

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

# LOCAL GOVERNMENT ENGINEERING DEPARTMENT



## STANDARD SPECIFICATIONS FOR FEEDER ROAD TYPE-B & RURAL ROAD TYPE-R1 UNDER LGED

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH  
**LOCAL GOVERNMENT ENGINEERING DEPARTMENT**

**STANDARD SPECIFICATIONS FOR  
FEEDER ROAD TYPE-B &  
RURAL ROAD TYPE-R1  
UNDER LGED**

Prepared by :  
**THE TECHNICAL WORKING GROUP  
LGED**

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# Foreword

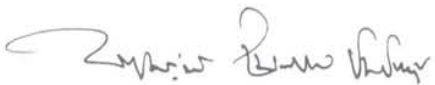
The Local Government Engineering Department (LGED) is responsible for construction of Feeder Road Type-B (FRB) and Rural Roads throughout the country. Specifications being followed for those constructions vary among projects as there was no Standard Specification in LGED.

To harmonize the construction procedures and activities under various projects, it was felt necessary to prepare Standard Specifications for LGED. A Technical Working Group was formed under the Chairmanship of Mr. Rubaiyat Nurul Hasan, Additional Chief Engineer (Implementation), LGED for preparation of the Standard Specifications for Feeder Road Type-B & Rural Road Type-R1 for LGED.

The Standard Specifications consist of different activities related to road construction like specifications for materials, testing of materials, construction methods, measurements, mode of payments etc. The Standard Specification will help the users to follow uniform and effective procedures in the construction of Feeder Roads Type-B and Rural Roads Type-R1 under LGED.

The Technical Working Group worked very hard and prepared the present document which will be very useful to LGED engineers at various levels for construction of roads.

I express my deep appreciation and thanks to the members of the Technical Working Group for preparing the document. I expect that all engineers of LGED should use the document in the construction of FRB and rural roads.



Quamrul Islam Siddique  
Chief Engineer, LGED

## **PREFACE**

The Local Government Engineering Department (LGED) is implementing quite a large number of Rural Development Projects where construction/improvement of Feeder Road Type-B (FRB) and Rural Roads are the major components. Many of those are financed by various Development Partners. Each project is supported by Technical Assistance Consultants who mainly develop the Specifications. Thus, specifications for constructing similar types of road pavement vary from project to project in the absence of any Standard Specifications in LGED.

Standardisation of specifications to suit the real needs as well as optimum utilisation of locally available road construction materials leading to cost-effective and durable pavements have become issues of importance to LGED. Keeping this end in view, a Technical Working Group consisting of LGED officials and consultants of different projects under LGED was formed by the Chief Engineer, LGED.

The Working Group reviewed the Technical Specifications being followed by the different projects. They also analysed the results of the trial activities on road pavement and surfacing conducted by a number of projects of LGED. The Group, on carrying out a thorough and careful in-depth study and analysis, developed this document which is considered to be of immense value as common specifications for construction of Feeder Road Type-B and Rural Road Type-R1 under all the Rural Development Projects and Programmes of LGED.

The Standard Specifications have covered different areas related to road construction like specifications for materials, testing of materials and construction methods, measurements, mode of payments, etc. The document will thus provide the users an opportunity to form a clear understanding on the different activities associated with the construction of Feeder Roads Type-B and Rural Roads Type-R1, in particular.

At this stage, when the dimension of activities of the LGED has become very wide and manifold, it is undoubtedly a timely intervention in setting the standard technical specification. Hopefully, this will contribute significantly towards efficient management of FRB and rural road construction by LGED which are significantly important for socio-economic development of the rural Bangladesh.

As a convenor of this Technical Working Group I take this opportunity to express my sincere thanks to all members of this Group who have given their minds and thoughts in developing this document despite their much occupation.



**Rubaiyat Nurul Hasan**  
Additional Chief Engineer, LGED  
and  
Convenor of the Technical Working Group

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## **ACRONYM**

AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society for Testing & Materials
ASS	-	Aggregate-Sand-Soil
BIT	-	Bangladesh Institute of Technology
BRRL	-	Bangladesh Road Research Laboratory
BS	-	British Standard
BSTI	-	Bangladesh Standards and Testing Institution
BUET	-	Bangladesh University of Engineering & Technology
CBR	-	California Bearing Ratio
FM	-	Finness Modulus
HBB	-	Herringbone Bond
LGED	-	Local Government Engineering Department
PVC	-	Poly Vinyl Chloride
STP	-	Standard Laboratory Test Procedures for Quality Control Laboratories, BRRL.
WBM	-	Water-bound Macadam

### **Note :**

Laboratory Tests in this specification are referred to the relevant section in the document "Standard Laboratory Test Procedures (STP) for Quality Control Laboratories" as published by the Bangladesh Road Research Laboratory. Thus STP T3.2.2 refers to the test detailed in Sub-section 3.2.2 of that document.

The test methods given in STP do not differ significantly from the equivalent BS or ASTM Standards and all commonly used tests are contained in one document.

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# **SECTION 1**

## **TRAFFIC MAINTENANCE, SITE FACILITIES AND TESTING**

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## **TRAFFIC MAINTENANCE, SITE FACILITIES AND TESTING**

### **1.1 TRAFFIC MAINTENANCE AND PROTECTION OF TRAFFIC :**

#### **1.1.1 General**

The Contractor shall at all time maintain the traffic flow along the existing roads, rivers and canals. The Contractor shall provide and maintain all detours, temporary roads, temporary bridges, necessary barricades, warning lights and guide signs as well as other equipment at all during the day and night throughout the period of construction.

Upon complete of the work, all temporary roads, temporary bridges, barricades, signs and other equipment shall be completely removed.

#### **1.1.2 Payment**

The construction, maintenance and ultimate removal of all temporary constructions as well as provision and maintenance of barricades, signs and other equipment shall be paid for at a lump sum price.

This sum shall cover all earthworks, temporary bridges and culverts, pavement and surfacing materials, warning signs, lights, control of traffic, including single lane working, by day and by night and all other items to ensure the smooth and safe flow of traffic and for their removal after the period of construction.

Partial payments to be inserted in the monthly certificates shall be directly proportional to the value of the completed works. However, payments shall not exceed the lump sum inserted in the Bill of Quantities.

Pay item shall be :

#### **Unit**

Maintenance and Protection of Traffic	Lump Sum
---------------------------------------	----------

### **1.2 OFFICE SPACE AND FACILITIES FOR THE ENGINEER**

#### **1.2.1 Field Office**

In addition to the office space required for his own use the Contractor shall provide and maintain Field Office space with toilet facilities, furniture and office equipment for the use of the Engineer and his staff.

Field Office for the Engineer shall mean a building constructed in 250mm brickwork with C.I. sheet roofing and a protective ceiling made of hard board and timber to be satisfaction of the Engineer. The floor shall be finished with a layer of brick, patent

stone and neat cement finish. No irregularity in the floor surface will be allowed. The foundation of this building shall be to the satisfaction of the Engineer.

Access road to the Field Office, sufficient parking accommodation and hardstanding shades for vehicles shall be constructed by the Contractor.

The Contractor shall provide, for each office, office table and four chairs all of a standard approved by the Engineer.

Offices shall be maintained waterlight and shall be provided with ventilation. All doors shall be fitted with approved locks.

Windows shall be provided with separate screens and blinds and shall have interior locking devices.

All offices, complete with furnishings, fittings, access roads and hardstandings shall be ready, for occupation by the Engineer, within four weeks of the date when the Contractor first occupies the site not later than ten weeks after the issue of the Notice of Proceed.

All offices shall be regularly and properly cleaned as long as they are in use.

All access roads and hardstandings shall be maintained in a well drained, conveniently trafficable condition, throughout the contract period.

The general location of the Field Office shall be decided by the Engineer in consideration of the Contractor's work plans. The field office shall be situated at locations that shall not be liable to flooding.

On completion of the contract the field office including furnishing shall become the property of the engineer.

### **1.2.2 Office Equipment**

Minor items of field office equipment such as filing trays, punches, staplers etc. shall be supplied in reasonable quantities as requested by the Engineer.

Consumables such as paper, pens, files etc. shall be supplied in reasonable quantities as requested from time to time by the Engineer.

Upon completion of the Contract, the office equipment listed above shall become the property of the Department.

### **1.2.3 Sign Boards**

The Contractor shall provide and maintain good condition at least two identification sign boards of a size to be specified by the Engineer, to be placed one at each end of the works, Each sign shall show :

- the name of the Project

- the name of the Employer
- all other details as may be required by the Engineer.

#### **1.2.4 Survey Equipment**

As per requirement of the programme survey equipment shall be provided on each contract site for use by the Contractor's and the Engineer's staff. List of such survey equipment are given below :

- 1 No. - Optical square
- 1 No. - Spirit level (metal 1m long)
- 1 No. - Steel measuring tape 25m long
- 1 No. - Steel measuring tape 5m long
- 1 No. - Levelling staff 3m long
- 5 Nos. - Ranging poles
- 1 No. - Surveyor's plumb bob
- 1 No. - Wild T-1A theodolite with tripod (or equivalent)
- 1 No. - Wild NA-2 automatic level with tripod (or equivalent)
- 1 No. - Traversing targets with tripods
- 1 No. - Measuring wheel

Miscellaneous tools and minor of survey equipment such as umbrellas, hammers, knives etc. shall be available on site in reasonable quantities at all times for use by the Contractor's and Engineer's staff.

Consumables such as pegs, stakes, string lines, paint marking crayons, etc., shall be available on site in reasonable quantities at all times for use by the Contractor's and Engineer's staff.

Upon completion of the Contract, the survey equipment listed above shall remain as the property of the Contractor.

#### **1.2.5 Responsibility for Office and Equipment**

The Contractor shall provide and maintain all the furnishings and equipment detailed and shall ensure his staff to take all reasonable precautions in the handling, operation and transport of such equipment.

The Contractor shall pay all expenses in respect of water, electricity (where available), garbage cleaning etc. necessary for the running of the offices.

The Contractor shall supply all necessary labour such as office boys, cleaners, messengers, roadmen, chairmen etc. to assist the Engineer and his staff in the fulfillment of their duties.



### **1.2.6 Measurement and Payment**

Payment for all the Field Office, equipment, sign boards, photographs, services etc. detailed in this article shall be made as described below, where price and payment shall be full compensations for complying with this section of the Specification and the Conditions of Contract.

Payment of the rates for the Pay Items shall be full compensation for supplying, erecting and maintaining the Field Offices for the Engineer, including all furniture and fittings, access roads, office equipment, sign boards, etc. all in accordance with the requirements of the above provisions.

No separate payment shall be made to the Contractor for providing the survey equipment mentioned in Article 1.2.4 and their maintenance and repair, if necessary including the miscellaneous tools and minor items, as well as the mentioned consumables. Compensation for the above shall be deemed to be included in the other pay items in the Bill of Quantities.

Payment of Field Office shall be made by means of the following Pay items :

	<u><b>Unit</b></u>
Supply, erect and maintain Sign Boards	Lump sum
Provide, erect and maintain office for the Engineer including consumables :	Lump sum

### **1.3 MATERIALS TESTING :**

Notwithstanding the requirements stated in the detailed specifications for individual items, the following minimum tests shall be carried out in the LGED specific laboratories and in the field. In cases the testing facilities are not available in the LGED laboratory, the tests shall be performed elsewhere as directed by the Engineer-in-charge. All test types and quantities described in the following paras 1.3.1 to 1.3.4 are considered "Normal Testing", whereas anything beyond that in type and quantity is considered as "Special Testing". The Engineer may increase the frequency of testing as required.

#### **1.3.1 EMBANKMENT AND PAVEMENT**

##### **1.3.1.1 Earthworks/Embankment Fill**

**Testing Frequency :**

The testing frequency shall be as follows:

ITEM & TYPES OF TESTS	TEST FREQUENCY
<b><u>EMBANKMENT</u></b>	
i) Liquid limit/plastic limit	1 per Km but minimum 1 if it is less than 1 Km (Greater than one if soil character changes).
ii) Maximum dry density (MDD).	1 per Km but minimum 1 if it is less than 1 Km (Greater than one if soil character changes).
iii) Compaction test	1 per 500m <sup>2</sup> per layer
iv) Laboratory CBR	1 per contract (Greater than one if soil character changes).

**1.3.1.2 Improved Sub-grade:****Testing Frequency:**

ITEM & TYPES OF TESTS	TEST FREQUENCY
<b><u>IMPROVED SUB-GRADE:</u></b>	
i) Liquid Limit/Plastic Limit	1 per Km. (Greater than one if material character changes).
ii) Gradation and F.M.	1 per Km (Greater than one if material character changes).
iii) Laboratory MDD	1 set per Km (Greater than one if material character changes).
iv) Laboratory CBR & Maximum Dry Density relationship.	1 per contract (Greater than one if material character changes).
v) Field compaction Tests :  By Sand Replacement Method/Core Cutter Method or any other method accepted by the Engineer-in-charge.	1 per 100m per layer

### 1.3.1.3 Sub-Base:

#### Testing Frequency:

ITEM & TYPES OF TESTS	TEST FREQUENCY
<b><u>SUB-BASE:</u></b>	
a) For approval of materials to be used in works the following tests are to be done	
i) Water absorption	1 per 500m
ii) AIV (Aggregate Impact Value)/LAA (Los Angeles Abrasion)	1 per 500m
iii) Laboratory CBR	1 per Km (Greater than one if material character changes).
iv) Laboratory MDD	1 per 500m
v) Gradation Test	1 per 500m (Greater than one if material character changes).
b) Field Test (Additional samples may be taken from pavement if necessary)	
i) Compaction (Sand replacement Method or any other method accepted by the Engineer-in-charge)	1 per 100m per layer

### 1.3.1.4 Water Bound Macadam base course and hard shoulder:

#### Testing Frequency:

ITEM & TYPES OF TESTS	TEST FREQUENCY
<b>WATER BOUND MACADAM BASE COURSE AND HARD SHOULDER</b>	
a) For approval of materials to be used in works the following tests are to be done	
i) Water absorption	1 per 500m
ii) AIV (Aggregate Impact Value)/ LAA	1 per 500m
iii) Laboratory CBR	1 per Km (Greater than one if material character changes).
iv) Laboratory MDD (Additional samples may be taken from the pavement if necessary)	1 per 500m
v) Gradation Test	1 per 500m (Greater than one if material character changes).
b) Field Test	
i) Compaction (Sand replacement Method or any other method accepted by the Engineer-in-charge)	One per 100m

## **1.3.2 SEALING AND SURFACING**

### **1.3.2.1 Bitumen Manufactures Certificates**

The contractor shall provide the Engineer with Manufactures Certificates relating to separate batches of bituminous material provided for sealing and surfacing operations.

These should include, but may not be limited to the following:

- a) Penetration Grade
- b) Specific Gravity
- c) Softening Point
- d) Flash Point
- e) Solubility

The contractor shall perform the above tests on bitumen or as directed by the Engineer-in-charge.

### **1.3.2.2 Bitumen Application Rates:**

- a) Prime Coat
- b) Tack Coat
- c) Bituminous Surface Treatment
- d) Otta Seal

#### **Testing Frequency:**

Manual Spray rates shall be measured in litres for each 10m<sup>2</sup> of spray area. Mechanical spray rates shall be measured in litres per square meter of spray area.

### **1.3.2.3 Aggregates:**

Gradation of Combined Aggregate (Fine and Course)

#### **Testing Frequency:**

1 test per 500m (or greater than one if material character changes).

### **1.3.2.4 Bituminous Carpeting:**

#### **a) Bitumen Content**

As per specification and on the basis of laboratory tests.

#### **b) Stability of Mixture**

#### **c) Density of Mixture**

As per specification and on the basis of laboratory tests.

### **1.3.2.5 Temperature Control:**

- a) Prime Coat
- b) Tack Coat
- c) Bituminous Carpet
- d) Bituminous Surface Treatment
- e) Otta Seal Coat

#### **Testing Frequency :**

- i) Temperature shall be checked during each days Prime Coat or Tack Coat operations as frequently as required by the Engineer.
- ii) For Bituminous Carpeting temperature shall be checked before mixing with aggregates, at the time of laying and also during rolling.

### **1.3.3 CONCRETE**

#### **1.3.3.1 Cement**

- a) Setting Time
- b) Strength

#### **Testing Frequency:**

Tests shall be carried out to determine the setting time and strength for each batch of cement prior to this cement being incorporated into the works.

#### **1.3.3.2 Aggregates**

##### **a) Coarse Aggregate**

- i) Gradation
- ii) Water Absorption
- iii) AIV or Los Angeles Abrasion
- iv) Specific Gravity

#### **Testing Frequency**

The above tests shall be carried out for each days casting or per 15m<sup>3</sup> of concrete, which ever provides the greater number of tests.

##### **b) Fine Aggregate**

- i) Grading
- ii) F.M.



### **Testing Frequency**

The above tests shall be carried out for each days casting or per 15m<sup>3</sup> of concrete, which ever provides the greater number of tests.

#### **1.3.3.3 Workability**

- a) Slump

### **Testing Frequency**

The above tests shall be carried out as frequently as required by the Engineer and not less than one per hour during concreting operations.

