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## SECTION 0

### SITE CLEARING, GRUBBING AND SETTING OUT OF WORKS

0.01 **DESCRIPTIONS:**

This section of specification shall consist of removal from the specified depth, grubbing and disposal of all surface objects, stumps, roots, bushes and trees with less than 150 mm girth, vegetation, logs, rubbish and other objectionable material except such objects as are designated to remain or are to be removed in accordance with other section of specification, and as directed by the Engineer.

0.02 **SCOPE OF WORK**

The work covered by this section of specifications consist of furnishing all labour, necessary equipment, services, miscellaneous and necessary items required to satisfactorily complete the clearing, grubbing and setting out of the works, as indicated on drawings, specified herein or both.

0.03 **CLEARING**

Clearing shall consist of cutting, or trimming of trees, if any, and the satisfactory disposal of tree and other vegetation designated for removal, together with the timber snags, bushes, and rubbish occurring within the area. Trees, other vegetation stumps, roots, and bushes in area to be cleared shall be cut off flush with or below the original ground surface except such individual trees, group of trees and vegetation as may be indicated on the drawing or designated by Engineer or his Representative to be left standing. Individual trees and other vegetation, to be left standing shall be thoroughly protected from damage during construction operation, by erection of barriers or by such other means as the circumstances require and as approved by the Engineer or his Representative. Clearing operation shall be conducted in a manner that existing structures and installations under construction, employees and others remain safe.

0.04 **GRUBBING**

Grubbing shall consist of the removal and disposal of all stumps, roots and matted roots in the designated grubbing areas. Stumps, roots, logs and timber and other debris, shall be excavated and removed to a depth not less than 2 feet below any sub-grade level. In areas where the cut is over 3'-6" grubbing shall not be necessary.

0.05 **DISPOSAL OF DEBRIS**

Timber and other refuse to be disposed off by burning shall be burned at location, approved by the Engineer or his Representative, in a manner that will avoid all hazard such as damage to existing structures, construction in progress, trees and vegetation. The contractor shall be responsible for compliance with all pertinent laws and regulations pertaining to the burning of fire. Disposal by burning shall be kept under constant attendance, and residual, until materials will not be permitted to be

pushed or placed on the adjacent areas without written approval of the owner/owners. The stones and concrete shall be broken and removed from the site for receiving the structure/flooring where required. All debris shall be disposed off by the Contractor as directed by the Engineer.

#### 2.06 **SETTING OUT OF WORKS**

The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the direction, levels, dimension and alignment of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall, at his own expense, rectify the error to the satisfaction of the Engineer. The Contractor shall construct accurate benchmarks so that the lines and levels can easily be checked by the Engineer.

#### 0.07 **DRAINAGE DITCHES**

The Contractor shall construct and maintain such ditches, in addition to those shown on drawings or as may be ordered by the Engineer to adequately drain and areas under construction.

#### 0.08 **PAYMENTS**

Payment for all the items under this section shall be made at the rate entered in the BOQ as appended to the contract and in accordance with the applicable conditions of the contract

## SECTION – 1

### GENERAL

1. This General Specification is to be taken as applying to all the works in this Contract unless otherwise specifically mentioned elsewhere. Figured dimensions on the working drawings shall be followed in preference to the scale.
2. Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality new and un-used and where not otherwise specified shall be according to latest engineering practice and conforming to Pakistan Standards (PS) or British Standard Specifications (BSS) or Standard of American Society of Testing Materials (ASTM). The Engineer or the Consultants may also supplement such specifications during the progress of work based on standard International Practice.
3. All materials and goods used for such and other items shall be subjected to standard testing and if found below the specified standard such as PS or BSS or ASTM or their equivalent shall be removed from the immediately at Contractor's own expense. All testing of materials finished and unfinished, shall be carried out by the Contractor at his cost, in the presence of Engineer or Engineer's Representative for which the Contractor shall make any other additional arrangement to the satisfaction and convenience of the Engineer. The Contractor shall include testing charges in his quotations and shall not be entitled to any reimbursement on this account.
4. The Contractor must give early attention to the submission of samples of materials for approval of the Engineer, indicating the names of the manufacturing firms, especially of pipes, fittings, valves, meters, cement, source of sand, aggregates, steel, and all fittings to be embedded. Whenever required samples shall be submitted at least three weeks before it is proposed to use the materials. Until and unless specified otherwise, whenever materials are ordered to be forwarded to a testing laboratory approved by the Engineer for checking / testing, the Contractor will bear the cost of fees for such tests. The Contractor shall indicate the name and address of factory from where he intends to get pipes manufactured and submits manufacturer's catalogues for valves, fittings, and water meters with his tender.
5. The Contractor must take all steps necessary to prevent damage or interference with all services such as road, water, electric power, fuel, telephones, drains, buried cables and any construction designed for the use of the public, government or semi government authorities or the Employer. The Contractor shall be responsible for any damage caused to such services or constructions and settle and make payment for all claims in respect of such damage.

6. The Contractor shall protect from damage or injury by covering all work, internally and externally needing protection including new concrete, block work / stone work, surface renderings, floors, etc., to the satisfaction of the Engineer.
7. The whole work shall be carried out in the best manner in accordance with the instructions contained in these documents and those given by the Engineer from time to time during the progress of the work. The work shall be carried out in conformity with the best standard construction practices preferably the British Codes of Practices.
8. The Contractor shall submit to the Engineer for his approval before beginning the work, a complete plan of the proposed sequence and methods of operations for the execution of the works.
9. Orders and directions may be given orally by the Engineer or his Representative, and shall be received and promptly obeyed by the Contractor or his Representative or any superintendent or foreman or any supervisor of the Contractor who so ever may have charge of the particular part or section of work in relation to which the orders or directions are given, and a confirmation in writing of such order or directions will be given to the Contractor by the Engineer within seven days. The Contractor shall provide and maintain at his own expense, during the performance of the work, an office in the vicinity of work, where he or his authorized representative shall be present at all times. Orders or directions, written or oral, from the Engineer or his Representative delivered at such office shall be considered as delivered to the Contractor.
10. The Contractor shall construct suitable office for Consultants and Client staff. This office shall comprise of a room of size 5m x 4m with attached wash room and provided with suitable furniture. The Contractor shall provide maintenance service for Consultants office including lighting and water for wash room and daily cleaning. The Contractor shall submit a detail drawing of office along with list of furniture and fitting in his tender.

## **11. PAYMENT**

Contractor shall not be entitled to any separate or additional payment on account of these entire general requirements and any other arrangement or action unless otherwise provide in the BOQ Contractor has to undertake, under the direction of the Engineer, for a proper carrying out of the works and meeting all obligations of the Contract.

## **12. INTERPRETATION**

- 12.1** The clause headings in these specifications shall not be deemed to be part thereof or to be taken into consideration in the interpretation or construction thereof or of the Contract.
- 12.2** Any clauses in these specifications, which relate to works or materials not required, shall be deemed not to apply.
- 12.3** Where this general specification contains any amendments, implications, etc. to subsequent sections of the specifications, the General Specification shall be deemed to apply in cases of conflict.

## **13. AUTHORITY'S LETTERS**

The Authority referred to in this specification shall be KDA unless specified otherwise.

## **14. CLIMATE**

The climate of the district is on the whole moderate. The months of May and June are very hot during the day with maximum and minimum temperatures of 41<sup>0</sup>C and 26<sup>0</sup>C. This follows by an abrupt falls in temperature during night with pleasant breeze, which makes night comfortable. December and January are the coldest months with maximum and minimum temperatures of 25<sup>0</sup>C and 9<sup>0</sup>C. Sometimes cold winds from Balochistan make the winter severe. Humidity varies, highest about the end of August which is much less in May when the air is uncomfortably dry. Fogs are common in the cold season.

The district lies in rain shadow area. Heavily laden south west monsoon clouds, rising from the Arabian Sea pass over this area without any shower, except occasional showers in the month of July. In winter, the district gets some rain from the cyclonic winds blowing from the Persian Gulf.

## **15. BRIEF DESCRIPTION OF WORKS**

The works under this Contract comprise of Revamping of Gujjar Nala including Services Roads according to the drawings and specifications and as per terms and conditions of contract.

## **16. KDA LOCATION AND ACCESS**

As per related plans and drawings in Volume VI of Tender Documents.

## **17. LEVELS AND REFERENCE POINTS**

The levels shown on the drawings are related to survey of Pakistan. The contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the direction, levels, and dimensions and for the alignment of all the components of the works. If at any time any error in this respect shall appear during the progress of work, the contractor shall at his own expense, rectify the error to the satisfaction of the Engineer or his representative(s). The contractor shall construct accurate benchmark so that the Engineer's representative can easily check the lines and levels.

## **18. DRAWINGS**

These specifications shall be read in conjunction with the drawings given in volume III of the tender documents. In case of errors or mistakes or any thing missing if required so shall be as decided by the Engineer.

Before proceeding to make preparation for fabrication, execution, and erection of any fittings and other details of any temporary or permanent works scaffolding, railings, shuttering, doors and windows, iron mongery works etc., the Contractor shall be under obligation to prepare and submit all detailed shop drawings for the approval of the Engineer before doing any or all of that described above or directed. KDA Karachi shall have the right to require the Contractor to make any change in the design, which may be necessary in the opinion of the Engineer to make the material or equipment conform to the requirement and intent of these specifications without any additional cost. Approval of Contractor's drawings shall not relieve from any part of his obligation to meet all the requirement of the specification or correctness of their drawings.

## **19. MATERIAL'S MAKE, STANDARDS AND REGULATIONS**

- 19.1** Until and unless specified otherwise, all goods and materials are to be Pakistan manufactured and to be of the best quality.
- 19.2** All reference to standards throughout these specifications shall be deemed to refer the latest current edition at the date of tender, unless a particular edition has been referred to in the Specification.
- 19.3** All materials and equipment shall comply with the appropriate standard published by the British Standard Institution, Pakistan Standard Institution, and American Society of Testing Materials or with an acceptable International Standard. The Engineer may also supplement such specification during the progress of work based on Standard International Practice.

- 19.4** Alternative International Standards will only be acceptable if found equal to or better than the relevant British or Pakistan or American Standard. Two copies of each alternative standard, all in English, must accompany any request by the Contractor for approval of alternative International Standards.

## **20. UNITS OF MEASUREMENTS**

- 20.1** The units shown in these specifications are in MKS. Units unless specified otherwise.
- 20.2** All gauges and instruments shall be calibrated in S.I. Units unless specified otherwise. Equipment and pipe work shall be designed in MKS. Units unless as decided by the Engineer.

## **21. WATER, ELECTRICITY SUPPLY, GAS AND OTHER UTILITIES**

- 21.1** The contractor shall make his own arrangements with regard to the supply of water and electricity as required by him for the purpose of Revamping of Gujjar Nala including Services Roads The Contractor shall apply for water connection direct to concerned authorities of KDA and it shall be his responsibility to obtain water connection from directly to authority under their prevailing terms and conditions. At the end of contract period, the Contractor shall arrange at his own risk and costs and shall furnish NO DUES CERTIFICATE (s) at the time of his final bills failing which the amount due shall be ascertained at his risks and costs by the Engineer and liable to be recovered from any money due to be paid to the Contractor. For electricity use for the Contractor's offices and during construction, the Contractor shall make his own arrangements and furnish NO DUES CERTIFICATE(s) from concerned authorities at the time of his final bills failing which the Engineer shall take necessary action as detailed above in respect of water supply dues. Similar procedure shall be adopted in case(s) of Gas Supply and other utilities.

## **22. PROGRESS REPORTING**

On or about the first working day of every month, the Contractor shall furnish Six Copies of Monthly Progress Report along with Photographs to the Engineer with the following information:

Activities completed since the last report on the Performa as prescribed by the Engineer. The progress report in general shall contain changes in Contract programme if any, Parts of the work ready to be tested, inspected or commissioned prior to hand over.



**23. ACCESS ROADS, FOOT PATHS ETC**

The Contractor shall provide & maintain reasonable & safe access to the site, vehicular accesses to commercial and residential properties, footpaths etc. affected by the work in progress under the Contract. All such access shall be kept clear of Contractor's construction materials, machinery, equipment tools and plants as well as any debris to provide complete 'right of way' to the public, pedestrians and vehicles including vehicles of supervisory staff engaged on work at the .

**24. DEMOLITION AND DISMANTLING OF THE EXISTING WORKS**

The Contractor shall obtain the prior approval of the Engineer before proceeding with demolition of existing works like sewer, manholes and culverts etc.

**25. CONSTRUCTION OF NEW CONCRETE STRUCTURES**

The Contractor shall submit his proposals including drawings showing formwork arrangement and position of construction joints to the Engineer for approval at least 7 days before execution

**26. FLOATATION**

The contractor is reminded that, fulfilling his obligations as to the care of the works in accordance with clause - 20 of the conditions of contract, Vol I he shall take all necessary precautions against floatation of structures and pipe works.

**27. WORKS IN THE VICINITY OF RAILWAYS, HIGHWAYS, WATER COURSES AND OTHER EXISTING STRUCTURES AND SERVICE LINES**

Any works crossing or having effect on railway property public highway watercourse and other existing structures shall be subject to the approval of the Engineer and the concerned competent authority.

**28. PROGRAM**

The Contractor shall submit along with his tender, his construction program, arrangement for dewatering, details of side supports for Concrete structure and trenches and Method Statement of Construction along with proposed sequence and methods of Operation for the execution of work.

**29. TESTS**

- 29.1** All materials and goods used for such and other items shall be subject to standard testing methods. If any item found below the specified standard shall be replaced immediately at Contractor's own expenses.

- 29.2** All reasonable facilities and assistance including access to drawings and production data shall be furnished when needed during the inspection at Contractor's or manufacturer's works or anywhere.
- 29.3** All testing of material items in finished or unfinished state if required shall be carried out by the Contractor at his cost in the presence of Engineer's Representative(s) for which the Contractor shall make all additional arrangements to the satisfaction and convenience of the Engineer. The Contractor shall construct a reasonably equipped laboratory at site area of work as instructed by the Engineer. The Contractor shall provide all machinery equipment, supply of Chemical, operate and maintain the laboratory besides employing competent and efficient staff up to the satisfaction of the Engineer to facilitate timely testing to expedite the progress of the works under Contract. The Contractor shall include testing charges in his tendered rates and shall not be entitled to any reimbursement on this account for testing other than permitted so.
- 29.4** The Contractor is required to submit the samples of materials required by the Engineer for approval. The Contractor shall indicate the name of manufacturing firm of cement, steel, pumping machinery, pipes, valves, fittings and sources of aggregates etc. to be used. Whenever required the samples shall be submitted at least three weeks before materials are proposed to be used. Until and unless specified otherwise whenever materials are ordered to be forwarded to a testing laboratory approved by the Engineer for check and testing. The Contractor will bear all cost for transport, lodging, boarding and reasonable daily expenses on visit by Engineer and his Representative(s) for inspection any goods materials, machinery, pipes, etc. at the place or country of manufacture. The Contractor shall quote separate unit rates for each of the aforesaid items in the BOQ of the particular Contract of work under the project at the time of tendering without fail.

Sampling for testing of materials at site shall be carried out as per standard sampling procedure to the satisfaction of the Engineer or his representative(s).

### **30. TEST CERTIFICATES**

- 30.1** When tests are carried out up to the approved appropriate standard the Contractor shall furnish to the Engineer such Test Certificate (in quadruplicate).
- 30.2** The Certificates shall display inter alia the date of each test location of each test and the results of each test together with the applicable limits defined in the standard. The certificates shall indicate as to whether in the manufacturer's opinion, the items have passed the test(s) satisfactorily or not. However the Engineer's or his representative's decision shall be final.

- 30.3** For Test which the Engineer or his representative(s) copies of the test records duly signed by the manufacture and the Engineer have witnessed or their representatives shall be appended to the test certificate.

### **31. FILL**

i) **Fill – Granular**

- ia) Granular fill material shall comprise well graded gravel or crushed rock and lie within the following grading limits.

<b>BS SIEVE SIZE</b>	<b>PERCENTAGE PASSING BY WEIGHT</b>
75 mm	100
37.5mm	85 - 100
10mm	45 - 100
5mm	25 - 85
600 microns	8 - 45
75 microns	0 - 10

- ib. The particle size shall be determined in accordance with the requirements of BS 812: Part 103 and BS 1377.

- ic. The material passing the BS Sieve size 250 microns, when tested in Accordance with BS 1377 shall be non-plastic.

ii) **Fill Selected**

Selected fill shall comprise uniform, readily compactable material free from organic materials tree roots, vegetable matter, salts, building rubbish and excluding clay lumps retained on a 75 mm sieve, stones retained on a 25 mm sieve, and shall be selected from the excavated material. Where the Engineer orders material to be obtained from other sources such material will be classed as imported selected fill.

### **32. GROUT**

- 32.1** Cement grout shall be made from either ordinary or sulphate resistant Portland cement as used for the structures with the minimum amount of water added to give the required degree of fluidity.

- 32.2** No sand or other materials shall be added except for grouting in holding-down bolts, etc when sufficient sand, graded in accordance with Table 1 of BS 1200, and an approved water reducing mixture complying with BS 5075: Part 1, to reduce shrinkage.

### **33. JOINT SEALING COMPOUNDS AND SEALANTS**

- 33.1** Joint sealing materials shall be of approved manufacture and supplies delivered fresh with adequate shelf life to meet contract requirements.
- 33.2** Joint sealing compounds shall be impermeable ductile materials of a type suitable for the conditions of exposure in which they are to be placed, capable of providing a durable, flexible and watertight seal by adhesion to the concrete throughout the range of joint movement.
- 33.3** All poured joint sealants shall comply with BS 2499, ordinary Type A-1 sealant.
- 33.4** Cold poured polymer-based joint sealants shall comply with BS 5212, Normal Type N Sealant.
- 33.5** Two-part poly sulphide-based sealants shall comply with the relevant provisions of BS 4254. Pouring Grade shall be applied to horizontal upward-facing and Gun Grade to joints of any other aspect or inclination. Other two-part polymer-based sealants of Gun or Trowel Grade shall comply with the physical and test requirements of BS 4254.
- 33.6** Silicon based building Sealants shall comply with the relevant provisions of BS 5889.
- 33.7** Polyurethane-based sealants shall comply with a specification of an approved manufacturer.
- 33.8** Primers for use with joint sealants shall be compatible with, and obtained from the same manufacturer as, the adjacent sealant. Primers shall have no harmful effects on concrete.
- 33.9** Sealants and primers, which will be in contact with water to be used for potable supply, shall not impart to water taste, colour, or any effect known to be harmful to health and shall be resistant to bacterial growth.
- 33.10** Sealants and primers, which will be in contact with sewage or sewage sludge, shall be resistant to biodegradation.

### **34. JOINT FILLER-PERFORMED**

- 34.1** The material comprising the joint filler shall be of such quality that it can be satisfactorily installed in position at the joint.

**34.2** Adhesives used to retain performed joint fillers in place during construction shall have no harmful effects on concrete, and, except for those used in connection with softwood fillers, shall be obtained from the same manufacturer as the joint filler.

**34.3** Performed filler for joints in structures to retain aqueous liquids shall consist to cork granules, bound together with bitumen or synthetic resin.

## **35. CEMENT MORTAR**

**35.1** Cement for mortar shall be ordinary Portland Cement except for sub structure, brickwork in manholes, chambers, pond division walls, substructures etc, where Sulphate Resisting Cement shall be used or except otherwise specified. Sand for mortar shall be as described in BS 1200 Table-1.

**35.2** Colouring agents and plasticizers shall not be used without the approval of the Engineer.

**35.3** Cement mortar to be used for plaster and masonry work shall be 1:4 or as specified.

## **36. PIPES AND FITTINGS**

### **36.1 RCC PIPES.**

Pipes shall be of RCC manufactured in SR cement from approved pipe factory. The pipes shall conform in all respects to ASTM C-76/ BS 5911. The thickness of barrel of pipe shall be 30% more than the thickness proposed in ASTM C-76 for the same internal diameter of pipe. The pipes shall be socketed for push on rubber joints. The Contractor shall submit with his tender a detailed sketch of R.C.C. pipe with statement indicating details of socketed joints and also details of reinforcement including numbers and diameter of horizontal and spiral bars for each diameter of pipe. Conforming the requirements All R.C.C. pipes shall be manufactured to S.R cement.

The Contractor shall supply the required number of rubber rings of size and dimension suitable for the diameter of pipe provided for making a fully watertight joint. The rubber ring shall comply in all respect with BS 2494 or equivalent, approved by the engineer.

### **36.2 UPVC PIPES.**

Upvc pipes for water supply manufactured from approved pipe factory .The pipe shall confirm in all respect to BS 3505 and PS 3051:1991. The uPVC pipe jointing shall be cement solvent joint or Z-joint.The all uPVC fittings shall be used to match the uPVC pipe as per manufacturer detail.

The contractor shall provide the technical detail and brochures to the Engineer or Engineer's representative for approval.

### **36.3 HDPE PIPES.**

Polyethylene pipe for water supply manufactured from approved pipe factory. The pipe shall be confirmed in all respect to ISO 4427:1996. HDPE pipe for water supply applications DIN 8074 / 8075 and PS-3580:1994. The PE pipe must confirm SDR-17 and PN-8.

The HDPE fitting shall be compatible with ISO (or metric) Dimension pipe and confirm to the specifications. ISO 3458, 3459, 3501, 3503 and BS 5114. The Butt fusion method for jointing of HDPE pipes shall be used .Other method shall also be used after the approval of engineer. No payment shall be made to the contractor for jointing of the pipes by Butt fusion or compression fitting.

### **36.3 GRP PIPES**

All GRP pipes and fittings shall be manufactured in accordance to International Standards. The GRP pipe and fitting laminate shall consist of an inner chemical resistant layer and an outer structural layer.

All pipes shall be manufactured by filament winding process employing a dual helix angle winding pattern, using pre-stressed continuous glass roving's.

The filament wound pipe shall be made on a straight steel mandrel with only slight taper to facilitate demoulding of the pipe from the mandrel.

The inner chemically resistant layer shall be composed of either a vinyl ester Oerakane 411-45 or Repoxy R-802 cr, suitably reinforced. This inner layer shall have a minimum thickness of 2mm for pipes conveying water and 1 mm for pipes conveying clean water and the inner surface shall be reinforced with 'C' glass. The resin content by weight reducing from approximately 90% at the inner surface to 65% - 75% at the outer surface of the liner.

