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10. BRIDGES

10.1 CONCRETE BRIDGES

10.1.1 SCOPE

The concrete bridges and concreter culverts shall be constructed in conformity with the lines, grades, dimensions and design shown on the drawings and in accordance with the provisions of

- Section 3 – Earthwork
- Section 5 – Plain &Reinforced Concrete
- Section 11 – Brickwork and
- Section 6 - Pre-Stressed Concrete Work

of these specifications and all other Technical Specifications which are to govern the complete construction of the structures as directed by the Engineer-in-Charge.

10.1.2 MATERIALS

The materials to be used for construction of a structure shall be those prescribed in the applicable Sections of the specifications referred as above.

10.1.3 CONSTRUCTION REQUIREMENTS

a) **Clearing the Site**

The contractor shall clear the site of the proposed structure of trees, bushes, stumps and debris in accordance with the Section 3.10 “Site Clearance”.Removal of existing buildings, concrete and other pavements shall be carried out and paid in accordance with the provisions of Section 4 "Dismantling (Demolition)".

Removal and relocation of public or private utilities such as telephone or telegraphs lines, power lines, underground cable lines, sewer and watersupply lines, railway tracks and their appurtenances etc shall be arranged by the Employer's representative with the specific; government agency, utility companies and persons involved. The Department shall bear the cost of relocating such utilities.

b) **Alignment and Grades**

All structural members such as pre-cast/in-situ girders, cast in-situ deck slabs, cast in-situ superstructures bridge rails including kerbs, wheel guards, safety fencing shall be so constructed and placed that finished vertical alignment and grade shall be as shown on the drawings.

Rails, sidewalks and kerbs on the curved portions of structures shall be constructed as far as possible after the completion of the entire superstructure slab. In such cases the height of rail, sidewalk and/or kerb may be varied with respect to the grade line of the slab in order to produce the desired appearance.

c) **Construction Methods**

Before moving any construction equipment to the site, the contractor shall submit for approval an outline of the method he proposes to follow in the construction of-the structure.

d) **Concreting**

The concrete of bridges shall be poured and surface finished and cured as per requirements conforming to Section 5.3 – Plain & Reinforced Concrete and Section10.1.5 of these specifications.

e) **Final Clearing**

Upon completion of structures, the contractor shall clean up the site, remove all temporary

buildings, false work, lumber, equipment and all other debris. The contractor shall level off all excavated material not used for backfill around piers, bends, abutments, culverts, headwallsand on embankment slopes. Bridge decks and sidewalks shall be left in clean and workman like condition. No specific payment for cleaning up shall be made but the cost shall be included in other items shown on the bill of quantities.

f) **Opening of Traffic**

Bridges or slab or box culverts having decks constructed with Portland Cement concrete shall remain closed to all traffic and contractor's equipment subject to the results of tests made of the concrete but not less than twenty eight (28) days after the placing of concrete.

The above time of opening to traffic is applicable when temperatures are above ten (10) degree C. When temperatures are below ten (10) degree C, the time of opening to traffic shall be increased at the direction of the Engineer-in-Charge. In any event bridges or culverts with concrete decks shall not be opened to traffic without the approval of the Engineer-in-Charge.

g) **Public Bodies/Service Authorities**

The contractor's methodology shall meet all statutory requirements of the irrigation or Service Authorities and contractor’s rates shall include all costs for meeting requirements.

h) **Foundation Data**

Foundation data including the location of all boreholes together with the records of ground conditions encountered have been obtained from soil investigation by test boring, test pits or other sources. It is the Engineer’s responsibility to ensure by additional investigations through the contractor at the very beginning of construction work that the foundation levels given in the Drawings coincide with the local requirements.

i) **Navigable Streams**

The channel of navigable streams shall be kept clear for safe passage of water. The contractor shall provide and maintain all necessary light and signals in accordance with the navigation authority’s requirements. The contractor shall pay due regard to the hazard of the river flow during period of intense rainfall. All material deposited in the channel shall be removed to the required depth and clearance lines at the contractor’s expense.

10.1.4 STRUCTURAL, EXCAVATION & BACKFILL

10.1.4.1 SCOPE

Structural excavation shall include the removal of all material of whatever nature, necessary for the construction of foundation of bridges, 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-in-Charge. 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 excavation of the work. It shall also include necessary backfill as hereinafter specified. It shall also include the disposing ofexcavated materials, 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.

10.1.4.2 MATERIAL REQUIREMENT

Backfill around Structure

Backfill around structure where specified shall be made with the following material.

a) Granular backfill of selected material as specified hereunder.

b) Common backfill shall be carried out from excavation material or anyother borrow

material approved by the Engineer-in-Charge complying with the Sub-Sections 3.8 & 3.9.

Backfill

a) Granular backfill materials where specified shall give the following grading requirements:

GRADING REQUIREMENT

Size (mm)	Size (Inches)	A	B
25.00	1”	100	100
19.00	3/4"	60-100	75-100
4.75	No. 4	50-85	55-100
2.00	No. 10	40-70	40-100
0.425	No. 40	25-45	20-50
0.075	No. 200	10-25	5-15

b) Material satisfying the requirements of coarse sand falling under 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 plastic index of not more than size (6) as determined by AASHTO T-89 and T-90.