#### **1.3.3.4 Concrete Strength**

- a) Cube/Cylinder Strength at 7 days and 28 days
- b) Density/Unit weight

### **Testing Frequency**

At least 6 cubes/cylinders shall be kept from each class of concrete for each days casting or 15m<sup>3</sup> of concrete for testing at 7 days and 28 days. The location in the structure of the concrete from which the samples were taken should be recorded.

### **1.3.4 REINFORCEMENT**

#### **1.3.4.1 Properties**

- a) Diameter
- b) Unit/Weight
- c) Tensile Strength

Only test Certificates issued by BUET or BIT shall be accepted by the Engineer.

### **Testing Frequency**

The above tests shall be carried out when requested by the Engineer, for each batch and diameter of reinforcing bar provided per structure or as directed by the Engineer.

### **1.3.5 PAYMENT**

#### **1.3.5.1 Normal Testing**

- a) The cost of providing and transporting samples to the Laboratory specified by the Engineer, shall be borne by the contractor.
- b) The cost of all normal testing as specified in paras 1.3.1 to 1.3.4 are to be borne by the contractor at LGED current Standard Rates, or, if they cannot be carried out by the LGED laboratory, at the rate charges by the respective laboratory.

### 1.3.5.2 Special Testing

- a) All tests instructed by the Engineer in type and quantity beyond those specified in paras 1.3.1 to 1.3.4 shall be paid to the contractor.
- b) The cost of these tests is covered by a provisional sum. Only in case of failure of the test results to meet the required Specifications, the cost will be charged to the contractor.

#### Item

Pay item shall be

Provisional Sum

#### **Note:**

In addition to the above Tests thickness of every items on pavements should be checked at an interval of 100m or may be increased as directed by the Engineer-in-charge.

# SECTION 2

## EARTHWORKS

# EARTHWORKS

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## **EARTHWORKS**

### **2.1 REPORTING & MONITORING**

- 2.1.1**     **01.** The Contractor shall keep a Site Order Book on site at all times
- 2.1.2**     **02.** Instructions on the work and all site visits shall be recorded in the Site Order book.

### **2.2 CLEARING AND GRUBBING**

#### **2.2.1 Description**

This work shall consist of all clearing and grubbing necessary for the performance of the work covered by the Contract in accordance with the Specification.

The clearing and grubbing shall consist of clearing the designated areas of all down timber, vegetation, rubbish and objectionable materials and shall include grubbing roots and stumps and disposing of all material resulting from the clearing and grubbing. It shall also include the demolition, removal and disposal of structures that obtrude the work except where provided for in Section 2.3 of these Specification.

Clearing shall be confined the areas enclosed within the Site. Grubbing shall be confined to areas covered by the works.

#### **2.2.2 Preservation of Property**

The contractor is responsible for preservation and protection of property, trees, shrubs, gardens and landscape and liable to compensate damage claims, if any.

#### **2.2.3 Methods of Execution**

##### **2.2.3.1 Clearing**

Clearing shall consist of the removal and disposal of everything above ground level including overhanging branches except those things the Engineer directs are to be left undisturbed. The material to be cleared shall include but not necessarily be limited to trees, stumps, logs, bush, undergrowth, grass, crops, loose vegetable matter and structures unless provided for elsewhere.

Within the limits of earthworks tree stumps shall be completely removed.

Clearing shall also include the removal of existing fences, remnants of buildings, pavements, etc.

##### **2.2.3.2 Grubbing**

The original ground surface shall be disturbed as little as possible. Grubbing shall, therefore, be confined to major roots beneath the road embankment, ditches, canal diversions and footing excavations'. Topsoil shall be removed as agreed with the Engineer and will be measured as roadway excavation. Grubbing beneath the embankment shall be as per at the direction of the Engineer.

In agricultural areas where the ground has been formed into ridges of dikes, the ground shall be roughly leveled or graded to form a surface suitable for embankment foundation and to the satisfaction of the Engineer.

#### **2.2.3.3 Ownership of Cleared Material**

All cleared material shall, unless otherwise provided for in the Contract, be the property of the Department.

#### **2.2.3.4 Disposal of Cleared Material**

Cleared material which is not required will be known as waste. Waste shall be the property of the Contractor. Waste shall be removed from the Site by the Contractor and shall be disposed of by the Contractor at his own expense.

#### **2.2.4 Measurement**

Clearing and grubbing will not be measured

Neither the work of clearing nor grubbing disposal sites, material sites, nor imported borrow pit sites shall be paid for when such sites are outside the areas designated for clearing or grubbing and the Contractor is permitted to exercise his own option as to whether he elects to use such disposal sites or borrow pit sites.

#### **2.2.5. Payment**

Clearing and grubbing will be paid at a lump sum price. The payment shall be full compensation for furnishing all labour, materials, tools, equipment and incidentals necessary to do the work and for doing all the clearing and grubbing in the designated area or as directed by the Engineer included the removal and disposal of all resulting material.

Pay item shall be:

**Unit**

Clearing and Grubbing

Lump Sum

### **2.3 REMOVAL OF EXISTING STRUCTURE**

#### **2.3.1 Description**

This work shall consist of the satisfactory dismantling, removal and disposal or salvage, wholly or in part, of all the existing structures, substructures, bridges, buildings, culverts etc., within the Site as indicated on the Drawings or as instructed by the Engineer.

All properties within the Site may have been removed by the owners before the Contractor takes occupation of the site. - All remaining fences, buildings, structures or encumbrances of any character, except those still to be removed or ordered to be salvaged upon or within the limits of the Site, shall be removed by the Contractor and placed carefully on the abutting property, or otherwise disposed of as indicated on the Drawings or as directed by the Engineer. Materials so removed, including any existing steel bridges, drain or pipes of culvert, which the Engineer may order

salvaged, shall be carefully removed and shall become the property of the Department.

Where a structure is to be replaced, the existing structure shall be demolished to the level of foundation of the new structure or as directed by the Engineer. All material obtained from the demolished structures shall be removed except as otherwise specified or directed by the Engineer. For all other areas that will be used for any other purpose with the exception of roadways, existing structures shall be demolished to a level lower than the lowest elevation of the finished ground level as indicated on the Drawings or as provided by the Specifications except as otherwise directed by the Engineer.

### **2.3.2 Materials**

Removed materials shall be the property of the Department unless otherwise stated in the Contract. Any materials not required by the Department shall be classed as waste and shall be disposed off by the Contractor at his own expense.

### **2.3.3 Methods of Execution**

If the superstructure any portion of the structure is deemed fit for use elsewhere, the usable portions shall be marked and removed without damage and stockpiled neatly at an accessible point above high water level.

Recovered structural steelwork and Bailey bridge components shall, on the instructions of the Engineer, be removed from site to the XENs office compound as directed by the Engineer. All other usable materials shall be neatly stockpiled within the site at points approved by the Engineer.

All material which is not considered of value by the Engineer shall be removed by the contractor from within the limits of the Site at his own expense. Use of explosives will not be permitted except on direction of the Engineer.

### **2.3.4 Measurement**

The work shall not be measured.

### **2.3.5 Payment**

Removal of existing buildings, bridges, culverts, etc. shall be paid on a lump sum basis.

The payment shall be full compensation for dismantling, removal and disposal of all materials including labour, equipment, tools and incidentals necessary to complete the work.

Pay item shall be	<b><u>Unit</u></b>
Removal of Existing Structures	Lump Sum

## **2.4 ROADWAY EXCAVATION**

### **2.4.1 Description**

The work shall consist of all the requirement excavation within the limits of the Site, the removal, hauling and proper utilisation or disposal of all excavated materials and shaping of excavation and preparation of exposed surfaces of excavation on the entire length of the roadway, in accordance with these Specifications and to the lines, levels, grades, dimensions and cross section shown on the Drawings or as required by the Engineer.

Roadway excavation shall include the following:

- (a) All excavation indicated on the Drawings within the faces of the cross sections and excavation of all materials for side roads and intersections.
- (b) The removal and disposal of existing pavement, sidewalks, kerbs or kerbs and gutters within the limits of construction.
- (c) Excavations directed by the Engineer.

### **2.4.2 Materials**

Excavated materials shall be the property of the Department and shall be classified as suitable and unsuitable soil and salvaged materials.

To be suitable as fill material as described above, the soil must not contain roots, sod or other deleterious materials and must conform to the requirements of Article 2.6.2. The Engineer will decide if the soil is suitable or unsuitable.

Different type of salvaged materials shall be stockpiled separately on site as directed by the Engineer and the Contractor shall remain responsible for these until such time as they are disposed off by the Engineer.

### **2.4.3 Construction Methods**

#### **2.4.3.1 General**

All roadway excavation and embankment construction shall be performed as specified here and shall conform to the required alignment, levels, grades and cross sections. In case of over excavation,, the contractor has to refill with suitable materials and compact to its original degree at his own cost.

#### **2.4.3.2 Excavated Material Used in the Works**

Suitable soil from the roadway excavation may be used as fill material as shown on the typical cross sections and described in Section 2.6 of these Specifications provided that prior approval is obtained from the Engineer.

All suitable excavated material shall be used so far as practicable in constructing the roadway.

Where necessary, the excavated material to be reused for the Works shall be temporarily stockpiled in a suitable and safe area, in accordance with the instructions of the Engineer.

#### **2.4.3.3 Waste**

Unsuitable material and required roadway excavation in excess of that needed for construction of any part of the Works shall be known as waste. Waste material shall be disposed off in accordance with the instructions of the Engineer.

#### **2.4.3.4 Unsuitable Materials**

If unsuitable material is encountered at or below subgrade level in cut areas or at or below embankment foundation level in fill areas it shall be excavated to limits as directed by the Engineer and be backfilled in accordance with Section 2.6 of these Specifications.

#### **2.4.3.5 Slopes**

All slopes shall be finished in a neat and workmanlike manner and to an accuracy appropriate to the material, and care shall be taken that no material is loosened below the required slopes.

#### **2.4.3.6 Drainage**

During construction, the road and ditches shall be maintained in such condition as to ensure proper drainage at all times. No excavation will be permitted in areas under water.

Ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section.

#### **2.4.3.7 Preparation of Excavated Area**

The surface of the excavated areas shall be neat and workmanlike and shall have the required form, superelevation, levels, grades and cross section.

#### **2.4.4 Measurement**

All required and accepted roadway excavation including excavation of unsuitable soil shall be measured for payment in its original position and the volume determined in cubic meters by the end area method as computed from the original and final geometric cross sections of the required and completed work.

### 2.4.5 Payment

The quantities of road way excavation measured as specified above will be paid for at the Contract unit price per cubic metre. Such price shall include excavation, shaping and completion of all surfaces and for furnishing all labour, materials, tools, equipment and incidentals to complete the work including handling of excavated materials stock piling and disposing off surplus excavated materials to a place as directed by the Engineer.

Waste roadway excavation shall be the property of the Contractor and shall be disposed off at his cost to the satisfaction of the Engineer.

Excavation in suitable material which is to be used for embankment fill material shall not be measured separately.

Excavation in borrow pits whether within the Site or not shall not be paid under this item but shall be deemed to be included in the relevant fill item.

The above price and payment shall be full compensation for ail work involved in performing the roadway excavation completely as shown on the Drawings and as specified in these Specifications and as directed by the Engineer, including the cost of temporary stockpiling, selecting and protecting the materials to be reused.

Pay items shall be:	<u>Unit</u>
i) Road way excavation in any classified material and disposal of spoil to fill in embankment, stockpile or otherwise.	Cubic metre
ii) Road way excavation (Picking up of HBB, WBM, Concrete etc.)	Cubic metre

## 2.5 CHANNEL EXCAVATION

### 2.5.1 Description

This work shall consist of excavation for channels/ditches and ponds and for discharging water from side ditches where shown on the Drawings, required in the Specifications or directed by the Engineer. The work shall include the proper utilisation and hauling or disposal of all excavated materials, and constructing, shaping and finishing of all earthwork.

### 2.5.2 Materials

Excavated materials shall be classified as unsuitable and suitable soil.

To be suitable as fill material as described above, the soil must not contain muck, roots, sod or other deleterious materials and must conform to be requirements of Article 2.6.2. The Engineer will decide if the soil is suitable or unsuitable and whether such soil can be used in the roadway, or shall be waste for the disposal by the Contractor at his own expense.



### **2.5.3 Construction Methods**

#### **2.5.3.1 Alignment and Levels**

Channel work shall be constructed in a neat and workmanlike manner correct to alignments, levels, grades and cross sections required on the Drawings, in the Specifications or by the Engineer.

#### **2.5.3.2 Excavation**

Deepening and realignment of existing canals and channels shall be carried out in a way to allow free flow of water.

During excavation of new channels these shall as far as possible be kept drained.

All suitable materials removed from the excavation shall be used as far as practicable in constructing the roadway.

#### **2.5.3.3 Filling of Obsolete Channels**

Any obsolete canals and channels within the embankment area shall be cleaned up and backfilled with sand (FM 0.80) to obtain sufficient stability. When sand fill is at a level of 500mm above water level, compaction shall be carried out as specified in Section 2.6.

#### **2.5.3.4 Waste**

Unsuitable material from channel excavations shall be known as waste and shall be the property of the Contractor. Waste shall be removed from the site by the Contractor and disposed off by the Contractor as his own expense and to the satisfaction of the Engineer.

### **2.5.4 Measurement**

Quantities of channel excavation in any material shall be measured in cubic metres determined by end area methods computed from the original and final geometric cross sections of the authorised and completed excavation.

Payment for backfilling of existing channels shall be in accordance with Section 2.6.

### 2.5.5 Payment

This work measured as provided above shall be paid for at the Contract unit price per cubic metre. The payment shall be full compensation for all excavation, for maintaining free flow in the channel where necessary and for all labour, materials, tools equipment and incidentals necessary to complete the work.

The above prices and payments shall be full compensation for all work involved in performing the channel excavation completely as shown on the Drawings and as specified herein and as directed by the Engineer.

Pay item shall be	<u>Unit</u>
Channel Excavation in any material and disposal to fill, stockpile or otherwise	Cubic Metre

## 2.6 EMBANKMENT

### 2.6.1 Description

This work shall consist of the construction of embankment and fill by furnishing, placing, compacting and shaping suitable material of acceptable quality obtained from approved sources in accordance with these specifications and to the lines, levels, grades, dimensions and cross sections shown on the Drawings or as required by the Engineer.

The location of borrow pit shall be approved by the Engineer and must be at a distance of 3.0m or 1.5 times the height of the embankment, whichever is higher from the toe to the designed embankment. The depth of excavation in borrow pits shall not exceed 0.8m under normal conditions.

### 2.6.2 Materials

All fill materials shall be free from roots, sods or other deleterious materials.

Materials for embankments shall be stockpiled outside the working areas. Materials shall be tested and approved by the Engineer.

The selected fill so stockpiled shall satisfy the following criteria:

- Liquid limit of fraction passing 425 micron sieve shall not exceed 50%  
} STP Sec. 3
- Plasticity index of fraction passing 425 micron sieve shall not exceed 20%

- The dry density after compaction in embankment layers more than 300mm below subgrade level shall not be less than 90% of the maximum dry density as determined in accordance with STP T4.5 (Standard Compaction).
- The dry density after compaction in embankment within 300mm below the top of the subgrade level (or such greater depth if shown in the plans and drawings) shall not be less than 95% maximum dry density as determined in accordance with STP T4.5 (Standard Compaction).
- Soaked (4 day) CBR greater than 4% at 95% MDD (STD).
- The moisture content at the time of compaction shall be the optimum moisture content (Standard Compaction)  $\pm 5\%$ .
- Sampling to be carried out as per STP Section 2 and Sub-section 4.1.

In case if the embankment material is sand, side slopes and shoulders shall be covered by cohesive soil of  $P_i$  value in between 8-20%.

## **2.6.3 Construction Methods**

### **2.6.3.1 Preparation of Foundation for Embankment**

Prior to placing any embankment upon any area, all clearing and grubbing operations shall have been completed in accordance with Section 2.2 and excavation under carriageways shall be carried out in accordance with Section 2.4.

The original ground surface should be prepared by scarifying, watering, aerating and compacting. The dry density after compaction shall not be less than 90% of MDD (STD).

Embankments in swamps or water shall be constructed as indicated on the Drawings and as described in these Specifications. The Contractor shall, when ordered by the Engineer, excavate or displace swampy ground and backfill with suitable material (refer to paragraph 2.4.3.4). Such backfill shall be river or beach sand unless otherwise directed by the Engineer.

### **2.6.3.2 Placing of Embankment**

#### **a. General**

Except as otherwise required by the Drawings, all embankments shall be constructed in layers approximately parallel to the finished grade of the road bed. During construction of embankment, a smooth grade having an adequate crown shall be maintained at all times to provide drainage.

The placing of fill shall be carried out in successive layers for the full width of fill as shown on the Drawings and in 500m lengths unless otherwise directed by the Engineer. The layers shall not exceed 150mm in thickness on completion of compaction.

When embankment fill is placed adjacent to structures it shall be performed in accordance with the direction of the Engineer.

