MALIR DEVELOPMENT AUTHORITY

BIDDING DOCUMENT

(Technical Proposal - Volume – II)

PUBLIC ECONOMY HOUSING PROJECT

COMPRISING OF

HOUSING UNITS ON RESIDENTIAL PLOTS OF SECTOR-18 OF NEW MALIR HOUSING PROJECT, MDA SCHEME-1 & SECTOR-6B, 12 & 85 OF TAISER TOWN, SCHEME-45, KARACHI ON SELF FINANCE BASIS

APRIL 2023

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SCHEDULE FOR SAMPLING AND TESTING OF EMBANKMENT AND SUBGRADE
(ITEM NO. 108 AND 113)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Soil	Classification	AASHTO M-145	1/2,000 CM	As per item 108.2 109.2.5 110.2 etc.
	CBR	AASHTO T-193	1/2,000 CM	As per item 108.2 and 110.2 etc.
	Swelling	AASHTO T-193	1/2,000 CM	As per item 108.2 ©
	Moisture Density (Lab) or	AASHTO T-180	1/2,000 CM	As per item 108.3
	Relative Density	ADTM D-4254-83	1/1,000 CM	109.2.2 etc. ref. Density
	Field Density	AASHTO T-191	1/200 CM	As per item 108.3 109.2.2 etc.

SCHEDULE FOR SAMPLING AND TESTING OF GRANULAR SUBBASE (ITEM NO. 201)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Aggregate	Gradation	AASHTO T-27	3/Source plus 1/1000 M	As per item 201.2
	Plasticity Index	AASHTO T-89 and T-90	3/Source plus as required based on visual observation	- do -
	CBR	AASHTO T-193	3/Source plus as required based on variation in gradation or 1/1000 CM	- do -
	Abrasion	AASHTO T-96	3/Source plus 1/500 CM	- do -
	Moisture Density	AASHTO T-180	1/1000 CM	- do -
	Field Density	AASHTO T-191	4/layer/400 M laid, 3 minimum / layer if less than 400 m laid	As per item No. 201.32.4
	Sand Equipment	AASHTO T-176	3/Source plus as required based on visual observation	As per item No. 201.2

SCHEDULE FOR SAMPLING AND TESTING OF AGGREGATE BASE COURSE (ITEM NO. 202)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Aggregate	Gradation	AASHTO T-27	3/Source plus 1/1000 M	As per item 202.2.(a)
	Plasticity Index	AASHTO T-89 and T-90	3/Source plus as required based on visual observation	As per item 202.2(a)
	CBR	AASHTO T-193	3/Source / stock pile plus as required base on variation in gradation	As per item 202.2(f)
	Abrasion	AASHTO T-96	3/Source plus 1/5,000 CM	As per item 202.2 ©
	Sodium Sulphate Soundness	AASHTO T-104	3/Source plus 1/5,000 CM	As per item 202.2 (d)
	Fractured faces	Visual	3/Source plus as required based on visual observation	As per item 202.2(b)
	Moisture Density	AASHTO T-180	1/1000 CM	As per item 203.3.3
	Field Density	AASHTO T-191 or T-238 and T-239	3/Layer/400 M laid 3 minimum /layer if less than 400 M Laid	As per item 202.3.3
	Sand Equipment	AASHTO T-176	3/Source plus as required based on visual observation	As per item 202.2(e)

SCHEDULE FOR SAMPLING AND TESTING OF ASPHALTIC BASE COURSE PLANT MIX (ITEM NO. 203)

Material	Test	Designation	Sampling and Testing Frequency	Reference
Mixture Compacted]in place	Thickness	AASHTO T-230	1/layer @ 100M interval per lane	As per item 203.3.11
Mixture	Compaction	AASHTO T-230 ASTM D2950	1/layer @ 100M interval per lane	As per item 203.3.9

Note:

a) Test locations will be selected a random.

SCHEDULE FOR SAMPLING AND TESTING OF ASPHALTIC BASE COURSE PLANT MIX (ITEM NO. 203)				
Material	**Test**	**Designation**	**Sampling and Testing Frequency**	**Reference**
Coarse Aggregate	Gradation	AASHTO T-27	1/1000 CM	
	Abrasion	AASHTO T-96	3/Source/Stock pile plus 1/5000 CM	As per Item 203.2.1 (a)
	Sodium Sulphate Soundness	AASHTO T-104	3/Source/Stock pile plus	As per Item 203.2.1 (b)
	Stripping	AASHTO T-182	3/Source plus 2/5000 CM	---
	Fractured faces	Visual	3/Source plus as required based on visual observation	As per Item 203.2.1
	Flat and Elongated Particle	Visual	3/Source plus as required based on visual observation	As per Item 203.2.1 (e)
	Specific Gravity and Absorption	AASHTO T-85	4/Source for each size in Hot bins of Asphalt Plant	For use in preparation of JMF
Fine Aggregate	Sand Equivalent or Plasticity Index	AASHTO T-176 AASHTO T-89 and T-90	3/Source plus as required based on visual observation 2/1000 CM	As per Item 203.2.1 © As per Item 203.2.1 (d)
	Specific Gravity	AASHTO T-84	4/Source	For use in preparation of JMF
	Friable Particles	AASHTO T-112	2/5000 CM	--
Asphalt Cement	Specific Gravity	AASHTO T-228	2/Shipment	For use in preparation of JMF
	Penetration	AASHTO T-49	2/Week of plant operation Samples taken from heating tank at staggered intervals.	As per item 203.2.2
Mixture	Extraction	AASHTO T-164	2/day's production	As per item 203.2.3
	Gradation	T-30		
	Bulk Sp. Gr.	AASHTO T-166 Method-B		
	Maximum Sp. Gr.	AASHTO T-209		
	Air Voids	AASHTO T-269		

SCHEDULE FOR SAMPLING AND TESTING OF CONCRETE
(ITEM NO. 401)

Material	Test	Designation	Sampling and Testing Frequency	Acceptance Limit
Course Aggregate	Gradation	AASHTO T-27	2/Stockpile Plus 1/1000 CM	As per Item 401.2.3
	Unit Wt.	AASHTO T-19	1/Source Plus 1/1000 CM	For use in preparation of mix design
	Sp. Gravity	AASHTO T-85	2/Source Plus 1/1000 CM	- do -
	Absorption	AASHTO T-85	1/Source Plus 1/500 CM	- do -
	Abrasion	AASHTO T-96	1/Source Plus 1/5000 CM	As per item 401.2.3
	Soundness	AASHTO T-104	1/Source Plus 1/5000 CM	As per item 401.2.3
	Deleterious Substance	AASHTO T-80	1/Source Plus 1/5000 CM	As per item 401.2.3
Fine Aggregate	Gradation	AASHTO M-6	2/Source Plus 1/1000 CM	As per item 401.2.2
	Unit Wt.	AASHTO T-19	4/Source Plus 1/800 CM	For use in Preparation of mix design
	Specific Gravity	AASHTO T-84	4/Source Plus 1/1000 CM	- do -
	Absorption	AASHTO T-84	1/Source Plus 1/1000 CM	- do -
	Organic Impurities	AASHTO T-21	1/Source Plus 1/1000 CM	As per item 401.3.9 and 401.2.2
	Soundness	AASHTO T-104	1/Source Plus 1/5000 CM	-
	Fitness	AASHTO M-6	1/Source Plus 1/1000 CM	As per item 401.2.2
	Deleterious Substance	AASHTO M-8	1/Source Plus 1/5000 CM	As per item 401.2.2
	Petrographic	-	1/Source Plus 1/5000 CM	-

TABLE FOR ALLOWABLE TOLERANCES
(EARTHWORKS, PAVEMENT COURSES AND CONCRETE)

Material	Test	Designation	Sampling and Testing Frequency	Acceptance Limit
Cement	Yield Test for Cement Content	AASHTO T-121	1/Lot or 1000 Bags	As per Item 310.3.3
	Setting Time	AASHTO T-131	1/Lot or 1000 Bags	As per Item 401.2.1
	Mortar Strength	AASHTO T-132	1/Lot or 1000 Bags	As per Item 401.2.1
Water	Chemical Tests	AASHTO T-26	1/Source	As per Item 401.2.7
Concrete Mix	Compression (Cube or Cylinder)	AASHTO T-22	6/Shift or 50 CM (2 sets of 3 each)	As per Item 401.1.1. Table 401.10
	Slump	AASHTO T-119	2/Shift or 50 CM	As per Item 401.1.1. Table 401.10

TABLE FOR ALLOWABLE TOLERANCES
(EARTHWORKS, PAVEMENT COURSES AND CONCRETE)

Description	Thickness (mm)	Level (mm)	5M Straight-edge (mm)	Cross-fall (%)	Longitudinal Grade in 30M (%)
Sub-grade	± 20	± 0 -40	30	± 0.5	± 0.1
Subbase (Granular or Stabilized)	± 10 -20	± 0 -25	20	± 0.3	± 0.1
Base Course (Granular of Stabilized)	± 5 -10	± 5 -10	6	± 0.2	± 0.1
Asphaltic Base Course	± 3 -10	± 3 -10	6	± 0.2	± 0.1
Asphaltic Wearing Course	± 3	± 3	5	± 0.2	± 0.1
Concrete for Pavement	± 10 -5	± 10 -5	5	± 0.2	± 0.1
Concrete for Structures	± 5	± 10	5	___	___

Note: 1. Material for stabilization of soil may be cement, lime or bitumen

2. Accumulative tolerance shall not be more than as specified against the final layer.

EARTHWORK

ITEM 100 GENERAL

100.1 DESCRIPTION

Earthwork will consist of all necessary work for the excavation and placing in embankment or backfill or disposal by dumping of earth, rock or other material from or to the roadway or adjacent thereto or from borrow areas, including the excavation of side and interception ditches, the removal of unsuitable subgrade material, the formation of laybyes, the widening of cuts and the flattening of cut slopes whether to obtain material for embankments of backfill, or to increase the stability of the slopes, clearing and grubbing, the selective removal of trees, stripping and the removal of existing obstructions within the approved cross section for excavation, in accordance with these specifications and in conformity with the lines, grades, sections and dimensions shown on the drawings or as directed by the Engineer.

100.2 SOIL INFORMATION

Any information concerning the properties of the soil or sub soil and other geotechnical information shown on the drawing or other documents forming part of the contract is for information only. The contractor is obliged to make his own assessment of site conditions prevailing. No claim for extra cost or time extension will be entertained based on the information provided.

The Contractor shall be deemed to have visited the site prior to making his bid and shall ascertain the nature of the earth and rock, its quantity, locations and suitability to meet the specified requirements, and he shall base his bid estimates solely on his own soil investigation. After the award of the contract no claim for a revision of bid prices depending on the sources of soil information will be entertained.

100.3 EXPLOSIVES

Where explosives are used the Contractor shall provide suitable buildings or warehouses in approved positions for the storage or explosives, which shall be stored in the manner and quantity approved by the Engineer or as per relative laws of government. Such storage places shall be accessible only to authorized personnel. They shall be properly marked, all doors or accesses thereto shall be constructed of materials as directed by the Engineer and provided with secure locks and all necessary means for preventing access by unauthorized persons. The Contractor shall be responsible for the prevention of any unauthorized issue or improper use of any explosives. The handling of explosives shall be entrusted only to experienced and responsible men, to the satisfaction of the Engineer. And in conformity with the statutory regulations.

All drilling and blasting shall be done in such a manner as to bring the excavation as close as possible to the required cross sections, and to disturb as little as possible the material to be left in place. Blasting by means of drill holes, tunnels, or any other method shall be performed at the entire risk and responsibility of the Contractor who shall have no claim to payment for extra work occasioned by breakage outside the cross-sections or dimensions.

The greatest care shall be taken by the Contractor during all blasting operations to ensure that no injury be done to persons or damage to property or to the finished work. Shots shall be properly loaded and capped, and only a moderate charge shall be used in each hole. A record of all explosives used, showing locations and amounts, shall be kept by the Contractor for checking by the Engineer.

Where directed by the Engineer, the Contractor shall provide heavy mesh blasting mat for protection of persons, property and the work. If necessary, blasting shall be restricted to time prescribed by the Engineer.

The Engineer may prohibit and order the rock to be excavated by other means, if, in his opinion, it would be dangerous to persons or adjacent structures, or is being carried out in a reckless manner. If traffic on the road has to be interrupted, the Contractor shall obtain approval of his schedule for such interruption from the proper authorities and shall satisfy the Engineer that he has obtained it. No extra payment shall be admissible for such arrangements as described here above.

100.4 REMOVAL OF EXISTING OBSTRUCTIONS

The pay items under Items 101, 103, 105, 106, 107 and 108 shall include the cost of removal of all material regardless of his nature, encountered within the limits of the approved cross-section, including the removal and disposal, as required by the Engineer, of existing brick, stone, concrete or masonry, rock boulders or fragments, old pavements, culverts, bridges or parts thereof, retaining walls or any other material encountered during the excavation, unless a separate item exists for such features.

100.5 REMOVAL OR DIVERSION OF WATER

Except where provided for, no separate payment will be made for control of or removal of water during or after earthwork operations. The cost of sheeting, shoring, cofferdams, pumping and draining shall be included in the bid prices for earthwork. The Contractor shall provided necessary facilities of dewatering and for draining or diverting watercourses when necessary for the protection of the contract work or where required by the Engineer.

The Contractor shall provide such drainage outlet ditches or canals as may be necessary to effect proper drainage before rain is expected. Such drainage ditches or canals for protection of work during construction and their maintenance and clearing to make them continuously effective during the work shall not be separately, but shall be deemed to be included in other items of work.

The Contractor shall also provide, fix maintain and operate such engines, pumps, hoses, chutes and other appliances as the necessary to keep the accumulated water at a level required for the safety of the structures as directed by the Engineer.

100.6 DITCHES

The Contractor shall construct side ditches, interception ditches, any inlet and outlet ditches as shown on the Drawings or where ordered by the Engineer, whether for temporary or permanent drainage. In order to keep water away from the embankment, subgrade, and / or pavement during construction, the Contractor shall at all times ensure adequate drainage by scheduling ditch and outlet so that the drainage is

operative before work is stated on the embankment, subgrade or pavement. He shall clean and trim all such drainage ditches from time to time, so that there may be free flow of water throughout the whole period of the Contract. Ditches shall first be trimmed according to approved cross-sections, and final trimming, including the repair of any damage that may have been done during the construction work, shall be carried out after completion of the other construction work and shall be condition for final approval and acceptance.

Unless otherwise specified no separate payment will be made for the excavation of side ditches, interception ditches, inlet and outlet ditches but such payment will be made under item 105 or 106 whichever applicable.

Where indicated on the drawings or when required by the Engineer, the Contractor shall take cross-sections of existing stream channels, and in collaboration with the Engineer, mark them with details of the excavation required for the relocation of the stream channel. Work shall not be proceed without written approval of the marked cross-sections by the Engineer.

100.7 EXCAVATION FOR CULVERTS

Except where otherwise specified excavation and backfill for culvert and drainage pipes, except granular backfill to under drains, will not be paid for separately, but shall be considered as a subsidiary obligation of the Contractor covered under the contract price for the various classes of pipe culvert as provided in Item 501.

100.8 LANDSLIDES, BENCHES, FLATTENING OF SLOPES

The Engineer may order the removal of material resulting from landslides, the construction of benches in above the cut slopes or in the embankment slope or where in his opinion the slope shows signs of instability, the flattening of the slope. Payment of all such work shall be at contract prices in item 106 or 108 as the case may be.

100.9 SURVEY AND LEVELING PRIOR TO COMMENCE OF EARTHWORK

The Contractor shall be responsible for the setting out of the work in accordance with Clause 17 of the General Conditions of Contract. Notwithstanding that project drawings have been issued to the Contractor, the Contractor shall also be responsible for taking joint cross-sections on the proposed alignment of the road, submitting three copies of the plotted cross-sections and longitudinal profile to the Engineer and obtaining the approval of the Engineer to such cross-section and longitudinal profile before any work in connection with Earthwork is commenced. These cross-sections and longitudinal provide that shall be in the form and manner as instructed in writing by the Engineer.

100.10 MEASUREMENT AND PAYMENT

The quantities of the various classes of excavation or embankment to be measured for payment under the contract shall be limited to the lines and level as taken under Clause 109.9 above. However, if the levels so taken differ appreciably from design levels the mater shall be referred to the client.

Excavation and filling beyond the lines and level shown on the drawings, approved profiles and cross-sections will not be paid for. The Engineer will decide the angle of the slope of cuts and fills as the work proceeds on the basis of evaluation of the soil characteristics. The actual lines of the cuts and fills as made will be duly measured and recorded by the Contractor. The Engineer will check these records and will approve the measurements, if correct, as a basis of payment. Excess of excavation shall be backfilled, as directed by the Engineer, with subbase materials without extra payment to the Contractor; excess of fill may be either left in place or removed as required by the Engineer. The quantities of excavation, backfill and earthwork to be paid for in Items 103, 106, 107 and 108 respectively shall be the number of cubic meters of material measured by the average end-area method, except where the error may exceed plus or minus five percent as compared with the prismoidal formula in which case the Engineer will authorize the use of the more accurate method. However, the Contractor shall request such authority before he submits his quantities for approval. Quantities measured on the average end-area basis, once they have been submitted and approved, shall not be subject to review for the purpose of applying a more accurate method.

ITEM 101 CLEARING AND GRUBBING

101.1 DESCRIPTION

This work shall consist of removal to the specified depth, grubbing and disposal of all surface objects, as and where directed in writing by the Engineer, 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.

101.1.1 CONSTRUCTION REQUIREMENTS

101.1.2 Clearing / Grubbing

In roadway cut areas, all surface objects or any object to the depth of 30 Cm. below subgrade level such as stumps, roots, vegetation, bushes, logs, rubbish shall be cleared and / or grubbed as directed by the Engineer. In roadway fill areas where clearing and grubbing is required, same shall be carried out to the depth of 30 Cm below natural surface level as described above.

Operation of clearing and grubbing shall in no way be deemed of effect any level or volume change of the area.

After clearing and grubbing, the compaction of the area will be restored to its original value without any extra payment. However, Engineer may direct in writing to the Contractor for stripping (if so required) under item 103 or for compaction under item 104, Compaction of Natural Ground, if the original compaction is less than the required for respective zone. Payment of these items will be made separately under the relative items used of such purpose.

Before bottom layer of embankment is placed, contractor will grub up and remove without extra payment, any vegetation that may, in the meantime have grown on surface previously cleared and grubbed.

All trees having girth less than 150 mm measured at (600) mm above ground and falling within the construction limits shall be felled & removed by the contractor. The excavation and removal of trees, roots and stumps including backfilling and compacting of holes and restoring the natural ground to the original condition shall be responsibility of the contractor for which no extra payment shall be made to him. The trees, stumps & roots remains the property of the Employer, which shall be delivered at designated place as directed by the Engineer.

101.1.3 Protection and Restoration

The Contractor shall prevent to all pipes, conduits, wires, cables or structure above or below ground. No land monuments, property markers, or official datum points shall be damaged or removed until the Employer / Engineer has witnessed or otherwise their locations and approved their removal. The Contractor shall so control his operations as to prevent damage to shrubs, which are to be preserved. Protection may include fences and boards latched to shrubs, to prevent damage from machine operations. Any damage as a result of contractor's operation shall immediately be rectified by him at his own expense.

101.2 MEASUREMENT AND PAYMENT

101.2.1 Measurement

Clearing and grubbing will be measured for payment only on areas so designated in writing by the Engineer or shown on the drawings. The quantity to be paid for shall be number of square meters satisfactorily cleared and grubbed. Any tree having girth of less than 150 mm (measured 600 mm above ground level) shall be measured to be under this item.

Engineer shall ensure that a minimum of 500 SM area is designated for clearing and grubbing in any stretch of roadway for the sake of ease to construction activities.

Clearing and grubbing carried out by the Contractor in roadway cut areas and borrow pits shall be measured for payment.

101.2.2 Payment

The quantities determined as provided above will be paid for at the contract unit price for the pay item mentioned below and shown in the Bill of Quantities, which price and payment shall be full compensation for clearing and grubbing and restoration of area, to its original condition.

Pay Item No.	Description	Unit of Measurement
101	Clearing and Grubbing	SM

ITEM 104 COMPACTION OF NATURAL GROUND

104.1 DESCRIPTION

The natural ground or surface ready for construction purposes after clearing and grubbing, or stripping, (if required) will be considered as (natural) Ground for the purpose of this item. The compaction of natural ground shall be carried out through a written order by the Engineer.

104.2 CONSTRUCTION REQUIREMENTS

Up to a depth of twenty (20) cm below the natural ground, all sods and vegetable matters shall be removed and clear surface shall be broken up by ploughing and scarifying to compact to the degree as defined below: -

For height of Embankment below sub grade level.	Percent of Maximum Dry Density as determined by AASHTO T-180. *
0 to 30 cm	95
30 to 75 cm	93
Over 75 cm	90
Below the foundation of structures	95

104.2.1 Compaction of original ground surface in areas of high water levels and Salinity

Compaction of the natural ground surface in such areas will be difficult if not impossible. See Items 108, etc. under Formation of Embankment for construction requirements under these conditions, where compaction of Natural Ground shall not be carried out.

104.3 MEASUREMENT AND PAYMENT

104.3.1 Measurement

The measurement shall be made by multiplying the length and breadth of the area approved in writing by the Engineer to be paid under this item. The measurement of the item shall be in Square meter.

Any subsidence of levels of Natural Ground due to compaction under this item shall not be measured for payment, the contractor is expected to take care of such factors while bidding.

104.3.2 Payment

The payment under this item shall be made for at the contract unit price for Square meter of compaction of (natural) ground measured as above and shall be deemed to include cost of scarification, watering, mixing, levelling, rolling, labour, equipment, tools, and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
104	Compaction of Natural Ground	SM

ITEM 106 EXCAVATION OF UNSUITABLE OR SURPLUS MATERIAL

106.1 DESCRIPTION

The work shall consist of excavation and disposal of unsuitable or surplus material arising from roadway excavation, which is declared in writing by the Engineer to be unsuitable for use or surplus to the requirements of the project, when excavation of unsuitable material requires special attention for a known condition on a specific project, construction requirements and payment shall be covered under relevant Provisions.

106.2 CONSTRUCTION REQUIREMENTS

All suitable material excavated within the limits and scope of the project shall be used in the most effective manner for the formation of the embankment, for widening of roadway, for backfill, or for other work included in the contract.

Any material surplus to these requirements or any material declared in writing by the Engineer to be unsuitable shall be disposed of and levelled in thin layers by the Contractor outside the right of way within 7 Km of excavation. The Engineer shall decide regarding the unsuitability of the material by conducting appropriate laboratory tests.

When unsuitable materials are ordered to be removed and replaced, the soil left in place shall be compacted to a depth of twenty (20) cm to the density prescribed under Item 108.3.1. Payment for such compaction shall be included. in the contract prices for the excavation materials.

If the unsuitable material, which is to be removed, is below standing water level and the replacement material is gravel or a similar self-draining material of at least thirty (30) cm in depth, the compaction may be dispensed with if approved by the Engineer.

Rock excavation shall be classified as under:

a) Hard Rock

Any rock which cannot be removed with Ripper of a 200 H.P. Bulldozer and constitutes a firm and continuous bed of rock only.

b) Medium Rock

Any rock which cannot be removed with the blade of 200 H.P. Bulldozer but can be removed by the ripper, will be termed as Medium Rock, irrespective of the fact that it is removed by blasting.

c) Soft Rock

Any rock which can be removed with the blade of a 200 H.P. Bulldozer. This item will be termed as Soft Rock, irrespective of the fact that it is removed by blasting.

106.3 MEASUREMENT AND PAYMENT

106.3.1 Measurement

When the contractor is directed to excavate unsuitable material below the surface of original ground in fill areas, the depth to which these unsuitable materials are to be removed will be determined by the Engineer. The contractor shall schedule his work in a such a way that authorized cross sections can be taken before and after the material has been removed. Only material which is surplus to the requirements of the project or is declared in writing by the Engineer to be unsuitable will qualify for payments under pay Item No. 106a, 106b, 106c, and 106d as the case may be.

The cost of excavation of material which is used anywhere in the project shall be deemed to be included in the pay Item relating to the part of the work where the material is used.

The under mentioned Pay Item Nos. 106a, 106b, 106c, and 106d shall include the cost of obtaining the consent of the owner or tenant of the land where the disposal of surplus or unsuitable material is made.

Unsuitable or surplus material shall be measured in its original position and its volume shall be calculated in cubic meters using end area method.

106.3.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay Items listed below and shown in the Bill of Quantities which prices and payment shall constitute full compensation for all costs involved in the proper completion of the work prescribed in this item.

Pay Item No.	Description	Unit of Measurement
106a	Excavate Unsuitable Common Material	CM
106b	Excavate Unsuitable Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
106c	Excavate Surplus Common Material	CM
106d	Excavate Surplus Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	

ITEM 107 STRUCTURAL EXCAVATION AND BACKFILL

107.1 DESCRIPTION

Structural excavation shall include the removal of ail material of whatever nature, necessary for the construction of foundations of bridges, culverts, retaining walls, headwalls, wing walls, catch basins, manholes, inlets and other structures not otherwise provided for in these specifications and in accordance with the plans or as directed by the Engineer. It shall include the furnishing of all necessary equipment and construction of all cribs, cofferdams, caissons, dewatering, sheeting, shoring etc., which may be necessary for the execution of the work. It shall also include the subsequent removal of cofferdams and cribs and the placement of all necessary backfill at hereinafter specified. It shall also include the disposing of excavated material, which is not required for backfill, in a manner and in locations so as not to affect the carrying capacity of any channel and not to be unsightly.

107.2 MATERIAL REQUIREMENT FOR BACKFILL

107.2.1 Backfill Around Structure

Backfill around structure shall be made with the following material.

a. Granular backfill of selected material as specified here under

b. Common backfill shall be carried out from excavated material or any other borrow material approved by the Engineer.

107.2.2 Grading Backfill

Granular backfill material shall meet the following requirements.

a) Grading Requirement

mm	Inch.	A	B .
25	V1	100	100
19	3 / 4”	60-100	75-100
4.75	No.4	50-85	55-100
2.0	No.10	40-70	40-100
0.425	NO.40	25-45	20-50
0.075	No.200	0-15	5-15

b) Material satisfying the requirements of coarse sand failing udder. soil classification A-3 (AASHTO). In case, coarse sand is utilised for granular fill it shall be ensured that the same is confined properly with approved material.

c) The material shall have a Plasticity Index of not more than size (6) as determined by AASHTO T-89 and T-90.

107.2.3 Common backfill

Use of excavated material as backfill may be allowed under this item. Use of borrow material for common backfill shall be allowed subject to approval of borrow material by the Engineer.

07.2.4 Rock backfill

Rock material of small size shall be permitted in the backfilling of structures or walls subject to the approval of methodology by the Engineer.

107.3 CONSTRUCTION REQUIREMENTS

107.3.1 Structural excavation

a) General

All substructures, where practicable, shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced, or protected by cofferdams in accordance with approved methods. When footings can be placed in the dry without the use of cribs or cofferdams, backforms may be omitted with the approval. of the Engineer, and the entire excavation filled with lean concrete to the required elevation of the top of the footing. The additional concrete shall be at the expense of the Contractor.

In case the contractor has excavated additional volumes than specified thereunder, the contractor shall at his own expense backfill the volume with approved material as directed by Engineer.

The classification of Hard, Medium or Soft Rock shall be same as described under item 106.2 of General Specifications.

b) Preservation of channel

Unless otherwise specified, no excavation shall be made outside of caissons, cribs, cofferdams, piling, or sheeting, and the natural stream bed adjacent to the structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs or cofferdams are in place, the Contractor shall, without extra charge, after the foundation base. is in place, backfill all such excavation to the original ground surface or river bed with material approved by the Engineer. Material deposited within the stream area from foundation or other excavation or from filling of cofferdams shall be removed and the stream bed freed from obstruction thereby.

c) Depth of Footings

The elevation of the bottoms of footings, as shown on the drawings, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

d) Preparation of Foundations of Footings

i) All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either levelled, stepped, or roughened, as may be directed by the Engineer.

ii) When masonry is to rest on an excavated surface other than rock special, care shall be taken not to disturb the bottom of the excavation, and the final levelling of the grade shall not be made until just before the masonry is to be placed.

e) Cofferdams and Cribs

i). For substructure work, the contractor shall submit, upon request, drawings showing his proposed method of cofferdams construction and other details left open to his choice or not fully shown on the Engineer's drawings. The Contractor shall not start work until the Engineer has approved such drawings.

ii). Cofferdams and cribs for foundation construction shall be carried to adequate depths and heights, be safely designed and constructed, and be made as water tight as is necessary for the p roper performance of the work which must be done inside them. In general, the interior dimensions of cofferdams and cribs shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside the forms. Cofferdams or cribs, which are tilted or moved laterally during the process of sinking, shall be righted, reset, or enlarged so as to provide the necessary clearance and this shall be solely at the expense of the Contractor.

iii) When conditions are encountered which, in the opinion of the Engineer, render it impracticable to dewater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation water shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight is utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal, and if the cofferdam is to remain in place, it shall be vented or ported at low water level.

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

v) Unless otherwise provided, cofferdams of cribs with all sheeting and bracing shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished masonry.

f) Pumping

i) Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping of water will be permitted during the placing of concrete or for a period of at least twenty-four (24) hours thereafter, unless it is done from a suitable sump pit separated from the concrete work by a watertight wall or other effective means.

ii) Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to with stand the hydrostatic pressure.

g) Inspection

After each excavation is completed the Contractor shall notify the Engineer, and no concrete or masonry shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

In case if an existing structure is to be replaced with a new structure the quantities for dismantling the structure shall be paid under item 510 (Dismantling of structures) and additional excavation required shall be carried out under this item.

h) Classification of Excavation

Classification of excavation shall be made as described under items 106.2 of this Specification.

107.3.2 Excavation in Embankments

Unless otherwise. specified, the Contractor may choose with the approval of the Engineer to excavate for structures, culverts, and pipe culverts after the embankment has been placed. Any space remaining after the placing of such structures or culverts shall be filled with material approved by the Engineer and compacted as follows:

Layers of not more than 20 cm in loose thickness shall be placed and compacted in succession, with mechanical tampers, plate compactors or hand guided rollers operated transversely to the roadway, to the densities specified in the item 108.3.1. Moisture content shall be adjusted as directed by the Engineer. Proper benching shall be made to ensure bonding of existing and new material without any extra payment.

The excavation in embankment and the placing of backfill for the purposes described above shall not constitute any claim for payment. also if sand or granular backfill is used by the contractor for his convenience, no extra payment will be made.

107.3.3 Backfill

a) Granular backfill where-ever directed shall be placed in the position and in the required depth, shown on the drawings or where and as required in writing by the Engineer and it shall be well compacted in layers not exceeding twenty (20) cm in thickness to 100 percent of Max. dry density as per AASHTO T-180 (D). In case of water logged areas the thickness of the layer shall not exceed fifty (50) centimetres or as directed by the Engineer. Volume of granular fill around structures shall be calculated within the vertical limits of approved 'excavation for such a structure, whereas the horizontal limits shall be those as specified on drawings.

b) Common backfill shall consist of earth free from large lumps, wood and other organic materials and of a quality acceptable to the Engineer. It shall be placed in the position and to the required depths shown on the Drawings and / or as required in writing by the Engineer and it shall be well compacted in layers not to exceed twenty (20) cms in depth to the density, 95 percent of maximum dry density, as per AASHTO T- 80 (D).

c) The rock backfill material whose individual sizes are not more than 30 cm shall be placed in the position to the required depth as specified and the voids shall be filled in layer of fine material approved by the Engineer. The compacting efforts shall be made so as to achieve the desired compaction approved visually by the Engineer. The depth of the layer in any case shall not exceed sixty (60) centimetres. However, in water logged areas, the thickness may be increased as directed by the Engineer. Rock backfill will not be placed within two meters from concrete face of any structure.

d) All spaces excavated and not occupied by abutments, piers or other permanent work shall be refilled with earth or granular fill as approved by the Engineer up to the surface of the surrounding ground, with a sufficient allowance for settlement. All such backfill shall be thoroughly compacted and, in general, its top surface shall be neatly graded.

e) The fill behind abutments and wing walls of ail bridge structures shall be deposited in well-compacted, horizontal layers not to exceed twenty (20) cm. in thickness. The common backfill in front of such units shall be placed first to prevent the possibility of forward movement.

Special precautions shall be taken to prevent any wedging action against the masonry, and the slope bounding the excavation for abutments and wing walls shall be destroyed by stepping or roughening to prevent wedge action. Jetting of the fill behind abutments and wing walls will not be permitted.

f) Fill placed around culverts and piers shall be deposited on both sides to approximately the same elevation at the same time. Where the Contractor does not have proper equipments to ensure compaction in restricted areas, Engineer may allow backfill with sand saturation method, at no extra cost to the Client.

g) Adequate provision shall be made for the through drainage of all backfill. French drains shall be placed as weep holes.

h) No backfill shall be placed against concrete or masonry structure before fourteen (14) days of placement and backfilling shall be carried out on both sides of the structure simultaneously.

107.4 MEASUREMENT AND PAYMEN

107.4.1 Measurement

a) Structural Excavation

The quantities of structural excavation to be paid for shall be the number of cubic meters of material measured in its original position computed by the average end-area method, and excavated to the satisfaction of the Engineer.

