes

It shall conform to the requirements of stone masonry under Subsection 2.4.1.3.7, Weepholes.

### Wash

This work shall be executed in compliance with subsection 2.4.1 & 2.6

### Gabion

#### Description

This Item shall consist of furnishing, forming wire mesh baskets, and placing rocks installed at the locations designated, in accordance with this Specification and in conformity with the lines, grades, dimensions, and arrangements shown on the Plans or as directed by the Engineer.

#### Material Requirements

##### General

Gabions shall be constructed of wire mesh and shall be supplied in various lengths and heights. A double twisted wire mesh container of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stones at the project site to form flexible, permeable, monolithic structures such as retaining walls, sea walls, channel linings, revetments and weirs for erosion control. The lengths shall be multiples of 2, 3 or 4 times the width of the gabion and heights shall be 0.50 m to 1.00 m or as shown on the plans. The horizontal width shall not be less than one meter. Gabion furnished shall be of uniform width.

The width, height and length of the gabion as manufactured shall not differ more than ±5% from the ordered size prior to filling.

Mattresses are double twisted wire mesh container uniformly partitioned into internal cells with relatively small height in relation to other dimensions, having smaller mesh openings than the mesh used for gabions. Mattresses are generally used for riverbank protection and channel linings. The length shall be 3.00 m to 6.00 m, the width shall be 2.00 m and the height shall be 0.17 m, 0.23 m or 0.30 m or as shown on the Plans.

The width and length of the revet mattress as manufactured shall not differ more than ±5%, and the height shall not differ more than ±10% from the ordered size prior to filling.

##### Wire

The wire used in the manufactured of double-twisted mesh for use in gabions and mattresses shall conform to the specifications as shown below as appropriate for the style ordered.

###### Style 1 double-twisted mesh shall be manufactured from zinc-coated steel wire conforming to Specification ASTM A 641, Class 3 coating, soft temper.

###### Style 2 double-twisted mesh shall be manufactured from Zn-5A1-MM-coated steel wire conforming to Specification ASTM A 856/A 856 M, Class 3 coating, soft temper.

###### Style 3 double-twisted mesh shall be manufactured from the same type of metallic-coated steel wire as style 1 with an additional PVC coating extruded into the metallic-coated steel wire. The PVC coating shall conform to the following requirements:

|  |  |  |
| --- | --- | --- |
|  |  | Test Method |
| 1. Specific Gravity | 1.30 to 1.35 | D 792 |
| 2. Tensile Strength, min | 20.6 MPa | D 412 |
| 3. Modulus of Elasticity, min | 18.6 MPa | D 412 |
| 4. Hardness, shore “D” | between 50 & 60 | D 2240 |
| 5. Brittleness Temp, max | 90C (150F) or lower temp. | D 746 |
| 6. Resistance to Abrasion, % weight loss, max. | 12% | D 1242 |

The PVC coating shall not show cracks or breaks after the wires are twisted in the fabrication of the mesh.

###### Style 4 double-twisted mesh shall be manufactured from aluminum-coated steel wire conforming to Specification ASTM A 809, soft temper.

##### Lacing Wire and Stiffener

Lacing wire and stiffeners shall be made of wire having the same coating material as the double-twisted wire mesh conforming to Specification ASTM A 641, A 856/A 856 M or A 809 with a tensile strength in accordance with subsection 2.5.5.2.2.

##### Manufacturer

Gabion and mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattresses lid which is produced separately from the base. All gabions and mattresses shall be supplied in the collapsed form, either folded and bundled or rolled, for shipping.

##### Dimensions

The minimum size of the galvanized and PVC coated wire to be used in the fabrication of the gabion and mattresses shall be as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | | Diameter, mm | |
| Gabion | | Mattresses | |
| Metallic Coated | PVC Coated | Metallic Coated | PVC Coated |
| Body Wire  Selvedge or Perimeter Wire  Tying and Connecting Wire | 3.05  3.80  2.20 | 2.70  3.40  2.20 | 2.20  2.70  2.20 | 2.20  2.70  2.20 |

Diameter Tolerances for Galvanized Wire to be used in the fabrication of gabion and mattress shall be ± .10.

The nominal and the minimum thickness of PVC coating shall be 0.50 mm and 0.38 mm, respectively.

##### Mechanical Properties

Tensile Strength – The tensile strength of Zinc-coated wire used in the fabrication of gabion and mattresses when tested in accordance with Test Methods ASTM A 370, shall be as follows:

|  |  |  |
| --- | --- | --- |
|  | Strength, max, Mpa | |
| Gabion | Mattresses |
| Body Wire | 485 | 515 |
| Selvedge or Perimeter Wire | 485 | 485 |
| Tying and Connecting Wire | 515 | 515 |

##### Weight of Coating

The minimum weight of zinc per unit area of uncoated wire surface shall be in accordance with ASTM A 975 or as follows:

|  |  |
| --- | --- |
| Wire Diameter, mm | Class 3 or A Coating, g/m2, ASTM A 641 |
| Over 1.90 to 2.30 | 220 |
| Over 2.30 to 2.70 | 230 |
| Over 2.70 to 3.10 | 240 |
| Over 3.10 to 3.50 | 260 |
| Over 3.50 to 3.90 | 270 |

##### Rock Fill

Rock used in the gabions and mattresses shall consist of hard, durable rock pieces that will not deteriorate when submerged in water or exposed to severe weather conditions. Rock pieces shall be generally uniformly graded in sizes ranging from 100 mm to 200 mm. Filled gabions shall have a minimum density of 1,400 kg/m3. Voids shall be evenly distributed.

No rock size shall exceed 2/3 the mattress depth and at least 85% by weight of the stone shall have a size greater than 80 mm. No stones shall be able to pass through the mesh.

The rock shall meet the requirements of AASHTO M 63 except that the sodium sulphate soundness loss shall not exceed 9% after 5 cycles.

##### Filter Fabric

Filter cloth shall consist of 70% polypropylene and 30% polyethylene.

#### Construction Requirements

#### Fabrication

1) Gabions and mattresses shall be in the form of rectangular baskets of the required dimensions and shall be manufactured from wire as specified in Subsection 2.5.5.2.5. Gabions shall be made of steel wire double twisted forming a uniform hexagonal mesh type 8 x 10 having a nominal mesh openings of 83 by 114 mm. Mattresses shall be made of steel wire double twisted forming a uniform hexagonal mesh type 6 x 8 having a nominal mesh openings of 64 by 83 mm. Tolerances on the hexagonal, double-twisted wire mesh opening shall not exceed ±10% on the nominal dimension D values, 64 mm for mattresses and 83 mm for gabions. The edges shall be formed into a securely connected selvedge adequate to prevent raveling.

Individual basket ties and connections shall be made by using a quantity of wire not less than 8% of the weight of each basket.

2) When the gabion length exceeds its width, it shall have securely tied diaphragms connected at all edges to form individual cells of equal length and width.

Gabions shall be fabricated in such a manner that the sides, ends, lids and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. Gabions shall be of single unit construction, base, lids, ends and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that the strength and flexibility at the point of connection is at least equal to that of the mesh.

The gabion shall be equally divided by diaphragms, placed at not more than 1.0 m intervals, and of the same mesh and gauge as the body of the gabions, into cells the length of which does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this junction will be necessary.

3) Four cross-connecting wires shall be provided in each cell having a height of one half the width or less, and eight cross-connecting wires shall be provided in each cell having a height greater than one half the width.

All perimeter edge of the mesh forming the gabion shall be securely selvedged so that the joints, by tying the selvedges, have at least the same strength as the body of the mesh.

Selvedge wire used through all the edges (perimeter wire) shall not be less than 3.80 mm diameter and shall meet the same specifications as the wire mesh.

##### Assembly and Construction:

###### Gabions shall be installed in a workmanlike manner. The gabions shall be placed on a smooth foundation. Final line and grade shall be approved by the Engineer.

Each gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately 152 mm (6 inches) spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil every 102 mm ( 4 inches). Empty gabion units shall be set to line and grade as shown on the Plans or as described by the Engineer. Wire ties or connecting wires shall be used to join the units together in the same manner as described above for assembling. Internal tie wires shall be uniformly spaced and securely fastened in each cell of the structure.

A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

###### When possible the subgrade of the mattress and gabion shall be properly compacted to a depth of 150 mm. The Contractor shall consider the cost of subgrade preparation in the unit prices. Filter fabric as beds of gabions and mattresses forming the structure shall be suitably leveled and shall be securely connected along the complete length of all contact edges by means of the above specified tying and connecting wire.

###### Before the filling material is placed, the gabions and mattresses shall be carefully selected for uniformity of size, and the pieces shall be handplaced to provide a neat appearance as approved by the Engineer.

The gabions shall be filled with stone carefully placed by hand or machine to assure alignment and avoid bulges with a minimum voids. Alternate placing of rock and connection wires shall be performed until the gabion is filled. After a gabion has been filled, the lid shall be bent over until it meets the sides and edges. The lid shall then be secured to the sides, ends and diaphragms with the wire ties or connecting wire in the manner described for assembling.

The vertical joints of gabions and mattress baskets shall be staggered as in running bond in brickwork.

###### The cells in any row shall be filled in stage so that local deformation may be avoided. That is at no time shall the cell be filled to a depth exceeding 30 cm more than the adjoining cell.

###### Filter fabric shall be placed between earth surface and gabion or mattress structures. Filter fabric shall be rolled out into a flat non-rutted surface free from sharp objects, weighing down the edges. Construction equipment shall not be allowed into unprotected fabric. Jointing is normally affected by overlapping not less than 300 mm, but it is preferable to joint by sewing or industrial stapling. Joint edges should be facing downwards to avoid protruding through the surface material.

## Structural Work (common)

### Steel Reinforcement Work

#### Material

###### Reinforcement bars shall be deformed cold worked ribbed steel bars of the size and dimensions shown on the drawings. Reinforcing steel shall be free from pitting, rust, mill scale, paint, oil, grease, adhering earth or any other dirt. Such materials will prevent the bond between the concrete and reinforcement, cause corrosion of the reinforcement and cause the breaking of the concrete.

###### All reinforcing steel bars shall conform to the requirements of the following specifications in 2.6.1.1 - 3). The Contractor shall submit mill certificates of the reinforcement prepared by the manufacturer to the Consultant for his approval.

###### The reinforced bar shall be deformed. The yield strength of reinforcement bar shall exceed 345N/mm2. It shall be equivalent to Class A-111(A-400) GOST2781-82 or better.

###### The quality of the reinforcing bars shall be confirmed by a material test in addition to checking of the mill sheets.

#### Material Test

###### The material test shall be entrusted to the private laboratory in Jalalabad to conduct the tensile test conforming to BS4449 for the purpose of receiving an official document on the test results.