**b. Placing Embankment over Swampy Ground**

Where new embankment will overlay existing canals, ditches, ponds or other waterways, these shall be filled in exclusively with sand in accordance with paragraph 2.5.3.3. Prior to filling, cofferdams shall be made to allow pumping and the bed shall left to dry until approved by the Engineer for filling. The works of damming, pumping and drying will not be an item for payment, but will be considered to be included in the rates for earthworks fill.

**c. Widening Existing Embankment**

Where embankment fill is being carried out to widen an existing embankment the new fill material shall be fully keyed into the old embankment by means of benching which shall be in steps each not less than 300mm high and 600mm wide. Steps shall be cut in advance of the filling. Material cut in benches may be used as fill if it compiles with Article 2.6.2 above or as directed by the Engineer.

**d. Embankment Fill from Roadway Excavation**

Existing Subgrade within 300mm depth of the existing road level, (or as specified) not having the required percentage of compaction, shall be excavated out.

Provided the excavated material is in accordance with article 2.6.2 then it shall be reworked and reused in widening or raising the embankment to the specified percentage of compaction and in accordance with paragraph 2.6.3.3.

No payment will be made for excavation under this item and it will be deemed to be included in the rates in accordance with Article 2.6.5.

Where the item "embankment fill from roadway excavation" is used and paid for, there shall be no separate payment for subgrade preparation under section 2.7.

**2.6.3.3 Compaction of Embankment**

Embankment shall be constructed in not more than 150mm compacted layers. When necessary, each layer, before being compacted, shall be mixed with dry material or otherwise processed to bring the moisture content to within the limits established in Article 2.6.2 above. The material shall be so worked as to have a uniform moisture content through the entire layer (STP Sec.4).

Each layer of material shall be compacted uniformly by use of adequate and appropriate mechanical compaction equipment. The compaction shall be carried out in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the centre except in the super elevated area in such a manner that each section receives equal compactive effort.

Compaction equipment shall be operated over the full width of each layer insofar as practicable.

Samples to determine the compaction shall be taken regularly with a minimum one sample for each full width 100 linear metres of a finished layer or as directed by the Engineer. Such density tests will be carried out according to STP T5.1. The compacted layer shall be approved by the Engineer before the Contractor can commence a new layer. If the test results show that the density is less than the required density the Contractor shall carry out further compaction to obtain at least the required density.

#### **2.6.3.4 Overfilling**

To ensure that, the embankment is properly compacted up to the edges of each layer, overfilling and compaction of approx. 300mm horizontally on both sides of the embankment is required, which later on has to be cut and removed. No extra payment will be made for this procedure.

#### **2.6.4 Measurement**

Embankment shall be measured in cubic metres based on cross sections compacted and accepted in place. The volume to be measured will be the net volume of required and accepted embankment, actually constructed and completed in accordance with the Specification, to the lines, levels, grades and cross sections required or as directed by the Engineer.

The cross section to be used will be the area bound by the subgrade (below improved subgrade or sub-base) the side slopes or edge limits and the original ground line.

No allowance will be made for material cut in benching operations.

The final volume of embankment fill shall not include the voids for bridges and boxculverts. The voids for pipes, manholes, catch basins and the like will not deducted.

#### **2.6.5 Payment**

This work measured as provided above shall be paid for at the Contract unit prices per cubic metre. Payment shall be full compensation for performing the work, furnishing the materials and providing all labour, equipment, tools and incidentals necessary to complete the work, including all payments for obtaining, carrying and stockpiling of the embankment fill.

Pay items shall be:	<u>Unit</u>
Embankment fill from any approved; source outside the site	Cubic Metre
Embankment fill from roadway excavation	Cubic Metre
Sand backfill to Swamp	Cubic Metre

## **2.7. PREPARATION OF SUBGRADE**

### **2.7.1 Description**

This work shall consist of the preparation of subgrade in embankment in cut by scarifying, watering, aerating, compacting and shaping existing or previously placed material in accordance with these specifications and to the lines, levels grades, dimensions, camber and cross sections shown on the Drawings or as instructed by the Engineer.

This item shall only be applicable where the existing embankment level is within 440mm of the designed formation level.

### **2.7.2 Materials**

All subgrade material shall be suitable material in accordance with the requirements of Article 2.6.2.

Any subgrade material in cut or existing old embankment which is found to be unsuitable shall be removed and replaced as directed by the Engineer.

### **2.7.3 Construction Methods**

The subgrade shall be prepared over the full width of the embankment including shoulders. Half width working may be allowed only with the prior written approval of the Engineer.

The subgrade shall be prepared in lengths of not less than 1 00 metres and not more than 500 metres at a time.

Existing subgrade material shall be excavated to a depth of 150mm and stockpiled and a further 150mm should be scarified and compacted. The excavated top layer material shall then be spread and compacted as specified.

When necessary, each layer, before being compacted, shall be allowed to dry or be watered to bring the moisture content with  $\pm 5\%$  of optimum to make possible its compaction to the required density. The material shall be so worked as to have a uniform moisture content through the entire layer (STP Section 4 or 5).

The subgrade material shall be compacted uniformly by use of adequate and appropriate mechanical compaction equipment. The compaction shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the centre in such a manner that each section receive equal compactive effort.

Samples to determine the compaction shall be taken regularly with at least one satisfactory sample for each 100 linear metres per finished layer or as directed by the Engineer. Such density tests will be carried out according to STP T5.1. STP T4.5 (Standard Compaction) the Contractor shall carry out further compaction to obtain at least the required density.

The subgrade material will be tested for CBR in accordance with STP-T6.1. The subgrade material shall be compacted to 95% Maximum dry density as determined by STP T4.5 (Standard Compaction), with at least one satisfactory sample per 100 liner metres per finished layer. Where existing ground or embankment is encountered at sub grade level, then a minimum of one satisfactory CBR test shall be performed per contract or more frequently if the material character changes. If the CBR proves to be unsatisfactory then appropriate steps will be ordered by the Engineer in writing.

#### **2.7.4 Measurement**

Subgrade preparation shall be measured in square metres based on the surface area of compacted subgrade, in accordance with the specification, to the lines, levels, grades and cross sections required as directed by the Engineer. No allowance will be made for overlapping of areas due to half width working.

#### **2.7.5 Payment**

This work measured as provided above shall be paid for at the contract unit price per square metre. Payment shall be full compensation for performing the work and providing all labour, equipment, tools and incidentals necessary to complete the work.

The rates shall include the cost of furnishing the additional subgrade materials to reach a compacted thickness of 300mm.

Pay item shall be:	<b><u>Unit</u></b>
(a) Preparation of subgrade 300mm compacted depth	Square Metres

The surface of the finished subgrade shall be neat and workmanlike and have the required form, superelevation, levels, grades and cross section. The finished surface shall be constructed with a tolerance of 20mm above or below the specified levels at any point. Separate item for this where no subgrade operation required.

### **2.8 IMPROVED SUBGRADE**

#### **2.8.1 Description**

This work shall consist of furnishin placing and compacting improved subgrade material on a prepared and accepted subgrade in accordance with these Specifications and to the lines, levels, grades, dimensions and cross sections shown on the Drawings or as instructed by the Engineer.

## 2.8.2 Materials

Material shall be of natural sand or soil or mixture of sand and soil, free from vegetable matter, from soft particles and from excess clay. If the material is sand the F.M. shall not be less than 0.8.

- (a) **Plasticity:** The fraction passing the 425 micron sieve shall, have a Plasticity Index not greater than 10 (STP Section 3).
- (b) **CBR:** The material shall have a soaked CBR value not less than 8% when compacted to 98% of maximum dry density as determined by STP T4.5.
- (c) The material shall be free draining.

## 2.8.3 Construction Methods

### 2.8.3.1 Preparation of Subgrade

The subgrade shall be shaped and compacted in conformity with the provisions of Section 2.7 and completed for at least 100 metres ahead of the placing of the improved subgrade material. Notwithstanding any earlier approval of subgrade, any damage to or deterioration of subgrade shall be made good before improved subgrade is laid.

Preparation of the subgrade shall be carried out, unless otherwise agreed by the Engineer, immediately prior to laying the improved subgrade.

### 2.8.3.2 Spreading

All subgrade drainage shall be completed prior to spreading the improved subgrade material.

Improved subgrade shall be spread in layers, with a compacted thickness up to 150mm subject to the approval of the Engineer, and the layers shall be as nearly equal in thickness as possible.

Prior to spreading the improved subgrade, a partial width of shoulder, not less than 750mm wide, shall be constructed to the elevation of the top of each uncompacted layer being placed and the inside edge made as straight as practicable. After the partial completion of the shoulders, the improved subgrade shall be spread upon the subgrade and against the previously formed shoulders, in layers of uniform thickness, as herein specified, to give the required compacted depth shown on the Drawings.

### 2.8.3.3 Sprinkling, Rolling and Compacting

Immediately after each layer has been spread and shaped to camber or super elevation satisfactorily, it shall be thoroughly compacted with mechanical compaction equipment approved by the Engineer. Rolling operations shall begin from the outer edge of roadbed toward the centre, gradually in a longitudinal direction, except on super-elevated curves, where rolling shall begin at the low side and progress towards the high side.



The moisture content at the time of compaction shall be the optimum moisture content (Standard Compaction)  $\pm 3\%$ .

Each layer shall be compacted to at least 98% of the - maximum dry density as determined by STP T4.5. 3 Nos. in situ density tests in accordance with STP T5.1 or T5.5 shall be taken each 1 00 linear metres of compacted improved subgrade.

If the density measurement checks fall below the specified density level then recompaction, shall be required, irrespective of the field compaction trial results.

In order to ensure uniform bearing capacity at the finished improved subgrade level CBR measurements shall be made. The CBR shall be such that the Laboratory Value obtained tested in accordance with STP T6.1, at the specified compaction and after 4 days soaking, shall exceed 8 percent. In areas where these requirements are not met, correction shall be made by such measures as the Engineer deems necessary.

Improved subgrade material which does not contain sufficient moisture to be compacted in accordance with the requirements of this section shall be reworked and watered as directed by the Engineer. The Contractor shall carry out this work at his own expense.

Improved subgrade material containing excess moisture shall be reworked and dried prior to or during compaction. Drying of wet material shall be performed by methods approved by the Engineer, at the expense of the Contractor.

The finished improved subgrade at any point shall not vary more than 20mm above or below the planned grade or adjusted grade. The thickness of the finished improved subgrade shall be on average not less than the required thickness and not thinner than 20mm less than the required thickness at any point and the average of five thickness measurements in any 100 metres of road shall be not thinner than 15mm less than the required thickness. Improved subgrade which does not conform to the above requirements shall be reworked, watered and thoroughly recompacted to conform.

#### **2.8.4 Measurement**

Improved subgrades described in this article shall be measured by the cubic metres of material compacted in place and accepted. Measurement shall be based on the average width and thickness of the improved subgrade shown on the Drawings or instructed by the Engineer and actual length measured horizontally along the centerline of the surface of the road.

#### **2.8.5 Payment**

This work measured as provided above shall be paid for at the Contract unit rate per cubic metre for improved subgrade as detailed below. The payment shall be full compensation for furnishing all materials, hauling, placing, compacting, sprinkling, finishing and shaping, and for all labour, equipment, tools and other incidentals necessary to complete the work specified.

Pay item shall be:

**Unit**

Improved subgrade

Cubic Metre

## **2.9. PREPARATION OF IMPROVED SUBGRADE**

### **2.9.1 Description**

This item will consist of leveling, dressing, cambering and compacting the existing improved subgrade surface exposed after removal of the brick flat soling, HBB and the edging to receive new sub-base and base course. Where necessary additional improved subgrade materials shall be added to make the finished compacted improved subgrade as per drawing.

### **2.9.2 Materials**

Materials should meet the requirements of Article 2.8.2

### **2.9.3 Construction Method**

The picking up of the brick pavement shall not done for more than 1 00m at a time in order to avoid disturbance to traffic and damage to the subgrade. The salvaged bricks shall be stacked separately from half or broken bricks on such a way that disturbance to traffic is minimized.

Before picking up the brick pavement the contractor must provide sub-base or base materials ready at the site so that this shall be placed and compacted immediately after preparation of the improved subgrade.

The improved subgrade shall be levelled, graded and cambered according to the design and compacted to 98% of MDD (STD) using an appropriate roller. Where necessary additional improved subgrade materials shall be added to make the finished compacted thickness as per drawing.

### **2.9.4 Measurement**

The preparation of Improved subgrade shall be measured in square metres.

### **2.9.5 Payment**

The payment will be in full compensation for doing the work according to Specification and drawings including supplying of additional materials, if any, labour, tools and machineries for levelling, dressing, cambering, and compacting the Improved subgrade.

Pay item	<u>Unit</u>
Preparation of Improved subgrade	Square metres

## **2.10 SUBGRADE DRAIN**

### **2.10.1 Description**

This work shall consist of excavation, furnishing material, backfilling and finishing drains to the prepared and accepted subgrade in accordance with Specifications and the dimensions and cross sections shown on the Drawings or as instructed by the Engineer.

### **2.10.2 Materials**

The material for backfilling of subgrade drains shall be clean free draining sand and gravel, free from any vegetable matter, soft particles, silt or clay.

The grading of the material shall conform to the grading shown in Table 2.10-1.

**Table 2.10-1**

#### **Grading requirements of Drain Backfill Material**

<b>Sieve Size</b>	<b>% Passing by Weight</b>
<b>1 Omm</b>	<b>100</b>
4.8mm	80-100
2.4mm	65-95
1.2mm	50-80
600 micron	25-50
300 micron	10-20
150 micron	0-10
75 micron	0-2

### **2.10.3 Construction Methods**

Subgrade drains shall be excavated neatly by hand in the prepared subgrade to dimensions and grades shown on the Drawings or directed by the Engineer.

Drains shall be constructed at the intervals shown on the Drawings and details of it as shown on the drawings. Drains on opposite sides of the road shall be staggered.

The excavation shall be backfilled with material in accordance with Table 2.1 0-1.

The backfill shall be compacted by hand ramming and struck off level with, or slightly above, the finished subgrade level.

The finished backfill shall be immediately covered with jute fabric material to act as a filter which shall extend 150mm beyond the edges of the drain on all exposed faces. Any joints in the fabric shall be overlapped by at least 150mm. Jute fabric shall be held in place by suitable means to prevent its movement during construction operations.

Shoulder and pavement materials over the drain and jute fabric shall be placed carefully by hand for a depth of not less than 100mm prior to placing and rolling of the general shoulder and pavement materials.

#### **2.10.4 Measurement**

Subgrade drains shall be measured in linear metres of drain completed and accepted.

Drains shall extend from a point vertically below the outer edge of the carriageway surfacing layer to the finished face of the embankment, or side ditch, side slope. In the event that the Contractor constructs the embankment to dimensions in excess of those shown on the plans and sections the Contractor shall extend the subgrade drains to the embankment face at his own expense.

#### **2.10.5 Payment**

The work measured as provided above shall be paid at the Contract unit rate per linear metre. Payment shall be full compensation for performing the work and providing all labour, equipment, materials, tools and incidentals necessary to complete the works.

Pay item shall be;

**Unit**

Subgrade drains

Linear Metre

# SECTION 3

## PAVEMENT WORKS

## PAVEMENT WORKS

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## **PAVEMENT WORKS**

### **3.1 INTRODUCTION TO PAVEMENT WORKS**

#### **3.1.1 General**

Section 3 of these Specifications covers all requirements for road pavements that will be incorporated in the works.

#### **3.1.2 Preparation and Stockpiling of Materials**

Materials to be used in pavement works shall be processed and stockpiled only in areas designated by the Contractor as approved by the Engineer. Preparation and storage of materials along the alignment will not be allowed. The Contractor shall make all arrangements and bear all costs associated with the provision of these storage areas.

The designated areas shall be cleared of all vegetation and topsoil prior to commencing of work and the arrival of any materials.

Bricks of different frog marks, different materials and size fractions shall be kept in separate stockpiles divided as necessary to prevent contamination.

The site of the stockpile shall be cleared of all vegetation and debris, graded and drained and where the Engineer deems it necessary, the areas shall be surfaced with a 100mm layer of approved stone or with brick flat soling.

Each stock pile shall be built with a maximum height of 1.25m or as specified by the Engineer-in-Charge with sufficient space left in between two stacks for easy inspection.

The bottom 50mm layer of aggregate or any contaminated aggregate shall not be used in the work.

#### **3.1.3 Brick aggregates/Stone aggregates**

Brick aggregates may be replaced by stone aggregates. In case of improved shoulder/sub-base both crushed and uncrushed stone can be used; in case of base course only crushed stone may be used provided that the quality of the stone satisfies the relevant specifications. No extra cost will be paid for replacing the brick aggregates by stone.

### **3.2 SHOULDERS**

#### **3.2.1 Improved Shoulders**

##### **3.2.1.1 Description**

This work shall consist of providing, laying and compacting Aggregate-Sand-Soil (ASS, 40:30:30 by volume in proportion in general) on the prepared and accepted Improved Subgrade to the lines levels, dimensions, and cross section shown on the Drawings or as directed by the Engineer. The soaked CBR of ASS should not be less than 35% when compacted to 100% of MDD. However the proportion would be subjected to refixation at the time of designing if the situation is different.