Structural Excavation will be classified for measurement and payment as "Structural Excavation in Common Material", "Structural Excavation in Common Material Below Water Level", "Structural Excavation in Rock Material" and according to whether the excavation is in earth or rock and according to whether the excavation is above or below the water level which is the constant level to which the water naturally rises in a foundation pit.

The volume of earth or rock to be measured for structural excavation shall consist of a prismoid bounded by the following planes: -

1) The vertical limits for computing pay quantities will be vertical planes 50 centimeters outside of the neat lines of footings or foundations as shown on the Drawings or as directed by the Engineer.

2) The upper limit for payment of structural excavation shall be the ground surface as it existed prior to the start of construction operations, except where structural excavation is performed within roadway excavation or ditch excavation areas, the upper limit shall be the planes of the bottom and side slopes of said excavated areas.

3) The lower limits for computing pay quantities of structural excavation or structure backfill shall be a plane at the bottom of the completed footings, foundations, structures or lean concrete.

Measurement for structural excavation shall not include material removed below the footing grade and beyond specific limits to compensate for anticipated swell or as a result of effective swell during pile driving, or additional material resulting from slides, slips, cave-ins, silting or fillings, whether due to the action of the elements or to carelessness of the Contractor. The depths of the footings shown on the drawings are approximate only and any variation found to be necessary during construction shall be paid for at the contract unit price.

b) Granular Backfill

The quantities of Granular Backfill to be paid for shall be the number of cubic meters of material laid and compacted in place within the fine of structure and limits defined in Item 107.4.1 (a) above, computed and accepted by the Engineer.

c) Common Backfill

The quantities of Common Backfill to be paid for shall be the number of cubic meters of material laid and compacted, placed within the lines of structure and limits defined in Item 107.4.1(a) above and accepted by the Engineer.

107.4.2 Payment

The quantities determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay item listed below that is shown in the Bill of Quantities, which price and payment shall be full compensation for all the costs involved in the proper completion of the work prescribed in this item.

Pay Item No.	Description	Unit of Measurement
107a	Excavate Excavation in Common Material	CM
107b	Excavate Excavation in Common Material Below Water Level	CM
107c	Excavate Excavation in Rock Material	
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
107d	Granular Backfill Type-	CM
107e	Common Backfill	CM

ITEM 108 FORMATION OF EMBANKMENT

108.1 DESCRIPTION

This work shall consist of formation of embankment, including preparation of area for placing and compaction of embankment material in layers and in holes, pits and other depressions within the roadway area in accordance with the specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the plans r established by the Engineer.

108.2 MATERIAL REQUIREMENTS

Material for embankment shall consist of suitable material excavated from borrow, roadway excavation or structural excavation and shall include all lead and lift. Borrow material 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 material under this item shall conform to the following specification.

a) Contractor shall use AASHTO Class A-1, A-2, A-3, A-4 or A-5 soil as specified in AASHTO M-145 or other material approved by the Engineer.

b) CBR of the material shall not be less than five (5) percent, determined in accordance with AASHTO TA 93. CBR value shall be obtained at a density corresponding to the degree of compaction required for the corresponding layer.

c) Swell value of the material for embankment formation shall not exceed five tenth (0.5) percent. However, while establishing the swell value, surcharge weights representing the overburden will be used. In case sandy material is used for embankment formation, it shall be properly confined at no extra payment with a material and to the extent as approved by the Engineer and sandy material shall not be used on slopes of embankment.

d) In areas subject to flood and prolonged inundation of the embankment, such as at bridge sites, the material used in embankment, unless rock, shall be AASHTO Class A1 (a), A1 (b) and A-2-4, soils. Other soils may be used only with the written consent of Engineer.

108.3 CONSTRUCTION REQUIREMENTS

108.3.1 Formation of Embankment with Borrow Common Material

Material for embankment, obtained and approved as provided above, shall be placed in horizontal layers of uniform thickness and in conformity with the lines, grades, sections and dimensions shown on the Drawings or as required by the Engineer. The layers of loose material other than rock shall be not more than 20 cm. thick, unless otherwise allowed by the Engineer after a trial section is prepared and approved.

The material placed in layers and that scarified to the designated depth for formation of embankment shall be compacted to the density specified below:

Depth in centimetres below subgrade level	Percent of Maximum Dry Density as determined by AASHTO T-180. *
0 to 30	95
30 to 75	93
Over 75	90

* Method 'B' or 'D' whichever is applicable, or corresponding Relative Density in case of sand fill.

In-place density determinations of the compacted layers shall be made in accordance with AASHTO T-191 or other approved methods. For all soils, with the exception of rock fill materials, containing more than 10% oversize particles (retained on 3/4 inch/ 19 mm sieve), the in-place density thus obtained shall be adjusted to account for such oversize particles or as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer.

Material for embankment at locations inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 15 centimetres thick and compacted to the densities specified above by the use of mechanical tempers, or other appropriate equipmen

The compaction of the embankment shall be carried out at the designated moisture content consistent with the available compacting equipment

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 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.

When materials of widely divergent characteristics, such as clay and chalk or sand, drawn from different sources, are to be used in the embankment they shall be deposited in alternate layers of the same material over the full width of the embankment to depths approved by the Engineer. Rock, clay or other material shall be broken up, and no accumulation of lumps or boulders in the embankment will be permitted. No surplus material shall be permitted to be left at the toe of embankment or at the top of cut sections.

Side slopes shall be neatly trimmed to the lines and slopes shown on the drawings or as directed by the Engineer, and the finished work shall be left in a neat and acceptable condition.

108.3.2 Formation of Embankment with Rock Material

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 eighty (80) centimetres of loose measurement and compacted by a vibratory roller with the minimum mass as shown in the following table.

Mass per meter width of vibrating roll (Kg / M)	Depth of fill layer (mm)	Number of passes of the roller on each layer
2300 – 2900	400	5
2900 – 3600	500	5
2600 – 4300	600	5
4300 – 500	700	5
>5000	800	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 twenty (20) centimeters. 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 levelled with motor grader, bulldozer or similar equipment capable of shifting and forming the layer into a neat and orderly condition. No rock larger than eight (8) centimeters in any dimension shall be placed in the top fifteen (15) centimeters 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 that 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) percent 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) percent of the thickness of the layer being placed.

108.3.3 Formation of Embankment on Steep Slopes

Where embankments are to be constructed on steep slope, hill sides 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 twenty (20) centimeters 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.

108.3.4 Formation of Embankment on Existing Roads

Before fill is placed and compacted on an existing roadway, the existing embankment and / or pavement may be levelled by cutting, rooting or scarifying by approved mechanical means to a level to be determined by the Engineer. The earth, old asphalt or other material arising as a result of this operation will be declared either suitable or unsuitable, for use in the embankment or other items, by the Engineer. If the material is declared suitable it will be measured under relative item and if it is declared unsuitable, it will be measured under item 106a.

108.3.5 Formation of Embankment in Water Logged Areas

Where embankments are to be placed in water logged areas and which are inaccessible to heavy construction equipment, a special working platform shall be first established, consisting of a blanket of fill material placed on top of the soft layer. The material of the working table shall consist of normal or processed granular fill, obtained from borrow excavation. This material shall conform to the following specifications:

Sieve Description	**Percentage of Weight Passing Mesh Sieve, AASHTO T-27**
3 inch (75 mm)	100

The remaining grading shall be such as to avoid intrusion into the working platform material of subgrade or natural ground surface material. For this condition to be met it will be required that the ratio.

$$\frac{D_{15}\text{(Working Platform Material)}}{D_{85}\text{ (Natural Ground Material)}} \text{ is less than 5.}$$

D_{85} and D_{15} mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

Construction of this working table shall proceed from one edge of the soft area by using the fill as a ramp for further material transport.

The thickness of the working table as prescribed above shall be approximately 0.5 meter unless directed otherwise by the Engineer, and the width shall be that of the embankment. The placement and compaction of the working table shall be carried out by use of light equipment, as directed by the Engineer.

No density requirements are specified for the working platform, however, subsequent layers above it shall be compacted to the densities specified in Item 108.3.1

108.3.6 General Requirements

To avoid interference with the construction of bridge abutments and wing walls, the Contractor shall at points determined by the Engineer, suspend work on embankments and / or in cuts forming the approaches to any such structure

until such time as the construction of the later is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included` in the contract unit prices for embankment. In carrying embankments up to or over bridges, culverts or pipe drainage, care shall be taken by the Contractor to have the embankments brought to equally on both sides and over the top of any such structure. Contractor shall make special arrangements to ensure proper compaction in restricted spaces and around structures. No compensation shall be made to the Contractor for working in narrow or otherwise restricted areas.

When as a result of settlement, an embankment requires the addition of material up to 30 cm in thickness to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified before the additional materials being placed, without extra payment to Contractor for the scarification.

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that in the opinion of the Engineer have been damaged or displaced due to carelessness or neglect on the part of the Contractor. Embankment material which may be lost or displaced as a result of natural causes such as storms, cloud-burst or as a result of unavoidable movement or settlement of the ground or foundation upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. No additional compensation will be allowed for the replacement.

During construction, the roadway shall be kept in shape and drained out at all times. When unsuitable material has been placed in the embankment by the Contractor, he shall remove it without extra payment.

108.4 MEASUREMENT AND PAYMENT

108.4.1 Measurement

The quantities to be paid for shall be the number of cubic meters calculated on theoretical designed lines and grades and the ground levels as established under clause 100.9, compacted in place, accepted by the Engineer formed with material resulting from:

i) Formation of Embankment from Borrow Excavation

Measurement shall be made as under: -
Formation from Borrow = Total Embankment Quantity (minus) Roadway excavation Quantity (minus) structural excavation Quantity.

ii) Formation from structural Excavation

This quantity shall be the same as calculated for structural excavation irrespective of its haulage distance except -that declared unsuitable by the Engineer.

iii) Formation from Roadway Excavation

This quantity shall be the same as calculated for Roadway Excavation. The contractor will be supposed to use material from Roadway Excavation irrespective of haulage distance. However, if contractor, for his own convenience, uses the material from borrow, the payment will still be made under this item 108 (a) & 108 (b).

In the measurement of "Formation of Embankment on steep slopes" no allowance will be made for the benching or volume of material cut out from the hill side or from the first half width fill to accommodate the compacting equipment but will be calculated only on the net volume of fill placed against the original hill sides, the old embankment or the first half width fill.

108.4.2 Payment

a) Formation from Borrow Excavation,

The quantity to be paid for shall be the number of cubic meters placed in embankment, measured as provided above for material from borrow excavation and such a payment will be deemed to include cost of excavation, payment of royalty, levies and taxes of Local, Provincial and Federal Government, cost of hauling including all lead and lift, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

b) Formation from Structural Excavation.

The quantity to be paid for shall be the number of cubic meters placed in embankment and measured as provided above for material from structural excavation and such payment will be deemed to include cost of excavation, hauling, dumping, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

c) Formation from Roadway Excavation

The quantity to be paid for shall be the number of cubic meters placed in embankment and measured as provided above for material form roadway excavation and such payment will be deemed to include cost of excavation, hauling, dumping, spreading, watering, rolling, labour, equipment, tools and incidental necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
108a	Formation of Embankment from Roadway Excavation in Common Material	CM
108b	Formation of Embankment from Roadway Excavation in Rock Material	CM
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM
108c	Formation of Embankment from Borrow Excavation in Common Material	CM
108d	Formation of Embankment from Structural Excavation in Common Material	CM
108e	Formation of Embankment from Structural Excavation in Rock Material	CM
	i. Hard Rock	CM
	ii. Medium Rock	CM
	iii. Soft Rock	CM

ITEM 109 SUBGRADE PREPARATIONS

109.1 DESCRIPTION

The subgrade preparation shall be that part of the work on which, the subbase is placed or, in the absence of subbase, act as the base of the pavement structure. It shall extend to the full width of the road bed including the shoulders and laybyes as indicated on the Drawings or as specified herein.

109.2 CONSTRUCTION REQUIREMENT

109.2.1 Prior Work

Before commencing the work all culverts, drains, ditches including fully compacted backfill over them outlets for drainage, head walls / wing walls of culverts and any other minor structure below thirty (30) centimetres of existing subgrade level or all structures which will be below thirty (30) centimetres of newly placed subgrade level, shall be in such operative conditions as to ensure prompt and effective drainage and to avoid damage to subgrade by surface water. No work of subgrade preparation will be started before the prior work herein described has been approved by the Engineer.

109.2.2 Compaction Requirements

All materials down to a depth of 30 cm below the subgrade level in earth-cut or embankment shall be compacted to at least 95 percent of the maximum dry density as determined according to AASHTO T-180 Method 'B' or V whichever is applicable or corresponding Relative Density as per D4254-83 (ASTM)

109.2.3 Subgrade Preparation in Earth Cut

In case bottom of subgrade level is within thirty (30) cm of the natural ground, the surface shall be scarified, broken up, adjusted to moisture content and compacted to minimum density of ninety-five (95) percent of the maximum dry density as determined by AASHTO T-180 Method D. Subsequent layer of approved material shall be incorporated to ensure that the depth of subgrade layer is thirty (30) cm.

In case, the bottom of subgrade 4 s below the natural ground by more than Thirty (30) cm, the material above the top of subgrade shall be removed and subsequent layer of thirty (30) cm shall be scarified, broken up, adjusted to moisture content and compacted to the same degree of compaction as described above.

In case, unsuitable material is encountered at the sub grade level within a depth of thirty (30) cm, the same shall be removed in total and replaced by the approved material. The contractor shall be paid for removal of unsuitable material as per pay Item 106a and for replacement of approved material, the payment will be made under pay Item 108c.

109.2.4 Subgrade Preparation in Rock Cut

Excavation in rock shall extend to the subgrade level as shown on drawings. Rock shall be undercut nearly for 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

subgrade level shall be backfilled with selected subbase material and compacted to minimum ninety-eight (98) percent of the maximum dry density as determined by AASHTO T-180, method U. No compensation shall be made to the Contractor for over-cut or remedial measures as described above.

No rock shall be higher than two (2) centimetres above the under cut section elevation. The under cut material shall be placed in embankment or disposed of at the direction of Engineer.

109.2.5 Subgrade in Embankment

When the subgrade is formed in embankment, its width shall be the full width of top of embankment and material placed in the upper part of embankment down to a depth of thirty (30) centimetres below subgrade level shall meet compaction requirement of 109.2.2. Soils having a minimum value of C.B.R of seven (7) percent and swell value of not more than 0.3 percent shall be used. C.B.R less than seven *(*7) % may be used in case, the design allows for it. Unsuitable material if encountered within the existing formation layer as per laboratory specified test, shall be removed, disposed of and replaced by suitable one as per direction of the Engineer of which the payment will be made under relevant items of work.

Rollers and other equipments of approved size and type, accepted by the Engineer, shall be used for compaction. Water shall be added to obtain optimum moisture content; if necessary. Contractor shall ensure proper compaction in restricted areas by use of special equipments and rollers. No compensation shall be made for extra work due to restricted space.

Performance of this item of work shall not be paid for under this section but shall be deemed to be covered by the contract price for pay item 108a, through 108e, Formation of Embankment.

109.2.6 Subgrade Level in Existing Road

Where indicated on the Drawings or directed by the Engineer that the existing road surface is to be used as the subgrade, the correct elevation on which the base or subbase is to be laid shall be obtained, where necessary, either by means of levelling course or by excavation. The levelling course shall be constructed to the requirements of the Engineer and paid for under the appropriate Pay Item involved. Excavation shall include disposal of any surplus material in the adjacent embankment or elsewhere as directed by the Engineer.

In case, the design level of subgrade is within 30 cm of the existing ground/road then the item shall be measured and paid accordingly.

109.2.7 Subgrade reinforcement

When the width of the existing pavement, either to be scarified or not, is insufficient to contain the subbase or base to be placed upon it, the Engineer may order to strengthen and support the subbase or base on one or both sides of the existing pavement. This work shall consist of the removal and disposal of any unsuitable material and its replacements with suitable material to such width and depth as required by the Engineer.

The excavated material shall, if declared suitable for use elsewhere in the embankment by the Engineer be so used, and payment for its removal shall be covered under the contract price of Pay Item No. 108a; if declared unsuitable it shall be disposed of and paid as provided in Item 106a. The finished compacted surface of the subgrade shall be as specified in Item 109.2.3.

109.2.8 Protection of Compacted Work

Any part of the subgrade that has been completed shall be protected and kept well drained. Any damage resulting from carelessness of the Contractor shall be repaired as directed by the Engineer without additional payment.

The Contractor shall be responsible for all the consequences of traffic being admitted to the subgrade. 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. He shall limit the area of subgrade preparation to an area easily maintained with the equipment available. Subgrade preparation and subbase or base placing shall be arranged to follow each other closely. The subgrade, when prepared too soon in relation to the placing of the subbase, is liable to deteriorate, and in such case the Contractor shall, with ' out additional payment, repair, reroll, or re-compact the subgrade as may be necessary to restore it to the state specified herein.

109.2.9 Templates and Straightedges

The Contractor shall provide for the use of the Engineer, satisfactory templates and straightedges in sufficient numbers to check the accuracy of the work, as provided in these specifications and no subsequent work shall be permitted until the subgrade levels have been checked and approved by the Engineer. For tolerances referred to the, 'Table for Allowable Tolerances" in these specifications.

109.3 MEASUREMENT AND PAYMENT

109.3.1 Measurement

The quantity to be paid for shall be the number of square meters of subgrade prepared as herein before prescribed and accepted. Subgrade in rock cuts and on embankment not consisting of the existing road surface in fill area shall not be measured for direct payment.

Subgrade preparation on "Existing Surface" shall only be measured for payment when ordered by the Engineer.

109.3.2 Payment

The quantities, determined as provided above, shall be paid for at the contract unit price respectively, for each of the particular pay items listed below that is shown in the Bill of Quantities which prices and payment shall be full compensation for furnishing of material, water, equipment, tools, labour, and all other items necessary for completion of work.

Pay Item No.	Description	Unit of Measurement
109a	Subgrade preparation in Earth Cut	SM

109b	Subgrade preparation in Existing Cut	
	i. Without any fill	SM
	ii. With fill less than 30 cms	SM

ITEM 201 GRANULAR SUBBASE

201.1 DESCRIPTION

This item shall consist of furnishing, spreading in one or more layers and compacting granular subbase according to the specifications and drawings and / or as directed by the Engineer.

201.2 MATERIAL REQUIREMENTS

Granular subbase material shall consist of natural or processed aggregates such as gravel, sand or stone fragment and shall! be clean and free from dirt, 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 subbase.

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

a) The subbase material shall have a gradation curve within the limits for grading A, B, and C given below. However, grading A may be allowed by the Engineer in special circumstances.

Grading Requirement for Subbase Material			
Sieve Designation		Mass Percent Passing Grading	
Mm	Inch	A	B
60.000	(2.1/2)	100	--
50.000	(2)	90-100	100
25.000	(1)	50-80	55-85
9.500	(3/8)	--	40-70
4.750	No.4	35-70	30-60
2.000	No.10	--	20-50
0.425	No.40	--	10-30
0.075	No.200	2-8	5-15

The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10%, respectively, passing (by weight) in a grain size analysis, curve.

b) The Material shall have a CBR value of at least 50%, determined according to AASHTO T-193. The CBR value shall be obtained at a density corresponding to Ninety-eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D.

c) The coarse aggregate material retained on sieve No. 4 shall have a percentage of wear by the Los Angeles Abrasion (AASHTO T-96) of not more than fifty (50) percent.

d) In order to avoid intrusion of silty and clayey material from the subgrade in the subbase, the ratio D15 (Subbase) / D85 (Subgrade) should be less than 5.

Where D85 and D15 are the particle diameters corresponding to eighty-five (85) % and fifteen (15) %, respectively, passing (by weight) in a grain size analysis, curve.

e) The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than two third of the fraction passing the 0.425 mm (No. 40) sieve. The fraction passing the 0.425 mm sieve shall have a liquid limit of not greater than 25 and a plasticity index of 6 or less.

f) If over-size is encountered, screening 6f material at source, shall invariably be done, no hand picking shall be allowed, however hand picking may be allowed by the Engineer, if over-size quantity is less than 5% of the total mass.

g) Sand equivalent for all classes shall be 25 min.

201.3 CONSTRUCTION REQUIREMENT

201.3.1 Spreading

Granular subbase shall be spread on approved subgrade layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse or fine materials.

Granular subbase shall be deposited on the roadbed or shoulders in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the subbase material. In case any material is to be added to compensate for levels, the same shall be done after scarifying the existing material, to ensure proper bonding of additional material.

When the required thickness is fifteen (15) cm or less, the aggregates may be spread and compacted as one layer, but in no case shall a layer be less than seven and z one half (7.5) centimetres thick. Where the required thickness is more than 15 cm, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness, but in any case the maximum compacted thickness of one layer shall not exceed 15 cm. All subsequent layers shall be spread and compacted in a similar manner.

Granular subbase shall be spread with equipment that will provide a uniform layer conforming to the specified item both transversely and longitudinally within the tolerances as specified in Table for Allowable Tolerances" in these specifications. No hauling or placement of material will be permitted when, in the judgment of the Engineer, the weather or road conditions are such that the hauling operation will cause cutting or rutting of subgrade or contamination of sub base material.

201.3.2 Compaction Trials

Prior to commencement of granular subbase operation, contractor shall construct a trial length, not to exceed, five hundred (500) meters and not less than two hundred (200) meters with the approved subbase material as will be used during construction to determine the adequacy of the contractor's

equipment, loose depth measurement 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. For details, refer to clause 1.20 (General) of these specifications.

201.3.3 Compaction

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

The subbase material shall be compacted by means of approved vibrating rollers or steel wheel rollers (rubber tyred rollers may be used as a supplement), progressing gradually from the outside towards the centre, except on super elevated curves, where the roiling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface free from ruts or ridges and having proper section and crown. Rolling shall continue until entire thickness of each layer is thoroughly and uniformly compacted to the specified density.

Any area inaccessible to rolling equipment shall be compacted by means of hand guided rollers, plate compactors or mechanical tampers, where the thickness in loose layer shall not be more than 10 cm.

If the layer of subbase material, or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and recompact the material before succeeding layer of the pavement structure is constructed.

Immediately prior to the placing of first layer of base course the subbase layer (both under the travelled way and the shoulders) shall conform to the required level and shape. Prior to placing the succeeding layers of the material, the top surface of each layer shall be made sufficiently moist to ensure bond between the layers. The edges or edge slopes shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the plans.

No material for construction of the base shall be placed until the subbase has been approved by the Engineer.

201.3.4 Compaction requirements

The relative compaction of each layer of the compacted subbase shall not be less than ninety-eight (98) percent of the maximum dry density determined according to AASHTO T-180 Method-D. The field density shall be determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19 mm sieve) as 'directed by the Engineer Also for adjustment of any material retained on 4.75 mm sieve, AASHTO Method T-224 shall be used

201.3.5 Moisture Content Determination

As it is customary in the project laboratories that small samples of materials are placed in ovens for moisture determination for proctor, following precautions are necessary to ensure proper compaction results.

a) Same size of sample is placed in oven for moisture determination in case of laboratory density (Proctor) and field density.

b) Moisture content for calculation of field density and proctor shall be observed on material passing 4.75 mm sieve.

201.3.6 Tolerance

The subbase shall be compacted to the desired level and cross slopes as shown on the drawings. The allowable tolerance shall be according to the "Table for Allowable Tolerances" in these specifications.

201.4 MEASUREMENT AND PAYMENT

201.4.1 Measurement

The quantity of subbase 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, placed and accepted in the completed granular subbase course. No allowance will be given for materials placed outside the theoretical limits as shown on the cross-sections.

201.4.2 Payment

The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of granular subbase, for the Pay Item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete the item.

Pay Item No.	Description	Unit of Measurement
201	Granular Subbase	CM

ITEM 202 AGGREGATE BASE COURSE

202.1 DESCRIPTION

This item shall consist of furnishing, spreading and compacting one (1) or more layers of aggregate base on a prepared subgrade, subbase, or existing road surface, in accordance with the specifications and the drawings and / or as directed by the Engineer.

202.2 MATERIAL REQUIREMENTS

Material for aggregate base course shall consist of crushed hard durable gravel, rock or stone fragments. It shall be clean and free from organic matters, lumps of clay and other deleterious substances. The material shall be of such a nature that it can be compacted readily under watering and rolling to form a firm, stable base for both flexible and rigid pavements.

The aggregate base shall comply to the following grading and quality requirements.

a) The gradation curve of the material shall be smooth and within the envelope limits for Grading A or B given below.

Grading Requirement for Aggregate Base Material			
Sieve Designation		Mass Percent Passing Grading	
Mm	Inch	A	B
50.000	2	100	100
25.000	1	70-95	75-95
9.500	3/8	30-65	40-75
4.750	No.4	25-55	30-60
2.000	No.10	15-40	20-50
0.425	No.40	8-20	12-25
0.075	No.200	2-8	5-10

The material shall be well graded such that the coefficient of Uniformity D60/D10 shall be greater than four (4).

b) Crushed Aggregate (material retained on sieve NO. 4) shall consist of material of which at least ninety (90) percent by weight shall be crushed particles, having a minimum of two (2) fractured faces.

c) The Coarse aggregate shall have a percentage of wear by the Loss Angeles Abrasion test (AASHTO T-96) of not more than forty (40).

d) The material shall have a loss of less than twelve (12) percent when subjected to five cycles of the Sodium Sulphate Soundness test according to AASHTO T-104.

e) The sand equivalent determined according to AASHTO T-176 shall not be less than 45 and the material shall have a Liquid limit of not more than twenty-five (25) and a plasticity Index of not more than 6 as determined by AASHTO T-89 and T-90.

f) The material passing the 19 mm sieve shall have a CBR value of minimum eighty (80) percent, tested according to the AASHTO T 193. The CBR value shall be obtained at the maximum dry density determined according to AASHTO T 180, Method D.

g) Laminated material shall not exceed 15% of total volume of Aggregate Base Course.

202.2.1 <u>Filler for Blending</u>

If filler, in addition to that naturally present in the aggregate base material is necessary for meeting the grading requirement or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the crushing plant or in a pugmill unless otherwise approved. The material for such purpose shall be obtained from sources approved by the Engineer. The material shall be free from organic matter, dirt, shale, clay and clay lump or other deleterious matter and shall conform to following requirement.

AASHTO Sieve	Percent Passing
$^3/_8$ Inch	100
4	85-100
100	10-30
Plasticity Index (AASHTO T-90)	6 maximum
Sand Equivalent (AASHTO T-176)	30 minimum

However, the combined aggregates prepared by mixing the coarse material and filler shall satisfy the requirements as mentioned in clause 202.2 above.

202.3 CONSTRUCTION REQUIREMENTS

202.3.1 Preparation of surface for Aggregate base course

In case crushed aggregate base is to be laid over prepared sub base course, the subbase course shall not have loose material or moisture in excess to optimum moisture content.

Spreading shall conform in all respects to the requirements specified under this heading in Item 201 - Subbase (201.3.1).

202.3.2 Compaction

Compaction process shall conform in all respect to the requirements specified under this heading in Item 201 (201.3.3).

202.3.3 Compaction Requirement

The relative compaction of each layer of the compacted base shall not be less than 100 percent to the maximum dry density determined according to AASHTO T-1 80, Method D (Modified). The field density shall be determined according to AASHTO T-191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19 mm sieve) as directed by the Engineer. Also for adjustment of any material retained on 4.75 mm sieve, AASHTO Method T224 shall be used

Completed base course shall be maintained in an acceptable condition at all times until prime coat is applied. When base course is to carry traffic for an indefinite ` length of time before receiving surfacing, the contractor shall maintain the surface until final acceptance and shall prevent revelling by wetting, blading, rolling and addition of fines as may be required to keep the base tightly bound and leave a slight excess of material over the entire surface which must be removed and the surface finish restored before application of prime coat.

202.3.4 Moisture Content Determination

Moisture content determination shall conform in all respects to the requirements specified under clause 201.3.5 for subbase.

202.3.5 Trial Sections

Prior to commencement of aggregate base course operations, a trial section of two hundred (200) meters minimum, but not to exceed five hundred (500) meters shall be prepared by the contractor using same material and equipment as will be used at site to determine the adequacy of equipment, loose depth measurement necessary to result in the specified compacted layer depths, field moisture content, and relationship between the number of compaction passes and the resulting density of material. For details refer to clause 1.20 (General) of these specifications.

202.3.6 Tolerance

The completed base course shall be tested for required thickness and smoothness before acceptance. Any area having waves, irregularities in excess of one (1) cm in three (3) M or two (2) cm in fifteen (15) M shall be corrected by scarifying the surface, adding approved material, reshaping, re-compacting and finishing as specified. Skin patching of an area without scarifying the surface to permit proper bonding of added material shall not be permitted. The allowable tolerances shall be according to the "Table for Allowable Tolerances" in these specifications.

202.3.7 Acceptance, Sampling and Testing

Acceptance of sampling and testing with respect to materials and construction requirements shall be governed by the relevant, “Table for Sampling and Testing Frequency” or as approved by the Engineer.

202.4 MEASUREMENT AND PAYMENT

202.4.1 Measurement

The quantity of aggregate base 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, placed and accepted in the completed crushed aggregate base course. No allowance will be given for materials placed outside the theoretical limits as shown on the cross sections.

202.4.2 Payment

The accepted quantities measured as above shall be paid for at the contract unit price per cubic meter of aggregate base, for the item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete this item.

Pay Item No.	Description	Unit of Measurement
202	Aggregate Base	CM

ITEM 302 BITUMINOUS PRIME COAT

302.1 DESCRIPTION

This work shall consist of furnishing all plant, labour, equipment, material and performing all operations in. applying a liquid asphalt prime coat on a previously prepared and untreated; earth sub grade, water bound base course, crushed aggregate base course, tops of roadway shoulders, and as otherwise shown on the plans in strict accordance with the specification and in conformity with the lines shown on the drawings.

302.2 MATERIAL REQUIREMENTS

Asphaltic material shall conform to the requirements of the item 301- “Asphaltic Materials", either cutback or Emulsified Asphalt, whichever is specified in the Bill of Quantities.

302.3 CONSTRUCTION REQUIREMENTS

Prime coat shall be applied when the surface to be treated is dry; except that when emulsified asphalt is used, the surface may be reasonably moist. The application is prohibited when the weather is foggy or rainy, or when the atmospheric temperature is below fifteen (15) degree C unless otherwise directed by the Engineer. Prior to the application of the prime coat, all loose materials shall be removed from the surface and the same 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. No traffic shall be permitted on the surface after it has been prepared to receive the bituminous material. Prior to the application of prime coat on bridge decks and concrete pavements, the surfaces shall be cleaned of all loose material as described in Section 302.3. All expansion joints shall be cleaned and filled with bituminous material as directed by the Engineer. Areas to be primed will be classified as under:

(i) The top of earth surface or water bound base courses from a point twenty (20) centimeters outside the edge of the pavement line to 20 cms outside the line on the opposite side of the roadway.

(ii) The top of the shoulders from the inter-section of embankment slope and top pf subgrade to the edge of the pavement line.

(iii) The bridge wearing surface from curb to curb and end to end of bridge wearing surface.

(iv) Other surfaces as shown on the plans or ordered by the Engineer.

Primed surface shall be kept undisturbed for at least 24 hours, so that the bituminous material travels beneath and leaves the top surface in non-tacky condition. No asphaltic operations shall start on a tacky condition.

302.3.1 Equipment

The liquid asphaltic material shall be sprayed by means of a pressure distributor of not less than 1000 litre capacity, mounted on pneumatic tyres of such width and number that the load produced on the road surface will not exceed hundred (100) Kg per cm width of tyre. It shall be of recognized manufacturer.

The tank shall have a heating device able to heat a complete charge of asphaltic liquid up to one hundred eighty (180) degree C. The heating device shall be so that overheating will not occur. Consequently, the flames must not touch directly on the casting of the tank containing the asphaltic liquid or gases therefrom. The Contractor will be responsible for any fire or accident resulting from heating of bituminous materials. The liquid shall be circulated or stirred during the heating. The tank shall be insulated in such a way that the drop in temperature when the tank is filled and not heated, will be less than two (2) degree C per hour. A thermometer shall be fixed to the tank in order to be able to control continuously the temperature of the liquid. The thermometer shall be placed in such a way that the highest temperature in the tank is measured. The tank shall be furnished with a device that indicates the contents. The pipes for filling the tank shall be furnished with an easily interchangeable filter.

The distributor shall be able to vary the spray width of the asphaltic liquid in steps of maximum 10 cm, to a total width of four (4) M. The spraying bar shall have nozzles from which the liquid is sprayed fan-shaped on the road surface equally distributed over the total spraying width.

The distributor shall have a pump for spraying the liquid driven by a separate motor, or the speed of the pump shall be synchronized with the speed of the distributor. The pump shall be furnished with an indicator showing the performance in litres per minute. At the suction side the pump shall have a filter easily exchangeable. A thermometer shall be fixed, which indicates the temperature of the liquid immediately before it leaves the spraying bar.

The distributor shall be furnished with a tachometer indicating the speed in meter per minute. The tachometer shall be visible from the driver's seat. The function of the distributor shall be so exact that the deviation from the prescribed quantity to be spread on any square meter does not exceed 10%. The distributor shall be equipped with a device for hand spraying of the bituminous liquid, to cover any irregular area or covering the area improperly sprayed.