###### In regard to the deformed bars to be used for the construction work, the tensile test shall be conducted once if the volume of delivery is less than 30 tons or once for every 30 tons if the volume of delivery exceeds 30 tons for each nominal diameter above a nominal diameter of 10 mm. No tensile test shall be conducted for the round bars unless the Consultant has so requested.

###### For each test, three test pieces shall be manufactured for each nominal diameter above 10 mm.

###### The tensile test items shall be the rupture strength, yielding point strength and coefficient of extension and Class-A2 deformed bars shall be deemed to pass the strength as shown in GOST.

#### Storage and Protection

###### All reinforcement shall be delivered to the Site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transported while doubly bent.

###### The reinforcing bars shall be stored as described in 2.1.1.5 - 3). Prior to placing concrete, reinforcing steel which is to be embedded, shall be free from rust, dirt, mud, loose scale, paint, oil, or any other foreign substance. If considered necessary by the Consultant, grit blasting shall be employed to clean bars at no extra cost to the Contract.

###### Bent or damaged reinforcing bars which will cause an impediment to the construction work shall not be used.

#### Processing

###### The reinforcing bars shall be processed cold to the dimensions and shape set forth in the design drawings and shop drawings and shall not undergo heat processing involving a gas flare, etc.

###### Cutting of the reinforcing bars shall be conducted by a shear cutter or power saw, etc. and gas cutting shall not be conducted.

###### A hook shall be created at the end of the main reinforcing bars for the four corner columns at the highest floor which form the main structure, the base bars for the footings, hoops and stirrups.

###### Table 2.6‑1 shall be referred to for the inner diameter for the bent reinforcing bars and their application positions.

###### At each site, the Contractor shall manufacture hoop and stirrup samples conforming to the dimensions set forth in the design drawings and shop drawings and bent bar samples attached with a hook and anchor of the stipulated length for each nominal diameter and shall have them inspected by the Client. Those samples passing the inspection shall be displayed for easy recognition in the steel bending yard and shall be used to check the processing accuracy.

###### The required accuracy of bar processing shall be ±15 mm of the dimensions set forth in the design drawings and shop drawings in the case of main reinforcing bars and ±5 mm for the hoops and stirrups.

Table ‑ Inner Diameter of Bent Reinforcing Bars and Places of Application

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Bending Angle** | **Bending Drawing** | **Inner Diameter of Bent Section (D)** | | **Hook Length (L)** | **Place of Application** |
| **Nominal Diameter ≤ 16 mm** | **Nominal Diameter**  **> 19 mm** |
| End Part | 180° |  | ≥ 4d | ≥ 5d | 4d | Main reinforcing bars for the top section of four corner columns on the highest floor |
| 135° |  | ≥ 4d | ≥ 5d | 5d | Hoops; stirrups; tie bars |
| 90° |  | ≥ 4d | ≥ 5d | 10d (\*5d) | Slabs; end parts of wall bars; end parts of base parts for footings \*free end parts of upper bars for canti-slabs |
| Middle Part | 90° |  | ≥ 4d | ≥ 5d | N/A |  |
| ≤ 90° |  | ≥ 4d | ≥ 6d | N/A |  |

###### At each site, the Contractor shall manufacture hoop and stirrup samples conforming to the dimensions set forth in the design drawings and shop drawings and bent bar samples attached with a hook and anchor of the stipulated length for each nominal diameter and shall have them inspected by the Consultant. Those samples passing the inspection shall be displayed for easy recognition in the steel bending yard and shall be used to check the processing accuracy.

###### The required accuracy of bar processing shall be ±15 mm of the dimensions set forth in the design drawings and shop drawings in the case of main reinforcing bars and ±5 mm for the hoops and stirrups.

#### Assembly

###### For the assembly of the reinforcing bars, the splicing points of the reinforcing bars and key cross points of the main reinforcing bars, hoops and stirrups shall be tied.

###### The outer main reinforcing bars for the beams shall be placed inside the main reinforcing bars for the columns and the outer main reinforcing bars for the beams and the main reinforcing bars for the columns shall be tied at the crossing points. The main reinforcing bars for the non-main structural columns or additional columns shall be placed inside the outer main reinforcing bars for the beams and shall be tied at the crossing points.

###### The tying of the reinforcing bars shall be conducted using a steel wire of a minimum diameter of 0.8 mm, and the ends of the wire turned into the body of concrete.

###### The first and last stirrups for the beams shall be placed 50 mm from the main reinforcing bars for the columns and other stirrups in between shall be placed at a spacing of or shorter than the design pitch. In the case of binders of which the supported ends are beams, the first and last stirrups shall be placed 50 mm from the main reinforcing bars for the supported end beams.

###### The first hoops for the columns at each floor shall be placed 50 mm from the main reinforcing bars for the upper end of the floor beams for the said floor while the last hoops shall be placed 50 mm from the main reinforcing bars for the lower end of the floor beams for the above floors. Other hoops in between shall be placed at a spacing of or shorter than the design pitch.

###### The distance between the column hoops for the crossing sections of the columns and beams (panel zones) shall not exceed 300 mm.

###### Spacers shall be placed at both sides of the column hoops and beam stirrups and also at the bottom of the beam to secure thickness of cover for the reinforcing bars. These spacers shall have a distance of approximately 1.0 m and shall be arranged in a staggered fashion.

###### Concrete shall not be placed in any member until reinforcement placement has been approved by the Consultant.

###### If a main reinforcing bar is found to be out of place from the designated position up to 25 mm as a result of setting-out after placing the concrete, the Contractor shall inform the Consultant, followed by positional correction of the main reinforcing bar in the following manner.

The concrete around the subject main reinforcing bar for positional correction shall be removed by some 50 mm from the concrete surface and the main reinforcing bar shall be bent from that position.

The bending gradient of the main reinforcing bar shall be not larger than 0.2 in the horizontal direction to the value of 1 in the vertical direction, i.e. approximate bending angle of 11°, and the main reinforcing bar shall be adjusted to the correct position.

An additional hoop shall be placed at the end of the bending part apart from the design pitch.

###### Spacers shall be placed at both sides of the column hoops and beam stirrups and also at the bottom of the beam to secure thickness of cover for the reinforcing bars. These spacers shall have a distance of approximately 1.0 m and shall be arranged in a staggered fashion.

###### The spacers shall be made of mortar and their dimensions shall be 40 mm x 40 mm specified cover thickness. Wires cast into the blocks for tying in to reinforcement shall be 1.6 mm diameter soft annealed iron wire. The mortar shall be mixed by volume and the standard mixing ratio shall be that given below. Immediately after manufacture, this mortar mix shall undergo wet curing for five days and shall then be covered to prevent dust and soil entering it until it is ready for use 28 days after manufacture. Spacers which are not immediately used shall be stored in bags, etc. Mixing ratio of mortar shall be; cement 1 : sand 2.

###### The Contractor shall be able to use steel or polyethylene spacer with the approval of the Client.

#### Splicing and Anchoring

###### Splicing of the reinforcing bars shall be conducted by lap-splicing and the lapped splices shall not have hooks. Table 2.6‑2 shall be referred to for the length and positions of the splices.

Table ‑ Lap-Splicing of Reinforcing Bars

|  |
| --- |
| Neighboring splices |
|  |
| Desirable position of splicing for main reinforcing bars for girders |
|  |
| Desirable position of splicing for main reinforcing bars for columns |
|  |

#### Cover Thickness and Spacing of Reinforcing Bars

###### The spacers shall be made of mortar and their dimensions shall be 40 mm x 40 mm specified cover thickness. Wires cast into the blocks for tying in to reinforcement shall be 1.6 mm diameter soft annealed iron wire. The mortar shall be mixed by volume and the standard mixing ratio shall be that given below. Immediately after manufacture, this mortar mix shall undergo wet curing for five days and shall then be covered to prevent dust and soil entering it until it is ready for use 28 days after manufacture. Spacers which are not immediately used shall be stored in bags, etc. Mixing ratio of mortar shall be; cement 1 : sand 2

###### The Contractor shall be able to use steel or polyethylene spacer with the approval of the Consultant.

###### Table 2.6‑3 shall be referred to for the cover thickness of the reinforcing bars.

Table ‑ Cover Thickness of Reinforcing Bars

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part of Structure** | | | | **Minimum Cover Thickness (mm)** |
| Parts without soil contact | Slabs; non-bearing walls | With finishing | | 20 |
| Without finishing | | 20 |
| Columns; beams; bearing walls | Indoor | With finishing | 30 |
| Without finishing | 30 |
| Outdoor | With finishing | 30 |
| Without finishing | 40 |
| Retaining walls |  | | 40 |
| Parts with soil contact | Columns; beams; slabs; walls; retaining walls | | | 40 |
| Footings; pressure containing boards | | | 60 |

###### The spacing between neighboring reinforcing bars shall be capable of securing clearance between the reinforcing bars or wider as described below.

* Nominal diameter (d) ≤ 14 mm clearance : 25 mm
* 16 mm ≤ nominal diameter (d) ≤ 22 mm clearance : 35 mm

#### Protection After Assembly

###### Following assembly of the reinforcing bars, footboards shall be placed on the slabs and beams, etc. so that none directly walks on top of the reinforcing bars.

###### Should rust occur on the assembled reinforcing bars, the rust shall be removed using a wire brush, etc.

###### Just prior to the placement of concrete, the reinforcing bars exposed to the sun shall be tested for temperature, and when the bars have become so hot that, in the opinion of the Consultant, the temperature of the fresh concrete shall be affected, the bars shall be covered with a water-soaked burlap or subjected to a spray of cold water by an approved method so that the temperature of the bar shall not exceed the local ambient temperature immediately before embedment in concrete.

#### Bar Arrangement Inspection

###### The Contractor shall record and confirm the number, accuracy of processing, cover, lap-splicing, distance and positioning of the reinforcing bars and shall have them inspected by the Consultant prior to the casting of the concrete work.

### Concrete Work

#### Types of Concrete

###### The concrete to be used shall be in-situ mixed concrete produced by a mixer installed at each site.

###### The design reference strength of the concrete Fc (compressive strength of 28 days old concrete) shall be 15 N/mm2 for blinding concrete, 20 N/mm2 for such sub-structures as the foundations, footing beams and Ground floor slab and 25 N/mm2 for the super-structures.

###### The mix proportion shall be determined through trial mix as described in subsection 2.6.2.3.1. Table 2.6‑4 shall be referred to for the recommended mix proportion of cement, fine aggregate and coarse aggregate.