### 3.2.1.2 Materials

The material shall consist of a homogeneous mixture of crushed brick aggregate, local sand and soil. The P<sub>i</sub> value of soil should not be of soil, but of combined material and should not be more than 6 (portion passing # 40 or .425mm sieve).

The aggregate shall be crushed First class and or Picked Jhama Bricks. The crushed bricks shall comply with the following requirements:-

- water absorption shall not exceed 18%
- maximum nominal size of aggregate shall be 38mm.
- Aggregate Impact Value of not more than 35 or Los Angeles Abrasion 45 or as directed by the Engineer in the case of reuse of salvaged materials.
- the unit weight shall comply with the minimum values stated in Article 3.3.2a of these Specifications.

The Material shall conform to the grading envelope shown in Table 3.2-1 given below and have a 4 days soaked CBR value not less than 35% when compacted to 100% of maximum dry density as determined by STP T4.5.

**Table 3.2-1**

Grading Requirements for Improved Shoulder:

Sieve Size	% Passing by Weight
38mm	100
25mm	80-95
10mm	60-80
2mm	40-60
# 200 Sieve	0-15

### 3.2.1.3 Construction Methods

The Improved Shoulder materials shall be at or near the optimum moisture content (OMC) at the time of placing. The brick aggregate, sand and soil shall be mixed thoroughly to obtain a homogeneous mix complying with the grading requirements of this Section. Water shall be added during mixing to keep the mixed material moist so as to prevent segregation during transportation.

The compacted thickness of improved ' shoulder should be minimum 150mm. Prior to laying the Improved shoulder, the existing surface shall be watered. The mixed Improved Shoulder material shall then be spread in equal layers so that the compacted thickness of each layer shall not be more than 150mm. On completion of the spreading and watering, the surface shall be shaped according to the crosssection shown in the drawing and compacted using approved mechanical compaction plant. Compaction shall continue until the material has attained the required density. The Improved Shoulder shall be compacted to have 100% maximum dry density (Standard) and soaked CBR of 35%. The field density shall be

checked at least once every 250 linear metres of hard shoulder surface. Moisture content at the time of compaction shall be optimum moisture content  $\pm 3\%$ .

The finished surface of the base course shall in no place be more than  $\pm 1$  Omm from the designed level longitudinally. But in no case the thickness of the hard shoulder shall vary  $\pm 5$ mm.

#### **3.2.1.4 Measurement**

The Improved Shoulder shall be measured in cubic metres. It shall be based on the average width and thickness of Improved shoulder course as shown on the drawings and the actual length measured horizontally along the centreline of the surface of the road.

#### **3.2.1.5 Payment**

This work as measured above shall be paid for at the Contract unit price for Improved shoulder course. Payment shall be full compensation for performing the work as per specification including furnishing the materials, water, carrying out all placing and compaction etc. all complete including other incidental charges.

Pay item shall be	<b><u>Unit</u></b>
Improved Shoulder Course	Cubic metre

### **3.2.2 Earth Shoulders**

#### **3.2.2.1 Description**

This work consists of the provision of specified wide strips of shoulders adjacent to the pavement on either side. The shoulders shall be constructed in accordance with the lines, levels, dimensions and cross sections shown on the Drawings and as directed by the Engineer.

#### **3.2.2.2 Materials**

The material used shall met the same requirements as that shown in Sections 2.6.2.

#### **3.2.2.3 Construction Methods**

Pre-work measurement should be taken just before commencing the work. The material shall be spread in layers of uniform thickness to achieve 150mm of compacted thickness and sprinkled with water. After approval by the Engineer, compaction shall be carried out on each layer by approved mechanical plant. The material shall be compacted to a density of 95% of the maximum dry density as determined by STP T4.5. Samples to determine the compaction shall be taken regularly with a minimum one sample for each 100 linear metres per layer of each finished shoulder or as decided by the Engineer. Such density tests will be carried out according to STP T5.1. The compacted layer shall be approved by the

Engineer before the Contractor can commence a new layer. If the test results show that the density is less than the required density the Contractor shall carry out further compaction to obtain at least the required density.

#### **3.2.2.4 Measurement**

This item of work shall be measured in cubic metres of the completed accepted works on the basis of pre and post work. The volume to be measured will be the net volume of required and accepted shoulder, actually constructed and completed in accordance with the Specification, to the lines, levels, grades and cross sections required or as directed by the Engineer.

#### **3.2.2.5 Payment**

Payment will be made as per the requirements of Article 2.6.5

### **3.3 BRICK ON END EDGING**

#### **3.3.1 Description**

This work consists of provided and placing brick on end edging along the road adjacent to the side of the pavement of single layer brick flat soling and herringbone bond brick or of waterbound macadam and bitumen carpet.

#### **3.3.2 Materials**

The materials shall consist of First Class or Picked Jhama Bricks which should meet the requirements given below.

##### **a. Bricks**

First Class Bricks shall be made from good brick earth free from saline deposits, and shall be sand moulded. They shall be thoroughly burnt by coal without being vitrified, of uniform and good colour, shall be regular and uniform in size, shape and texture with sharp square edges and parallel faces. They must be homogeneous in texture and emit a clear metallic ringing sound when struck one against the other. They shall be free from flaws, cracks, chips, stones, modules of lime or canker and other blemishes. A first Class Brick shall not absorb more than 16% of its weight of water after being soaked for one hour, and shall show no sign of efflorescence on drying.

Picked Jhama bricks are those which are so overburnt as to become vitrified. Those bricks may be broken and used for aggregate in roadworks provided the vitrified mass has not become porous or spongy as a result of overburning and the aggregate satisfies the requirements of those Specifications.

First Class Bricks should have the following dimensions after burning: 250mm x 120mm x 70mm. Picked Jhama Bricks may have dimensions slightly below those for other brick but not less than 235mm x 110mm x 70mm. The unit weight of First Class Bricks shall not be less than 1100 kg per m<sup>3</sup> and the unit weight of picked Jhama Bricks shall not be less than 1200 kg per m<sup>3</sup>.



The crushing strength of bricks shall be tested in accordance with ST 7.9. The average crushing strength of Bricks shall not be less than 17 N/m m<sup>2</sup>.

### **3.3.3 Construction Methods**

Bricks shall be laid on end edging with their longest side vertical and 75mm/125mm side across the road including necessary excavation filling and ramming to the satisfaction of the Engineer. The completed work shall be true to line and level and grade as indicated on the Drawings. Interstices between brick edging and adjacent paving or soling shall be filled by brushing in sand until voids are filled; the edging shall be sprinkled then with water.

### **3.3.4 Measurement**

This item shall be measured in linear metres of completed brick on end edging.

### **3.3.5 Payment**

This work shall be measured as provided above and shall be paid for at the Contract unit price per unit of measurement. The prices and payment shall be full compensation for preparation of the edging including excavation, furnishing and placing of materials, backfilling, ranging including provision of labour, equipment, tools and incidentals necessary to complete the works as specified in this Section.

Pay item shall be:

**Unit**

Brick on end edging

Linear Metre

## **3.4 SINGLE LAYER BRICK FLAT SOLING**

### **3.4.1 Description**

This item consists of providing single layer brick flat soling on the subgrade or improved subgrade as directed by the Engineer.

### **3.4.2 Materials**

The materials shall consist of First Class or Picked Jhama Bricks which meet the requirements of Article 3.3.2a of these Specifications.

### 3.4.3 Construction Methods

The bricks shall be laid flat in one layer or as specified on the consolidated and prepared surface. Bricks shall be laid in a regular and uniform manner. Interstices of bricks shall be filled with sand of FM 0.8 and water shall be applied by sprinkling. No bricks shall be laid on a foundation or any surface until the same has been inspected and approved by the Engineer. The gaps between two adjacent bricks should not exceed 10mm. The pattern and placing of the bricks shall be as indicated in the drawings.

### 3.4.4 Measurement

Brick flat soling shall be measured in square metres for areas covered by the same.

### 3.4.5 Payment

This item of work shall be measured as provided above and shall be paid at the contract unit price. The price and payment shall include all costs for completion of the work and supply of all required materials, including cost of all labour, equipment, tools and incidentals necessary to complete the works as specified in this Section.

Pay item shall be:	<b><u>Unit</u></b>
Single layer brick flat soling	Square Metre

## 3.5 DOUBLE LAYER BRICK FLAT SOLING

### 3.5.1 Description

This item consists of providing double layer brick flat soling on the subgrade or improved subgrade as directed by the Engineer.

### 3.5.2 Materials

The materials shall consist of First Class or Picked Jhama Bricks which meet the requirements of Article 3.3.2a of these Specifications.

### 3.5.3 Construction Methods

First layer of the bricks shall be laid flat on the consolidated and prepared surface in a regular and uniform manner. Interstices of bricks shall be filled with sand of FM 0.8 and water shall be applied by sprinkling. Then a sand cushion of 25mm thickness (minimum) with sand of FM not less than 0.8 should be placed over the first layer. Second layer of the bricks shall be laid flat on the sand cushion in a regular and uniform manner. Interstices of bricks shall be filled with sand of FM 0.8 and sprinkling water as did in case of first layer. No bricks shall be laid on a foundation or any surface until the same has been inspected and approved by the Engineer. The pattern and placing of the bricks shall be as indicated in the drawings.

#### **3.5.4 Measurement**

Brick flat soling shall be measured in square metres for areas covered by the same.

#### **3.5.5 Payment**

This item of work shall be measured as provided above and shall be paid at the Contract unit price. The price and payment shall include all costs for completion of the work and supply of all required materials, including cost of all labour, equipment, tools and incidentals necessary to complete the works as specified in this section.

Pay item shall be:	<b><u>Unit</u></b>
Double layer brick flat soling	Square Metre

### **3.6 HERRINGBONE BOND BRICK PAVEMENT**

#### **3.6.1 Description**

This work shall consist of a base composed of bricks, laid on edge in a herringbone pattern, placed on a prepared single layer brick flat soling in accordance with these Specifications and to the lines, grades levels, dimensions and cross sections shown in the Drawings and as required by the Engineer.

#### **3.6.2 Materials**

The materials shall consist of First Class or Picked Jhama Bricks which meet the requirements of Article 3.3.2a of these Specifications.

#### **3.6.3 Construction Methods**

##### **3.6.3.1 Laying the Bricks**

A sand cushion of 25mm thickness (minimum) with sand of F.M. not less than 0.8 would be placed over the brick flat soling. The brick then shall be laid on edge with 125mm across the surface in a single layer in a herringbone pattern to the lines, grades, levels, dimensions and cross section shown on the Drawings and as required by the Engineer. The edge of the layer shall be made with cut bricks to produce a line which is compatible with brick edging. The joints shall be filled with sand of FM 0.8 brushed in and the completed layer shall be sprinkled liberally with water.

### 3.6.3.2 Surface Tolerance

In those areas in which pavement is to be placed, any deviation in excess of five millimetres from the specified surface within 3 metre shall be corrected by removal, reshaping and relaying.

### 3.6.4 Measurement

This item shall be measured in square metres of material in place and accepted.

### 3.6.5 Payment

The work measured as provided above shall be paid for at the Contract unit price per square metre. The price and payment shall include all costs for completion of the work including all materials, labour and equipment necessary to complete the work prescribed under this section.

Pay item shall be:

**Unit:**

Brick Pavement (HBB only).  
excluding soling and edging

Square Metre

## 3.7 SUB-BASE

### 3.7.1 Description

This work shall consist of providing, laying and compacting sub-base on the finished approved subgrade or improved subgrade, to the lines, levels, dimensions and cross section shown on the drawings or as directed by the Engineer.

### 3.7.2 Aggregate-Sand sub-base

#### 3.7.2.1 Materials

The sub-base should consists of AS (Aggregate & Sand). The sub-base shall consist of a homogeneous mixture of crushed brick aggegare, local sand and natural or artificial mixture of sand free from vegetation and excess clay. The FM shall not be less than 0.8.

The aggregate shall be crushed First Class or Picked Jhama Bricks. The crushed bricks shall comply with the following requirements:-

- o water absorption shall not exceed 18%
- o maxumum size of aggregate shall be 38mm.,
- o Aggregate Impact Value of not more than 35'or LAA-45 or as directed by the Engineer in the case of reuse of salvaged materials.

The resultant mixture shall meet the following requirements:-

- a) Plasticity: The fraction passing the 425 micron sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6. (STP Section 3)

- b) CBR: The materials shall have a soaked CBR value not less than 25% when compacted to 100% of maximum dry density as determined by STP T4.5.

#### Grading Requirements for sub-base material

Sieve Size	% Passing by Weight
38 mm	100
20 mm	55-95
10 mm	35-75
4.8 mm	25-60
2.4 mm	15-50
600 micron	10-35
300 micron	10-25
75 micron	5-15

#### 3.7.2.2 Construction Method

Sub-base materials shall be at or near the optimum moisture content (OMC) at the time of placing. The brick aggregate and sand shall be mixed thoroughly to obtain a homogeneous mix complying with the grading requirements of this Section before placing it on the subgrade. The mixed materials shall be spread uniformly upon the prepared and approved subgrade in such quantities that the thickness of the layer after compaction shall not exceed 150mm. The material shall be mixed or sprinkled with water to bring it to the correct moisture content. Total thickness required shall be in accordance with the drawings. The relationship between the loose thickness and compacted thickness shall be determined from field trials and used in controlling the loose thickness at the time of spreading the mix.

After spreading has been completed and the surface shaped according to the cross sectional requirements, rolling shall commence. Rolling should be done by a power roller weighing 8 to 10 tons or equivalent vibratory roller. Rolling shall begin at the outer edge towards the centre of the road with the rear wheel overlapping the shoulder. When the broken aggregates becomes firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until the mix has attained the required density.

The rolled surface shall be checked for correctness of levels and cross-falls and any irregularities therein shall be corrected by loosening the affected areas, adding or removing the necessary quantities of aggregate and re-rolling until the entire surface conforms to the correct levels and cross levels and cross-falls.

The dry density after compaction shall not be less than 100% of the maximum dry density as determined by STP T4.5. The field density shall be checked at least once in every 100 linear meters of sub-base surface. The prepared sub @ base layer shall be protected against damage until covered by the basecourse. Moisture content at the time of compaction shall be the optimum moisture content  $\pm 3\%$ .

The finished surface shall be within a tolerance of  $\pm 10$ mm or of the elevation shown in the drawings and it shall nowhere vary more than 10mm from the straight edge 3m long applied to the surface parallel to the centre line of the pavement and no more than 12mm from a template conforming to the cross-section.

The depth over each 100m shall be measured in at least 3 places by digging holes. The average depth should be as per drawings but the minimum depth shall not be less than 95% of the specified depth.

### **3.7.2.3 Measurement**

Sub-base shall be measured in cubic metres. It shall be based on the average width and compacted thickness of sub-base as shown on the drawings and the actual length measured horizontally along the centreline of the surface of the road.

### **3.7.2.4 Payment**

The work, measured as provided above, shall be paid for the contract unit price. The price and payment shall be full compensation for performing the work including furnishing and placing the materials, supplying all labour, equipment, tools and incidentals necessary to complete the work prescribed in the Section. Separate measurements should be taken at the bends if found necessary.

Pay item shall be:

**Unit**

Sub-base

Cubic Metre (Compacted thickness)

## **\*3.7.3 Aggregate-Sand-Soil sub-base**

### **3.7.3.1 Materials**

The sub-base should consist of ASS (Aggregate-sand-soil). The sub-base materials shall be crushed aggregates from well burnt bricks, sand and soil mixture. The aggregate shall be clean, sound and durable of uniform quality and sand or soil shall be free from vegetation, soft particles and excess of clay. F.M. for sand shall not be less than 0.8.

The aggregate shall be crushed First Class or Picked Jhama Bricks. The crushed bricks shall comply with the following requirements,-

- o water absorption shall not exceed 18%
- o maximum size of aggregate shall be 38mm.
- o Aggregate Impact Value of not more than 35 or LAA-45 or as directed by the Engineer in the case of reuse of salvaged materials.

The resultant combined materials shall meet the following requirements:-

- a) Plasticity: The fraction passing the 425 micron sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6. (STP Section 3)

\* As the behaviour of ASS is still under trial & monitoring, use of this specification will fully depend upon the judgement of the users.

- b) CBR: The materials shall have a soaked CBR value not less than 25% when compacted to 100% of maximum dry density as determined by STP T4.5.

Brick chips may be mixed with local sand and locally available soil in the proportion of 1:1:1 (by volume) and the combined grading of these shall be within the grading envelope mentioned in Table 3.7.3.1

**Table 3.7.3.1 : Gradation limit for aggregate sub-base material**

Sieve Designation	Mass % Passing
38 mm	100
4.75mm	40-80
75 micron	6-25

**3.7.3.2 Construction Method**

Sub-base materials shall be at or near the optimum moisture content (OMC) at the time of placing. The brick aggregate, sand and soil shall be mixed thoroughly to obtain homogeneous mix complying with the grading requirements of this Section before placing it on the subgrade.

The blending or mixing aggregate with sand and soil shall not be done over the approved sand sub-base bed. Water should be mixed up to optimum moisture content level. There shall not be any excess watering in the subbase materials while compacting this layer.

The mixed materials shall be spread uniformly upon the prepared and approved subgrade in such quantities that the thickness of the layer after compaction shall not exceed 150mm.