302.3.2 Application of Asphaltic Material

Immediately before applying prime coat, the full area of surface to be treated shall be swept with a power broom to remove all dirt and other objectionable material. If required by the Engineer, the surface shall be made moist but not saturated. Asphaltic Materials shall be applied at temperature stated in Item 301 by approved pressure distributors operated by skilled workmen. The spray nozzles and spray bars shall be adjusted and frequently checked so as to ensure uniform distribution. Spraying shall cease immediately upon any clogging or interference of any nozzle and remedial measures taken before spraying is resumed.

The rate for application of asphaltic material (cut back/emulsified) shall be as under:

TYPE OF SURFACE	LITRES PER SQUARE METER	
	Minimum	Maximum
1. Subgrade, Subbase, Water bound base & Crushed stone base course,	0.65	1.75
2. Bridge, Wearing Surfaces, Concrete Pavement	0.15,	0.4

However, the exact rate shall be specified by the Engineer determined from field trials.

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

The prime coat shall be left undisturbed for a period of at least 24 hours, and shall not be opened to traffic until it has penetrated and cured sufficiently so that it will not be picked up by the wheels of passing vehicles. The Contractor shall maintain the prime coat until the next course is applied. Care shall be taken that the application bituminous material is not in excess of the specified amounts; any excess shall be blotted with sand or similar treatment. All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying from the distributor.

The surface of structures and trees adjacent to the area being treated shall be protected in such manner as to prevent their being spattered or marred.

Where no convenient detour is available for traffic, operations shall be confined to one-half the roadway width at a time. The Contractor shall provide proper traffic control so that vehicles may proceed without damage to the primed area. Work shall not be started on the portion of the road not covered by previous application until the surface previously covered has dried and is ready for traffic.

302.4 MEASUREMENT AND PAYMENT

302.4.1 Measurement

The unit of measurement shall be square meter as actually covered by prime coat in accordance with these specifications. No measurement or payment will be made for the areas primed outside the limits, specified, herein, shown on the plans or designated by the Engineer.

Blotting material will not be measured for payment and shall be considered subsidiary to the prime coat.

302.4.2 Payment

The payment for area primed measured as stated above, shall be made for the contract unit price per SM, which payment shall be full compensation for furnishing all labour, material, tools, equipment and incidentals and for performing all the work involved in applying prime coat, complete in place in accordance with these specifications:

Pay Item No.	Description	Unit of Measurement
302	Bituminous Prime Coat.	SM

304.1 DESCRIPTION

This work shall consist of one or more applications of asphaltic material and one or more covers of aggregates or an application of asphaltic material without aggregates applied in accordance with these specifications and in conformity with the lines and width shown on the typical cross-sections or as established by the Engineer.

304.2 MATERIAL REQUIREMENTS

304.2.1 Aggregate

Aggregate shall consist of clean, dry, hard, durable, tough, angular, sound crushed stone or crushed gravel of uniform quality, and free from dirt, clay and other objectionable matter. Aggregates from only the sources of established adhesion properties would be used. The percentage of wear by the Los Angeles Abrasion test (AASHTO T-96) shall not be more than forty (40). Aggregate crushing value (ACV) when tested as per BS-812 (1990) shall not exceed 25%. When subjected to five (5) cycles of sodium-sulphate soundness testing as determined by AASHTO T-104, it shall have a weight loss of 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 (3) 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 drawing from the truck bed.

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 of flat or elongated, or both, that the ratio between the maximum and the minimum dimensions exceeds 2.5:1. Flakiness Index, tested under BS-812 (1990) part 105, shall be 25 (max) for nominal size 18 mm and 12 mm and 30 (max) for nominal size 9mm.

The nominal sizes of aggregates used for surface treatment; shown against table 304-1 shall be 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

The nominal size are defined in the table below:

Nominal Size (mm)	Specified Size *			
	Passing		Retained	
	Sieve (mm)	%age	Sieve (mm)	%age
18	19	100	12.5	85
12	12.5	100	9.5	85
9	9.5	100	6.3	85
6	6.3	100	4.75	85

* By convention, this item defines a fraction of material within the respective sieves.

For Material passing 31W Sieve, following Table shall be used:

Sieve Designation		Percent Passing by Weight			
Mm	**Inch**	**Size No.1**	**Size No.2**	**Size No.3**	**Size No.4**
9.5	3/8	0-15	0-10	-	-
4.75	No.4	0-5	0-5	0-10	-
2.38	No.8	-	-	0-5	0-5
1.18	No.16	-	-	-	0-3
0.75	No.200	0-2	0-2	0-1	0-1

304.2.2 Asphaltic Material

The asphaltic material shall conform to the requirements of Item 301 'Asphaltic Materials'. The type shall be one of the following, as shown in the Bill of Quantities or ordered by the Engineer. Spraying temperature shall be as shown against each type.

Table: Spraying Temperatures (OC) for Surface Treatments

Asphalt Type / Grade Spraying Temperature	Spraying Temperature Surface Treatments
a. Asphalt Cements	
AC-2.5.	130 min.
AC-5	140 min.
AC-10	140 min.
AC-20	145 min.
AC-40	150 min.
AR-1000	155 min.
AR-2000	140 min.
AR-4000	145 min.
AR-8000	145 min.
AR-16000	-
200-300 pen.	130 min.
120-150 pen.	130 min.
85-100 pen.	140 min.
60-70 pen.	145 min.
40-50 pen.	150 min.
b. Emulsified Asphalts	
RS-1	20-60
RS-2	50-85
MS-1	20-70
MS-2	-
MS-2h	-
HFMS-1	20-70
HFMS -2	-
HFMS -2h	-
HFMS -2s	-
SS-1	-
SS-1h	-
CRS-1	50-85
CRS-2	50-85
CMS-2	-
CMS-2h	-
CSS-1	-
CSS-1h	-

Asphalt Type / Grade Spraying Temperature	Spraying Temperature Surface Treatments
c. Cutback Asphalts (RC, MC, SC)	
30 (MC only)	30 min.
70	50 min.
250	75 min.
800	95 min.
3000	110 min.

304.3 CONSTRUCTION REQUIREMENTS

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 as per item 302. If so directed by the Engineer, the surface shall be cleaned by power brooming or wire brush until all loose and foreign materials are removed.

304.3.1 Equipment

Equipment shall conform in all respects to the provisions under Item 302.3.1. The equipment shall be operated by # the manpower specially trained for this work. Necessary safety arrangement for the workers, equipment and traffic shall be ensured during the operations.

304.3.2 Preparation of Surface

Irregularities and surface damage e.g. pot-holes, depressions, ravelling, shall be corrected prior to surface dressing. The Engineer shall also satisfy himself that fundamental pavement defects e.g. base failure, drainage problems etc. have been remedied before surface dressing is attempted. Areas, which are excessively rich in bitumen e.g. 'bleeding', shall be cut out and patched. All patches, however, occasioned shall be thoroughly compacted, sealed and blinded with crusher dust before opening to traffic for several days before surface dressing commences.

Immediately prior to the application of binder all dirt, dust are foreign material shall be removed by thorough brooming and 1 or the use of compressed air. Adhering mud or other soiling may be removed using water and brushes, the general use of water to wash the road shall not be permitted.

304.3.3 Application of Asphaltic Materials

Asphalt cement, liquid asphalt and emulsified asphalt shall be applied by means of pressure distributor manual or automatic at the temperature specified for the type and grade of asphalt being used. The rates of application shall be within the ranges given in Table 304-1.

The spread of bituminous materials shall be at least ten (10) cm more than the width to be covered by the aggregate from the spreading device. 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 exceed than that which trucks loaded with cover coat material can immediately cover. 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 material on the surface of the travelled 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. The angle of the spray nozzles and the height of the spray bar shall be so adjusted and frequently checked that uniform distribution is ensured. The distribution shall cease immediately upon any clogging or interference of any nozzle and corrective measures shall be taken before distribution is resumed.

304.3.4 Spreading of Aggregate

Immediately after applying the asphaltic material, dry aggregate shall be uniformly and evenly distributed over the treated surface from an approved mechanical aggregate spreader or any other means approved by the Engineer. The truck carrying the aggregate shall move backward as it spreads same, so as to prevent the tyres ~of the truck and the mechanical aggregate spreader from driving directly on the newly sprayed asphalt. No portion of the binder shall remain uncovered for a period in excess of twenty (20) minutes after spraying.

Immediately after spreading of the aggregate, the treated surface shall be rolled with a self-propelled pneumatic-tyre roller having a minimum contact pressure of 2.8 Kg/square centimetre. A steel-wheeled roller weighing between six (6) to eight (8) tons may be used as a second roller. Rolling shall continue only until a smooth, thoroughly compacted surface is obtained. 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 be prohibited.

Any place where binder shows on the surface shall, be covered with additional aggregate and further rolled and broom dragged until an even surface results, and does not adhere to Wheels of vehicles. Overlapping the applications of cover material shall be avoided and. all spillage shall be removed from the surface.

The quantity of aggregates to be applied shall be within the ranges specified in Table 304.1.

304.3.5 Maintenance of Traffic

Detouring of highway traffic for this work on running road will not be provided for or permitted, except when authorized by the Engineer. All construction operations shall be coordinated to result in the least practicable delay of traffic. One way traffic shall be maintained and traffic speeds restricted to fifteen (15) Km per hour. The contractor shall provide flagmen, warning signs, barricades,

and a sufficient number of pilot cars to control traffic through the bituminous sealing operations when so directed by the Engineer. Pilot cars shall be used to lead the traffic through the areas of all distribution and sealing operations. Pilot cars shall be light "Pick up" trucks or other approved vehicles and shall be equipped with signs reading "PILOT CAR - DO NOT PASS in both English and Urdu languages. Two (2) signs shall be mounted on the vehicles so as to be clearly Visible from both directions. One (1) flagman shall be stationed immediately ahead of the application of the bituminous material and one (1) flagman immediately behind the section being rolled. Suitable speed limit signs shall be displayed, and the signs shall move forward with the flagman as the work progresses.

No separate payment shall be made for conformance to this paragraph. All these items being considered subsidiary to the item (s) given in the Bill of Quantities.

304.3.6 Working Period

All work shall be so conducted 1hat the work of applying asphalt and aggregate and of all rolling shall be completed during the time from sunrise to sunset and under favourable weather conditions as determined by the Engineer.

304.3.7 Maintenance of completed work

When directed by the Engineer, the Contractor will be required to add bituminous material or aggregate or both to the portion of road identified for such purpose on 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 relevant item of "Bituminous Surface Treatment".

304.3.8 Opening of Traffic and after-care

There shall be no delay in opening a completed surface dressing to traffic at a controlled speed. Prior to opening to traffic any spillage of aggregates shall be removed and any binder drips or windblown contamination shall be dusted with crusher waste. After 2-3 days under traffic, excess stone will be removed by brushing.

304.3.9 Pad Coat

To ensure chipping retention when surface dressing a very hard surface, a pad coat consisting of application of an initial binder spray followed by 6 mm. chipping will be applied. After stabilizing of pad coat under traffic, the 3ppropriate surface dressing will be applied.

304.4 MEASUREMENT AND PAYMENT

304.4.1 Measurement

The quantity of surface treatment to be paid for shall be measured in square meter within the theoretical line in place as shown on drawing. No allowance will be given for material placed outside the theoretical limits of finished surfacing whether placed for, due to requirement of contractor's operations or placed outside the limits due to inadequate control.

304.4.2 Payment

The aggregate and asphaltic material measured as stated above shall be paid for at the contract unit price per square meter for a particular item listed below and shown on the bill of quantities, which payment shall be full compensation for furnishing all labour, materials, tools equipment and incidental for performing all the work in the construction of bituminous surface treatment or seal coat complete in place and according to specification, including priming of surface.

Pay Item No	Description	Unit of Measurement
304 a	Single Surface Treatment	SM
304 b	Double Surface Treatment	SM
304 c	Triple Surface Treatment	SM
304 d	Seal Coat 1 Pad Coat	SM

TABLE 304-1

Quantities of Materials for Bituminous Surface Treatments

Surface Treatment		Aggregate		Bituminous Material	
Type	Application	Size No.	Quantity Kg. / Sq.M	Quantity Litres / Sq.M	Type
Single	Single	2	12.5	1.19	(a)
				1.63	(b)
Double	First	1	24.0	1.19	(a)
				2.14	(b)
	Second	3	12.5	1.19	(a)
				1.63	(b)
Tripple	First	1	24.0	1.90	(a)
				2.14	(b)
	Second	2	12.5	1.19	(a)
				1.63	(b)
	Third	3	6.5	0.68	(c)
Seal Coat / Pad Coat with Aggregate		4	4	0.5	(c)

Notes:-

i) Bituminous material types are (a) asphalt cement, (b) cut-back or emulsified and (c) asphalt cement, cut-back and emulsified.

ii) Quantities of bituminous material may be varied by the Engineer by + 15% depending on site conditions.

iii) Prime coat shall be applied prior to the surface treatment for the newly constructed pavement at the rate as specified in the item 302.3.2.

305.1 DESCRIPTION

This work shall consist of furnishing aggregates and asphalt binder at a central mixing plant, to a specified mixing temperature, transporting, spreading and compacting the mixture in an approved manner on primed or tacked base, subbase, subgrade, bridge deck or concrete pavement in accordance with these specifications and in conformity with the lines, grades and typical cross-sections shown in the drawings or as directed by the Engineer.

305.2 MATERIAL REQUIREMENTS

305.2.1 Mineral Aggregates

The Aggregates shall consist of coarse aggregates, fine aggregates and fitter material, if required and shall be clean, hard, tough, durable and sound particles of uniform quality, geology, petrology and free from decomposed material, vegetable matter, soil, clay, lumps and other deleterious substances.

Coarse aggregate which is the material retained on an AASHTO No. 4 Sieve, shall consist of one hundred (100) % crushed rock or crushed gravel having two (2) faces mechanically crushed. The type of source shall be uniform throughout the quarry location from where such a material is obtained. The coarse aggregates shall be free fro" an excess of flat or/and elongated particles.

Fine aggregate which is the material passing from AASHTO No. 4 sieve, shall consist of 100% crushed material from rock or boulder. Fine aggregate shall be stored separately, and no natural sand will be allowed in the mix.

When the combined grading of the coarse and fine aggregates is deficient in material passing the AASHTO No. 200 sieve, mineral filler material shall be added as approved by the Engineer. The filler shall consist of finely divided mineral matter such as rock dust, hydrated lime, hydraulic, calcined dust cement or other suitable mineral matter free from lumps, balls or other deleterious material and shall conform to the following gradation:

Sieve Designation		Percent Passing by Weight
mm	Inch	
0.600	No.30	100
0.300	No.50	95-100
0.075	No.200	70-100

The coarse and fine aggregates shall meet the following requirements:

a) The percent of wear by the Los Angeles Abrasion test (AASHTO T 96) shall not be more than thirty (30).

b) The loss when subjected to five cycles of the Sodium Sulphate Soundness test (AASHTO T 104) shall be less than twelve (12) percent.

c) The Sand Equivalent (AASHTO T 176) determined after all processing except for addition of asphalt cement shall not be less than 45.

d) All aggregates shall have a liquid limit of not more than twenty-five (25) and a Plasticity Index of not more than four (4) as determined by AASHTO T-89 and T-90.

e) The portion of aggregates retained on the 9.5 mm (3/8 inch) sieve shall not contain more than 10 percent by weight of flat and/or elongated particles (ratio of maximum to minimum dimension = 2.5:1).

f) Stripping test shall be performed on crush aggregates as described under AASHTO-182 and only that material shall be allowed which qualifies the test.

g) The coarse aggregates shall be checked if desired by the Engineer for cationic and anionic behaviour so that their affinity with the bitumen to be used is verified.

h) Petrographic examination of the coarse aggregate shall be conducted if so directed by the Engineer.

The percentage of particles having certain proportions between their largest and smallest dimensions (i.e. between the largest distance the particles can fill out between two parallel planes that will permit the particle to pass), shall be determined in the following way:

i. Form a sample of coarse aggregates, all particles passing No. 4 sieve are eliminated. The sample shall be of sufficient quantity that at least 100 particles remain.

ii. By means of a sliding caliper, the largest and smallest dimensions, as defined above, are determined for each particle and its proportion calculated (with one decimal).

iii. The total weights of particles having the proportions two and a half (2.5) or less and three (3) or less, are determined and their percentage in relation to the total sample are calculated.

305.2.2 Asphaltic Material

Asphaltic binder to be mixed with the aggregate to produce asphaltic base shall be asphalt cement penetration grade 40-50, 60-70 or 80-100 as specified by the Engineer. Generally, it will meet the requirement of AASHTO M-20.

305.2.3 Asphalt Concrete Wearing Course Mixture

The composition of the asphaltic concrete paving mixture for wearing course shall conform to Class A and/or Class B shown in the following table:

Table 305-1

Asphalt Concrete Wearing Course Requirements

Mix Designation	Class A	Class B
Compacted Thickness	50-80 mm	35-60 mm
Combined Aggregate Grading Requirements		

Sieve Designation		Percent Passing by Weight	
Mm	Inch		
25	1	100	-
19	3/4	90-100	100
12.5	1/2	-	75-90
9.5	3/8	56-70	60-80
4.75	No.4	35-50	40-60
2.38	No.8	23-35	20-40
1.18	No.16	5-12	5-15
0.075	No.200	2-8	3-8

Asphalt Content weight percent of total mix	3.5 (Min.)	3.5 (Min.)

The asphalt concrete wearing course mixture shall meet the following Marshal Test Criteria:

Compaction, number of blows each end of specimen	75
Stability	1000 Kg (Min)
Flow, 0.25 mm (0.01 inch)	8-14
Percent air voids in mix	4-7
Percent voids in mineral aggregates	according to table 5.3 MS-2 (Asphalt Institute - USA), sixth addition, 1993.
Loss of Stability	20% (Max.)

305.2.4 Job Mix Formula

At least one week prior to production, a Job-Mix Formula (JMF) for the asphaltic wearing course mixture or mixtures to be used for the project, shall be established jointly by the Engineer and the Contractor.

The JMF shall be established by Marshall Method of Mix Design according to the procedure prescribed in the Asphalt Institute Manual Series No. 2 (MS-2), sixth edition 1993 or the latest Edition.

The JMF, with the allowable tolerances, shall be within the master range specified in Table 305-1. Each JMF shall indicate a single percentage of aggregate passing each required sieve and a single percentage of bitumen to be added to the aggregates.

The ratio of weight of filler (Passing No. 200) to that of asphalt shall range between 1 - 1.5 for hot climate areas with temperature more than 40 ^{o}C.

After the JMF is established, all mixtures furnished for the project represented by samples taken from the asphalt plant during operation, shall conform thereto with the following ranges of tolerances:

Combined aggregates -gradation

Retained No. 4 and larger	± 7.0%
Passing No. 4 to No. 100 sieves	± 4.0%
Passing No. 200	± 1.0%

Asphalt Content

Weight percent of total mix	± 0.3%

In addition to meeting the requirements specified in the preceding items, the mixture as established by the JMF shall also satisfy the following physical property:

Loss of Marshall Stability by immersion of specimen in water at sixty (60) degree C. for twenty-four (24) hours as compared with the stability measured after immersion in water at sixty (60) degree C. for twenty (20) minutes shall not exceed twenty (20) percent. If the mixture fails to meet this criterion, the JMF shall be modified or an anti-stripping agent shall be used.

Should a change of sources of materials be made a new Job Mix Formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, a new Job Mix Formula will be required.

305.3 CONSTRUCTION REQUIREMENTS

Construction requirements for this Item shall conform with the same as specified for Asphaltic Concrete Base Course Plant Mix under Item 203.3, except as modified in the following sub-items.

305.3.1 Preparation of Base Course Surface

Before spreading materials, the surface of the previously constructed and accepted base course on which the mix is to be placed shall be conditioned by application of a tack coat, if directed by the Engineer

305.3.2 Pavement Thickness and Tolerance

The asphalt concrete wearing course shall be compacted to the desired level and cross slope as shown on the drawing or as directed by the Engineer.

The tolerances in compacted thickness of the wearing course shall be ± 3mm from the desired thickness shown on the drawings. For determination of thickness one (1) core per hundred meters of each lane will be taken. If the thickness so determined is deficient by more than three (3) mm, but not more than ten (10) mm, payment will be made at an adjusted price as specified in table-1, clause 305.4.2.(2) of this specification.

The surface of the wearing course shall be tested by the Engineer using a 5 meters' straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts, longitudinal or transverse with the surface shall at no point exceed five (5) millimetres. The cross fall (camber) shall be with + 0.2 percent of that specified, and the level at any point shall be within + three (3) mm of the level shown on the Drawings. All humps or depressions exceeding the specified tolerance shall be corrected by removing the defective work and replacing it with new material, by overlaying, or by other means satisfactory to the Engineer.

305.3.3 Acceptance Sampling and Testing

Acceptance of sampling and testing for this Item with respect to materials and construction requirements, not specified herein, shall be in accordance with the relevant, Tables for Sampling and Testing Frequency" in these specifications.

305.4 MEASUREMENT AND PAYMENT

305.4.1 Measurement

The quantities of Asphaltic wearing course shall be measured by volume in CM. laid and compacted in place. Measurements shall be based on the dimension as shown on plans or as otherwise directed or authorized by the Engineer. A tolerance of + three (3) mm shall be allowed in compacted thickness of wearing course. However, any asphalt in excess of 3 mm shall not be paid and any layer deficient by more than 3 mm but not exceeding 10 mm shall be paid as per clause 305.4.2 (2) of this specification.

The quantity of bitumen material used is included in the asphalt concrete mixture and will not be measured separately.

Quantities of Bitumen or asphaltic concrete wasted or remaining on hand after completion of the work shall not be measured or paid for.

305.4.2 Payment

1) The quantity determined as provided above shall be paid for at the contract unit price respectively for each of the particular pay items listed below and shown in the Bill of Quantities, which prices and payment shall constitute full compensation for all the costs necessary for the proper completion of the work prescribed in this item. Asphalt additive or antistripping agent, if allowed and used to meet with JMF requirement shall not be paid directly, payment shall be deemed to be included in the respective pay items of Asphaltic wearing course.

2) **Price adjustment.** If the thickness determined as per clause 305.3.2 of this specification is deficient by more than three (3) mm, but not more than ten (10) mm, payment will be made at an adjusted price as specified in table-1 below: -

Table - 1

Deficiency in thickness as determined by cores	Proportional Rate of contract Price allowed
0.0 mm to 3.0 mm	100%
3.1 mm to 50.0 mm	90%
5.1 mm to 10.0 mm	80%

When wearing course is more than ten (10) mm deficient in thickness, the contractor shall remove such deficient areas and replace them with wearing course of an approved quality and thickness or the contractor may opt to place an additional layer of wearing course asphalt, grading with a minimum thickness of 35 mm. The contractor will receive no compensation for the above additional work.

Alternately, the Contractor may choose to overlay the area in a thickness of 30 mm (min.) with smooth transition as approved by the Engineer on either side with no extra compensation.

Pay Item No.	Description	Unit of Measurement
305a	Asphaltic Concrete for Wearing Course (Class A)	CM
305 b	Asphaltic Concrete for Wearing Course (Class B)	CM

ITEM 401 CONCRETE

401.1 DESCRIPTION

This work consists of furnishing placing, curing, finishing including transport of cement concrete made from approved type of Cement, water, fine and coarse aggregates all in accordance with the requirements in these specifications and conforming to the lines, grades, and typical sections shown on the Drawings or called for in the special Provisions and to the approval of the Engineer.

401.1.1 Classes of Concrete

The classes of concrete recognized in these specifications shall be designated: A,13, QD1, D2, D3, Y and Lean Concrete. The Class of concrete to be used shall be as called for on the Drawings or as directed by the Engineer or specified in the Special Provisions. The following requirements shall govern unless otherwise shown on the Drawings.

Class A1 Concrete shall be used everywhere, for non-reinforced and reinforced concrete structures, except as noted below or directed by the Engineer. Concrete placed under water shall be Class A2 with a minimum cement content of three hundred fifty (350) kg per cubic meter of concrete with a slump between ten (10) and fifteen (15) cm. Concrete placed for piles shall be class A3 with a minimum cement content of four hundred (400) Kg per cubic meter.

Class B Concrete shall be used only where specified.

Class C Concrete shall be used for cribbing, or as otherwise directed by the Engineer or specified in the Special Provisions or on the Drawings.

Class D1, D2 or D3, concrete shall be used for pre-stressed and post tensioned elements, as indicated on drawings.

Class Y concrete shall be used as a filler in steel grid bridge floors, in thin reinforced sections, or as otherwise specified in the Special Provisions.

Lean Concrete shall be used in thin layers underneath footings and when called for on the Drawings or directed by the Engineer.

The concrete of the various classes shall satisfy the requirements shown in Table 401 –1

Table 401-1

Portland Cement Concrete Requirements

Class of Concrete	Min. Cement Kg / Cubic Meter	Maximum Size of Coarse Aggregate (mm)	28 Days Compressive Strength (Min.) (Cylinder) (Kg / Sq.cm)	Consistency (Range in Slump) Vibrated (mm)	Maximum Permissible Water – Cement Ratio
A_1	300	20	210	25 – 75	0.58
A_2	350	25	245	100 – 150	0.58
A_3	400	38	280	100 – 150	0.58
B	250	51	170	25 – 75	0.65
C	275	38	210	25 – 75	0.58
D_1	450	25	350	50 – 100	0.40
D_2	500	25	425	50 – 100	0.40
D_3	550	25	500	50 – 100	0.40
Y	400	13	210	25 – 75	0.58
Lean Concrete	175	51	100	–	–

401.1.2 TYPES OF CONCRETE WORKS

Under Ground Concrete

Concrete poured below Natural Surface Level with or without shuttering and shoring.

On Ground Concrete

Concrete poured by erecting formwork with necessary bracings on ground.

Elevated Concrete

Concrete poured by erecting props, bracing and towers to support the formwork at higher levels.

401.2 MATERIAL REQUIREMENTS

401.2.1 Portland Cement

Cement remaining in bulk storage at the mill, prior to shipment, for more than six (6) months or cement stored in local storage by contractor for more than three (3) months after shipment from the factory may be retested before use and shall be rejected if it fails to meet any of the specification requirements.

Portland cement shall conform to the requirements of the Standard Specifications for Portland cement, AASHTO Designation M85 (ASTM Designation C150). The type of the cement to be used, unless otherwise shown on the Drawings, shall be type 1.

Sampling of cement shall be in accordance with AASHTO Designation T-127.

Mill certificates shall accompany delivery of the material to the work.

Cement shall be delivered in sufficient quantities to ensure that there is no suspension of the work of concreting at any time. Different brand or different types of cement from the same mill, or the same brand or type from different mills shall not be mixed or used alternately in the same item of construction unless authorized by the Engineer, after preparing new mix design.

401.2.2 **Fine Aggregate**

The fine aggregate shall consist of sand, stone screenings or other approved inert materials with similar characteristics, or a combination thereof, having clean, hard, strong, sound, durable, uncoated grains free from injurious amount of dust, lumps, soft or flaky particles, shale alkali, organic matter, material reactive with alkalis in the cement loam or other deleterious substances, and shall not contain more than three (3) percent of material passing the No.200 sieve by washing nor more than one percent of clay lumps or one (1) percent of shale. The use of beach sand is prohibited without the written consent of the Engineer.

For exposed work, the fine aggregate shall be free from any substance that will discolour the concrete surface.

The fine aggregate shall be uniformly graded and when tested in accordance with AASHTO Designation T-1 1 and T-27 shall meet the following grading requirements:

GRADING OF FINE AGGREGATES

3/8”	100
No. 4	95 – 100
No. 16	45 – 85
No. 50	10 – 30
No. 100	2 – 10
No. 200	0 – 3

In case if fine aggregates fail under Fineness Modulus or Gradation however material passing No. 4 in combined aggregate, qualifies for these requirements, then the material can be accepted.

Fine aggregates shall be of such quality that mortar specimens, prepared with standard Portland cement and tested in accordance with AASHTO Designation T-71, shall develop a compressive strength at 7 days of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded sand having a fineness modulus of 2.3 to 3. 1. Natural aggregates if required shall be thoroughly and uniformly washed before use. Sand equivalent (T-176) shall be 75 min.

For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples submitted by the Contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus of greater than 0.20 either way from the fineness modulus of mix design samples submitted by the Contractor may be rejected till new trial mixes are prepared and tested by the contractor. Testing of the aggregate is specified under Item 401.3.9 of these specifications.

401.2.3 **Coarse Aggregate**

The coarse aggregate shall consist of crushed or broken stone, gravel or other approved inert materials with similar characteristics, or a combination thereof, having clean, hard, strong, sound, durable uncoated particles, free from injurious amount of soft, friable, thin elongated, or laminated pieces, alkali, organic or other deleterious matter and conforming to the requirements of these Specifications.

The coarse aggregate shall be of uniform grading with maximum sizes as required for the various classes of concrete as shown in Table 401-2 and when tested in accordance with AASHTO Designation T-11 & T-27 shall meet the following grading requirements.

TABLE 401.2
GRADING OF COARSE AGGREGATES

Designated Sizes	Percentage by Weight Passing Laboratory Sieves Having Square Openings, in Inches							
½" to No. 4	-	-	-	-	100	90-100	40-70	0-15*
¾" to No. 4	-	-	-	100	90-100	-	20-55	0-10*
1" to No. 4	-	-	100	95-100	-	25-60	-	0-10*
1½" to No. 4	-	100	95-100	-	35-70	-	10-30	0-5
2" to No. 4	100	95-100	-	35-70	-	10-30	-	0-5
1½" to ¾"	-	100	90-100	20-55	0-15	-	0-5	-
2" to 1"	100	90-100	35-70	0-15	-	0-5	-	-

*Not more than five 5 percent shall pass No.8 sieve.

Coarse aggregate shall contain not more than one (1) percent by weight of material passing the No.200 sieve by washing and not more than five (5) percent of soft fragments.

It shall have an abrasion loss of not more than forty (40) percent at five hundred (500) revolutions, when tested in accordance with AASHTO T-96.

When tested in accordance with AASHTO TA 04, for five cycle, the loss with the sodium sulphate soundness test shall be not more than 12 percent.

Natural aggregates shall be thoroughly washed before use. Testing of coarse aggregate is specified under Item 401.3.9 of these Specifications.

The aggregate shall be non-alkali / silica reactive where the concrete is to be poured under water or exposed to humid conditions. In case the Contractor proposes to use the aggregate having the alkaline / siliceous characteristics with the intention to use it with Blast Furnace Slag Cement, he will undertake to carry out the job without any extra cost and shall arrange to conduct the necessary tests as directed by the Engineer.

401.2.4 Combined Aggregate

The coarse and fine aggregate shall be combined in the proportions according to the approved trial mixes for each class of concrete.

401.2.5 Rubble or Cyclopean Concrete

Rubble or cyclopean concrete shall consist of tough, sound, and durable rock. The stone shall be free from coatings, seams, or flaws of any character. In general, the percentage of wear shall not exceed fifty (50) when tested in accordance with the Standard Method of Testing for Abrasion of Coarse Aggregate by the use of the "Los Angeles Machine", ASTM C535.

401.2.6 **Storage of Cement and Aggregate**

a) All cement shall be stored, immediately upon arrival on the site of the work, in weather-proof building, which will protect the cement from dampness. The floor shall be raised from the ground. The buildings shall be placed in locations approved by the Engineer. Provisions for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner as to provide easy access for identification and inspection of each shipment. Storage buildings shall have capacity of a sufficient quantity of cement for at least thirty (30) days use. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. However, if approved, sacked cement on small jobs may be stored in the open, upon a raised platform provided that ample waterproof covering is ensured. Stored cement shall meet the test requirements at any time after storage when the Engineer orders retest. At the time of use all cement shall be free flowing and free of lumps. Cement bags shall be weighed at random to cheek for variation.

   Copies of cement records shall be furnished to the Engineer showing such detail as, the quantity used during the day run or at each part of the work Cement held in storage for a period of over sixty (60) days, or cement, which, for any reason the Engineer may suspect of being damaged, shall be subject to a retest before being used in the work.

b) The handling and storing of concrete aggregates shall be such as U prevent segregation or the inclusion of foreign materials. The Engineer ma, require that aggregates be stored on separate platforms at satisfactory, locations.

   In order to secure greater uniformity of the concrete mix, the Engineer ma require that the coarse aggregate be separated into two or more size Different sizes of aggregate shall be stored in separate bins or in separate stock piles to prevent the material at the edges of the piles from becoming intermixed.

   If aggregates are stored on the ground the bottom layer of aggregate shall not be disturbed or used without reclining and as approved by the Engineer.

401.2.7 **Water**

The water for curing, for washing aggregates and for mixing shall be subject to the approval of the Engineer. It shall be free from oil and shall contain not more than one thousand (1,000) parts per millions of chlorides nor more than one thousand three hundred (1,300) parts per million of sulphates (S04). In no case shall the water contain an amount of impurities that will cause a change in the setting time of Portland cement of more than twenty-five (25) percent nor a reduction in the compressive strength of mortar at fourteen (14) days of more than five (5) percent when compared to the result obtained with distilled water.

In non-reinforced concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than two thousand (2,000) parts per millions of chlorides nor more than one thousand five hundred (1,500) parts per millions of sulphates as S04.