Table ‑ The Standard Concrete Type, Mix Proportions, Water Cement Ratio and Slump

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Grade** | **Strength N/mm2** | **Cement:Sand:Coarse Aggregate** | **Water : Cement Ratio** | **Slump (mm)** | **Uses** |
| M100 | 15 | 1:3:6 | 0.6 – 0.7 | 50 – 70 | Blinding |
| M150 | 20 | 1:2:4 | ~ 0.6 | 50 – 70 | PCC Flooring |
| M200 | 25 | 1:1.5:3 | 0.55 – 0.6 | 50 – 70 | RCC structural concrete |
| M250 | 30 | 1:1:2 | 0.45 | 50 – 70 | RCC Pipe |

Note: The mix proportion of cement, fine aggregate and coarse aggregate shall be by dry volume.

#### Materials

##### Cement

###### The cement shall be normal Portland cement M400.

###### Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer’s sealed unbroken bags. Bagged cement shall be transported in vehicles provided with effective means of ensuring that the cement is protected from the weather. Any cement which has deteriorated due to dampness or other causes shall not be used in the Works under any circumstances.

###### The cement shall be stored in the cement storage referred to in 2.1.1.5 - 1), 3) and not more than 15 bags shall be stacked. Storage shall be such that the earliest deliveries shall be used first. Cement stored for more than 60 days shall not be used in the works.

##### Aggregates

###### Coarse aggregates shall be two types, i.e. 5/15 (within the size of 5 mm to 15 mm) and 15/25 (within the size of 15 mm to 25 mm) conforming to BS882, and shall be crushed granite stone procured from the approved place by the Consultant. No injurious amount of rubbish, dirt, organic impurities and other foreign matters shall be contained. Elongated pieces shall not exceeding 5 percent.

**25 mm to 4.75 mm Graded Coarse Aggregate**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sieve** | **37.5 - mm (No. 4)** | **25 – mm**  **(1 in)** | **9.5 - mm**  **(3⁄8 - in.)** | **4.75 - mm**  **(No. 4)** | **2.36 - mm**  **(No. 8)** |
| % Passing by mass | 100 | 95 – 100 | 25 – 60 | 0 – 10 | 0 – 5\* |

**\*- the transmission rate through the 75 m sieve shall not be more than 3%.**

###### Fine aggregates shall be river sand with a maximum diameter of 5 mm conforming to BS882 and procured from the approved place by the Consultant. The fine aggregates to be used for the in-situ mixed concrete shall be screened through a sieve with a 5 mm zinc coated mesh more than 5 cycles to remove such impurities as litter and wood chips, etc.

**Grading of Sand**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sieve** | **9.5 - mm**  **(3⁄8-in.)** | **4.75 - mm**  **(No. 4)** | **2.36 - mm**  **(No. 8)** | **1.18 - mm**  **(No. 16)** | **600 - μm**  **(No. 30)** | **300 - μm**  **(No. 50)** | **150 - μm**  **(No. 100)** |
| % Passing by mass | 100 | 95 – 100 | 80 – 100 | 50 – 85 | 25 – 60 | 5 – 30 | 0 – 10\* |

**- Increased to 20% for crushed rock fines, except when they are used for heavy duty floors**

**- the transmission rate through the 75 m sieve shall not be more than 3%.**

###### Mechanical properties: When determined in accordance with 6.4 and 7.4 of BS 812-111:1990, the oven-dry 10% fines value shall not be less than 50 kN. As an alternative to the 10% fines test, the aggregate impact value may be carried out in accordance with BS 312-112 and the oven dry aggregate impact value shall not exceed 45%.

###### Flakiness index: When determined in accordance with BS 812-105.1, the flakiness index of the combined coarse aggregate shall not exceed 50 for uncrushed gravel and 40 for crushed rock or crushed gravel.

###### Aggregates shall be delivered to Site in clean and suitable vehicles. Different types or sizes of aggregates shall not be delivered in one vehicle.

###### Aggregates shall be stored as referred to in 2.1.1.5 - 4).

###### Aggregates exposed to strong sun for a long period of time shall not be used as they are. Should these aggregates be used, they should first be cooled down by the sprinkling of water or other means.

###### The aggregate shall be tested at the private laboratory in Jalalabad with a request to issue an official document of the test results.

###### In regard to coarse aggregates, a test on either the specific gravity in absolute dry conditions or the specific gravity in saturated surface-dry conditions, a test on the percentage of water absorption and a sieve analysis test on 5/15 and 15/25 gravel (conforming to BS812) shall be conducted and the following criteria must be met.

* Density ≥ 2.4 g/cm3
* Percentage of water absorption ≤ 4%
* In the case of the sieve analysis test, the transmission rate through the sieve openings for small size gravel shall not be more than 3% and the transmission rate through the sieve openings for large size gravel shall not be less than 99%.

##### Water

###### Water used in concrete shall be clean and free from any substance harmful to concrete. Its neutrality, iron content, sulphur content and calcium content shall be tested at the private laboratory in Jalalabad, and shall be satisfied the following values.

* Neutrality 7 – 8.5
* Iron content ≤ 0.1 mg/litre
* Sulphur content ≤ 500 mg/litre
* Calcium ≤ 75 mg/litre

###### The same water will be used for cleaning out the concrete mixers and transit trucks.

##### Admixture

###### No admixture shall be used for the planned construction work.

#### Mix Proportion

##### Trial Mix

###### Trial Mix shall be done by the Contractor to specify the mix proportion of the concrete, and specified mix proportion shall be approved by the Consultant.

###### Conditions of Materials and Mixing shall be as follows.

The minimum value for the unit cement quantity for such sub-structures as the foundations, footing beams and ground floor slab shall be 300 kg/m3 and the minimum value for the unit cement quantity for the super-structures shall be 375 kg/m3.

The air volume contained in the concrete shall not be more than 1%.

The water to cement ratio shall not exceed 55%.

The slump of the concrete before casting shall be 6 cm ± 1 cm for the sub-structures, slab-on-earth and super-structures while the concrete temperature shall not be higher than 35°C.

The standard air-dried unit volume weight of the concrete shall be 2.35 tons/m3 – 2.45 tons/m3.

###### The specified mix shall be determined based on the in-situ test mix and mixing operation shall continue until such time that the proportioning strength, specified slump, specified air volume and required air-dried unit volume weight are achieved.

###### Trial mixing shall be conducted based on the mixing ratio of volume using the volume of one bag of cement as one portion. The volume of one bag of cement shall adopt a mean value by measuring three bags in the following manner.

A wooden or steel measure with internal dimensions of 316 mm in length, 316 mm in width and 450 mm in depth shall be prepared and placed on a level floor. In the case of a wooden measure, its inner surface shall be finished with varnish.

The cement of one bag shall be thrown in one movement into the measure without any spillage.

After (b) above, the measure shall be raised by 200 mm from the floor and freely dropped. This free fall process shall be repeated three times.

The height from the crown of the measure to the surface of the cement shall be measured.

The volume of cement bag No.1 shall be determined as the value obtained by {450 – height obtained in iv} (mm)}/10.

###### The coarse aggregates and fine aggregates shall be measured by fabricating a measure with an equal volume to that of one bag of cement based on the results of b) above. Both the coarse aggregates and fine aggregates shall be placed in the measure to level with the crown of the measure without any heaping above the measure. No striking of the fine aggregates by a spade or other tool to fill them into the measure shall be permitted.

###### In regard to the coarse aggregates and fine aggregates, the weight of the volume equivalent to the capacity of the measure in question (excluding the weight of the measure itself) shall be measured three or more times for each type of aggregate.

###### Based on the volume of each material and the volume of water thrown into the batch of test mixing, the test results referred to in subsection 2.6.2.2.2 and the measurement results referred to in subsection 2.6.2.3.1 - 6), etc., the absolute volume of concrete per m3 shall be calculated and recorded together with a record of the volume of concrete mixed as one batch.

###### The proportioning strength of Fc28 shall be not less than the strength achieved by the design reference strength Fc plus the additional strength ΔF (3 Mpa) which considers the difference between the strength of structure concrete and the strength of the test piece. Accordingly, the proportioning strength for the planned construction work shall be as follows.

* In the case of Fc = 20 N/mm2 F28 ≥ 23 N/mm2
* In the case of Fc = 25 N/mm2 F28 ≥ 28 N/mm2

##### Slump Test

###### The specified slump test shall be conducted on site in the following manner for each batch and achievement of the specified slump value must be confirmed.

A slump tester (consisting of a steel slump cone with a top diameter of 100 mm, bottom diameter of 200 mm and height of 300 mm, a base plate with a clamp and a slump measure) shall be prepared and the inside of this slump cone and the base plate shall be washed clean.

Concrete shall be injected to one-third of the height of the slump cone and shall be evenly rammed 25 times using a tamper.

Concrete shall be injected to two-thirds of the height of the slump cone and shall be evenly rammed 25 times using a tamper. The ramming depth shall be that the tamper almost reaches the previous layer.

Concrete shall be injected to the slump cone above the rim of the cone and shall be evenly rammed 25 times using a tamper to make the concrete surface flat and level with the crown of the slump cone.

The slump cone shall be pulled up at a rate of 30 cm in approximately 30 seconds.

The slump from the crown of the slump cone to the centre of the concrete surface shall be measured in 0.5 cm units.

The test shall be repeated until the specified slump is achieved.

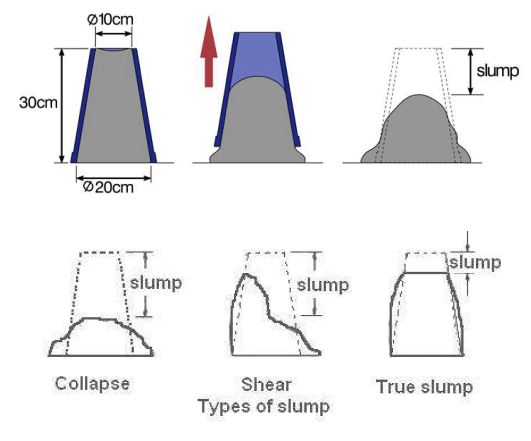


Figure ‑ Dimensions and Removal of Slump Cone

##### Air Volume Test

###### The air volume test shall be entrusted to the private laboratory in Jalalabad and a laboratory engineer shall conduct the test at the site using an air volume tester. After the test, shall have an official document of the test results which is issued by the said Laboratory.

###### The specified air volume test shall be conducted in the following manner with two batches of the test mix. The selection of the subject batches for this test shall follow the instruction by the Consultant.

Concrete shall be injected to one-third of the height of the testing container and shall be evenly rammed 25 times using a tamper.

Concrete shall be injected to two-thirds of the height of the testing container and shall be evenly rammed 25 times using a tamper. The ramming depth shall be that the tamper almost reaches the previous layer.

Concrete shall be injected to the crown of the testing container and shall be evenly rammed 25 times using a tamper.