The outer structural layer shall be composed of an isophthallic resin reinforced with 'ECR' (electro corrosion resistant) glass rovings, for pipes conveying clean water as appropriate to give a final product of sufficient strength to meet the tensile and flexural requirements of the pipe. The exterior surface shall be relatively smooth with no exposed fibers or projections.

### **37. SHORT PIPE LENGTHS**

**37.1** Short pipes shall be supplied in specific lengths according to pipe diameter and as detailed on the Drawings and in the Bill of Quantities.

**37.2** Additional random short lengths of PVC lined concrete pipes of diameter less than 600mm will be necessary for completion of pipeline gaps between manholes where no cutting of pipes is permitted under normal circumstances.

### **38. ROAD MATERIALS**

- 38.1** The aggregate for base course and wearing course shall consist of clean durable crushed rock complying with the quality requirements of BS 4987 "Bitumen Macadam with Crushed Rock or Slag Aggregate".
- 38.2** Filler shall consist of crushed rocks, or other material approved by the Engineer, and least 75% of it shall pass a No. 200 BS Sieve. Filler shall be used, if required for compliance with the grading limit for aggregates in base or wearing courses or for surface application.
- 38.3** Bitumen for surfacing shall be of grade 80 / 100 penetration (BS 3690 Part (1) and shall have a known specific gravity and a known temperature / viscosity relation.
- 38.4** Bitumen for prime coat to base shall be of mix on (MC-0) or similar approved cut back bitumen.
- 38.5** Bitumen for tack coat to existing carriage ways prior to resurfacing shall be of Mix Composition (MC-1) or similar approved cut back bitumen.

### **39. SAND FOR MORTAR, RENDERING AND SCREEDS:**

- 39.1** Sand shall pass a 5mm (3 / 16") sieve and consist of disintegrated rock or crushed hard stone or gravel or a combination of these, graded in accordance with BS 1200: Table - 1, as follows.

BS SIEVE	% BY WEIGHT PASSING SIEVE.
5MM	100
No. 7	90-100
No. 14	70-100
No. 25	40-80
No. 52	5-40
No.100	0-10

- 39.2** Sands shall be washed and free from impurities such as sulphate and organic material incompatible with cement; clay or oil that reduce bonding qualities; material that will expand or shrink; organic matter that can decompose salts and substances that attract moisture; minerals that can cause staining of mortar.

- 39.3** Sands shall be tested regularly in accordance with BS: 812 part 103 to give a continuing proof of suitability. The presence of fine clay, silt and dust shall be limited to 5% by weight.

**40. DAMP PROOF COURSE**

DPC where required shall be provided are to be used as per direction of Engineer in accordance with the following specifications:

- 40.1** Damp Proof Courses shall be of hessian based bituminous sheeting weighing 4.3 kg per sqm. and conform to BS 743. The damp proof course shall be of the proper width to suit the walls.
- 40.2** Damp Proof Course of cement concrete class C (1:2:4) of 2 Inches (50 mm) thickness shall be laid on walls at plinth or at location shown in drawing. Pudlo or other waterproofing agent as approved by Engineer shall be mixed with concrete as per the manufacturer's direction and approved by the Engineer. The size of the coarse aggregate shall be limited to 3 / 4" to 3 / 16" (19mm to 4.8mm). The damp proof course shall be of proper width to suit the wall.

**41. MANHOLE COVER**

- 41.1** Mild steel frame and R.C.C. cover shall be made as per drawings.
- 41.2** Cover shall be fitted to matching frames and tested at the manufacturer's working. Each set (cover and frame) shall be similarly numbered in a legible and permanent manner. The marked position is not to be visible when fitted in place.
- 41.3** The Contractor shall ensure that the covers are fitted to the appropriately numbered frames after the frames have been fitted.
- 41.4** KW&SB clearly casted in the upper side of the covers in letters approximately 3 inches (75 mm) high.
- 41.5** Covers shall be lockable to the frame by means of an inside catch which is key operated.

**42. PAINTS**

- 42.1** The Engineer shall approve all brands of paint, under coat and other finishing material. Different brands of paint shall not be intermixed or interchanged on any surface.
- 42.2** All coating materials shall be supplied in container not greater than 5 litres capacity and labelled with the type of material manufacturer's batch number, date of manufacture and manufacturer's name brand name, formula and shall be mixed and applied in accordance with directions of the manufacturer.



- 42.3 Batch deliveries of coating material shall be dated for use in order of delivery, shall be stored in a dry area, protected from extreme temperature and shall not be used if more than 18 months old from date of manufacture.
- 42.4 All material shall be acceptable, proven top grade products and shall meet exceed the minimum standards of reputable manufacturer as approved by the Engineer.
- 42.5 Colors shall be pure, non-fading pigments mildew-proof, finely ground in approved medium. Colors used on plaster and concrete surfaces shall be lime proof. All materials shall be subject to Engineer's approval.
- 42.6 All emulsion paints and primers for metal work and walls will be the best available of its type. The Engineer prior to its procurement shall be approved the make and shade.
- 42.7 Approved quality of Cement wash paint shall be used for painting the exteriors of the structures or other surfaces as directed by the Engineer.
- 42.8 The plastic emulsion paint or similar as approved by the Engineer shall be used for interior surface.
- 42.9 Un slaked lime, gun and marine blue shall be used for white washing.
- 42.10 All material for bitumen painting shall consist of Bitumen PB-4 Grade 10/ 20. It shall be used for foundation or wherever recommended by the Engineer.
- 42.11 Approved quality, Epilac enamel paint shall be used for chemicals and water resistance where specified.
- 42.12 DUROCEM a cement base heavy-duty waterproof coating manufactured approved by the Engineer shall be used for painting on the surface specified. The cement base water proof coating for concrete shall conform to ASTM C-109, C-67, D-822 and G-23 Solvent for cleaning metal work prior to application of metallic lead primers to BS 2523 shall be as recommended by manufacturer.

#### **43. WATER PROOFING**

- 43.1 Cement, aggregate and coarse sand shall be in accordance with the Specifications
- 43.2 for "Concrete". Bitumen used for this purpose shall be as per B.S.S or P.S.
- 43.3 Samples of all materials proposed for use under this section shall be submitted to the Engineer for his approval.
- 43.4 Water Proof Building paper shall be grade B2 as per BS-1521.

#### **44. LADDERS - RUNG TYPE**

- 44.1 Steel ladder shall consist of specified size of M.S Plates in strings and 1" (25mm) dia. M.S Steel bars in rungs. The M.S Rungs shall be riveted and welded in 25mm dia. holes in Plates. The end of each climb of the ladder shall be embedded in the concrete.

- 44.2** Ladder shall be fixed using M 16 stainless steel bolts unless otherwise detailed.
- 44.3** Ladder shall be of integral or welded construction and shall comply with the requirements of BS 4211 for the spacing of stringers, rungs, safety hoops and hand holds unless otherwise detailed.
- 44.4** Ladders shall be made of mild steel and be hot dipped galvanized after manufacture.

## **SECTION – 2**

### **EXCAVATION, FILLING, BACKFILLING AND DISPOSAL**

#### **1. GENERAL EXCAVATION AND BACKFILLING**

The work covered by this section of the specifications consists of furnishing all plants, equipment, appliances, labour and materials in performing all operations in connection with excavating, filling and backfilling for all types of construction works including pipelines and other foundations complete in strict accordance with proper gradient, slope with top and bottom of trenches etc. as per specifications and drawings and subject to the terms and conditions of the Contract.

#### **2. EXCAVATION – GENERAL**

The Contractor shall remove the whole of the vegetation, top soil, concrete, flagging, paving, and curbing, road metalling and other materials from the site of any excavation and shall keep separately and preserve the same for reuse where applicable. The ground shall be excavated for the permanent and temporary works to the required depths, width and levels so that the dimensions of the permanent works shall not be less than as shown on the drawings or as may be directed by the Engineer.

All rubbish, filth and matter of an offensive nature taken out of any excavation shall be disposed off at once and not left on the surface within the site.

The major works for excavation involved in borrow pits indicated on drawings or otherwise proposed by the Contractor. The Contractor shall carry out the excavation in borrow areas for obtaining earth for construction of embankments. The Contractor shall provide necessary transport for excavated earth from the borrow areas to the site / location of embankment with means approved by the Engineer. The Contractor shall ensure that earth obtained from borrow areas is suitable for construction of embankments and shall not contain excess water. Excess water if any shall be removed by the Contractor through exposure to natural whether or through any other means approved by the Engineer. The borrow pits shall not be measured for accessing the quantity of earth required for excavation.

#### **3. EXCAVATION – PIPELINES / SUMP WELL**

- 3.1 The excavation shall be carried out to the required alignment, levels, slopes or gradients as per drawings or described in the specifications and bill of quantities taking into account bedding required below pipes or to such other dimensions and slopes as the Engineer may direct in writing to facilitate laying of pipes. The Contractor shall provide masonry pillars of suitable size and fix temporary benchmarks at intervals to be determined by the Engineer or his representative. No trench excavations shall be commenced without prior approval of the Engineer. Excavation shall proceed at the same rate of laying, jointing and backfilling.

- 3.2 The quantity of excavation shall be the volume of materials removed from below the original surface of the ground to the limits of excavation specified or shown on the drawings. For soft and unstable soils, the Contractor shall provide adequate side supports. The cost of supply of all material, plant and labor necessary for site clearance, excavation, over break, timbering, sheet piling, shoring, shuttering, refilling, watering and ramming etc. shall be included in the Contract rates for excavation. In case sides or ends of any excavation collapse under self-weight or due to any other reason, the Contractor shall at his own cost remove all disturbed material. Should sides or ends of any excavation give way, the Contractor shall at his own cost remove all disturbed material. Any excavation outside the limits shown shall be treated as excess and shall not be paid for.
- 3.3 Where the Contractor has excavated to depths in excess of the requirements, he shall refill and compact the excess excavation with 1:4:8 cement concrete up to the correct level at his own cost. Any excavation done in excess of specified width due to any reason whatsoever shall not be paid.
- 3.4 For excavation the width of the trench shall be equal to the external diameter of the pipe plus 450 mm up to pipe diameters not exceeding 200 mm.
- 3.5 Additional excavation will be necessary at all valves chambers, sump well and pipe welding joints to facilitate the making of joints. Additional excavation for construction of valve chambers and joint holes shall be of such dimensions as shown in the drawing, so as to give clear working space. The Contractor shall make allowance for the additional excavation required for the sump well and valve chambers in the price tendered for trench excavation. These shall not be separately measured or paid.
- 3.6 The length of the trench shall be measured along the centerline of the trench and the depth shall be measured vertically for original ground level to the average bed level.

#### **4. TIMBERING, SHORING AND BRACING**

##### **GENERAL**

- 4.1 The Contractor shall provide where required all shoring, supports etc., to the sides of excavation to prevent sliding or any movement. The timbering, shoring and bracing; shall be of adequate strength to withstand the pressure encountered and the Contractor shall be solely responsible for the losses due to collapse or failure of shuttering, bracing, shoring etc.
- 4.2 No payment for side support including shoring, shuttering or bracing or sheet piling shall be made. The Contractor's rate for excavation shall be deemed to include the cost of providing and removing side supports timbering, strutting and bracing with all connected operations.
- 4.3 The Contractor shall at all times support effectively the sides of the pipe trenches and other excavation by suitable timbering, shuttering etc.
- 4.4 Where required the contractor shall use close timbering in all loose or sandy or unstable strata both above or below ground level, if found necessary by the

Engineer and accord approval It is intended that all timbering and side supports for pipe trenches shall be removed as the work proceeds. The Contractor shall ensure that the removal of timbering and side support is done gradually and carefully to avoid any damage to existing or new structures, roads, pavements or any other private or public property. All timbering, sheeting and their supports shall be of adequate strength and dimension and full braced and strutted so that no collapse, subsidence or and damage to public or private property shall take place. The Contractor shall be solely responsible for the sufficiency put all timbering and their supports to be used an all damages to persons or property resulting from the improper quality, strength, placing, maintaining or removal of the same shall be payable by him under all circumstances.

## **5. PUMPING, BAILING AND DEWATERING**

- 5.1 The work covered by this section of Specifications consists of furnishing all plants, labour, materials, and equipment appliances for performing all operations for Pumping. Bailing Dewatering and Draining water from the areas, excavated for all works in this contract in accordance with this section of Specifications, and subject to terms and conditions of the contract.
- 5.2 The Contractor shall at all times during the progress of work remove any water from any source which may accumulate, inflow or be found in the trenches and other excavations made under the contract and shall, keep them entirely free from water at all time while excavating.
- 5.3 The Contractor shall keep excavations free form water at all time and provide adequate pumping plant including special dewatering equipment and means of disposing off the pumped water as directed by the Engineer In charge. The Contract shall ensure to keep away un-desired water from all sump clear of excavation and provide all necessary plant and equipment for dealing with any subsoil condition that may be encountered.
- 5.4 The work covered by this section of Specifications consists furnishing all plants, labour, materials, equipments are appliances for performing all operations for Pumping, Bailing Dewatering and Draining water from the areas, excavated and all other works in this contract accordance with this section of Specifications, and subject to terms and conditions of the contract.
- 5.5 If necessary for the construction of the works, the contractor shall lay-sub-drain where directed to convey the water to pumping sumps. The sub-drains shall be laid un-jointed with the invert not less than 300 mm below formation level of the permanent works and shall be covered with gravel to formation level.
- 5.6 Water pumped from the trenches shall be disposed off by the Contractor in a manner that will neither cause injury to the public health nor damage to the existing structures or the works completed or in progress or to the surface of any road or streets, nor cause any interference with the use of the same by the public.
- 5.7 The Contractor shall be held fully and wholly responsible for all damages done to structures or property resulting from his dewatering, pumping and all other connected operations. If he fails to make good or to pay the expenses of making

good damages with all practicable dispatch the Engineer shall be at liberty to get the work done by other means or to pay the cost of the said damages by deducting the amount from any money that may be or become due to the Contractor or may recover the same from the Contractor from his dues, as decided and found feasible by Engineer, the decision of Engineer will be final and contractor shall be liable to be bound.

## **6. FILL, BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION**

- 6.1 Fill where required to raise the sub-grade for concrete slabs shall be clean unadulterated local river sand and shall be free from wood, stones and other debris. Excavated material shall only be used for fill if approved by the Engineer or his representative.
- 6.2 All fill backfilling or earthwork in embankment shall be compacted by mechanical rammer, or other approved equipment in layers not more than 150 mm thick. Each layer shall be uniformly spread and fully compacted and shall have proper moisture content for the required degree of compaction that shall be done by mechanical tampers as approved by Engineer.
- 6.3 Backfill shall not be placed against walls etc., prior to the water proofing treatment if provided and approved by the Engineer. Backfill shall be brought up evenly on each side a wall as far as practicable. Heavy equipment for spreading and compacting backfill shall not be operated closer to tie wall than distance equal to the height of the backfill above the top of base slab footing. No back filling shall be done before the new structure has been cured for at least two weeks.

## **7. BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION**

- 7.1 The back filling of the trench shall be allowed after the sewer pipe has been laid and jointed over the specified bed, inspected, checked, tested and approved by the Engineer.
- 7.2 Backfilling of the trenches shall be carried out by filling half pipe level. The filling shall then be thoroughly rammed. More filling shall be carried out and rammed again until the consolidated filling reaches pipe top level. Only selected dry materials free from stones or debris shall be used for backfilling that shall be spread and rammed evenly across the trench. Thereafter, the trench shall be filled in layers not exceeding 150 mm in depth, each layer being properly rammed before the next layer is placed so that 95-100% compaction is obtained as per AASHO Standard.
- 7.3 On completion of backfilling, the Contractor shall level a grounds disturbed by him in the course of the work, spread t soil where necessary as directed by the Engineer.

#### **7.4 ROUGH GRADING**

Necessary rough grading if required shall be carried out by the Contractor to establish the finish grade as specified in the drawings or construction requirements of the site, or otherwise indicated shall have uniform levels or slop between points on existing and finished grades. Abrupt changes in slopes shall be rounded.

#### **8. COMPACTION**

- 8.1 Fill and/or backfill within the building or structure and for a distance of five (5) feet outside building or structure shall be compacted to a density of not less than 95% of the maximum density at optimum moisture as determined by 110 AASHO T-99.
- 8.2 Isolated boulders and rubble not exceeding 0.1 cubic meter in volume may be incorporated at the Engineer's discretion.
- 8.3 If any material after placing reaches a condition such that it cannot be thoroughly compacted the contractor shall either remove all of the material which is in unsuitable condition or improve the condition of the material by mechanical or chemical means.

#### **9. REMOVAL OF EXCESS AND UNDESIRABLE MATERIALS**

- 9.1 Excess and undesirable material from excavation not require for fill or backfill shall be disposed off, removed and/or deposited and levelled on the site where directed by the Engineer. Earth suitable and meant for backfill if required shall be stored at site in a manner not to interfere with the progress of construction works in progress.
- 9.2 The Contractor shall keep all excavated soil sprinkled with water during the excavation work so as to prevent any dust nuisance.
- 9.3 All surplus soil arising out of the work shall be carried away to approved site within a week, deposited and spread as directed by the Engineer.
- 9.4 The Contractor shall carry out the cutting of existing bituminous road as required for excavation for carrying out the work to the full depth of hard crust of any existing thickness. The stone metal soling etc. shall be separately stacked along the side of excavation for possible reuse.

#### **10. PROTECTION OF UTILITY SERVICES**

##### **10.1 DAMAGE TO SURFACE**

If carriage ways, verges or footways in roads whether paved or unpaved or gardens, plantations or other surfaces are damaged outside the limits of the excavations due to lack of proper traffic control or moving plant and equipment or other operations of the contractor then such surfaces shall be reinstated by the contractor at his own expenses. The surfaces shall be restored to their original condition using such materials as may be required whether obtained from the excavated materials or not.

## **10.2 MAINTENANCE OF TRAFFIC**

When the excavation is in roads care shall be taken to cause the least inconvenience to traffic. When directed or necessary for the maintenance of traffic, the contractor shall remove from the site all materials as excavated from the trenches and return the same as necessary for refilling after the structures have been completed or the pipes tested and approved.

## **10.3 CONTROL OF TRAFFIC ON ROADS**

The Contractor shall ensure that the flow of traffic over existing roads and access to properties is maintained at all times during the contract. The flow of traffic is to take place at all time over a reasonable surface that is to be segregated as far as possible from areas where work is progress.

## **11. MEASUREMENT AND PAYMENT**

- 11.1 All excavation shall be measured net and perpendicular and no allowance shall be made for any increase in bulk of the excavated material after excavation or for sloping sides, or widened trenches to accommodate formwork, shoring and bracing etc. Similarly the measurements for filling/backfilling shall be thoroughly compacted and measured net and no allowance shall be made for any increase in bulk after excavation. Excavation, filling and Disposal shall include all leads and lifts as specified elsewhere in these specifications.
- 11.2 Payment for all the items under this section shall be made at the rates entered in the Estimates appended to the contract and in accordance with the applicable conditions of the contract.



## **SECTION – 3**

### **CONCRETE**

#### **1. SCOPE OF WORK**

The work covered by this section of the Specifications consists of furnishing all plants, labour equipment appliances and materials and in performing all operations in connection with concrete work complete in strict accordance with the applicable drawings and the Specifications herein and subject to the terms and Condition of the Contract.

#### **2. GENERAL**

Full cooperation shall be extended to other trades to install embedded items, and opening etc. Embedded items shall have been inspected and check tests for concrete and other materials or for mechanical operations shall have been completed and approved before concrete is placed.

#### **3. MATERIALS**

##### **3.1 PORTLAND CEMENT**

##### **1) General Requirements**

- a) Portland Cement shall be indigenous stuff unless otherwise approved by the Engineer.
- b) Unless otherwise permitted, cement from not more than two plants shall be used and in general, the product of only one plant shall be used in any particular section of the work.

## 2) Specification

These specifications cover five types of Portland cement, as follows:

No.	Applicable Specifications		Application
	ASTM	BS	
a.	C150 (Type I)	BS 12	Ordinary Portland Cement: For use in general concrete construction when the special properties specified for Type II, III, IV and V are not required.
b.	C150 (Type II)	BS 1370	Moderate Heat Portland Cement: For use in general concrete construction exposed to moderate sulfate action, or when moderate heat of hydration is required.
c.	C150 (Type III)	BS 12	Rapid Hardening Portland Cement: For use when high early strength is required.
d.	C150 (Type IV)	BS 1370	Low Heat Portland Cement: For use when low heat of hydration is required.
e.	C150 (Type V)	BS 4027	Sulfate Resisting Portland Cement: For use when high sulfate resistance is required.

## 3) Packing and Marking

- Cement shall be furnished in sacks or in bulk form, as approved by the Engineer.
- Cement in sacks shall be delivered in strong, well made, paper or cloth bags, each plainly marked with the manufacturer's name, brand, type of cement and the weight of cement contained therein, except that, in the case of Type-I cement, the type need not be identified.
- A bag shall contain 50 Kg. net.
- When the cement is delivered in bulk; this information shall be contained in the shipping invoice, accompanying the shipment.

## 4) Inspection

The Contractor shall facilitate the Engineer, in all respects, for careful sampling and inspection, either at the mill or at the site of work, as may be specified by the Engineer. The following periods, in days, from the time of sampling shall be allowed for completion of testing.

- |    |             |    |
|----|-------------|----|
| a) | 1-day test  | 6  |
| b) | 3-day test  | 8  |
| c) | 7-day test  | 12 |
| d) | 28-day test | 33 |

**5) Rejection**

- a) Cement may be rejected if it fails to meet any of the requirements of these specifications.
- b) Cement remaining in bulk storage at the mill, prior to shipment, for a period greater than six months after completion to the tests, may be tested and may be rejected if it fails to conform to any of the requirements of these specifications.
- c) Packages varying more than 3% from the weight marked thereon may be rejected and if the average weight of packages in any consignment as determined by weighing fifty packages taken at random, is less than that marked on the packages, the entire consignment may be rejected.
- d) Packages received in broken or damaged condition shall be rejected or may be accepted only as fractional packages as determined by the Engineer.
- e) Cement that is found to be adversely affected by moisture, as determined by the Engineer, shall be rejected.

**6) Method of Sampling and Testing**

- a) The sampling and testing of Portland cement shall be in accordance with relevant BS or ASTM standard specifications.
- b) Contractor shall carry out all tests on Portland cement, at his own cost, if required by the Engineer.

**7) Transportation of Cement**

Transportation of the cement from the mill to the site stores and to the point of use shall be accomplished in such a manner that the cement is completely protected from exposure to moisture.