In addition to the above requirements, water for curing concrete shall not contain any impurities in a sufficient amount to cause discolouration of the concrete or produce etching of the surface.

When required by the Engineer, the quality of the mixing water shall be determined by the Standard Method of Test for Quality of Water to be used in concrete, AASHTO Methods of Sampling and Testing, Designation: T 26.

401.2.8 Admixtures

Admixtures shall only be allowed to be used with written permission from the Engineer. If air-entraining agents, water reducing agents, set retarders or strength accelerators are permitted to be used, they shall not be used in greater dosages than those recommended by the manufacturer, or permitted by the Engineer, and shall conform to the requirements for each of the agents specified by the manufacturer.

401.3 CONSTRUCTION REQUIREMENTS

The manufacturing, transport, handling and placing of concrete shall conform with the requirements given hereinafter.

Unless otherwise specified, ordinary Portland cement shall be used for all types of concrete. When sulphate resisting cement or other type of cement is required, it will be specified on the Drawings/or in BOQ or ordered by the Engineer.

401.3.1 Proportioning of Concrete

All. Weighing shall proportion concrete, except as specified herein. The proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce concrete of the required strength and the Engineer shall approve consistency. Such approval may be withdrawn at any time, and changes in the proportions may be required for the purpose of required workability, density, impermeability, durability and strength.

Based on the approved mix proportions, the Contractor shall prepare lists showing the number of kilograms of the various material to be used in the batch size adopted. The required consistency shall also be shown. Such lists are subject to approval by the Engineer, and shall be posted at the mixer. The amount of water in the mix is the total amount of free water, including the free water held by the aggregates.

No concrete shall be placed in the works until the results of the twenty-eight (28) days test indicate that the design proportions are satisfactory as per requirements under Item 401.3.10 'Testing of Compressive Strength". Adjustment of the proportions shall be subject to the following provisions:

a) Adjustment for variation in workability - If it is found impossible to obtain concrete of the desired workability with the proportions originally approved, the Engineer shall make such changes as are necessary.

b) Adjustment for new materials - No change in the source or character of the material shall be made without due notice to the Engineer and no new materials shall be used until the Engineer has accepted such materials and has approved new proportions based on trial mixes. The Contractor's attention is drawn to the time required to prepare and test trial batches and the Contractor shall be responsible for production of trial batches at a sufficiently early date so that the progress of the work is no delayed.

401.3.2 Consistency

Concrete shall have a consistency such that it will be workable in the required position. It shall be of such a consistency that it will flow around reinforcement steel but individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportionate amount of sand. The consistency of concrete shall be determined to be as dry as is practicable to satisfy the requirements for transportation and placing the concrete as described hereinafter.

Consistency of concrete shall be determined as specified in AASHTO T-119. The Consistency of concrete at the time of delivery shall be shown in Table 401.1 or as designated by the Engineer.

401.3.3 Mixing Concrete

a) Mixing General

The concrete shall be mixed only in the quantity required for immediate use. Concrete that has developed an initial set shall be rejected.

Concrete shall be thoroughly mixed in a mixer of an approved size and type that will ensure a uniform distribution of the materials throughout the mass.

All concrete shall be mixed in mechanically operated mixers. Mixing plant and equipment for transporting and placing concrete should be arranged with an ample auxiliary installation to provide a minimum supply of concrete in case of breakdown of machinery or in case the normal supply of concrete should be disrupted. The auxiliary supply of concrete shall be sufficient to complete the casting of a section up to a construction joint.

Equipment having components made of aluminium or magnesium alloys, which would have contacted with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

Concrete mixers shall be equipped with adequate water storage and a device for accurately measuring and automatically controlling the quantity of water used.

Materials shall be measured by weighing, except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall ensure accurate measurement of each ingredient.

The accuracy of all weighing devices except that for water shall be such that successive quantities can be measured to within one (1) percent of the desired value. Cement in standard packages (bags) approved by the Engineer need not be weighed. The water measuring device shall be accurate to plus or minus half percent + 0.50%. All measuring devices shall be subject to the approval of the Engineer' Scales and measuring devices shall be tested at the expense of the Contractor as frequently as the Engineer may deem necessary to ensure their accuracy.

Weighing equipment shall be isolated so that vibration or movement of other operating equipment do not affect the accuracy of reading. When the entire plant is running, the scale reading at cut-off shall not vary from the weight designated by the Engineer more than one (1) percent for cement, one and half (1.112) percent for any size of aggregate, or one (1) percent for the total aggregates in any batch.

Where volumetric measurements are authorized by the Engineer, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowances shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregates. Boxes or similar containers of the exact volume required shall be filled and struck off. Measurement by wheel barrow volumes will not be permitted.

b) Mixing at Site

Concrete mixers may be of the revolving drum or the revolving blade type and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. The pick-up and throw-over blades of mixer shall be restored or replaced when any part or sections is worn two and half (2.5) cms. or below than the original height of the manufacturer's design. Mixers and agitators, which have an accumulation of hard concrete or mortar, shall not be used.

When bulk cement is used and volume of the batch is one cubic meter or more, the scale and weigh hopper for Portland cement shall be separate and distinct from the aggregate hopper or hoppers. The discharge mechanism of bulk cement weigh hopper shall be interlocked against opening before the full amount of cement is in the hopper. The discharging mechanism shall also be interlocked against opening when the amount of cement in the hopper-is underweight by more than one percent or overweight by more than three (3) percent of the amount specified.

When the aggregates contain more water than the quantity necessary to produce a saturated surface-dry condition, representative samples shall be taken and the moisture content determined for each kind of aggregate.

The temperature of mixed concrete, immediately before placing, shall be not more than thirty-two (32) degree C. Aggregates and water shall be cooled as necessary to produce concrete within this temperatures limit. If ice is used to cool the concrete, discharge of the mixer will not be permitted until all ice is melted.

The batch shall be so charged into the mixer that some water will enter in advance of cement and aggregates. All water shall be in the drum by the end of the first quarter of the specified mixing time.

Cement shall be batched and charged into the mixer by means that will not result in loss due to the effect of wind, or in accumulation of cement on surfaces of conveyors or hoppers, or in other conditions, which reduce or vary the required quantity of cement in the concrete mixture.

The entire contents of a batch mixer shall be removed from the drum before materials for a succeeding batch are placed therein. The materials composing a batch except water shall be deposited simultaneously into the mixer.

All concrete shall be mixed for a period of not less than one and half (1.1/2) minutes after all materials, including water, are in the mixer. During the period of mixing, the mixer shall operate at the speed for which it has been designed.

Mixers shall be operated with an automatic timing device that can be locked by the Engineer. The time device and discharge mechanism shall be so interlocked that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided he furnishes an approved timepiece equipped with minute and second hands. If the timing device is not repaired within twenty-four (24) hours, further use of the mixer will be prohibited until repairs are made.

The first batch of concrete material placed in the mixer shall contain cement, sand, and water in excess to the requirement of mix, to ensure that the drum does not extract mortar from the mix changing its design characteristics. When mixing is to stop for a period of one hour or more, the mixer shall be thoroughly cleaned.

c) Plant Mixing

At central mixing plant, batches shall be discharged from the weighing hopper into the mixer either directly by gravity or by an elevating container large enough to contain the batch. The plant shall be arranged to ensure that there is no loss of cement during transfer from weighing hopper to the mixer drum. The mixing time shall neither be less than fifty (50) second, nor more than ninety (90) seconds.

The plasticizer, accelerator or retarder or water-reducing admixture, if required, shall be fed separately at the rate recommended by the manufacture, or as established by laboratory trials.

d) Transit Mixing

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured and charged into the drum at the proportioning plant. The truck mixer shall be equipped with a device by which the quantity of water added can be readily verified. The mixing water may be added directly to the batch, in case the concrete batch is poured within twenty five (25) minutes of adding water.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer, and stamped in metal on the mixer. Truck mixing shall be continued for not less than fifty (50) revolutions after all ingredients, including water, are in the drum. The mixing speed shall not be less than six (6) rpm, nor more than ten (10) rpm.

Mixing shall begin within thirty (30) minutes after the cement has been added either to the water or aggregate, but when cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above thirty-two (32) degree C, this limit shall be reduced to fifteen (15) minutes. The limitation in time between the introduction of the cement to the aggregate and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregate is sufficiently free from moisture, so that there will be no harmful effects on the cement.

e) Partial Mixing at the Central Plant

When a truck mixer, or an agitator provided with adequate mixing blades, is used for transportation, the mixing time at the stationary plant mixer may be reduced to thirty (30) seconds and the mixing completed in a truck mixer / agitator. The mixing time in the truck mixer or agitator equipped with adequate mixing blades shall be as specified for truck mixing.

f) Stiff Concrete Mix

For mixing concrete of zero slump to be laid by pavers, gravity mixer shall not be used. Only force mixer of moving blades shall be allowed to ensure homogenous mix.

g) Hand Mixing

Hand mixing of materials shall not be allowed in any case.

401.3.4 Hauling of concrete

a) Hauling

Mixed concrete may be transported to the delivery point in truck agitators or truck mixers operating at the speed designated by the manufacturer, provided the consistency and workability of the mixed concrete upon discharge at the delivery point is suitable for adequate placement and consolidation in place.

Truck agitators shall be loaded not to exceed the manufacturer's rated capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

Bodies of non-agitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof, will not occur at any time, and they shall be self-cleaning during discharge.

For zero slump concrete to be laid be paver, concrete will be allowed to be hauled in open trucks. However, concrete hauled in open-top vehicles shall be protected during hauling against rain, or exposure to the sun for more than twenty (20) minutes when the ambient temperature exceeds twenty-five (25) degree C.

No additional water shall be incorporated into the concrete during hauling or after arrival at the delivery point.

The rate of discharge of mixed concrete from truck mixer agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

b) Delivery of Mixed Concrete

When a truck mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within one hour, or before two hundred fifty (250) revolutions of the drum or blades, whichever comes first, after the introduction of cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is thirty (30) degree C or above, use of long troughs, chutes, and pipes for conveying concrete to the forms shall be permitted only on written authorization of the Engineer. In any case the Engineer will reject the use of equipment for concrete transportation that will allow segregation, loss of fines, or in any other way will have a deteriorating effect on the concrete quality.

Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear off the structure.

When placing operations would involve dropping the concrete more than one half (1.1/2) meters, it shall be conveyed through sheet metal or other approved pipes. As far as practicable, the pipe shall be kept buried in the newly placed concrete. After initial set of the concrete the forms shall not be jarred and no loading of any kind shall be placed on the ends of projecting reinforcement bars.

The concrete shall be placed as nearly as possible to its final position and the use of the vibrators for the extensive shifting of the mass of fresh concrete will not be permitted.

c) Pneumatic Placing

Pneumatic placing of concrete will be permitted only if authorized by the Engineer. The equipment shall be so arranged that no vibration will occur that might damage freshly place concrete.

Where concrete is conveyed and place by pneumatic means, the equipment shall be suitable in kind and adequate in capacity for the work. The machine shall be located as close as practicable to the work. The discharge lines shall be horizontal or inclined upwards from the machine.

At the conclusion of placing the concrete, the entire equipment shall be thoroughly cleaned.

d) Pumping

The placing if the concrete by pumping will be permitted only if specified in the special Provisions or if authorized by the Engineer. The equipment shall be so arranged that no vibration will occur that might damage freshly placed concrete.

a time less than one hour will be required except when retarder is used in which case it shall be one (1) hour.

When non-agitating hauling equipment is used for transporting concrete to the delivery point, discharge shall be completed within one hour after the addition of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is thirty (30) degree C or above, the time between the introduction of cement to the aggregates and discharge shall not exceed forty-five (45) minutes.

d) Delivery

The organization supplying concrete shall have sufficient plant capacity and transportation vehicles to ensure continuous delivery at the rate required. The rate of the delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing, and finishing of the concrete. The rate shall be such that the interval between batches shall not exceed twenty (20) minutes. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum re-handling and without damage to the structure of the concrete.

e) Re-tempering

The concrete shall be mixed only in such quantities as are required for immediate use and any concrete that has developed initial set shall not be used. Concrete that has partially hardened shall not be re-tempered or remixed.

401.3.5 Handling and Placing Concrete

a) General

In preparation for the placing of concrete all sawdust, chips and other construction debris and extraneous matter shall be removed from inside the formwork, and struts, stays and braces serving temporarily to hold the forms in correct shape and

alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used that does not reach its final position in the forms within the time stipulated above under Item 401.3.4 "Hauling and Delivery of Mixed Concrete".

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is obtained. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

b) Placing Concrete Under Water

Concrete shall not be placed under water except where inevitable in which case approval must be sought from the Engineer and the work carried out under his immediate supervision. In this case the method of placing shall be as hereinafter specified.

Concrete deposited under water shall be class A concrete with a minimum cement content of three hundred fifty (350) Kg per cubic meter of concrete.

The slump of concrete shall be maintained between ten (10) and fifteen (15) cm. To prevent segregation, it shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom-dump bucket, or other approved means, and it shall not be disturbed after being placed. Water must not be allowed to flow past the fresh concrete surface.

A tremie shall consist of a tube having a diameter of not less than 25 cm constructed in sections having flanged couplings fitted with gaskets with a hopper at the top. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be completely submerged in concrete at all times; the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, but always keeping it in the placed concrete. The flow shall be continuous until the work is completed.

When the concrete is placed with a bottom-dump bucket, the top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

Dewatering may proceed when the concrete seal is sufficiently hard and strong. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping or other means, which will not injure the surface of the concrete.

c) Compaction

Concrete, during, and immediately after placing shall be thoroughly compacted, except lean concrete under footings and concrete deposited under water. Concrete in walls, beams, columns, etc. shall be placed in horizontal layers not more than thirty (30) centimetres thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the layers. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer, which has not taken an initial set.

The compaction shall be done by mechanical vibration. The concrete shall be vibrated internally unless special authorization of other methods is given by the Engineer or is provided herein. Vibrators shall be of a type, design, and frequency approved by the Engineer. The intensity of vibration shall be such as visibly to affect a mass of concrete with a 3 cm slump over a radius of at least half a meter. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms and shall be applied at the point of placing and in the area of freshly placed concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to compact the concrete thoroughly but shall not be continued at anyone point to the extent that localized' areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. Vibration shall not be applied directly to the reinforcement or to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation and vibrators shall not be used to transport concrete neither in the forms nor in troughs or chutes.

Vibration shall be supplemented by such external vibrator as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the normal vibrators.

401.3.6 Casting Sections and Construction Joints

a) General

The concrete in each integral part of a structure shall be placed continuously, and the Contractor will not be allowed to commence work on any such part unless sufficiently inspected and approved material for the concrete is at hand, and manpower and equipment are sufficient to complete the part without interruption in the placing of the concrete.

Construction joints shall be allowed only where specified on the plans or otherwise approved. If not detailed on the plans, or in the case of emergency, construction joints shall be placed as directed. Shear keys or inclined reinforcement shall be used where necessary to transmit shear or bond the two sections together. When shear keys or inclined reinforcement are not provided, the concrete shall be roughened as directed. Joints in the concrete due to discontinuity of work shall be avoided as far as possible. Such joints, when necessary, shall, be constructed to meet the approval of the Engineer.

When the placing of concrete is temporarily discontinued, the concrete after becoming firm enough to retain its shape, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. Where a 1eathered edge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an inset formwork shall be used to produce an edge thickness of not less than 15 centimetres in the succeeding layer. Work shall not be discontinued within fifty (50) centimetres of the top of any face, unless provision has been made for a coping less than 50 centimetres thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of coping.

Immediately following the discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcing steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. Care shall be exercised, during the cleaning of the reinforcing steel, not to injure or break the concrete steel bond near the surface of the concrete.

b) Slab Culverts

In general, the lean concrete below the foundation shall be placed and allowed to set before the reinforced concrete is started.

After the construction of masonry abutment walls, as specified in Special Provisions, the concrete bed plate and curtain walls shall be constructed monolithically. Construction joints in wing walls where unavoidable shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

c) Box Culverts

Vertical construction joints shall be at right angles to the axis of the culvert.

In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case, suitable *provision shall be made for bonding the sidewalls to the culvert base, preferably by means of raised longitudinal keys so constructed as to prevent, as far as possible, the percolation of water through the construction joint.

In the construction of box culverts one and quarter (1.114) meters or less in height, the sidewalls and top slab may be constructed as a monolithic unit. When this method of construction is used, necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In the construction of box culverts more than one and quarter (1.114) meters in height the concrete in the walls shall be placed and allowed to set before the top slab is placed. In this case, appropriate keys shall be left in the sidewalls for anchoring the cover slab.

If possible, each wingwall shall be constructed as a monolithic unit. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wingwall above the ground line.

d) Girders, Slabs and Columns

For simple spans, concrete shall preferably be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. For continuous spans, where required by design considerations, the concrete placing sequence shall be shown on the plans or in the Special Provisions.

Concrete in girder haunches less than one (1) meter in height shall be placed at the same time as that in the girder stem, and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of one (1) meter or more, the abutment or columns, the haunch; and the girder shall be placed in three successive stages; first, to. lower side of haunch; second, to the lower side of the girder; and third to completion.

For haunched continuous girders, the girder stem (including haunch) shall be placed to the top of stem. Where the size of the pour is such that it cannot be made in one continuous operation, vertical construction joints shall preferably be located within the area of contraflexure.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided. The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case a special shear anchorage shall be provided to ensure monolithic action between girder and floor.

Concrete in T-beam or deck girder spans may be placed on one continuous operation or may be placed in two separate operations; each of which shall be continuous; first, to, the top' of the girder stems and second, to completion. In the latter case, the bond between stem and slab shall be provided by suitable shear keys or by artificially roughening the surface of the top of the girder stem. In general, suitable keys may be formed by the use of timber blocks approximately five (5) by ten (10) cm in cross-section and having a length of ten (10) cms less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall be not greater than thirty (30) cms center to center. The blocks shall be removed as soon as the concrete has set sufficient to retain its shape.

Concrete in box girders may be placed in two or three separate operations. In either case the bottom slab shall be placed first. Bond between the bottom slab and stem shall be positive and mechanical. If the webs are placed separately from the top slab, bond between the top slab and webs shall be secured in the same manner as for T-beams. Requirements for shear keys for T-beams shall also apply to box girders, except that keys need not be deeper than the depth to the top of bottom slab reinforcement.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least 24 hours before the caps are placed.

When friction collars are used to support cap forms, the concrete of columns shall have been poured at least seven (7) days earlier.

Unless otherwise permitted, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until the test cylinders representing the bents have obtained the minimum compressive strength but in no case in less than seven (7) days.

e) Construction Joints

Construction joints shall be made only where shown on the Drawings or called for in the pouring schedule, unless otherwise approved by the Engineer. If not detailed on the Drawings, construction joints, also in cases of emergency shall be placed to meet the approval of the Engineer. Shear keys or reinforcement shall be used, unless otherwise specified, to transmit shear or to bond the two sections together.

Before depositing new concrete on or against concrete, which has hardened, the forms shall be re-tightened. The surface of the hardened concrete shall be roughened as required by the Engineer, in a manner that will not leave loose particles of aggregate or damage concrete at the surface.' It shall be thoroughly cleaned of foreign matter and laitance. When directed by the Engineer, the surface of the hardened concrete which will be in contact with new concrete shall be washed with water to ensure an excess of mortar at the juncture of the hardened and the newly deposited concrete, the cleaned and watered surfaces, including vertical and inclined surface, shall first be thoroughly covered with a coating of mortar of the same proportion of sand and cement as the class of concrete used against which the new concrete shall be placed before the grout or mortar has attained its final set.

The placing of concrete shall be carried out continuously from joint to joint. The face edges of all joints, which are exposed, to view shall be carefully finished true to line and elevation.

f) Rubble or Cyclopean Concrete

Rubble or cyclopean concrete shall consist of Class B concrete containing large embedded stones. The stone for this class of work shall be placed carefully so as to avoid damage to the forms or to the partially set adjacent concrete. Stratified stone shall be placed upon its natural bed. Stone shall be washed and saturated with water before placing.

The total volume of the stone shall not be greater than one third of the total volume of the portion of the work in which it is placed. For walls of piers greater than sixty (60) cms in thickness, stone of such size that one man can handle it, shall be used. Each stone shall be surrounded by at least fifteen (15) cms of concrete and no stone shall be closer than thirty (30) cms to any top surface nor any closer than fifteen (15) cms to any coping. For walls or piers greater than one (1) meter in thickness, larger stone (50 Kg or more) may be used. Each stone shall be surrounded by at least thirty (30) cms of concrete, and no stone shall be closer than sixty (60) cms to any top surface nor closer than twenty (20) cms to any coping.

g) Concrete Exposed to Sea Water

Unless otherwise specifically provided, concrete for structures exposed to seawater shall be Class A. The clear distance from the face of the concrete to the nearest face of reinforcement steel shall be not less than 10 cms. The concrete shall be mixed for a period of not less than 2 minutes and the water content of the mixture shall be carefully controlled and regulated so as to produce concrete of maximum impermeability. The concrete shall be thoroughly compacted and air pockets shall be avoided. No construction joints shall be formed between levels of extreme low water and extreme high water as determined by the Engineer. Between these levels sea water shall not come in contact with the concrete for a period of not less than thirty (30) days. The original surface, as the concrete comes from the forms, shall be left undisturbed.

h) Concrete Exposed to Alkali Soils or Alkali Water

Where Concrete may be exposed to the action of alkaline water or soils, special care shall be taken to place it in accordance with specifications herein. Wherever possible, placing shall be continuous until completion of the section or until the concrete is at least fifty (50) cms, above ground or water level. Alkaline water or soils shall not be in contact with the concrete during placement and for a period of at least seventy-two (72) hours thereafter.

i) Protection of Concrete from Environmental Conditions

i. General

Precautions shall be taken as needed to protect concrete from damage due to weather or other environmental conditions during placing and curing operations.

Any concrete placed during hot weather or during cold weather shall be at the Contractor's risk and any damaged concrete shall be removed and replaced at the Contractor's expense.

ii. Rain Protection

Under conditions of rain, the placing of concrete shall not commerce or shall be stopped unless adequate protection is provided to prevent damage to the surface mortar or damaging flow or wash of the concrete surface.

iii. Work in Hot Weather

The temperature of concrete shall not exceed thirty-two (32) degree C at the time of laying, unless the Contractor incorporates in the mix a plasticiser, of a make and in proportion which he has shown by laboratory tests and full scale trial to be satisfactory, to eliminate detrimental effects of high temperature without introducing any other detrimental effect on quality.

The following may be used to keep the temperature of concrete below the above limitations:

i) Chilling of concrete water by heat exchange coils or by addition of broken ice, provided that the water shall be free from ice at the time of entry into the mixer.

ii) Cooling of coarse aggregate by watering, provided that the water content of the aggregate so cooled shall be uniform.

iii) Reclaiming of aggregate from stock piles by the tunnel method to avoid using the surface layer of the stockpile with shade and wind protection of conveyor elevating to batching plant.

iv) Night work provided that (i), (ii) and (iii) are proved inadequate or unsatisfactory in their results and providing also that the Engineer has no other reason for refusing permission for night work.

The Engineer shall have power to order the suspension of concrete production in case of not taking precautionary measures by the Contractor as mentioned above. Under no circumstances will the Contractor be entitled to receive any additional payment for complying with the requirements of this clause.

iv. Work in Cold Weather

Except by written approval of the Engineer, concreting operations shall not be continued when a descending air temperature in the shade and away from artificial heat fails below five (6) degree C, nor resumed until an ascending air temperature in the shade and away from artificial heat reaches two (2) degree C. In such cases, the mixing water and / or aggregates shall be heated to not less than twenty-one (21) degree C nor more than sixty-six (66) degree C, prior to being placed in the mixer by an approved type of heating device so that the temperature of the concrete shall not be less than ten (10) degree C, nor more than twenty-seven (27) degree C, at the time of placing. No materials containing frost shall be used. Cement or fine aggregates containing lumps or crusts of hardened materials shall not be used.

401.3.7 Concrete Surface Finishing / Rendering

a) General

Concrete surface finishes shall be classified as follows:

- Bridge Deck Surface Finish
- Sidewalk Surface Finish
- Ordinary Surface Form Finish
- Class 1 Surface Form Finish

The bridge deck surface finish shall be given to the surface of the bottom slabs of all box type underpass structures.

The requirements for sidewalk surface finish apply to the surface of the bottom slabs in box culverts, except that the acceptable variation from a three-meter straightedge shall be 10 mm, and booming shall be omitted.

The ordinary surface form finish shall be the final finish applied to all surfaces after removal of forms, unless otherwise specified or called for on the drawings.

The Class 1 surface form finish shall be applied only where specified, or as required by the Engineer when the ordinary surface finish did not produce the required smooth, even surface of uniform texture and appearances.

b) Bridge Deck Surface Finish

A smooth riding surface of uniform texture, true to the required grade and cross-section, shall be obtained on all bridge roadway decks. The Contractor may use hand tools, or finishing machines or a combination of both, conforming to the requirements specified herein for finishing bridge roadway deck concrete.

Finishing of concrete placed in bridge decks shall consist essentially of compacting and striking off the surface of the concrete as placed and floating with longitudinal floats the surface so struck off.

The placing of concrete in bridge roadway decks will not be permitted until the Engineer is satisfied that the rate of producing concrete will be sufficient to complete the proposed placing and finishing operations within the schedule time, that experienced finishing machine operators and concrete finishers are employed to finish the deck, that fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. Finishing machines shall be set up sufficiently in advance of use to permit inspection by the Engineer during the daylight hours before each pour.

The adjustment and operation of deck finishing machines shall be verified by moving the machine over the full length of the deck section to be placed and traversing the float completely across ail end bulkheads before placement of concrete is begun.

Unless adequate lighting facilities are provided by the Contractor, the placing of concrete in bridge decks shall cease at such time that finishing operations can be completed during daylight hours.

Rails for the support and operation of finishing machines and headers for hand-operated stick-off devices shall be completely in place and firmly secured for the scheduled length for concrete placement before placing of concrete. Rails for finishing machines shall extend beyond both ends of the scheduled length for concrete placement to a sufficient distance that will permit the float of the finishing machine to fully clear the concrete to be placed. Rails or headers shall be adjustable for elevation and shall be set to elevations, with allowance for anticipated settlement, camber, and deflection of false work, as required to obtain a bridge roadway deck true to the required grade and cross-section. Rails or headers shall be of a type and shall be so installed that no springing or deflection will occur under the weight of the finishing equipment and shall be so located that finishing equipment may operate without interruption over the entire bridge roadway deck to be finished.

Rails or headers shall be adjusted as necessary to correct for unanticipated settlement or deflection, which may occur during finishing operations

Should settlement or other unanticipated events occur, which in the opinion of the Engineer would prevent pouring of bridge deck conforming to the requirements of these specifications, placing of deck concrete shall be discontinued until corrective measures satisfactory to the Engineer are provided. In the event satisfactory measures are not provided prior to initial set of the concrete in the effected area, the placing of concrete shall be discontinued and a bulkhead installed at a location determined by the Engineer. All concrete in place beyond the bulkhead shall be removed.

Unless otherwise permitted by the Engineer, bridge deck concrete shall be placed in a uniform heading approximately parallel to the bridge pier or bent caps. The rate of placing concrete shall be limited to that which can be finished before the beginning of initial set except that concrete for the deck surface shall not be placed more than three (3) meters ahead of strick off.

After the concrete has been placed, compacted, and consolidated, the surface of the concrete shall be carefully struck off by means of a hand operated strick board operating on headers, or by a finishing machine operating on rails ' A uniform deck surface true to the required grade and cross-section shall be obtained.

Following strike off, the surface of the concrete shall be floated longitudinally. In the event strike-off is performed by means of a hand operated strike board, two (2) separate hand-operated float boards for longitudinal floating shall be provided. The first float shall be placed in operation as soon as the condition of the concrete will permit and the second float shall be operated as far back of the first float as the workability of the concrete will permit.

In the event the strike off is performed with a finishing machine, longitudinal floating of the concrete shall be performed by means of a hand-operated float board or a finishing machine equipped with a longitudinal wooden float. The longitudinal wooden float on the finishing machine shall have a length of not less than two and half (2.5)

meters nor more than three and half (3.5) meters. When both strike off and longitudinal floating are to be performed by finishing machines, one machine, with operator, shall be used for strike off and a second machine, with a second operator, shall be used for longitudinal floating. Longitudinal floating may be performed with the same finishing machine that is used for strike off provided that the length of deck unit being placed is not more than 10 meters and the strike off operation is completed for said deck unit before the condition of the concrete requires that longitudinal floating be started.

Finishing machines used for strike off having a wheel base 1.8 meters or less shall be followed by 2 separate hand-operated float boards for longitudinal floating. All the provisions in this Item pertaining to hand operated float boards shall apply to the 2 separate float boards for longitudinal floating.

Longitudinal floats, either hand-operated or machine-operated, shall be used with the long axis of the float parallel to the center line of the bridge roadway. The float shall be operated with a combined longitudinal and transverse motion planning off the high areas and floating the material removed into the low areas. Each pass of the float shall lap the previous pass by one-half the length of the float. Floating shall be continued until a smooth riding surface is obtained.

In advance of curing operations, the surface of the concrete shall be textured by booming with a stiff bristled broom or by other suitable devices, which will result in uniform scouring. The operation shall be performed at a time and in a manner to produce a hardened surface having a uniform texture.

Hand-operated float boards shall be from three and half (3.5) to five (5) meters long, ribbed and trussed as necessary to provide a rigid float and shall be equipped with an adjustable handle at each end. The float shall be wood, not less than two and half (2.5) cms thick and from ten (10) cm to twenty (20) cm wide. Adjusting screws spaced as not to exceed 60 cms on centers shall be provided between the float and the rib. The float board shall be maintained free of twist and true at all times.

Hand-operated float boards shall be operated from transverse finishing bridges. The finishing bridges shall span completely the roadway area being floated & a sufficient number of finishing bridges shall be provided to permit operation of the floats without undue delay. Not less than two (2) transverse finishing bridges shall be provided when hand-operated float boards are used. When a finishing machine is used for longitudinal floating, one finishing bridge equivalent to the transverse finishing bridge specified herein shall be furnished for use by the Engineer.

All finishing bridges shall be of rigid construction and shall be free of excessive wobble and springing when used by the operators of longitudinal floats and shall be easily moved.

Immediate following completion of the deck finishing operations, the concrete in the deck shall be cured as specified in Item 401.3.8 "Curing Concrete" hereinafter.

The finished surface of the concrete shall be tested by means of a straightedge three (3.0) meters long. The surface shall not vary more than three (3) mm from the lower edge of the straightedge. All high areas in the hardened surface in excess of three (3) mm as indicated by testing shall be removed by abrasive means. After grinding by abrasive mean has been performed, the surface of the concrete shall not be smooth or polished. Ground areas shall not be of uniform texture and shall present neat and approximately rectangular patterns.

Where the concrete of the bridge deck is to be covered by bituminous surfacing, earth, or other cover, two and half 2.5 cms or more in thickness, the surface of the concrete shall not vary more than nine (9) mm from the lower edge of the three (3) meter straightedge.

Bridge deck surfaces under the curbs, railings and sidewalk shall be struck off to the same plane as the roadway and left undisturbed when future widening is shown on the plans.

c) Sidewalk Surface Finish

After the concrete has been placed it shall be compacted and the concrete shall be struck off by means of a strike board, floated with a wooden or cork floating and finished with a broom. An approved edging tool shall be used on all edges and at all expansion joints. Brooming shall be transverse to the line of traffic and if water is necessary, it shall be applied to the surface immediately in advance of brooming. The surface shall not vary more than six (6) mm under a three-meter straightedge, and the finished surface shall be free of blemishes.

d) Ordinary Surface Form Finish

Ordinary surface finish shall consist of filling holes or depressions in the surface of the concrete, repairing all rock pockets, removing stains and discolouration visible from travelled ways. Ordinary surface finish shall be applied to all concrete surfaces either as a final finish or preparatory to the Class 1 finish. On surfaces, which are to be buried underground or surface, which are enclosed, such as the cells of box girders.' the removal of fins will not be required.

Except as provided herein, all form bolts and any metal placed for-the convenience of the Contractor shall be removed to a depth of at least two and half (2.5) cms below the surface of the concrete. All rock pockets and other unsound concrete shall be removed. The resulting holes or depression shall be cleaned and filled with mortar. Form bolts projecting into the cells of box girders need not be removed unless permanent access is provided into the cells, in which case such bolts shall be removed flush with the surface of the concrete. Mortar used to fill bolt holes shall consist of one part cement and two parts sand. Other depressions and pockets shall be filled with either packed mortar or air blown mortar as directed by the Engineer. Mortar shall be cured in conformance with the requirements in Item 401.3.8 (c) "Curing Structures".

If rock pockets or holes in the opinion of the Engineer, are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

e) Class 1 Surface Form Finish

Class 1 surface finish shall consist of finishing the surfaces of the structure as necessary to produce even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections. The degree of care in building forms and character of materials used in form work will be a contributing factor in the amount of additional finishing required to produce even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections, and the Engineer shall be the sole judge in this respect.

After completion of the ordinary surface finish, areas, which do not exhibit the required, smooth, even surface. of uniform texture and appearance shall be sanded with power sanders or other approved abrasive means until smooth, even surfaces of uniform texture and appearance are obtained. The use of power carborundum stones or disks will be required to remove bulges and other imperfections.