The site of the testing container shall be lightly hit by a wooden hammer or similar approximately 10 times to make the concrete surface flat and level with the crown of the testing container.

A lid shall be placed and fastened by a crank, followed by the injection of water to the 0 position of the glass air volume indicator of the lid.

The air exhaust cock and the water drainage cock shall be closed and pressure of one atmosphere shall be applied using an air pump to read the value on the glass air volume indicator.

An air volume reading of not higher than 1% shall be deemed to have passed the test.

##### Air-Dried Unit Volume Weight Test

###### The air-dried unit volume weight test shall be entrusted to the private laboratory in Jalalabad. The Contractor shall request the said Laboratory to issue an official document of the test results after the test.

###### The test shall be conducted in the following manner.

Prior to the compression test of three test pieces having reached each of the specified age (7 days, 14 days and 28 days), the weight of each test piece shall be weighed by a weighing machine of which the minimum scale is not more than 10 g.

The unit volume weight per m3 of concrete shall be calculated using the mean value of the measured weight of the three test pieces and the falling of this calculated value in the range between 2.35 tons/m3 and 2.45 tons/m3 shall be confirmed.

##### Strength Test

###### This strength test shall be entrusted to the private laboratory in Jalalabad to conduct the compression test conforming to BS1881 for the purpose of receiving an official document of the test results.

###### Nine test pieces, i.e. three pieces of seven days old, three pieces of 14 days old and three pieces of 28 days old, shall be collected from one batch of concrete.

###### The test pieces shall be made in the following manner using a cube mould conforming to BS1881.

Concrete shall be injected to the crown of the mould and shall be evenly rammed 25 times using a tamper.

The side of the mould shall be lightly hit by a wooden hammer or similar approximately 10 times to remove air from the concrete and the concrete surface shall be finished using a trowel to make it level with the crown of the mould.

###### The test pieces shall be stripped between 24 hours and 48 hours after moulding and shall be cured in water in the on-site curing tank until they reach the specified age.

###### Three test pieces having reached each of the specified ages shall be promptly delivered to the laboratory for the compression test after capping.

###### The test results shall be deemed to pass the test when the mean value of the compressive strength of the three seven day old test pieces at the time of their rupture is not less than the value given below and when the mean value of the compressive strength of the three 28 day old test pieces at the time of their rupture is not less than the proportioning strength. The mean value of the compressive strength of the three 14 day old test pieces at the time of their rupture shall be used for the preparation of a concrete strength occurrence curve.

X7 ≥ 1.05 F7

X7 :mean value of the compressive strength of the seven day old test pieces at the time of their rupture (Mpa)

F7 :{(Fc + ΔF) – 4}/1.35 (Mpa)

###### Should the criterion described in f) above not be met, the Contractor shall consult the Consultant to decide suitable measures.

#### In-Situ Mixed Concrete

##### Production in General

###### The mixer to be used to produce the in-situ mixed concrete shall be one of which the inside of the drum is properly maintained, of which the mixing blades are not deformed and which is in proper working order.

###### The Contractor shall confirm that there are no problems regarding the production of concrete by inspecting or conducting a trial run of the mixer delivered to the site in the case of a power-operated mixer and the existence of measures to prevent electrification and the wiring, etc. shall be checked to confirm their propriety.

###### The concrete mixer shall be installed in line with the relevant conditions described in subsection 2.1.1.5 - 2).

###### The mixed concrete shall be received by a receiver made of mortar, concrete or steel and this receiver shall be cleaned on the completion of each casting operation.

###### The injection hopper receiving the materials shall be provided with a slipway or similar to facilitate the input of the materials.

###### The inside of the drum and the mixing blades of the concrete mixer shall be cleaned every time casting operation is completed together with inspection of the moving sections.

##### Proportioning and Mixing

###### The proportioning of the materials shall be based on volume proportioning vis-à-vis one bag of cement determined by the test mixing and the coarse aggregates and fine aggregates shall be measured using the measure referred to in subsection 2.6.2.3.1 - 4).

###### In regard to the water volume, a bucket marked to confirm one litre of water or another container with which the water volume can be confirmed shall be used.

###### The volume proportions determined by the test mixing shall be displayed in a highly visible place near the concrete mixer. The volume of each batch shall be recorded to prevent any erroneous measurement.

###### The standard mixing duration in the concrete mixer shall be 1 minute and 30 seconds after the input of all of the materials.

##### Tests on In-Situ Mixed Concrete

###### The tests on the in-situ mixed concrete shall be the strength test, the slump test and the unit volume weight test. The air volume test shall not be conducted.

###### The strength test shall be entrusted to the private laboratory in Jalalabad and nine test pieces, consisting of three pieces of seven days old, three pieces of 14 days old and three pieces of 28 days old, shall be sampled for each concrete casting operation. The production process of the test pieces and the test shall follow the descriptions in subsection 2.6.2.3.5.

###### The slump test shall be conducted for the first batch prior to the casting of the concrete, followed by repetition of the test for every two batches thereafter, and a test result of 6 cm ± 1 cm shall be deemed to pass the test. The test shall be conducted in accordance with the descriptions in subsection 2.6.2.3.2.

###### Measurement of the temperature of the in-situ mixed concrete shall be conducted for the first batch prior to the casting of the concrete and shall be repeated every two batches thereafter. Concrete of which the temperature exceeds 35°C as a result of the test shall not be cast.

###### The unit volume weight test shall be entrusted to the private laboratory in Jalalabad and the test shall be conducted as described in subsection 2.6.2.3.4.

##### Casting

###### Prior to casting, the target area shall be cleaned to remove any litter and shall be watered to wet the sheathing boards or construction joint faces.

###### Great care shall be taken to keep the temperature of concrete as low as possible during hot weather so as to prevent cracking or crazing of the concrete. In hot weather consideration shall be given to carrying out concreting operations in the very early morning or late evening. The Implementation Engineer will decide the best time for concreting.

###### Cantilevers and cantilever slabs, etc. shall be cast at the same time as the structural parts which supports them.

###### Within a block which is planned for casting in a single operation, casting shall be continually conducted to ensure the monolithic property of the concrete. The time required to prepare the next pour, i.e. the duration of suspended casting operation, during continual casting of the same block shall not exceed 30 minutes. Should casting operation fail to restart within 30 minutes, the entire concrete cast earlier shall be removed for recasting after cleaning the block.

##### Construction Joints

###### The position of a vertical construction joint shall be the lower end of the thickest beam through which the said column runs through. The position of a horizontal construction joint shall be near the centre of the span in the case of a beam or a slab. Each positions of construction joints shall be consulted and approved by the Consultant.

###### A stop-end board or similar shall be used for the construction joint faces to prevent leakage of the cement paste, etc.

###### For the casting of a construction joint face, the laitance at such face shall be removed and seemingly fragile concrete shall be chipped to expose sound concrete prior to casting.

##### Compaction

###### Compaction shall be conducted with the combined use of a bar vibrator and a tamper. If necessary, the outside of the form shall be hit using a wooden hammer or similar so that concrete can be filled into every corner of the form to prevent the occurrence of honeycombing.

###### A bar vibrator shall be inserted almost vertically for every concrete casting height of approximately 1.0 m in the case of columns and shall be vibrated. In the case of beams or slabs, a bar vibrator shall be inserted at intervals of approximately 60 cm and shall be vibrated. This vibrating operation shall continue until such time when the paste begins to float on the concrete surface.

###### A bar vibrator shall not be vibrated in contact with a reinforcing bar or form.

##### Curing

###### Wet condition shall be maintained for at least 6 days after the casting of the concrete by the sprinkling of water or other means to prevent rapid drying of the concrete surface after casting. The surface shall never be allowed to become dry during this period. Curing shall start immediately after laying of the concrete and shall be maintained uninterrupted.

###### No walking or work shall be conducted above the cast concrete for at least 24 hours after the casting of the concrete. If work is essential, a footboard or similar should be used as a protection measure so as not to damage the cast concrete.

#### Forms

##### Materials

###### The material for sheeting shall be waterproofed plywood of not less than 12 mm thick or new wooden planks which are commonly used in the project area. In the case of an exposed concrete finish, new material of waterproofed plywood of not less than 12 mm thick shall be used.

###### The material for supporting shall be steel pipe or square timber which is commonly used in the project area. Trimmed logs may be partially used provided that such use is approved by the Consultant.

###### The materials for sheeting and supporting may be re-used up to 5 times. However, prior to their use, the forms must be cleaned and the absence of any flaws or cracks, etc. must be confirmed.

##### Processing and Assembly of Forms

###### The forms shall be planned to be able to resist the work load, design weight and lateral pressure of the concrete, vibration and impact at the time of casting and external forces, including the horizontal load.

###### The standard forms shall be processed and assembled to the dimensions specified by the shop drawings.

###### The sheeting shall be supported by appropriate studs, walling and/or stays to prevent any deformation or distortion at the time of concrete casting and shall be fastened by conventional clamps, 16 mm screw clamp bolts and nuts.

###### When the forms for columns are constructed above slabs, a concrete kicker of some 50 mm in height shall be introduced at the foot of the column so that the form for the column can achieve the specified dimensions. Accurate setting-out shall be conducted to determine the position and dimensions of this concrete kicker as set forth in the design drawings.

###### At the construction joints of the sheeting, plywood of some 4 mm in thickness and 45 mm in width shall be nailed down from the outer side of the sheeting.

###### In the case of forms for after casting columns between brick walls or the sheeting for beams at the top of brick walls, a sponge of some 20 mm in thickness and 40 mm in width shall be installed to the brick surface prior to the work of applying the sheeting. The sheeting shall then be applied and fastened to prevent any leakage of the cement paste.

###### The standard distance between the posts used for shoring shall be approximately 600 mm and the shoring shall be free of any deformation and shall be safe, taking the load from above and other factors into consideration. A wooden plank of 30 mm in thickness shall be placed at the lower part of the posts and the height shall be adjusted by the camber between the planking and post.

###### The posts for supporting shall be tied by the horizontal girth.

###### Forms shall not be tied to such temporary structures as the scaffolding and profile.

##### Completed Amount Inspection for Form Work

###### The Contractor shall record and confirm the completed amount on completion of the form work but prior to the casting of the concrete and shall have it inspected by the Consultant.

###### Table 2.6‑5 shall be referred to for the tolerance for the completed amount.

###### Should the completed amount exceed the tolerance, the Contractor shall consult the Consultant on how to correct the situation and shall conduct the correction using an approved method.

##### Retention Period and Stripping of Forms

###### The forms shall be stripped only after the passing of the minimum retention period as described below. At the time of stripping, no damage shall be caused to the concrete body.