**8) Storage**

- a) Cement shall be stored in dry, weather tight and properly ventilated structures. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification of each consignment.
- b) The sacks should be stacked closely on a damp proof floor or on timber planks, raised by a minimum of 12" (300 mm), from the ground, with air space below. There should be similar air space between the stacks and walls.
- c) To avoid bursting of bags and setting under pressure, the height of the stacks shall be limited 8 bags.
- d) Adequate storage capacity shall be furnished to provide sufficient cement to meet the peak needs of the project.
- e) Cement storage facilities shall be emptied and cleaned by the Contractor when so directed, however, the interval between required cleaning normally will not be less than four months.

9) **Usage**

- a) The Contractor shall use cement in the approximate chronological order in which it is received at the site. All empty sacks shall be promptly disposed off as approved by the Engineer.
- b) No cement stored through a monsoon, or for a period of more than six months, should be used, unless tests have been applied and cement found up to the requisite standard.
- c) Suitable, accurate scales shall be provided by the Contractor for weighing the cement in stores and elsewhere on the work, if required, and he shall also furnish all necessary test weights.

10) **Delivery and Usage Record**

Accurate records of delivery of cement and its use in the works shall be kept by the Contractor. Copies of these records shall be supplied to the Engineer in such a form as he may require.

### 3.2 **AGGREGATE**

1) **General Requirements**

- a) Aggregates for normal concrete shall conform to the requirements of ASTM Designation C 33 "Specifications for Concrete Aggregates".
- b) In case the Contractor prefers to use aggregate from a source other than that approved by the Engineer; following tests shall be carried out, at the Contractor's cost, to determine suitability of the material for the intended use:
  - i) Mechanical properties
  - ii) Porosity
  - iii) Organic impurities
  - iv) Clay and Silt Contents
  - v) Abrasion and Soundness Tests
  - vi) Alkali Reactivity Potential
  - vii) Water soluble Chloride Contents
- c) The nominal maximum size of the aggregate shall not be larger than one fifth of the narrowest dimension of the finished wall or slab, or larger than three fourth of the minimum clear spacing between the reinforcing steel and embedment.

2) **Nature of Aggregate**

- a) Fine Aggregate: The use of natural sand or a combination of natural and manufactured sands may be permitted, provided that the fine aggregate meets the applicable requirements of the specifications herein, for particular use intended.
- b) Coarse Aggregate: Except where otherwise specified, coarse aggregate shall consist of crushed natural stone.

3) **Source**

The Contractor shall obtain concrete aggregate from deposits of natural sand and gravel or shall procure crushed aggregate from approved quarries, which produce aggregates meeting with the Specifications contained herein.

4) **Sampling and Testing**

- a) The Contractor shall provide facilities, as may be necessary, for the ready collection of representative test samples, of the aggregates, to determine compliance with specifications.
- b) The Engineer will obtain and test such samples, at the expense of the Contractor, using appropriate standard test methods, selected by the Engineer.
- c) Testing of concrete aggregates by the Engineer shall not relieve the Contractor of his responsibility to maintain, control and ensure the production, stockpiling and handling of both fine and coarse aggregates, in accordance with these Specifications.

5) **Aggregate Processing**

- a) General: All aggregates, as delivered to the mixer, shall consist of clean, hard, dense and durable and uncoated particles.
- b) Light Weight Elements: Light weight elements, like chalk, clay and organic matter shall be separated by vibro-floatation process. Where required, fines shall be removed from the coarse aggregate by adequate washing.
- c) Soft Particles
  - i) The Contractor in planning his aggregate processing operations shall make necessary provisions, as regards methods and equipment, to ensure effective elimination of soft particles from all aggregates.
  - ii) The percentage of soft particles present in the processed coarse aggregate shall not exceed 3 percent by weight, when determined in accordance with the applicable requirements of ASTM Designation C235 "Standard Method of Test for Scratch Hardness of Coarse Aggregate Particles" or other standard test method, selected by the Engineer.
  - iii) Test Samples shall be representative of the each size group of processed coarse aggregate, as specified in Article 5.6, obtained according to the ASTM Methods D 75.

## 6) Grading Requirements

Compliance with the aggregate grading and uniformity requirements will be determined at the mixer. The aggregates, as delivered to the mixers, shall conform to the following specific grading requirements:

### a) Fine Aggregates

- i. The grading of fine aggregate shall conform to the following requirements:

U.S. Standard Sieve Mesh	Percent Passing
0.375" (9.50 mm)	100
No.4 (4.75 mm)	95-100
No.8 (2.37 mm)	80-100
No.16 (1.18 mm)	50-85
No.30 (0.60 mm)	25-60
No.50 (0.30 mm)	10-30
No.100 (0.15 mm)	2-10

- ii. Fineness modulus shall range between 1.9 and 2.78.
- iii. The sand equivalent value, as determined by ASTM Designation D 2419, "Standard Test Method for Sand Equivalence Value of Soils and Fine Aggregate", shall not be less than 75.

- b) Coarse Aggregate: The grading of the coarse aggregate, within the separated size groups, shall conform to the following requirements:

US Standard Sieve Size (Nominal Size)	Percent by Weight Finer than Each Laboratory Sieve			
	1/4"(6.25 mm) to No. 4 Group	3/4"(19 mm) to No. 4 Group	1"(25 mm) to No. 4 Group	1.5"(37.5 mm) to No. 4 Group
2.00" (50.00 mm)	-	-	-	100
1.50" (37.50 mm)	-	-	100	95-100
1.00" (25.00 mm)	-	100	95-100	-
0.75" (19.00 mm)	100	90-100	-	35-70
0.50" (12.50 mm)	90-100	-	25-60	-
0.375" (9.50 mm)	40-70	20-55	-	10-30
No. 4 (4.75 mm)	0-15	0-10	0-10	0-5
No. 8 (2.37 mm)	0-5	0-5	0-5	-

7) **Particle Shape**

- a) A flat particle is one having a ratio of width to thickness greater than three. An elongated particle is one having a ratio of length to width greater than three.
- b) The shape of the particles shall generally be spherical or cubical.
- c) The quantity of flat and elongated particles, in the separated size groups of coarse aggregate, as defined and determined by standard tests, approved by the Engineer, shall not exceed 15% by weight in any size group.

8) **Deleterious Substances**

- a) Fine Aggregate: The maximum percentages of deleterious substances, in the fine aggregate, as delivered to the mixer, shall not exceed the following values, with sum of the percentages of all deleterious substances not to exceed 5 percent, by weight.

<b>Substances</b>	<b>Percent of Weight</b>
Material passing No. 200 sieve	3
Shale	1
Total of other deleterious substances including mica, chloride, coated grains and soft flaky particles	3

- b) Coarse Aggregate: The maximum percentages of deleterious substances, in any size of coarse aggregate, as delivered to the mixer, shall not exceed the following values, with the sum of the percentages of all deleterious substances not to exceed 3 percent by weight.

<b>4. Deleterious Substances</b>	<b>Percent of Weight</b>
Material passing No. 200 sieve	1
Shale	1
Clay lumps	0.5
Other deleterious substances	1

9) **Storage**

- a) Aggregate shall be stored, at the site, in such a manner as to prevent its deterioration or the inclusion of foreign matter.
- b) Aggregate, which has deteriorated or which has been contaminated, shall not be used for concrete.

- c) All methods employed by the Contractor for loading, unloading, handling and stock-piling aggregates shall be subject to the approval of the Engineer, at all times.
- d) Sufficient aggregate shall be maintained at the site, at all times, to assure continuous placement and completion of any lift of concrete started.

#### 10) **Moisture Control**

- a) All fine aggregate and smallest size group of the coarse aggregate shall remain in free draining storage at the site for at least 72 hours, immediately prior to use.
- b) The free moisture content of the fine aggregate and of the smallest size group of coarse aggregate, as delivered to the mixer, shall be controlled so as not to exceed 4% and 1% respectively, expressed as percent by weight, of the dry aggregates; unless higher limits are allowed by the Engineer.
- c) In addition to the limits on the maximum amounts of free moisture in aggregate, the moisture content shall be controlled so that, for each size, the variation in the free moisture will not be more than 0.5 percent, during any one hour of mixing plant operation.
- d) Coarse aggregates, with other sizes, as delivered to the mixers, shall have the least amount and least variation, of the free moisture contents, practicable under the job conditions.
- e) Under no conditions shall the aggregate be delivered to the mixed plant being dripping wet.
- f) The Contractor shall carry out such tests, at his own expense, as the Engineer may deem necessary, to determine the free moisture content of aggregate.

### 3.3 **WATER**

Water is discussed in water section.

### 3.4 **CONCRETE STRENGTH**

The minimum compressive strength of concrete required on the basis of test cubes and minimum quantity of cement required for the concrete shall be as under:

Class of Concrete	Min. Qty. of Cement		Cylindrical Strength	
	Lbs. per 100 cft.	Kg. / Cu.m.	At 7 Days	At 28 Days
			Lbs./ Sq. in.	Lbs./ Sq. in.
A	3024	485	3000	4000
B	2520	404	2250	3000
C	2016	323	1875	2500
D	1344	216	900	1200
E	1008	161	600	800



### 3.5 PROPORTIONING OF CONCRETE MIXES

All concrete shall be proportioned by volume for design of concrete mixes, unless specifically directed by the Engineer to proportion them by weight. The Contractor shall submit to the Engineer before the start of concreting proposed mix designs for concrete to be used based on laboratory tests to determine the proportion of cement, aggregates, and water in the concrete conforming to the quality and strength requirements specified. The source and specific gravity of aggregates and name of laboratory shall be submitted along with mix design. The cost of all such testing and mix design shall be deemed to have been included in the item rates of Contractor.

### 3.6 MAXIMUM ALLOWABLE WATER CONTENT

All concrete specimens shall be made, cured and tested in accordance with British Standard or ASTM Standard and Water cement ratio shall be varied to achieve the required strength and this ratio shall be got approved by the Engineer before the start of concrete work.

### 3.7 SLUMP TEST

The slump for concrete, determined in accordance with PS 422:1964 "Slump Test for concrete" should be minimum of 25 mm (1") and a maximum of 75 mm (3") provided the requisite strength is obtained.

### 3.8 MIXING

Concrete shall be mixed by mechanical mixing with adequate facilities for accurate measurements and control of each material entering the mixer and for changing the proportions to conform to varying conditions of the work. Volumetric batching can be adopted, using cement by weight, according to the following table:

Nominal	Cement		Sand Cft.	Coarse Aggregate Cft.
1:1½:3	110 Lbs	50 Kg.	1 7/8	3 ¾
1:2:4	110 Lbs	50 Kg.	2 ½	5
1:3:6	110 Lbs	50 Kg.	3 ¾	7 ½
1:4:8	110 Lbs	50 Kg.	5	10

Water shall be measured for every batch with due allowance made for water already present in aggregates.

- 1) Mixers shall not be charged in excess of noted capacity nor be operated in excess of noted speed. Excessive mixing shall not be permitted. The entire batch shall be discharged before re-charging.
- 2) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids.
- 3) Mixing water shall be introduced before one-fourth of the mixing time has elapsed. Mixing time for mixers of one cubic meter or less shall be 2 minutes.

- 4) No hand mixing shall be permitted. If during concreting the mixing plant fails, the concrete already poured shall be removed, unless otherwise directed by the Engineer or his Representative.
- 5) Test cubes of concrete shall be prepared and stored by the Contractor, in accordance with PS: 560:1965, as and when directed by the Engineer or his Representative. Test cube be tested in laboratory and the Contractor shall bear the charges for the same.

### **3.9 TRANSPORTING AND PLACING CONCRETE**

- 3.9.1 Concrete shall be conveyed and deposited as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the work is done in on operation. Concrete that has attained its initial set or has contained its mixing water for more than 30 minute shall not be allowed to be placed in the works.
- 3.9.2 Transport of concrete shall be in a manner approved by the Engineer or Engineer's Representative and shall be so as to avoid segregation or loss of ingredients of concrete.
- 3.9.3 All foundations and portions of work to be concreted shall be approved by the Engineer's Representative before concrete is poured.
- 3.9.4 All forms and reinforcement shall be completed, cleared inspected and approved before pouring of concrete. No concrete is to be deposited till the Engineer's Representative has inspected and approved in writing all reinforcement, foundations forms, details, positioning of all fixture and materials to be embedded in concrete. The Engineer or his representative shall issue an authorization to start concrete for each day work in a form to be called pour slip. This pour slip will give the result of checking of form work, reinforcement, and quality of aggregates cement and mixing & vibrating equipment and date of, pouring of concrete. This pour slip shall form the basis for payment to Contractor. No payment will be made for the concrete for which pour slip has not been issued by the Engineer or his representative. The Contractor: shall maintain a complete record of concrete pour slips issued by the Engineer or his authorized representative. Laying concrete shall be carried out only in presence of authorized representative of the Engineer. Dry concrete laid without the presence of Engineer's representative will not be accepted and will not be paid for.
- 3.9.5 All concrete shall be thoroughly compacted and consolidated by means of Pneumatic or mechanical vibrators or other approved compacting method. Care shall be taken to avoid segregation due to excessive vibration. The Contractor shall maintain on site at all times one or more stand by vibrators. Tapping or other external vibration of forms shall not be allowed, unless so directed by the Engineer's Representative. Compaction shall be done until the whole mass assumes a jelly like appearance and consistency with the water just appearing on the surface. Concrete shall be sufficiently tamped and consolidated around the steel rods, care taken that the vibrator does not touch steel or formwork and is worked into all parts of the moulds in order that no voids or cavities are left. Steel shall not be disturbed during operations of concreting. Concrete shall be brought up in even layers of about 300 mm (12") thickness or as approved by the Engineer and worked against side of forms to give a smooth and uniform surface. No surplus water shall be

allowed to come out and lie on the surface of concrete. The concrete must be of such a consistency that after ramming, consolidating and tamping is completed, a thin film of water is just appearing on the surface.

- 3.9.6 Hardened concrete, debris and foreign material shall be removed from interior of forms and from inner surface of mixing and conveying equipments.
- 3.9.7 Runways shall be provided for wheeled concrete handling equipment, and such equipment shall not be wheeled over reinforcement, nor shall runways be supported on reinforcement.
- 3.9.8 Concrete shall not be dropped freely from a height of more than 2.5 m in columns and 1.5 m (5 ft) elsewhere. In case where an excessive drop is inevitable the Contractor shall provide spouts, down pipes, chutes, or side ports to form with pockets that will let concrete flow easily into the form without any risk of segregation. The discharge of the spouts, down pipes or chutes shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 300 mm (12") thick.
- 3.9.9 When concrete is laid on hard-core, such as sub grade for floor slabs, or other absorbent material, the surface is to be watered, consolidated and, where specified, blinded before the concrete is deposited.
- 3.9.10 Fresh concrete shall not be placed on previously laid concrete or on old concrete surfaces until the latter has been cleaned of dirt, scum and laitance by wire brushes. The clean surface shall then be thoroughly wetted and grouted with cement slurry as approved by the Engineer's Representative.
- 3.9.11 Care shall be taken not to disturb newly placed concrete by vibrator, indirect loading or otherwise. No traffic or loading shall be allowed on the concrete until it has thoroughly set and hardened.
- 3.9.12 No concrete shall be placed during rains or when the sun, heat, winds or other weather conditions prevent proper placing, finishing and curing of concrete or when the temperature is above 43 degree Centigrade and below 35 degree Fahrenheit or when the concrete is likely to be subjected to freezing temperatures. All fresh concrete shall be suitably protected from rainfall and excessive heat or cold.
- 3.9.13 Should any part of the exposed surface present a rough uneven or imperfect appearance when the shuttering is removed, it shall be picked out to such depth and refilled and properly re-surfaced or entirely redone as per directions of Engineer or his Representative at the cost of the Contractor.
- 3.9.14 On removal of the forms and before the skin has had time to harden, all faces of the concrete inside or outside, to be kept exposed shall be rubbed over with carborundum stone and washed with cement to remove all marks, projections hollows or any other defect. No extra payment shall be made for this work.
- 3.9.15 All exposed surfaces and lines of the concrete work are to be true and fair without cracks, bends, windings and distortions of all kinds without any extra charges by the Contractor.

### **3.10 PROTECTION AND CURING**

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature change and mechanical injury or injury from rain or flowing water for a period of at least ten days. Curing shall be started as soon as the concrete has hardened sufficiently for the surface not to be marked. Curing shall be done either by continuous sprinkling of water on the surface or by covering with sand, hessian, canvas or other approved fabric mats that shall be kept continually wet. If required and so directed by the Engineer or his Representative, formed surfaces with form in position shall also be cured by keeping all form continually wet. Minimum period of curing for any concrete shall be ten days or more as directed by the Engineer. All concrete pours and concreted structures shall be clearly marked with non-wash able paints to indicate the date of placing concrete. During hot weather curing shall be done even at nights.

### **3.11 FORMWORK**

#### **3.11.1 GENERAL**

The form work shall be inclusive of all labour, material, workmanship and alike. All formwork and supports thereto shall be designed by the Contractor and relevant drawings shall be submitted to the Engineer and his Representative for approval before the work is put in hand. Such approval shall not relieve the contractor from all the obligations of the contract or give rise to any claim.

#### **3.11.2 MAKING FORMS**

The formwork for all concrete work to be cast in situ shall be made of sound and properly seasoned timber or other approved material for all works above ground water table. For all works below ground water table formwork of steel shall be used. These formworks shall be properly jointed and erected with packing material to provide watertight forms. These forms shall be properly cleaned to give a smooth finished surface and shall be rigidly formed and designed by the Contractor to the shapes and forms as per drawings in accordance with the best existing practices so as to be able to withstand, without displacement deflection or deformation movements of any kind, the pressure of the moist concrete and all other loads.

#### **3.11.3 RIGID WITH ALLOWANCE FOR CAMBER AND BULGES**

It shall be fabricated and erected in position, perfect in alignment, levels and true to plumb and shape and securely braced so as to enable it to with stand all weights, live and vibrating, to be endured during placing of concrete and its subsequent hardening till the formwork is struck. It shall be sufficiently rigid as not to loose its form or bulge, or deflect and to give the finished concrete the required lines, plumb, size and shape.

#### **3.11.4 MATERIALS AND LABOUR**

The Contractor shall supply all materials and labour necessary for a good and speedily erecting formwork such as shuttering, planks, struts, bolts, stays, gangways boards, fillets etc. and shall do all that is essential in executing the job in a workman like manner to the satisfaction of the Engineer.

### 3.11.5 FORMWORK NOT TO INTERFERE OR INJURE WORK

The formwork shall be so designed and arranged as not to unduly interfere with concrete during its placing and easy to be removed without injuring the finished concrete.

Wedges, clamps, bolts and the rods shall be used when permitted and where practicable in making the formwork rigid and in holding it to true position.

### 3.11.6 JOINTS IN FORMWORK

All joints in the formwork shall be sufficiently closed to prevent undue leakage of mortar from concrete or show an appearance of leaking mortar on concrete surface.

### 3.11.7 TREATMENT AND INSPECTION OF FORMS

All rubbish particularly chipping, shavings and saw etc. shall be removed from the interior of the forms immediately before placing concrete. Forms shall be coated with approved mould oil before reinforcement is placed. Surplus oil on forms and any oil on reinforcing steel shall be removed.

### 3.11.8 REMOVAL OF SHUTTERING

No struts or timbering which serves the purpose of supporting the shuttering or centring shall be struck a removed before the minimum periods for the main classes of work given as under:

Removal of Shuttering	Cold Whether Days	Normal Whether Days
Beams, sides, walls and columns (unloaded)	5	3
Slabs soffits (Props left under)	10	7
Removal of props to slabs	18	14
Beams soffits (props left under)	13	10

Struts or other timbers or supports, the removal of which may cause the transference of load to the finished work shall be kept in place for three weeks after the placing of the concrete.

### 3.11.9 INJURY OR DAMAGE

The Contractor shall be responsible for any injury to the work and any consequential damages caused by or arising from the removal and striking of forms, centring and supports, and any advice, permission or approval given by the Engineer or his Authorised Representative, related to the removal and striking of forms, centring and support shall not relieve the Contractor from the responsibilities herein defined.

**3.11.10 TREATMENT AFTER REMOVAL OF FORMS**

Any minor surface honey combing or other irregularities are to be properly made good immediately upon the removal the formwork and the surface made good to the satisfaction of the Engineer and his Representative. Any small voids shall be neatly stopped with cement mortar consisting of one part of cement to two parts of sand and the whole surface rubbed over with carborundum stone and cements wash and bring the whole to a smooth and pleasing finish and uniform colour.

**3.11.11 MEASUREMENT AND PAYMENT**

Formwork shall not be measured or paid for separately and shall be deemed to be included in the unit price of concrete whether cast-in-situ or pre-cast and subsequently fixed in position.

**3.12 CONSTRUCTION JOINTS**

Construction joints shall be located as indicated on the drawings and / or as approved or directed by the Engineer or his Representative.

**3.13 ANCHOR BOLTS, INSERTS, SLEEVES, CHASES, RECESSES, STEEL FRAMES ETC.**

The Contractor shall furnish and place in position accurately shown on drawings, all inserts, sleeves, chases, recesses. etc., supplied by himself or other Contractors, as directed and full cooperation and coordination shall be maintained with other Contractors, Sub-Contractors in this regard.

**3.14 CLEANING AND REMOVAL OF RUBBISH**

On completion of works herein the Contractor shall remove all concrete debris, rubbish, shuttering materials, scraps etc., from the vicinity of the structures completed. All areas shall be cleaned to the satisfaction and approval of the Engineer.

**3.15 PLACING STEEL REINFORCEMENT ON FORM WORK**

3.15.1 Clear cover to main reinforcement in concrete members is as follows:

a.	For slabs, projections, chajjas, fins, walls, staircases pre-cast slabs.	19 mm
b.	For beams, Columns, all members of water retaining structures on the side in contact with water	50 mm
c.	For foundations retaining walls and foundation beams	50 mm

**3.15.2** All the reinforcing bars are to be properly placed and spaced as shown on the working drawings. Steel chairs and concrete spacer blocks are to be used without any extra cost. Concrete spacer blocks are to be properly cured to avoid their damage during concreting thereby causing displacement of bars. Holes made by bolts etc., introduced for keeping the shuttering in act should be properly treated after striking the shuttering. No such hole shall be allowed in walls of water retaining structures and earth retaining walls.

### **3.16 WATER PROOF CONCRETE**

All concrete work below ground level shall be executed in SR cement with water proof compound of approved type and shall be mixed in with concrete in strict accordance with the instruction of manufacturer or as directed by the Engineer.