Class 1 surface finish shall not be applied until a uniform appearance can be obtained.

Class 1 surface finish may be required to be applied as the final finish for the following surfaces, unless otherwise directed by the Engineer:

i) All form finish surfaces of bridge super-structures, except the under surfaces between girders and the inside vertical surfaces of T girders.

ii) All surfaces of bridge piers, columns and abutments, and retaining walls above finished ground and to at least three tenth (0.3) meter below finished ground.

iii) All surfaces of open spandrel arch rings, spandrel columns and abutment walls.

iv) All surfaces of pedestrian undercrossings, except floors and surfaces to be covered with earth.

v) Surface above finished ground of culvert headwalls, endwails and retaining wails.

vi) Surface inside of culvert barrels having a height of one and half (1.5) meters or more for a distance inside the barrel at least equal to the height of the culvert.

vii) All surfaces of railings.

f) Surface Rendering

All faces of concrete, which are to come in contact with back fill or pavement materials, shall be applied two coats of hot bitumen of approved quality, before placing any material around concrete.

401.3.8 Curing Concrete

a) General

All newly placed concrete shall be cured in accordance with these specifications, unless otherwise directed by the Engineer.

b) Method of Curing

The curing method shall be one or more of the following as described hereinafter.

- Water Method
  Curing compound Method
- Reinforced Waterproof Paper Method if required by the Engineer.
- Forms-in-Place Method Steam Method Polyethylene Sheeting Method

Water Method

The concrete shall be kept continuously wet by the application of water for a minimum period of seven (7) days after the concrete has been placed.

Cotton mats, burlaps, rugs, carpets, or earth or sand blankets, may be used as a curing medium to retain the moisture, the entire surface of the concrete shall be kept damp by applying water with a nozzle that so atomized the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period the concrete surface shall be cleared of all curing mediums.

When concrete bridge decks and flat slabs are to be cured without the use of a moisture retaining medium, the entire surface of the bridge deck or slab shall be kept damp by the application of water with an atomizing nozzle as specified in the preceding paragraph until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for a period of not less than seven (7) days.

Curing Compound Method

Surfaces exposed to the air may be cured by the application of an impervious membrane if approved by the Engineer.

The membrane-forming compound used shall consist of a practically colourless liquid. The use of any membrane forming compound that will alter the natural colour of the concrete or impart a slippery surface to any wearing surface shall be prohibited. The compound shall be applied with a pressure spray in such a manner as to cover the entire concrete surface with a uniform film, and shall be of such character that it will harden within 30 minutes after application. The amount of compound applied shall be ample to seal the surface of the concrete thoroughly. Power operated spraying equipment shall be equipped with an operational pressure gauge and means of controlling the pressure.

The curing compound shall be applied to the concrete following the surface finishing operation immediately after the moisture sheen begins to disappear from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any delay in the application of curing compound, which results in any drying or cracking of the surface, application of water with an atomizing nozzle as specified under "Water Method", shall be started immediately and shall be continued until application of the compound which shall not be applied over any free standing water surface. Should the film of compound be damaged from any cause before the expiration of seven (7) days after the concrete is placed in the case of structures, the damaged portion shall be repaired immediately with additional compound.

Curing compounds shall not hard settle in storage. They shall not be diluted or altered in any manner after manufacture. At the time of use, the compound shall be in a thoroughly mixed condition. If the compound has not been used within one hundred twenty (120) days after the date of manufacture, the Engineer may require additional testing before use to determine compliance to requirements.

An anti-settling agent or combination of anti-settling agents shall be incorporated in the curing compound to prevent caking.

The curing compound shall be packaged in clean barrels or steel containers or shall be supplied from a suitable storage tank located at the job-site. Onsite storage tanks shall have a permanent system designed to completely re-disperse any settled material without

introducing air or any other foreign substance. Containers shall be well sealed with ring seals and lug type crimp lids. The linings of the containers shall be of a character that will resist the solvent of the curing compound. Each container shall be labelled with the manufacturer's name, specification number, batch number, number of gallons, and date of manufacture, and shall have a label warning concerning flammability. The label shall also warn that the curing compound shall be well stirred before use. When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required*herein for container labels.

Curing compound may be sampled by the Engineer at the source of supply and at the job-site.

Reinforced Waterproof Paper Method

The exposed finished surfaces of concrete shall be sprayed with water, using a nozzle that so atomizes the flow that a mist and not a spray is formed, until the concrete has set, after which the waterproof paper shall be placed. The paper shall remain in place for a period of not less than 72 hours.

Reinforced waterproof paper shall comply with ASTM C 171 specifications. It shall be composed of two sheets of Kraft paper cemented together with a bituminous adhesive and reinforced with fibre. The waterproof paper shall be formed into sheets of such width as to provide a complete cover of entire concrete surface.

All joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. The joint seams shall have minimum lap of ten (10) cm.

The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

Should any portion of the sheets be broken or damaged within seventy-two (72) hours after being placed, the broken or damaged portions shall be immediately repaired with new sheets properly cemented into place.

Sections of sheets, which have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing the concrete shall not be used

Forms-in-Place Method

Formed surfaces of concrete may be cured by retaining the forms-in-place. The forms shall remain in place for a minimum period of seven (7) days after the concrete has been placed, except that for members over five (5) cms in least dimension, the forms shall be in place for a minimum period of five (5) days. Wooden forms shall be kept wet by watering during the curing period.

Steam Method

After placing and vibrating, the concrete shall be allowed to attain its initial set before steam is applied. During the placing of concrete and application of steam, provision shall be made to prevent surface drying by means of a coating of approved material. The optimum curing temperature shall not exceed sixty-five (65) degree C.

Polyethylene Sheeting Method

The wet surface of fresh concrete shall be covered with white polyethylene sheeting as soon as possible without marring the surface and should cover all exposed surfaces of the concrete. The edges of the sheeting shall be weighted securely with a continuous windrow of

earth or any other means satisfactory to the Engineer to provide an air-tight cover. Adjoining sheets shall overlap not less than thirty (30) cms. and the laps shall be securely weighted with earth, or any other means satisfactory to the Engineer to provide an airtight cover.

c) Curing Structures

All newly placed concrete for cast-in-place structures, other than highway bridge decks, shall be cured by the water method, the forms-in-place method, or, as permitted herein, by the curing compound method, ail in accordance with the requirements in Item 401.3.8 (b), Methods of Curing".

The curing compound method may be used on concrete surfaces, which are to be buried, underground, and surfaces where only Ordinary Surface Finish is to be applied and on which a uniform colour is not required and which will not be visible from any public travelled way.

The top surface of highway bridge decks shall be cured by both the curing compound method, and by the water method. The curing compound shall be applied progressively during the deck finishing operation immediately after finishing operations are completed on each individual portion of the deck. The water cure shall be applied not later than four (4) hours after completion of the deck finishing or, for portions of the decks on which finishing is completed after normal working hours, the water cure be applied not later than 8.00 a.m. the following morning.

When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surfaces being cured by the curing compound method or by the forms-in-place method, until the Engineer determines that a cooling effect is no longer required.

d) Curing Precast Concrete Members

Precast concrete members shall be cured for not less than seven (7) days by the water method or by steam curing for a period in which 80% of strength achieved, at the option of the Contractor. Steam curing for precast members shall conform to the following provisions:

After placement of the concrete, members shall be held for a minimum four (4) hours precasting period.

To prevent moisture loss on exposed surfaces during the presteaming period, members shall be covered immediately after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of the tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

Steam at jets shall be low pressure and in a saturated condition. Steam at jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure shall not exceed twenty (20) degree C per hour. The curing temperature throughout the enclosure shall not exceed sixty-five (65) degree C and shall be maintained at a constant level for a sufficient time necessary to develop the required compressive strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature recording devices that will provide an accurate continuous permanent record of the curing temperature shall be provided. A minimum of one temperature recording device per sixty (60) meters of continuous bed length will be required for checking temperature.

Curing of precast concrete will be considered completed after a termination of the steam curing cycle.

e) Curing Precast Concrete Members

All newly placed concrete precast piles, both conventionally reinforced and prestressed shall be cured by the "Water Method" as described in Item 401.3.8(b) except that the concrete shall be kept under moisture for at least fourteen (14) days. At the option of the Contractor steam curing may be used in which case the steam curing provisions in Item 401.3.8(b) "Curing Precast Concrete Members" shall apply except that the concrete shall be kept wet for at least seven (7) days including the holding and steaming period.

401.3.9 Testing of Aggregates

Samples of fine and coarse aggregate to be used shall be selected by the Engineer. It shall be the responsibility of the Contractor to designate the source or sources of aggregate and to obtain the necessary samples and submit them for testing at least thirty (30) days before actual concreting operations are to begin.

Samples of aggregates shall be obtained and tested in accordance with the following standard AASHTO methods:-

i)	Sampling aggregates	T-2
ii)	Sieve analysis	T-27
iii)	Amount of material passing the No.200 sieve.	T-11
iv)	Organic impurities	T-21
v)	Mortar Strength	T-71
vi)	Sodium sulphate soundness	T-104
vii)	Friable particles	T-112
viii)	Abrasion loss	T-96
ix)	Specific Gravity	T-84
x)	Absorption.	T-85
xi)	Production of Plastic Fines.	T-210
xii)	Fineness Modulus	T-27
xiii)	Sand Equivalent	T-17
xiv)	Potential Reactivity of Carbonate Rocks for Concrete Aggregate (Rock Cylinder Method)	ASTM C586
xv)	Potential Alkali Reactivity of Cement for Aggregate Combinations (Morta-Bar Method).	ASTM C227
xvi)	Potential Reactivity of Aggregates (Chemical Methods)	ASTM C289

No aggregate for testing during the production of concrete shall be sampled at the discharge gates of the bins feeding the weight hopper. The Contractor, at his expense, shall provide safe and suitable facilities for obtaining the samples. No concreting work on the project will be permitted until the Engineer signifies in writing his approval, following the performance of the necessary tests, on all the materials involved in making concrete.

401.3.10 Testing of Compressive Strength

Concrete compressive strength requirements consist of a minimum strength at the age of twenty-eight (28) days and the minimum strength, which must be attained before various loads or stresses, are applied to the concrete. The various strengths required are specified in Table 401-1.

The compressive strength of concrete will be determined from test cylinders, which have been fabricated from concrete sampled and tested in accordance with AASHTO T 23 and AASHTO T 22.

A set of six (6) cylinders shall be taken from each fifty (50) cubic meters of each class of concrete or fraction thereof placed each day, three (3) of the six (6) cylinders to be tested after seven (7) days and three (3) after twenty-eight (28) days.

a) The minimum average 28 days' test result of all samples tested at any time shall be the specified twenty-eight (28) days strength.

b) No individual samples tested after 28 days shall show a test result lower than eighty-five (85) percent of the required twenty-eight (28) days.

Concrete represented by any single test cylinders that fails to comply with the requirement under (b) above will be rejected unless the Contractor at his expense, provides evidence that the strength and quality of the concrete placed in the work are acceptable. If such evidence consists of tests made on cores taken from the work, the cores shall be obtained and tested in accordance with the specifications of AASHTO T-24.

Test results of the cores shall meet the following requirements:-

a) Average test result of the cores shall be less than the minimum required twenty eight (28) days strength.

b) No individual core shall show a strength less than Ninety five (95) percent of the required twenty eight (28) days strength.

Should the above test results fail to comply with the requirements, concrete of that particular pour shall be rejected and removed as directed by the Engineer. Furthermore contractor shall redesign the concrete mix for approval of the Engineer.

In case, seven (7) days strength shows less than seventy (70) percent of the twenty eight (28) days strength (in case of type-1 cement), Engineer may stop further work on that particular portion of concrete, unless twenty eight (28) days strength gives satisfactory results.

Trial Batches for Mix Productions

The placing of concrete shall not begin until trial batches of the mix design to be used have been produced by the Contractor and tested and approved by the Engineer. The trial mix proportions shall be such that the average strength of five (5) consecutive test cylinders shall be 20% higher than the specified twenty eight (28) days strength and no individual test cylinder shall be below the specified strength.

When concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member, test cylinders will be cured under conditions similar to those at the casting site. The compressive strength of concrete determined for such purposes will be evaluated on the basis of individual tests.

401.4 MEASUREMENT AND PAYMENT

401.4.1 Measurement

The quantity of concrete to be paid for shall be the number of cubic meters of concrete of the various classes complete in place and accepted.

In measuring the volume of concrete to be paid for, the dimension to be applied shall be those shown on the Drawings except where others ordered by the Engineer in writing.

Deductions from the theoretical volume of concrete shall be made for the volumes of draining holes, weep holes, pipes and conduits, etc., in case where their cross-sectional areas exceed 500 square centimetres.

The measurement shall not include any concrete used in the construction of cofferdams or falsework.

The volume involved in fillets, scorings, or chamfers ten square centimetres in cross-sectional area or less shall be disregarded when measuring the quantity of concrete to be paid for

Concrete for railings, pipe culverts, etc., is not to be measured under this item, but under separate items.

401.4.2 Payment

The accepted quantity measured as provided above shall be paid for at the contract unit price respectively for the pay items listed below that as per shown in the Bill of Quantities which prices and payment shall be full compensation also for such works as curing, surface finishing and / or rendering as required, formation of construction joints and any such work and incidentals necessary to complete the item except works that are paid for under other pay items.

For all concrete structures or portions, thereof, no separate measurement or payment shall be made for false work, centering, formwork or any other temporary work to complete the concrete structure or portion thereof, payment for all such temporary works shall be deemed to be included in the contract price paid under various items of concrete work.

Pay Item No.	Description	Unit of Measurement
401a	Concrete Class:	
	i) Underground	Cm
	ii) On Ground	Cm
	iii) Elevated	Cm
401b	Concrete Class “B”	Cm
401c	Concrete Class “C”	
	i) Underground	Cm
	ii) On Ground	Cm
	iii) Elevated	Cm
401d	Concrete Class D_1	Cm
	Concrete Class D_2	Cm
	Concrete Class D_3	Cm
401e	Concrete Class Y	Cm
401f	Lean Concrete	Cm
401g	Precast Concrete, Class …..	Cm

ITEM 601 CONCRETE KERBS, GUTTERS AND CHANNELS

601.1 DESCRIPTION

This work shall consist of kerb, gutter, channel, or combination of kerb and gutter or channel; constructed of the following materials and in accordance with the specifications at the location and of the form, dimensions and designs shown on the Drawings or as directed by the Engineer. The kerb, gutter, channel or in combination may be constructed by one of the following methods.

i) Cast in place concrete kerbing.
ii) Precast concrete kerbing.
iii) Extruded concrete kerbing.

601.2 MATERIAL REQUIREMENTS

The concrete for cast in place concrete kerbs, gutters and channels shall be either Class W or class 'C' or as indicated on the Drawings and shall conform to the requirements of that particular class prescribed under item 401.1.1. "Classes of concrete". An air entraining agent, if required, shall be added during mixing an amount to produce five (5) to eight (8) percent air by volume in the mixed concrete.

Precast concrete kerbing units shall consist of class 'C' concrete conforming to the requirement of item 401 and to lengths, shape and other details shown on the Drawings. Kerbing which shows surface irregularities of more than five (5) mm when checked with three meter straight edge or surface pits more than fifteen (15) mm in diameter will be rejected.

Forms to hold the concrete shall be built and set in place as described under item 403-Formwork.

Forms for at least sixty meters of kerb or combination of kerb and gutter or channels shall be in place and checked for alignment and grade before concrete is placed. Curved sections shall have forms of either wood or metal and shall be accurately shaped to radius of curvature shown on the Drawings. Steel Reinforcement if required shall conform to item 404 "Steel Reinforcement".

Expansion joint filler shall be either the performed type conforming to requirement of AASHTO-M 153 or shall be precast fiber board packing.

Joint filler shall consist of one part cement and two parts of approved sand with sufficient quantity of water necessary to obtain the required consistency. The mortar shall be used within thirty (30) minutes after preparation.

The Bonding compound when used shall conform to AASHTO M-200.

601.3 CONSTRUCTION REQUIREMENTS

601.3.1 Cast-in-Place

a) Excavation and Bedding

Excavation shall be made to the required depth and the base upon which the kerb or combination of kerb and gutter is to be set shall be compacted to a minimum density of ninety (90) percent of the maximum dry density as determined by AASHTO T-191 Method. All soft and unsuitable material shall be removed and replaced with suitable material acceptable to the Engineer.

Where directed by the Engineer, a layer of cinders or clean sand and gravel, or other approved porous material having a minimum compacted thickness, of fifteen (15) cm shall be placed to form a bed for the kerb or combination of kerb and gutter

b) Placing Concrete

Concrete may be placed in the gutter to the full depth required. The top of the kerb or combination of kerb and gutter shall be floated smooth and the edges rounded to the radii shown on the Drawings. Before finishing, the surface of the gutter shall be tested with a three (3) meter straight-edge and any irregularities of more than five (5) mm in three (3) meters shall be eliminated. In finishing concrete only mortar normally present in the concrete shall be permitted for finishing. The use of a separate mortar finishing coat or the practice of working dry cement into the surface of the concrete will not be permitted.

c) Joints

The kerb and gutter shall be constructed in uniform sections of not more than twenty five (25) meters in length except where shorter sections are required to coincide with the location of weakened planes or contraction joints Of the concrete pavement or for closures but no section shall be less than two (2) meters long. The sections shall be separated by sheet templates set perpendicular to the face and top of the kerb and gutter. The templates shall be approximately five (5) mm in thickness, of the same width as that of the kerb or kerb and gutter and not less than five (5) cm greater than the depth of the kerb or kerb and gutter. Templates shall be set carefully and held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place. When pre-cut fiber-board packing is used in the expansion joints it may be used in place of the sheet template referred to above, on the approval of the Engineer. In this event the fiber board

During seventy two (72) hours following placing of concrete, the kerbs, channels and gutters shall be protected against premature drying by covering with suitable cotton or Hessian mats and by frequent sprinkling with water, with liquid forming compounds or with waterproof paper or by any other method as mentioned in section 401.3.8-Curing, Concrete and approved by the Engineer.

h) Backfilling

After forms has been removed and concrete has been cured as specified, the excavation of kerbs, gutters or channels shall be backfilled with suitable earth or granular material tamped into place in layers of not more than fifteen (15) cms each until firm and solid.

601.3.2 Pre-Cast

a) Excavation and Bedding

Excavation shall be made to the required depth as shown on the Drawings. All soft and unsuitable material shall be removed and replaced with a suitable material acceptable to the Engineer.

Bedding shall consist of Class B Concrete conforming to the requirements of Item 401 and shall be to the section and dimension shown on the Drawings.

b) Placing

The precast concrete kerbs shall be set in 1:3 of cement sand mortar to the line, level and grade as shown on the Drawings or as directed by the Engineer.

c) Joints

Joints between consecutive kerbs shall be three (3) to five (5) mm wide and filled with cement mortar to the full section of the kerb.

d) Backfilling

Backfilling shall meet the requirements of Item 601.3.1 (h).

601.3.3 Extruded Concrete Kerbing and Channels

a) Excavation and Bedding

Excavation and bedding shall conform to the requirements as described under item 601.3.1 (a).

b) Placing

shall be pre-cut to the shape of the kerb so that its outer edge will be flush with the abutting kerb.

Expansion joints shall be formed in the kerb and gutter at intervals of six (6) to ten (10) meters in order to coincide with the expansion joints of cement concrete pavement or as shown on the Drawing.

d) Dowels at Expansion Joints in Channels

At expansion joints in channels and in the channel portion of kerbs and channel built monolithically, painted dowel bars with slip sleeve shall be provided as a load transfer medium at locations shown on the Drawings.

The size and spacing of the dowel bars shall be as indicated on the Drawings. Each dowel shall be set accurately parallel to the top surface of the gutter and accurately at right angles to the expansion joint.

e) Contraction Joints

Transverse contraction joints shall be provided opposite to all contraction joints in abutting concrete pavement and other locations shown on the Drawing spaced to a maximum of four (4) meters.

The contraction joints shall be provided by forming grooves in the face and surface of structure at right angle to the kerb alignment and kerb surface. The grooves shall be rectangular in cross-section, five (5) cm deep by five (5) cm wide. The grooves shall be formed in the top of all kerbs and in the exposed roadway face of kerb and in the channel surface of monolithic type kerb and channels and in the surface of channels. The edges of the joints shall be tooled and the joints shall be left clean, neat and of specified width and depth.

f) Removal of Forms and Finishing

The forms shall be removed within twenty four (24) hours after concrete has placed except that the, form used against the face of the kerb in a combination of kerb and gutter shall be removed as soon as the concrete has set sufficiently to hold its shape. Minor defects shall be repaired with mortar containing one part of portland cement and two parts of the fine aggregate. Plastering shall not be permitted on the face of a kerb or kerb and gutter and all rejected kerb or gutter shall be removed and replaced without additional compensation. Ail surfaces which will be exposed in the finished construction of the kerb and gutter shall be finished, while the concrete is still "green" by wetting a wood block of float and rubbing the surface until they are smooth.

g) Curing

Concrete shall be fed to the machine at a uniform rate. The concrete shall be of such consistency that after extrusion it will maintain the shape of the kerb section without support and shall contain the maximum amount of water that will permit this result. The machine shall be operated under sufficient uniform restraint to forward motion to produce a we!] compacted mass of concrete which requires no further finishing other than light brushing with a brush filled with water only. The forming tube portion of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine. A grade line gauge or pointer shall be attached to the machine so that a continual comparison can be made between the kerb being placed and the established kerb grade as indicated by an offset guideline.

The top end face of the finished kerb shall be true and straight and the top surface of the kerb shall be of uniform width, free from bumps or surface pits larger than fifteen (15) mm in diameter. When a straight-edge three (3) meters long is laid on the top or face of the kerb. or surface of the gutter, the surface shall not be more than five (5) mm from the edge of the straightedge except at grade changes or curves.

Where adhesive is used to bond the kerb to an ~existing pavement, the surface shall be first thoroughly cleaned of all dust, loose material and oil, the cost of which shall be included in other items of work.

c) Joints

Expansion joints shall be constructed by sawing through the kerb section to its full depth. The width of the cut shall be such as to admit the joint filter with a tight fit. Preformed joint filler shall conform to the provisions of Item 601.2 and shall be inserted and mortared in place.

If sawing is performed before the concrete has hardened, the adjacent portion of the kerb shall be supported firmly with close fitting shields and the operations of sawing and inserting the joint filler shall be completed before curing the concrete.

Alternatively pre-cut joint fillers shall be permitted to be placed at the location of the expansion joints prior to the placing of the extruded kerb with the approval of the Engineer. The joint fillers shall be set firmly in place in a vertical position to the line and grade of the kerb profile.

d) Curing and Backfilling

Curing and backfilling shall be as described in item 601.3.1(g) and Item 601.3.1 (h).

601.4 MEASUREMENT AND PAYMENT

601.4.1 Measurement

The unit of measurement for concrete kerb, gutter, or combination of kerb and gutter, channel, or extruded kerbs and channels shall be measured by the linear meter along the front face of the section at the finished grade elevation. Deduction in length will be made for drainage structure installed in the kerbings such as catch basins and drop inlets etc. Measurement will not include any area in excess of those shown on the Drawings except for any area authorised by the Engineer in writing.

601.4.2 Payment

Measured and accepted quantities shall be paid for at the contract unit price per linear meter for each of the particular pay item listed below and shown in the Bill of Quantities which prices and payment shall constitute full compensation for furnishing and placing all materials for concrete, for reinforcing steel if required on the Drawings for expansion Joints, material, form for drainage opening, excavation, backfilling and dumping and disposal of surplus material and for all labour, equipment, tool and incidentals necessary to complete the item.

Payment for expansion joint filler material used in transverse expansion and contraction joints in kerbs and channel shall be understood to be included in the price tendered per linear meter for the kerbs and channels and shall not be paid for separately.

Concrete and mortar required for bedding of precast concrete kerbs as shown on the Drawings shall not be paid for as separated item, but the cost shall be included in the contract unit price for precast concrete kerb.

Pay Item No	Description	Unit of Measurement
601a	Concrete Kerb, in place, Type ____	M
601b	Combination of Kerb and Gutter in Place, Type ____	M
601c	Combination of Kerb and Channel in Place, Type ____	M
601d	Pre-Cast Kerb in Place, Type _____	M
601e	Concrete Channel, Type _____	M
601f	Extuded Kerb and Channel, Type ___	M

SECTION 1
GENERAL

1. General Specification shall apply to all the works in this Contract unless otherwise specifically mentioned elsewhere. Figured dimensions on the working drawings and shall be follow 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 PEHP MDA unless specified otherwise.

14. CLIMATE

The climate of the Karachi features an arid climate, albeit a moderate version of this climate. Karachi is located on the coast and as a result has a relatively mild climate. Karachi has two main seasons; Summer & Winter, while spring and autumn are very short. Summer season persists for longer period during the year. The level of

precipitation is low for the most of the year. Less precipitation during summer is due to inversion layer. Karachi also receives the monsoon rains from July to September. The city enjoys a tropical climate encompassing mild winters and warm summers. The humidity levels usually remain high from March to November, while very low in Winter as the wind direction us North Easterly. Since summer temperatures (From the end of April till the end of August) are approximately 30 °C (86 °F), the winter months (From November toll the end of March) are the best time to visit Karachi. Most visitors, tourist and expatriates come to Karachi during the month of December.

15. BRIEF DESCRIPTION OF WORKS

The works under this Contract comprise of construction of Water Supply, Sewerage and Drainage System for PEHP MDA Karachi according to the drawings and specifications and as per terms and conditions of contract.

16. PEHP MDA LOCATION AND ACCESS

As per Plans and Drawings of Bidding 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 IV 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. PEHP MDA 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 construction of Water Supply, Sewerage and Drainage System for PEHP MDA. The Contractor shall apply for water connection direct to concerned authorities of PEHP MDA and it shall be his responsibility to obtain water connection from and pay water charges 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 programmed 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 s, 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.

29.5 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 with in the following grading limits.

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

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

iiic. The material passing the BS Sieve size 250 microns, when tested in

Accordance with BS 1377 shall be non-Plastics''.

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 BS5889.

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, color, 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 Coloring 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 for sewers 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 sewer 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 tube well and pump house 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 brouchers 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.

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.
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 sulphates 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 sq.m 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 manufacturers 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 PEHP MDA clearly casted in the upper side of the manhole covers in Capital letters.

41.5 Covers shall be lockable to the frame by means of a 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 liters capacity and labeled 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 or 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 for "Concrete". Bitumen used for this purpose shall be as per B.S.S or P.S.

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

43.3 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
EARTHWORKS

1. SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plants, equipments, appliances labour and materials in performing all operations in connection with excavating, filling and backfilling construction works required for laying pipelines, fitting valves and other ancillary works 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

2.1 General

The contractor shall remove the whole of the vegetation, top soil, concrete, flagging, paving, and curbing, road metaling and other materials from the site of any excavation and shall keep separately and preserve the same for re-use 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 work shall not be less than as shown on the Drawings, or as may be directed.

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 area.

2.2 For Pipelines

(i) 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. No trench excavations shall be commenced without prior approval of the Engineer. Excavation shall proceed at the same rate as laying, jointing, testing and backfilling.

(ii) 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 all necessary supports including timbering or sheet piling to support the sides of trenches. The cost of supply of all material, plant and labour that may be necessary for clearance, excavation, over break, timbering, sheet piling, shoring, strutting, refilling, watering and ramming, etc., shall be included in the Contract Rates for excavation. In all cases, the quantity of excavation measured shall be the in- volume of the undisturbed material with in allowable limits mentioned in the specification. 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.

(iii) 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 expense. Any excavation done in excess of specified width due to any reason, what so ever shall not be payable.

(iv) The width of the trench for pipes shall be as per drawing. The depth shall be according to drawing and as per direction of the engineer.

(v) Additional excavation will be necessary at all pipe joints to facilitate the making of joint and application of sealant Joint. Holes shall be of such dimensions, so as to give clear working space around the joint. The Contractor shall make allowance for the additional excavation required for these joint holes in the price tendered for trench excavation. These shall not be separately measured or paid.

(vi) The length of the trench shall be measured along the centre line of the trench and the depth shall be measured vertically from original ground levels to the average bed level. No deductions shall be made for the lengths of Tee, beds etc.

2.3 Trial / Test Pits

The Contractor is required to excavate trial pits and trial trenches upto about 5% of the total quantity of excavation specified in the contract at appropriate locations to determine the position of existing conduits, water mains, gas mains, cable ducts and sewers etc. This excavation work shall be done carefully with due precaution, so as not to damage any existing services. The Contractor may be precluded from carrying out any permanent work until this information is obtained and may have to adopt his program in accordance with the information so obtained by the Contractor.

Trial test pits will be required to be dug before or during the execution of work at locations approved by the Engineer for determining the condition of soil, checking the location of utility services water levels etc. The size of individual trial pits may be kept 1.0 x 1.0 meters or as appropriate / approved by the Engineer upto the required depth. The dimensions may be varied depending upon the site condition and as per instruction of the Engineer. The Contractor shall obtain prior permission from Engineer in writing before start of work on trial pits. No separate payment shall be made for trail pits required to be dug by the Contractor.

The cost incurred by the Contractor on the trial / test pits shall be deemed to be included by the Contractor in his rates for excavation.

2.4 Classification of Soils

Excavation shall include the removal of all materials in all kinds of soils or stratas of every name and nature. If rock is encountered it shall be removed carefully and without excessive noise and vibration. Blasting shall not be allowable. The quantities of earthwork for category of excavation in rock are provisional. The Engineer shall do the classification of soil during actual excavation. In case the Contractor meets rock during the excavation, the contractor shall request the Engineer in writing for a joint inspection for classification of soil. The Engineer shall visit the site during excavation and give his opinion in writing about classification of soil for the particular site or alignment. The Contractor shall not be paid for the quantities of rock.

The excavation payable shall be limited to the dimensions and elevations as indicated on the drawings.

3. TIMBERING SHORING & BRACING

3.1 General

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 with stand the pressure encountered and the Contractor shall be solely responsible for the losses due to collapse or failure of shuttering, bracing, shoring etc. No payment for side support including shoring, shuttering or bracing shall be made. The Contractor's rate for excavation shall be deemed to include the cost of providing and removing side supports timbering, shoring, strutting and bracing with all connected operations.

3.2 For Pipeline Trenches

The Contractor shall at all times support effectively the sides of the pipe trenches and other excavation by suitable timbering, bracing, strutting etc. Where required the contractor shall use close timbering in all loose or sandy or unstable stratas if found necessary by the Engineer. It is intended that all timbering and side supports for trenches shall be removed as the work proceeds. The Contractor shall ensure that the removal of timbering and side supports 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 fully braced and strutted so that no collapse, subsidence or any damage to public or private property shall take place. The Contractor shall be solely responsible for the sufficiency of all timbering and their supports to be used and 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.

4. PUMPING, BAILING AND DEWATERING

The work covered by this section of Specifications consists of furnishing all plants, labour, materials, equipments and appliances for performing all operations for pumping, bailing, dewatering and draining water from the areas, excavated for trenches and all other works in this contract in accordance with this section of Specifications, and subject to terms and conditions of the contract.

4.1 The Contractor shall at all times during the progress of work remove any water 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 times while excavating, providing bedding and laying of pipes.

4.2 The Contractor shall keep excavations free from water at all time and provide adequate pumping plant including special dewatering equipment and means of disposing off the pumped water. The Contractor shall ensure to keep away un-desired water clear of excavation for permanent works and provide all necessary plant and equipment for dealing with any subsoil condition that may be encountered.

4.3 The cost of all the works required for pumping and disposal of water from trenches shall not be included in the BOQ rate of excavation, bailing and pumping of subsoil water. Separate payment for dewatering, bailing and pumping will be made to the contractor if agreed

4.4 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 roads or streets, nor cause any interference with the use of the same by the public.

4.5 The Contractor shall be held fully and wholly responsible for all damages done to building and other 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.

5. BACKFILLING AND RESTORING OF GROUND TO ORIGINAL CONDITION

The back filling of the trench and shall be allowed after the pipe has been laid and jointed over the specified bed, inspected, checked, tested and approved by the Engineer. Filling to depth up to half pipe level shall carry out for backfilling of the trenches. 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, which 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% compaction is obtained as per AASHTO Standard.

On completion of backfilling, the Contractor shall level all grounds disturbed by him in the course of the work, spread topsoil where necessary as directed by the Engineer.

6. REMOVAL OF EXCESS AND UNDESIRABLE MATERIALS

6.1 Excess and undesirable material from excavation not required for fill or backfill shall be disposed off, removed and leveled on the site where directed by the Engineer. Earth suitable and meant for backfill shall be stored at site in a manner not to interfere with the progress of construction works in progress.

6.2 The Contractor shall keep all excavated soil sprinkled with water during the excavation work so as to prevent any dust nuisance.

6.3 Surplus Excavation Debris etc.

All surplus soil arising out of the work shall be carried away to approved site, within a week, and spread as directed by the Engineer.

6.4 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 crest of any existing thickness. The stone metal soling etc. shall be separately stacked along the side of excavation for possible reuse.

