foundation structure for shoring and other protective supports and for disposal of Unsuitable/surplus excavated materials by hauling to any distance at approved locations.   
Should it be necessary, in the opinion of the Engineer, to lower the footing/foundation to an elevation below the level shown on the approved drawings, payment for the excavation and backfill for structures required below plan level up to 1 .5m for any individual footing or whole foundation will be made at unit price equal to 115% of Contract unit price and payment for the excavation from an elevation greater than 1.5m below plan level up to 3m below will be made at a unit price equal to 125% of the Contract unit price. In case, where additional depth required for any footing/foundation beyond 3m, a supplementary agreement shall be made covering the excavated quantities recovered from depths in excess of 3m below the plan grade.

**11 Formwork**

**L8.1 Description**

The Formwork consists of furnishing all materials, labour, equipment, manufacturing, installation and removal of formwork. The materials required for manufacturing of formwork may be timber, plywood, bamboo, steel, paint etc. In all hydraulic structures, steel shutter shall only be used except minor joints and chamfer.

It shall be the responsibility of the Contractor to perform the work by engaging well trained and experienced staff or by the sub-contractor who shall have enough number of well trained and experienced staff to coordinate his activities with the other operatories. However the Contractor shall be responsible for the quality of work performed by the sub-contractor as per the requirements of these specifications.

**2.8.2 Concrete Formwork**

1) The Contractor shall submit for the approval of the Engineer details of the methods and materials proposed for formwork to each section of the work, Details of all proposed wrought formwork and formwork to produce special finishes are to be submitted, for approval in writing to the Engineer before any materials are brought on to the Site. If the Engineer so requires, samples of formwork shall be constructed and concrete placed so that the proposed methods and finish effect can be demonstrated.

ii) Formwork shall be constructed from sound materials of sufficient strength, properly braced strutted and shored as to ensure rigidity throughout the placing and compaction of the concrete without visible deflection. Formwork shall be so constructed that it can be removed without shock or vibration to the concrete.

iii) All joints shall be close fitting to prevent leakage of grout and at construction joints the formwork shall be tightly secured against previously cast or hardened concrete to prevent stepping or ridges to exposed surfaces.

iv) Where the Contractor proposes to make the formwork from standard sized manufactured formwork panels, the size of such panel shall be approved by the Engineer before they are used in the construction of the work. The finished appearance of the entire elevation of the structure and the adjoining structures shall be considered when planning the patterns of joint lines caused by formwork and by construction joints to ensure continuity of horizontal and vertical lines.   
v) Formwork shall be constructed to provide the correct shape, lines and dimensions of the concrete shown on the Drawings. Due allowance shall be made for any deflection which will occur during the placing of concrete within the formwork. Panels shall have true edges to perm accurate alignment and provide a neat line with adjacent panels and at all construction joints. All panels shall be fixed with their joints either vertical or horizontal, unless otherwise specified of approved.

vi) Formwork shall be provided for the top surfaces of sloping work where the slope exceeds 15 with the horizontal and shall be anchored to enable the concrete to be properly compacted and prevent floatation; care shall be taken to prevent air being entrapped. Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed as to be easily closed before placing concrete.   
vii) Forms Panels shall be supported by scaffolding pipe and steel joist sufficient enough to withstand all impact, weight of green concrete, moving loads etc.

**2.8.3 Formwork for Exposed Concrete Surfaces**

i) Unless otherwise stated on the Drawings, wrought formwork shall be used for all permanently visible concrete surfaces. Wrought formwork shall be such as to produce a smooth and even surface free from perceptible irregularities. Tongued and grooved planed boards, plywood or steel forms shall have their joints flush with the surface. The formwork shall be formed from approved standard sized panels. The panels shall be arranged in a uniform approved pattern, free from defects likely to be detected in the resulting concrete surface.

ii) Formwork for structural concrete permanently exposed to public inspection shall be faced with plain 28/28 gauge steel sheet fitted over 38 mm thick wooden plank panels suitably braced or steel framing faced with minimum 12/14 BWG mild steel sheet.

iii) The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.

iv) The panels I forms shall be supported by scaffolding pipe and steel joist sufficient enough to withstand all impact, weight of green concrete, moving loads etc.

**2.8.4 Formwork for Non-Exposed Concrete Surfaces**

Unless otherwise stated on the Drawings, rough formwork may be used for all surfaces which are not permanently exposed. Rough formwork may be constructed of plain butt joined sawn timber but the Contractor shall ensure that all joints between boards shall be grout tight.   
The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.

**2.8.5 Preparation of Formwork**

I) Before concrete is placed, the surfaces of formwork shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chippings or other foreign matter.

ii) Before placing concrete all reinforcement bars, anchoring, steel, beams, cables, fixing truss, bolts, pipes or conduits or any other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not be cut in any concrete without the approval of the Engineer.

iii) All exterior and interior angles on the finished concrete shall be given 20 mm by 20 mm chamfers unless otherwise shown in Drawings or ordered by the Engineer. When chamfers are to be formed, the fillets shall be accurately cut to size to provide a smooth and continuous chamfer:

iv) No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Engineer. The whole or part of any such supports embedded in reinforced concrete shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50mm from the surface. Holes left after removal of such supports shall be neatly filled with well rammed dry-pack mortar.

v) After cleaning, the formwork in contact with the concrete shall be treated with suitable no staining mould oil or approved form oil to prevent adherence of the concrete. Care shall be taken to prevent the oil from coming in contact with reinforcement or mixing with the concrete. At construction joints, surface retarding agents shall be used only where ordered by the Engineer.

vi) The ue of spacer blocks for the reinforcement shall be prohibited whenever the same effect can

be achieved by properly dimensional spacer rings mounted directly on the reinforcement All spacer blocks and rings shall be of the same strength as the concrete iii which they are embedded and shall be adequately cured before use.

Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil. or release agent shall not react with concrete to affect the strength nor shall it give any color. It shall be applied in such a manner as not to contaminate the reinforcement and other fixtures to be embedded in concrete.

**2.8.6 Removal of Formwork**

1) Formwork shall be removed in such a manner as will not damage the concrete. No formwork shall be removed until the concrete has gained sufficient strength to support itself. Centers and props may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety.   
ii) The following table is a guide to the minimum periods which must elapse between the completion of the concreting operations and the removal of formwork. No formwork shall be removed without the permission of the Engineer and such permission shall not relieve the Contractor of his responsibilities for the safety of the structure.

**Table : 2.8.6 Minimum period** of curing **before removal of formwork**

Notwithstanding the foregoing the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

**2.8.7 Openings**

Temporary and permanent opening in concrete shall be framed neatly with provisions for keys or reinforcing steel as shown on the drawing or approved or directed by the Engineer.

**2.8.8 Defects in Formed Surfaces**

Workmanship in formwork and concreting shall be such that concrete shall normally require no repair to surfaces being perfectly compacted and smooth.

If any blemish is revealed after removal of formwork, the Engineers decision concerning remedial measures to be undertaken shall be obtained immediately. These measures may include, but shall to be limited to, the following:

|  |  |
| --- | --- |
| Type and Position of Formwork | Approximate Period (days) |
| Side of beams, walls and columns (unloaded) | 3 |
| Slab soffits (props supporting) | 14 |
| Removal of props to slabs | 21 |
| Beam soffits (props supporting) | 21 |
| Removal of props to beams | 28 |

1) Fins, pinholes, bubbles, surface discoloration and mirror defects may be rubbed down with sacking immediately the formwork are removed;

ii) Abrupt and gradual irregularities may be rubbed down with carborundum stone and water after the concrete has been fully cured;

iii) Deep honey combed concrete shall be repaired within 24 hours of stripping the forrnwork by cutting back to sound concrete. The concrete shall be cut back at least 50mm behind face reinforcement. Cut edges shall be regular and not feathered. Recasting shall be with the same concrete as the original casting; the Contractors formwork and method of placing shall be approved by the Engineer.

iv) Under some circumstances, abrupt and gradual irregularities of shallow honey combed concrete may be repaired by cutting back and reforming with an approved epoxy resin or mortar in accordance with the Manufacturer’s instructions.

**2.8.9 Holes to be filled**

i) Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry pack mortar made from one part by weight of Ordinary Portland Cement/Portland Composite Cement and three parts of specified fine aggregate approved by the Engineer. The mortar shall be mixed with only sufficient water to make the materials stick together when being molded in the hands.

ii) The Contractor shall thoroughly clean any hole that is to be filled and break out any loose, broken or cracked concrete or aggregate, removing any dry cement in the hole. The surrounding concrete shall be soaked until the whole surface that will come into contact with the dry pack mortar has been covered and darkened by absorption of the free water by the cement. The surface shall then be dried so as to leave a small amount of free water on the surface.

iii) The-dry pack material shall then be placed and packed in layers having a compacted thickness not greater than 10mm in thickness. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry pack against the sides of the hole;

iv) After compaction the surface of each layer shall be scratched before further loose material is added. The hole shall be slightly over filled and the surface shall be finished by laying a hardwood block against the dry pack fill and striking the block.

**2.8.10 Design Joints**

i) Design joints shall be formed in the positions and manner shown on the Drawings and shall be shuttered square to the work to provide a smooth surface to the concrete. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The face of the joint first formed shall be smooth, dense and free from irregularities and honeycombing. The plane of the joint shall extend completely through the structure unless shown otherwise on the Drawings.

ii) Caulking grooves shall be provided as shown on the Drawings or in accordance with the joint sealant manufacturer’s recommendations. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried It shall be primed and caulked with approved sealant compound applied in accordance with the manufacturer’s instructions.

iii) Filters, as specified on the Drawings, shall be placed between the joints and adjacent earth surface.

**2.8.11 Contraction Joints**

Contraction joints are defined as joints placed in structures or slabs to provide for volumetric shrinkage of monolithic unit or movement between monolithic units. The joints shall be constructed so that there will be no bond between the concrete surface forming the joints.

**2.8.12 Expansion Joints**

Expansion joints are intended to accommodate relative movement between adjoining parts of a structure. The size of expansion joints shall up to 40mm depth and 20-25mm wide.

Compressible filler shall be placed between the joint faces to provide freedom for the two adjacent concrete masses to expand. Care shall be taken to ensure that the material fails the joint completely and that no concrete or hard material is left in the joint after the second face of the joint has been cast.

Measurement:

The item formwork shall be measured in Square Meter of the exposed concrete surface including all designed joints.

Payment:

Payment shall be made at the rate Square Meter as included in BoQ.