### **3.17 FINISHING OF FORMED SURFACES**

All concrete surfaces exposed to public view or inside of sump or wet well and screening chamber shall be smooth form finish. No plastering will be allowed or paid for. The concrete surfaces not exposed to public view e.g. external surfaces of sump or wet well or screening chamber shall be fairly smooth for application of water proofing treatment. Other surface may be rough form finish.

### **3.18 BITUMEN COATING ON WALLS**

Unless otherwise specified all concrete and masonry work in contact with earth upto plinth level shall be given an application of two coats of Industrial Bitumen paints at the rate of 15 lbs per 100 sq.ft ensuring that no pin holes / patches are left out. Bitumen will be applied after cleaning all dirt, dust and loose material from the surface and ensuring that the concrete or masonry has been cured and dried. Second coat will be applied after the first coat completely dried backfilling of each in foundation up to plinth will only be carried out after the application of bitumen coats and after the final coat completely dried as specified hereinabove or as directed by the Engineer. Bitumen coat shall be measured in square metre of area to be coated and payment for all the items under this section shall be made at the rates entered in the BOQ appended to the contract and in accordance with the applicable conditions of the contract.

### **3.19 MEASUREMENT AND PAYMENT**

Payment for concrete shall be made on the basis of approved tendered rates of the Contractor for all types of concrete work carried out by the Contractor and approved by the Engineer except that no separate payment shall be made for concrete work in valve chambers. This shall be deemed to have included in the lump sum rate for valve chambers quoted by the Contractor.

The rate of concrete quoted by the contractor shall be deemed to include the cost of formwork to produce fair faced concrete.

No payment shall be made for the concrete work that has been laid without the issue of pour slip by the Engineer or his representative.

## SECTION – 4

### STEEL REINFORCEMENT

#### 1. DESCRIPTION

Contractor to require in this section is to supplying, cutting, fabricating, bending, placing and installing/binding in position etc., straight or curved hot rolled or cold-worked deformed steel bar reinforcement having minimum yield strength 414 Mpa , including cost of G.I binding wire 18SWG, chairs, wastages, precast c.c. spacers and welding where required by the Engineer, as per ASTM A615 standard. Only those overlaps shall be paid which are according to the approved Bar Bending Schedule/shown on drawings or instructed by the Engineer/as per BSI 4466, complete in all respects as per drawing and specifications for all kind of R.C.C. work. Bars to be cut and placed in position at any level according to the Bar bending schedule prepared by the contractor and approved by the Engineer.

#### 2. SCOPE OF WORK

The work covered by the section of the specification consists of furnishing all materials, tools, labour, equipment & appliances and in performing all operations in connection with the providing, straightening, cutting, bending, binding, fixing, elsewhere with necessary overlaps, wastage including binding wire, chairs, pins, spacer block complete in strict accordance with this section of the Specifications, the applicable drawings, approved bar bending schedule according to BS-4466 and the terms and conditions of the Contract. All steel reinforcement should be placed at locations, to lines and level as shown in the drawings and as directed by the Engineer.

#### 3. MATERIALS

3.1 Reinforcing steel to be new billet stock of mild steel (plain bar), hard grade (deformed bar) and Ribbed Tor steel as specified on the drawings and shall conform to British Standard Specifications or equivalent ASTM or Pakistan Standard.

3.2 The Contractor shall furnish to the Engineer's Representative Manufacturers' mills certificate to guarantee that steel meets the standard, specifications requirements and minimum certified yield stresses as follows:-

i. Mild Steel plain bars conforming to B.S.S. 4449 or PS-231

- a) Tensile Strength - 438 to 517 N/Sq.mm (63.5 to 75 Kips/Sq. in).
- b) Yield Strength - 250 N/Sq. mm (36 Kips/Sq. in)
- c) Elongation - 16% to 24% (average 20%).

ii. Hot rolled deformed bars conforming to ASTM A-615 Grade 60 or PS-605

- a) Tensile Strength - 560 N/Sq. mm (81 Kips/Sq. in).
- b) Yield Strength - 415 N/Sq. mm (60 Kips/Sq. in).
- c) Elongation - 11%



- 3.3 All steel to be true to the Standard Specifications with regard to bend ability specially the hard grade deformed bars under 19 mm (3/4") dia. shall be capable of being bent cold through 90 degree round a bar of four times its own diameter without fractures or injury of any kind. In case of deformed bars over 19 mm (3/4") dia. and under 28 mm (1-1/8") dia. round a bar of 6 times its own diameter.
- 3.4 18 gauge galvanized wire shall be used for binding the steel reinforcement.

#### **4. TESTING**

Reinforcement shall be obtained only from manufacturers approved by the Engineer or his Representative. All reinforcement shall be tested according to ASTM standard.

If and when required samples shall be tested for above specification in an approved laboratory when required by the Engineer or his Representative and all costs of such tests shall be borne by the Contractor as a minimum three (03) samples will be tasted per twenty (20) ton of steel.

#### **5. STORAGE**

Reinforcing bars shall be stored on platforms above surface of ground and be free from scales, oil, structural defects prior to placement in works. Rusted or dirty steel bars shall not be used in the works unless brushed and cleaned by proper steel wire brushes and after being approved for use by the Engineer or his Representative.

#### **6. REINFORCEMENT CUTTING AND PLACING**

- 6.1 All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules approved and drawings supplied by Engineer. The Contractor shall prepare bar bending schedule from approved structural working drawings conform to ACI 318-02 section 12.5. The bending schedules shall be drawn on approved forms and submitted to the Engineer or his Representative for checking and approval. The steel reinforcement shall be cut and bent to sizes as per drawings and approved bending schedules. In case any bars, cut, bent or even fixed in position are found incorrect in dimensions size or shape according to the requirements of the drawings and instructions of Engineer, the Contractor shall replace such steel bars cut bent or fixed in position by correct sized bars at his own cost and no extra payment shall be made to the Contractor on such account. The system of holding bars in place shall ensure that all steel in top section will support weight of workmen without displacement or distortion. Suitable spacers and chairs as approved by the Engineer or his Representative shall be used for supporting and spacing purposes of bars. In case any bars are bent or displaced they shall be straightened or replaced prior to pouring. All reinforcement bars within the limit of a days pour shall be in place and firmly tied with 18 gauge G.I. wires. Bars with kinks or bends not shown on drawings shall not be used.

- 6.2 Where indicated in the drawings, mesh shall be of the sizes as shown on drawings and conform to British Standard B.S.785. Mesh reinforcement when used in slabs shall be supported at proper elevations by standard accessories. In slabs on ground, pre cast concrete blocks may be substituted for chairs.

## 7. LAPS AND SPLICES

- 7.1 No splicing of bars shall be allowed at position other than shown on the drawings. All lap lengths shall be of the minimum sizes as indicated on the drawings or in conform to ACI-318-02 section 12.5 and in no case shall lap length be less than 40 times the diameter of the bigger lapping bars for nominal M.S. bars. Hard grade bars and tor steel shall have laps of 50 times the bigger diameter of lapping bars. Splices of adjacent bars shall be staggered unless approved otherwise by the Engineer or his Representative.
- 7.2 All reinforcing steel fixed in position shall be inspected by the Engineers Representative and no concrete shall be poured until steel placement has been approved by the Engineers Representative. For inspection purposes the Contractor shall give to the Engineers Representative reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as indicated on the drawings/specified.

## 8. MANUFACTURE

Steel shall be manufactured from prime Pakistan Steel billets.

## 9. MEASUREMENT AND PAYMENT

- 9.1 The quantity to be paid for shall be the calculated in theoretical number of metric ton of reinforcement steel bars or mesh as determined from the approved bar bending diagrams and incorporated in the concrete and accepted, except when reinforcement is paid for under other items.
- 9.2 The weight of plain or deformed bars will be computed from the theoretical weight of plain round bars of the same nominal size as shown in the following tabulation:

Size Inch	Weight in		Size Inch	Weight in	
	lbs per ft.	Kg. per ft.		lbs per ft.	Kg per ft.
¼	0.167	0.076	¾	1.502	0.681
3/8	0.376	0.170	7/8	2.044	0.927
½	0.668	0.303	1	2.672	1.212
5/8`	1.043	0.473	1-1/18	3.382	1.534

- 9.3 Clips, ties, separators, and other material used for positioning and fastening the reinforcement in place, and structural steel, shall not be included in the weight calculated for payment under this item. If bars are substituted upon the Contractor's request and as a result more steel is used than specified only the amount specified shall be included.
- 9.4 When laps are made for splices, other than those shown on the drawings or required by the Engineer and for the convenience of the Contractor, the extra steel shall not be measured nor paid for.
- 9.5 When continuous bars are shown on the drawings, without the splices being shown, the necessary steel in the splices will be paid for on the basis of the individual bars not being shorter than 40 ft (12 m).
- 9.6 The accepted quantity measured as provided above shall be paid for at the contract unit price for the items listed in the Bill of Quantities, which price and payment shall be full compensation for furnishing materials, labour, equipment and incidentals necessary to complete the item.

## SECTION – 5

### WATER

#### 1. SCOPE:

The work covered by this section of the Specification consists of furnishing all labour, appliances and in performing all operations in connection with obtaining, conveying and storing water at site of work.

#### 2. QUALITY OF WATER:

The water used for construction the contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plants and tools. Where doubt exists as to the suitability of the water, it shall be tested at the cost of the contractor in accordance with BS3148. Where water shall be shown to contain any organic impurities sugar or an excess of acid, alkali or salt, or inorganic impurities in solution or suspension, the engineer shall refuse to permit its use. The suitability of water shall be subject to test when required by the engineer.

#### 3. CHEMICAL REQUIREMENTS

As a guide, water may be used as mixing water if the chemical contents do not exceed the following limits, otherwise control test's to show the suitability have to be made.

<u>Kinds of Ingredient</u>	<u>Permissible Limits</u>
Dissolved Solids	2,000 ppm
Alkali Carbonate and Bicarbonate	1,000 ppm
Chloride*	500 ppm
	1,000 ppm
Sulphate (So <sub>4</sub> )	3,000 ppm
Alkalies (Na <sub>2</sub> O+0.658 K <sub>2</sub> O)	600 ppm
PH – Value	4 (minimum)

\* The maximum concentration of chloride (Cl) in prestressed concrete should not be higher than 500 ppm.

In general, for reinforcement concrete in moist environment, or concrete containing imbedded aluminium structures with dissimilar metals, a maximum concentration of 1000 ppm is acceptable.

If the result of the acceptance tests are within 90% of the permissible limits, the quality control tests for above impurities shall be down each month, or not otherwise directed by the engineer.

If the amounts of each chemical ingredient are lower than specified in the section, and trial mixes show that no harmful effects appear due to the subject tested, the water can be used as mixing water.

**4. TEMPORARY STORAGE TANK:**

The Contractor shall provide on site at his own cost temporary storage water tank with all necessary G.I. Pipes and fittings as per instructions of the Engineer. No separate payment will be made for tank, pipes and accessories, etc. These tanks shall be removed or dismantled or demolished and the area shall be cleaned and made good on completion of work as per direction of Engineer.

**5. PAYMENT:**

No separate payment will be made for the work covered under this section, and all costs in connection therewith shall be deemed to be included in the unit rates.

## **SECTION – 6**

### **BITUMEN COATING**

#### **1. SCOPE**

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations for bitumen coating treatment to foundations, complete in strict accordance with this section of this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

#### **2. SUBMITTAL**

Samples of all materials proposed for use under this section, shall be submitted to the Engineer for approval.

#### **3. MATERIALS**

Bitumen 10/20 grade.

#### **4. DELIVERY STORAGE AND HANDLING**

Materials shall be protected from damage during loading shipment delivery and storage Non-staining materials shall be used for blocking and packing.

#### **5. PREPARATORY WORK**

All surfaces, to be treated shall be dust free and dry. Application shall not start unless the preparatory work has been inspected and approved by the Engineer.

#### **6. WATER PROOFING TREATMENT IN FOUNDATION / SUB-STRUCTURES**

All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire brushing or as directed by the Engineer. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 1 gallon /100 square feet. Two coats of hot bitumen paint shall be applied at the rate of 40 lbs/100 sft. each coat. The first coat shall be allowed to dry for about 6 hours before applying the second coat. During operation of painting great care shall be taken to avoid air bubbles. The manufacturer's advice/ recommendations shall be taken to avoid air bubbles. The manufacturer's instructions and Engineer's directions shall be followed.

#### **7. MEASUREMENT AND PAYMENT**

##### **7.1 GENERAL**

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works

related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the BOQ.

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

**7.1.1** All preparatory work, scrapping, scratching and cleaning.

## **7.2 BITUMEN COATING**

### **7.2.1 MEASUREMENT**

Measurement of acceptably completed works of bitumen coating will be made on the basis of net actual area in square meter as shown on the Drawings or as directed by the Engineer.

### **7.2.2 PAYMENT**

Payment will be made for acceptable measured quantity of bitumen coating on the basis of unit rate per square meter quoted in the Bills of Quantities. The unit rate shall include all cost of surface preparation and shall constitute full compensation for all the works related to the item.

## **SECTION – 7**

### **PLASTER**

#### **1. SCOPE OF WORK**

The work covered by this section of specifications consists of furnishing all plant labour, appliances and material and services required for cement plastering, including all items incidental thereto as specified herein and as shown on the Drawings.

#### **2. GENERAL REQUIREMENTS**

- 2.1 Contractor shall examine all other sections of the specifications for requirements that affect work of this section whether or not such work is specifically mentioned in this section. Plaster surface shall include walls, partitions, jambs, recesses, heads of doors & windows soffits etc.
- 2.2. Contractor shall co-ordinate work with that of all other trades affecting or affected by work of this section especially all embedded items in walls.

#### **3. MATERIALS**

For specification of sand and cement for plastering refer Section II (Materials).

#### **4. WORKMANSHIP**

- 4.1. All work shall be done in the best possible manner by skilled workmen of the plastering trade. Contractor will be responsible for results of the highest quality. Unsound and unsightly work shall be removed and replaced by work satisfactory to the Engineer at no additional cost.
- 4.2. All finished surfaces shall be even and properly trowelled. Finished surfaces shall be even in colour, free from stains, marks or defects. Finished surfaces shall be straight-edged and plumb or level in every direction, angles shall be straight, true and perfect.
- 4.3 All work shall be protected from rapid drying- Exterior openings shall be kept properly adjusted to regulate the drying and curing of cement plaster.

#### **5. CEMENT PLASTER APPLICATION**

##### **5.1 INSERTS AND EMBEDDED ITEMS**

Plastering shall not commence until all metal lath, electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts are fixed in position. It shall be the responsibility of the Contractor to



make sure that all such work is carried out before starting of plasterwork. Chiselling and repairing of cement plaster shall not be permitted. Before commencing plasterwork Contractor shall check to ensure that all embedded and other items are in place.

## **5.2 PREPARATION OF MASONRY SURFACE TO BE PLASTERED**

All masonry surfaces to be plastered shall be cleaned to remove all matter which will otherwise adversely affect the adhesion of plaster to the surface concerned. All masonry joints and concrete surfaces shall be properly roughened before plaster work is commenced. The surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one part cement to one part sieved sand by volume with water added to make a thick creamy mix. The slurry shall be applied with a stiff brush on surface that shall be well wetted before the application of the slurry.

## **5.3 PREPARATION OF CEMENT MORTAR FOR PLASTER**

- a. The mortar shall be prepared from prescribed cement mixed with clean sieved sand in the volumetric ratio of one part cement to three parts of sand (1:3) or as specified. The mixtures shall be turned over and over till the ingredients are thoroughly mixed.
- b. Only limited quantity of water shall be added for proper workability and such quantity of the mortar shall be prepared that will be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other times more than that stipulated above is expressly prohibited.

## **5.4 APPLICATION OF PLASTER**

The minimum thickness of plaster shall be 13 mm. If the plaster is to be more than 18 mm thick it shall be done in two layers. The surface of first layer shall be made rough after the initial set. The second layer shall be applied after a period of three (3) days of application of the first layer. The plaster shall not have wavy surfaces and shall be perfectly in line level and plumb. The edges and corners shall represent straight lines. The plaster shall be kept wet continuously for at least 10 (ten) days. - Plaster shall be carried in jambs, junctions, corners, edges, round surfaces. The plasterwork is to cover all. conduits, pipes etc. fixed in the walls and ceiling.

## **5.5 PATCHING**

Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any such plaster or loose plaster shall be removed and replaced with plaster in conformity with these specifications and as directed by the Engineer.

Contractor shall remove completely and provide plaster in lieu of all defective work in patches as directed, at no additional expense to the employer.

Patching plaster shall match appearance of and shall be finished level with the adjoining plaster.

## **5.6 DRIPS**

The Contractor shall make drips for rainwater protection.

## **5.7 ALIGNMENT AND SMOOTHNESS**

All cement plaster shall be uniformly true in line level and plumb, smooth trowel finished, free of waves and blemishes etc. to the full satisfaction of the Engineer.

## **5.8 CLEANING AND PROTECTION**

Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer.

As each room or space is completed all rubbish., debris, scaffolding and tools should be removed to leave the roof clean.

Protect finished plaster from injury by any source.

Prior to plastering all windows doors and finished metal shall be covered by plastic adhesive tape or any other approved system to completely protect it from damage and defacement.

Contractor shall also protect walls, floors and work of other trades from plaster materials.

## **6. WATERPROOF PLASTER**

### **6.1 STRUCTURE BELOW GROUND WATER TABLE**

All structures to be constructed below ground water level shall be given a waterproofing treatment on the inside and outside. The plaster shall be made by mixing Puddlo or an other equivalent water proofing compound approved by the Engineer in the cement-sand mix of 1:3 by volume according to the manufacturer's instructions for treatment and applied in one layer of 19 mm on all required surfaces. Waterproofing compound in sealed containers only shall be allowed. Only water proofing compound duly approved by the Engineer shall be allowed for use. The surfaces to receive waterproofing treatment shall be made rough for bonding. The layer of waterproofing plaster 19 mm thick shall be then applied and its surface shall be made smooth by the use of a trowel or other suitable instrument. The plaster shall be allowed to cure for a minimum of 14 days.

**6.2** Waterproof plasterwork shall not be started till all pipes have been installed. Any damage or leak discovered shall be repaired by the Contractor at his own cost.

## **7. CUTTING AND PATCHING**

When so directed and prior to painting and finishing of cement plastered surfaces, the Contractor shall check all cement plastering throughout the work, including all cutting, patching and refinishing required in a manner satisfactory to the Engineer.

**8. PROTECTION AND CLEANING**

- 8.1** During the operation of cement plastering, protect the work of other trades against undue soilage and damage by the exercise of reasonable care and precautions. Repair, replace, or both, any work so damaged and soiled.
- 8.2** Upon completion of all work remove all rubbish, scaffolding and tools from the work and leave the premises clean and to the Engineer's satisfaction.

**9. MEASUREMENT AND PAYMENT**

Plasterwork will be measured and paid for the net area over which it is laid. All openings exceeding one sq. metre shall be deducted. The cost for drips and architectural grooves corner jambs and sills shall be included in the unit rate of plaster and no separate payment shall be made for these. All unit rates shall include cost of all, materials, labour, scaffolding and curing etc.

No extra payment shall be made to the Contractor for thicker plaster required due to unevenness in the masonry or defective masonry.

## **SECTION – 8**

### **BLOCK MASONRY**

#### **1. SCOPE OF WORK**

The work covered by this section of the specifications consists of furnishing all Plant, Labour, Equipment, Appliances, and materials and in performing all the operations in connection with brick masonry work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the Contract.

#### **2. MATERIAL**

##### **2.1 CEMENT**

Cement shall be Portland cement meeting the requirements specified under clause of section of “Concrete.”

##### **2.2 AGGREGATES**

Aggregates used shall meet the requirements specified under clause of section of “Concrete”.

##### **2.3 WATER**

Water shall be as specified under clauses of the section of “Concrete”.

##### **2.4 CONCRETE MASONRY UNITS.**

2.4.1 Concrete masonry units shall be made on the project site and shall be of the size required by the drawings and / or directed by the Engineer Incharge.

2.4.2 The blocs shall be solid or hollow as required and shall be carefully made so that they are true in line and face with square corners and free from all defects.

2.4.3 The concrete for the blocks shall be mixed in the proportion of one (1) part of cement, three (3) parts of sand and six (6) parts of well graded coarse aggregate not exceeding  $\frac{1}{2}$ ” in size.

2.4.4 Concrete blocks shall be machine moulded. The concrete shall be well worked in the moulds, vibrated tamped and pressed to ensure that the blocks are dense and free from voids.

2.4.5 The blocks shall be cured by keep moist continuously for a period of at least ten (10A) days and then shall be allowed to dry in a shady location for atleast eight (8) days before being used in masonry.

- 2.4.6 Where blocks are to be exposed to view they shall have clean, cut straight and true, edges, smooth dense faces of uniform appearance without voids, honeycombs, projections or variation in texture and shall be free from cracks, chips, ragged edges or other defects detrimental of their appearance.
- 2.4.7 Where blocks are to be plastered the exposed surfaces shall have a coarse texture suitable for bonding the plaster as approved by the Consultants.
- 2.4.8 .The average compressive strength of any five blocks priced at random shall be not less than the strength as specified for 1:3:6 concrete under clause of the section of "Concrete".
- 2.4.9 The average moisture content of all concrete masonry units shall not exceed 30% of the total absorption of the units.

### **3. MATERIAL**

Concrete masonry unit shall be stacked on platforms and covered or stored in any other manner approved by the Consultants to protect from contact with the soil and exposure to weather. Care shall be taken in handling to avoid chipping and breakage. Storage piles stacks, or bins shall be so to avoid being disturbed or shall be barricaded to protect the blocks from damaged by construction operations.

### **4. MORTAR FOR MASONRY**

- 4.1 Cement shall be Portland as specified under Clause of the Section of "Concrete".
- 4.2 Fine aggregate shall be clean, hard, durable particles free from laminated material well graded from No. 4 to 100 sieve.
- 4.3 Water shall be clean and free from injurious acids, alkalies and organic impurities.
- 4.4 All mortar fro masonry shall be proportion of one (1) cement and four (4) sand (fine aggregate) and the ingredients shall be mixed by volume.
- 4.5 Mortar shall be mixed thoroughly in a drum type batch mixer for a period of not less than three minutes, using the quantity of water required to obtain the desired workability. Hand mixing shall be subject to approval by the Engineer Incharge and if he allows the mortar materials shall be mixed in a light mortar mixing box. In no case the mixing of mortar shall be done on open platform.
- 4.6 The mortar shall be subject to compressive strength test and the average compressive strength of three numbers 2" cubes of mortar shall be not less than 1,800 lbs per sq. inch at 28 days.
- 4.7 Mortar shall be used in the masonry within half an hour from addition of water into the mortar. The mortar which has already set shall not be used un the masonry.