7. PROTECTION OF UTILITY SERVICES

7.1 Utility Lines

When any existing utility line(s) are encountered within the area of operations, the contractor shall take all necessary measures so that these are neither disturbed nor damaged. The Contractor shall be fully and solely responsible for any damage occurring due to non-providing of adequate measures for the protection of such services. The Contractor shall be required to obtain all necessary permissions from concerned departments in writing prior to start of work and maintain the affective liaison for trouble free progress of work(s). The contractor shall pay all fees, charges officially levied by such department while issuing required permission. The Contractor shall furnish originals of payment receipts along with his written request for allowing

payments by the Engineer accordingly. In case of restoration to unavoidable damage to any utility service, line or by passing such line the procedure as detailed shall be followed in accordance with rules, regulation, specification or practice as preferred by the concerned department.

7.2 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.

7.3 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.

7.4 Control of Traffic on Roads

The Contractor shall ensure that the flow of traffic over the 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, which is to be segregated as far as possible from areas where work is in progress. In the planning and execution of any temporary or permanent works, which may affect the traffic flow and / or access to properties, the contractor shall cooperate closely with the Engineer and the appropriate controlling Authority.

7.5 MEASUREMENT AND PAYMENT

The measurement and payment for different categories of earth excavation inclusive of disposal of surplus earth upto any lead or lift shall be done in accordance with BOQ rates.

Excavation shall be measured according to the net volume within the outlines as shown on the drawing. The rate for excavation entered in the Bill of Quantities shall include for excavation in all kinds of soils and removal surplus excavated earth/material as per instruction of Engineer. Separated payment for back filling will be made to the contractor.

For all works of excavation cutting or filling required to be carried out as per drawings, specifications or instructions of engineer which cannot be measured after carrying out of work, the contractor shall arrange joint measurements with representative of Consultants and PEHP MDA. These measurements will be recorded in three copies duly signed by these three representatives and one copy to be retained by each. These joint measurements shall form the basis of agreement. No payment will be made for such work for which joint measurement are not made and recorded. The surplus excavated material shall be utilized for filling as directed by the Engineer. The Contractor may also be required to excavated and remove some dumps / heaps of waste material which may cause obstruction in proposed pipe line. These removed materials shall also be used for filling. The measurements recorded shall form the basis of payment and no payment shall be made in case joint measurements are not carried out and recorded.

All timbering, shoring, bracing etc. required for supporting the sides of excavation to prevent sliding or movement of soil shall be deemed to be included in the tendered rate of excavation.

8. CUTTING & RESTORING OF ROAD AND MAKING DIVERSION

8.1 General

The Contractor shall arrange and provide adequate warning lights and signs to the satisfaction of the Engineer for the road cutting and diversion in the road from the start of the road cutting 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.

8.2 Cutting and Restoration of Road

Whenever a road is required to be cut for lying of pipeline 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 department. 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 pipe and backfilling and reinstatement work of the road shall be done as quickly as possible. After laying and jointing and testing of pipe, 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. The Contractor shall follow the prevalent regulations of the concerned department of road in respect of the road cutting and reinstatement. In all cases Contractor shall carry out backfilling with required compaction. The sub-grade shall be prepared by using the dismantled hard crust of existing road. In case a cash deposit is required by the concerned department for road restoration work, the Contractor shall get the estimate of reinstatement of road cut prepared and submit the required cash to the department for obtaining the permission of road cutting. The actual amount of such cash deposit shall not be reimbursed by PEHP MDA to the Contractor along with the monthly running bills of the Contractor on presentation of actual paid vouchers.

8.3 Making Diversion

Whenever a road is cut for laying of pipe or otherwise, a diversion of smooth and even surface is to be provided by the Contractor for the unhindered flow of normal traffic before the digging of road is undertaken to provide a good smooth road to avoid any inconvenience to traffic. On crossing of two way traffic road, only one side of the road shall be dug first. Full excavation, bedding and pipe lying should be done and got checked and backfilled and adequately compacted and opened to traffic. The other side shall be opened only after the first side is completed satisfactorily. Traffic diversion signs in bold letters with arrows shall be provided on both sides for convenience of traffic. For the work of laying pipelines along the road, the Contractor shall restrict the space required for excavated earth to minimum and provide a reasonable space for flow of traffic with all measures to protect any damage due to excavation work. Suitable pedestrian crossings shall be provided at reasonable spacing to reduce in convenience for public to minimum. The Contractor shall have to maintain diversion in proper grade and level to the satisfaction of the Engineer from the beginning of the cutting of road and till it is restored to its original condition. Throughout this period any cut or depression formed on the surface shall have to be filled, watered and properly rolled to give a smooth surface. Continuous arrangements of sprinkling water shall be made to avoid formation of dust and dirt. The Contractor shall provide necessary diversion signs, fence, guards, flags, lights. The diversion shall be maintained with labor and staff round the clock for convenience of traffic. Cost of maintenance of diversion shall be included by the Contractor in his rates for excavation and shall also include arrangements for traffic directions. No separate payment shall be made for making diversion or arrangements for diverting the traffic. The Contractor shall provide adequate staff to meet with any emergency at all times round the clock.

8.4 Payment

The reinstatement work shall be required to be done by the Contractor only, when permissible by regulations of PEHP MDA. Payment for each road cutting and reinstatement work if required shall be made as per approved tendered rates after restoring the road to the satisfaction of the Engineer. The work of reinstatement of road work shall be subject to the regulations of concerned department of PEHP MDA.

The width of road cutting allowed for payment shall be same as allowed for payment of excavation of trenches. No Extra payment will be made to the contractor for extra excavation of all concrete structure except shows in the drawings.

No separate payment shall be made for making diversion or arrangements for diverting the traffic for the purpose of execution of work.

SECTION – 3

PIPES AND SPECIALS

1. M.S. PIPES

1.1 Mild Steel Specifications

The pipes shall be made of Steel plate / coil X-42 of API standard No. 5 D Grade or PSS-0014-84.

1.2 Chemical Properties and Tests

The chemical composition of the steel shall fall within the following limits:

- Carbon - 0.28% max.
- Manganese - 1.25% max.
- Phosphorous - 0.04% max.
- Sulphur - 0.05% max.

1.3 Mechanical Properties and Tests

- Yield Stress - 42000 psi (min. psi)
- Ultimate Tensile Strength - 60000 psi (min. psi)
- Elongation on Gauge - 27 (min. %)

1.4 Standard Specifications

For sampling testing & tolerances limits, specifications No. AWWAC-200-80 shall be followed.

1.5 Thickness of Plates / Coil

Thickness of plate / coil shall be as specified in the respective items in the BOQ. All plates used shall be free of surface defects.

1.6 Pipe

The term pipe signifies a hollow cylinder made of M.S. Steel plate / coil of uniform internal dia. & having a uniform thickness of wall throughout its length.

1.7 Diameter

The internal diameter of the pipes shall correspond to the net specified diameter after protective lining.

The outside diameter of the body of the pipe as measured by taping the circumference shall be uniform.

1.8 Lengths

Pipes shall be finished in uniform lengths.

1.9 Straightness

The pipe shall be straight.

1.10 Ends

The ends of the pipe shall be so formed that when pipes of the same class and diameter are welded or jointed together to form a continuous straight conduit with a smooth & uniform interior surface.

1.11 Joints

Joints shall be welded as per AWWA specifications.

1.12 Manufacture of Pipes

Before starting production of M.S. pipes the contractor shall furnish the following manufacturing procedure. This procedure shall include but not limited to the following information.

i) Material quality, full details and checks analysis including residual elements.
ii) Material manufacturing details.
iii) Method of plate / coil forming.
iv) Welding procedures, including procedures for skelp welding.
v) Method & degree of coil expansion where applicable.
vi) Method of straightening, sizing and hydrostatic testing.
vii) Inside diameter.
viii) Quality control and Inspection procedures. The submitted procedures and any agreed modifications shall be strictly followed in the production of pipes. The pipes shall be spirally welded with at least two welding passes, one of which shall be on the inside. The Contractor may propose straight welding for pipe manufacturing. This should be clearly mentioned in the tender submitted by the Contractor.

The Contractor shall submit all manufacturing procedures and qualification tests result to the Engineer for approval before the total production has exceeded 20 pipes. In the event test results are not available before production has exceeded 20 pipes, the contractor shall stop production and not restart until all test results have been approved by the Engineer.

The Engineer shall witness the manufacture and testing operation of desired quantity of pipes to verify compliance with the agreed procedure.

1.13 Internal Protection of Pipes – Cement Mortar Lining

The internal cement mortar lining shall be applied in-situ of cement, sand, mortar 1:3 after completion of laying and backfilling of pipeline in trench, in continuity, in one course or more, by electronically driven lining machine traveling through pipe and centrifugally distributing the mortar uniformly across the pipe. The discharge shall be from the rear of the machine so that machine will be continuously fed with mortar by train of intermediate loading machine fed by Power Loader and high speed electric mixers, to achieve desired standard of lining.

The rate of travel of machine and rate of mortar discharge shall be mechanically regulated to produce a smooth surface and uniform thickness throughout. The lining machine shall have electronically controlled rotary trowels for smoothing of the lining so as to obtain William Hazel Coefficient in range 130-140. The mortar shall be densely packed and adhere wherever applied, there shall be no injurious rebound.

1.14 Lining Material

a) Sand

Sand shall consist of inert granular material. The grains shall be strong, durable and uncoated. The sand shall be well graded and shall pass a No. 16 mesh screen, with not more then fiver 5 percent passing a No. 100 Sieve.

Graded sand will be bagged to ensure 1:1 mix while feeding the mixer.

Sand shall be clean and free from injurious amount of dust, clay, lumps, shale, soft or flaky particles, mica, loam, oil, alkali and other deleterious substances. The total weight of such substances shall not exceed three percent of the combined weight of the substances and the sand that contains them.

b) Portland Cement

Portland cement shall confirm to type I or type II of ASTM C150 or shall be as otherwise specified by the Engineer.

c) Water

Water for mixing mortar shall be clean and free of mud, oil and injurious amounts of organic materials or the deleterious substances. Potable water shall be used.

1.15 Mix for Lining

a) Composition

Mortar for lining shall be composed of cement, sand and water that have been well mixed by the concrete mixer and shall be such consistency as to produce a dense, homogeneous lining.

b) Proportions

The approximate proportions of cement and sand in the mortar for the lining shall be 1 part of Portland cement to 1 part of sand by volume. The exact proportions shall be determined by the characteristics of the sand used as approved by the Engineer.

c) Water Content

The water content shall be the minimum that produces a workable mixture, with full allowance made for moisture collecting on the interior of the pipe surface.

d) Mixing

Mortar shall be mixed long enough to obtain maximum plasticity. The mortar shall be used well before initial set.

1.16 Thickness of Lining

The lining shall be uniform in thickness within the allowable tolerance, except at joints or deformations in the pipeline, at which places also the thickness shall be as uniform as possible to the satisfaction of the Engineer. Cement Mortar Lining thickness shall be as specified by AWWA C602-83 and approved by the Engineer.

1.17 Curing

Curing operations shall begin immediately following completion of the machine placement of the mortar lining in a section of pipeline. The selection of pipe shall be closed with airtight cover over all openings and shall be maintained in a moist condition.

When a section of pipeline has been completed, the Contractor shall be responsible for careful curing of the mortar lining until the Engineer fills the section with water, or until the lining work has been accepted by the Engineer, but in no case for less than seven days.

1.18 Cleaning of Pipe for Lining

The interior surface of pipe to be lined shall be cleaned to remove corrosion products, chemicals or other deposits, loose and deteriorated remains of old coating materials, oil, grease and accumulations of water, dirt and debris. Shot or sand blasting is not required to prepare surface for lining.

1.19 Machine Application of Mortar Lining

The lining shall be applied in one course or more by machine traveling through the pipe and distributing the mortar uniformly across the pipe. The discharge shall be from the rear of the machine so that the newly applied mortar is not marked. The rate of travel of the machine and the rate of mortar discharge shall be mechanically regulated to produce a smooth surface and uniform thickness throughout to the satisfaction of the Engineer. The mortar is density packed and adheres wherever applied; there shall be no injurious rebound.

1.20 Guarantee and Performance Criteria

Internal Cement Mortar Lining should be got done by an approved and specified firm, who must have proven past experience in machine application of cement mortar lining. During the warranty period if any damage occurs because of lining defect it shall be got rectified by the specialist company at no cost to the Employer. 15 years written warranty would be required to be provided by the specialist company with proven record. The Contractor will be allowed cement lining for individual pipes and specials in case of inclined or vertical length or for start length of pipes.

1.21 Payment

Payment for the internal cement lining and external protection of the steel pipeline shall be made for the acceptably completed work as per specifications at the approved tender rates, which shall include all costs for labor, material and equipments etc.

2. MILD STEEL SPECIALS

2.1 General

The specials like bends; tees etc. to be used shall be manufactured with mild steel plates of specified thickness. Internal diameters shall be as given on the drawings or as directed by the Engineer. The Contractor shall submit shop drawing for all special before the manufacturing of special.

2.2 Quality of Steel

- **Chemical Properties**

  All collars and specials shall be made from steel, the analysis of which shows not more than 0.06% of sulphur or phosphorous.

- **Physical Properties**

  The steel shall comply with the requirements as described for M.S. Pipes.

2.3 Diameter

The internal diameter of the specials and collars shall be as specified for pipes or as approved and directed by the Engineer.

2.4 Joints

The specials shall have standard flanges with holes at both ends and nuts and bolts with matching flanges provided with pipes. Plain ended bends shall be provided where specified for making weld joints or as approved and directed by the Engineer.

2.5 Length / Width

Length of each special and the width of the collar shall be as shown in drawing or approved and directed by the Engineer.

2.6 Coating

The internal and external coating for specials for rising main shall be same as provided for M.S. Pipes.

2.7 Tests

The specials and the pipes shall withstand a pressure of 61 meters.

2.8 Payment

The rates quoted for M.S. specials shall include cost of providing for material, labor, equipment including cost of cutting, rolling, levelling, chamfering, welding, drilling holes in flanges etc. complete including internal and external protection similar to M.S. Pipes mentioned in these specification cement lining. Payment shall be made as per tendered rates.

3. VALVES

3.1 He valve body shall be made of cast iron of good quality from approved manufacture. The metal of casting shall be strong, tough, even grained, smooth surfaced and free from all defects without plugging or filling. All valves shall be flanged and conform to the dimensions of specials, fittings and pipes to be supplied and installed by the same Contractor. All valves shall be designed for a working pressure of not less than 100 psi and tested by hydro-statistically to a pressure of 200 psi. The marking cast on the body of calve shall indicate manufacturer's name, size of valve and designated working water pressure. Asphalt varnish shall be applied to the ferrous parts of the valve except bearing surfaces. Jointing material including nuts, bolts, washers and rubber packing shall be supplied in quantities required plus 10% extra.

3.2 Sluice Valves

The sluices valves shall be in general conform to the requirements of BS 5163. The sluice valve shall provide an unobstructed waterway of same nominal diameter as of connecting pipe. The valve shall be provided with bronze seats accurately machined and fitted. The spindle shall be non-rising and shall be of solid forged bronze with a tensile strength of 28 to 30 tons per sq. in. shaped properly and machined all over with strong square threads to suit valve nut. The stuffing box shall be deep, large and liberal and capable of packing under pressure. The stuffing shall be properly packed and ready for service when delivered. The stuffing box packing shall be made of asbestos. Hemp or jute packing shall not be used. The valve shall be provided with cast iron cap for manual operation of the valve through key. One operating key of length of 3.28 ft shall be supplied free of cost. The valve shall open anticlockwise and close clockwise direction.

3.3 BUTTERFLY VALVES

(Manually Operated) (Direct mounted Worm gear, Clockwise rotation to close).

- All butterfly valves shall be of the double flanged, rubber sealed, droplight closure type.
- Valve shall be drop-tight at rated pressure with flow in either direction and shall be satisfactory for duties involving flow regulation and frequent operation.
- Valve shafts shall be of stainless steel operating in self lubricating bushes. Shaft seals shall be designed for the use of standard split -V type packing or 'O' ring seals. The design of the shaft seal shall be such as to allow replacement of seals without removing the valve shaft.
- Disc seals shall be removable and made of high quality nitrile rubber attached to the disc edge by a retaining ring.
- Disc shall be of ductile iron and have curve streamlining to minimize the head loss. Seat shall be of red brass and secure to valve body by corrosion resistant screws.
- The valve body shall be of Mehanite cast iron and shall be capable of with-standing a test pressure of 10 bars without leakage.
- Bearing shall be of special type self-lubricating to carry the stub shafts and shall be designed to ensure good bearing performance at maximum hydraulic head.

3.4 Gate Valves

Gate valves shall generally comply with BS 5163. Valves shall be of the non-rising stem type with flanged ends to BS 4504 PN 16. The body, wedge, bonnet, stuffing box, gland and thrust bridge shall be of best quality cast iron to BS 1452 Grade 14, the seats, nut, faces and guides of gunmetal to BS 1400 Grade LG2-C and the stem of forged bronze to BS 2872 Grade CZ114. Each valve shall have a drain plug fitted at the bottom of its seating along with proper

arrangement of disposal of drain water. Stuffing boxes shall be designed to have soft packing fitted. Valves shall be rated for 20 bar maximum working pressure with the bodies capable or withstanding a test pressure of 30 bars and the seat 20 bar without leakage.

3.5 Air Release Valves

Air release valves shall be of 4 inches and 6 inches diameter double acting float type having a cast iron body and bolted cover, bottom inlet, a ball float and valve operating mechanism. The float and all parts of the valve and operating mechanism shall be made of non-corrodible materials. Every valve must be tested to required pressure before installation. All air valves shall be fitted with isolating gate valves of 4 inches and 6 inches diameter.

4. PAYMENT

No advance payment shall be made to Contractor except as allowable under the conditions of contract. Part payment will be allowed for material at site brought or imported and transported to Contractor's store at site approved by Engineer duly provided with watch and ward and protection arrangements.

SECTION – 4

LAYING AND JOINTING OF PIPES, VALVES AND FITTINGS

1. SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plants, equipments, appliances labor and materials in performing all operations in connection with construction of Water Supply, Sewerage and Drainage System for PEHP MDA.

2. ALIGNMENT AND GRADE

The Contractor shall follow the alignment and grade as given in the drawings and approved by the Engineer.

3. PIPE LAYING

3.1 All pipes shall be examined for defects before lowering in the trench. Defective or damaged pipes shall not be used. Pipes shall be handled carefully so as not to damage them in any way. Wide slings shall be used. The pipe shall be laid as per instruction of the manufacture and directions given below.

Each pipe immediately before being laid shall be carefully brushed out and tested for soundless. Each pipe shall be laid accurately to line and levels so that except where horizontal and vertical deflection is required as per drawings or directions of the Engineer, the finished pipeline shall be in a straight-line both in horizontal and vertical planes. Pipes shall be laid upon an even bed of well compacted bed of granular material as shown in the drawing and specified for the full length of each pipe, extending for the full width of the trench and with sufficient material at the sides to permit the pipes being marked on the bed and firmly supported to true line and level. Sufficient space should be left to enable the field joints, tested and inspected but the Contractor shall ensure that at least three quarters of the pipe length is fully supported. After the pipeline has been tested and approved by the Engineer or his representative, the space left out at the joints should be carefully filled with granular or concrete bedding. Each pipe shall be laid in such a manner as to prevent the in-grass of sand, mud or other deleterious materials. The open ends of pipes shall be suitably protected at the end of each days work or whenever a pipe end is left unattended, to prevent any foreign matter gaining access to the pipes.

3.2 Granular Bedding for Pipes

Where directed by the Engineer, the pipes shall be laid by the Contractor on granular bedding. This bedding material shall consist of broken stone or gravel mixed with coarse sand. The material shall be graded from 20mm to 5mm, all passing 20mm sieve and not more than 20% passing 5mm B.S. sieve. The thickness of the bedding material below the pipe shall be 150mm or as specified and directed by the Engineer. It shall be laid in full width of the trench in layers not exceeding 150mm in thickness and shall be thoroughly compacted with an approved type of vibrating plate or light vibrating roller. After pipe laying and if directed by the Engineer, further granular bedding material shall be placed and compacted in a similar manner to fill the entire space between the pipe and the undisturbed sides of the trench upto specified depth.

If the granular bedding material is contaminated by water, sewage or collapse of the sides of the trench, it shall be removed and replaced with new material before the pipes are laid or relaid.

3.3 Concrete Surround and Bedding for Pipes

The pipes shall be encased in reinforced cement concrete of nominal mix 1:2:4 at Nullah or road crossings as per directions of the Engineer. The minimum thickness for the concrete surround shall be as shown in the drawings.

The pipes shall be laid on a reinforced cement concrete bed of nominal mix 1:2:4 at locations where directed by the Engineer. The concrete shall be laid on well-compacted and leveled bed. The reinforcement steel shall consists of 10 bars of 12mm diameter as shown in drawing to the entire length of pipe to be encased and cross stirrups of 10 mm at 1000 mm centre to centre.

The material used in the concrete, method used in mixing, laying and curing etc. of the concrete shall be as described under the section 5 “Concrete”. The reinforcement steel has confirmed to the requirements given to Section 6 of reinforcement steel.

4. VALVES

All valves shall be laid and jointed as shown on the drawings or as per manufacturer’s specifications.

5. VALVE CHAMBERS

Valves shall be housed in R.C.C. chambers to be constructed by the Contractor. These valve chambers and method of assembly shall be as shown in the drawings or as directed and approved by the Engineer. All manhole covers and frames in the slab of chambers of size 600mm x 600mm shall be of cast iron of robust construction and suitable for heavy duties and provided with locking arrangements.

6. CONCRETE THRUST BLOCKS / ANCHORAGES

Concrete thrust blocks and cradles shall be constructed of 1:2:4 cement concrete or as directed by the Engineer. Concrete thrust blocks of adequate sizes shown in drawing or directed by the Engineer shall be provided at all tees and bends. Thrust blocks shall be poured against proper formwork or against undisturbed earth where possible and approved by the Engineer. The concrete shall be cured for minimum 7 days by keeping the surface wet. All forms shall be removed prior to backfilling.

7. HYDROSTATIC TESTS (Water supply System)

Hydrostatic tests shall be performed as per AWWA C-200-80 for 61 meters = 6.0 bar test pressure.

a) The test pressure shall be held for not less than 15 Minutes

The test information shall be recorded on a suitable recording chart. The pipeline shall be manually cleaned of all debris, stones and sand prior to laying, jointing and hydraulic test. Pipeline and pipe work shall be subjected to hydraulic pressure tests in the presence of the Engineer. Such tests shall comply with BS 8010 or CP 312, unless otherwise specified. Testing shall be carried out in two stages.

Test of sections as construction proceeds.
A final test of the whole of the pipe work or pipeline on completion.

The Contractor shall provide all plant, equipment, fittings etc including water, necessary for the hydraulic test. He shall inform the Engineer, well in advance of the time for tests, details of his proposals including the supply of water, its source and method of conveyance. No connections to the pipeline or pipe work which would involve cutting, tapping or altering the Permanent Works, shall be allowed.

Test gauge shall be of approved manufacture having dials at least 200 mm diameter, graduated such that the test pressure is at least 75 % of the full scale reading. If necessary different gauges shall be supplied for different pipeline sections. Two gauges of each type shall be provide for the sole use of the Engineer and shall remain in the Engineer's possession for the duration of the Contract.

7.1 Test Procedure

Each section of the pipeline or pipe work to be tested shall be capped or blanked off at each end and securely strutted or restrained to 'withstand the forces that will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Hydrants, washout valves and isolation valves shall be fitted with blank flanges and these together with in-line valves shall be left open. Air valves already fitted shall be permitted to function during the test. The air valve manufacturer's confirmation shall be obtained that the valves are capable of withstanding the test pressure involved.
Proposals for testing where thrusts on structures are involved, even where thrust collars on the piping are installed, shall be submitted, with the calculations of the forces to be carried, to the Engineer for approval.
The Contractor's proposed method of filling the pipeline or pipework with water shall be approved by the Engineer. The sectional length under test shall be filled making certain that all air is displaced through an air valve installed at the high end of the line. The section shall then remain under constant pressure - 10 to 20 m head of water - for a period of several hours until the pressure can be maintained without additional pumping. Pipes of materials liable to absorb water, eg concrete lined pipes shall be allowed to become saturated under this moderate pressure for 24 hours.
The pressure shall then be slowly increased to the full test pressure and pumping discontinued for 3 hours or until the pressure has dropped by I0 m, whichever occurs earlier. Thereafter pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped to restore the pressure shall be the measure of leakage from discontinuation of pumping until its resumption.
The pipe section shall pass the test if the leakage is not more than 0.35 litre per mm of pipe diameter per kilometer per 24 hours for each 100 m head of pressure applied.
Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the

hydraulic test.

No pipeline shall be accepted until and unless the leakage of any section of the pipeline tested is not more than the rate of leakage specified above and all sources of discernible leakage have been rectified.

Pipelines shall be tested as above except where the Engineer issues such instructions as are necessary for testing parts of the Works that have been designed for stresses limited by consideration other than those applying to the pipeline system.

7.2 Test Pressure

Test pressure is to be measured at the centre of the blank flange situated at the lowest end of the pipeline under test. Unless otherwise specified or shown on the drawing all pipelines and pipe work shall be tested at a pressure 6.0 bar or as determined by the Engineer.

The contractor shall submit a schedule of pipeline test pressures to the Engineer for approval prior to commencing testing.

7.3 Sectional Hydraulic Test

The Sectional Hydraulic Test shall be carried out after the pipeline or pipe work section to be tested has been laid, jointed and backfilled to a depth sufficient to prevent flotation of the pipeline, but leaving the joints exposed. The sections to be tested shall be to the approval of the Engineer and shall be not longer than 2,000mor 500 m when either the pipeline is laid adjacent to or underneath the carriageway. The joints between each tested section shall be left exposed until the pipeline has passed the Test on Completion:

8. HYDRAULIC TEST ON COMPLETION

The test on completion shall be carried out after all the pipeline or pipe valve sections have been joined together on completion of sectional testing. The joints between sections shall be backfilled once the test is satisfactorily completed.

9. DISINFECTION & CLEANING OF PIPE

9.1 Disinfecting Water Mains

Applicable procedures for disinfecting new and repaired potable water mains are presented in standards such as ANSI/ AWWA C651, Disinfecting Water Mains.(8) ANSI/ AWWA C651 or equivalents uses liquid chlorine, sodium hypochlorite, or calcium hypochlorite to chemically disinfect the main. Disinfecting solutions containing chlorine should not exceed 12% active chlorine, because greater concentration can chemically attack and degrade pipes

9.2 Cleaning

Pipelines operating at low flow rates (around 2 ft/sec or less) may allow solids to settle in the pipe invert. Upvc has a smooth, non-wetting surface that resists the adherence of sedimentation deposits. If the pipeline is occasionally subject to higher flow rates, much of the sedimentation will be flushed from the system during these peak flows. If cleaning is required, sedimentation deposits can usually be flushed from the system with high pressure water.

Pressure piping systems may be cleaned with the water-jet process, or may be pigged. Pigging involves forcing a resilient plastic plug (soft pig) through the pipeline. Usually, hydrostatic or pneumatic pressure is applied behind the pig to move it down the pipeline. Pigging should employ a pig launcher and a pig catcher.

9.3 Payment for Testing, Disinfection and Cleaning of Pipelines

No separate payment will be made for pressure and leakage testing of pipelines for the supply of clean water and all necessary testing apparatus, pumps, gauges and pipe-works, the cost of supervision and labour in testing and retesting, if necessary and all other work, materials and equipment in complying with the requirements of testing of pipelines.

9.4 Measurement and Payment

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules.

9.5 Measurement

Pipes shall be measured in linear meter, their lengths the net length of the pipe as laid, after deduction of the length of overlap at any spigot and socket joint to be made with the pipe. Plain ended pipe shall be measured and paid by effective length as laid.

9.6 PAYMENT

Payment shall be made for the acceptably completed pipeline valves, fittings, granular, bedding valve chambers and concrete thrust block laid in accordance with the specifications, drawings and directions of the Engineer including all costs for labor, materials, equipment, transportation, handling, testing and disinfection complete at the approved tender rates.

SECTION – 5
CONCRETE

1. SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing of all plant, 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 Cement

i) All cement used under this Contract shall be S.R Cement.

ii) Sulfate Resistant Cement shall be normal where required shall conform to Pakistan Standard Specification PS No. 612:1967 or BS 4027 and satisfying to requirements for fineness, chemical composition, strength, setting time and soundness etc.

iii) The average compressive strength of three mortar cubes prepared with 1:3 cement and standard silica sand shall be not less than 155Kg/sq cm. in at three days and not less than 239 Kg/sq cm. in at seven days.

iv) The initial setting time shall not be less than 45 minutes and final setting time not more than 10 hours.

v) The supply of cement must be so programmed by the Contractor that at no time the quantity of cement stock shall be less than that required for an average consumption of four weeks, lorry or truck or other means of transportation, for the conveyance of cement to the site of works, shall be clean, dry, metaled lined and covered from top with water proof sheets, so that cement is sufficiently protected from any deterioration during transit. The Contractor shall provide at his own cost on the site all necessary sheds which shall be perfectly dry and water tight for the storing of cement delivered to the works to ensure adequate supplies being available for the works.

vi) If at any time Engineer or his Representative considers that any batch of cement may have deteriorated on the site during storage for any reason, he will direct that tests shall be made and the batch of cement on the site which may be in question shall not be used until it has been shown by test at a laboratory, approved or appointed by the Engineer to be satisfactory. Contractor shall bear all costs of such testing. The Contractor without delay shall remove any rejected cement from the site. Cement reclaimed from cleaning bags or leaking containers shall not be used.

vii) Cement shall be consumed in the sequence of receipts from factory unless otherwise directed by the Engineer or his Representative.

viii) The total acid soluble alkali content {$Na_2O+0.658k_2O$} of cements determined in accordance with BS 4550. Part-2 shall not exceed 0.60% by weight, except where otherwise approved or required.

3.2 Aggregates

i) All fine and coarse aggregates to be used shall be supplied from approved sources, which shall not be changed without permission in witting from the Engineer. Aggregates shall conform to the test requirements of Pakistan Standard 243:1963 or equivalent or B.S 5882.

ii) Fine aggregates, shall be approved sand and shall be clean, sharp, free from clay, earth, vegetable and organic matters, alkaline or acid reactions or other deleterious matter or impurities.

iii) Fine aggregates shall conform to Pakistan Standard Specifications PS No: 243:1963 "Natural Aggregates for Concrete" and shall be graded as follows:

BS 410	Percentage by weight passing	
	Grading Zone – I	Grading Zone – II
3 / 8” (9.5 mm)	100	100
3 / 16” (4.8 mm)	90 – 100	90 – 100
No. 7	60 – 95	75 – 100
No. 14	30 – 70	55 – 90
No. 25	15 – 34	35 – 59
No. 52	5 – 20	8 – 30
No. 100	0 – 10	0 – 10

iv) Coarse aggregates shall be approved or hard crushed stone from a source approved by the Engineer and shall be clean, free from sand, dust, salt, lime, chalk, clay organic impurities or other deleterious matter.

v) Coarse aggregates shall conform to the relevant Pakistan Standard Specifications PS NO. 243:1963 coarse aggregate shall be graded as follows:

FOR CONCRETE 1:1-1 / 2:3 and 1:2:4 (Nominal Size of Graded Aggregates 3 / 4" to 3 / 16" (19 mm to 4.8 mm).

B.S. SIEVE NUMBER	PERCENTAGE BY (WEIGHT) PASSING
1" (25.4 mm)	100
3 / 4" (19 mm)	90 – 100
3 / 8" (9.5 mm)	20 – 55
3 / 16" (4.8 mm)	0 – 10

FOR CONCRETE 1:3:6 or 1:4:8 (Nominal Sizes of Graded Aggregates 1-1 / 2" to 3 / 16" (38 mm to 4.8 mm)

1-1 / 2"(38 mm)	100
1" (25.4 mm)	95 – 100
3 / 4" (19 mm)	35 – 70
3 / 8" (9.5 mm)	10 – 33
3 / 16" (4.8 mm)	0 – 5

vi) All aggregates shall be stored on properly constructed paving and in bins and there shall be a physical Partition between the stockpiles of coarse and fine aggregates. No mixed up aggregate shall be used in any concrete. Under no circumstances aggregates shall be allowed to be in contact with ground.

If required, the aggregates shall be washed and screened to the satisfaction of the Engineer before use. Adequate time shall be allowed for the moisture content to become substantially uniform before use in works.

vii) Sieve analysis and other necessary tests of all aggregates shall be carried out as and when required by the Engineer. Samples for such tests shall be taken in presence of Engineer. All costs in connection with the test shall be borne by the Contractor.

viii) If suitable gravel meeting with the specification is not available the Contractor will arrange suitable crushed stone conforming to the specifications. No extra payment will be made to the Contractor for this aggregates or crushed stone.

ix) Water absorption of aggregates shall not exceed 2% and mechanical strength (Measured by the Aggregate Impact Values) shall exceed 25%.

x) Marine aggregates will not be permitted and all aggregates shall not contain applicable amounts of flaking and or elongated particles.

xi) The amount of dust material passing B.S. No.200 sieve (75 micron) in the combined aggregates shall not exceed 6% by weight for fine aggregates and 1% by weight for coarse aggregates.

xii) Aggregates for granolithic concrete shall be all in granite aggregate complying with B.S 882 and be 10 mm nominal size.

xiii) All aggregates shall be subject to the approval of the Engineer. Any aggregate not found to the required standard shall be rejected by the Engineer or his representative and shall have to be removed from Site without delay. Concrete structures executed and rejected shall be dismantled and rebuilt at the Contractors expense.