###### The minimum retention period for the shuttering for the foundation, side of the beams, columns and walls shall be 3 days from the day on which the casting of the concrete is completed.

###### The shuttering below the beams (including cantilever beams) and slabs (including cantilever slabs) shall only be stripped after the stripping of the shoring posts. The minimum retention period for the shoring posts shall be 28 days from the day on which the casting of the concrete is completed.

##### Completed Amount Inspection for Concrete Work

###### The Contractor shall record and confirm the completed amount after the completion of the casting concrete and the stripping of the forms and shall have the completed amount inspection by the Consultant.

###### Table 2.6‑5 shall be referred to for the tolerance of the completed amount.

###### The condition of the finished concrete surface shall have little dislocation, unevenness or honeycombs and shall not have air holes of 5 mm in diameter or larger.

###### Should the completed amount exceed the tolerance or should the condition of the finished surface be problematic, the Contractor shall consult the Consultant regarding the repair method and shall conduct the necessary repair using an approved method.

Table ‑ Tolerances for Completed Amount of Forms & Concrete Body

|  |  |  |
| --- | --- | --- |
| **Structure / Body** | **Design Dimensions** | **Tolerance for Design Dimensions** |
| Position of each design member |  | L1: ±15 mm  L2: ±15 mm |
| Beam |  | D: ±5 mm  b: ±5 mm |
| Column |  | a: ±5 mm  b: ±5 mm |
| Construction error at the column base and column capital |  | H1: ±10 mm  c/H≦1/300 |

### Mortar Work

#### Materials

###### The fine sand to be used for the finishing mortar shall have a maximum diameter of 2.5 mm and the rate of passing through sieve openings of 2.5 mm and 0.16 mm shall be 100% and not higher than 10% respectively. The sand to be used shall be screened through a sieve with a 2.5 mm zinc-coated mesh to remove such impurities as litter and wood chips, etc.

###### Fine aggregates shall conform with Paragraph 2.6.2.2.2-2)

###### Paragraph 2.6.2.2.1 shall be referred to for the cement.

###### The water to be used shall be as referred to in Paragraph 2.6.2.2.3.

#### Mixing of Mortar

###### The cement plaster shall be mixed by the volume of materials and Table 2.6‑6 shall be referred to for the mixing ratio and coating thickness. The coating thickness here includes the base coat of which the thickness shall not exceed a maximum of 10 mm in any case.

Table ‑ Mixing Ratio by Volume and Coating Thickness of Cement Plaster

|  |  |  |
| --- | --- | --- |
|  | **Cement** | **Sand** |
| Stone riprap and masonry | 1 | 6 |
| Stone Foundation Pointing | 1 | 3 |
| Pipe collar | 1 | 3 |

## Pavement Work

### Preparation of Surface Treatment of formation

#### Description

This Item shall consist of the preparation of the subgrade for the support of overlying structural layers. It shall extend to full width of the roadway. Unless authorized by the Engineer, subgrade preparation shall not be done unless the Contractor is able to start immediately the construction of the pavement structure.

#### Material Requirements

Unless otherwise stated in the Contract and except when the subgrade is in rock cut, all materials below subgrade level to a depth 150 mm or to such greater depth as may be specified shall meet the requirements of Subsection 2.3.4.2, Selected Borrow for Topping.

#### Construction Requirements

###### Prior Works

Prior to commencing preparation of the subgrade, all culverts, cross drains, ducts and the like (including their fully compacted backfill), ditches, drains and drainage outlets shall be completed. Any work on the preparation of the subgrade shall not be started unless prior work herein described shall have been approved by the Engineer.

###### Subgrade Level Tolerances

The finished compacted surface of the subgrade shall conform to the allowable tolerances as specified hereunder:

Table ‑ Subgrade Level Tolerances

|  |  |  |
| --- | --- | --- |
| **Particular** | **Value** | **@ Every** |
| Design level of surface | +50 mm | 40 m |
| Width of finish grade | -100 mm | 40 m |

###### Subgrade in Common Excavation

Unless otherwise specified, all materials below subgrade level in earth cuts to a depth 150 mm or other depth shown on the Drawings or as directed by the Engineer shall be excavated. The material, if suitable, shall be set aside for future use or, if unsuitable, shall be disposed of in accordance with the requirements of Subsection 2.3.2.2-9).

Where material has been removed from below subgrade level, the resulting surface shall be compacted to a depth of 150 mm and in accordance with other requirements of Subsection 2.3.4-3).

All materials immediately below subgrade level in earth cuts to a depth of 150 mm, or to such greater depth as may be specified, shall be compacted in accordance with the requirements of Subsection 2.3.4.3-3).

###### Subgrade in Rock Excavation

Surface irregularities under the subgrade level remaining after trimming of the rock excavation shall be leveled by placing specified material and compacted to the requirements of Subsection 2.3.4-3).

###### Subgrade on Embankment

After the embankment has been completed, the full width shall be conditioned by removing any soft or other unstable material that cannot be compacted properly. The resulting areas and all other low sections, holes, or depressions shall be brought to grade with suitable material. The entire roadbed shall be shaped and compacted to the requirements of Subsections 2.3.4-3). Scarifying, blading, dragging, rolling, or other methods of work shall be performed or used as necessary to provide a thoroughly compacted roadbed shaped to the cross-sections shown on the Drawings.

###### Subgrade on Existing Pavement

Where the new pavement is to be constructed immediately over an existing Portland Cement concrete pavement and if so specified in the Contract the slab be broken into pieces with greatest dimension of not more than 500 mm and the existing pavement material compacted as specified in Subsection 2.3.4-3), as directed by the Engineer. The resulting subgrade level shall, as part pavement construction be shaped to conform to the allowable tolerances of Subsection 2.7.1.3-2) by placing and compacting where necessary a leveling course comprising the material of the pavement course to be placed immediately above.

Where the new pavement is to be constructed immediately over an existing asphalt concrete pavement or gravel surface pavement and if so specified in the Contract the pavement shall be scarified, thoroughly loosened, reshaped and recompacted in accordance with Subsection 2.3.4-3). The resulting subgrade level shall conform to the allowable tolerances of Subsection 2.7.1.3-2).

###### Proof Rolling

Before final finishing of subgrade, the entire surface shall be rolled with a minimum of three coverage of rubber-tired equipment having a minimum dual wheel load of 8 tons and a minimum contact tire pressure of 7.0 kg/cm2 and approved by the Engineer. Any yielding areas shall be removed, repaired or reconstructed by the Contractor.

###### Protection of Completed Work

The Contractor shall be required to protect and maintain at his own expense the entire work within the limits of his Contract in good condition satisfactory to the Engineer from the time he first started work until all work shall have been completed. Maintenance shall include repairing and recompacting ruts, ridges, soft spots and deteriorated sections of the subgrade caused by the traffic of the Contractor’s vehicle/equipment or that of the public.

###### Templates and Straight-edges

The Contractor shall provide for use of the Engineer, approved templates and straight-edges in sufficient number to check the accuracy of the work, as provided in this Specification.

### Construction of Hard Shoulder

This work shall be executed in compliance with subsection 2.7.4.

### Aggregate Sub-base Course

#### Description

This item shall consist of furnishing, placing and compacting an aggregate subbase course on a prepared subgrade in accordance with this Specification and the lines, grades and cross-sections shown on the Drawings, or as directed by the Engineer.

#### Material Requirements

Aggregate for subbase shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matter. The composite material shall be free from vegetable matter and lumps or balls of clay, and shall be of such nature that it can be compacted readily to form a firm, stable subbase.

The subbase material shall conform to Table 2.7‑2, Grading Requirements

Table ‑ Grading Requirements

|  |  |  |
| --- | --- | --- |
| **Sieve Designation** | | **Mass Percent Passing** |
| **Standard, mm** | **Alternate US Standard** |
| 50 | 2” | 100 |
| 25 | 1” | 55 – 85 |
| 9.5 | 3/8” | 40 – 75 |
| 0.075 | No. 200 | 0 – 12 |

The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than 0.66 (two thirds) of the fraction passing the 0.425 mm (No. 40) sieve.

The fraction passing the 0.425 mm (No. 40) sieve shall have a liquid limit not greater than 35 and plasticity index not greater than 12 as determined by AASHTO T 89 and T 90, respectively.

The coarse portion, retained on a 2.00 mm (No. 10) sieve, shall have a mass percent of wear not exceeding 50 by the Los Angeles Abrasion Tests as determined by AASHTO T 96.

The material shall have a soaked CBR value of not less than 50% at 98% MDD as determined by AASHTO T 193. The CBR value shall be obtained at the maximum dry density and determined by AASHTO T 180, Method D.

#### Construction Requirements

##### Preparation of Existing Surface

The existing surface shall be graded and finished as provided under 2.7.1, Subgrade Preparation, before placing the subbase material.

##### Placing

The aggregate subbase material shall be placed at a uniform mixture on a prepared subgrade in a quantity which will provide the required compacted thickness. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from vehicles especially equipped to distribute the material in a continuous uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted the finished layer be in reasonably close conformity to the nominal thickness shown on the Drawings.

When hauling is done over previously placed material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer, to minimize rutting or uneven compaction.

##### Spreading and Compacting

When uniformly mixed, the mixture shall be spread to the plan thickness, for compaction.

Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, the aggregate subbase shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.

The moisture content of subbase material shall, if necessary, be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required in order to obtain the required compaction.

Immediately following final spreading and smoothening, each layer shall be compacted to the full width by means of approved compaction equipment. Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road and shall continue until the whole surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until surface is smooth and uniform. Along curbs, headers, and walls, and at all places not accessible to the roller, the subbase material shall be compacted thoroughly with approved tampers or compactors.

If the layer of subbase material, or part thereof, does not conform to the required finish, the Contractor shall, at his own expense, make the necessary corrections.

Compaction of each layer shall continue until a field density of at least 95 percent of the maximum dry density determined in accordance with AASHTO T 180, Method D has been achieved. In-place density determination shall be made in accordance with AASHTO T 191.

##### Trial Sections

Before subbase construction is started, the Contractor shall spread and compact trial sections as directed by the Engineer. The purpose of the trial sections is to check the suitability of the materials and the efficiency of the equipment and construction method which is proposed to be used by the Contractor. Therefore, the Contractor must use the same material, equipment and procedures that he proposes to use for the main work. One trial section of about 500 m2 shall be made for every type of material and/or construction equipment/procedure proposed for use.

After final compaction of each trial section, the Contractor shall carry out such field density tests and other tests required as directed by the Engineer.

If a trial section shows that the proposed materials, equipment or procedures in the Engineer’s opinion are not suitable for subbase, the material shall be removed at the Contractor’s expense, and a new trial section shall be constructed.