Rock Backfill

Rock material consisting of excavation material that in the opinion of the Engineer-in-Charge requires drilling and blasting with explosive for its removal, can be permitted in the construction of embankments in water logged areas and backfilling of wells or as directed by the Engineer-in-Charge.

10.1.4.3 CONSTRUCTION REQUIREMENTS

10.1.4.3.1 Structure Excavation

a) **General**

All sub-structures, 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, back forms may be omitted with the approval of the Engineer-in-Charge 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.

b) **Preservation of Channels**

Unless otherwise specified, no excavation shall be made outside of caissons, cribs, cofferdams, piling or sheeting and the natural stream bed adjacent to the structures shall not be disturbed without permission from the Engineer-in-Charge. If any excavation or dredging is made at the site of the structure before caissons, cribs of 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 satisfactory to the Engineer-in-Charge. 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-in-Charge 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) The rock or other hard foundation material shall be freed from allloose material, cleaned and cut to a firm surface, either level, stepped or roughened as may be directed by the Engineer-in-Charge.

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 masonry is placed.

e) **Cofferdams and Cribs**

i) For sub-structures work, the contractor shall submit if asked, drawings showing his proposed method of cofferdams construction and other details left open to his choice or not fully shown on the Drawings. The contractor shall not startwork until the Engineer-in-Charge has approved such drawings.

ii) Cofferdams and cribs for foundation construction shall be carried to adequate depths and heights and be safely designed and constructed and be made as water tight as is necessary for the proper 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 form 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 corrected, 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-in-Charge, 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 shall then be pumped out and 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 cofferdams shall be controlled to prevent any flow through the seal and if the cofferdams are 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 sub-structure masonry without written permission from the Engineer-in-Charge.

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

vi) 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 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 water tight wall or other effective means.

ii) Pumping to unwater a sealed cofferdams shall not commence until the seal has set

sufficiently to withstand the hydrostatic pressure.

g) **Inspection**

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

In case an existing structure is to be replaced with a new structure the quantities for dismantling the structure shall be paid under Section 4 "Dismantling (Demolition)" and additional excavation required shall be carried out under this item.

10.1.4.3.2 Excavation of Embankments

a) General

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

Layers not more than 8 inches (20 cm) in loose thickness shall be placed and compacted in succession with mechanical tampers or tires or tracks of motor driven equipment operated transversely to the roadway, to the specified densities as per Sub-Section 21.1.8.3(a) Roadway Embankment Construction. Moisture content shall be adjusted as directed by the Engineer-in-Charge. Proper benching shall be made to ensure bonding of layers of existing and new material without any extra payment.

The excavation in embankment and the placing of backfill for the purpose described above shall not constitute any claims for payment. However granular backfill when specified by the Engineer-in-Charge shall be measured and paid.

10.1.4.3.3 Backfill

a) Granular backfill shall be placed in the position and to the required depth, shown on the drawings or where and as required in writing by the Engineer-in-Charge and it shall be well compacted in layers not exceeding 8 inches (20 cm) in thickness to the density 100% of Max dry density as per AASHTO T-180 (D). In case of water logged areas the thickness of the layer shall not exceed 20 inches (50 cm) or as directed by the Engineer-in-Charge. Volume of granular fill around structures shall be calculated within the vertical limits of approved excavation for such a structure where as 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-in-Charge complying with Sub-Section 3.12.3.2(iii). It shall be placed to the required depths shown on the drawings and/or as required in writing by the Engineer-in-Charge and it shall be well compacted in layers not to exceed 8 inches (20 cm) in depths to the density 95% of max dry density as per AASHTO T-180 (D).

c) The rock backfill material whose individual sizes are not more than eight and half cubic ft. (a quarter cubic meter) shall be placed to the required depth as specified and the voids shall be filled with fine materialapproved by the Engineer-in-Charge. The compacting efforts shall be made so as to achieve the desired compaction approved visually by the Engineer-in-Charge. The depth of the layer in any case shall not exceed 2 feet (60 cm). However in waterlogged areas, the thickness may be increased as directed by the Engineer-in-Charge.Rock fill shall not be placed within 2 metre 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-in-Charge 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 all bridge structures shall be deposited in well-compacted, horizontal layers not to exceed 1 foot (30 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 or 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.

g) Adequate provision shall be made for the through drainage of the backfill;Transition granular material shall be placed at the mouth of weep holes.

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

10.1.5 CONCRETE

The specifications for composition, mixing transportation and placement of concrete are given in Section 5 – Plain & Reinforced Concrete. The following are the supplementary specifications relating to placement of concrete in road structures.

10.1.5.1 PNEUMATIC PLACING OR PUMPING CONCRETE

The following methods may be employed for the placement of concrete.

i) **Pneumatic Placing**

Where concrete is conveyed and placed 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. The equipment shall be so arranged that no vibration will occur that might damage freshly placed concrete.

ii) **Pumping Concrete**

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 acontinuous 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. The equipment shall be arranged that no vibration will occur that might damage freshly placed concrete.Equipment shall be cleaned after operation.