3.3 Water

Water shall be free from all suspended or dissolved impurities. The water used for concrete shall be generally fit for human consumption. If required water shall be subject to standard testing at Contractor's expenses and if found unsuitable for construction the Contractor shall take suitable action as directed by the Engineer or his representative(s).

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:

Nominal Min. Ratio	Min. Qty. of Cement		Preliminary Cube trength				Work Cube Strength			
			At 7 days		At 28 days		At 7 days		At 28 days	
	Lbs. Per 100 Cft.	Kg / Cum	Lbs / Sq. in	N / Sq mm	Lbs / Sq. in	N / Sq. mm	Lbs / Sq. in	N / Sq. mm	Lbs / Sq. in	N / Sq. mm
1:1½:3	2520	404	3350	23.4	5000	35	2500	17.5	3750	26.2
1:2:4	2016	323	2700	18.9	4000	28	2000	14.0	3000	21.0
1:3:6	1344	216	1300	9.1	2000	14	1000	7.0	1500	10.6
1:4:8	1008	161	550	5.9	1350	9.4	650	4.5	1000	7.0

5. PROPORTIONING OF CONCRETE MIXES

All concrete shall be proportioned by Volume for design of concrete mixes, unless specifically directed by 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 aggregate 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.

5.1 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 the Engineer before the start of concrete work shall be approved this ratio.

5.2 Slump Test

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

6. MIXING

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

Nominal	Cement	Sand Cft.	Coarse Aggregate Cft.
1:1½:3	110 Lbs 50 Kgs	1-7 / 8	3-3 / 4
1:2:4	110 Lbs 50 Kgs	2½	5
1:3:6	110 Lbs 50 Kgs	3-3 / 4	7½
1:4:8	110 Lbs 50 Kgs	5	10

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

a) 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.

b) Mixing time shall be measured from the instant water is introduced into the mixer drum containing all solids.

c) 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.

d) No hand mixing shall be permitted. If during concreting, the Batching plant fails, the concrete already poured shall be removed, unless otherwise directed by the Engineer or his Representative.

e) 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 cubes be tested in laboratory and the Contractor shall bear the charges for the same.

7. TRANSPORTING AND PLACING CONCRETE

a. Concrete shall be conveyed and as quickly as possible after mixing and shall proceed so that, as far as possible, a complete section of the work is done in one operation. Concrete, which has attained its initial set or has contained its mixing water for more than 30 minutes shall not be allowed to be placed in the works.

b. Transport of concrete shall be in a manner approved by the Engineer's Representative and shall be so as to avoid segregation or loss of ingredients of concrete.

c. The Engineer's Representative shall approve all foundations and portions of work to be concreted before concrete is poured.

d. All forms and reinforcement shall be completed, cleared inspected and approved before pouring of concrete. No concrete is to be poured 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 formwork, 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 of 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.

e. 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 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.

f. Hardened concrete, debris and foreign material shall be removed from interior of forms and from inner surface of mixing and conveying equipments.

g. 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.

h. 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 forms with pockets, which 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.

i. 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 laid.

j. 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.

k. 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.

l. 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 deg. C and below 35 degree F 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.

m. 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.

n. 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.

o. 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.

8. PROTECTION AND CURING

All exposed concrete shall be cured. Curing shall be accomplished by preventing loss of moisture, rapid temperature changes 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, which shall be kept continually wet. If required and so directed by the Engineer or his Representative, keeping all forms continually wet shall also cure formed surfaces with forms in position.

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-washable paints to indicate the date of placing concrete. During hot weather, curing shall be done even at night.

9. FORMWORK

a. General

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

b. Making Forms

The formwork for all concrete work to be cast in situ shall be made of steel or other approved material for all works. These forms work 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.

c. 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 form work 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.

d. Materials and Labour

The Contractor shall supply all materials and labour, necessary for a good and speedily erection of form work 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.

e. 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.

f. Joints in Formwork

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

g. Treatment and Inspection of Forms

All rubbish particularly chipping, shavings and sawdust 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.

h. Removal of Shuttering

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

Removal of Shuttering	Cold Weather Days	Normal Weather Days
Beams sides, walls and Columns (unloaded)		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.

i. 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, centering and supports, and any advice, permission or approval given by the Engineer or his Authorized Representative, related to the removal and striking of forms, centering and supports shall not relieve the Contractor from the responsibilities herein defined.

j. Treatment after Removal of Forms

Any minor surface honeycombing or other irregularities are to be properly made good immediately upon the removal of 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.

k. Form work 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 precast and subsequently fixed in position.

10. 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.

11. PLACING STEEL REINFORCEMENT ON FORM WORK

11.1 Clear cover to main reinforcement in concrete members be as follows :-

For slabs, projections, chajjas, fins, walls, staircases precast slabs.	19 mm
For beams, Columns, all members of water retaining structures on the side in contact with water.	37 mm
For foundations, retaining walls, and foundation beams.	50 mm

11.2 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 holes shall be allowed in walls of water retaining structures and earth retaining walls.

12. WATERPROOF 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.

13. 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 eg. External surfaces of sump or wet well or screening chamber shall be fairly smooth for application of water proofing treatment. Other surfaces may be rough form finish.

14. 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 chambers and concrete work required for reinstatement of drains dismantled / cut for laying pipes across the drains. This shall be deemed to have included in the lump sum rate of chambers and concrete work required for reinstatement of drains dismantled / cut for laying pipes across the drains quoted by the Contractor.

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

SECTION – 6
REINFORCEMENT STEEL

1. SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all materials, tools labors and in performing all operations in connection with the providing, straightening cutting, bending, binding, fixing including binding wire, chairs, pins, spacer block complete in strict accordance with this section of the Specifications, the applicable drawings, approved bar bending schedule, and the terms and conditions of the Contract.

2. MATERIALS

Reinforcing steel shall be new billet stock of mild steel (Plain bar) hard grade (deformed bar) and Ribbed Tor Steel as specified on the drawings and shall be obtained from the approved manufacturer and shall conform to British Standard Specifications or equivalent ASTM or Pakistan Standard. It should comply with BS. 4360 and be of No. 1 quality.

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

Mild steel plain bars conforming to B.S.S. 4449 or PS-231- 1962, Hard graded deformed bars conforming to PS-605-1966 and rubbed for steel conforming to BS-4461.

Tensile Strength :- 438 to 517N / mm(28to33 tons / sq.in).
Yield strength :- 250 N / mm^2 (16 Tons / sq / .in).
Elongation :- 16% to 24% (av. - 20%).

Hard grade deformed bars conforming to PS-605-1966.
Tensile strength :- 560 N / mm^2 (35.7 Tons / sq in).
Yield strength :- 350 N / mm^2 (22.3 Tons / sq.in).
Elongation :- $\dfrac{1100\,000 \times \%}{\text{Tensile strength}}$

Ribbed Tor steel conforming to B.S. 4461.
Tensile strength :- 490 N / mm^2 (70,000 lbs / sq.in).
Yield strength :- 420 N / mm^2 (60,000 lb / sq.in).
Elongation :- 14.5 %

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

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. Samples shall be taken from the stocks brought by the Contractor. All under gauge bars shall be rejected. Engineer may allow use of over gauge bars on the condition that only standard weight shall be allowed for such steel bars.

Steel bars for reinforcement of concrete shall comply with the requirements of B.S.4461 for cold worked steel bars Grade 460 / 425 and BS.4449 for hot rolled steel bars Grade 250.

3. 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.

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4. REINFORCEMENT CUTTING AND PLACING

All reinforcement steel shall be cut and bent cold in strict accordance with bar bending schedules approved and drawings supplied by the Engineer. The Contractor shall prepare bar bending schedule from approved structural working drawings and instructions to be provided to him by the Engineer. 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 Contractors 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 chairs as approved by the Engineer 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.

5. LAPS AND SPLICES

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 and in no case shall lap length be less than 40 times the diameter for bars in tension and 35 times the diameter for bars in compression for nominal M.S. bars. Hard grade bars and tor steel shall have laps of 50 time the bigger diameter of lapping bars. Splices of adjacent bars shall be staggered unless approved otherwise by the Engineer or his Representative.

The Engineer Representative shall inspect all reinforcing steel fixed in position and no concrete shall be poured until the Engineer's representative has approved steel placement. For inspection purposes the Contractor shall give to the Engineer Representative reasonable notice before the scheduled pouring time. Clear concrete cover to reinforcement steel shall be as indicated specified.

6. MEASUREMENT AND PAYMENT

Payment for steel reinforcement shall be made on the basis of approved tendered rate for all steel supplied, cut, bend and binded by the Contractor as required and as determined from the approved bar bending diagrams and incorporated in the concrete

and checked and accepted except that no separate payment of steel reinforcement will be made for chambers and reinstate work for drains cut for laying pipeline. This will be deemed to have been included in the lump sump rate of chambers and reinstate work for drains cut for laying pipeline quoted by the Contractor. The weight of plain or deformed bars will be computed from the theoretical standard weight of M.S. bars, in case of oversize bars. If the Engineer allows the use of undersized bars only within allowable tolerance of weight the Contractor shall be paid on the basis of actual weight of bars supplied.

No separate payment shall be made for the spacers, binding wire and chairs etc. not included in the bending schedule.

SECTION – 7

LAYING, JOINTING AND TESTING OF SEWERAGE PIPES

1. SCOPE OF WORK

This Section covers transportation of pipes and accessories to site work, handling, cleaning, lowering in trenches, making alignment, cutting, jointing, fittings, sewer mains including testing and commissioning and handing over / taking over in strict accordance with specifications and condition of the contract or as directed by the Engineer. For specification of pipes, referred to items of Section-I.

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2. ALIGNMENT AND GRADE

The Engineer or his representative(s) shall lay the pipes in trench to the required levels slopes, lines, alignment and grades at the required location, as shown in the drawings or as directed.

3. CLEANING AND CHECKING OF PIPE AND FITTINGS

All pipes shall be brushed and wiped clean before the pipe are laid. Before laying, all pipes shall be inspected for defects and when required by the Engineer shall be tapped with a light hammer to detect cracks. The pipes and fittings if found containing any defects shall be removed from the site to be replaced with defect free items which shall be got inspected in the same way as described above and so on so forth.

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4. BEDDING FOR SEWERS

The sewers shall be laid on proper bedding as specified below.

- In all types of soils above water table and hard soils, which can stand vertical without, support, the sewers shall be laid on approved granular bedding. This bedding material shall consist of broken stone or gravel mixed with coarse sand. The materials grading shall be in accordance with BSS 410, and as described item 2 of Section II. The material should be free from dust, plants or any organic compound etc. The thickness of bedding material below the pipe shall be upto full width of trench and shall be thoroughly compacted upto 95-100 % as per AASHTO Standards after laying pipes, further granular bedding shall be laid and compacted in a similar manner to fill the entire space between the pipes and un-disturbed sides of trench up to a depth as per drawing. Adequate space as prescribed by the Engineer shall however be provided for pipe sockets at required points.

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  If the granular bedding material is contaminated by water, sewage or soil materials due to the collapse of the sides of the trenches it shall be removed from the trench and replaced with new material before any of the pipes are laid or re-laid.

- **Sewer in Soft-Soil below ground water table**

  In case the invert of pipes is below ground water table or stable strata are not available at the pipes invert level, the same shall be supported on the following bedding.

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  a) Concrete bedding: In case the pipe is required to be laid below ground water table where the subsoil is unstable and may cause formation of slush during the excavation and dewatering, a bed of concrete of 1:3:6 shall be provided for laying pipes in the trenches. The thickness of this concrete bed shall be as under:

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  i) 200mm for all sewer pipes upto 300mm internal dia.

ii) 300 mm for all sewer pipes exceeding 300 mm internal dia.

This concrete bed shall be laid over a stone soling 225 mm to 450 mm thick as per instruction of the Engineer.

The concrete bed shall be laid in full width of trench and adequately vibrated as per direction of the Engineer / Engineers representative present at Site. Space shall however be provided for pipe sockets at required places.

After laying pipe sewer, further cement concrete of mix 1:3:6 shall be placed and vibrated in a similar manner to fill the entire space between the pipe and the undisturbed sides of trench upto depth equal to 1 / 4 of the outer diameter of the pipe or as directed by the Engineer in writing depending upon the stability of the strata encountered at each individual location.

The Engineer can however reduce or increase to any required extent the thickness or width of concrete or granular bedding below pipe or depth of granular bedding or concrete on the sides of pipes through instructions in writing and the Contractor shall be paid accordingly.

In case of excessive slush formation in the bed of trench for which the Engineer, who shall be the sole judge, may instruct in writing to lay gravel or stone soling below the bed of concrete. The Engineer shall do this after detailed inspection of excavated trench. The Engineer shall instruct the depth of such bed of gravel or soling in writing before laying the bedding. No payment of bedding shall be made if no such written instruction specifying depth, the Engineer specifies width and length of bedding and its location.

b) Concrete encasing for pipes: when directed by the Engineer in writing, the contractor shall encase (surround) pipe with concrete. The concrete for surrounding the pipes shall be 1:1-1 / 2:3 ratios (grade 30) to the dimensions given in the drawings. As directed by the Engineer, cradle supports shall be provided as under:

i) The cradles shall be 300 mm wide, and a depth minimum of 200 mm. For a length of full width of trenches.

ii) Neither trench sides nor trench timber or sheeting is to be used in lieu of proper formwork to concrete surrounds. All spaces at the sides or in other places shall be filled up with selected fine material and the ground made solid as the work advances. No extra payment will be made for the concrete in excess than as provided.

iii) Concrete shall be placed evenly over the entire width and to within 25 mm of the bottom of the pipe then, without stopping, it shall be placed gently on one side of the pipeline only and carefully worked under the pipe, ensuring that no voids are left under the pipe. The concrete shall be brought up equally on each side of the pipe to the required finished height.

iv) Horizontal construction joints will not be permitted in the concrete surround below half pipe height Vertical construction joints shall be formed only at each pipe joint and must extend through the blinding where appropriate. Diaphragm of approved compressible expansion jointing material cut to the exact shape of the outside face of the pipe and the bedding or surround shall be positioned and supported in contact with the end face of each socket. The contractor shall take precautions to ensure that a firm seat exists between the diaphragm and the end face of the socket and that no concrete intrudes into the joint. Flexible joint at the pipe joint should be provided all along the concrete encasing and concrete bedding as specified by Engineer.

5. PLACING AND LYING

Pipes, specials and fittings where applicable shall be carefully lowered into the trench by means of derrick, rope, slings, or other suitable equipment. Under no circumstances shall any of the pipeline or any materials be dropped, dragged or dumped into the trench. The full length of each section of pipe shall completely rest upon the pipe bed, with recesses excavated to accommodate joints. Pipe that has the grade or joints disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. The sewer pipes shall be correctly laid in correct position, alignment, level and grade and checked so that the invert of the sewer conform to that shown on the drawings and sockets are placed on the place provided for them in the excavation and the complete sewer will have a smooth and uniform inverts. Each pipe shall be inspected for defects before being put in place.

a) In laying out pipes, fittings and specials they shall not be allowed to impede or harm traffic pedestrians or animals or to obstruct paths and access to private other property. Pipes shall not be laid out in beds of watercourses and every precaution shall be taken to preserve their sound and perfect condition before laying.

b) Trench excavation and pipe laying shall proceed in an orderly and continuous fashion working from one end of the pipeline to the other. Piecemeal excavation and pipe laying of isolated lengths will not be permitted prior to written approval of the Engineer. Similarly, manhole / chamber foundation bases shall be correctly proposed to avoid cutting of pipes wherever possible.

c) Laying Pipes alongside existing pipes, service etc.

Where new pipes are to be laid alongside, over or under existing sewer, surface water drains, nullahs, water or gas mains, conduit electric cables or telephone cables, the contractor shall take care to interfere as little as possible with the existing services and connections thereto and the Contractor shall repair, or arrange for the repair of any damage at his own cost to the satisfaction of the utilities owner and the Engineer.

The contractor shall make all arrangements for supporting existing services and for temporarily dealing with the flow from any pipe, drain, nullah, channel, etc. and shall provide all troughs, pumps, plant and material necessary for this purpose without any additional cost.

d) Laying pipe under hedges, fences, walls and near trees

Where hedges are damaged or destroyed, the whole shall be restored and reinstated with two rows of the same kind as the hedges, planted in due season in topsoil 300 mm deep and fenced on each side with post and wire. Stock proof fences finished on top with one strand of galvanized barbed wire, or otherwise protected as required by the owners or occupiers and the Engineer without extra cost.

Where fences or walls are damaged or destroyed, the whole shall be restored and reinstated with like materials to the satisfaction of the owners or occupiers and the Engineer without any additional cost.

e) Laying pipes through water courses canals etc.

Work shall be carried out in such a manner that, in the opinion of the Engineer, the watercourses are left unimpeded and their appearance and use unimpaired. The work shall be so completed that the trench line cannot, in the opinion of the Engineer, be eroded, and water cannot seep

along the trench line.

The top 600 mm of the trench shall be refilled with clay puddle to the watercourse bed level and for at least two maters into each bank.

The pipe line shall be laid with a minimum cover as indicated on the Drawings under the base of water course, canals, etc. and surrounded with concrete for a distance extending into the banks as far as the Engineer may determine at Site. Different types of materials excavated from the bed of the river shall be set on one side separately and after the pipe surround has been completed, the trench shall be backfilled and consolidated in such a way as to restore as far as possible each type of material of which the bed is composed to its original position and state of compaction.

The contractor shall submit Methodology of all temporary works he intends to construct to maintain the flow in watercourse during construction of the works for the Engineer's approval.

Where a pipeline runs parallel to a water course, the distance between the edge of the ditch and the edge of the pipe line trench shall not be less than either the depth of the ditch or the depth of the pipe line trench, whichever is greater.

f) Laying pipes across railways

Where any pipe crosses a railway or work is carried out within railway property, the work shall be carried out in an approved manner and to the requirements and satisfaction of Pakistan Railways and their Engineer.

Details of the method of working and any particulars that Pakistan Railways may request, shall be furnished to their Engineers, and approved by them before work commences. After approval has been received, the contractor shall give written notice to Pakistan Railways of at least one month, or longer if required, of his proposed date of commencing work on any crossing.

6. JOINTING

After a length of pipeline is laid in trench, the pipes, specials, and fittings, shall be jointed in accordance with the recommendation of the manufacturer of pipes.

Both sewer pipes and socketed or collared pipes shall be jointed with rubber ring. Rubber ring shall be mounted on the spigot end, socket of pipe or collar as required and pipe be pushed into socket / collar after lubrication of approved quality as approved by the Engineer in writing, to form a water tight joint. For cut pipes of RCC for sewers the contractor may provide a collar joint for connecting the cut pipes only on written approval of Engineer. The adjacent ends of cut pipes shall be butted together concentrically so that a dowel is left between the two ends. jute or hemp yarn soaked in cement or molten bitumen shall be wound in the dowel space and joint smoothed with cement mortar (one part of cement and 1-1 / 2 parts of fine aggregate). The RCC collar shall be carefully pushed in position and the space between the pipe and the collar shall be filled and adequately caulked with cement mortar 1:1-1 / 2 so that even space appears all round the external diameter of pipe. The work of jointing / working joints shall be done only in the presence of Engineer's representative(s). Any joint not made in presence of Engineer's representative shall be rejected and will have to be dismantled and remade on the Contractor's risk and cost.

The open ends of pipes being laid for sewers after the Contractor shall not leave a day work open. These open ends shall be carefully closed adequately by wooden plug of appropriate size to stop any sand, garbage, debris, insects, animals or water entering into the pipe. No payment shall be made for such plug, which shall be watertight. The cost of providing and dismantling of such plugs shall be deemed to be included in Contractor's rate of laying and jointing of pipes or sewers.

On completion of joints in a section or whole of pipe line, backfilling shall be done for the length of pipes except joints which shall be kept open till the pipes or sewer line is pressure tested and approved.

Unless otherwise detailed, all pipelines shall have approved flexible joints.

All joints shall be sound and watertight when subjected to pressure test and under all working conditions. Before any pipe joint is made, the ends of the pipes to be jointed shall be thoroughly cleaned.

Care shall be taken to ensure that the rubber rings, when finally fixed, shall be concentric with the pipe.

Care shall be exercised to ensure that, with flexible rubber ring joints of all types, the pipe spigots are not driven tight home. The correct space as recommended by the manufacturer, between the spigot end and socket shoulder shall be maintained.

7. CUTTING OF PIPE

The cutting of pipe shall be done neatly without damage to the pipe so as to leave smooth end at right angles to the axis of pipes.

Pipe ends shall be properly shaped for the required joints.

The contractor shall fix all manholes, junctions, in the positions as per drawing or as directed by the Engineer and shall as far as possible select the lengths of pipes to avoid cutting to waste.

8. TESTING OF SEWERS

Non pressure pipe line upto 600 mm diameter shall be tested with air at the completion of each working day, or when 20 meters of pipe have been laid between manholes, or such other length as may be agreed by the Engineer, and shall be tested whilst uncovered. A gauge in the form of a glass U-tube shall be provided and air shall be blown or pumped into the length of the pipe until a pressure of 125 mm of water is indicated on the gauge. Without further blowing or pumping the pressure shall not have fallen below 10 mm after a period of 5 minutes and pipes shall continue to withstand this pressure without further loss and without blowing or pumping for further period of 5 minutes.

After a sufficient length of sewer is laid and required manholes and vent shafts are constructed and enough interval has been allowed for the joint to set, the sewers will be tested for a head of at least 8 meter of water. In addition, the sewer shall be examined for leaks of ground water making its way through the pipes, joints, and manholes or ventilation shafts into the sewers. The contractor shall make the sewers water tight against the infiltration of ground water from outside and also against the leakage of water from the inside of the sewers to the full satisfaction of the Engineer.

Non-pressure pipes shall be tested before any concrete surround or bedding is placed and before commencing any trench refilling.

For infiltration test, water table may be allowed to rise to natural level by stoppage of pumping. No infiltration shall be permitted inside the pipe. No extra payment shall be made to the contractor for such tests and for any work including closing of pipes or removing obstruction. Any work required for the purpose of the required test shall be deemed to have been included in the rate of laying and jointing of pipes. All defective or leaking pipes or joints shall be taken out and replaced and made good by the contractor at his own cost and charges or in the case of any joints that may be defective and cannot be remade, they shall be entirely surrounded externally with cement concrete 1: 1-1 / 2:3 to render the joints water tight and this should be allowed to set before the sewer line is tested again and trench is backfilled.

Non-pressure pipe lines 600 mm diameter and onwards shall be visually inspected internally and a suitable trolley for this purpose shall be provided where necessary.

Allowable infiltration shall not exceed 0.5 liters / linear metre of nominal bore in 30 minutes provided that there is no discernable flow of water entering the pipe line, which can be located by inspection.

In case any leakage observed during pipe testing, the contractor is wholly responsible to replace or make the pipe line water tight on his own risk and cost as per specification or otherwise as per Engineer's satisfaction. A strong color should be added to the water used for testing pipes in order that any leakages may be

more easily detected. No connection with the existing sewer or sewage pumping station shall be made until the new sewers laid are tested as described above.

9. CLEANING OF EXISTING SEWERS

The Contractor is first required to check the completion of the following works before taking in hand the work of cleaning of existing branch sewers:

a) Laying, jointing and testing of new sewers.
b) Construction of sewage pumping station.
c) Providing, installing and commissioning pumping machinery, valves, special and manifold.
d) Laying and jointing of rising main.
e) Testing of pumping machinery and rising or pressure main.

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On completion of work of testing of new sewers and issue of certificate of the Engineer for satisfactory completion of the work of laying of new sewers, the Contractor shall start the work of cleaning of existing branch sewers before making connection with the new sewers. The Contractor shall undertake the following steps:

i) Each branch sewer shall be cleaned one by one.

ii) Portable dewatering / sewage pumps of adequate capacity with stand-by shall be installed at the last manhole of the branch sewer connecting with existing trunk sewer and pumping of sewage shall be done by the Contractor continuously.

iii) As the sewage level in the manhole goes down, cleaning of the manholes shall be done manually to avoid damage. The manholes shall be cleaned of all debris, sludge and any other matter lying inside while continuous pumping of sewage is done to avoid rising of sewage level. The Contractor shall provide adequate safety equipment and light for the safety of his labour and staff. The Contractor shall be fully and solely responsible for the safety of his labour and staff and shall be wholly responsible for any mishap, damage or loss for any reason whatsoever.

iv) The Contractor shall carry out rodding of the sewers after the manholes on the branch lines are cleaned. The Contractor shall provide all rodding equipment for cleaning of sewers.

v) The Contractor shall arrange for disposal of pumped sewage into the existing trunk sewer or new main sewers. The disposal of this pumped sewage into new sewers shall be done only after testing of the whole new system and electric connection is obtained and new pumping station, sewers and rising main are in full operation.

vi) The Contractor will however be allowed to obtain if possible mechanical sewer cleaning equipment from PEHP MDA on payment of hire charges to be determined by City district government official for pumping sewage or removal of sludge but the debris from manholes will have to be removed manually. The availability of such equipment cannot be guaranteed by from PEHP MDA.

vii) The Contractor shall carry out all necessary and miscellaneous repairs to the existing manholes including replacement of manhole covers as instructed by the Engineer.

viii) On satisfactory completion of cleaning each branch sewer and written approval by the Engineer, the Contractor shall connect this cleaned branch sewer to the new main sewer through additional length of sewer. The payment for this additional sewer including excavation, dewatering laying and jointing of sewer pipes will be done on the rate applied for laying new sewers as per BOQ.

ix) In case of serious clogging of branch sewers, the Contractor shall locate the damaged part of sewer and replace this sewer on written authority of the Engineer and lay the required portion of the damage sewer as new sewer on the basis of rates provided in the BOQ and get it tested as per specification.

x) On completion of cleaning of one branch sewer, the Contractor shall start work on other branch sewers utilizing the experience gained on previous sewers till all the branch sewers are completely cleaned. repaired and connected to the new main sewers.

10. CONSTRUCTION OF MANHOLES AND VENT SHAFTS

Contractor shall construct the manholes and vent shafts in positions as shown in drawings or where otherwise directed by the Engineer. The work of construction of manholes and vent shafts shall proceed along with the work of laying of sewer pipes. The timbering steel sheet piling and other side supports of trenches shall not be removed, dewatering for trenches shall not be stopped and backfilling of trenches over laid sewers shall not be allowed until the manholes are fully constructed at the required places, checked, tested and approved by the Engineer.

Manholes shall be constructed concurrently with the adjacent pipe lengths. The contractor shall build in pipes and for grades as directed. Short length pipes with flexible joints shall be used immediately adjacent to manholes as detailed. Benching shall be left completely smooth to the satisfaction of the Engineer.

Manholes and vent shafts shall be constructed of cast-in-situ vibrated concrete. Dimensions and mix of concrete shall be as shown in drawings.

All channels and benching shall be finished smooth and accurately shaped in accordance with the drawings.

Mild Steel steps shall be provided as shown in drawings. The M.S. reinforcement Bars shall conform to the requirements of Drawings and specifications.

The manhole walls shall be constructed of fair face steel forms and no plaster will be required. However, in case smooth surface is not attained inside and out side of manholes shall be plastered smoothly with 19 mm thick cement sand mortar of 1:3 using S.R. cement and the manhole shall be absolutely water tight. Two coats of hot bitumen at the rate of 7 Kg per 10 Sq.m shall be applied on external surfaces. No extra payment shall be paid for this work.

Mild Steel sheet frame and R.C.C. cover shall be made as per drawing.

The concrete used in the manholes shall conform to the specifications given in Section-V of this Specification. The cement used shall be sulphate resisting cement.

Refilling around manholes shall be carried out as specified for refilling excavations.

11. NEW MANHOLES ON EXISTING SEWER

In case new manholes are to be constructed on existing sewers either for replacement of damaged manholes or additional manholes. The Contractor shall construct these manholes as per written instructions of Engineer. The shape and size of these manholes shall be the same as the existing manholes on the existing line. Payment shall be made on the basis of actual quantity of items of work carried out by Contractor for excavation, stone soling, dewatering, reinforcement and concreting paid for such items available in BOQ.

12. MAKING CONNECTION WITH EXISTING SEWERS

After the whole work of laying, jointing and testing of new sewers, manholes, vent shafts pumping station pumping machinery and rising or pumping main is completed, tested satisfactorily and certified in writing by the Engineer, the Contractor shall start the work of making connection for the following:

i) Connecting the main sewers with the sump (wet well) of pumping Station.

ii) Connecting the existing sewers with the manholes on the new sewers if existing or required.

This work shall include laying the required connecting length of the diameter of existing sewer with the new manholes including all operations of excavations, timbering bracing dewatering, making holes in new manholes, or pumping station, laying and jointing of sewer pipes, repairing of cut portions, backfilling, testing and all other operation for a

complete job of making connection of sewers with pumping station or as required.

Payment shall be made for excavation, laying sewer pipes, bedding etc. for connecting sewers on the basis of general items of work in the BOQ. The item for making connection shall include for cutting of walls for making connection, repairs of cut portions and all other miscellaneous item not covered by description of items in BOQ. After making connection and completion of repair, manholes should be water tight.

The contractor shall reinstate the surfaces over all trenches except where otherwise described. Reinstatement shall be carried out as soon as trenches or other excavations have been backfilled and thoroughly compacted as specified.

13. PAYMENT

Rate shall include for supplying, laying, jointing and testing of sewers as per rates quoted in the BOQ. The rate shall include the cost of the pipes, rubber rings, sockets, collars and all other material, equipment, plant and labour required for laying, jointing and testing of pipes or sewers for a complete job. No deduction shall be made for the manholes in the measurement for the length of sewers, of the pipe laid in continuation. Payment for manholes and vent shafts shall be made for complete work of manholes or vent shafts as per drawings and specifications

SECTION-08

UPVC PRESSURE PIPES

8.1. 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 lying, jointing, testing, disinfection and commissioning of uPVC pipe work complete in strict accordance with the specifications herein and the applicable drawings and subject to the terms and conditions of the contract.

8.2. UPVC PIPES

UPVC pipes shall be approved manufacture and confirm to the standard as specified in General section.

8.3. STANDARDS AND SPECIFICATION

For sampling testing and tolerance limit, specification BS: 3505:1968 and PS 3051 1991 shall be followed. The uPVC pipes jointing shall be cement solvent joint or Z-joint. The contractor should provide the Technical Detail and Boucher to the Engineer or Engineer's representative for approval.

8.4. PHYSICAL PROPERTIES

The physical properties of uPVC pipes shall fall within the following limits

Properties	Value	Unit
Specific Gravity	1.42 - 1.46	-
MECHANICAL		
Tensile strength at 23 °C	450 – 600	kgf/cm^2
Modulus of elasticity at 20°C	30,000	kgf/cm^2
Elongation at break	> 80	%
Impact strength at 0°C	0.5 – 1	Ft lb / in of notch
Impact strength at 20°C	1 – 2	Ft lb / in of notch
Compressive strength	600 – 700	Kgf/cm^2
Bending Strength	1000	Kgf/cm^2
THERMAL		
Specific heat at 20°C	0.24	Cal/gm/°C
Vacate softening point	85	°C
Heat distortion temperature at 18.5 kgf/cm^2	75	°C
Thermal conductivity	0.12 – 0.14	W/m °C
Coefficient of linear thermal expansion	0.08	Mm/mm°C
ELECTRICAL		
Dielectric constant (800 cycle)	3	-
Dielectric strength	425	Volts/mil
Inflammability	Will not support combustion	-
Water absorption (24 hrs at ambient temp.)	0.07	%

8.5. ABBREVIATIONS

uPVC	Unplasticized polyvinyl chloride
PVC	Polyvinyl chloride
BS	British Standard

PS	Pakistan Standard
OD	Outside diameter
PN	Nominal Pressure

8.6. Nominal Pressure (PN)

The following class/pressure shall be followed.

Class B (PN=6 bars),

Class C (PN= 9 bars)

Class D (PN=12 bars),

Class E (PN= 15 bars)

8.7. THICKNESS AND DIAMETER

The diameter and thickness shall be as followed

Nominal size	Mean Outside Diameter	Wall Thickness			
		Class B 6 bar	Class C 9 bar	Class D 12 bar	Class E 15 bar
Inch	max	min	min	min	min
	mm	mm	mm	mm	mm
3”	89.1	2.9	3.5	4.6	5.7
4”	114.5	3.4	4.5	6.0	7.3
5”	140.4	3.8	5.5	7.3	9.0
6”	168.5	4.5	6.6	8.8	10.8

8.8. UPVC FITTINGS

uPVC fittings shall be approved manufacture and shall be confirm to the standard as specified For sampling testing and tolerance limit, BS and PS Specification shall be followed. Metal fittings (cast iron and ductile iron fittings) can be used for diameter ranging 10 inches and above. The metal fittings are connected with the pipe using rubber ring Z-joint system.

8.9. JOINTING

8.9.1 **Solvent Cement joint**

Jointing is done by applying a uniform layer of solvent cement to spigot and socket ends of pipes to be jointed together and assembling them with a quick action. Right after jointing, the surplus cement shall be removed and a period of 24 hours should be allowed to elapse before pressure testing. It may be noted that completion.