## **5. MASONRY AND JOINTING**

- 5.1 All masonry shall be laid plumb, true to the line and level and accurately spaced coursed and with each course breaking joints with the course below. Bond shall be keeping plumb, corners and reveals shall be plumb and true. Chases, grooves, reglet blocks and raked out joints shall be kept free from mortar and other debris.
- 5.2 The thickness and length of various walls shall be as indicated on the drawings.
- 5.3 Unless otherwise shown on the drawings or specified the spaces around forms and other built in items shall be solidly filled with mortar except that joints that are to be caulked shall be raked out  $\frac{3}{4}$  inch.
- 5.4 Work required to be built-in with masonry including anchors, wall plugs and accessories shall be built-in as the work progress. Wood plugs and blocking shall not be built into masonry.
- 5.5 All horizontal and vertical joints shall be completely and solidly filled with mortar when and as the blocks are laid.
- 5.6 The thickness of joints shall not exceed  $\frac{3}{8}$ " and the joints shall be raked  $\frac{1}{2}$  "deep" when the mortar is still fresh so as to give proper bond to the plaster.
- 5.7 Where masonry abuts RCC columns or walls it shall be anchored thereto by means of wire anchors of galvanized metal not less than 10 gauge or 1" wide G.I. strip 22 gauge located at every fourth horizontal joint.
- 5.8 The top course of partitions under slabs beam shall not be laid until the forms have been removed and the roofing placed.
  - i. Masonry walls shall be cured for at least ten
  - ii. Days from the day it is installed.

## **6. MEASUREMENT AND PAYMENT**

All the items of work covered by this section of the specifications shall be measured by the standard method of measurements and paid in accordance with unit rates entered in the Bill of Quantities. No separate payment will be made for masonry anchor etc. required.

**SECTION – 9****POLYVINYLCHLORIDE WATER STOPPER****1. DESCRIPTION**

The work shall comprise providing and installing of all types of polyvinylchloride (PVC) water stops and expansion joints, in concrete structures and elsewhere, in accordance with these specifications and to the location, lines, grades and cross-sections shown on the Drawings and/or as directed by the Engineer.

**2. MATERIAL REQUIREMENTS**

- a. PVC water stops shall be extruded from an elastomeric plastic compound, having basic resin of polyvinylchloride (PVC).
- b. The compound shall contain such additive resins, plasticizers, stabilizers or other materials, needed to ensure following physical characteristics when tested by the US Corps of Engineers Test Methods, as specified below:

<b>Characteristics</b>	<b>Minimum Requirement</b>	<b>Test Method</b>
Tensile strength, using die III	123 kg/cm <sup>2</sup> (1750 psi)	568
Ultimate elongation, using die III	350%	573
Low temperature brittleness with no sign of failure such as cracking or chipping	- 35° F	570
Stiffness in flexure, 1/2" span	28 kg/cm <sup>2</sup> (400 psi)	571

**3. CONSTRUCTION REQUIREMENTS**

All the operations of installing, jointing and splicing the water stops shall be carried out in accordance with the recommendations and instructions of the Manufacturer and the directions of the Engineer.

- a. All embedment in concrete, lapping, turning and sealing shall ensure absolute water tightness.
- b. No holes shall be made through any water stops.
- c. The water stops, wherever indicated on drawings or directed by the Engineer, shall be cast
- d. Integrally with the in-situ concrete, with separate junction and intersection pieces, placed and jointed at Site.

- e. The water stops shall be installed, in such a way that they are held securely, in their correct position, during the placement of concrete.
- f. The concrete shall be fully and properly compacted around the water stops to ensure that no voids or porous areas remain.
- g. Where reinforcement is present; adequate clearance shall be left, between water stops and the reinforcement, to permit proper compaction of concrete.
- h. Splices, in the continuity, or at the intersections of runs of PVC water stops, shall be performed by heat-sealing the adjacent surfaces.
- i. A thermostatically controlled electric source of heat shall be used to make all splices. The correct temperature at which splices should be made will differ with the material used but should be sufficient to melt but not char the plastic.
- j. After splicing, a remoulding iron, with ribs and corrugations to match the pattern of the water stop, shall be used to reform the ribs at the splice. The continuity, of the characteristic components of the cross-section, of the water stop design (ribs, tabular center axis, protrusions, and the like) shall be maintained across the splice.

#### **4. MEASUREMENT**

- a. Measurement, for PVC water stops, will be made in the specified units of length, of the water stops, of specified type and size, acceptably placed, on the basis of the dimensions, in accordance with the Drawings or directions of the Engineer.
- b. No allowance will be made, in the above computed lengths, for the laps and splices.

#### **5. PAYMENT**

- a. Payment for, PVC water stops, of specified type and size, will be made for the quantity of water stops, measured in accordance with Article 4, at the unit rates, tendered in the priced Bill of Quantities.
- b. The unit rates tendered, for all items of concrete, shall be deemed to be inclusive of, but not limited to the following:
  - i. Providing all materials including splicing, sealing, jointing and filler materials
  - ii. All operations related with transportation, involved in the process
  - iii. All operations related with storage of materials
  - iv. All sorts of wastages
  - v. All operations including installing, splicing, sealing, jointing and securing water stops; laying of sealants and fillers in expansion joints; and protection, maintenance and repairs, of the water stops
  - vi. Carrying out all sampling and testing
  - vii. All other operations, procedures and requirements necessary to complete the work in accordance with these specifications.



## **SECTION - 10**

### **REINSTATEMENT OF ROAD**

#### **1. SCOPE OF WORK**

The work covered by this section of specifications consists of furnishing all plants, labour, equipment, appliances, and material required for all operations in connection with road cutting works during pipe laying work and restoring the road to original condition.

#### **2. GENERAL**

The Contractor shall arrange and provide adequate warning, lights and a sign to the satisfaction of the Engineer for the road cutting from the start of the road cutting work till it is restored to its original condition. Contractor shall be fully responsible for any damage or claim in case any accident takes place due to his negligence in not making proper arrangements in this regard.

#### **3. CUTTING AND RESTORATION OF ROAD**

Whenever a road is required to be cut for laying of pipe line or otherwise, prior intimation shall be given by the Contractor and approval taken from the Engineer. Also the Contractor shall have to obtain prior permission for cutting the road from the concerned Authority having the administrative control of the road in question. The Engineer shall provide the required authorization for obtaining the required permission. Cutting of road, digging the trench to the required level, laying and jointing the pipes, and backfilling and reinstatement work of the road shall be done as quickly as possible. After laying jointing and testing of pipes proper compaction of the backfill shall be done. Sub-base course and surface treatment of road in the reinstatement work shall be of the same quality and thickness as that of the original road. In all cases the Contractor shall carry out backfilling with required compaction. The sub-grade shall be prepared by using the dismantled hard crust of existing road.

#### **4. PAYMENT**

Payment for each road cutting and reinstatement work if required shall be made as per the approved BOQ rates after restoring the road to the satisfaction of the Engineer. The width of road cutting allowed for payment shall be same as allowed for payment of excavation for trenches.

## **SECTION -11**

### **EMBANKMENT**

#### **1. SCOPE**

The work shall consist of constructing common and select embankment including preparation of areas, upon which they are to be placed. The placing and compaction of approved material in areas as shown in the plans or as ordered by the Engineer/Engineer's Representative after removal of unsuitable materials and the placing and compacting of embankment materials in holes, pits and other depressions in accordance with the Specification and in conformity with the lines, grade, thickness and typical cross-sections shown on the plans or established by the Engineer/Engineer's Representative. Only approved materials obtained from the excavation within project area or from outside borrow sources shall be used in the construction of embankments. Select embankment shall be constructed in areas selected from those, which are to be paved or upon which structures are to be built or as specified by the Engineer/Engineer's Representative. In all other areas common embankment shall be constructed. Select embankment shall not be constructed in areas where foundations for structures are to be constructed unless load bearing test has been completed and approved by the Engineer/Engineer's Representative.

If material for embankments or select embankment is obtained from sources outside the Project/Scheme boundary, the Contractor shall provide the Engineer/Engineer's Representative, within fourteen (14) days prior to the scheduled beginning of construction with a complete statement of origin and composition of various materials to be used for construction of embankment or select embankment from borrow excavation. Borrow excavation will be used only when material obtained from roadway or structural excavation is not suitable or is deficient for embankment formation and shall include all lead and lift.

The Quarry pits or gravel deposits shall be approved by the Engineer / Engineer's Representative in all cases. The Contractor shall determine the location, suitability and quantity of material available before tendering as well as the cost and the amount of work required to arrange, screen and the length of haulage to the job site. The Contractor shall also satisfy himself and make a determination of the amount of over burden that must be removed from any borrow area or quarry site and the cost of handling such over burdens. The Contractor shall include all costs in his quoted price.

#### **2 MATERIALS**

The embankment materials shall be free of excessive clay, organic and other unsuitable matters. All material from excavations shall be used unless otherwise declared unsuitable by the Engineer/Engineer's Representative. The material from excavation shall be improved by mixing with other good quality material as and when directed by the Engineer/Engineer's Representative. The material used in common and select embankment shall comply with the properties as described hereinafter for the respective type of embankment.

**a COMMON EMBANKMENT**

Material obtained from common excavation, structural and trench excavation shall be used in the construction of common embankment unless otherwise declared unsuitable by the Engineer / Engineer's Representative. Borrow area shall be approved by the Engineer / Engineer's Representative before start of excavation in borrow areas to obtain material for the construction of common embankment.

**b. SELECT EMBANKMENT**

Material for construction of select embankment shall be well graded on coarser side commonly known as GERA material and generally available from river/nullah bed. It shall generally conform to AASTHO Class A-1 as specified in AASHTO M-145 or better materials, which may be approved by the Engineer/Engineer's Representative. The maximum particle size shall not exceed 2-1/2" and the material must be having sufficient binding material to form a compact mass for sub-grade. All the materials shall have a plasticity index of six (6) and a maximum liquid limit of twenty five (25) and CBR value not less than 20%.

**c. ROCK MATERIAL EMBANKMENT**

Embankment formed of material consisting predominantly of rock fragment of such size that the material cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces, such material may be placed in layers not exceeding in thickness than the approximate average size of the rocks except that no layer shall exceed thirty (30) inches of loose measurement and compacted by a vibratory roller with minimum mass as shown in the following table.

<b>Mass per feet width of vibrating roll (lb/ft)</b>	<b>Depth of fill layer (in.)</b>	<b>Min. Number of passes of the roller on each layer</b>
1550 – 1950	16	5
1950 – 2400	20	5
2400 – 2900	24	5
2900 – 3350	28	5
> 3350	31	5

The material shall be carefully placed in layers, so that all larger stones will be well distributed and voids completely filled with smaller stones, clean small spells, shale, earth, sand, gravel, to form a solid mass. After placing rock material, surface shall be covered with a layer of fine material having thickness less than eight (8) inches. Such fine material shall be reserved from roadway excavation by the contractor. Should such material be available but not reserved, Contractor will supply and place borrow material for forming smooth grade without extra payment.

Each layer shall be bladed or leveled with motor grader, bulldozer or similar equipment capable of shifting and forming the layer into a neat and orderly condition. No rock larger than three (3) inches in any dimension shall be placed in the top six (6) inches of embankment unless otherwise allowed by the Engineer.

Material for each layer should be consolidated with heavy weight vibratory roller until settlement as checked between two consecutive passes of roller is less than one (1%) percent of the layer thickness. In evaluation of settlement, survey points should be established and rolling continued until difference of levels as checked after two consecutive passes is less than one (1%) of the total layer thickness. More over initial rolling of overlaid fine material shall be done without watering to ensure their intrusion in voids of rock layer beneath. Watering shall be done when voids are properly filled.

Embankments, which are formed of material that contain rock but also contain sufficient compactable material other than rock or other hard material to make rolling feasible, shall be placed and compacted in the manner prescribed above and to the point when settlement is within above mentioned requirement. Compaction test will be made whenever the Engineer determines they are feasible and necessary. Each layer must be approved by the Engineer before the next layer is placed.

When rock to be incorporated in fill is composed largely of weak or friable material, the rock shall be reduced to a maximum size not exceeding fifty (50%) of the thickness of the layer being placed.

**d. EMBANKMENT ON STEEP SLOPES**

Where embankments are to be constructed on slope, hillsides or where new fill is to be placed and compacted against existing pavement or where embankment is to be built along one half the width at a time, the original slope of the hill side, of existing pavement or adjacent to half width of embankment shall be cut in steps of eight (8) inches depth. Benching shall be of sufficient width to permit operation of equipment possible during placing and compaction of material.

Cut material shall be incorporated with the new embankment material and compacted in horizontal layers. No extra payment will be allowed for such an operation.

### **3 EXECUTION**

#### **3.1 EMBANKMENT**

Logs, sods, trees, stumps, weeds, heavy grass, or other undesirable materials shall not be placed in embankments.

Before the start of fill, the Contractor shall satisfy himself as to the levels and slopes of the fill shown on the Drawings, the requirements of compactions, the possibility of settlement and all other particulars whatsoever in connection with the filling works.

Embankment shall be constructed to the lines and elevations designed. The existing ground under embankments shall be stripped off to a minimum depth of six (06) inches and compacted to 95 percent of modified AASHTO density.

The embankment material shall be placed in successive horizontal layers of not more than eight (8) inches in loose depth for the full width of the cross-section. Placement shall begin in the deepest portion of the fill and the layers shall be constructed approximately parallel to the finished surface. Embankments shall be free from material containing visually recognizable quantities of gypsum, and from lenses, streaks, pockets and layers of material differing substantially in texture or gradation from surrounding material.

When embankment is to be placed and compacted on hillsides or where new embankments is to be compacted against existing embankments, or where embankments is built part width at a time, the slopes that are steeper than four to one 4:1 when measured at right angles to the roadway shall be continuously benched over those areas where it is required as the work is brought up in layers of eight (8) inches depth. Benching shall be of sufficient width to permit operations of placing and compacting equipment and or as directed by the Engineer/Engineer's Representative. Each horizontal cut shall begin at the intersection of the original ground and vertical sides of the previous cuts. Material thus cut out shall be re-compacted along with the new embankment material at the Contractor's expense.

Whenever embankments are placed adjacent to structures or at locations where it is not practicable to use roller, the embankment materials shall be tampered by the use of mechanical tampers. Loose material shall be placed in horizontal layer for a maximum of six (6) inches thick layer and each layer shall be compacted to a density to or greater than obtained under the above rolling procedures for the type of compaction designated.

If the embankments can be deposited on only one side of abutments, wing walls, piers or culverts headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structures.

The Engineer/Engineer's Representative shall have full authority to require any time, the suspension of delivery of material to the embankment until previously delivered materials are properly placed and preceding layers are satisfactorily smooth and uniform and tested.

The Contractor shall be responsible for the stability of all embankments and shall replace all sections of same which in the opinion of the Engineer/Engineer's Representative, have been damaged or displaced due to carelessness or neglect on the part of the Contractor, or due to natural causes, such as rains, and not attributable to the unavoidable movement of the natural ground upon which the embankment is made. During construction, the roadway shall be kept shaped and drained at all times. When unsuitable material has been placed in the embankment, its removal shall be at the expense of the Contractor.

Side slopes shall be neatly trimmed to the lines and slopes shown on the plans or as directed by the Engineer/Engineer's Representative and the finished work left in a neat and acceptable condition. During the progress of work it may be found necessary or desirable by the Engineer/Engineer's Representative to vary the levels, elevations and grades of filling from those shown on drawings and the Contractor shall perform filling to the revised levels, elevations and grades as established by the Engineer/Engineer's Representative.

If the Contractor fills any area to levels and grades greater than required he shall excavate and re-instate the surfaces and dispose-off excess material as directed by the Engineer/Engineer's Representative at his own cost.

Rock, clay or other material shall be broken up and no accumulation of lumps and boulders in the embankment will be permitted.

### **3.2 MOISTURE CONTROL**

The moisture content of the material during compaction shall be not more than two-percent above or below the optimum moisture content as determined by ASTM D 1557, Method D, unless otherwise approved.

The moisture content of loose material in embankments shall be adjusted as necessary so that the moisture of the entire layer is uniform and within the required limits.

Embankment material that does not contain sufficient moisture to obtain the required compaction shall be given additional moisture by means of approved sprinklers and mixing.

Material containing more than the optimum moisture content may not, without written approval of the Engineer, be incorporated in the embankment until it has been sufficiently dried out. The drying of wet material may be expedited by scarification, disking or other approved methods.

If the top or contact surfaces of the previous embankment layer, or foundation, are determined to have become too dry to permit a satisfactory bond between those surfaces and the embankment to be placed thereon, such surface shall be scarified, the loosened material dampened to the required moisture content, and then re-compacted to the specified density.

Before placing additional embankment, material determined to be soft and yielding due to excessive moisture shall be replaced with satisfactory material, or scarified and allowed to dry out to the specified moisture content and re-compacted.

### **3.3 COMPACTION**

95 percent maximum dry density shall be determined for the material to be compacted in accordance with ASTM D1557, Method D unless otherwise specified. In-place density shall be determined as a percentage of the percent maximum dry density in accordance with AASHTO T-191 or ASTM D2167.

Embankment shall be compacted to at least 95 percent maximum dry density for the top three (03) feet layer and compacted to 90 percent maximum dry density below the three (03) feet top layer.

Embankment under structural foundations shall be constructed in eight (08) inches thick layers and each layer shall be compacted to 95 percent maximum dry density.

### **3.4 WEATHER LIMITATIONS**

Earthwork operations shall be suspended when satisfactory results cannot be obtained because of rain or other inclement weather. Drag, blade or slope the embankment to provide proper surface drainage. However no additional payment of extension in completion period shall be given to the Contractor for this suspension and he shall make his work schedule keeping in view such events.

### **3.5 TOLERANCES**

Surfaces of areas to receive pavement or base course and inverts of ditches shall be of such smoothness that, when tested with a five (05)- foot straightedge there shall be no deviation in excess of one (01) inch.

There shall be no deviation in elevation of more than one (01) inch from the elevations shown.

Other surfaces shall have a smoothness deviations not greater than two (02) inches when tested with a five-meter straightedge and no deviation in elevation in excess of two (02) inches from elevations shown.

### **3.6 WATER CONTROL**

Remove water accumulating in excavations during the installation of utility lines and structures, while concrete is setting, and until sufficient backfill has been placed to prevent movement and damage to utilities or structures.

## **4. TESTING**

A testing program is required. Tests shall be performed by the Contractor to ensure compliance with these specifications as required. A copy of all test reports shall be submitted to the Engineer/Engineer's Representative for approval. Tests shall be performed in accordance with the following test procedures and frequency of testing.

4.1 Gradation

ASTM C136. One initial series for each material from each source and then weekly.

4.2 Density of Soil in Place

AASHTO T – 191 or ASTM D 2167, as determined. One series for each 2000 Sft. of sub-grade or layer of fill.

4.3 Laboratory Maximum Density and Optimum Moisture Content

ASTM D 1557, Method D. One initial series for each material from each sources and then weekly.

4.4 Relative density for cohesionless soils ASTM D 2049. One initial series for material from each source and then weekly.

4.5 Moisture Content

AASHTO T-265/ASTM D 2216, as required for density testing and as directed by the Engineer/Engineer's Representative may increase or decrease the frequency of testing as required.

Prior to the commencement of embankment the Contractor shall construct trial compaction lengths as directed by the Engineer/Engineer's Representative. The soils used in the trials shall be those encountered during excavation and the compaction equipment to be used shall be that specified in the Contractor's detailed Program of Work and approved by the Engineer/Engineer's Representative. The object of these trials is to determine the best field moisture content of the material and the relationship between the number of compaction equipment passes and density attained. The Engineer/Engineer's Representative may order additional compaction trials when he deems them necessary.

**5. MEASUREMENT AND PAYMENT**

The quantities to be paid for shall be the number of cubic feet in the volume of embankment compacted in place, after clearing, grubbing and stripping, accepted by the Engineer/Engineer's Representative formed with material resulting from :

- 1) Common and Rock Excavation
- 2) Out side sources
- 3) Trench and Structural Excavation

Material from Common and Rock Excavation or other project areas which is placed in the embankment and accepted by the Engineer/Engineer's Representative will be paid for in the embankment and such payment will be deemed to include the cost of hauling or transportation up to any lead and lift unless otherwise mentioned in the Estimates and all other costs in constructing the embankment with this material. No separate payment shall be made to prepare the base/surface to start construction of embankment.



Material from out side sources arranged/obtained by the contractor at his own, which is placed in the embankment and accepted by the Engineer/Engineer's Representative will be paid for only in the embankment and such payment will be deemed to include the cost of excavating hauling or transportation upto any lead and lift unless otherwise mentioned in the Estimates, payment of royalties to landowners and/or local communities and all other costs in constructing the embankment with this material.

Material from Trench and Structural Excavation which is placed in the embankment and accepted by the Engineer/Engineer's Representative will be paid for in the embankment and such payments will be deemed to include all costs for hauling and transportation upto any lead & lift unless otherwise mentioned in the Estimates in constructing the embankment with this material.

The quantities, determined as provided above shall be paid for at the contract unit price, respectively, for each of the particular pay items shown in the Estimates which price and payment shall be full compensation for all the costs necessary for the proper completion of the work prescribed in this item, as shown on drawings or as directed by the Engineer/Engineer's Representative, including cost of excavation, hauling or transportation upto the place of work, stockpiling, spreading, watering, rolling, labour, equipment, tools and other incidentals in connection with construction of embankment.

## **SECTION -12**

### **ROAD WORKS AND PAVEMENTS**

#### **1. SCOPE**

The work under this section of the Specifications consist of furnishing all plant, materials and labor and performing all operations for the construction of roads, and all other paved areas in accordance with the drawings and specification and to the satisfaction of the Engineer/ Engineer's Representative. The work shall include preparation of sub-grade, placing and compacting of sub-base course, base course, bituminous concrete paving, precast concrete pavers, stone blocks, gutter and kerbs.

#### **2. EXECUTION**

##### **2.1 SURVEY**

The Engineer/Engineer's Representative will provide the Contractor with survey and all necessary construction drawings before commencement of works. A joint survey of the areas designated for paving shall be made and submitted to the Engineer/Engineer's Representative for approval. The Engineer/Engineer's Representative may make amendments in the Construction Drawings before or during the execution.