10.1.5.2 PLACING CONCRETE UNDER WATER, CONCRETE EXPOSED TO ALKALI SOILS/ALKALI WATER

The following specifications shall be followed for placing concrete under water, or exposed to saline water.

i) **Placing Concrete under Water**

Concrete shall be placed under water only after the approval of the Engineer-in-Charge and the work shall be carried out under his supervision. Concrete deposited under water shall be

4000 psi concrete with a minimum cement content of four hundred (400) kg per cubic meter of concrete.

The slump of concrete shall be maintained between 4 inches and 6 inches(10 cm and 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 10 inches (25 cm) constructed in sections having flanged couplings fitted with gaskets with a hoer 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 tried. The bucket shall be completely filled and slowly lowered to avoid back wash. 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 chipping or other mean which will not injure the surface of concrete.

ii) **Placing 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.

10.1.5.3 CASTING SECTIONS & 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 sufficient 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-in-Charge. .

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 "feathered 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 6 inches(15 cm) in the succeeding layer. Work shall not be discontinued within20 inches (50 cm) of the top of any face, unless provision has been made for a coping less than 20 inches (50 cm) thick, in which case, if permitted by the Engineer-in-Charge, 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 in the foundation shall be placed and allowed to set before the reinforced concrete is started.After the construction of masonry abutment walls, the concrete bed plate and curtain walls shall be constructed monolithically. Construction joints in wing walls where unavoidable shall be horizontal and so locatedthat no joints 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 50 inches (1-1/4 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 verticaland at right angles to the axis of the culvert.

In the construction of box culverts more than 50 inches (1-1/4 meters) in height the concrete in the walls shall be placed and allowed to set before the top slabis 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 centre of the span and working from the centre 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 drawing or as specified.

Concrete in girder haunches less than 40 inches (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 40 inches (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 contra

flexure.Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided. The floors and girders of super-structures 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 in 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 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 2 inches by 4 inches (5 cm by 10 cm) in cross-section and having a length of 4 inches (10 cm) less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall not be greater than 12 inches (30 cm)centre to centre. 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 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 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 super-structure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of the super-structure 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.

10.1.6 STEEL REINFORCEMENT

The work of steel reinforcement shall be carried out complying with the provisions of Sub-section 5.4 – Plain and Reinforced Concrete.

10.1.7 PRESTRESSED CONCRETE STRUCTURES

The work of steel reinforcement shall be carried out complying with the provisions of Section 6 – Pre-stressed Concrete.

10.1.8 JOINTS AND BEARING DEVICES FOR CONCRETE STRUCTURES

10.1.8.1 SCOPE

The workcovered in the item shall consist of furnishing all plant, equipment, materials and labour in performing all operations in connection with providing and placing (in concrete structures) all deck expansion joints and seals, metal bearing pads and elastomeric bearing pads complete and in accordance with the specifications, the Drawings, and or as required by the Engineer-in-Charge.

10.1.8.2 MATERIAL REQUIREMENTS

(i) **Concrete Joint Filler**

a. **Preformed Expansion Joint Filler**

Unless otherwise directed by the Engineer-in-Charge preformed joints filler shall conform to the requirements of AASHTO M213.

b. **Neoprene Rubber Sheet with Bitumastic Seal**

Unless otherwise directed by the Engineer-in-Charge, neoprene rubber sheets 1/4 inch (6 mm) in thickness, shall be used as a joint filler covered with a Bitumastic seal as shown in the Drawings.

ii) **Steel for Deck Expansion Joint Seals**

Plates, angles or other structural shapes including anchor bolts required for the expansion joint seals shall conform, unless otherwise directed by the Engineer-in-Charge, to the requirements of AASHTO M160 and shall be hot zinc sprayed (galvanized) with the exception of the nuts and washers which shall be in stainless steel.

iii) **Elastomer for Deck Expansion Joint Seals**

Elastomer shall be either neoprene or polyvinyl chloride (PVC). Neoprene shall be manufactured from a vulcanized elastomeric compound containing neoprene as the elastomer and shall have the following physical characteristics in accordance with ASTM Method D15, Part B;

iv) **Metal Bearing Devices**

Unless otherwise directed by the Engineer-in-Charge or specified, the requirements for metal bearings shall conform to the following:

a) AASHTO M 107 for bronze bearing
b) AASHTO M 108 for rolled copper alloy bearings
c) ASTM B 438 for sintered metal powder bearings
d) AASHTO M 160 for galvanized steel bearings.

v) **Elastomeric Bearing Pads**

Elastomeric bearings as herein specified shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates).The reinforcing steel plate laminations for bearing pads shall conform to the requirements of AASHTO M 183.Elastomeric bearing pads shall conform to the requirements in these specifications and the Special Provisions as made.Pads 1/2 inch (12 mm) and less in thickness may be either laminated or all elastomer. Pads over 1/2 inch (12 mm) in thickness shall be laminated. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together.

The thickness called for elastomeric bearing pad is deemed to be the total effective thickness of the elastomeric laminations.The outside laminations shall be metal or fabric. The outside edges of metal laminations shall be coated over with elastomer not more than 1/8 inch (3 mm) in thickness. The edges of the steel reinforcing plates of the bearing pads shall be carefully treated to prevent notch effects. Steel plates shall be fully enclosed in elastomer so that there is no danger of corrosion.