8.9.2 Guide to the Consumption of Lubricant, Cleaner and Solvent Cement per 100 Joints

Range of pipe and fittings diameter (mm)

Aprox.	32 – 40	50 – 63	75 - 90	110 – 125	140 - 200
	1” – ¼”	1” – ½”	2 ½” – 3”	4”	5” – 6”
Lubricant (kg)	-	2.0	3.50 – 4.00	4.00 – 5.00	5.0 – 6.5
Cleaner (liter)	0.35 –0.50	0.65 – 0.90	1.00 – 2.00	3.00 – 5.00	6.5 – 9.0
Solvent Cement (Liter)	0.78 –1.00	1.30 – 1.800	2.00 – 4.00	6.00 – 10.00	13.0 – 18.0

8.9.3 Z-joint

Z – Joint is also commonly known as “rubber ring” joint. These joints contain an electrometric sealing component which is automatically compressed to form an effective seal when the spigot end of uPVC pipes inserted into the socket.

These joints are not designed to resist end thrust. Therefore, particular care should be taken to ensure that the pipeline is property anchored. Anchor blocks should be designed to withstand the thrust resulting from the maximum pressure to which the pipe is likely to be subjected, normally the test pressure. It is desirable to insulate the uPVC pipe from direct contact with the anchor block by means of a suitable flexible membrane.

8.9.4 Flanged Joint

Flanged joints can be used to connect uPVC pipes with metal pipes, valves and fittings provided with flanges. Joints are made by the compression of the gasket or a ring seal set in the adaptor of the flange. Flanged joints are also preferable, where there is a need to dismantle pipeline from time to time. Care should be taken while selecting flange accessories their flange should be compatible with the uPVC flange adaptor.

8.10 DISINFECTION PROCESS

Disinfection shall be effected by filling the pipeline with water heavily dosed with chlorine and shall be carried out when filling the pipeline with water for carrying out the hydraulic test on completion. Alternative methods may be adopted with approval of the engineer.

The level of the chlorine dosing shall be such as to make available 50mg/l of free chlorine throughout the pipeline.

The water heavily dosed with chlorine shall stand in the pipeline for a period of 24 hours for such longer period as the engineer shall require and all valves in the system shall be operated at least once during this period.

At the termination of the required period, chlorine residual test shall be taken at the end of the pipeline farthest from the point of injection and the test shall be repeated if necessary until the residual is not less than 10mg/l.
The contractor shall obtain the engineer’s approval to the method to be adopted for disposing of the chlorinated water and the time when such disposal shall take place on completion of disinfection.

Connections of the new mains to the existing shall only be made when disinfection has been satisfactorily completed. Absolute cleanliness is essential. No groundwater shall be allowed to come in to contact with the water main pipes. All cut ends or newly exposed parts of the pipes or fittings shall first be thoroughly cleaned to remove swarf and other extraneous matter, and then sprayed with a 10% hypochlorite solution. All couplings and make up pieces and tools shall be cleaned and sprayed with 10% hypochlorite solution prior to fixing. The newly made joint shall be put under operating pressure as soon as possible and checked for leakage.

8.11. INSTALLATION OF uPVC PRESSURE PIPES

8.11.1 Installation of Buried Pipe

Un-plasticized PVC pipes must be laid onto a trimmed trench bottom, where soil is uniform, fine grained and free from sharp objects. The trench width must be sufficient to enable the lying and jointing of the pipes and proper compaction around the pipe. The minimum recommended trench width (W) is equal to pipe OD plus 600 mm or as specified in the Drawings.

The minimum depth of cover required for water mains is 900mm from finished surface level to the crown of the pipe. Thus, the minimum excavated depth (D) of the trench for water mains is pipe OD + 900mm + Bedding.

The normal thickness of bedding is a min of 100mm. for pipe sizes greater than 8 inches; the bedding thickness should be increased to a minimum of 150mm and or specified in the Bill of Quantities.

Because of the flexible nature of the material the pipe should be suitably anchored at all changes of direction and at fixed points. The anchors should be designed to withstand the maximum thrust developed during hydrostatic pressure testing.

Un plasticized PVC pipes should not be installed in direct sunlight or near any heat source. The liner expansion of uPVC is about six to seven times that of steel, so precaution is to be taken to compensate for it. The pipe line should be installed in such a way as to minimize the stress. The best way of doing this is to arrange piping so that bends occur between anchor points. Along walls pipe rack, hangers, clamps, straps or u-bolt can be used.

8.11.2 Support Spacing

Recommended horizontal and vertical support spacing is given in the table.

*Pipe Outside Diameter	Water Temperature °C				Vertical spacing
	20°C	30 °C	40 °C	50°C	
OD	Horizontal Spacing				
mm	cm	Cm	cm	cm	cm
16	75	60	40	-	80
20	85	70	50	-	90
25	90	75	55	45	100
32	100	85	65	50	120

8.12 MEASUREMENT

- All pipes shall be measured according to the work actually done and no allowance will be made for any waste in cutting to the exact length required. The measurement for pipes shall be in running meter nearest to a cm of length along the centre line of pipe as actually laid at work sites.
- The rate for providing, laying and jointing of pipes shall be deemed to include the cost of collars/rubber rings, jointing material, testing and extra excavation required for ordinary bedding of pipes and also for collars and pipe sockets, if any.

- If any damage is caused to the pipe line during the execution of work or while cleaning/testing, the pipe line as specified. The contractor shall be held responsible for the same and shall replace the damage pipe line and retest the same at his own cost to the full satisfaction of Engineer.
- Water for testing of pipeline shall be arranged by Contractor at his own cost.
- Pipes shall be brought on site proportionate to the required progress for Thirty days only.

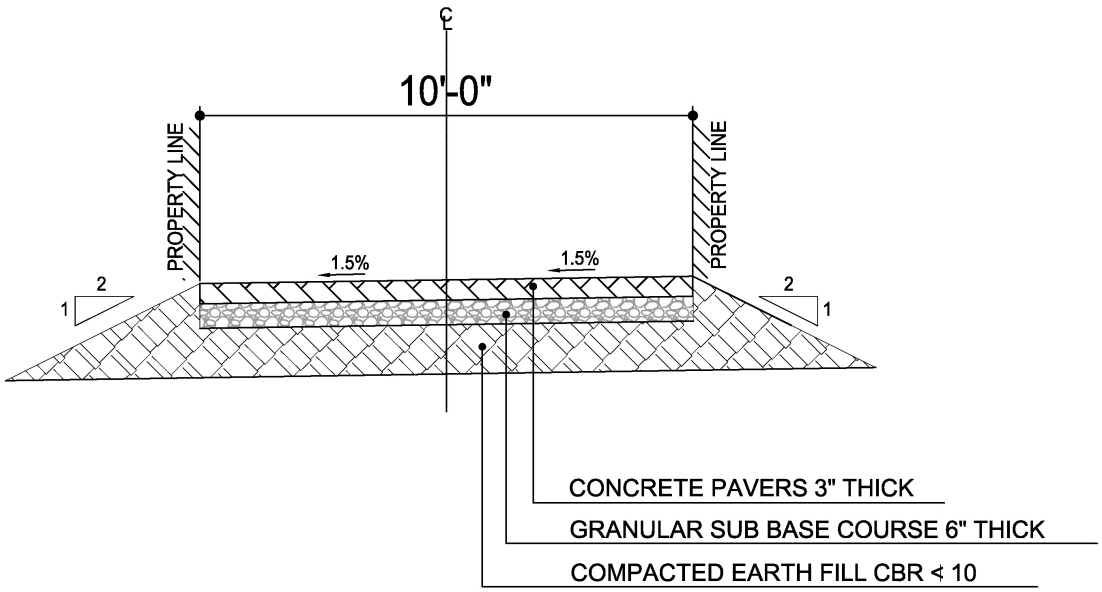
SCHEDULE OF CONSTRUCTION AREAS OF THE HOUSING UNITS

SCHEDULE OF CONSTRUCTION AREAS

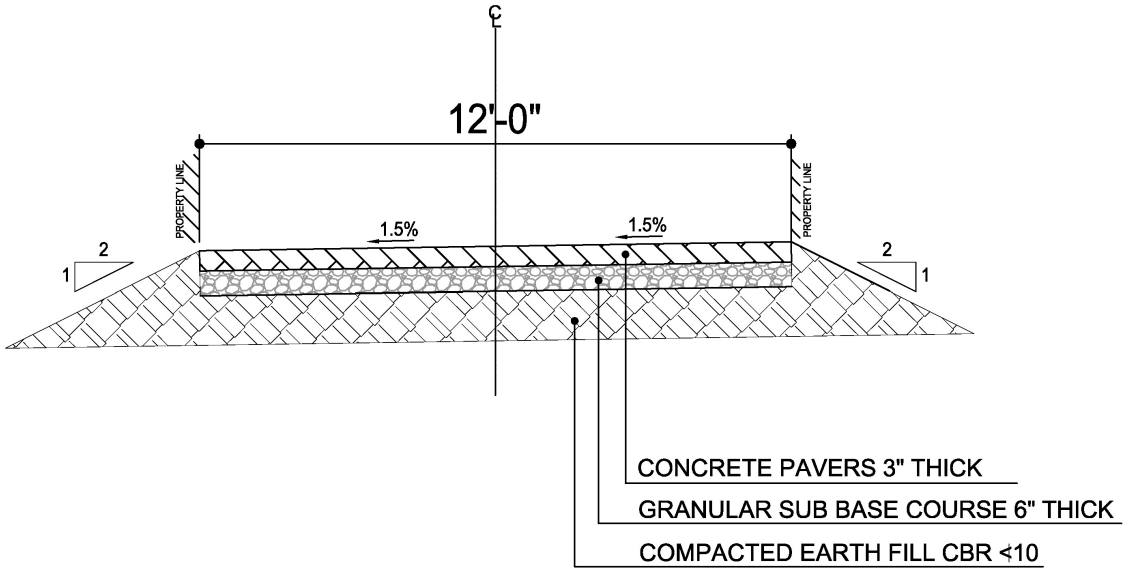
S.No	Housing (Sq.yds)	Plot Size (Sq.ft)	F.A.R	Foot Print (Sq.ft) (70%)	Allowable (Sq.ft)	Covered (Sq.ft)	Cir. (Sq.ft)	Const. (Sq.ft)
1	Single Storey							
	80	24' x 30'	1:2	504	1440	504	114	618
	100	25' x 36'		630	1800	630	97	727
	120	24' x 45'		756	2160	720	166	886
	200	30' x 60'		1170	3600	1060	91	1151
2	One Unit							
						Net Cov. Area (Sq.Ft)		
						G.F	1st Floor	Const. (Sq.ft)
	80	24' x 30'	1:2	504	1440	504	450	954
	100	25' x 36'		630	1800	630	607	1237
	120	24' x 45'		756	2160	720	602	1322
	200	30' x 60'		1170	3600	1060	1046	2106
3	Multi-storey Unit (G + 02-storey)							
						Covered (Sq.ft)	Cir. (Sq.ft)	Const. (Sq.ft)
	80	24' x 30'	1:2	504	1440	476	117	593
	100	25' x 36'		630	1800	598	93	691
	120	24' x 45'		756	2160	695	78	773
	200	30' x 60'		1170	3600	1026	128	1154

PROPOSED X-SECTION OF

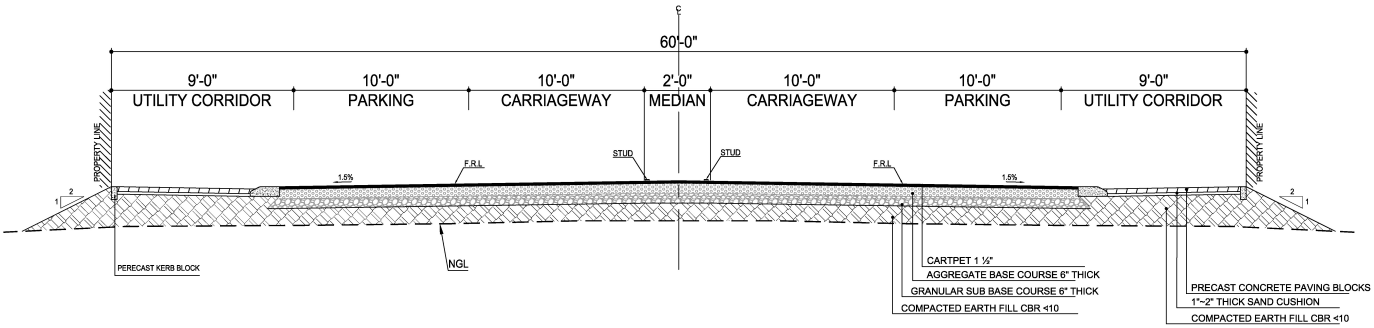
ROADS & STREETS



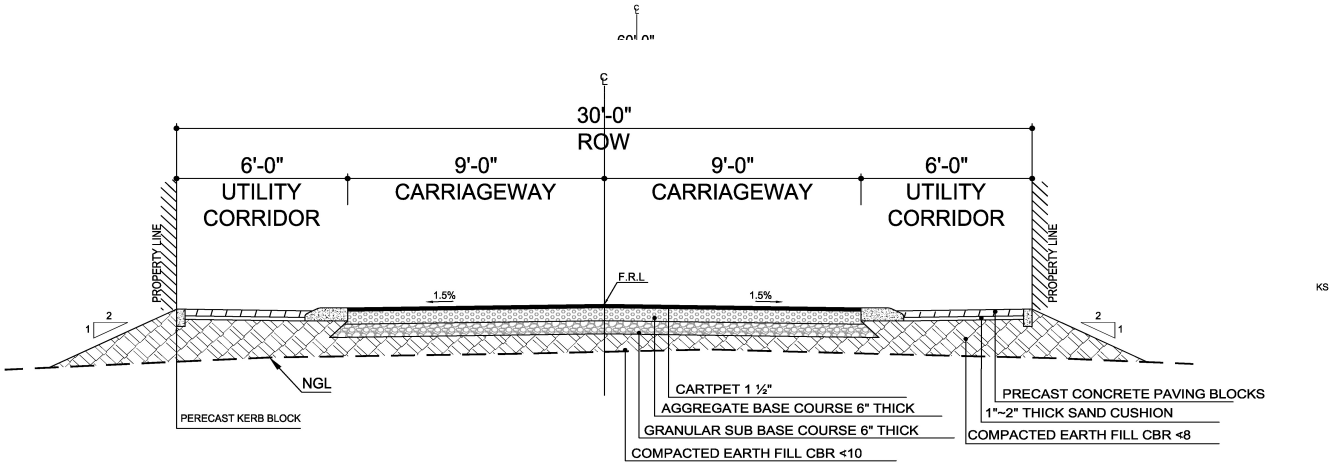
TYPICAL CROSS SECTION FOR 10ft WIDE STREET



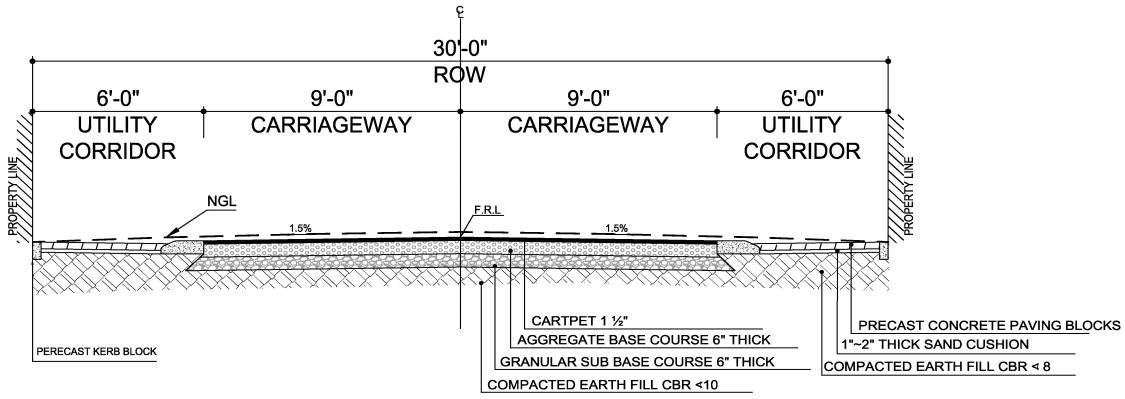
TYPICAL CROSS SECTION FOR 12ft WIDE STREET



TYPICAL CROSS SECTION FOR 60ft WIDE STREET (FILL AREA)



TYPICAL CROSS SECTION FOR 30ft WIDE STREET (FILL AREA)



TYPICAL CROSS SECTION FOR 30ft WIDE STREET (CUT AREA)

METHODOLOGY AND WORK PLAN

METHODOLOGY AND WORK PLAN OF PUBLIC ECONOMY HOUSING PROJECT

The following tasks are required to be undertaken severally/jointly/simultaneously/subsequently by parties to contract (as the case may be) upon award of the contract:-

A- <u>Consortium (contractual obligations)</u>

1. Project will be launched in the name and on behalf of the MDA by the Consortium.
2. Arrange seed money from its own resources at its risk and cost for preparation of requisite documents/papers for launching of the project as per the methodology.
3. Prepare and print office stationery, files, advertising/promotional material (brochures, leaflets and banners etc), Application Forms (with suggested terms and conditions for booking /allotment of housing unit overleaf), Payment Schedules and other allied material for booking /sale and recoveries.
4. The successful consortium will manage and launch the project through advertisement in media (press & electronic) and marketing upon preparation but not limited to the following:-

(i) Printing of leaflets, brochures and other advertisement material etc from its own resources including material for subsequent recoveries, maintenance and handling of records etc.

(ii) Preparation of all documents (Allotment Orders, Possession Orders, Site Plans & Acknowledgement of Physical Possessions) and carrying out all functions of record keeping of the housing units and material required for facilitation of house building loan from loan lending institutions.

5. Proposed numbers of housing units (category wise) are anticipated being based on conceptual layout plans of the sectors submitted with the proposal and the same are subject to re-planning on the basis of site conditions and public response after launching of the project at no extra cost to the project.
6. Modifications in Conceptual Building Plans of the housing units (if required) submitted with the bid at no extra cost to the project/employer for making use in promotional material and thereafter for the project etc.
7. Facilitate negotiations with the bank(s) for issuance and collection of "Application Forms" of the housing units and finalize designated bank branches and house building loans from loan lending institutions.
8. Establish & Equip Project Marketing/Sale/Recovery Office(s) in vicinity of major roads in owned /rented premises before / after launching of the project .
9. Invite applications of the housing units from prospective buyers through media publicity and scrutinize and categorize determination by the consortium for the allottees' willingness for the option of purchase in the order of the following preferences:-

i. 1st Preference for those applicants, who want to purchase housing unit(s) on cash basis.
ii. 2nd Preference, who want to purchase housing unit(s) on Cash-cum-Loan basis under house building loan lending institution(s) policy.

10. Scrutiny of the Applications for their eligibility in order of the mentioned preferences. If the project does not attract public response than the booking will be made on first-cum-first basis, however, in case numbers of applications exceeds number of planned housing units than computer draw will be held for successful applicants.
11. Marketing Management Charges once paid to the consortium as quoted in the Bidding Document-Financial Proposal shall not be adjustable/refundable in case of cancellations of the booked units.
12. Carryout Topographic surveys & Sub-Soil Investigations including Construction of precast boundary wall being a gated community project.
13. Prepare/submit Final Layout Plans of the sectors as per SBTPR-2002 (amended upto date) based on the topographic survey and number of booked each type design of housing units.

14. Prepare/submit design/drawings of infrastructure development works, as per standard engineering practice and SB&TPR-2002 (amended upto date).

15. Cutting to the required gradient and/or Earth filling for formation of road embankments and upto bottom of plinth only is accounted as maximum 2-feet depth. Any consequential plus variation will be payable to the consortium as variation to contract on recovery from the allottee(s) /purchaser(s)/transferee(s).

16. Prepare/submit Final Architectural Submission Plan including Structural design/drawings based upon existing bearing capacities. The structure of proposed housing units shall be invariably designed for Ground + 02-storey buildings i.e Single storey & One unit, thus permitting construction of upper floors later on by the allottee(s)/purchaser(s) themselves.

17. Prepare and submit Plumbing, Electrical & Environmental designs/drawings of each type of housing units as per SB&TPR-2002 (amended upto date).

18. Cutting and/or Earth-filling with excavated earth or imported earth in road embankment and foundations and/or plinths of the housing units shall be considered maximum 2-ft depth. Any consequential plus variation of cutting/filling will be payable to the successful consortium under as variation to the contract on recovery from the allottee(s) under ancillary charges.

19. There shall be no parapet wall of individual housing unit(s) except construction of single stack plastered block masonry 5-inches thick on each periphery of building block(s) being row houses.

20. Carryout internal development and construction works of the housing units based on broad guide line specifications attached with the Bidding Document-Technical Proposal.

21. Cost of residential plot(s) of each type of booked housing unit will be disbursed proportionally and progressively, out of the collected monthly sale receipts of the housing units through Banker Cheque prepared in favour of MDA, out of the project account under irrevocable joint instructions to the designated bank(s).

22. Physical possession of the housing unit will be handed over to the allottee/purchaser on completion of construction after recoveries of all dues in advance of unit booked on cash basis, while in case of cash-cum-loan basis, the entire cash component will be recovered from the allottee in advance and/or on receipt of loan component from the loan lending institution(s) granted as per their policy.

23. Consortium may relaunch un-booked/cancelled housing units at appropriate times at the prices determined by consortium, which shall be paid to the consortium to compensate for risk and costs involved for investing seed money and long payback period of the initial investment till completion of the project.

24. Costs of preparatory, development and construction works including extra charges (west open, road/park facing and corner charges) shall be payable to the consortium.

25. Will apply for approval(s) before commencement of each activity of project, which the employer will accord within 07-days or otherwise the same will be treated as automatically approved and the consortium may proceed with the works, services and goods etc accordingly.

26. The housing units on the residential plots shall be disposed in the manner as per the contract only, while planned commercial, educational institutional and amenity plots developed under the project will be the absolute property (free of cost) of the Procuring Agency.

27. Indemnify MDA from all litigations whatsoever arising from their other business and defend the same themselves at their risks and costs.

B- <u>Malir Development Authority (contractual obligations)</u>

1. Will not be responsible for any financial liability or any commitment money or any advance payment to be paid to the bidder except mobilization advance, which to will be paid out of the collected sale proceeds of the housing units only.

2. Will provide necessary guarantees/sureties to the loan lending institutions for providing project bridge financing for the project (if required), which will be transferred to the allottee(s) of the unit(s). Any markup over the financing shall be recovered from the allottee(s) of the units booked under 2nd Preference, which he/she will have to pay promptly to the loan lending institution(s).

3. May make sum of payment(s) directly to any of the JV/Associates/Firm(s) of the Consortium out of the Project Disbursement Account on written request at the time of processing and passing of IPCs upon deduction of Income Tax and other taxes at the applicable rates.

4. Intend to develop internal infrastructure of the earmarked sectors together with construction of anticipated housing units costing Rs. 5,000 million in initial phase of the project. The remaining phases are deemed to constitute integral part and parcel of this contract but is subject to receipt of applications over and above of initial phase of invitation under the terms and conditions of the contract.

5. Will obtain all NOCs/Approvals from the concerned authorities/departments/agencies for the project (as required).

6. Provision for "Cottage/Multi-Units" on each category of residential plots are subject to amendment in MDA Disposal of Plots/Lands Rules, 2015 by the competent forum.

7. Will indemnify the successful consortium/firm in case of all litigations on the land and will prosecute and/or defend any such litigations etc.

The above methodology has been prepared for successful execution and completion of the project in addition to the provisions appended in the PEHP Bidding Documents (Technical & Financial), which shall abide in letter and spirit by the parties to the Contract.

MODE OF MEASUREMENT & PAYMENTS

M O D E O F M E A S U R E M E N T & P A Y M E N T

{(Subject to availability of funds in PEH Project the Disbursement Account(s)

PREAMBLE

i. Mode of Measurement & Payment supersede all modes of measurements appended in Bidding Document- Technical Proposal (Volume-I & II) & Financial Proposal and will be applied for all payments(s) under the contract.

ii. Payment of Departmental Charges, Utility System Development Charges (electricity, gas supply & bulk water supply etc), Escalation, Incidental Charges, Ancillary Charges or any other charges etc shall paid on demand to the relevant quarters under the contract out of the head of Provisional Sum, which shall be paid out of the Disbursement Account(s) of the project subject availability of funds.

iii. The sum of amount of all procurements of works, services, goods and cost of plots etc shall form unit prices of each type of the housing units, as quoted in the Bidding Document - Financial Proposal by the Consortium. If any works, services or goods etc are not executed, the payment percentage against the same shall be added to the next or prior activity.

iv. All eligible payments of the project under the contract shall be paid for based on the superficial method of measurement, as specified herein below, which supersede all other method of measurements appended in the Bidding Documents, Technical and/or Financial Proposals.

I. **Interim Payment Certificate(s)/Running Account Payment(s)**

a)	**Preparatory**	Interim/Running/Final account payment(s) for rendered services will paid as per rates quoted in the Bidding Documents - Financial Proposal by the successful Consortium, which will be apportioned to arrive at the unit costs of the housing unit(s) eventually.
b)	**Internal Infrastructure Development**	Interim/Running/Final account payment(s) for executed works will paid on the component unit percentages (%-ages) of the derived infrastructure development cost of the housing unit(s), as quoted by the successful Consortium in the Bidding Documents - Financial Proposal, as per respective mode of measurement.
c)	**Construction**	Interim/Running/Final account payment(s) for executed works will paid based on component unit percentages (%-ages) of the derived infrastructure development cost of the housing unit(s), as quoted by the successful Consortium in the Bidding Documents - Financial Proposal, as per respective mode of measurement.
d)	**Marketing Management Charges**	Interim/Running/Final account payment(s) will be paid based on the quoted component unit percentage (%-age) of the recoveries of the housing unit(s) (Cost of Preparatory works + Internal Infrastructure Development + Construction + Plot) etc, as quoted by the successful Consortium in the Bidding Document - Financial Proposal. All other associated recoveries of utility system development charges etc inclusive of recovery of Provisional Sum etc will also paid at the %-age separately under the Contract.
(e)	**Associated Charges etc**	Anticipatory Service charges of "The Engineer" (Vetting & Supervising Consultant(s) + "International Auditor(s)" (if any) appointed by MDA + Ancillary & Incidental Charges etc will be paid out of "Provisional Sum" and separate recovery made from the allottees/owners/purchasers of the housing

units by the successful Consortium. Any other recovered associated cost etc will also paid at the sole discretion and under verification of MDA.

MODE OF MEASUREMENTS OF DEVELOPMENT

S.No	Description of Works	%-age Total	%-age breakup
1	**Roads**	**45**	**-**
I	Clearing, Grubbing & Removal of Tress/bushes	-	03
ii	Compaction of Natural Ground	-	02
iii	Cutting to the required gradient ordinary soil including disposal of excavated stuff with in one chain and/or Earth filling for formation of road embankments with excavated or imported earth with in right-of-way of roads/streets	-	25
iv	Subgrade preparation to the required degree of compaction	-	05
v	Providing/laying & spreading of granular sub-base course including compaction	-	20
vi	Providing/laying & spreading aggregate base course including compaction	-	15
vii	Single surface treatment or bituminous prime coat (60/70 grade bitumen) of Pakistani origin	-	10
viii	Laying of 1-1/2 inch thick single layer asphalt machine carpet wearing course	-	20
	Total	**-**	**100**
2	**Internal Water Distribution System**	**25**	
I	Excavation in all kind of ordinary soil	-	20
ii	Providing pressure pipes and specials (tees, bends, cross, elbows, air & gate /sluice valves etc.) of the specification.	-	60
iii	Laying , Jointing & Fixing of pressure pipes and specials in trenches	-	05
iv	Construction of 1:2:4 C.C Thrust-Block on all specials.	-	05
v	Backfilling of excavated stuff over pipes in trenches.	-	05
vi	Construction of C.C Block Masonry (0'-6") Chambers including inside plaster and benching etc.	-	05
	Total	**-**	**100**
3	**Internal Sewage Disposal System**	**30**	
i	Excavation in all kind of ordinary soil	-	20
ii	Providing Sewage pipes of the specifications	-	55
iii	Laying, Jointing & Fixing of sewerage pipes in trenches	-	10
iv	Backfilling of the excavated stuff in trenches	-	05
v	Construction of Manholes	-	10
	Total	**100**	**100**

MODE OF MEASUREMENTS OF CONSTRUCTION WORKS

S. No	Description of Works		Percentage (%-age)		
			Single Storey	One Unit	Cottage /Multi-storey
1	Sub-structure upto plinth level	a) Excavation for foundation i/c lean Concrete 1:4:8	2	2	2
		b) RCC Under Ground Water Tank (or otherwise)	6	6	6
		c) RCC Foundation & RCC Column below Plinth Beam	10	5	10
		d) RCC Plinth Beams	10	5	10
		e) Bituminous coating for moisture protection on all RCC members	2	2	2
		f) Earth-filling with excavated or imported earth in foundations & plinth with compaction under sub-flooring up to maximum 2'-0" depth	2	2	2
		g) sub flooring CC 1:4:8, stone soling & termite proofing	3	3	3
		Sub Total	**35**	**25**	**35**
2	Super Structure	a) RCC Columns, Beams & Ground floor slab	20	10	20
		b) RCC Columns, Beams & 1st floor slab	-	10	-
		c) RCC Columns, Beams & 2nd Floor slab	-	-	-
		Sub Total	**20**	**20**	**20**
3	Block Masonry & flooring	a) Block Masonry walls (Ground floor) DPC i/c	5	5	5
		b) Masonry walls (1st floor)	-	3	-
		c) Masonry walls (2nd floor)	-	-	-
		d) G. floor Marble/Tiles flooring	8	4	8
		e) 1st. floor Marble/Tiles flooring	-	3	-
		f) 2nd. floor Marble/Tiles flooring	-	-	-
		g) External pavement work	2	-	2
		Sub Total	**15**	**15**	**15**
4	Ground Floor	a) Inside plaster	3	3	3
		b) Glazed Tiles in Bathrooms	3	3	3
		c) G.I Sheet Door Frame	1	1	1
		d) Semi solid Flush door with all drops	3	3	3
		e) Aluminum window & ventilators (economy section)	2	2	2
		f) Internal paint	3	3	3
		Sub Total	**15**	**15**	**15**
5	1st Floor	a) Inside plaster	-	2	-
		b) Glazed Tiles in Bathrooms	-	2	-
		c) Door Frame	-	1	-
		e) Semi solid Flush door with all drops	-	1	-
		e) Aluminum window & ventilators (economy section)	-	1	-
		f) Internal paint	-	3	-
		Sub Total	**0**	**10**	**0**
6	2nd Floor	a) Inside plaster	-	-	-
		b) Glazed Tiles in Bathrooms	-	-	-
		c) Door Frame	-	-	-
		f) Semi solid Flush door with all drops	-	-	-

		e) Aluminum window & ventilators (economy section)	-	-	-
		f) Internal paint	-	-	-
		Sub Total	**0**	**0**	**0**
7	External Plaster Paint & Roof	a) Ground floor External plaster	2	1	1
		b) 1st floor External plaster	-	-	-
		c) 2nd floor External plaster	-	1	-
		d) Ground floor External paint	2	-	-
		e) 1st floor External paint	-	0.5	-
		f) 2nd floor External paint	-	-	-
		g) Fiber glass overhead water tank (or otherwise)	1	1	1
		h) Roof Screeding incl. single stack block mry	1	0.5	1
		Sub Total	**4**	**4**	**4**
8	Electrification	a) G.Floor upvc conduits in slab & walls including upvc back boxes	2	1	2
		b) 1st Floor upvc conduits in slab & walls including upvc back boxes	-	1	-
		c) 2nd Floor upvc conduits in slab & walls including upvc back boxes	-	-	-
		d) G. Floor wiring in slab & walls (Internal / main)	2	1	2
		e) 1st Floor wiring in slab & walls (Internal / main)	-	1	-
		f) 2nd Floor wiring in slab & walls (Internal / main)	-	-	-
		g) G.Floor DBs, 03-phase wiring for A/C in bedrooms	2	1	2
		h) 1st Floor DBs, 03-phase wiring for A/C in bedrooms	-	1	-
		i) 2nd Floor DBs, 03-phase wiring for A/C in bedrooms	-	-	-
		Sub Total	**6**	**6**	**6**
9	Plumbing	a) Installation of Internal Water & Sewerage lines	5	5	5
		b) Connection of Internal Water & Sewerage lines with External water supply line and sewer main.			
		c) Installation of Internal drainage system and manhole			
		d) Fixing of sanitary wares & CP fittings in bath rooms			
		e) Installation of Internal gas line			
		Sub Total	**5**	**5**	**5**
		Total S.No. 1 to 9	**100**	**100**	***100**

****Note:** Measurement will be paid 03 (three) times being G + 02-Storey units per plot.*

II. Payment of Cost of Residential Plots to MDA

Proportionate cost of residential plots calculated in term of percentage of the housing units progressively, out of each monthly receipt of booked housing unit(s).

III. Payment to Utility agencies/departments etc

Payment shall be paid, out of the purposeful separate recovery from the project allottee(s) by the Consortium, which is paid as per demand of respective utility agencies/departments etc.

This Bidding Document (Technical Proposal, Volume-II) contains 164-pages only.

Project Director, MDA