##### **2.2 UNDERGROUND SERVICES**

Before commencing any excavations, the Contractor or his representative shall accompany the Engineer/Engineer's Representative on Site inspection in order to consider any circumstances, which may indicate the presence of water or other service pipes at or in the vicinity of the excavations. Thereafter the Contractor shall carryout the excavations in such a manner and sequence as the Engineer/Engineer's Representative directs.

If during excavations the Contractor's workmen uncover any cables, water pipes or other service pipes, work shall be stopped immediately and shall not be started again until the matter has been reported to the Engineer/Engineer's Representative, who will issue whatever directions he deems appropriate.

#### **3. MEASUREMENT AND PAYMENT**

No separate payment shall be made for the work involved within the scope of this section of specifications, except when otherwise provided for in the Estimates or herein. The cost thereof shall be deemed to be included in the quoted percentage and unit rates of other items of Estimates.

## **SECTION -13**

### **PREPARATION OF SUB-GRADE**

#### **1. SCOPE**

The sub-grade is that part of the work on which sub-base is placed or if there is no sub-base, the base of pavement structure. Preparation of sub-grade shall consist of excavating from higher area and filling of lower area to the required level and grades and compaction as shown in the drawing or as directed by the Engineer/Engineer's Representative.

#### **2. MATERIALS**

The suitable material from excavation for Sub-grade shall have minimum CBR of five (05) Percent.

#### **3. EXECUTION**

##### **3.1 PRIOR WORKS**

Culverts, drain pipes and any other minor structures below the sub-grade level, including the fully compacted backfill over them, if necessary to within twelve (12) inches below the sub-grade level; ditches, drains, outlets for drainage and headwalls and wing walls for culverts, shall be in such operative condition as to ensure prompt and effective drainage and to avoid damage to the sub-grade by surface water. No work shall be started on the preparation of the sub-grade before the prior works herein described have been approved by the Engineer/Engineer's Representative.

##### **3.2 SUBGRADE IN CUT**

Unless otherwise directed by the Engineer/Engineer's Representative, the soil below sub-grade elevation shall be excavated to a minimum depth of six (06) inches if required, and material removed from the road way portion to the areas within the Site as directed by the Engineer/Engineer's Representative. Moisture content shall be adjusted within the designated moisture range and compacted to 95% of maximum dry density as determined by AASHTO method T-180. If soil encountered at the sub-grade elevation as shown in the plans is found unsuitable in the opinion of the Engineer/Engineer's Representative then this unsuitable soil shall be removed, disposed off and replaced by the approved select embankment material to the depth as directed by the Engineer/Engineer's Representative.

##### **3.3 SUBGRADE IN ROCK CUT**

Excavation in rock shall extend to the sub-grade level as shown on drawings. Rock shall be undercut nearly to required elevation and sections shown on the plans or as directed by the Engineer. Transverse and longitudinal profiles checked by template shall be accurate to the requirement. Cuts below sub-grade level shall be backfilled with selected sub-base material and compacted to minimum ninety eight (98) percent of the maximum dry density as determined by AASHTO T-180, method 'D'. No compensation shall be made to the Contractor for over cut remedial measures as described above.

No rock shall be higher than one (01) inch above the under cut section elevation. The under out material shall be placed in embankment or disposed of at the direction of Engineer.

### **3.4 PROTECTION OF COMPLETED WORK**

Any part of the sub-grade that has been completed shall be protected and well drained and any damage resulting from default of the Contractor shall be repaired as directed by the Engineer/Engineer's Representative without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the sub-grade. He shall repair any ruts or ridges occasioned by his own traffic or that of others by reshaping and compacting with rollers of the size and type necessary for such repair. The Contractor shall limit the amount of sub-grade preparation to an area that can be maintained with the equipment available. The Contractor shall arrange for sub-grade preparation and sub-base or base placing to follow each other closely. The sub-grade, when prepared too soon in relation to the laying of the sub-base, is liable to deteriorate, and in such case the Contractor shall, without additional payment, repair, re-roll, or re-compact the sub-grade as may be necessary to restore it to the state specified herein.

### **3.5 FINISHES AND TOLERANCES**

The finished sub-grade surface with specified camber shall be smooth and even and when measured with 10 ft. straight edge the tolerance from the designed grades shall be no more than 1 inch. No tolerance above the designed grade is allowed. Sub-grade that does not conform to this shall be reshaped at the expense of the Contractor and no material for the subsequent work shall be placed until the sub-grade is in perfect condition and approved by the Engineer/Engineer's Representative.

## **4. MEASUREMENT AND PAYMENT**

The quantity to be paid for shall be the number of square feet of sub-grade prepared as hereinbefore prescribed and accepted. Sub-grade on embankments shall not be measured for direct payment.

The quantities, determined as provided above, shall be paid for at the contract unit price respectively, for each of the particular pay items shown in the Estimates. These prices and payments shall be full compensation for all costs necessary for the proper completion of the work prescribed in this item including disposal of unsuitable and surplus material as directed by the Engineer.

## **SECTION -14**

### **SUB-BASE AND BASE COURSE**

#### **1. SCOPE**

##### **1.1 GRANULAR SUB-BASE/SOIL AGGREGATE COURSE**

This work shall consist of furnishing and placing one (1) or more courses of granular sub-base/soil aggregate, on a prepared sub-grade in accordance with the Specifications, in conformity with the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer/ Engineer's Representative.

##### **1.2 AGGREGATE BASE COURSE**

This work shall consist of furnishing and placing one (1) or more layers of aggregate base, on a prepared surface in accordance with the Specifications, and in conformity with the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer/Engineer's Representative.

#### **2. MATERIALS**

##### **2.1 AGGREGATES**

All aggregates for use in the construction of the sub-base and base courses shall be obtained only from sources approved by the Engineer/Engineer's Representative. The actual quarry pits or gravel deposits shall be in all cases approved by the Engineer/Engineer's Representative.

The Contractor shall determine the location, suitability and quantity of material available before tendering as well as the cost and the amount of work required to crush, screen and the length of haulage to the job site. The Contractor shall also satisfy himself and make a determination of the amount of overburden that must be removed from any quarry site and the cost of handling such overburden. The Contractor shall include all costs in his unit price.

The Contractor shall provide the Engineer/Engineer's Representative, within twenty-eight (28) days prior to the scheduled beginning of construction with a complete statement of the origin and composition of all stone and/or gravel aggregates to be used in the work, including those for sub-base and base course. All material shall comply with the specified requirements for the various aggregates.

The location and the manufacture of aggregates at the rates and in the quantities required to complete the work within the specified Contract Time, which must meet the requirements of the Specifications is the sole responsibility of the Contractor

The approval of the Contractor's crushing and screening plant equipment by the Engineer/Engineer's Representative shall in no way relieve the Contractor of the responsibility of producing aggregates which meet the specifications and in the quantities required for the completion of the work within the specified Contract Time.

No aggregate producing equipment shall be put into operation prior to the approval of the equipment by the Engineer/Engineer's Representative. If after the equipment is put into operation it fails to perform as proposed, the Contractor shall provide additional approved equipment or replace the original equipment with more suitable equipment, as may be directed by the Engineer/Engineer's Representative.

The Contractor shall commence crushing and screening of aggregates for sub-base, base, concrete, or as otherwise may be required immediately after the occupancy of the Project Laboratory by the Engineer/Engineer's Representative and/or immediately after the Contractor receives approval of aggregate sources.

## 2.2 GRANULAR SUB-BASE/SOIL AGGREGATE COURSE

The sub-base material shall be clean and free from organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm stable base.

The material shall comply to the following grading and quality requirements:-

- a) Material for sub-base/soil aggregate shall consist of well-graded gravel with sand and silt, conforming to the following requirements:

AASHTO Sieve	Percent Passing
2-1/2 in.	100
2 in.	90 - 100
No. 4	35 - 70
No. 200	0 - 15

The grading is based on aggregates of uniform specific gravity, and the percent passing the various sieves are subject to correction by the Engineer/Engineer's Representative when aggregates of varying specific gravities are used.

- Liquid Limit (AASHTO T-89) 25 maximum
- Plasticity Index (AASHTO T-90) 6 maximum
- Sand Equivalent (AASHTO T-176) 25 minimum
- Loss by Abrasion (AASHTO T-96) 50 maximum

- b) The material shall have a CBR value of at least 30%, determined according to AASHTO T-193. The CBR value shall be obtained at a density corresponding to 100% of the maximum dry density determined according to AASHTO T-180 method D.

## 2.3 AGGREGATE BASE COURSE

Materials shall conform to the requirements for the "Aggregate Base Course" specified. All aggregates for base course shall consist of clean, tough, durable, sharp angle fragments free of any excess of thin or elongated pieces, and reasonably free of soft, disintegrated or decomposed stone, dirt or other deleterious matter.

Crushed gravel or stone fragments for base courses shall consist of the product obtained by crushing gravel or rock that, if directed by the Engineer/Engineer's Representative, has first been screened in such a manner that not less than ninety (90) percent of the material to be crushed is retained on a one-quarter (1/4) inch sieve. The amount of crushing shall be regulated so that at least ninety (90) percent by weight, of the pieces retained on the No.4 sieve have at least two (2) mechanically fractured faces.

o Co-efficient of uniformity	$\frac{D_{60}}{D_{10}}$	4 Minimum
o' Co-efficient of curvature	$\frac{D_{30} \times D_{30}}{D_{10} \times D_{60}}$	Between 1 & 3

- Physical Requirements: All base course aggregates shall conform to the following physical requirements:

Loss of Sodium Sulfate Soundness	
Test (AASHTO T-104)	10 percent maximum
Loss of Magnesium Sulfate soundness	
Test (AASHTO T-104)	12 percent maximum
Loss by Abrasion Test (AASHO T-96)	40 percent maximum
Sand Equivalent (AASHTO T-176)	45 Minimum
Laminated material shall not exceed	
15 % percent of total volume of aggregate base course.	
Friable Particles (AASHTO T 112)	0.25 percent maximum
CBR of material passing 3/4 inch sieve	80% minimum

- Gradation: Coarse materials for base course shall be crushed rock or crushed gravel conforming to the following grading requirements:

<b>AASHTO Sieve</b>	<b>Percent Passing</b>
2 1/2 in.	100
2 in.	90 - 100
1 1/2 in.	35 - 70
1 in.	0 - 15
1/2 in.	0 - 5

Fine materials for base course shall be quarry screenings or natural material and of suitable binding quality as approved by the Engineer/Engineer's Representative. The material shall be free from foreign or organic matter, dirt, shale, clay and clay lumps, or other deleterious matter and shall conform to the following requirements:-

<b>AASHTO Sieve</b>	<b>Percent Passing</b>
3/8 in.	100
No. 4	85 - 100
No. 100	10 - 30
Plasticity Index (AASHTO T-90)	6 maximum
Sand Equivalent (AASHTO T-176)	30 minimum

The combined material shall consist of a mixture of all aggregate uniformly graded from coarse to fine to conform to the following gradation requirements:

<b>AASHTO SIEVE</b>	<b>PERCENT PASSING</b>
2 in.	100
1 in.	70 - 95
3/8 in.	30 - 65
No. 4	25 - 55
No. 10	15 - 40
No. 40	8 - 20
No. 200	2 – 8

When the aggregate is a total aggregate, it may be accepted at the crusher. Acceptance of the material by the Engineer/Engineer's Representative does not constitute acceptance of the base course, only that the material is approved for use in the base course.



### **3. STORAGE**

Materials shall be stored so as to ensure preservation of their specified quality and fitness for the work. The material shall be placed on hard, clean surfaces and, when required by the Engineer/Engineer's Representative, shall be placed under cover. Stored materials shall be located so as to facilitate prompt inspection and control. Private property shall not be used for storage purposes without written consent of the owner.

The centre of the storage area shall be elevated and sloped to the sides so as to provide proper drainage of excess moisture. The material shall be stored in such a way as to prevent segregation and coning to ensure proper control of gradations and moisture. Coarse aggregate storage piles shall be built-up in layers not exceeding 3 ft. The height of a stockpile shall be limited to a maximum of 15 ft. The equipment and methods used for stockpiling aggregates and for removing from the stockpiles must be approved by the Engineer/Engineer's Representative and shall be such that no detrimental degradation of the aggregate will result and no appreciable amount of foreign material will be incorporated into the aggregate.

The stockpile site shall be prepared by clearing and smoothing and must be approved by the Engineer/Engineer's Representative. Prior to any stockpiling of aggregates, cross sections of the stockpile site shall be taken and control points established for use in determining the quantity of subsequently stockpiled material.

### **4. TESTING**

In order to ascertain the properties of all aggregate materials, the Contractor shall submit for approval by the Engineer/Engineer's Representative, test certificates from an approved testing laboratory for all materials intended for incorporation in the work prior to commencement of work.

Representative samples for such testing shall be taken by the Contractor, at his expense, in the presence of the Engineer/Engineer's Representative, and duplicate samples shall be submitted to the Engineer/Engineer's Representative for future reference.

The Contractor may, if approved by the Engineer/Engineer's Representative, conduct the necessary tests in the Project Laboratory. The tests shall be conducted in the presence of the Engineer/Engineer's Representative by the Contractor's Material-Engineer. The qualifications of the Contractor's Materials-Engineer must be submitted to and approved by the Engineer/Engineer's Representative prior to any testing operations.

This testing, whether performed at an approved testing laboratory, or in the Project Laboratory, shall be solely the Contractor's responsibility and will be at the Contractor's expense. The testing frequency, acceptance limits and other pertinent information for proper control of each work item shall conform to the following tables No. 1520-A and 1520-B. The tables provide the minimum under normal conditions.

**TABLE 1520-A**  
**SCHEDULE OF SAMPLING AND TESTING AGGREGATE BASE COURSE**

<b>WORK ITEM</b>	<b>MATERIAL</b>	<b>TEST METHOD/ AASHTO</b>		<b>SAMPLING AND TESTING FREQUENCY ACCEPTANCE LIMIT</b>
Aggregate Base Course	Aggregate	Gradation	T27	3/Source plus 1/20000 cft.
		Plasticity	T89, T90	3/Source plus as Index required based on Visual observations
		CBR	T180,T193	3/Source plus as required based on variation in gradation
		Abrasion	T96	3/Source plus 1/100000 cft.
		Sodium Sulphate Soundness	T104	3 source plus 1/10000 cft.
		Fractured Faces	Visual	3/source plus as required based on visual observation.
		Flat and elongated particles	Visual	- do -
		Moisture Density	T180	1/35000 cft.
		Field Density	T191 T238 & T239	4/layer/1500 ft. 3 min./layer if less than 1500 ft.laid Note (a)

**Note:** (a) For number of tests 3 or more, average value must be equal to or greater than 100% as specified compaction requirements in section 1520 and no individual test shall yield less than 98%. Test locations shall be selected by random method.

**TABLE 1520-B**  
**SCHEDULE OF SAMPLING AND TESTING FOR GRANULAR SUB-BASE**

WORK ITEM	MATERIAL	TEST METHOD / AASHTO		SAMPLING AND TESTING FREQUENCY ACCEPTANCE LIMIT
Granular Sub-Base	Aggregate	Gradation	T27	3/Source plus 1/20000 cft.
		Plasticity	T89, T90	3/Source plus as Index required based on Visual observations
		CBR	T180,T193	3/Source plus as required based on variation in gradation
		Abrasion	T96	3/Source plus 1/200000 cft.
		Moisture Density	T180	1/20000 cft.
		Field Density	T191 T238 & T239	4/layer/1500 ft. 3 min./layer if less than 1500 ft.laid Note (a)

**Note:** (a) For number of tests 3 or more, average value must be equal to or greater than 100% as specified compaction requirements in section 1520 and no individual test shall yield less than 98%. Test locations shall be selected by random method.

#### 4.1 Approval and Inspection

All sources of material shall be approved by the Engineer/Engineer's Representative prior to procuring or processing material from such sources. Test certificates obtained or performed by the Contractor at his expense are intended to assist the Contractor in his estimate of the location, extent and quantities which will comply with the Specifications when properly processed, and will in no way obviate the need for further testing by the Engineer/Engineer's Representative. Only materials from approved sources shall be processed for incorporation into the work. Approval of specific sources of materials shall not be construed as final approval and acceptance of materials from such sources.

All processed material shall be tested and approved before being stored on the site or incorporated in the work and may be inspected and tested at any time during the progress of their preparation and use. Questionable materials, pending laboratory testing and subsequent approval, shall not be unloaded and incorporated with

materials previously approved and accepted. If however, the grading and quality of the material delivered to the site do not conform to the grading and quality as previously inspected and tested, or do not comply with the Specifications, the Engineer/Engineer's Representative reserves the right to reject such materials at the site of the work. Only materials conforming to the requirements of the Specifications shall be used in the work.

Samples must meet all test requirements as specified under the Specifications. The Contractor shall permit the Engineer/Engineer's Representative or his designated representative to inspect any and all materials used or to be used, at any time during or after its preparation, or while being used during the process of the work or after the work has been completed. All such materials not complying with the required Specifications, whether in place or not, shall be rejected and shall be removed promptly from the work. The Contractor shall supply, or arrange with any producers or manufacturers to supply all necessary material, labour, tools and equipment for such inspection.

## **5. EXECUTION**

### **5.1 GRANULAR SUB-BASE/SOIL AGGREGATE**

- a) Preparation of Sub-grade: Unless otherwise sub-grade preparation is called for on the plans or sub-grade preparation appears as a separate item for compensation in the Estimates, the Contractor shall, as part of the work of sub-base, prepare the sub-grade. The formation of the sub-grade shall be excavating sufficient material from the roadway area and placing the "Granular Sub-base" on the sub-grade obtained thereby. The sub-grade shall, as hereinafter described, be brought to the lines, grades, and typical section shown on the plans for the bottom of the "Granular Sub-base".
- b) Spreading: Sub-base aggregates shall be spread on sub-grade, which has been approved by the Engineer/Engineer's Representative. Sub-base which has been placed on a sub-grade not approved by the Engineer/Engineer's Representative, shall be removed at the Contractor's expense.

Sub-base aggregate shall be spread on the sub-grade in layers not exceeding six (6) inches in compacted depth. Spreading shall be done by means of approved mechanical spreaders, distributing the material to the required width and loose thickness. Where the required sub-base thickness is greater than six (6) inches, the material shall be placed in layers of equal thickness, in no case shall a layer be less than three (3) inches thick

The material shall be handled so as to avoid segregation. Segregated materials shall be remixed until uniform. Suitable precautions shall be taken to prevent rutting of the sub-grade during the spreading of the sub-base material. No hauling or placement of material will be permitted when, in the judgment of the Engineer/Engineer's Representative, the weather or road conditions are such that the hauling operations will cause cutting or rutting of the sub-grade or cause contamination of the sub-base material.

- c) **Compaction:** The moisture content of the sub-base material shall be adjusted prior to compaction, by watering with approved sprinkler trucks or by drying out, as directed by the Engineer/Engineer's Representative, to that extent required to obtain the specified density for sub-base. Sub-base shall be compacted to one-hundred (100) percent of the maximum dry density as determined according to AASHTO T-180 Method D, or to seventy-eight (78) percent of the relative density in accordance with ASTM D-2049, as deemed appropriate by the Engineer/Engineer's Representative. The moisture content directed by the Engineer/Engineer's Representative shall be the optimum moisture content determined from the moisture-density test performed in the laboratory on the sub-base material, or as otherwise directed by the Engineer/Engineer's Representative after compaction trials as specified in sub- paragraph (d) of this section.

The sub-base aggregate shall be compacted by means of approved compaction equipment progressing gradually from the outside towards the center with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to the specified density. Rolling shall be accompanied by sufficient blading, in a manner approved by the Engineer/Engineer's Representative, to ensure a smooth surface free from ruts or ridges and having the proper section and crown.

Any areas inaccessible to normal compaction equipment shall be compacted by means of mechanical tampers until satisfactory compaction is obtained.

Each layer of sub-base course must be completely compacted and approved by the Engineer/Engineer's Representative prior to the delivery of materials for a succeeding layer of sub-base.

- d) **Compaction Trials:** If directed by the Engineer/Engineer's Representative, prior to the commencement of his sub-base operations, the Contractor shall construct trial lengths, not to exceed two hundred (200) ft. The materials used in the trials shall be that approved for use as sub-base and the equipment used shall be that according to the Contractor's approved detailed program of work.

The object of these trials is to determine the adequacy of the Contractor's equipment, the loose depth measurements necessary to result in the specified compacted layer depths, the field moisture content, and the relationship between the number of compaction passes and the resulting density of the material.

The Contractor may proceed with sub-base and work only after the methods and procedures established in the compaction trial have been approved by the Engineer/Engineer's Representative.

- e) **Finishing:** The Contractor shall program his operations to avoid the drying out of the sub-base during construction. If any layer of sub-base material, or part thereof, is permitted to dry out after compaction, or does not conform to the required density or finish, the Contractor shall, at his own expense, rework,

water or recompact the material, as directed by the Engineer, to the density specified, before the next layer of sub-base is superimposed thereon.

Immediately prior to the placing of the first layer of base course on the sub-base the final layer of sub-base shall be at the specified density and to the required grade and section. In order to maintain these requirements while placing the next course, it may be necessary to water and reshape the surface of the sub-base, which work shall be at the Contractor's expense.

The surface of the finished sub-base will be tested with a ten (10) ft. long straight edge by the Engineer/Engineer's Representative at selected locations. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed one half (1/2) inches when placed on or parallel to the centerline or when placed perpendicular to the center line of the roadway. The sub-base shall be compacted to the thickness and cross section as shown on the plans and shall not vary by more than one half (1/2) inch from the required elevation. All humps and thickness deficiencies exceeding the specified tolerances shall be corrected by removing the defective work or by adding new material as directed by the Engineer/Engineer's Representative.

No material for base course shall be placed until the sub- base has been approved by the Engineer/Engineer's Representative.

## **5.2 AGGREGATE BASE COURSE**

- a) Combining Aggregate and Water: Aggregate for base course shall be combined into a uniform mixture and water added by watering and mixing in a manner approved by the Engineer/Engineer's Representative, before final placement of the material.

The moisture added to the aggregates shall be that required, as designated by the Engineer/Engineer's Representative, to obtain the specified density thereby preparing an aggregate completely ready for compaction after spreading on the sub-base. In no case will the wetting of aggregates in stockpiles or trucks be permitted.