Laminations of elastomer shall be 1/2 inch + 1/8 inch (12mm + 3mm) thickness. Variation in thickness of an individual elastomer lamination shall not exceed 1/8 inch (3 mm) within the width or length of a pad and the variation in thickness of all elastomer laminations within a pad shall be such that each metal or fabric lamination will not vary by more than 1/8 inch (3 mm) from a plane parallel to the top or bottom surface of the pad.

The total overall thickness of a pad shall not be less than the thickness shown on the drawings nor more than 1/4 inch (6 mm) greater than that thickness. Variation of total thickness within an individual pad shall not exceed 1/8 inch (3 mm). The length and width

of a pad shall not vary more than 1/8 inch (3 mm) from the dimensions shown on the Drawings.

Where elastomeric bearing pads over 1/2 inch (12 mm), in thickness are shown on the Drawings or required by the Engineer-in-Charges, such pads may be manufactured as a molded laminated pad, or at the option of the Contractor, may be made up by stacking individual laminated pads.

When laminated pads are stacked, their contact surfaces shall be cleaned prior to stacking and an approved method shall be used to hold the individual pads in the stack in proper alignment. Pads of all elastomer or with fabric laminations may be cut from large sheets. Cutting shall be performed in such a manner as to avoid heating of the material and to produce a smooth edge with no tears or other jagged areas and to cause as little damage to the material as possible.

Corners and edges of moulded pads may be rounded at the option of the Contractor. Radius at corners shall not exceed 3/8 inch(10 mm) and radius of edges shall not exceed 1/8 inch (3 mm).The bond between elastomeric and metal or fabric shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and metal or fabric. Metal laminations shall be rolled mild steel sheets not less than twenty (20) gauge in thickness.

Fabric laminations shall be either, (1) a long chain synthetic polymer containing at least eighty five (85) percent of polyester from ethylene glycol and tera-phthalic acid or (2) a long chain synthetic polymeric amide from Hexa-methylene diamine and adipic acid. Each ply of fabric shall have a breaking strength of not less than 125 Kg. per cm. of width in both directions. Fabric laminations shall be single ply at top and bottom surface of the pad and either double ply or double strength within the pad.

The sole polymer in the elastomeric compound shall be neoprene and shall be not less than sixty (60) percent by volume of the total compound.

The elastomeric, as determined from test specimens, shall conform to the following:

Test	ASTM Designation	Requirements
Tensile strength, kgs/sq.cm	D 412	160 Min
Elongation at break, percent	D 412	350 Min
Compression set, 22 hrs at 67^{o}C, %	D 395 (Method B)	25 Max
Tear strength, kgs per cm^{2}	D 624 (Die C)	13 Min
Hardness (Shore A)	D 2240	60 $\pm$ 5 points
Ozone resistance 20% strain100 hrs at 38^{o}C $\pm$ 100 $\pm$ 20	D 1149 (except 100 $\pm$ 20 parts per 100,000,000	No Cracks
Low temperature stiffness,Young'sModulus at35^{o}C - kgs per cm^{2}	D 797	350 Max
Low temperature brittleness5 hours at 40^{o}C	D 736	Passed

After accelerated aging in accordance with ASTM Designation D 573 for 70 hours at 100°C, the elastomer shall not show deterioration changes in excess of the following:

Tensile strength, percent	± 15
Elongation at Break, percent	- 50 (but not less than 300% total elongation of the material)
Hardness points	+ 10
Shear Test (without vertical load)	7Kg/sq.cm (Min.)

Sampling shall be performed in accordance with AASHTO M251-74 as appropriate for the tests required during or immediately after manufacture.

The Contractor shall furnish to the Engineer-in-Chargea certificate from the manufacturer that the elastomer, and fabric (if used), in the elastomeric bearing pads to be furnished conforms to all of the above requirements. The certificate shall be supported by' a certified copy of the results of tests performed by the manufacturer upon samples of the elastomer and fabric to be used in the pads.

The Engineer-in-Charge will take a sample of not less than 6 inches x 12 inches (15x30 cm) in size for testing from each lot of pads or batch of elastomer to be furnished. The samples will be selected at random at the point of manufacture or, at the option of the Contractorat the job site. Samples taken at the job site shall consist of complete pads asdetailed on the plans, and the Contractor shall furnish additional complete padsto replace those taken for testing. Pads shall be available for sampling 3 weeks in advance of intended use. All sample pads for testing shall be furnished by the Contractor at his expense.

10.1.8.3 CONSTRUCTION REQUIREMENTS

i) **Open Joints**

Open joints shall be constructed at the locations shown on the Drawings or required by the Engineer-in-Charge using a suitable material, which is subsequently removed. When removing the material, care shall be exercised to avoid chipping or breaking of concrete. Reinforcement shall not extend across an open joint, unless shown on the Drawings.

ii) **Filled Joints**

When joints of preformed type are required as per Drawings or per instruction of the Engineer-in-Charge, the filler shall be placed in correct position.before concrete is placed against it. Preformed Filler with holes and cracks shall not be permitted and shall be rejected.

iii) **Steel Joints**

Plates, angles of other structural shapes shall be accurately shaped at the shop, to conform to the section of the concrete floor as per drawing. The fabrication shall conform to the requirements as specified. Care shall be taken to ensure that the surface in the finished plane is true and free of warping. Methods approved by the Engineer-in-Charge shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that to avoid impairment of the clearance in any manner.

v) **Water-stops (Joint Seals)**

Water-stops shall be furnished and installed in accordance with the details shown on the drawings or where required by the Engineer-in-Charge and in accordance with the provisions of Sub-section 5.3.1.8 of these specifications.