Normally mixing of three types of component (aggregate/sand/soil) shall be carried out in a stockyard nearly to the working area to achieve the grading. The mixing shall be made manually as per proportions mentioned earlier or by any other approved method.

The three different boxes of equal area and the height shall be proportional to aggregate volumes are required. First the aggregate box shall be filled up with brick aggregate and then sand box shall be placed and filled with sand; the third box shall be on top of the sand and filled with soil. Then the boxes will be lifted and mixing shall be done manually or by any other approved method. The material shall be mixed thoroughly and uniformly to form a homogeneous mass. During mixing, water is to be added to keep the mixed material moist so as to prevent segregation during transportation. Excess water shall not be used.

Three different materials from different sources are to be proportioned and mixed in place as per relative proportions fixed earlier. The proportioning and mixing shall be done manually or by any other method approved by the Engineer. Water shall be added cautiously to avoid any damage to the previous subbase layer.

The material shall be mixed or sprinkled with water to bring it to the correct moisture content. Total thickness required shall be in accordance with the drawings. The relationship between the loose thickness and compacted thickness shall be determined from field trials and used in controlling the loose thickness at the time of spreading the mix.

After spreading has been completed and the surface shaped according to the cross sectional requirements, rolling shall commence. Rolling should be done by a power roller weighing 8 to 10 tons or equivalent vibratory roller. Rolling shall begin at the outer edge gradually moving towards the centre of the road with the rear wheel overlapping the shoulder. When the broken aggregates become firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until the mix has attained the required density.

The rolled surface shall be checked for correctness of levels and cross-falls ; any irregularities therein shall be corrected by loosening the affected areas, adding or removing the necessary quantities of aggregate and re-rolling until the entire surface conforms to the correct levels and cross levels and cross-falls.

The dry density after compaction shall not be less than 100% of the maximum dry density as determined by STP T4.5 . The field density shall be checked at least once in every 100 linear meter of sub-base surface. The prepared sub-base layer shall be protected against damage until covered by the basecourse. Moisture content at the time of compaction shall be the optimum moisture content  $\pm 3\%$ .

The finished surface shall be within a tolerance of  $\pm 10\text{mm}$  or of the elevation shown in the drawings and it shall not vary more than 10mm from the straight edge 3m long applied to the surface parallel to the centre line of the pavement and no more than 12mm from a template conforming to the cross-section.

The depth over each 100m shall be measured in at least 3 places by digging holes. The average depth should be as per drawings but the minimum depth shall not be less than 95% of the specified depth.

#### **3.7.3.3 Measurement**

Sub-base shall be measured in cubic metres. It shall be based on the average width and compacted thickness of sub-base as shown on the drawings and the actual length measured horizontally along the centreline of the surface of the road.

#### **3.7.3.4 Payment**

The work, measured as provided above, shall be paid for the contract unit price. The price and payment shall be full compensation for performing the work including furnishing and placing the materials, supplying all labour, equipment, tools and incidentals necessary to complete the work prescribed in the Section. Separate measurements should be taken at the bends if found necessary.

Pay item shall be:

**Unit**

Sub-base

Cubic Metre (Compacted thickness)



### 3.8 GRADED AGGREGATE-SAND BASE COURSE

#### 3.8.1 Description

This work shall consist of providing, laying and compacting Graded Aggregate-Sand basecourse on the prepared and accepted sub-base to the lines, levels, dimensions, and cross sections shown on the Drawings or as directed by the Engineer.

#### 3.8.2 Materials

The basecourse material shall consist of a homogeneous mixture of crushed brick aggregate and local sand.

The aggregate shall be crushed Picked Jhama or mixed with First class bricks. The crushed bricks shall comply with the following requirements:-

- Water absorption shall not exceed 16%
- Maximum size of aggregate shall be 38mm
- Aggregate impact value (AIV) of not more than 32 or Los Angeles Abrasion (LAA) 40
- Flakiness index 15%

The F.M. of sand shall not be less than 0.80 and shall be free from deleterious material. Basecourse material shall conform to the grading envelope shown in the table given below and have a soaked CBR value not less than 65% when compacted 100% of maximum dry density as determined by STP T4.5.

#### Grading Requirements for Graded Aggregate-Sand Basecourse

Sieve Size	% Passing by Weight
38mm	100
20mm	60-90
10mm	40-70
4.8mm	30-55
2.4mm	20-45
600micron	10-30
300micron	10-25
75micron	5-15

In addition the material shall be well graded with the envelope having no excess or deficiency in any size. The fraction passing the 75 micron sieve shall not be more than 75% of that passing the 300 micron sieve. The portion of the material passing the 425 micron sieve shall, if it is plastic, have a liquid limit not more than 25 and a plasticity index not more than 6.

#### 3.8.3 Construction Methods

The base-course materials shall be at the optimum moisture content (OMC) 3% at the time of placing. The brick aggregate and sand shall be mixed thoroughly to obtain a homogeneous mix complying with the grading requirements of this Section. Water shall be added during mixing to keep the mixed material moist so as to prevent

segregation during transportation. Prior to laying the basecourse, the sub-base shall be watered. The mixed basecourse material shall then be spread in two equal layers so that the compacted thickness of each layer shall combine to conform to the thickness shown on the Drawings or as directed by the Engineer. On the completion of the spreading and watering, rolling shall commence.

Rolling should be done by a power roller weighing 8 to 10 tons or equivalent vibratory roller. Rolling shall begin at the outer edge gradually moving towards the centre of the road with the rear wheel overlapping the shoulder. When the broken aggregates become firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until mix has attained the required density.

The base course shall be compacted to have 100% maximum dry density (standard) and soaked CBR as specified in Article 3.8.2. The field density shall be checked at least once in every 100 linear metre of base course surface. Moisture content at the time of compaction shall be the optimum moisture content  $\pm 3\%$ .

The finished surface of the base course shall in no place be more than  $\pm 10\text{mm}$  from the designed level and the mean of five measurements of thickness taken in any 200 metres long section shall at least equal to or more than the required base course thickness.

#### **3.8.4 Measurement**

Basecourse shall be measured in cubic metres. It shall be based on the average width and compacted thickness of basecourse as shown on the Drawings and the actual length measured horizontally along the centreline of the surface of the road.

#### **3.8.5 Payment**

The work, measured as provided above, shall be paid at the contract unit price. The price and payment shall be full compensation for performing the work including furnishing and placing the materials, supplying all labour, equipment, tools and incidentals necessary to complete the work prescribed in the section. Separate measurements should be taken at the bends if found necessary.

Pay item shall be:

**Unit**

Aggregate-Sand Basecourse

Cubic Metre (Compacted thickness)

### **3.9 WATER BOUND MACADAM BASE COURSE**

#### **3.9.1 Description**

This work shall consist of providing, laying, watering and compacting waterbound macadam base course on the prepared and accepted sub-base to the lines, levels, dimensions, and cross profiles shown on the Drawings or as directed by the Engineer in charge.

### 3.9.2 Materials

The base course material shall consist of crushed first class brick and/or picked Jhama brick aggregates wellgraded and of desired strength, mechanically "Keyed" or locked by rolling and cemented or bounded together by the application of sand and water.

The aggregate shall be crushed Picked Jhama or mixed with First class bricks. The crushed bricks shall comply with the following requirements:

- Water absorption shall not exceed 16%
- Maximum nominal size of aggregate shall be 38mm according to ASTM-C-131
- Los Angeles Abrasion Test (AASHTO Designation T-96) with a percentage of wear less than 40 at 500 revolution.
- Flakiness index as per BS-812-15%
- Aggregate Impact Value of not more than 32% ( According to BS-812)

The F.M. of Sand shall not be less than 0.80 and shall be free from deleterious material.

Material shall conform to the grading envelope shown in the Table A and have a soaked CBR value not less than 65% when compacted to 100% of maximum dry density as determined by STP T 4.5.

#### Grading Requirements for Water Bound Macadam Basecourse

SIEVE SIZE	% PASSING BY WEIGHT
38mm	100
20mm	60-80
10mm	40-60
4.8mm	25-45
2.4mm	15-32
600 micron	10-20
75 micron	0-15

The material shall be well graded with the envelope having no excess or deficiency in any size.

The above grading may be changed by the Engineer-in-charge when the laboratory results of the above proportion does not meet the quality requirements of the specification.

### 3.9.3 Construction Methods

Prior to laying of base course the aggregate drainage layer shall be shaped true to cross fall or super elevation and shall be rolled as necessary till the surface is smooth, firm and tight. The prepared aggregate drainage layer shall be protected against damage until covered by the base course.

Mixing of various course aggregates should be carried out in a stockyard to achieve the specified grading. Different kinds of materials shall not be mixed together except that sand or naturally occurring granular materials finer than 5mm size can be mixed with any of these materials to meet the grading requirements. The mixing may be done by mechanical means or a combination of manual labour and machinery. The materials shall be mixed thoroughly and uniformly to have a homogeneous mass also satisfying the grading requirements. During mixing, water is to be added to keep the mixed material moist, so as to prevent segregation during transportation.

The materials shall be spread in layers, the compacted thickness of which shall not exceed 100mm. However the Engineer may allow higher compacted thickness upto 150mm if he is satisfied that the specified degree of compaction can be imparted throughout such greater thickness of layer with the contractor's equipments and methods used by the contractor. The spreading shall be done using methods acceptable to the Engineer. The required amount of water, predetermined from laboratory tests and field trials, shall be added and mixed thoroughly. The moisture content of the material during compaction shall be guided by the optimum moisture content (OMC) as determined from laboratory compaction tests but subject to variations as needed for achieving specified density as decided by the Engineer on the basis of trial compaction.

Rolling should be done by a power roller weighing 8 to 10 tons or equivalent vibratory roller. Rolling shall begin at the outer edge with the rear wheel overlapping the shoulder. When the broken aggregates become firm, the roller will be shifted to the opposite side of the road and the operation will be repeated. After both edges rolled modestly firm, the roller will be gradually moved towards the centre by overlapping 150mm of the rolled width until the entire base course thoroughly compacted.

The base course shall be compacted to have 100% maximum dry density (standard) and soaked CBR as specified in Article 3.9.2. The field density shall be checked at least once every 100 linear metre of base course surface. Moisture content at the time of compaction shall be the optimum moisture content  $\pm 3\%$ .

The finished surface of the base course shall in no place be more than  $\pm 1$  Omm from the designed level and the mean of five measurements of thickness taken in any 200 metres long section shall be equal to or more than the required base course thickness.

#### **3.9.4 Measurement**

Basecourse shall be measured in cubic metres of material complete in place and accepted. It shall be based on the average width and compacted thickness of base course as shown on the Drawings and the actual length measured horizontally along the centreline of the surface of the road.

### 3.9.5 Payment

The work as measured above shall be paid for at the contract unit prices for each of the items listed below and shown in the Bill of Quantities. Payment shall be for full compensation for performing the work including furnishing the materials, water, carrying out all, placing, compaction, protection work, trials, tests and all other procedures described herein and providing all labour, tools, equipments and incidentals necessary to do the work.

The pay item shall be	<u>unit</u>
Water Bound Macadam	Cubic Metre (Compacted Thickness)

### 3.10 UPGRADING THE OLD EXISTING WATER BOUND MACADAM/GRADED AGGREGATE-SAND BASECOURSE

#### 3.10.1 Description

The top 75mm of existing Water Bound Macadam/Graded Aggregate-Sand Base Course shall be loosened, reshaped and compacted, as directed by the Engineer, to the proper grade and camber, supplying additional quantities of base course material if required to bring the grading of the scarified salvaged material to the specification described in Article 3.8.2 & 3.9.2; spreading the properly mixed and graded salvaged and additional materials on top of the prepared and accepted exposed layer of the Base Course, compacting the spreaded materials to the specified grade and camber to make the total thickness as per design to the line, levels, dimensions and crosssection shown on the drawings or as directed by the Engineer.

#### 3.10.2 Materials

The materials required for this item should meet the specifications described for Water Bound Macadam and for Graded Aggregate-Sand Basecourse.

#### 3.10.3 Construction Methods

The top 75mm layer of the existing water bound macadam/graded aggregate-sand basecourse shall be scarified or loosened by any suitable means.

The grading of the salvaged materials shall be checked and additional base course materials shall be added to bring to the required shape, size and quality as specified and mixed to bring the grading of the mixed base course materials within the grading envelope specified.

The scarified surface of the exposed layer shall be reshaped, watered and compacted to bring it to the proper line, levels, dimensions and cross-section.

Additional materials to the specified grading, and quality shall then be spread over the prepared and accepted surface. The base course materials shall be spread in such a way that the compacted thickness of the base course is not less than the design

thickness. On the completion of the spreading and watering, the surface shall be shaped according to the cross-section shown in the drawings and compacted using approved mechanical compaction equipment. Compaction shall continue until the material has attained the required density. The base course shall be compacted to have 100% maximum dry density (standard proctor) and a soaked CBR as specified in Article 3.9.2. The in-situ density shall be checked at every 100 linear metres of recompacted surface.

#### **3.10.4 Measurement**

The salvaged material and supplying of additional material shall not be measured. Only the accepted base course compacted as specified shall be measured in square metres. It shall be based on the average width and thickness of base course shown on the drawings and the actual length measured horizontally along the centre line of the surface of the road.

#### **3.10.5 Payment**

This work as measured above shall be paid for at the contract unit price for the additional works required to the base course. Payment shall be full compensation for performing the work including but not limited to scarifying and picking up the existing top layer, supplying additional base course materials, mixing to the proper grading spreading the mixed base course materials, watering, compacting to the specified density, grade, cross-section and thickness.

Pay item shall be:

**Unit**

Upgrading the old existing Water Bound Macadam/  
Graded Aggregate-Sand Base Course

i)	Scarifying and loosening the existing surface	Square Metre
ii)	Spreading and supply of additional material	Square Metre
iii)	Compaction	Square Metre

### **3.11 GENERAL REQUIREMENTS FOR BITUMINOUS SURFACING**

#### **3.11.1 Description**

##### **3.11.1.1 General**

This work shall cover the general requirements that are applicable to all types of bituminous bound surfacing irrespective of gradation of mineral aggregate, grade and amount of bituminous materials used. Deviations from these general requirements are indicated in the specific requirements as set forth in the respective sections for each type.

The work shall consist of one or more courses of p're-mixed bituminous mixtures constructed on a prepared and accepted base course or other road bed in accordance with these Specifications and the specific requirements of the type under Contract, and in conformity with the required lines, levels, grades, dimensions and typical cross sections.

### **3.11.1.2 Composition of Mixtures**

The bituminous mix shall be composed basically of coarse mineral aggregate, fine mineral aggregate, filler and bituminous binder. The several mineral constituents shall be sized, uniformly graded and combined in such proportions that the resulting blend meets the grading requirements for the specific type under the Contract. To such composite blended aggregate shall be added bitumen within the percentage limits set in the specifications for the specific type.

### **3.11.2 CONSTRUCTION**

#### **3.11.2.1 Weather Limitation**

Bituminous mixtures shall be placed only when the surface is dry, when the weather is not rainy and when the prepared road bed is in a satisfactory condition. However, the Engineer may permit, in case of sudden rain, the placing of mixture then in transit if laid at proper temperature and if the road bed is free from pools of water.

Such permission shall in no way relax the requirements for quality and smoothness of surface.

#### **3.11.2.2 Progress of Work**

No work shall be performed when there is insufficient hauling, spreading or finishing equipment or labour to ensure progress at a rate consistent with meeting proper temperatures and rates of compaction.

#### **3.11.2.3 Equipment**

##### **a. Equipment for preparation of bituminous binder**

Tanks or kettles for storage of bituminous binder shall be capable of heating the binder under effective control at all times, to a temperature within the range specified. Bitumen shall not be heated in open pans or drums. Suitable means shall be provided for maintaining the specified temperature of the bituminous binder at all times. Generally Tar boilers with thermometer are used to heat the bitumen.

##### **b. Thermometric Equipment**

Armoured thermometers in good condition reading from 500 C to 2000C shall be available at the sites of mixing and laying at all times.

c. Equipment for hauling bituminous mixtures shall have tight, clean and smooth metal sides that have been sprayed with soapy water, thinned fuel oil, paraffin oil or lime solution to prevent the mixture from adhering to the beds. The amount of sprayed fluid shall however be kept to the practical minimum. Any equipment causing excessive segregation of material by its suspension or other contributing factors, or that shows oil leaks in detrimental amount or that causes undue delays, shall upon direction of Engineer in charge. be removed from the site until such conditions are corrected.

- d. The equipment for spreading and finishing shall be capable of spreading and finishing the mixture true to the lines, grades, levels dimensions and cross sections.
- e. The Contractor shall provide suitable means for keeping all small tools clean and free from accumulation of bituminous material. He shall provide and have ready for use at all times enough tarpaulins or covers, as may be directed by the Engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may have been dumped and not spread.