- b) Spreading: Unless otherwise specified, aggregate for base courses shall be delivered to the roadbed as a uniform mixture and shall be placed on the existing prepared sub base, in a uniform layer or layers not exceeding six (6) inches in compacted depth, including any binder that is to be blended on the base. Spreading shall be done by means of approved self-propelled spreader box distributing the material to the required width and loose thickness. When the required base thickness is greater than six (6) inches the material shall be spread in layers of equal thickness.

The material shall be so handled, as to avoid segregation. If an aggregate spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be eliminated easily or prevented by adjustment of the spreader operation, the use of such spreader shall be discontinued and the spreader replaced. All segregated material

shall be removed and replaced with well-graded material. No "skin" patching shall be permitted.

No hauling or placement of material will be permitted when, in the judgment of the Engineer/Engineer's Representative, the weather or road conditions are such that hauling operations will cause cutting or rutting of the sub-base surface or cause contamination of the base course material.

- c) Compaction: If directed by the Engineer/Engineer's Representative, prior to starting the aggregate base operation, the Contractor shall construct trial lengths in accordance with sub-paragraph d) "Compaction Trials" in section 5.1 "granular Sub-base".

Immediately after placing, the base course material shall be compacted. The material shall be compacted to a density of not less than one-hundred (100) percent of Maximum Density as determined according to AASHTO T-180 Method C, or to seventy-eight (78) percent of the Relative Density in accordance with ASTM D-2049, as deemed appropriate by the Engineer/Engineer's Representative. The field determination of density shall be made in accordance with AASHTO T-181. The percent of density shall be adjusted to compensate for the weight and volume of aggregate larger than the aggregate used in the compaction control test where applicable.

Rolling shall be continued until the entire thickness of each layer is thoroughly and uniformly compacted to the density specified. The final rolling of the completed base course shall be done with a self-propelled roller. Rolling shall be accompanied by sufficient blading in a manner approved by the Engineer/Engineer's Representative, to ensure a smooth surface, free from ruts or ridges and having the proper section and crown. When additional water is required it shall be added in the amount and manner approved by the Engineer/Engineer's Representative. Each layer of base course must be completely compacted by the Contractor and approved by the Engineer/Engineer's Representative prior to the delivery of materials for a succeeding layer.

Surface finishing shall meet the requirements in accordance with sub-paragraph-e) "Finishing" in section 5.1 "Granular Sub-Base" except that the variation of the surface from testing edge of 10 ft long straight edge between any two contacts shall at no point exceed one quarter (1/4) inch when placed perpendicular or parallel to the center of the roadway. The base course shall be compacted to thickness and cross-section as shown on the plans and shall not vary by more than minus one quarter (1/4) inch from the required elevation. No tolerance above the designed grade or level of base course shall be allowed. All lumps and depressions and thickness deficiencies exceeding the above specified tolerances shall be connected by removing and replacing the defective work or as directed by the Engineer/Engineer's Representative.

If the material for the base course is laid and compacted in more than one (1) layer, the Contractor shall plan and coordinate the work in such a manner that the previously placed and compacted layers be allowed ample time for

drying and development of sufficient stability before vehicles hauling materials for the succeeding layers, or other heavy equipment are permitted on the base. Prior to placing the succeeding layers of material, the top of the layer shall be made sufficiently moist to ensure bond between the layers. The edges and edge slopes of the base course shall be bladed or otherwise dressed to conform to the lines dimensions shown on the plans and present straight, neat and workmanlike lines and slopes as free of loose material as practicable.

The Contractor shall also plan the work and handle the various operations so that the least amount of water will be lost by evaporation from uncompleted surfaces. If the Contractor delays placing of succeeding layers of base course material to the extent that additional water must be applied to prevent raveling or excessive dripping, the application of such water shall be at the Contractor's expense and will not be considered as the basis for a claim for additional compensation. Water shall be applied at such times and in such quantities as directed by the Engineer/Engineer's Representative, and the Engineer /Engineer's Representative shall have full authority to require the suspension of all other work on the project to ensure the proper maintenance of previously compacted material. If after the base is compacted, any areas are above or below proper grade and true elevations, such area shall be loosened and after having had additional materials added or excess material removed, as the case may require, shall be reconstructed as described herein. If after the base is compacted, any areas fail to meet the specified density and gradation requirements, they shall be loosened or removed as directed by the Engineer/Engineer's Representative and reconstructed as described before.

- d) **Maintenance of Base Course:** Following the construction of the aggregate base, the Contractor at his own expense shall maintain the compacted base course. The Contractor shall blade, broom and otherwise maintain the base, keeping it free from raveling, and other defects until such time as the bituminous prime or other surface is applied. Water shall be applied at such time and in such quantities as directed by the Engineer/Engineer's Representative.

The Engineer/Engineer's Representative shall determine when the surface of the base course is in the proper condition to permit the bituminous prime and/or surfacing to be applied. If the Contractor chooses not to apply the bituminous prime and/or surfacing at that time, he must continue to maintain the surface of the base course, including the application of necessary water, at his expense until such time as the bituminous prime and/or surfacing is applied. Any additional expense incurred by the Contractor because of his failure to apply the bituminous prime and/or surfacing when so permitted by the Engineer/Engineer's Representative will not be considered as the basis for a claim for additional compensation.



## **6. MEASUREMENT AND PAYMENT**

The quantity of sub-base and base courses to be paid for shall be measured by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer/Engineer's Representative, placed and accepted in the completed granular sub-base course and aggregate base course. No allowance will be given for materials placed outside the theoretical limits shown on the cross sections. Trial sections shall not be measured separately but shall be included in the quantities above.

The accepted quantities measured as provided above shall be paid for at the contract unit price of Granular Sub- base course and Aggregate Base Course for the pay item shown in the Estimates, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labor, equipment, tools and incidentals necessary to complete the item.

## **SECTION -15**

### **BITUMINOUS SURFACE COURSE**

#### **1 SCOPE**

##### **1.1. BITUMINOUS PRIME COAT**

This work shall consist of applying a liquid asphalt prime coat on previously constructed base courses, toe of roadway shoulders, and concrete surfaces (and when otherwise shown on the plans) in accordance with the specifications, and in conformity with the lines shown on the plans or established by the Engineer/Engineer's Representative.

##### **1.2. BITUMINOUS WEARING COURSE**

"Bituminous Wearing Course" work shall consist of the construction of one course of hot-mixed, hot-laid, bituminous mixture conforming to the requirements of this section, spread and compacted on a new or existing base course, concrete pavement, or bridge /culvert top in accordance with the specifications and in conformity with the lines, grades and typical cross sections shown in the plans.

##### **1.3. BITUMINOUS SURFACE TREATMENT**

This work shall consist of a wearing surface composed of a bituminous prime coat followed by two (2) or three (3) applications of bituminous seal coats with each seal coat receiving an application of aggregates cover material in accordance with the specification and in conformity with the lines shown on the plans or established by the Engineer/Engineer's Representative.

#### **2. MATERIAL**

##### **2.1. BITUMINOUS PRIME COAT**

The prime coat shall be medium-curing cutback asphalt consisting of an asphaltic base or an appropriate type of penetration grade asphalt fluxed with suitable petroleum distillates. The product shall be free of water, show no separation prior to use and shall conform to all requirements of Grade MC-1 as per AASHTO M-82 or appropriate penetration grade asphalt.

##### **2.2. BITUMINOUS WEARING COURSE**

###### **Mineral Aggregates**

Mineral aggregates for "Bituminous Wearing Course" shall consist of coarse aggregates, fine aggregates, and filler material, if required all complying with the following requirements.

- a) Coarse aggregates which is the material retained on an AASHTO No.4 sieve, shall consist of crushed rock or crushed gravel as directed by the Engineer/Engineer's Representative. It shall be clean, hard, tough, durable

and sound, and shall be of uniform quality and free from decomposed stone, organic matter, shale, clay, lumps and other deleterious substances.

The coarse aggregate shall be free from an excess of flat elongated pieces (in no case more than ten (10) percent) and shall be of such character that when coated with asphalt shall pass a stripping test performed in accordance with AASHTO T-182.

Crushed gravel for use as coarse aggregate shall consist of the product obtained by crushing material that has first been screened in such a manner that not less than ninety (90) percent of the material to be crushed is retained on 3/8-inch sieve. The amount of crushing of gravel shall be regulated so that at least ninety (90) percent by weight of the material retained on an AASHTO No.4 sieve shall consist of pieces with at least one (1) mechanically fractured face, and when tested for stability of bituminous mix shows satisfactory stability.

- b) Fine aggregates shall consist of that portion of the total aggregate that passes an AASHTO No.4 sieve. Fine aggregate obtained by crushing gravel shall be produced that after crushing, at least eight-five(85) percent by weight of the material passing the AASHTO No.4 sieve and retained on the AASHTO No. 8 sieve shall consist of pieces having at least one (1) mechanical fractured face. Should natural material passing the AASHTO No. 4 sieve be included in the mixture, this material shall be fed to the dryer as a separate aggregate and the amount used shall be so limited that the mixture of fine aggregates will contain not less than twenty-five (25) percent by weight of the crushed aggregates.
- c) When the combined grading of the coarse and fine aggregates is deficient in material passing the AASHTO No. 200 sieve, mineral filler shall consist of finely divided mineral matter such as rock dust including limestone dust, slag dust, hydrated lime, hydraulic cement, or other suitable mineral matter. At the time of use it shall be sufficiently dry to flow freely and essentially free from agglomerations. Filler material shall be free from lumps, balls or other deleterious material, and shall conform to the requirements of AASHTO M-17. Gradation requirements are as follows:

<b>Sieve</b>	<b>Percentage Passing (By Weight)</b>
No. 30	100
No. 50	95 - 100
No. 200	70 - 100

The combined mineral aggregate shall conform to the following physical requirements.

Sand Equivalent (AASHTO T 176) determined after all processing except for addition of asphalt binder.	45 minimum
Plasticity index (AASHTO T 90)	3 maximum
Loss of Marshall Stability by submerging specimens in water at 60 degrees C for twenty-four (24) hours as compared to stability measured after submersion in water at 60 degrees C for twenty (20) minutes.	25 percent maximum

When tested according to AASHTO T-11 and AASHTO T-27 the combined mineral aggregate shall conform to the following grading:

<b>AASHTO Sieve Size</b>	<b>Percent Passing</b>
3/4 in.	100
1/2 in.	90 – 100
No. 4	44 – 74
No. 8	28 – 58
No. 50	5 – 21
No. 200	2 – 10

The grading limits specified are based on materials of uniform specific gravity and shall be adjusted by the Engineer/Engineer's Representative to compensate for any variations in specific gravity of the individual sizes. The grading may be varied by the Engineer/Engineer's Representative on the basis of Marshall Tests to obtain optimum stability and life of the completed "Bituminous Wearing Course".

### 2.3. Asphalt

Asphalt for "Bituminous Wearing Course" shall be petroleum asphalt cement, grade 60-70 penetration conforming to the requirements in the following table:

#### **Specifications for Asphalt Cements (AASHTO M20)**

General Requirements	AASHTO Test Method	The asphalt shall be prepared by the refining of petroleum. It shall be uniform in character and shall not foam when heated to 176.7 degree C
- Penetration, 25 °C 100 grams, 5 seconds	T-49	60 - 70
- Specific Gravity at 25, °C	T -228	1.01 - 1.06
- Softening Point R+B, °C	ASTMD-36	49 - 57
- Flash point(Cleveland) Open Cup °C	T-48	218
- Loss on heating,		
(a) 163° C 5 hours, percent wt. max.	T-47	0.2
(b) Penetration after Loss on heating 25° C, 100 grams, 5 second, % of original	T-49/T-47	75
- Ductility: At 25° C 5 cm. per min., cm.	T-51	100
- Solubility in organic solvents percent	T-44	99

#### **Job Mix**

At least twenty-eight (28) days prior to the date he intends to begin production of plant-mix. "Bituminous Wearing Course" mixtures, and after receiving approval of the aggregates from the Engineer/Engineer's Representative and after the delivery, on site of the asphalt specified for "Bituminous Wearing Course", the Contractor shall make written request for the approved job-mix formula from the Engineer/Engineer's Representative.

The job-mix formula will be prepared by the Contractor, under the supervision of the Engineer/Engineer's Representative, in the Project laboratory.

The job-mix. formula shall combine the mineral aggregates and asphalt in such proportion as to produce a mixture conforming to the following composition limits by weight.

	<u>Percent by weight</u>
Total Mineral Aggregates	96 - 93
Asphaltic Binder (percent of total mix)	4 - 7

When tested according to the Marshall Method, the bituminous mixture shall conform to the following requirements:

Stability - Kg	800 (min.)
Flow in mm	2.4 - 4.0
Voids in total mix(percent)	3.0 - 5.0
Voids filled with asphalt (percent)	65 - 75

All trial mixes shall be prepared by the Contractor in the presence of the Engineer/Engineer's Representative and will be tested by the Engineer/ Engineer's Representative.

The Marshall test procedure will be used to determine the percentage of liquid asphalt that is to be incorporated into the mixture. Open bituminous mixes deteriorate rapidly due to the drying and oxidizing effect of the sun, therefore, the mix will be densely graded and relatively on the high-side in fines. For the same reasons, a low asphalt content in the mix is detrimental. The job-mix formula will therefore provide for as high an asphalt content as possible for a mix designed by the Marshall test procedure to provide the specified stability. The mix formula will also take into consideration the absorption of asphalt into the aggregates. Thus for calculations for voids the adjusted bulk specific gravity of the Marshall specimens adjusted for the portion of asphalt lost by absorption, shall be used.

The gradation for the combined aggregate, including the mineral filler shall be within the limits specified in the specifications. The Engineer/Engineer's Representative may vary the specified limits where he deems it necessary, on the basis of the Marshall tests, to obtain optimum stability and life of the completed mix.

Upon receiving the job-mix formula approved by the Engineer/Engineer's Representative the Contractor shall adjust his plant to proportion the individual aggregates, mineral filler and asphalt to produce a final mix that, when compared to the job-mix formula shall be within the following limits:

#### Maximum Variations of Percentage of Materials Passing

	<u>Percent</u>
AASHTO No. 4 and larger	$\pm 5$
AASHTO No. 10 and retained on the 200	$\pm 4$
AASHTO No. 200	$\pm 1.5$
Asphalt Content	$\pm 0.3$

The Engineer/Engineer's Representative will test the mix periodically and, if necessary, direct the Contractor to readjust the plant to maintain conformity to the job-mix formula. If, during production, the grading of the aggregates alters, the mix shall be redesigned and the plant readjusted as outlined above.

The assistance of the Engineer/Engineer's Representative in the preparation of the job-mix formula in no way relieves the Contractor of the responsibility of producing a bituminous mixture meeting the requirements of the specifications.

## 2.4. BITUMINOUS SURFACE TREATMENT

### A) *Bituminous Materials*

**Prime Coat.** The prime coat shall be medium-curing cutback asphalt consisting of an asphaltic base or an appropriate type of penetration grade asphalt fluxed with suitable petroleum distillates as directed by the Engineer/Engineer's Representative. The product shall be free of water, show no separation prior to use, and shall conform to all the requirements of Asphalt Institute USA, for the specified or approved type of penetration grade asphalt.

**Seal Coat:** The seal coat shall be rapid-curing cutback asphalt consisting of an asphaltic base or an appropriate type penetration grade asphalt fluxed with suitable petroleum distillates as directed by the Engineer/Engineer's Representative. The product shall be free of water, show no separation prior to use and shall conform to all the requirements Asphalt Institute, USA, for the specified or approved type.

### B) *Cover Material*

Aggregate for cover material shall be screenings of crushed stone, which are clean, tough, durable and free from dirt and other objectionable matter. The percentage of wear shall not be more than forty (40) as determined by AASHTO T-96. When subjected to five (5) cycles of sodium-sulfate soundness testing, as determined by AASHTO T-104, it shall have a weight loss not greater than ten (10) percent. The moisture content in the aggregate applied directly to the surface of the bituminous

material shall not exceed three (03) percent by weight plus one-half (1/2) the water absorption of the aggregate at the time of delivery to the Project. In no case shall free moisture be drawn from the truck bed. Aggregate shall conform to the following gradations and shall be approved by the Engineer/Engineer's Representative.

c) Aggregate Gradation

The percentage composition by weight of aggregate shall conform to the following gradations:

US Standard Sieve	Percentage Passing by Weight		
	Size No. 1	Size No. 2	Size No. 3
1"	100	-	-
3/4"	90-100	-	-
1/2"	20- 55	100	
3/8"	0- 15	85-100	100
1/4"	-	-	90-100
No. 4	0- 5	10-30	60- 85
No. 8	-	0-10	0- 25
No. 16	-	0- 5	0- 5
No. 200	-	0- 2	0- 2

The size of aggregate for seal coat shall be 3/8 inches.

The portion of aggregate retained on the 9.5 mm (3/8 inch) sieve shall not contain more than fifteen (15) percent of particles by weight so flat or elongated, or both, that the ratio between the maximum and the minimum dimensions exceeds 5:1.

The nominal sizes of aggregates used for surface treatment shown against table as under:-

Size No. 1 - Nominal size 18 mm

Size No. 2 - Nominal size 12 mm

Size No. 3 - Nominal size 9 mm

Size No. 4 - Nominal size 6 mm

D) Equipment

Equipment shall conform to the standards outlined in Section 1540 "Equipment", and shall be according to the type and number outlined in the Contractor's detailed Program of Work as approved by the Engineer/Engineer's Representative.



In addition to the above requirements trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin oil, line solution, or other approved material to prevent the mixture from adhering to the beds. When required by the Engineer/Engineer's Representative, each vehicle shall be equipped with a canvas cover or other suitable material of such size as to protect the mixture from the weather.

### **3. EXECUTION**

#### **3.1. BITUMINOUS PRIME COAT**

- a) *Preparation of Road Surfaces:* It shall be the Contractor's sole responsibility to maintain the surface in an approved condition, conforming to the required grades and sections. Any defect, which may develop, shall be immediately corrected at the Contractor's expense.

Prior to the application of the bituminous material, all loose materials shall be removed from the surface and the surface shall be cleaned by means of approved mechanical sweepers or blowers and/or hand brooms, until it is as free from dust as is deemed practicable. If deemed necessary by the Engineer/Engineer's Representative, and if the surface is an earth surface or a water-bound base course or sub-base, the cleaned surface shall be given a light application of water and allowed to dry to a surface-dry condition before the bituminous material is applied. No traffic shall be permitted on the surface after it has been prepared to receive the bituminous material.

- b) *Preparation of Concrete surfaces:* Prior to the application of the prime coat, the concrete surface or pavement shall be cleaned of all loose material by means of approved mechanical sweepers and/or hand brooms, followed by approved blowers. All expansion joints shall be cleaned and filled with bituminous material as directed by the Engineer/Engineer's Representative.
- c) *Heating of Bituminous Materials:* Heating shall be with equipment as specified in Section 1540 "Equipment for Heating Bituminous Materials". The use of any method of agitation or heating that introduces free steam or moisture into the bituminous material is prohibited. Materials heated to temperatures above twenty-eight (28) degrees C higher than the maximum application temperature specified shall be considered as overheated and shall be rejected until the material can be re-sampled and retested. The Engineer/Engineer's Representative on the same requirements under which the material was originally tested will make the reacceptance or final rejection.
- d) *Temperature of Bituminous Materials at Time of Application:* Bituminous materials shall be applied temperatures within the ranges specified by the asphalt institute, USA for the respective type & grade.

- e) *Prime Coat:* The prime coat shall be applied to approved earth surfaces, water-bound base courses, top of roadway shoulders, and concrete surface and pavements as soon as practicable as determined by the Engineer/Engineer's Representative, after they have been prepared and are sufficiently dry.

- ***Areas to Be Primed:***

- The top of earth surfaces or base courses from a point six (6) inches outside the edge of the pavement line to the like point on the opposite side of the roadway.
- The top of the shoulders from the intersection of embankment slope and top of sub-grade to the edge of the pavement line.
- The concrete surfaces from end to end.
- Other surfaces as shown on the plans or ordered by the Engineer/Engineer's Representative.

- *Application of the Prime:* specified bituminous material shall be applied at the rate as directed by the Engineer/Engineer's Representative, by approved pressure distributors operated by skilled workmen. The spray nozzles and spray bar shall be adjusted and frequently checked so that uniform distribution is insured. Spraying shall cease immediately upon any clogging or interference of any nozzle, and corrective measures taken before spraying is resumed.

Hand sprays will be approved only for priming small patches or inaccessible areas that cannot be primed by normal operation of the distributor.

Care shall be taken that application of bituminous material at the junction of spreads is not in excess of the specified amount. Any excess shall be squeezed from the

surface when ordered by the Engineer/Engineer's Representative. Any skipped areas or recognized deficiencies shall be corrected by means of approved hand sprays.

- *Test Section and Rates of Application:* The rate of application for prime material shall be specified by the Engineer within the limits shown below as determined from field trials conducted on a test section or sections. The Contractor shall prior to the time he intends to begin his priming operation, prepare a test section of an approved length for the determination of the rate of application for the prime coat. On projects where surfaces to be primed are constructed of different materials, a test section for each type of material shall be prepared by the Contractor.

The test methods shall be determined by the Engineer/Engineer's Representative and performed by the Contractor in the presence of the Engineer/Engineer's Representative.

The Engineer/Engineer's Representative may order subsequent test sections and/or alter the previously established rate or rates of application when he deems it necessary.

Application Rates for bituminous material for prime coat shall range from 0.12 gal/sq.yd to 0.32 gal./sq.yd.

In the event that it would be necessary to apply the asphalt in two applications instead of one. In order to attain the required quantity or specified results the contractor shall accomplish the same without additional payment.