Water-stops shall be furnished in full length for each straight portion of the joint, without field splices. Manufacturer's shop splices shall be fully vulcanized. Reinforcing bars provided to support the Water-stops shown on the Drawings or as required by the Engineer-in-Charge shall be securely held in position by the use of spacers, supporting wires, or other approved devices. Such reinforcing bars shall be considered, for payment purpose's, as part of the water-stop. If, after placing concrete, Water-stops are materially out of position or shape, the surrounding concrete shall be removed, the Water-stop reset, and the concrete replaced, all at the Contractor's expense.

Field splices for neoprene Water-stops shall be either vulcanized, or mechanical, using stainless steel parts, or made with a splicing union of the same stock as the Water-stop, at the option of the Contractor. All finished splices shall have a full size tensile strength of eighteen (18) kg per cm of width.

Field splices for polyvinyl chloride Water-stops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The heat shall be sufficient to melt but not char the plastic. Water-stops when being installed shall be cut and spliced at changes' in direction as may be necessary to avoid buckling or distortion of the web or flange.

v) **Metal Bearing Devices**

Steel bearing plates, bars, rockers, assemblies, and other expansion or fixed devices shall be constructed in accordance with the details shown on the drawings and shall be hot-dip galvanized after fabrication.

Bronze or copper alloy plates shall be installed as shown on the drawings. The bearing plates shall be set level and the rockers or other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.

When bearing assemblies or masonry plates are shown on the Drawings to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished. by grinding or other approved means to a true level plane which shall not vary perceptibly from a straight edge placed in any direction across the area. The finished plane shall not vary more than 1/8 inch (3 mm) from the elevation shown on the Drawings or that required by the Engineer-in-Charge.

vi) **Elastomeric Bearing Pads**

When elastomeric bearing pads are shown on the Drawings, the concrete surfaces on which pads or packing are to be placed shall be wood float finished to a level plane, which shall not vary more than 1/16 inch (1.5 mm) from a straightedge placed in any direction across the area. The finished plane shall not vary more than 1/8 inch (3 mm) from the elevation shown on the Drawings or that required by the Engineer-in-Charge.

10.1.9 PILING

The work of piling shall be carried out according to the provisions of Section 7- RC Pile Work.

10.2 SUSPENSION BRIDGE

10.2.1 SCOPE

The Contractor shall furnish all plant, equipment materials and labour in performing all operations in connection with the construction of suspension bridges complete and in accordance with the specifications, the Drawings and or as required by the Engineer-in-Charge.

10.2.2 BRIDGE LAYOUT

The contractor shall establish centre points of the two towers on the two banks of the rivers. The distance between the two points should be measured. It should be ensured that this distance corresponds with that shown on the two drawings.

Similarly the centre points of anchorage blocks for main cable and wind guys on the two banks shall be established. The further layout and construction can then be proceeded.

10.2.3 CIVIL WORKS

The civil work as shown on drawings and specified shall include but not limited to the following:

i) The preliminary works.

ii) RCC Anchor Blocks for main cables and wind guys.

iii) The suspension towers complete with RCC foundations, main structure as shown on drawing. The foundation shall be RCC block foundation or on concrete piles as specified.

iv) The access roads and completion work.

The works shall be carried out according to the applicable provisions of Section 10.1 and other Technical Specifications as contained in various sections.

10.2.4 SUSPENSION BRIDGE STRUCTURE

10.2.4.1 MATERIAL REQUIREMENTS

i) Steel Wire Ropes (Cables)

Steel wire ropes shall be of diameter shown on drawings conforming with the requirements of ASTM A 603.

ii) The steel transom and runners for deck of bridge and the handrail shall be as specified and shown on drawings complying with the provisions of ASTM A-36. The clamps shall be as specified and shall be made of ASTM A-36 steel plates strips.

iii) The timber for wooden deck shall be as specified complying with the provisions of Section 16 – Wood work.

The bolts, screws, nuts and washers shall conform with BS-916.

The steel parts where specified shall be galvanised. The Contractor shall supply manufacturer certificate along with test reports for conformance with specifications of the materials for approval by the Engineer-in-Charge before use.

10.2.4.2 STORAGE & HANDLING

i) **Storage of Steel Parts**

The following rules must be observed while transporting and storing the steel parts to avoid any damage.

Galvanized and non-galvanized steel parts must always be stored under a roof with adequate protection from rain, and they should not be in contact with the ground.

Galvanizedsteel parts should not be transported or stored together with salt or acid.

Steel parts should be stacked and stored element/component-wise by avoiding mixing up the different elements. This way, any element or component can be easily located during the erection of the bridge.

All fixtures (nuts/bolts, washers, thimbles and bulldog grips) should be packed/marked and stored separately according to their sizes.

Steel parts, particularly suspenders and reinforcement bars, should not be bent during carriage and storage.

ii) Wire Rope (Cable) Transportation and Storing

It is vital to handle and transport the steel rope carefully in order to avoid causing any damage like kinks, splices and broken strands.