#### **3.11.2.4 Preparation and Placing**

##### **a. Preparation of Existing Surface**

Where the existing road bed is broken or shows instability, the unstable material shall be removed and disposed off as directed by the Engineer and be replaced with the same mixture as specified for the next course, compacted to the standard and elevation of the adjacent surface. The surface upon which the mixture is to be placed shall be swept thoroughly and cleaned of all loose dirt and other objectionable material immediately before spreading the bituminous mixture. If directed by the Engineer Tack coat is to be applied before placing the next layer. If this has become necessary due to delays caused by the contractor in starting the next layer this will not be paid.

##### **b. Preparation of Bituminous Binder**

The bituminous binder shall be heated to the specified temperature (140OC-155'C for 60/70 or 80/100 penetration bitumen) in Tar boiler, kettle or tanks so designed as to avoid local overheating and to provide a supply of the bituminous binder at a uniform temperature at all times.

##### **c. Preparation of Mineral Aggregate**

The aggregates produced, whether by machine or by manual methods should be screened into the major component sizes prior to recombining in the correct proportions.

The mineral aggregates for the mixture shall be dried and heated to a temperature of between 150'C-170'C before mixing. The aggregates shall be heated to the temperature specified in the applicable section.

##### **d. Preparation of Mixture**

The heated mineral aggregate prepared above, shall be combined in the amount of each fraction of aggregate required to meet the mix formula for the particular mixture. The bituminous material shall be measured or gauged and introduced into the mix in the amount determined by the Engineer. Only sufficient heat shall be applied during mixing to maintain the temperature of the mix without increasing the temperature. The proper amount of bituminous material shall be distributed over the mineral aggregate and the whole thoroughly mixed for a period of at least 60 seconds, or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. Mixing should not be carried out on fire.



e. **Transportation and Delivery of Mixture**

The mixture shall be transported from the mixer to the point of use in equipment conforming to the requirements of Article 3.11.2.3. Loading and transporting shall be such that spreading, compaction and finishing shall all be carried out during daylight hours unless satisfactory illumination is provided by the Contractor.

f. **Spreading and Finishing**

'Upon arrival at the point of use, the mixture shall be spread and struck off to the grade, elevation, and cross-section shape intended, either over the entire width or over such partial width as may be practicable. The mixture shall be laid upon an approved surface and only when weather conditions are considered suitable by the Engineer.

g. **Compaction of Mixture**

- (i) **General** : Immediately after the mixture has been spread and struck off, the surface shall be checked and any inequalities adjusted. The mixture shall then be thoroughly and uniformly compacted by rolling. Each course shall be rolled as soon after being placed as the material will support the roller without undue displacement or cracking.
- (ii) All rollers shall be self propelled, capable for being reversed without backlash. Each roller shall be in good condition and worked by a competent and experienced operator. Generally Tandem roller is suitable for B.C work; in addition Tyre roller is also needed.
- (iii) Rolling shall start longitudinally at the sides and proceed toward the centre of the pavement except that on super-elevated curves rolling shall begin at the low side and progress toward the high side. Successive trips of the roller and alternative trips shall not terminate at the same point.

Rolling shall start with a temperature of at least 1200 C and shall be discontinued if temperature falls below 900 C.

The speed of the rollers shall not exceed 4 kilometers per hour for steel wheeled rollers and 6 kilometers per hour for pneumatic tyred rollers and shall at all times be slow enough to avoid displacement of the hot mixture. Any displacements occurring as a result of reversing the direction of the roller or from any other cause shall at once be corrected with rakes and fresh mixture where required. Care shall be exercised in rolling not to displace the line and grade of the edges.

Rolling shall progress continuously as may be necessary to obtain uniform compaction while the mixture is in a workable condition and until all roller marks are eliminated.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water will not be permitted.

Heavy equipment or rollers shall not be permitted to stand on the finished surface until it has thoroughly cooled or set.

Any petroleum products dropped or spilled from the vehicles or equipment employed by the Contractor upon any portion of the pavement, under construction is caused for the removal and replacement of the contaminated pavement by the Contractor. The

surface of the mixture after compaction shall be smooth and true to the established crown and grade within the tolerance specified. Any mixture that becomes loose and broken, mixed with dirt, or which is defective in any way, shall be removed and replaced with fresh hot mixture, which shall be compacted immediately to conform with the surrounding area. Any areas of one square metre or more showing an excess or deficiency of bituminous material shall be removed and replaced. All high spots, high joints, depressions, and honeycombs shall be adjusted as directed by the Engineer.

#### **h. Joints**

Both longitudinal and transverse joints in successive courses shall be staggered so as not to be one above the other. Longitudinal joints shall be arranged so that the longitudinal joint in the top course shall be at the location of the line dividing the traffic lanes. Lateral joints shall be staggered a minimum of 250 millimeters and shall be straight.

The edges of the pavement shall be straight and true to the required lines. Any excess material shall be cut off after final rolling and disposed off by the Contractor at the end of a day's work.

Just prior to recommencing operations, the sides of all longitudinal and transverse joints shall be painted with hot bitumen to ensure a satisfactory bond between the old and new work.

### **3.11.3 Measurement**

All work prescribed above shall be measured and paid for as provided in the respective sections for each type of pavement. The quantity measured and paid for shall always be the quantity ordered with any permitted excess or the actual quantity used whichever is the less.

### **3.11.4 Payment**

The work shall be paid for as provided in the respective section for each type of bituminous layer.

## **3.12 PRIME COAT**

### **3.12.1 Description**

This work shall consist of the careful cleaning of the surface of the granular base material to be primed and furnishing and applying bituminous material in accordance with these Specifications to the areas shown on the Drawings and as directed by the Engineer.

### **3.12.2 Materials**

#### **3.12.2.1 Bituminous Materials**

Bituminous prime coat material shall be a cut back bitumen, conforming to the requirements of ASTM/ AASHTO.

Cut back bitumen may be prepared by cutting back 60/70 or 80/100 penetration grade straight run bitumen with kerosene/diesel in the ratio of 100 parts by volume of bitumen to 40-60 parts by volume of kerosene depending on the porosity of the surface and will be decided by field trials or as directed by the Engineer. The correct amount is the quantity that is completely absorbed within 24 hours. The spraying temperature of the cutback bitumen shall be 100°C to 120°C.

### **3.12.2.2 Blotting Material**

Blotting material shall be clean, dry, free-flowing sand not containing any cohesive materials or organic matter. Not more than 10 percent of the sand shall be finer than the 75 micron sieve.

### **3.12.3 Construction Methods**

#### **3.12.3.1 Weather Limitations**

Prime coat work shall not be carried out when the weather conditions are, in the opinion of the Engineer, likely to adversely affect the stability of wet prime coat material. Such conditions may include but shall not necessarily be limited to rain, low temperatures or storms.

#### **3.12.3.2 Cleaning Surface**

Immediately before applying the prime coat material, all loose stones, dirt and other objectionable materials shall be removed from the surface with a broom or blower as appropriate. When so directed by the Engineer, a light application of water shall be made just before the application of the prime coat.

#### **3.12.3.3 Application of Prime Coat**

Prime coat material shall be applied by mechanical distributor or manually at a uniform rate between 1.00 and 1.20 litres/square metre as directed by the Engineer, and at a temperature between 100°C to 120°C. Additional primer shall be applied where surface conditions indicate this to be necessary, if the Engineer so directs. No further coatings shall be applied until the prime coat has been cured.

The contractor may be required to lay a trial section of prime coat for the approval of the Engineer with regard to the method of operations and to establish the optimum spray rate for the prime coat to achieve adequate penetration. Following the approval of the Engineer in writing of such trial section (s), the prime coat works may then be carried out strictly in accordance with the approved method and spray rates and the specification.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being splattered or marred. No bituminous material shall be discharged into a borrow pit, gutter or kerb.

### **3.12.4 Maintenance and Opening to Traffic**

After application of the prime coat there shall be a curing period of 48 hours or more, when traffic shall not be permitted on the coated surface. In case of any damage caused by traffic, the surface shall be redone at the cost of the contractor. The period of curing shall be extended if necessary till the bituminous material has penetrated and dried and, in the opinion of the Engineer, will not be picked up by traffic. At the end of the curing period, minor areas where prime coat material is still not dry shall be treated by sprinkling, blotting sand as necessary to avoid picking up of prime coat material before allowing traffic to use the coated areas. For existing roads, the work shall be done over half width at a time, the other half being used to carry the traffic.

### **3.12.5 Measurement**

Prime coat shall be measured in square meter. Blotting material shall not be measured for payment and shall be considered to be included in the rate for prime coat.

### **3.12.6 Payment**

This work, measured as provided above, shall be paid at the Contract unit price. The price and payment shall be full compensation for preparation of the surface and furnishing and placing the materials including all labour, equipment, tools and incidentals necessary to complete the work prescribed in the Section.

Pay item shall be	<b><u>Unit</u></b>
Prime Coat	Square Metre

## **3.13 TACK COAT**

### **3.13.1 Description**

This work shall consist of the cleaning and preparation of the bituminous surface specified, or otherwise as directed by the Engineer, together with the furnishing and application of the tack coat in accordance with these Specifications to the areas shown on the Drawings and as directed by the Engineer.

Tack Coat should be applied only in between two bituminous surfaces.

### **3.13.2 Materials**

Bituminous tack coat material shall be 60/70 or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM / AASHTO.

### **3.13.3 Construction Methods**

#### **3.13.3.1 Weather Limitations**

Tack coat work shall not be carried out when the weather conditions are, in the opinion of the Engineer, likely to adversely affect the stability of wet tack coat material. Such conditions may include but shall not necessarily be limited to rain, low temperatures or storms.

### **3.13-3.2 Cleaning Surfaces**

Immediately before applying the tack coat all loose stone dirt and other objectionable material shall be removed from the surface with a broom or blower as appropriate.

### **3.13.3.3 Application of Tack Coat**

Tack coat material shall be applied by mechanical distributor or manually at a rate of 0.5 litreS/m<sup>2</sup> and at a temperature between 135°C and 155°C. Additional tack coat shall be applied where surface conditions indicate this to be necessary, if the Engineer so directs.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being splattered or marred. No bituminous material shall be discharged into a borrow pit, gutter or kerb.

### **3.13.4 Measurement**

Tack coat shall be measured in square meter as shown on the Drawings or ordered by the Engineer, complete, in place and accepted.

### **3.13.5 Payment**

This work, measured as provided above, shall be paid for at the contract unit price per unit of measurement stated below. The price and payment shall be full compensation for preparation of the surface and furnishing and placing the materials including supply of all materials, labour, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

Pay item shall be:	<b><u>Unit</u></b>
Tack Coat	Square Metre

## **3.14 PREMIX BITUMINOUS CARPETING (Dense graded)**

### **3.14.1 Description**

This work shall consist of a premix bituminous carpet of a bituminous macadam type of material constructed on a prepared and primed granular base course in accordance with these Specifications and to the lines, levels, grades, dimensions and cross-sections shown on the Drawings and as directed by the Engineer. The bituminous carpeting shall consist of a compacted single layer of surfacing of thickness as shown on the drawings. No seal coat is required over the BC as the mix is density graded.

### **3.14.2 Materials**

#### **3.14.2.1 Bituminous Material**

Bituminous material shall be 60/70 or 80/100 penetration grade straight run bitumen complying with the requirement of ASTM / AASHTO.

### 3.14.2.2 Coarse Aggregate

The coarse aggregate shall be the material component fully retained on an 4.75mm sieve and shall consist of clean crushed rock or crushed gravel or blended combinations of both, free from decomposed stone, organic matter, shale, clay and any other substances which, in the opinion of the Engineer, may be deleterious to the mixture. Coarse aggregate shall satisfy the following physical characteristics when tested:

- Aggregate Crushing Value or AIV of not greater than 30 or LAA value of 40
- Bulk specific gravity not less than 2.50
- Flakiness index not greater than 35% except where specially approved by the Engineer.

The coarse aggregate shall have weight loss not more than 12% when subjected to 5 alternations of the sodium sulphate soundness test, AASHTO: T. 104.

Not less than 75% by weight of the particles of coarse aggregate shall have at least two fractured faces.

### 3.14.2.3 Fine Aggregate

The portion of the aggregate passing a 4.75mm sieve shall be known as fine aggregate and shall consist of natural sand, stone screenings, or a combination of both. Fine aggregate shall be composed of clean, hard durable particles, rough surfaced and angular, free from vegetable matter, soft particles, clay balls or other objectionable material.

### 3.14.2.4 Overall Aggregate Grading

The mix of the coarse and fine aggregates combined shall comply with the following grading given in Table 3.14.1.

**Table 3.14.1**

Sieve Size	For 25mm B.C.	For 40mm B.C.
	% by Weight Passing	% by Weight Passing
25mm	100	100
20mm	100	75-100
16mm	100	-
12.5mm	75-100	60-80
10mm	60-80	-
6.3mm	-	-
4.75mm	35-55	35-55
2.4mm	20-35	20-33
600 micron	10-20	6-18
75 micron	2-8	2-8
Bitumen Content % by weight of total mix.	5.5% ± 0.3% (5.2% to 5.8%)	5.2% ± 0.3% (4.9% to 5.5%)

Required bitumen content should be determined by trials.

### **3.14.2-4.1 Bituminous Mixture Requirements**

The resultant density of the compacted bituminous mixture shall be between 2250 and 2400 kg/m<sup>3</sup>. The bitumen content and stability of mixture shall be as per specification or as decided by the Engineer.

### **3.14.3 Construction Methods**

#### **3.14.3.1 Preparation of the road base**

A prime coat shall be applied and cured to the surface of the granular base material in accordance with Section 3.12 before spreading the premixed aggregates.

#### **3.14.3.2 Mixing of Bituminous Material**

Prior to heating, the various sizes of aggregate shall be thoroughly mixed together to give a stockpile of aggregate of the required grading of sufficient quantity for at least one day's surfacing work.

The bitumen and the aggregates shall be separately heated to a temperature between 140°C to 155°C and 150°C to 170°C for bitumen and aggregate respectively before mixing. The temperature of bitumen aggregate mixture should be between 140°C to 160°C. Bitumen, or bitumen aggregate mixture, which has been overheated at any time shall be rejected. The percentage of bitumen in the mix shall be between 5.2% and 5.8% by weight of total mix for 25mm BC and between 4.9% and 5.5% by weight of total mix for 40mm BC.

The final combined grading shall be within the limits of the specification and the actual bitumen content shall be determined on the basis of laboratory tests by the Engineer and the final grading of the combined aggregates and the bitumen content shall be approved by the Engineer.

The laying temperature of the mixture shall not be less than 130°C.

The mixed materials shall be laid to a uniform thickness. The thickness and proper camber shall be maintained by the use of steel angle screeds of the correct size. The sides of the angle shall be at least 25% greater than the compacted thickness specified and as shown on the drawings or as directed by the Engineer.

#### **3.14.3.3 Rolling**

After laying, the materials shall immediately be compacted using a power driven road roller. The initial pass of the roller on the bituminous premix shall be at temperatures specified above and shall be carried out with these steel angles in position. Subsequent passes of the roller may be made with these steel angles removed.

When the temperature of the bituminous premix falls below 90°C no further compaction should be permitted.

The bituminous premix shall be compacted using an approved roller (preferably a pneumatic tyre roller) and a minimum of five passes shall be made, or as directed by the Engineer from time to time. Material that falls below the minimum working temperature of 90°C, that has not been compacted as described, may be rejected and shall be replaced by new material to the required specification and compaction by the contractor at his own expenses.

The premix carpeting shall be fully compacted maintaining the proper grade and camber. The compacted thickness as shown in the drawing and as provided in the Bill of Quantities shall be uniformly maintained all along the road surface.

Rollers and other mechanical plant shall not be allowed to stand on newly laid material that may be deformed thereby. Sections of newly finished work shall be protected from traffic of any kind until the mixture has cooled to ambient air temperature.

The finished surface shall be within a tolerance of  $\pm 5\text{mm}$  or of the elevation shown in the drawings and it shall nowhere vary more than 5mm from the straight edge 3m long applied to the surface both longitudinally and transverse.

#### **3.14.3.4 Open to Traffic**

When the initial rolling is completed, commercial traffic could be allowed in the surfaced area. The speed of traffic shall be temporarily reduced to avoid the damage to the surface. Maximum speed limit of 30-40 km/hour shall, therefore, be enforced during the first month after construction (by speed breaker as an example or any other method approved by the Engineer.)

#### **3.14.4 Measurement**

Premix bituminous carpeting shall be measured as the number of square metres of finished surface of the specified thickness completed in place and accepted by the Engineer. Measurement shall be based upon the nominal width of surface course at its top surface as shown on the Drawings. Surface widening will be measured extra, if directed by the Engineer. Mean of the three measurements of thickness taken in any 100 metre long section shall at least equal to or more than the required thickness.

#### **3.14.5 Payment**

The quantities measured as provided above shall be paid for at the Contract unit shown below. The price and payment shall be full compensation for furnishing, placing and compacting all materials, for all labour, equipment, tools and incidentals necessary to complete the work.

Pay item shall be:	<b><u>Unit</u></b>
Premix Bituminous Carpeting:	
i) 40mm total thickness	Square Metre
ii) 25mm total thickness	Square Metre



### 3.15 PREMIX BITUMINOUS SEAL COAT 7MM THICK

#### 3.15.1 Description

This work shall consist of premix bituminous seal coat applied to a prepared and primed granular base course or over the bituminous surfacing in accordance with these Specifications or as directed by the Engineer. The thickness of premix bituminous seal coat shall be 7mm.