If the basic conditions regarding the type of material or procedure change during the execution of the work, new trial sections shall be constructed.

##### Proof Rolling

Before final finishing of sub-base course, the entire surface shall be rolled with a minimum of three coverage of rubber-tired equipment having a minimum dual wheel load of 8 tons and a minimum contact tire pressure of 7.0 kg/cm2 and approved by the Engineer. Any yielding areas shall be removed, repaired or reconstructed by the Contractor.

##### Tolerances

Aggregate subbase shall be spread with equipment that will provide a uniform layer which when compacted will conform to the designed level and transverse slopes as shown on the Drawings. The allowable tolerances shall be as specified hereunder:

Table ‑ Aggregate Sub-base Course Tolerances

|  |  |  |
| --- | --- | --- |
| **Particular** | **Value** | **@ Every** |
| Permitted variation from design thickness of layer | -45 mm | 200 m |
| Permitted variation from design level of surface | +40 mm | 40 m |
| Permitted variation from the design width | -50 mm | 80 m |

### Sand Aggregate Base Course

#### Description

This Item shall consist of furnishing, placing and compacting crushed gravel, crushed stone or crushed rock on a prepared subgrade/subbase in one or more layers in accordance with this Specification and lines, grades, thickness and typical cross-sections shown on the Drawings or as established by the Engineer.

#### Material Requirements

##### Crushed Aggregate

It shall consist of hard, durable particles or fragments of stone or gravel crushed to the size and of the quality requirements of this Item. It shall be clean and free from vegetable matters, lumps or balls of clay and other deleterious substances. The material shall be of such nature that it can be compacted readily to form a firm, stable base.

The base material shall conform to the grading requirements of Table 2.7‑4, whichever is called for in the Bill of Quantities.

Table ‑ Grading Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **Sieve Designation** | | **Mass Percent Passing** | |
| **Standard, mm** | **Alternate US Standard** | **Grading A** | **Grading B** |
| 37.5 | 1 – 1/2” | 100 |  |
| 25 | 1” | - | 100 |
| 19 | 3/4” | 60 – 85 | - |
| 12.5 | 1/2” | - | 60 – 90 |
| 4.75 | No. 4 | 30 – 55 | 35 – 65 |
| 0.425 | No. 40 | 8 – 25 | 10 – 30 |
| 0.075 | No. 200 | 2 – 14 | 5 – 15 |

The portion of the material passing the 0.075 mm (No. 200) sieve shall not be greater than 0.66 (two thirds) of the fraction passing the 0.425 mm (No. 40) sieve.

The portion of the material passing the 0.425 mm (No. 40) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 as determined by AASHTO T 89 and T 90, respectively.

The coarse aggregate retained on a 2.00 mm (No. 10) sieve shall have a mass percent of wear not exceeding 45 by the Los Angeles Abrasion Test as determined by AASHTO T 96, and not less than 50 mass percent shall have at least one (1) fractured face.

The material passing the 19 mm (3/4 inch) sieve shall have a minimum soaked CBR-value of 80% at MDD tested according to AASHTO T 193. The CBR-value shall be obtained at the maximum dry density determined according to AASHTO T 180, Method D.

If filler, in addition to that naturally present, is necessary for meeting the grading requirements or for satisfactory bonding, it shall be uniformly blended with the crushed base course material on the road or in a pugmill unless otherwise specified or approved. Filler shall be obtained from sources approved by the Engineer, free from hard lumps and not contain more than 15 percent of material retained on the 4.75 mm (No. 4) sieve.

##### Placing

The aggregate subbase material shall be placed at a uniform mixture on a prepared subgrade in a quantity which will provide the required compacted thickness. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed.

The placing of material shall begin at the point designated by the Engineer. Placing shall be from vehicles especially equipped to distribute the material in a continuous uniform layer or windrow. The layer or windrow shall be of such size that when spread and compacted the finished layer be in reasonably close conformity to the nominal thickness shown on the Drawings.

When hauling is done over previously placed material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer, to minimize rutting or uneven compaction.

##### Spreading and Compacting

When uniformly mixed, the mixture shall be spread to the specified thickness, for compaction.

Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, the aggregate subbase shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.

The moisture content of subbase material shall, if necessary, be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required in order to obtain the required compaction.

Immediately following final spreading and smoothening, each layer shall be compacted to the full width by means of approved compaction equipment. Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road and shall continue until the whole surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until surface is smooth and uniform. Along curbs, headers, and walls, and at all places not accessible to the roller, the subbase material shall be compacted thoroughly with approved tampers or compactors.

If the layer of subbase material, or part thereof, does not conform to the required finish, the Contractor shall, at his own expense, make the necessary corrections.

Compaction of each layer shall continue until a field density of at least 98 percent of the maximum dry density determined in accordance with AASHTO T 180, Method D has been achieved. In-place density determination shall be made in accordance with AASHTO T 191.

##### Trial Sections

Before subbase construction is started, the Contractor shall spread and compact trial sections as directed by the Engineer. The purpose of the trial sections is to check the suitability of the materials and the efficiency of the equipment and construction method which is proposed to be used by the Contractor. Therefore, the Contractor must use the same material, equipment and procedures that he proposes to use for the main work. One trial section of about 500 m2 shall be made for every type of material and/or construction equipment/procedure proposed for use.

After final compaction of each trial section, the Contractor shall carry out such field density tests and other tests required as directed by the Engineer.

If a trial section shows that the proposed materials, equipment or procedures in the Engineer’s opinion are not suitable for subbase, the material shall be removed at the Contractor’s expense, and a new trial section shall be constructed.

If the basic conditions regarding the type of material or procedure change during the execution of the work, new trial sections shall be constructed.

##### Proof Rolling

Before final finishing of sub-base course, the entire surface shall be rolled with a minimum of three coverage of rubber-tired equipment having a minimum dual wheel load of 8 tons and a minimum contact tire pressure of 7.0 kg/cm2 and approved by the Engineer. Any yielding areas shall be removed, repaired or reconstructed by the Contractor.

##### Tolerances

The aggregate base course shall be laid to the designed level and transverse slopes shown on the Drawings. The allowable tolerances shall be in accordance with following:

Table ‑ Tolerances for Crushed Aggregate Base Course

|  |  |  |
| --- | --- | --- |
| **Particular** | **Value** | **@ Every** |
| Permitted variation from design thickness of layer | -25 mm | 200 m |
| Permitted variation from the design width | -50 mm | 80 m |

### Inverted Filler Drains

#### Description

This work shall consist of construction of aggregate sub surface drain 500mm×2000mm, composing.

#### Material Requirement

The material shall be single size aggregate (60mm) mixed with sand, complete as per MRRD / MPW Standard Drawing DR-08).

### Bituminous Prime Coat

#### Description

This Item shall consist of preparing and treating an aggregate base course with material in accordance with the Drawings and Specifications, preparatory to the construction of a bituminous surface course.

#### Material Requirements

Bituminous material shall be either Rapid Curing (RC) or Medium Curing (MC) Cut-back Asphalt, whichever is called for in the Bill of Quantities. It shall conform to the requirements of 5.8, Bituminous Materials. The type and grade shall be specified in the Special Provisions.

#### Construction Requirements

##### Surface Condition

Prime coat shall be applied only to surfaces which are dry or slightly moist. No prime coat shall be applied when the weather is foggy or rainy.

##### Equipment

The liquid bituminous material shall be sprayed by means of a pressure distributor of not less than 1000 liters capacity, mounted on pneumatic tires of such width and number that the load produced on the road surface will not exceed 1 kN(100 kgf) per cm width of tire.

The tank shall have a heating device able to heat a complete charge of bituminous liquid to 1800C. The heating device shall be such that overheating will not occur. Consequently, the flames must not directly touch the casing of the tank containing the bituminous liquid. The liquid shall be insulated in such a way that the drop in temperature when the tank is filled with bituminous liquid at 1800C and not heated will be less than 20C per hour. A thermometer shall be fixed to the tank in order to be able to measure continuously the temperature of the liquid. The thermometer shall be placed in such a way that the highest temperature in tank is measured. The tank shall be furnished with a calibrated dipstick to indicate the contents. The pipes for filling the tank shall be furnished with an easily changeable filter.

The distributor shall be able to vary the spray width of the bituminous liquid in maximum steps of 100 mm to a total width of 4 m. The spraying bar shall have nozzles from which the liquid is sprayed fan-shaped on the road surface equally distributed over the total spraying width.

For adding the liquid bituminous material, the distributor shall have a pump either driven by a separate motor, or with a device to synchronize its speed with the speed of the distributor. The pump shall be furnished with an indicator showing the rate of flow. The suction side of the pump shall have an easily changeable filter. A thermometer shall be fixed, such that it indicates the temperature of the liquid immediately before it leaves the spraying bar.

The distributor shall be furnished with a tachometer, indicating its forward speed, which shall be visible from the driver’s seat. The distributor shall be designed so that the deviation from the prescribed rate of application does not exceed 10% and shall be equipped with a device for hand spraying of the bituminous liquid.

##### Application of Bituminous Material

Immediately before applying the prime coat, the full width of surface to be treated shall be swept with a power broom and if necessary, scraped to remove all dirt and other objectionable materials. When required by the Engineer, immediately prior to the application of the prime coat, the surface shall be slightly sprayed with water but not saturated. Bituminous material shall be applied by means of a pressure distributor at the temperature given in 5.8, Bituminous Materials. The rate of application of the bituminous material shall be within the range of 1 to 2 litres/m2, the exact rate to be ordered by the Engineer.

The prime coat shall be left undisturbed for a period of at least 24 hours and shall not be opened to traffic until it has penetrated and cured sufficiently so that it will not be picked up by the wheels of passing vehicles. The Contractor shall maintain the prime coat until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amount, any excess shall be blotted with sand or removed as directed by the Engineer. All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying. The surface of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred.

### Double Bituminous Surface Treatment

#### Description

Unless otherwise stated in the Drawings and Specifications, Double Bituminous Surface Treatment shall consists of two layer applications of bituminous material each followed by a spreading of aggregate (double bituminous surface treatment).

#### Material Requirements

##### Quantities of Materials

The approximate amounts of materials per square metre and sequence of operations for single and double surface treatment shall be as provided in Table 2.7‑6 and Table 2.7‑7, whichever is called for in the Bill of Quantities.

The quantities given in the Tables are those of aggregates having a bulk specific gravity of 2.65 as determined by AASHTO T 84 and T 85. Proportionate corrections will be made when the aggregate furnished on the job has a bulk specific gravity above 2.75 or below 2.55. In such case, the corrected amount will be the product of the quantity shown in the tables and the ratio of the bulk specific gravity of aggregate to 2.65.