The pulling or dragging the cable along the road during transportation is not permitted. The steel rope should be unreeled straight without any kinks or bends. Before cutting the rope, ends should be secured by a binding-wire (seizing) to avoid loosening of the cable wires. The ropes when unreeled shall always be transported in straight position.

10.2.4.3 ERECTION OF BRIDGE

i) **General**

Before undertaking the bridge erection, the contractor shall submit for approval of the Engineer-in-Charge a detailed method statement stating the procedure that shall be followed for erection of bridge. Any deviations from the approved procedure shall be only with the prior approval of the Engineer-in-Charge. The approval of method by Engineer-in-Charge or described hereof shall not relieve the Contractor of his responsibility to complete the work in all respects as specified and as directed by the Engineer-in-Charge.

ii) **Safety & Security**

As soon as the anchor blocks and towers are completed, the bridge erection works can be started. The bridge erection and fitting works are some what risky, and require especially skilled labourers who will not suffer from giddiness. Because of this somewhat risky work, the necessary statutory safety precautions should strictly be followed and the respective responsibilities should be clarified before starting the work.

iii) **Hoisting of Main Cable**

The Contractor shall pull the steel ropes across the river safely with the help of anylon rope or any other safe method proposed by him and approved by the Engineer-in-Charge. The ends of cables pulled across the river should be protected by attaching an empty airtight plastic jerry can to safe guard their sticking in stones and rocks lying on river bed. The main steel rope should be pulled over the saddle plates installed at top of thetowers and fixed temporarily at the respective turnbuckle at the main cable anchors. The cover plate of the saddle should be kept loose during bridge erection time but should be tightened firmly after completion of operation**.**

iv) **Sag setting**

It is one of the most important tasks during the erection of the bridge.

The cables over saddle plates are loose as stated above. With this arrangement, the main cables can slide over the saddles when the bridge is being erected**.**

With a levelling instrument, the exact hoisting sag could be fixed in the following way:

- The elevation of the hoisting sag should be marked on both the towers with permanentpaint. The hoisting sag is difference between the top of cable on two towers and top of specified dip at mid point.
- The levelling instrument should be setup onthe tower foundation so that its line of sight matches with the mark on the tower across the river. Setting up the levelling instrument at the prescribed hoisting sag
- elevation has to be done by trial and error, and may require several attempts

- The Main Cables should be pulled until they reach a level of about 8 inches (20 cm) higher than the hoisting sag.
- The cables should be clamped around the thimbles at the cross bar of the Turnbuckle of the main cable anchorage. The crossbar should be in the middle position of the threaded anchor bars when clamping the main cables, secured with two nuts in the front and one in the back in the turnbuckle as shown on drawings.
- The Main Cables should be left in this “over pulled” position for at least 12 hours so that some relaxation can take place.
- The turnbuckles should be moved to achieve the exact sag setting. For compensating elongations due to change in air temperature, the hoisting sag is to be checked at different times of the day for necessary adjustments. It is advisable to adjust the final sag setting during the hot day after noon, when the cables have accumulated maximum heat, i.e., during maximum elongation condition.
- The hoisting sags of the two Main Cables must be identical at any point of time.
- The sags should be checked from time to time when the fitting works are going on. Different elongations may take place due to dissimilar hidden cable relaxations when the tension increases. The possible sag differences should be adjusted with the help of the turnbuckles at the main cable anchor so that the Main Cables are always parallel. The dead load sag should be compared with the pre-calculated values after installation.

v) **Fitting Suspenders and Centre Row of Bridge Deck**

Fitting the suspenders and walkway elements shall be carried out observing full safety and security arrangements.

The suspender fitting work should start from both the towers and proceed towards the centre of the bridge. This procedure should be easier and more advantageous than starting the fitting work from the centre. However, in order to achieve a proper symmetry of the suspenders, the central suspenders must be fitted first.

Due to inaccuracies, the remaining spacing at the centre of the bridge might be either too long or too short.To safeguard this, the required distances to the towers and the centre have to be rechecked after fitting 10 suspenders.

For proceeding with further erection, all the suspenders should be laid in sequence on the ground. The deck material consisting of transoms, clamps hooks and bridge deck should be ready. Special and safe, fitter platforms should be made for working on main cables and bridge deck. In addition cablecars should be installed on the top of two main cables.

The suspenders pair in the centre of bridge should be erected first after precisely determining their position. The deck at centre suspenders should also be erected.Thereafter the erection of suspenders should start simultaneously from the two towers.

To ensure the exact location of suspenders, the gauge sticks should be used for checking the spacing between them. While the suspenders &transoms are being erected, the distance between tower and centre should be checked at suitable interval say after ten installations and inaccuracies rectified. The installation of bridge deck consisting of runners and wooden floor can then be proceeded.

It should be ensured that all clamps which hold the suspenders and deck are tightened firmly.

vi) **Fitting Wind Guys and Bracings**

The contractor should submit the shop drawing giving the sizes and length of wind guy and wind ties.

The Contractor shall provide suitable platforms, cable car for working as required.