#### 3.15.2 Materials

##### 3.15.2.1 Bituminous Material

Bituminous material shall be of 60/70 or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM AASHTO.

##### 3.15.2.2 Aggregate

The aggregates shall consist of 6.3mm down graded stone or gravel free from any organic matter, clay and any other objectionable matter.

Where required to achieve the specified grading the aggregate shall be mixed with natural sand. Sand shall be non-plastic, clean and free from any deleterious substances. The minimum F.M. of sand for the sealing premix shall be between 2.00 to 2.50 and that of sand to be spread over the seal coat as blotting material shall be between 0.80 to 1.00.

##### 3.15.2.3 Overall Aggregate Grading

The mix of the aggregates and sand combined shall comply with the following grading given in Table 3.15.1

**Table 3.15.1**

**Grading Requirements for 7mm Premix Bituminous Seal Coat**

Sieve Size	% by Weight Passing Sieve
6.3mm	100
4.75mm	80-100
2.4mm	70-95
600 micron	20-50
75 micron	5-15

#### 3.15.3 Construction Methods

Bitumen and aggregates shall be heated separately at the following temperatures:

Only Bitumen	:	between 140°C to 155°C (Max)
Only Aggregate	:	between 150°C to 170°C
Mix of Bitumen & Aggregate	:	between 140°C to 160°C

Material that has been over-heated at any time shall be rejected. No mixing of pre-heated bitumen and aggregate should be done on fire. 0.01 M3 of aggregate will be mixed with 1 litre of bitumen and shall be laid on 1 (one) square metre of road surface.

The aggregate mixed with bitumen shall be laid over the bituminous carpeting or over the primed granular base to a uniform thickness which shall be at least 25% greater than the compacted thickness and immediately compacted fully with a power driven road roller to the satisfaction of the Engineer. Temperature of bitumen and aggregate mix at the time of starting of rolling should not be less than 130°C.

#### **3.15.4 Measurement**

Premix bituminous seal coat shall be measured in square metres completed and accepted by the Engineer. Measurement shall be based upon the nominal width of seal coat at its top surface as shown on the Drawings or as directed by the Engineer. The measurement will be exclusive of prime coat. Mean of the three measurements of thickness taken in any 100 metre long section shall at least equal to or more than the required thickness.

#### **3.15.5 Payment**

The quantities measured as provided above shall be paid for at the contract unit shown below. The price and payment shall be full compensation for supplying, placing and compacting all materials, for all labour, equipment, tools and incidentals necessary to complete the work.

Pay item shall be:	<b><u>Unit</u></b>
7mm premix bituminous seal coat	Square metre

### **3.16 PREMIX BITUMINOUS SEAL COAT 12MM THICK**

#### **3.16.1 Description**

The work shall consist of a premix bituminous seal coat applied to a prepared and primed granular base course or over bituminous surfacing in accordance with these Specifications or as directed by the Engineer. The thickness of the premix bituminous seal coat shall be 12mm.

#### **3.16.2 Materials**

##### **3.16.2.1 Bituminous Material**

Bituminous material shall be of 60/70 or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM/AASHTO.

### 3.16.2.2 Aggregate

The course aggregates shall consist of 10mm down graded stone or gravel free from any organic matter, clay and any other objectionable matter.

Where required to achieve the specified grading the aggregate shall be mixed with natural sand. Sand shall be non-plastic, clean and free from any deleterious substances. The F.M of sand for the sealing premix shall be between 2.00 and 2.50. The F.M of sand to be spread over the seal coat as blotting material shall be between 0.80 and 1.00

### 3.16.2.3 Overall Aggregate Grading

The mix of the aggregates and sand combined shall comply with the following grading given in Table 3.16.1

**Table 3.16.1**

**Grading Requirements for 12mm Premix Bituminous Seal Coat**

<b>Sieve Size</b>	<b>Percentage by Weight Passing Sieve</b>
<b>10mm</b>	<b>100</b>
6.3mm	80-100
4.75mm	70-95
2.4mm	20-50
600 micron	5-15
75 micron	2-10

### 3.16.3 Construction Methods

Prior to heating the aggregate and sand shall be mixed together to give a stockpile of mixed aggregate of the required grading in sufficient quantity for at least one day's surfacing work.

Bitumen and aggregates shall be heated separately at the following temperatures:

Only Bitumen	:	between 140°C to 155°C (Max)
Only Aggregate	:	between 150°C to 170°C
Mix of Bitumen & Aggregate	:	between 140°C to 160°C

Material that has been over-heated at any time shall be rejected. No mixing of pre-heated bitumen and aggregate should be done on fire. 0.016M<sup>3</sup> of pea gravel will be mixed with 1.40 litre of bitumen and shall be laid on 1 (one) square metre of road surface.

The mixture shall be laid to a uniform thickness which shall be at least 25% greater than the compacted thickness and immediately compacted fully with a power driven road roller to the satisfaction of the Engineer.

### 3.16.4 Measurement

The premix bituminous seal coat shall be measured in square metres completed and accepted by the Engineer. Measurement shall be based upon the nominal width of seal coat at its top surface as shown on the drawings or as directed by the Engineer. The measurement will be exclusive of prime coat.

### 3.16.5 Payment

The quantities measured, as provided above, shall be paid for at the contract unit shown below. The price and payment shall be full compensation for supplying, placing and compacting all materials, for all labour, equipment, tools and incidentals necessary to complete the work.

Pay item shall be:	<b><u>Unit</u></b>
12mm premix bituminous seal coat	Square metre

## 3.17 BITUMINOUS SURFACE TREATMENT

### 3.17.1 Description

This work shall consist of application of bituminous binder material and cover aggregates over primed aggregate base course or over cleaned, prepared and accepted bituminous or concrete surface in accordance with these specifications and the lines, dimensions and cross-section shown on the drawing or as required by the Engineer. Specifications for application of bituminous surface treatment may be divided into the following categories:

1. Single Bituminous Surface Treatment (SBST)
2. Double Bituminous Surface Treatment (DBST)
3. Single Otta Seal. (SOS)
4. Double Otta Seal (DOS)

### 3.17.2 Single Bituminous Surface Treatment

#### 3.17.2.1 Materials

##### 3.17.2.1.1 Bituminous Materials

The binder material shall be of 60/70 or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM / AASHTO.

##### 3.17.2.1.2 Aggregate

Aggregate shall consist of clean, hard, dry, tough, sound, crushed stone or crushed gravel of uniform quality free from dust, clay, dirt and other deleterious matter and from excess of flat or laminated pieces. Crushed stone shall comply with BS 63 and gravel shall comply with BS: 1984.

Aggregate shall be of such a nature that, when thoroughly coated with the bituminous material proposed for the work, the coating will not be removed upon contact with water.

The aggregate, when tested shall have an Aggregate Impact Value not more than 30 and Los' Angeles Abrasion 40 and water absorption of not more than 2%. The flakiness index, as determined in accordance with BS: 812, shall not exceed 35%.

The size of stone chippings shall be in accordance with Table 3.17 (1)

**Table 3.17 (1)**

**Size Requirements of Stone Chippings for SBST**

SL. No.	Type of Construction	Nominal size of Stone Chippings	Specifications
1.	Single bituminous surface treatment	14mm	100 percent passing through 16 mm sieve and retained on 10 mm sieve

**3.17.2.1.3 Quantities of Materials**

The quantities of materials used for this work, shall in general, be within the range specified in Table 3.17 (2)

**Table 3.17 (2)**

**Quantities of Materials Required for one Square metre of Single Bituminous Surface Treatment**

SL. No.	Type of Construction	Stone Chippings		Bitumen
		Nominal Size	Quantity	
1.	Single bituminous surface treatment	14 mm	0.015 m <sup>3</sup>	1.2 to 1.4 Kg

The actual quantity of stone chips and bitumen will be decided on the basis of field trials.

**3.17.2.1.4 Stockpiling of Aggregates**

Stockpiling of aggregates will be permitted only where agreed by the Engineer. A separate stockpile shall be made for each nominal size of aggregate at each location.

The site of the stockpile shall be cleared of all vegetation and debris, graded and drained, and where the Engineer deems it necessary, the area shall be surfaced with an approved separation layer to keep the aggregate clear and clean without any contamination.

The bottom 5 centimeter layer of aggregate, or any contaminated aggregate, shall not be used in the work.

**3.17.2.2 Construction Methods**

**3.17.2.2.1 Weather and Seasonal Limitations**

The surface treatment work shall be carried out only when the atmospheric temperature in the shade is above 10°C. No bituminous material shall normally be applied when the material of the surface to be covered is damp, when the weather is foggy or rainy, or during dust storms.

#### **3.17.2.2.2 Preparation of Base**

The base on which surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross-sections in accordance with the drawings and as directed by the Engineer. Where the existing surface shows signs of fatting up, this shall be rectified.

The surface shall be thoroughly swept and scraped clean of dust and any other extraneous matter before the spraying of the binder. As necessary, the cleaning shall be done first with hard brushes, then with softer brushes and finally by blowing with a blower or wiping with clean sacks or gunny bags.

#### **3.17.2.2.3 Application of Bituminous Material**

Bitumen shall be heated between 140°C to 155°C and the specified quantity shall be sprayed on to the dry surface in a uniform manner preferably with the help of mechanical sprayers if available. In absence of mechanical sprayers, hand sprayers may also be used.

Excessive deposits of binder caused by stopping or starting spraying operations or through leakage or for any other reason shall be rectified before the stone chippings are spread.

#### **3.17.2.2.4 Application of Stone Chippings**

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly in the surface, preferably by means of a mechanical gritter or approved aggregate spreader, or otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure the uniform spread of chippings. The stone chippings shall be spread over the binder coat and initial rolling not later than 3 (three) minutes after application of the binder coat.

#### **3.17.2.2.5 Rolling**

Immediately after the application of the stone chippings, the entire surface shall be rolled with an approved smooth wheeled steel roller or with a pneumatic tyred roller having sufficient weight to embed the stone chippings into the bituminous binder layers. Rolling shall commence at the edges and progress towards the centre except in super-elevated portions where it shall proceed from the lowest level to the highest level. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface. In case of steel roller, it shall not be too heavy so that the aggregates are not crushed during rolling.

#### **3.17.2.2.6 Opening to traffic**

Traffic shall not be permitted to run on any newly surface dressed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases speed shall be limited to 16 km, per hour until the following day ( by speed breaker as an example or any other method approved by the Engineer.)

### 3.17.2.3 Measurement

Single bituminous surface treatments shall be measured in square metres of materials of the specified quantities provided, placed and accepted. Measurements shall be based upon the nominal width of the surface course at its top surface as shown in drawings and measured at site and the actual length measured horizontally along centerline of the surface of the road.

Priming on the aggregate base course shall be measured and paid separately.

### 3.17.2.4 Payment

The quantities measured for surface treatment shall be paid for at the contract unit price for the item listed below and as shown in the Bill of Quantities. The prices and payment shall be full compensation for furnishing and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the works.

Where defective work is corrected, or additives are used which have not been specified or ordered by the Engineer, no payments shall be made in respect of the extra work or materials used in excess of the quantities specified or ordered.

Pay item shall be:	<b><u>Unit</u></b>
Single Bituminous Surface Treatment (SBST)	Square metre

### 3.17.3 Double Bituminous Surface Treatment

#### 3.17.3.1 Materials

##### 3.17.3.1.1 Bituminous Materials

The binder material shall be of 60/70 or 80/100 penetration grade straight run bitumen complying with the requirements of ASTM / AASHTO.

##### 3.17.3.1.2 Aggregate

Aggregate shall consist of clean, hard, dry, tough, sound, crushed stone or crushed gravel of uniform quality free from dust, clay, dirt and other deleterious matter and from excess of flat or laminated pieces. Crushed stone shall comply with BS 63 and gravel shall comply with BS: 1984.

Aggregate shall be of such a nature that, when thoroughly coated with the bituminous material proposed for the work, the coating will not be removed upon contact with water.

The aggregate, when tested shall have an Aggregate Impact Value not more than 30 and Los Angeles Abrasion 40 and water absorption of not more than 2%. The flakiness index, as determined in accordance with BS: 812, shall not exceed 35%.

The size of stone chippings shall be in accordance with Table 3.17 (3)

**Table 3.17 (3)****Size Requirements of Stone Chippings for DBST**

<b>SL. No.</b>	<b>Type of Construction</b>	<b>Nominal size of Stone Chippings</b>	<b>Specifications</b>
1.	First coat of double bituminous surface treatment	14mm	1 00 percent passing through 16 mm sieve and retained on 10 mm sieve
2.	Second coat of double bituminous surface treatment	7 mm	1 00 percent passing through 1 0.00 mm sieve and retained on 5.00 mm sieve

**3.17.3.1.3 Quantities of Materials**

The quantities of materials used for this work, shall in general, be within the range specified in Table 3.17 (4)

**Table 3.17 (4)****Quantities of Materials Required for one Square metre of Double Bituminous Surface Treatment**

<b>SL. No.</b>	<b>Type of Construction</b>	<b>Stone Chippings</b>		<b>Bitumen</b>
		<b>Nominal Size</b>	<b>Quantity</b>	
1.	First coat of double bituminous surface treatment	14 mm	0.015 m <sup>3</sup>	1.2 to 1.4 Kg
2.	Second coat of double bituminous surface treatment	7 mm	0.008 m <sup>3</sup>	0.8 to 1.0 kg

The actual quantity of stone chips and bitumen will be decided on the basis of field trials.

**3.17.3.1.4 Stockpiling of Aggregates**

Stockpiling of aggregates will be permitted only where agreed by the Engineer. A separate stockpile shall be made for each nominal size of aggregate at each location.

The site of the stockpile shall be cleared of all vegetation and debris, graded and drained, and where the Engineer deems it necessary, the area shall be surfaced with an approved separation layer to keep the aggregate clear and clean without any contamination.

The bottom 5 centimeter layer of aggregate, or any contaminated aggregate, shall not be used in the work.



### **3.17.3.2 Construction Methods**

#### **3.17.3.2.1 Weather and Seasonal Limitations**

The surface treatment work shall be carried out only when the atmospheric temperature in the shade is above 100C. No bituminous material shall normally be applied when the material of the surface to be covered is damp, when the weather is foggy or rainy, or during dust storms.

#### **3.17.3.2.2 Preparation of Base**

The base on which surface dressing is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross-sections in accordance with the drawings and as directed by the Engineer. Where the existing surface shows signs of fatting up, this shall be rectified.

The surface shall be thoroughly swept and scraped clean of dust and any other extraneous matter before the spraying of the binder. As necessary, the cleaning shall be done first with hard brushes, then with softer brushes and finally by blowing with a blower or wiping with clean sacks or gunny bags.

#### **3.17.3.2.3 Application of Bituminous Material**

Bitumen shall be heated between 1400C to 1550C and the specified quantity shall be sprayed on to the dry surface in a uniform manner preferably with the help of mechanical sprayers if available. In absence of a mechanical sprayers hand sprayers may also be used. Excessive deposits of binder caused by stopping or starting spraying operations or through leakage or for any other reason shall be rectified before the stone chippings are spread.

#### **3.17.3.2.4 Application of Stone Chippings for the first coat**

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly in the surface, preferably by means of a mechanical gritter or approved aggregate spreader, or otherwise manually so as to cover the surface completely, If necessary, the surface shall be broomed to ensure the uniform spread of chippings. The stone chippings shall be spread over the binder coat and initial rolling not later than 3 (three) minutes of after application of the binder coat.

#### **3.17.3.2.5 Rolling**

Immediately after the application of the stone chippings, the entire surface shall be rolled with an approved smooth wheeled steel roller or with a pneumatic tyred rollers having sufficient weight to embed the stone chippings into the bituminous binder layers. Rolling shall commence at the edges and progress towards the centre except in super-elevated portions where it shall proceed from the lowest level to the highest level. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface. In case of steel roller, it should not be too heavy so that the aggregates are not crushed during rolling.

### 3.17.3.2.6 Application of the Second Coat of Surface Dressing

The second coat shall be applied immediately or within 15 days of laying the first coat as decided by the Engineer on the basis of field condition, and volume and type of traffic. The construction operations for the second coat shall be the same as described in clauses 3.17.3.2.3 up to 3.17.3.2.5.

### 3.17.3.2.7 Opening to traffic

Traffic shall not be permitted to run on any newly surface dressed area until the following day. In special circumstances, however, the Engineer may open the road to traffic immediately after rolling, but in such cases speed shall be limited to 16 km per hour until the following day ( by speed breaker as an example or any other method approved by the Engineer.)

### 3.17.3.3 Measurement

Double bituminous surface treatments shall be measured in square metres of materials of the specified quantities provided, placed and accepted. Measurements shall be based upon the nominal width of the surface course at its top surface as shown in drawings and measured at site and the actual length measured horizontally along centerline of the surface of the road.

Priming on the aggregate base course shall be measured and paid separately.

### 3.17.3.4 Payment

The quantities measured for surface treatment shall be paid for at the contract unit price for the item listed below and as shown in the Bill of Quantities. The prices and payment shall be full compensation for furnishing and placing all materials, including all labour, equipment, tools and incidentals necessary to complete the first coat and the second coat of the double bituminous surface treatment.