The amounts given in the Tables are approximate and the exact amounts will be set by the Engineer. Total amount of bituminous material per square metre may be varied by the Engineer as necessary to fit conditions, but the total amount of aggregate per square metre, after adjusting for specific gravity will not be changed.

Table ‑ Quantities of Materials and Sequence of Operations Using Cut-Back Asphalt or Asphalt Cement

|  |  |
| --- | --- |
| **Aggregate Grading and Sequence of Operations** | **Double S.T.** |
| First Course: | 1.6 – 2.0 AC |
| Apply bituminous material (80-10), l/m2 | 1.8 – 2.3 MC |
| Spread Aggregate: |  |
| Grading A, kg/m2 | 22.0 – 27.0 |
| Second Course: | 2.3 – 2.7 AC |
| Apply bituminous material (80-100), l/m2 | 2.8 – 3.5 MC |
| Spread Aggregate: |  |
| Grading C, kg/m2 | 11.0 – 14.0 |

Table ‑ Quantities of Materials and Sequence of Operations Using Emulsified Asphalt

|  |  |
| --- | --- |
| **Aggregate Grading and Sequence of Operations** | **Double S.T.** |
| First Course: |  |
| Apply bituminous material, l/m2 | 1.4 – 2.0 |
| Spread Aggregate: |  |
| Grading A, kg/m2 | 14.0 – 19.0 |
| Second Course: |  |
| Apply bituminous material, l/m2 | 2.1 – 3.0 |
| Spread Aggregate: |  |
| Grading C, kg/m2 | 5.0 – 8.0 |

##### Bituminous Materials

Bituminous materials shall be either CRS-1 (Cationic Rapid Setting), CRS-2 (Cationic Rapid Setting), RS-1 (Rapid Setting), RS-2 (Rapid Setting), AC 120-150 (Asphalt cement), MC 250-800 (Medium Curing), whichever is called for in the Bill of Quantities. It shall conform to the requirements of 5.8, Bituminous Materials, Penetration Grade No. of asphalt cement, the type and grade of cut-back and emulsified asphalt will be specified in the Special Provisions.

##### Aggregates

The aggregates shall be crushed stone, crushed slag, or crushed gravel. Only one type of aggregate shall be used in a project unless alternative types are approved. The gradation shall conform to Table 2.7‑8.

Table ‑ Aggregate Grading Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **Sieve Designation** | **Mass Percent Passing** | | |
| **Standard, mm** | **Grading A** | **Grading B** | **Grading C** |
| 25.0 | 100 | - | - |
| 19.0 | 85 – 100 | - | - |
| 12.5 | 0 – 45 | 100 | - |
| 9.5 | 0 – 7 | 85 – 100 | 100 |
| 4.75 | - | 10 – 45 | 85 – 100 |
| 2.36 | - | - | 10 – 40 |

The aggregate shall have a mass percent of wear not exceeding 40 when tested by AASHTO T 96.

When crushed gravel is used, not less than 50 mass percent of the particles retained on the 4.75 mm (No. 4) sieve shall have at least one fractured face.

When crushed slag is used, it must be of uniform density and quality and shall have a density not less than 960 kg/m3 (60 lb/cu.ft.) as determined by AASHTO T 19.

#### Construction Requirements

##### Rates of Application/Spreading of Asphalt and Aggregate

The rates of application/spreading of asphalt and aggregate shall be within the range in Table 2.7‑6 and Table 2.7‑7 respectively. These quantities are given as guide only and will vary considerably according to the type and condition of the surface, the grading, type, shape and absorbency of the aggregate, the weather condition and the traffic. The actual quantities to be used for surface treatment shall be determined by the Contractor in accordance with the design methods for one-size aggregate given in the Asphalt Institute Manual (MS-13), Asphalt Surface Treatment. The proposed design shall be subject to the approval of the Engineer.

The Contractor shall furnish the Engineer a certified vendor’s certificate in duplicate immediately upon delivery of asphaltic material to the Site.

The Contractor shall provide weighing equipment on the Site to control the application of aggregates. The weighing equipment shall have an approved multiple beam type scale with indicator and other necessary dials for accurately weighing the aggregate. The scale shall be protected by a weather-proof house with a floor area not less than 10 m2. The Contractor shall at his own expense have the scale tested.

##### Equipment

Equipment for applying the bituminous material shall conform to the requirements of Subsection 2.7.6.3.2, Equipment of Bituminous Prime Coat. A mechanical spreader shall be used for spreading the aggregates. It shall be capable of spreading the aggregate uniformly over the full width of the area being treated and shall have controls to regulate the feed gates, the feed roll, the auger and the truck hatch. The equipment shall be subject to the approval of the Engineer.

##### Application of Bituminous Material

The application of bituminous material shall be done when the weather is warm and dry.

The required asphaltic material shall be applied to the surface at least twenty four (24) hours after it has been prime coated.

Prior to applying the asphaltic material, dirt and other objectionable material shall be removed from the surface. If so directed by the Engineer, the surface shall be cleaned by power broom until all dust and loose materials are removed. Asphaltic material shall be applied on a dry surface whenever cut-back or asphalt cement is used; moist surface when emulsified asphalt is used.

Spraying shall not be done unless the road temperature has been above 200C for at least one hour prior to the commencement of spraying operations, and the temperature shall not be less than 200C during the spraying.

The application temperature for asphalt cement shall be within the range that produces a viscosity of 10 to 60 second Saybolt Furol and for cut-back asphalt shall be within the range given in subsection 2.7.8, Bituminous Material. The temperature shall be such that no fogging occurs.

##### Spreading of Aggregate

Immediately after applying the asphaltic material, dry aggregate shall be uniformly and evenly distributed over the treated surface from an approved mechanical aggregate spreader. The truck carrying the aggregate shall move backward as it spreads the aggregate so as to prevent the tires of the truck and the mechanical aggregate spreader from driving directly on the newly sprayed asphalt.

No portion of the sprayed surface shall remain uncovered for a period in excess of 2 minutes. Immediately after spreading the aggregate, the treated surface shall be rolled with an approved pneumatic-tire roller.

Where asphaltic material is exposed during rolling, the area shall be covered with additional aggregate and further rolled until an even surface results.

Table ‑ Tolerances for Spreading of Aggregate for DBST

|  |  |  |
| --- | --- | --- |
| **Particular** | **Value** | **@ Every** |
| Permitted variation from design width | -25 mm | 80m |

##### Control of Traffic

The Contractor shall take all steps necessary to control traffic over newly-laid bituminous surface treatment so that the surface is not damaged in any way. Traffic shall be prohibited from traveling at speeds in excess of 40 km/h until the asphaltic material has set. The Contractor shall ensure that no vehicles, including those delivering aggregates, shall be permitted to turn around on newly-laid material.

### Bituminous Materials

#### Asphalt Cements

Asphalt cement shall conform to the requirements of AASHTO M 226.

#### Liquid Asphalts

Liquid asphalt shall conform to the requirements of the following specifications:

|  |  |  |
| --- | --- | --- |
| Rapid Curing Liquid Asphalts | - | AASHTO M 81 |
| Medium Curing Liquid Asphalts | - | AASHTO M 82 |

#### Emulsified Asphalts

Emulsified asphalts shall conform to the requirements of the following specifications:

|  |  |  |
| --- | --- | --- |
| Emulsified Asphalt (Anionic) | - | AASHTO M 140  (ASTM D 977) |
| Emulsified Asphalt (Cationic) | - | AASHTO M 208 |

#### Acceptance Procedures for Bituminous Materials

##### General

Bituminous materials will be accepted at the source of shipment subject to the following conditions:

###### The supplier shall conduct laboratory tests of all materials intended for shipment to the Government and certify that the materials meet the Contract Specifications.

###### Before loading, the producer shall examine the shipping container, remove all remnants of previous cargoes which night contaminate the material to be loaded and certify that it was clean and free of contaminating material and loaded.

###### The Contractor shall furnish with each shipment two copies of the delivery ticket. The delivery tickets shall contain the following information:

|  |  |
| --- | --- |
| Consignees \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Destination \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Project Number \_\_\_\_\_\_\_\_\_\_\_\_\_ | Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Grade \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Loading Temp. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Net Liters \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Specific Gravity \_\_\_\_\_\_\_\_\_\_\_\_\_\_  At 15.50C (600F) |
| Net Weight \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |
| Identification No. (Truck, Car, Tank, etc.) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | |

###### The Contractor or the supplier as his agent, shall deliver to the Engineer or his representative a certification signed by an authorized representative of the supplier to cover the quality and quantity of material and the condition of container for each shipment. The certification shall be essentially in the following form and may be stamped, written or printed on the delivery tickets.

“This is to certify that this shipment of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (tonnes/litres) or \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of asphalt meets all Contract Specification requirements of the DPWH, and the shipping container was clean and free from contaminating material when loaded.

Producer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Signed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Failure to sign the certification will be a cause to withhold use of the material until it can be sampled, tested and approved.

##### Quality Control Reviews

Quality control reviews will be conducted by the Government, or an authorized representative at the point of production, at frequencies prescribed by the DPWH, to determine the reliability of the producer’s certifications.

If this review indicates that the certifications are not reliable, the acceptance of bituminous materials by certification will be discontinued and the contents of each shipping container will be sampled at point of delivery, tested and accepted prior to incorporation into the work. This procedure will be followed until the engineering determination is made that the supplier’s quality control and testing procedures are such that material meeting Contract Specifications is being consistently produced.

##### Alternate Acceptance Procedures for Asphalt Materials

Where required by the Special Provisions, the following alternate acceptance plan for asphalt material will apply in lieu of (a) and (b) above. The Contractor shall provide deliver tickets and certifications as set out in (a), above.

Acceptance samples of bituminous materials shall be obtained in accordance with AASHTO T 40, Sampling Bituminous Materials, at the applicable point of acceptance as defined herein:

Bituminous materials used in direct application on the road. Acceptance samples shall be obtained under the supervision of the Engineer from the conveyances containing the bituminous material at the point of delivery. Single samples shall be taken of each separate tank load of bituminous material delivered, at the time of discharge, into distributors or other conveyances on the project.

Bituminous materials initially discharged into storage tanks on the project. Acceptance samples shall be obtained from the line between the storage tank and the distributor of the bituminous mixing plant after each delivery. A single acceptance sample shall be taken after sufficient period of circulation of such bituminous material has taken place to insure samples representative of the total materials then in the storage tank.

As soon after sampling as practicable, the acceptance sample shall be delivered by the Engineer to the nearest authorized laboratory for tests to determine compliance.

##### Requirements for Bituminous Materials containing Anti-stripping Additives

All the foregoing requirements of 5.8 shall apply for the type of bituminous material involved.