The wind guys shall be carried across the river and installed at turnbuckles of their anchors in the same manner as for main cableand shall be given initial tension. The ties for wind guys shall be laid on the deck. The ties shall be fixed with transoms and wind guys using clamps and turn buckles, as shown on drawings at correct position. Final adjustment of wind ties shall be made by using the grips with transoms and also turn buckle. The wind guys should then be adjusted at the final tension using turn buckles. After the wind guys and ties are installed, it should be checked if all the cables are tight and balancely fixed.

vii) **Finishing Erection Work**

After all the erection is completed, the cover plates at the top of saddles of main hoisting cables shall be fixed in position.

The handrail as shown on drawings shall be installed.

The contractor shall submit a report in the form of check list for daily installation in accordance with the approved erection procedure.

10.3 CONCRETE BEAM GUARDRAIL

10.3.1 SCOPE

The work shall consist of concrete guardrail constructed in accordance with the provisions of the relevant Section of the specifications at the locations and in conformity with the dimensions, and design shown the Drawings or ordered by the Engineer-in-Charge.

10.3.2 MATERIAL REQUIREMENTS

10.3.2.1 CONCRETE BEAM GUARDRAIL

The rail shall be of concrete as specified in accordance with Section 5-Plain & Reinforced Concrete. Reinforcing steel shall conform to requirement as stipulated in Section 5.4. Concrete Beam Guardrail shall be of size 125 mm x 300mm,where as reinforcing steel shall be provided at the rate of one hundred twenty (120) Kg. Per cubic meter. Dimension of guardrail and reinforcement may change as per Drawings or as directed by the Engineer-in-Charge.

10.3.2.2 CONNECTIONS AND SPLICES

Bolts, nuts, washers, sleeves and other fittings shall conform to ASTM Designation A 325 (AASHTO M-164) and shall be zinc coated in accordance with the requirement of ASTM Designation A (AASHTO M232)

10.3.2.3 GUARDRAIL POSTS

Posts shall be of concrete 1:3:6 in accordance with Section 5 – Plain & Reinforced Concrete.

Per-cast reinforced concrete posts shall be of a section 250 mm x 250 mm. The concrete shall be 1:2:4 or as specified. Reinforcement shall conform to the requirements of AASHTO M-31 or M-53. All bars shall be of the deformed type conforming to AASHTO M-31. Reinforcing Steel shall be provided at the rate of one hundred twenty (120) Kg per cubic meter. Dimensions of post and reinforcement may change as per Drawings or as directed by the Engineer-in-Charge.

10.3.2.4 POST FOUNDATION BLOCKS

Where required or as ordered by the Engineer-in-Charge post foundation blocks, shall be constructed in concrete according to the specified section and length or as directed by the Engineer-in-Charge.

10.3.3 CONSTRUCTION REQUIREMENTS

10.3.3.1 FORMWORK

Formwork shall be supplied and fixed in the position required for the concrete to be cast as shown on the Drawings or as required by the Engineer-in-Charge, and shall be supplied, erected and removed as specified in Sub-Section 5.5.

10.3.3.2 STEEL REINFORCEMENT

Steel reinforcement shall be furnished, bent and fixed where shown on the Drawings, or where required by the engineer-in-charge and its furnishing, bending, bending & fixing shall be in accordance with Sub-Section 5.4.

10.3.3.3 CONCRETE

Concrete as specified shown on the Drawings or as required by the Engineer-in-Charge shall be supplied, placed, finished and covered as specified in Section 5.

10.4 BRIDGE RAILING

10.4.1 SCOPE

The work consists of the supply and erection of concrete railing for bridges and other structures in accordance with these specifications and to the details shown on the Drawings.

10.4.2 MATERIAL REQUIREMENTS

10.4.2.1 FORMWORK

Formwork where necessary, shall conform to provisions of Sub-Section 5.5.

10.4.2.2 STEEL REINFORCEMENT

Steel reinforcement shall be as specified in Sub-Section 5.4.

10.4.2.3 CONCRETE

Concrete shall be as specified in or as shown on the Drawings.

10.4.3 CONSTRUCTION REQUIREMENTS

10.4.3.1 FORMWORK

Formwork shall be supplied and erected at the required position for the concrete to be cast as shown on the Drawings, or as directed by the Engineer-in-Charge, and shall be removed as specified in Sub-Section 5.5 under Plain & Reinforced Concrete.

10.4.3.2 STEEL REINFORCEMENT

Steel reinforcement shall be furnished, bent and fixed where shown on the Drawings or where directed by the Engineer-in-Charge and its furnishing, bending, and fixing shall be in accordance with the Section 5.4 under Plain & Reinforced Concrete.

10.4.3.3 CONCRETE

Concrete as specified on the Drawings or as directed by the Engineer-in-Charge shall be supplied, placed, finished and covered, as specified in Section 5-Plain & Reinforced Concrete.

10.5 METAL BEAM GUARD-RAIL

10.5.1 DESCRIPTION

This item shall consist of metal beam Guard rail constructed in accordance with these specifications at the locations and in conformity with the dimensions, and design shown on the Drawings or as ordered by the Engineer-in-Charge

10.5.2 MATERIAL REQUIREMENTS

10.5.3 METAL BEAM GUARD RAIL

The rail elements shall be galvanized corrugated steel beam conforming to the requirements of AASHTO M 180 of the designated type and class.

The mechanical properties of the base metals for beams shall conform to the following requirements:

Yield Point	-	3500 kg / sq. Cm. (minimum)
Tensile Strength	-	4900 kg / cm. (minimum)
Elongation	-	not less than 12 percent in a 2 inch (5.08 cm) Gauge length when tested in accordance with ASTM E 8.