Where defective work is corrected, or additives are used which have not been specified or ordered by the Engineer, no payments shall be made in respect of the extra work or materials used in excess of the quantities specified or ordered.

Pay item shall be:	<b><u>Unit</u></b>
Double Bituminous Surface Treatment (DBST)	Square metre

### 3.17.4 Otta Seal

#### 3.17.4.1 Description:

Otta Seal, named after the name of Otta valley in Norway where it was first introduced is basically one of the methods of surface dressing. This work consists of one or two careful applications of bituminous material and covered with aggregate on prepared bituminous, concrete and aggregate base course surface in accordance with the specifications, lines, dimensions and cross-sections as shown on the drawings or as directed by the Engineer. When one application placed, the term "Single Otta Seal" shall apply; when two applications are placed the term "Double Otta Seal" shall apply.

### 3.17.4.2 Single otta Seal

#### 3.17.4.2.1 Bituminous Material

Bituminous material shall be of 80/100 penetration grade bitumen complying with the requirements of ASTM/ AASHTO. The binder has to be cut back by using the cutters, power paraffin and engine oil (SAE 30 grade) blended by the proportions of 10% and 8% respectively as percentage of total volume at blending temperature of the bitumen (maximum 140°C). If directed by the Engineer, trial should be carried out before application.

#### 3.17.4.2.2 Aggregate

Both natural gravel and crushed gravel or a mixture of both may be used. The maximum size of stone shall be 16 mm. Screening of aggregate shall be required to remove over size stones as well as excess of fines. The gradation of aggregate is given below.

Sieve (mm)	Dense % Passing	Coarse % Passing
19.0	100	100
16.0	79-100	77-100
12.5	61-100	59-100
9.5	42.100	40.85
4.750	19-68	17-46
2.360	8-51	1-20
1.180	6-40	0.10
0.600	3.30	0.3
0.300	2.21	0.2
0.150	1-16	0-1
75 micron	0-10	0-1

For light traffic (Less than 1 00 vehicles per day) gradation should be in the coarser side and at finer side for more than 100 vehicles per day. For roads carrying more than 200 vehicles per day., a blend of crushed and uncrushed aggregate at a ratio of 30/70 is preferable. The aggregate strength shall have a minimum dry 10% FACT strength value (ref. BSI 812) 70 kN or an ACV value (aggregate crushing value. ref. BSI 812) not more than 30. If crushed aggregate is used, the weighted Flakiness index shall be determined using 13.2 mm and 6.7 mm sieves and shall not exceed 30%.

#### 3.17.4.2.3 Preparation of Binder

The emptying of the 80/100 pen. bitumen from drums and into bitumen boilers shall be carried out under strict control. Any opened drum must be checked if water is present, and water removed before placed onto the bitumen boiler. Water in contact with hot bitumen will cause boil over and foaming, which may lead to a fire or an explosion. The bitumen boiler shall be equipped with a thermometer and gas or paraffin/diesel burners to control overheating of the bitumen.

Maximum heating temperature in bitumen boilers shall not exceed 130°C.

Required quantity of bitumen from the boiler should be loaded into the distributor by using the equipment designed for that purpose (filling hose and the filling valve). It is important to ensure that the bitumen level in the distributor is minimum 150 mm above the heating flue before the burner is operated.

The adding of cutter (power paraffin) and flux oil (engine oil) at the correct quantity shall follow the same procedure as for the bitumen and be added using the designed hose and valve and NOT through the manhole. The cutter shall be added first and followed by adding the flux oil.

The maximum temperature of the bitumen (80/100 pen) during the blending process shall NOT exceed 140°C.

To ensure a homogeneous mix of the components the blend shall be circulated for minimum ONE HOUR after all three components are filled into the distributor. The last 15 minutes before spraying the blend shall also be circulated through the spray bar. During the circulation time the binder is heated up to the required spray temperature of minimum 150°C and maximum 155°C. In general, blends should not be held at temperatures within the spraying range for periods exceeding 10 hours.

### **3.17.4.3 Construction Method**

#### **3.17.4.3.1 Preparation of the road base**

The preparation of the road base to be surfaced shall be in such a condition that a good bond between the base and the surfacing is achieved. The base shall be broomed free of sand, mud, excess dust or any other foreign matter. Places where lamination can be seen in the top base shall be removed and repaired. The brooming work shall preferably be carried out manually.

Water should be sprayed to dampen the entire road surface, but not cause the moisture content in the base to rise significantly or allow water to pond within the area to be sealed. If voids near the surface are filled with water, the surface shall be allowed to dry out by evaporation to a slightly damp condition.

Traffic can be allowed to pass during the preparation phase, but excessive speeding shall be avoided.

#### **3.17.4.3.2 Spraying of Binder**

Area to be sprayed shall be set out with a string line and shall be 20cm off verge of the spray. Prior to spraying, all the necessary arrangement for sealing shall be ensured. Three trays at staggered position shall be used to check the application rate. No priming is needed for Otta Seals. The application rate of binder shall be 2.1 to 2.5 litre/sqm which shall be decided by trial. A light spray of water in some cases may be required to develop a good bond between the base and the seal.

#### **3.17.4.3.3 Spreading of Aggregate**

The spreading of aggregate does not require any mechanical equipment, manually spreading of aggregate can be considered as appropriate. Aggregate shall be stockpiled with sufficient quantity at staggered intervals (left and right hand side of the road) of 10 metres or as seems to be appropriate. The spreading of aggregate shall

commence immediately after spraying of binder has started. The binder shall be covered with aggregate as quickly as possible. The spreading should be done in such a way that there are no areas left out with too little aggregate or no aggregate at all. Any such spots shall be covered with aggregate immediately.

A spray length of 1 00 metre at full sealing width shall be taken in one lift so that an immediate cover with aggregate and rolling operation can be started within 10 minutes after bituminous binder applied. The contractor shall arrange the following equipment required to carry out the sealing operation.

1. Bitumen distributor or a suitable hand spray machine with an arrangement of heating and mixing the cut back bitumen to the desired temperature.
2. Brush, broom/powerbroom and drag-broom capable of distributing the unevenly sprayed aggregate without disturbing the particles freshly bedded in the bitumen binder.
3. Pneumatic (5 Ton )Tyre Roller and steel roller. In the absence of pneumatic-tyred roller two half loaded trucks can be arranged.

If any initial occurrence of fatty spots, shall be blinded off with more aggregate and rolled. During spreading of aggregate care shall be exercised to apply the cover material a bit excessive in order to ensure proper covering. If the application is far in excess shall be broomed off about a week after since completion. All of the loose aggregate shall not be broomed off as the remaining aggregate plays an important role in forming the final surfacing.

#### **3.17.4.3.4 Rolling**

Immediately following the spreading of aggregate to the satisfaction of the Engineer, rolling shall commence (preferable within 10- minutes after spraying of binder) with preferably a pneumatic tyred roller or a steel roller followed by half to embed the chips in the bituminous binder. Before traffic is allowed to pass, the entire surfaced area shall be rolled minimum three times by the pneumatic roller. As the centre of the road has less exposure to traffic loading compared to the wheel path, the centre section of the surfacing shall be rolled more heavily during the initial rolling. Care shall be taken not to destroy the camber.

Rolling shall generally begin at the outer edge of surfacing and progress uniformly toward the centre except on super elevated curves where rolling shall begin at the lower edge and progress uniformly towards the higher edge. Consecutive roller passes shall generally overlap by about one third of the roller's width.

After days production is completed, rolling shall commence for the entire sprayed area with all rolling equipment available until sunset. The following day from noon time rolling shall be commenced again and be continued for the rest period of the day.

Excess of aggregates shall be broomed off not before one week since completion. The brooming of material shall be carried out in the morning. It is important not to broom off all aggregate as the remaining aggregate plays an important role in forming the final surfacing.

### 3.17.4-4 Open to Traffic

When the initial rolling is completed, commercial traffic could be allowed in the surfaced area. The speed of traffic shall be temporarily reduced to avoid the damage to the aggregate cover materials. Maximum speed limit of construction (but not less than 30-40 km/hour shall, therefore, be enforced during the first month after the speed breaker as an example or any other method approved by the Engineer.)

#### 3.17.4.5 Measurement

Ottoseal surface shall be measured in square metre for the surface completed and accepted by the Engineer. Measurement shall be based upon the nominal width at its top surface as shown on the drawings or as directed by the Engineer.

#### 3.17.4.6 Payment

Payment for the measured and accepted Ottoseal surface shall be at the contract price for the item listed below and as shown in the Bill of Quantities. Payment shall be the full compensation for the provision of all materials, labour, equipment and all other incidental including trial sections required to complete the work as specified or as directed by the Engineer.

Pay item shall be:	<b><u>Unit</u></b>
Single Ottoseal coat	Square metre

### 3.17.5 Double Ottoseal

#### 3.17.5.1 General:

The second seal should be applied after about one year or at least one rainy season of application of the first seal.

By delaying the second seal until after the first rainy season, any occurring failures or defects of the surfacing or pavement caused by the rain can be repaired before the second seal is applied. This will ensure a better short and long term performance of the surfacing.

The preparatory work before the sealing operation commences and the way it is constructed is similar to what is required for the first seal. The surface to be sealed has to be clean from any foreign matter, including droppings from animals, which will reduce the adhesion between the old and the new surfacing.

#### 3.17.5.2 Bituminous binder:

Bituminous binder shall be of 80/100 penetration grade bitumen complying with the requirements of ASTM/ AASHTO. The binder has to be cut back by using, the cutters, power paraffin and engine oil (SAE 30 grade) blended by the proportions of 10% and 8% respectively as percentage of total volume at blending temperature of the bitumen (maximum 140°C).

### 3.17.5.3 Aggregate:

Both natural gravel and crushed gravel or a mixture of both may be used. The maximum size of stone shall be 16 MM. Screening of aggregate shall be required to remove over size stones as well as excess of fines. The gradation of aggregate is given below.

Sieve (mm)	Dense % Passing	Coarse % Passing
19.0	100	100
16.0	79-100	77-100
12.5	61-100	59-100
9.5	42-100	40.85
4.750	19-68	17-46
2.360	8-51	1-20
1.180	6-40	0.10
0.600	3.30	0.3
0.300	2.21	0.2
0.150	1-16	0-1
75 micron	0-10	0-1

For light traffic (Less than 100 vehicles per day) gradation should be in the courser side and at finer side for more than 100 vehicles per day. For roads carrying more than 200 vehicles per day., a blend of crushed and uncrushed aggregate at a ratio of 30/70 is preferable. The aggregate strength shall have a minimum dry 10% FACT strength value (ref. BSI 812) 70 kN or an ACV value (aggregate crushing value. ref. BS[ 812) not more than 30. If crushed aggregate is used, the weighted Flakiness index shall be determined using 13.2 mm and 6.7 mm sieves and shall not exceed 30%.

### 3.17.5.4 Preparation of Binder:

The emptying of the 80/100 pen. bitumen from drums and into bitumen boilers shall be carried out under strict control. Any opened drum must be checked if water is present, and water removed before placed onto the bitumen boiler. Water in contact with hot bitumen will cause boil over and foaming, which may lead to a fire or an explosion. The bitumen boiler shall be equipped with a thermometer and gas or paraffin/diesel burners to control overheating of the bitumen.

Maximum heating temperature in bitumen boilers shall not exceed 130°C.

Required quantity of bitumen from the boiler should be loaded into the distributor by using the equipment designed for that purpose (filling hose and the filling valve). It is important to ensure that the bitumen level in the distributor is minimum 150 mm above the heating flue before the burner is operated.

The adding of cutter (power paraffin) and flux oil (engine oil) at the correct quantity shall follow the same procedure as for the bitumen and be added using the designed hose and valve and NOT through the manhole. The cutter shall be added first and followed by adding the flux oil.

The maximum temperature of the bitumen (80/100 pen) during the blending process shall NOT exceed 140°C.

To ensure a homogeneous mix of the components the blend shall be circulated for minimum ONE HOUR after all three components are filled into the distributor. The last 15 minutes before spraying the blend shall also be circulated through the spray bar. During the circulation time the binder is heated up to the required spray temperature of minimum 150°C and maximum 155°C. In general, blends should not be held at temperatures within the spraying range for periods exceeding 10 hours.

### **3.17.5.5 Construction Method:**

#### **3.17.5.5.1 Preparation of the road base**

The preparation of the road base to be surfaced shall be in such a condition that a good bond between the base and the surfacing is achieved. The base shall be broomed free of sand, mud excess dust or any other foreign matter. Places where lamination can be seen in the top base shall be removed and repaired. The brooming work shall preferably be carried out manually.

Water should be sprayed to dampen the entire road surface, but not cause the moisture content in the base to rise significantly, or allow water to pond within the area to be sealed. If voids near the surface are filled with water, the surface shall be allowed to dry out by evaporation to a slightly damp condition.

Traffic shall be allowed to pass during the preparation phase, but excessive speeding shall be avoided.

#### **3.17.5.5.2 Spraying of Binder**

Area to be sprayed shall be set out with a string line and shall be 20cm off verge of the spray. Prior to spraying, all the necessary arrangement for sealing shall be ensured. Three trays at staggered position shall be used to check the application rate. No priming is needed for Otta Seals. The application rate of binder shall be 2.1 to 2.5 litre/sqm for the 1st layer.

For the 2nd layer application rate of binder shall be 1.8 to 2.2 litre/sq.m. Both the spray rates shall be decided by trials.

#### **3.17.5.5.3 Spreading of Aggregate**

The spreading of aggregate does not require any mechanical equipment, manually spreading of aggregate can be considered as appropriate. Aggregate shall be stockpiled with sufficient quantity at staggered intervals (left and right hand side of the road) of 10 metres or as seems to be appropriate. The spreading of aggregate shall commence immediately after spraying of binder has started. The binder shall be covered with aggregate as quickly as possible. The spreading should be done in such a way that there are no areas left out with too little aggregate or no aggregate at all. Any such spots shall be covered with aggregate immediately.

A spray length of 100 metre at full sealing width shall be taken in one lift so that an immediate cover with aggregate and rolling operation can be started within 10 minutes after bituminous binder applied. The contractor shall arrange the following equipment required to carry out the sealing operation.



1. Bitumen distributor or a suitable hand spray machine with an arrangement of heating and mixing the cut back bitumen to the desired temperature.
2. Brush, broom/powerbroom and drag-broom capable of distributing the unevenly sprayed aggregate without disturbing the particles freshly bedded in the bitumen binder.
3. Pneumatic 5 ton Tyre Roller and steel roller. In the absence of pneumatic-tyred roller two halfloaded trucks can be arranged.

If any initial occurrence of fatty spots, shall be blinded off with more aggregate and rolled. During spreading of aggregate care shall be exercised to apply the cover material a bit excessive in order to ensure proper covering. If the application is far in excess shall be broomed off about a week after since completion. All of the loose aggregate shall not be broomed off as the remaining aggregate plays an important role in forming the final surfacing.

#### **3.17.5.5.4 Rolling:**

Immediately following the spreading of aggregate to the satisfaction of the Engineer, rolling shall commence (preferable within 10 minutes after spraying of binder) with preferably a pneumatic tyred roller or a steel roller followed by half loaded 5-ton trucks to embed the chips in the bituminous binder. Before traffic is allowed to pass, the entire surfaced area shall be rolled minimum three times by the pneumatic roller. As the centre of the road has less exposure to traffic loading compared to the wheel path, the centre section of the surfacing shall be rolled more heavily during the initial rolling. Care shall be taken not to destroy the camber.

Rolling shall generally begin at the outer edge of surfacing and progress uniformly toward the centre except on super elevated curves where rolling shall begin at the lower edge and progress uniformly towards the higher edge. Consecutive roller passes shall generally overlap by about one third of the roller's width.

After days production is completed, rolling shall commence for the entire sprayed area with all rolling equipment available until sunset. The following day from noon time rolling shall be commenced again and be continued for the rest period of the day.

Excess of aggregates shall be broomed off not before one week since completion. The brooming of material shall be carried out in the morning. It is important not to broom off all aggregate as the remaining aggregate plays an important role in forming the final surfacing.

#### **3.17.5.6 Open to Traffic:**

When the initial rolling with the pneumatic roller is completed, commercial traffic could be allowed in the surfaced area. The speed of traffic shall be temporarily reduced to avoid the damage to the aggregate cover materials. Maximum speed limit of 30-40 km/hour shall, therefore, be enforced during the first month after construction ( by speed breaker as an example or any other method approved by the Engineer.)

**3.17.5.7 Measurement:**

Otta seal surface shall be measured in square metre for the surface completed and accepted by the Engineer. Measurement shall be based upon the nominal width at its top surface as shown on the drawings or as directed by the Engineer.

**3.17-5.8 Payment:**

Payment for the measured and accepted Otta Seal surface shall be at the contract price for the item listed below and as shown in the Bill of Quantities' ' Payment shall be the full compensation for the provision of all materials, labour, equipment and all other incidental including trial sections required to complete the work as specified or as directed by the Engineer.

Pay item shall be:	Unit
Double Otta Seal coat	Square metre