- *Protection of Adjacent Structures:* When bituminous materials are being applied, the surfaces of all structures, wheel guards, guard rail, kerbs and gutters, and other roadway appurtenances shall be protected in a manner approved by the Engineer/Engineer's Representative to prevent them from being splattered with bituminous material or marred by equipment operation. In the event that any appurtenances becomes splattered or marred, the Contractor shall at his own expense, remove all traces of bituminous materials, and repair all damage and leave the appurtenances in an approved condition.
- *Blotting:* If deemed necessary by the Engineer/Engineer's Representative after the bituminous material has been applied for forty-eight (48) hours under favorable conditions and the prime coat has not dried sufficiently that it will not be damaged by traffic, a light application of aggregate shall be applied. The blotter material shall be a clean fine sand, other material as approved by the Engineer/Engineer's Representative. Blotting material shall be applied sparingly on only the areas that have not dried. Blotting of the prime coat shall be done only when directed by the Engineer/Engineer's Representative. Normally, additional time shall be allowed for drying of the prime coat when in the opinion of the Engineer/Engineer's Representative this procedure does not seriously delay subsequent operations.
- *Maintenance of Prime Coat:* The Contractor shall maintain the prime coat treatment and the surface of the subgrade or base course intact until it shall have been covered by the surface course. Any area where the prime coat has been damaged by traffic or by the Contractor's operations, shall be cleaned of all loose material, the defective base course or subgrade repaired to the satisfaction of the Engineer/Engineer's Representative and the prime coat reapplied. The maintenance and repair of the prime coat and the underlying subgrade or base course shall be done at the Contractor's expense.
- *Traffic Control:* The Contractor shall provide detours for the traveling public and for operational use in areas where priming is being done. Where no convenient detour can be made available, the priming operation shall be confined to one-half (1/2) of the roadway at a time and the Contractor shall provide traffic control to the satisfaction of the Engineer/Engineer's Representative.
- *Weather and Temperature Limitations:* Application of prime coat shall be performed only when the surface is dry, when the atmospheric temperature is above fifteen (15) degrees C, and when the weather is not foggy or rainy.

### 3.2. BITUMINOUS WEARING COURSE

#### **A     *Construction Requirements:***

Rolling equipment shall be self-propelled. The wheels on the rollers shall be equipped with adjustable scrapers and the rollers shall have water tanks and sprinkling apparatus which shall be used to keep the wheels wet and prevent the surface material from sticking.

Weights of two-axle tandem steel rollers, three axle tandem steel rollers, three-wheel steel rollers, and self-propelled pneumatic-tired rollers shall be as specified in Section 1540. The total weight of the pneumatic-tired roller shall be varied as directed by the Engineer/Engineer's Representative.

- a)     *Preparation of Asphalt Cement:* Asphalt cement shall be heated within a range of 135 degrees C to 163 degrees C at the time of mixing. All material reheated more than 42 degrees C above the maximum shown shall be considered overheated and shall be rejected until the material can be re-sampled and tested. The re-acceptance or rejection will be made on the same requirements as established for the original material. Asphalt cement received from the refinery at temperatures in excess of 163 degrees C but not exceeding 191 degrees C may be used.
- b)     *Preparation of Mineral Aggregates:* Each aggregate ingredient shall be heated and dried at such temperatures that the temperature as recorded in the hot fines bin after screening shall not exceed 163 degrees C. If the aggregates contain sufficient moisture to cause foaming in the mixture or their temperature is in excess of 163 degrees C, they shall be removed from the bins and returned to their respective stockpiles.

Immediately after heating, the aggregate or aggregates shall be screened into at least three (3) sizes and conveyed into separate bins ready for batching and mixing with bituminous material. When the aggregates furnished are of such size and grading that separating into three (3) bins is impractical, the number of required separations may be reduced to two (2) with the approval of the Engineer/Engineer's Representative. The efficiency of the screening operations shall be sufficient to produce, at plant operating capacity, gradations in each of the sizes of heated and dried aggregates which are reasonably uniform and result in the production of a mixture complying with the limits specified for the aggregate.

- c)     *Preparation of Bituminous Mixture:* Dried aggregate as specified for bituminous construction and prepared as prescribed above shall be combined in the plant in the proportionate amounts as approved. Asphalt cement shall be introduced into the mixture in the proportionate amount determined by the Engineer/Engineer's Representative, all according to the job-mix formula.

The initial mixing time will be designated by the Engineer/Engineer's Representative. Mixing time may be increased by the Engineer/Engineer's Representative if additional time is necessary to obtain a homogeneous

mixture and satisfactory coating.

On batch plants, timing shall be at the start of the asphalt introduction into the pug mill.

The length of mixing time for continuous plants will be determined by the following formula or other approved methods.

$$\text{Mixing time in seconds} = \frac{\text{Pug mill dead capacity in Kilos}}{\text{Pug mill output in Kilos/second}}$$

The temperature of the asphalt, except for temporary fluctuations, shall not be lower than fourteen (14) degrees C below the temperature of the aggregate at the time the two (2) materials enter the mixer or pug mill.

d) *Preparation of Existing Surface:*

- When the bituminous mixture is placed on a prepared surface, and whether or not a prime coat is designated on the plans, the surface shall be prepared to meet the requirements provided in sub-clause A (a) of Section 1520, clause 5.2. "Aggregate Base Course". The surface shall be maintained in accordance with sub-clause A (b) of this Section.
- *Prime Coat:* Prior to the placing of the mixture, a prime coat shall be applied to the subgrade or surface in accordance with the standards specified in Part 1530, Clause 2.1 and as directed by the Engineer/Engineer's Representative.

e) *Placing of the Mixture:*

- The bituminous mixture shall be spread and finished true to crown and grade by the automatically controlled bituminous paver. Bituminous mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by the Engineer/Engineer's Representative.
- The automatically controlled paver shall spread the bituminous mixtures without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.
- The paver shall be operated at a speed which will give the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mixture to the paver so as to provide a uniform rate of placement without intermittent operation of the paver.

All bituminous mixtures shall be delivered to the paver at a temperature between 139 degrees C and 163 degrees C. Mixtures delivered to the paver at lower temperatures shall be discarded.

The maximum thickness for layers may be increased slightly when such increase is more adaptable to total pavement thickness and when in the opinion of the Engineer/Engineer's Representative it is not detrimental to placement and rolling conditions.

- *Preliminary Survey and Reference String Line:* The Contractor shall make the survey required for the reference grade. When the survey is approved by the Engineer/Engineer's Representative, the Contractor shall erect and maintain an approved reference string line and operate the paver to conform to the string line for the initial layer and/or any other layers as directed. Elevation control point stakes for the subgrade and first layer of base course shall be set at a maximum spacing of seventy five (75) feet.

The use of the automatically controlled bituminous paver to provide both longitudinal and transverse control shall include the furnishing and maintaining of a string line, whether it be erected or mobile, by the Contractor. The longitudinal and transverse controls shall operate independent of each other to the extent that the surface of the bituminous mixture will conform to the string line and will be uniform in cross section or crown.

The Contractor shall establish the centerline points and shall maintain the location of the points until the completion of the surfacing or as directed. When directed by the Engineer/Engineer's Representative, the Contractor shall erect a string line to be used as a guide for the finishing machine in order to maintain a uniform edge alignment. If any other method is proposed by the Contractor it may be approved by the Engineer.

- *Machine Spreading:* The Contractor shall make a survey study of the center line profile and crown of the existing surface or base and determine or calculate a Reference Grade Line and shall furnish to the Engineer/Engineer's Representative for reference and approval the fill values at each profile point necessary to erect the Reference String line.
- On the initial traffic lane-paving operation the asphaltic mixture shall be spread with the bituminous paver to a grade line constant to the Reference String Line.
- The erection and maintenance of the Reference String Line shall be so coordinated that the string will be taut and free from sags at the time it is in use as a guide for the paver.
- The Mobile String Line or equivalent shall be used as the reference guide on all paving operations except when the Reference String Line is used or other provisions are made and approved by the Engineer/Engineer's Representative.
- The use of the automatically controlled paver may be waived

on irregular sections or other sections when approved by the Engineer/Engineer's Representative.

- If the Contractor uses an approved manually controlled bituminous paver, the same general placement procedures shall be followed. Twenty eight (28) days prior to the time the Contractor intends to begin paving, he shall present to the Engineer/Engineer's Representative, for approval, a placement procedure, incorporating the intent of the procedures outlined above, adapted to the Contractor's approved manually-operated bituminous paver. No mixture shall be placed prior to the Engineer/Engineer's Representative's approval of the Contractor's proposed methods and procedures for placing the mixture.

- f) *Thickness of Cores:* Thickness determination shall be made at a minimum of six (6) locations per lane per kilometer, or at locations designated by the Engineer/Engineer's Representative.

The Contractor shall furnish and operate an approved saw or core drill for cutting samples from the compacted mixtures on the road. The equipment shall be capable of cutting the mixture without shattering the edges of the specimen or otherwise disturbing the density of the specimen. Sawed samples shall be four (4) inches square (nominal) and cored samples shall be four (4) inches in diameter (nominal).

Unless otherwise permitted, cores extracted for thickness measurement shall not be used for density determination and density samples shall not be used for thickness measurements.

- g) *Compaction of Mixtures:* After spreading and strike-off and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted. Rolling shall not be prolonged till cracks appear.

Rollers shall be of the steel wheel and/or pneumatic-tire type and shall be in perfect condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted. A minimum of three (3) rollers, two (2) steel wheels and one (1) pneumatic-tire type, shall be used with each spreading operation.

Initial or breakdown rolling shall be done by means of either a tandem power steel roller or a three (3) wheel power steel roller. Rolling shall begin as soon as the mixture will bear the roller without undue displacement. Rolling shall be longitudinally, beginning at the low side of the spread of material and proceeding toward the high side, overlapping on successive trips by at least one-half (1/2) the width of the rear wheels. Alternate trips of the roller shall be of slightly different lengths.

The motion of the roller shall at all times be slow enough to avoid displacement of the mixture and the speed of the roller shall be as approved by the Engineer/Engineer's Representative. To prevent adhesion of the mixture to the rollers, the wheels of the rollers shall be kept properly moistened with water, but an excess of water will not be permitted.

The initial or breakdown rolling shall be followed by rolling with a pneumatic-tired roller. Final compaction and finish rolling shall be done by means of a tandem power steel roller unless otherwise designated. When the specified density is not obtained, changes in size and/or number of rollers shall be made as corrective measures to satisfy the density requirement.

Rollers shall be operated by competent and experienced roller men and shall be kept in operation continuously, if necessary, so that all parts of the pavement will receive substantially equal compaction at the time desired. The Engineer/Engineer's Representative will order the mixing plant to cease operation at any time proper rolling is not being performed.

The road density requirements shall be equal to or greater than ninety-six (96) percent of the Marshall Density of each day's production.

Any mixture that becomes loose, broken, mixed with foreign material, or which is in any way defective in finish or density, or which does not comply in all other respects with the requirements of the specifications shall be removed, replaced with suitable material, and finished in accordance with the specifications.

- h) Contact Surfaces:* Contact surfaces of kerb, gutters, man holes, and similar structures shall be painted with a thin uniform coating of asphaltic material approved by the Engineer / Engineer's Representative. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be one half (1/2) inch above the edge of such structures.
- i) Joints:* Joints between old and new pavements or between successive days' work shall be made using proper heaters so as to insure thorough and continuous bond between the old and new mixtures. Transverse construction joints in previously laid material shall be constructed by cutting the material back vertically for its full depth so as to expose a fresh surface.

Before placing the fresh mixture against a cut joint or against old pavement, the contact surface shall be sprayed or painted with a thin uniform coat of appropriate type of bitumen. Where a finishing machine is used, the longitudinal joint shall be made by overlapping the screed on the previously laid material for a width of at least one (1) inch and depositing a sufficient amount of mixture so that the joint formed will be smooth and tight.

- j) Protection of Fresh Mixture:* The Contractor shall protect all sections of newly compacted mixture from traffic until they have hardened properly.



- k) *Maintenance of Traffic:* Traffic be maintained through the project, detouring of traffic will be permitted.

## **B. Surface Tolerances**

The surface will be tested with a ten (10) feet straightedge by the Engineer/Engineer's Representative at selected locations. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall at no point exceed point one (.10) inch when placed on or parallel to the center line or when placed perpendicular to the center line of the roadway. All humps and depressions exceeding the specified tolerance shall be corrected by removing the defective Work and replacing it with new material as directed by the Engineer/Engineer's Representative.

## **C. Compaction, Sampling and Testing**

Densities herein called "Field Mold Densities" will be determined as the Work progresses. The Field Mold Density shall be determined in accordance with AASHTO T-166. The briquettes used in this ascertainment shall be made of the same material used in construction, taken from samples of freshly mixed bituminous mixture at the plant. Reheating of the mixture will not be permitted.

The density of the mixture as placed and compacted on the road shall be determined from samples cut from the compacted courses on the road at locations specified by the Engineer/Engineer's Representative. Samples shall be obtained in sets of two (2) cut from the same location on the road. The frequency of testing shall be one (1) set of samples per traffic lane per two thousand (2000) linear feet or a minimum of one (1) set per day for shorter runs, and such additional tests to determine limits of areas deficient in density, or for recheck. The density of these samples will be referred to as "Road Density".

The Contractor shall cut the samples with an approved saw or core drill in the presence of the Engineer/Engineer's Representative. The equipment shall be capable of cutting the mixture without shattering the edges of the specimen or otherwise disturbing the density of the specimen. Samples shall be four (4) inches square (nominal) or four (4) inches in diameter (nominal).

Unless otherwise permitted, samples extracted for thickness measurement shall not be used for density determination and density samples shall not be used for thickness measurements.

The Contractor shall when necessary furnish and apply cold water, ice or other cooling substance to the surface of the pavement to prevent the samples from shattering or disintegrating. The Contractor shall cut all samples and fill and compact all test holes at his own expense.

#### **D. Weather Limitations**

Hot asphaltic mixtures shall be placed only when the air temperature is four (4) degrees C or above and when the weather is not foggy or rainy and when the existing surface is free from moisture.

### **3.3 BITUMINOUS SURFACE TREATMENT**

a) *Preparation of Surfaces:* Surfaces shall be prepared in accordance with the requirements specified in Clause 3.1 "Bituminous Prime Coat". At the time of the application, the weather shall be warm and dry and the road surface shall be clean and dry. Spraying shall not be done unless the road temperature is above twenty (20) degree C for at least one hour prior to the commencement of spraying operations, and the temperature shall not be less than twenty (20) degree C during the spraying. Prior to applying the asphaltic material, dirt and other objectionable materials shall be removed from the surface and surface shall be primed. If so directed by the Engineer/Engineer's Representative the surface shall be cleaned by power brooming or wire brush until all loose and foreign materials are removed.

b) *Traffic Control:* Traffic shall be detoured during execution of this work. No separate payment shall be made for conformance to this paragraph, all items being considered subsidiary to all of the items in the Estimates.

c) *Heating of Bituminous Materials:* Heating shall be with equipment as specified in section 1540 "Equipment for Heating Bituminous Materials".

The use of any method of agitation or heating that introduces free steam or moisture into the bituminous material is prohibited. Materials heated to temperatures above twenty-eight (28) degrees C higher than the maximum application temperature specified shall be considered as overheated and shall be rejected until the material can be resampled and retested. The reacceptance or final rejection will be made by the Engineer/Engineer's Representative on the same requirements under which the material was originally tested.

d) *Temperature of Bituminous Materials:* The temperature of bituminous materials at the time of application shall be within the ranges specified in Clause 2.4 "Bituminous Wearing Course".

e) *Prime Coat:*

- *General:* The bituminous prime coat shall be applied to the base course as shown on the plans or as established by the Engineer/Engineer's Representative. The prime coat shall be applied in accordance with the requirements specified in Clause 3.1 "Bituminous Prime Coat".

- *Rate of Application:* The rate of application shall be in accordance with the requirements specified in sub-para graph D of Clause 3.1 "Bituminous Prime Coat".

f) *First Seal Coat:* After the prime coat has been applied and has thoroughly penetrated the surface and cured as specified in Clause 3.1 "Bituminous Prime Coat", the Contractor shall apply the bituminous Seal Coat and shall apply the cover material and roll and manipulate the surface all in accordance with the requirements specified hereinafter:

- *Application of Bituminous Material:* Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified. The quantity of bituminous material to be used per square feet shall be within the limits hereinafter specified and as directed by the Engineer/Engineer's Representative.

A strip of building paper, at least three (3) feet wide and with a length equal to that of the spray bar of the distributor plus twelve (12) inches shall be used at the beginning of each spread. If the cut-off is not positive, the use of paper may be required by the Engineer/Engineer's Representative at the end of each spread. The paper shall be removed and disposed of in an approved manner. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected in an approved manner. Junctions of spreads shall be carefully made to assure a smooth riding surface.

The length of spread of bituminous material shall not be in excess of the which trucks loaded with cover coat material can immediately cover.

The spread of bituminous material shall not be more than six (6) inches wider than the width covered by the cover coat material from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the cover coat.

The distributor, when not spreading, shall be so designed that the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

Distribution of the bituminous material shall be so regulated and sufficient bituminous material left in the distributor at the end of each application so that there will be a uniform distribution of bituminous material. In no case shall the distributor be allowed to expel air with the bituminous material thereby causing uneven coverage.

- *Application of Aggregate:* Immediately following the application of the bituminous material, cover material shall be spread with an approved

aggregate spreader in quantities as specified by the Engineer/Engineer's Representative and within the limits specified herein. Spreading shall be accomplished in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material. No portion of the binder shall remain uncovered for a period in excess of 20 (twenty) minutes after spraying.

- Procedures of starting, stopping or turning of any piece of equipment which results in displacement of the cover material or damage to the seal courses shall be prohibited.
- The spreading equipment shall be of such width and arrangement that as the aggregate is placed complete coverage will be obtained. No brooming, dragging, or blading of the cover material shall be permitted prior to initial rolling. Any arrangement of the cover material shall be done with hand methods. Overlapping the applications of cover material shall be avoided and all spillage shall be removed from the surface. Before rolling, the bituminous material shall be uniformly covered.
- When directed by the Engineer/Engineer's Representative, the Contractor will be required to add bituminous material or aggregate or both bituminous material and aggregate to portions of the project. Furnishing additional bituminous material and furnishing spreading dragging and rolling of additional aggregate will not be paid for separately but will be considered as subsidiary Work pertaining to the item of "Triple Bituminous Surface Treatment".
- *Manipulation:* Immediately after the application of bituminous material and aggregate to the road surface and after the aggregate has been rearranged as may be necessary to provide uniform and complete coverage, the surface shall be sufficiently rolled with an approved pneumatic-tired roller to embed the aggregate thoroughly into the bituminous material. Sufficient rollers shall be provided that the initial rolling consisting of two (2) complete coverage with the pneumatic-tired roller shall be completed within thirty (30) minutes after the cover material is applied. The rollers shall be operated on each coverage so that each succeeding trip of the roller will overlap at least fifty (50) percent of the width of the preceding trip. No blading or dragging of the aggregate will be permitted for the first seal coat. Any rearrangement of the cover material before or during the initial rolling shall be done by approved hand methods. Rolling shall be continued after the rolling specified above is completed until a maximum amount of the aggregate is satisfactorily embedded in the bituminous material. Pneumatic-tired rollers shall be operated at a maximum speed of eight (8) kilometers per hour.

- g) *Second and third Seal Coat:* Immediately prior to the second application of bituminous material for sealing the surface shall be cleaned in an approved manner of all dust and excess cover material which is not embedded in the first application of bituminous material for sealing. Care shall be exercised not to dislodge any cover material which is embedded in the bituminous material. The second seal coat shall be applied as specified hereinbefore, except that immediately following completion of the initial pneumatic rolling the surface shall be rolled with an approved steel roller. Brooms or drag brooms shall not be used to shift the cover material until the initial rolling with the pneumatic-tired and steel rollers is completed and until the bituminous material has cooled and set up sufficiently to hold the cover material, preferably not earlier than the day following the application of the second seal coat. Any rearrangement of the cover material during the initial rolling shall be done by approved hand methods.

The rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center. Rolling shall continue until the entire surface has been completely covered at least two (2) times with a pneumatic-tired roller and one (1) time with a steel wheel roller. Maximum speed of rollers shall be as hereinbefore specified.

- *Additional Manipulation of Completed Surface:* The Contractor shall manipulate the surface for a period of five (5) days after the second seal coat has been applied. The manipulation shall consist of the application of additional bituminous material or aggregate or additional dragging and rolling or all of these operations to portions of the surface that, as determined by the Engineer/Engineer's Representative, require such additional treatment. The manipulation shall also include the dragging and one (1) complete rolling with the steel roller over the entire surface each day from the time the surface is completed until and including the fifth (5th) day after. A light blade equipped with broom drag shall be operated immediately ahead of the roller throughout all rolling during the manipulation period. The daily dragging and rolling under manipulation may be omitted, if in the opinion of the Engineer/Engineer's Representative, the weather and roadbed conditions are such that the dragging and rolling would not be beneficial to the surface.

The third seal coat shall also be applied in a similar way, if required.

Bituminous material, aggregate and additional manipulation ordered by the Engineer/Engineer's Representative, in this Work, will not be paid for separately but will be considered subsidiary to the item of "Triple Bituminous Surface Treatment" included in the "Estimates".

- h) *Rates of Application:* The rates of application for bituminous material and aggregate for "Bituminous Surface Treatment" shall be within the following limits:

Application of	Aggregate Coverage Bituminous material				
	Size min.	Lbs./sq.ft max	Lbs./sq.ft min	lbs/sq.ft max	lbs/sq.ft min
First Course	1	4.5	5.5	0.37	0.46
Second Course	2	2.5	3.0	0.18	0.32
Third Course	3	1.4	2.5	0.14	0.18
Seal Coat with Aggregate		0.75	0.85	0.10	-

The specific rates of application of the bituminous material and aggregates will be established by the Engineer/Engineer's Representative from a test section performed in general conformance to the requirements specified in Clause 3.1 "Bituminous Prime Coat" and as directed by the Engineer/Engineer's Representative.

- i) *Final Inspection:* After all other Work has been completed, and prior to final inspection and acceptance the excess loose cover material along the edges of the surface shall be broomed and bladed off the shoulder to provide a definite and distinct line along the edge of the sealed surface. The tolerance limits or finishing requirements shall be same as given for bituminous wearing course.
- *Working Period:* All Work shall be so conducted that the Work of applying asphalt and aggregate and of all rolling shall be completed during the time from sunrise to sunset and under favorable weather conditions as determined by the Engineer/Engineer's Representative.

#### 4. MEASUREMENT AND PAYMENT

The quantities of bituminous wearing course and bituminous surface treatment including prime/tack coat shall be measured by number of square feet of the surface of compacted material placed in accordance with the plans, specifications and direction of the Engineer/Engineer's Representative.

The quantity of bituminous or Asphaltic material used is also included in the asphalt concrete mixture and will not be measured separately.

No separate or direct payment shall be made for prime/tack coat, furnishing all labor, materials tools, equipment and incidentals and for performing all the work involved in applying prime/tack coat complete in place as per specifications or direction of the Engineer/Engineer's Representative. The cost thereof shall be deemed to be included in other items of bituminous concrete wearing course or

bituminous surface treatment. Quantities of bituminous material, wasted or remaining on hand after completion of the work shall not be measured or paid for.

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items as shown in the Estimates, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item.