In addition to the above, the rail shall withstand a cold bend without cracking of one hundred eighty (180) degree around a mandrel of a diameter equal to two and half (2.1/2) times the thickness of the plate.

10.5.4 END OR BUFFER SECTION

The end or buffer sections shall be formed from open hearth, electric furnace or basic oxygen steel. The section shall be of the same or superior class and type used for the beam to which it is attached.

10.5.5 CONNECTIONS AND SPLICES

All connections or splices shall be formed with oval shoulder button – headed bolts to minimize projections on the side of the guard. All bolts and nuts for beams shall conform to or exceed the requirements of ASTM A-307 and shall be galvanized as specified in ASTM A-153.

The bolted connection of the rail element to the post shall withstand a two thousand two hundred seventy (2270) kg pull at right angles to the line of the railing.

10.5.6 GUARD RAIL POSTS

Posts shall be of either steel or concrete as specified. Only one type of post shall be used for any one continuous Guard rail, except at junctions between bridges and approach embankments.

a) Steel posts shall be galvanized and of the section and length specified or as shown on the Drawings. They shall conform to the requirements of AASHTO M-183 for the grade specified.

b) Precast reinforced concrete posts shall be of a section and length as specified or as shown on the Drawings. The concrete shall be as specified on drawings. Reinforcement shall be of the deformed type, conforming to the provisions of Sub-Section 5.4 under Section 5 – Plain & Reinforced Concrete.

10.5.7 WOODEN SPACER BLOCKS

Wooden spacer blocks between the Guard rail and the posts shall conform to AASHTO M-133 and M-168 and be constructed to the section and length specified or as shown on the Drawings.

10.5.8 POST FOUNDATION BLOCKS

Where required or as ordered by the Engineer-in-Charge, post foundation blocks shall be constructed in 1:3:6 concrete as specified in the Sub-Section 5.3.2.2 and length specified or as shown on the Drawings.

In order to facilitate the removal of posts damaged by vehicle impact, posts shall be set in galvanized tubular steel sockets cast in to foundation blocks. The sockets shall be of internal dimension(s) after galvanizing such that there is a clearance of 3 to 5 mm between the socket and the guard rail post. Following erection of guardrails, the space between posts and sockets shall be filled with epoxy mortar.

10.5.9 CONSTRUCTION REQUIREMENTS

All posts shall be set vertically in the position shown on the Drawings and where embedded in a concrete foundation block shall remain undisturbed for a minimum of forty eight (48) hours. The space around the post foundation blocks shall be backfilled to the ground line, with selected earth containing no rocks, in layers of not exceeding ten (10) cm and each layer shall be moistened and thoroughly compacted as specified on drawing or as directed by Engineer-in-charge. Where steel posts are driven into the ground no buckled post or deformed head shall be accepted.

10.5.10 ERECTION OF RAIL

All metal work shall be fabricated in the shop and no cutting or welding shall be done in the field unless otherwise ordered by the Engineer-in-Charge. Rail elements terminal sections shall be installed in accordance with the manufacturer's recommendation.

10.6 MEASUREMENT AND PAYMENT

10.6.1 COMPOSITE RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

10.6.2 LABOUR RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

10.6.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR are measured in the above mentioned criteria;
   Item No.: 10-1 to 10-33, 10-42 to 10-54,10-56 to 10-58,10-61 to 10-62 and 10-67
2. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following item of CSR is measured according to this criteria;
   Item No.: 10-65

3. For bulk items, the quantity of work shall be measured in units of weight i.e. Tonne or Tons. Following items of CSR are measured according to this criteria;

   Item No.: 10-35, 10-38, 10-68

4. The following Items of CSR shall be measured as Weight units i.e. Kilogram or Pound;
   Item No.: 10-34,10-36, 10-37 and 10-39 to 10-41
5. The following items shall be measured as %age Nos.;
   Item No.: 10-55, 10-59, 10-60
6. The following items shall be measured as Each;
   Item No.: 10-63, 10-64, 10-66

10.6.4 JOINTS, WATER-STOPS BEARING DEVICES ASPHALT FELT

a) **Filled Concrete Joints**

The quantity to be paid for shall be in square meters of either expansion joint with preformed joint filler or expansion joint with neoprene rubber sheet six(6mm) thick and covered with bitumastic seal, completed and accepted in work.

b) **Steel Joints**

The quantity to be paid for shall be in kilograms of steel for steel joints fabricated, galvanized and placed in the work completed and accepted.

c) **Water-stops**

The quantity to be paid for shall be in linear meters of Water-stop placed in the work, completed and accepted.

d) **Bearing Devices**

The quantity to be paid for shall be in cubic centimetres of bearing devices either steel bearing or elastomeric bearing pads installed in the work completed and accepted.

e) **Asphaltic Felt**

The quantity to be paid shall be in square meter of 3 ply rating Fibre/Fabric based asphaltic felt weighing forty one (41) kg to forty five (45) kg per 20 square meter including sticking coat/paint coat and flood coat of special industrial bitumen and sand blinding as approved by the Engineer-in-Charge, laid in place as directed by the Engineer-in-Charge.