Additionally, the Contractor or the supplier as his agent, shall furnish the Engineer or his representative along with and the time of delivery of the initial shipment of fortified bituminous material to the project, and thereafter with the subsequent shipments when ordered by the Engineer, 1 litre (1 quart) sealed sample of the bituminous material taken at the time of loading at the refinery and prior to introduction of the additive, along with a separate 0.5 litre (1 pint) sample of the anti-stripping additive involved.

#### Application Temperatures

Bituminous materials for the several application indicated in the Specifications shall be applied within the temperature ranges indicated in Table 2.7‑10.

Table ‑ Application Temperatures

|  |  |  |
| --- | --- | --- |
| **Type and Grade**  **Of Material** | **Application**  **Spray (Min./Max.)** | **Temperature Range**  **(0C) Mix (Min./Max.)** |
| RT 1-2-2 | 15.5 – 54 | 15.5 – 54 |
| RT 4-5-6 | 29 – 65.5 | 29 – 65.5 |
| RT 7-8-9 | 65.5 – 107 | 65.5 – 107 |
| RT 10-11-12 | 79 – 121 | 79 – 121 |
| RTCB 5-6 . . . . 30 | 15.5 – 48.9 | 15.5 – 48.9 |
| MC . . . . . . . . . 30 | 21 – 62.8 | 15.5 – 40.5 |
| RC-MC . . . . . . 70 | 40.5 – 85 | 32 – 68 |
| RC-MC . . . . . . 250 | 60 – 107 | 51.7 – 93 |
| RC-MC . . . . . . 800 | 79 – 129 | 71 – 107 |
| RC-MC . . . . . . 3000 | 106.7 – 143 | 93 – 126.7 |
| All Emulsions | 10 – 71 | 10 – 71 |
| Asphalt Cement  (All Grades) | 204 Max. | As required to achieve viscosity of 75 – 150 seconds to achieve a  Kinematic Viscosity of 150-300 mm2/s (150-300) centi-stokes |

Table 2.7‑10 shall apply unless temperatures ranges applicable to specific lots of material delivered to the job are supplied by the producer.

#### Material for Damp proofing and Waterproofing Concrete and Masonry Surfaces

Material shall conform to the requirements of the following specifications:

Table ‑ Damp proofing and Waterproofing Materials

|  |  |  |
| --- | --- | --- |
| a. | Primer for use with asphalt | AASHTO M 116 |
| b. | Primer for use with tar | AASHTO M 121 (ASTM D 43) |
| Or | |
| It may be a liquid water-gas tar conforming to the following requirements: | |
| Specific gravity, 250/250C | 1.030 – 1.100 |
| Specific viscosity at 400C (Engler), not more than | 3.0 |
| Total distillate, mass percent 3000, not more than | 50.0 |
| Bitumen (soluble in carbon disulphide), not less than | 98.0 percent |
| Water not more than | 2.0 percent |
| c. | Tar for mop or seal coats:  Coal tar pitch (heated to free flowing but not to exceed 1490C (3000F) | ASSHTO M 118,  Type B (ASTM D 450) |
| Or | |
| Tar applied at about 270C (800F) | AASHTO M 52,  RTCB 5 or 6 |
| Rubberized tar (heated to free flowing but not to exceed 1210C (2500F) | ASTM D 2993 |
| d. | Asphalt for mop coat | AASHTO M 115 |
| e. | Waterproofing fabric | ASSHTO M 117  (ASTM D 1668) |
| Fabric shall be waterproofed with tar or asphalt in agreement with the material specified for prime and mop coats. | |
| f. | Mortar materials shall conform to Section 5.12 except that the mortar shall be uniformly mixed to spreading consistency in the proportion of 1 part Portland Cement to 3 parts fine aggregate. | |
| g. | Asphalt plank | AASHTO M 46  (ASTM D 517) |
| Unless otherwise shown on the Drawings, planks shall be 30 mm thick and may be from 150 to 300 mm in width but all pieces for one structure shall be of the same width except such “closers” as may be necessary. The lengths shall be such as to permit the laying of the planks to the best advantage on the surface to be covered but shall not be less than 0.9 nor more than 2.5 m. | |
| h. | Asphalt roll roofing | ASTM D 224,  65 pound grade |

#### Membrane Material for Waterproofing Bridge Decks

Bridge deck waterproofing membrane shall be mesh-reinforced self-sealing rubberized asphalt preformed membrane and shall have the following properties:

Table ‑ Waterproofing Membrane Specifications

|  |  |  |
| --- | --- | --- |
| Thickness  Permeance-Perms  Kg/Pa.s.m2  (grains/sq.ft./hr./in.Hg) | 1.65 mm (655 mils)  57.213 x 10-11 (0.10) | ASTM E 96  Method B |
| Tensile strength | 344.5 kPa (50 lb/in) | ASTM D 882  modified for 25.4 mm  (1 inch) opening |
| Puncture resistance  (mesh) | 90.8 kg (200 lb) | ASTM E 154 |
| Pliability – 6.35 mm  (1/4”) mandrel 1800  bend at –8.30C (-150F) | No cracks in rubberized asphalt | ASTM D 146 |

Primer and mastic shall be as recommended by the manufacturer and shall be compatible with the membrane.

#### Tars

Tars shall conform to the requirements of AASHTO M 52.

#### Dust Oils

Dust oils and clarified dust oil shall conform to the following requirements:

Table ‑ Dust Oils

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **General** | **ASTM** | **Dust Oil** | | | **Clarified** |
| Requirements | METHOD | Light | Medium | Heavy | Dust Oil |
| Flash Point, 0C (Open tag.), min. | D 1310 | 51.6 | 51.6 | 51.6 | 93.3 |
| Viscosity at 380C (1000F) Kinematic, CS | D 2170 | 40 - 70 | 90 - 135 | 145 - 200 | 20 - 100 |
| Water, % maximum | D 95 | 2.0 | 2.0 | 2.0 | 2.0 |
| Asphaltenes % | \*D 2006 | 3.0 - 6.0 | 4.0 - 7.0 | 5.0 - 8.0 | 0 - 5.0 |
| Saturates % minimum | \*D 2006 | 25 | 25 | 25 | 10 |
| Distillation | | | | | |
| Total Distillate to 2880C (550oF), Max. % | \*\*D 402 | 35 | 30 | 30 | 5 |
| Test on residue from Distillation to 2880C (5500F) | | | | | |
| Viscosity at 100oT, Kinematic, CS | D 2170 | 75 - 250 | 200 - 630 | 540 - 1500 | 20 - 150 |
| Solubility in Trichloroethylene, % Min. | \*\*\*2042 | 97.0 | 97.0 | 97.0 | 97.0 |

\* As modified in procedure as “Test Method for Determination of Asphaltene and Saturate Content of Dust Oils” by Materials Testing Laboratory, Region I, USDA Forest Service, Missoula, MT dated November 1970. Copies of the procedure are available from the Regional Materials Engineer, Region I, USDA Forest Service, Missoula, MT 598011.

\*\* Except that the residue remaining after a temperature of 2880C (instead of 3600C) shall be used for further testing, as modified in procedure identified as “Standard Method of Test for Distillation of Forest Service Dust Oil” dated July 1972. Copies of the procedure are available from the Regional Materials Engineer, Region I USDA Forest Service, Missoula, MT, 59801.

\*\*\* Trichloroethylene shall be used as a solvent instead of carbon disulphide.

* 1. **Contractor Insurances**
     1. **Policy and Requirements**

The Contractor shall procure and maintain for the duration of the contract insurance against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the work hereunder by the Contractor, his agents, representatives, employees or subcontractors.

The Contractor shall furnish the Implementing Agency with original certificates and amendatory endorsements effecting coverage required by this clause. The endorsements should be on forms provided by the Implementing Agency or on other than the Entity’s forms, provided those endorsements or policies conform to the requirements. All certificates and endorsements are to be received and approved by the Implementing Agency before work commences. However, failure to obtain the required documents prior to the work beginning shall not waive the consultant’s obligation to provide them. The Entity reserves the right to require complete, certified copies of all required insurance policies, including endorsements affecting the coverage required by these specifications at any time.

The Contractor shall provide insurance policy complying with the insurance requirements as set out under Schedule 14 of the Contract. The insurance policies and any endorsements, including amounts of any deductibles and all exclusions shall cover:

• Construction All Risks Insurance/Third Party Liability Insurance

• Workers’ Compensation/Employer’s Liability Insurance

• Contractor’s Plant and Equipment Insurance

* + 1. **Scope of Insurance Coverage**

**Construction All Risks Insurance/Third Party Liability Insurance**

All risks of physical loss or damage from any cause not excluded, in relation to all property and interest of every description used for and intended for incorporation in the Works relating to design, engineering, development, procurement, fabrication, construction, erection, installation, rehabilitation, upgrading, completion, supply, testing, commissioning, recommissioning or ownership of the Works.

Indemnity in respect of legal liability of the insured parties to third parties for or arising from: bodily injury, illness, death; physical loss or damage to the property; and interference, trespass, loss of amenities, nuisance, infringement, obstruction, arising out of or in connection with the design, engineering, development, procurement, fabrication, construction, erection, installation, rehabilitation, operating, completion, testing, commissioning, supply of products, recommissioning and ownership of the Works.

Insured parties include the Employer; the Contractor and subcontractors; and each for their respective rights and interests.

The Terms of this policy cover From the Date of the Contract to the issue of the Final Completion Certificate

The Limit of Indemnity cover Contract Works – Full Estimated Contract Value, and Third Party Liability, if any one occurrence.

The Level of Deductible cover Major Perils/Testing and Commissioning, Others/Underground Services, Third Party Property Damage, and Body injury to, illness or death of a third party.

Policy Jurisdiction must be worldwide.

**Workers’ Compensation/Employer’s Liability Insurance**

The Limit of Indemnity must include incident in the aggregate or as otherwise required by Law.

**Contractor’s Plant and Equipment Insurance**

The Limit of Indemnity must include the replacement value of the Contractor's Plant and Equipment.

## Measurement and Payment

#### Works to be Measured and Method of Measurement

Except as otherwise stated in the Contract, Permanent Works is to be measured from records, prepared by the Employer, and examined and agreed by the Contractor.

The works shall be measured, and valued for payment, in accordance with the contract. Except as otherwise stated in the contract, whenever any permanent works are to be measured, these shall be determined through measurements of the net actual quantity of each item of the Permanent Work.

The method of measurement shall be in accordance to the method specified in the Schedule of Contract Price.

#### Evaluation

For each item of work determinations shall apply the agreed works to be measured, method of measurement, and the appropriate rate of price for the item specified in Contract bill of Quantities, or if there is no such item, specified for similar works.

A new rate or price shall be appropriate as specified in the General conditions of the signed Measured Price Construction Contract.