

Formwork

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Formwork

1501. DESCRIPTION

Formwork shall include all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support. The design, erection and removal of formwork shall conform to IRC:87 "Guidelines for Design and Erection of Falsework for Road Bridges" and these specifications.

1502. MATERIALS

All materials shall comply with the requirements of IRC:87. Materials and components used for formwork shall be examined for damage or excessive deterioration before use / re-use and shall be used only if found suitable after necessary repairs. In case of timber formwork, the inspection shall not only cover physical damages but also signs of attacks by decay, rot or insect attack or the development of splits.

Forms shall be constructed with metal or timber. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolts should be countersunk. The use of approved internal steel ties or steel or plastic spacers shall be permitted. Structural steel tubes used as support for forms shall have a minimum wall thickness of 4 mm. Other materials conforming to the requirements of IRC:87 may also be used if approved by the Engineer.

1503. DESIGN OF FORMWORK

1503.1. The Contractor shall furnish the design and drawing of complete formwork (i.e. the forms as well as their supports) for approval of the Engineer before any erection is taken up. If proprietary system of formwork is used, the Contractor shall furnish detailed information as per *Appendix 1500/II* to the Engineer for approval.

Notwithstanding any approval or review of drawing and design by the Engineer, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

1503.2. The design of the formwork shall conform to provisions of IRC:87. It shall ensure that the forms can be conveniently removed without disturbing the concrete. The design shall facilitate proper and safe access to all parts of formwork for inspection.

1503.3. In the case of prestressed concrete superstructure, careful

consideration shall be given to redistribution of loads on props due to prestressing.

1504. WORKMANSHIP

1504.1. The formwork shall be robust and strong and the joints shall be leak-proof.

Balli shall not be used as staging. Staging must have cross bracings and diagonal bracings in both directions. Staging shall be provided with an appropriately designed base plate resting on firm strata.

1504.2. The number of joints in the formwork shall be kept to a minimum by using large size panels. The design shall provide for proper "soldiers" to facilitate alignment. All joints shall be leak proof and must be properly sealed. Use of PVC JOINT sealing tapes, foam rubber or PVC T-section is essential to prevent leakage of grout.

1504.3. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be withdrawn easily. Use of double headed nails shall be preferred.

1504.4. Use of ties shall be restricted, as far as practicable. Wherever ties are used they shall be used with HDPE sheathing so that the ties can easily be removed. No parts prone to corrosion shall be left projecting or near the surface. The sheathing shall be grouted with cement mortar of the same strength as that of the structure.

1504.5. Unless otherwise specified, or directed, chamfers or fillets of sizes 25 mm x 25 mm shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, bevelled edges and mouldings shall be made in the formwork itself. Opening for fixtures and other fittings shall be provided in the shuttering as directed by the Engineer.

1504.6. Shuttering for walls, sloping members and thin sections of considerable height shall be provided with temporary openings to permit inspection and cleaning out before placing of concrete.

1504.7. The formwork shall be constructed with precamber to the soffit to allow for deflection of the formwork. Pre-camber to allow for deflection of formwork shall be in addition to that indicated for the permanent structure in the drawings.

1504.8. Where centering trusses or launching trusses are adopted

for casting of superstructure, the joints of the centering trusses, whether welded, riveted or bolted should be thoroughly checked periodically. Also, various members of the centering trusses should be periodically examined for proper alignment and unintended deformation before proceeding with the concreting. They shall also be periodically checked for any deterioration in quality due to steel corrosion.

1504.9. The formwork shall be so made as to produce a finished concrete true to shape, line and levels and dimensions as shown on the drawings, subject to the tolerances specified in respective sections of these specifications, or as directed by the Engineer.

1504.10. Where metal forms are used, all bolts and rivets shall be countersunk and well ground to provide a smooth, plane surface. Where timber is used it shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the surface of concrete.

1504.11. Forms shall be made sufficiently rigid by the use of ties and bracings to prevent any displacement or sagging between supports. They shall be strong enough to withstand all pressure, ramming and vibration during and after placing the concrete. Screw jacks or hard wood wedges where required shall be provided to make up any settlement in the formwork either before or during the placing of concrete.

1504.12. The formwork shall take due account of the calculated amount of positive or negative camber so as to ensure the correct final shape of the structures, having regard to the deformation of false work, scaffolding or propping and the instantaneous or deferred deformation due to various causes affecting prestressed structures.

1504.13. Suitable camber shall be provided to horizontal members of structure, specially in long spans to counteract the effects of deflection. The formwork shall be so fixed as to provide for such camber.

1504.14. The formwork shall be coated with an approved release agent that will effectively prevent sticking and will not stain the concrete surface. Lubricating (machine oils) shall be prohibited for use as coating.

1505. FORMED SURFACE AND FINISH

The formwork shall be lined with material approved by the Engineer so as to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and so fixed to its backing as not to impart any blemishes. It shall be of the same type and obtained from only one source throughout

for the construction of any one structure. The contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and embedded metal parts shall be carefully detailed and their use shall be subject to the approval of the Engineer.

1506. PRECAUTIONS

- (i) Special measures in the design of formwork shall be taken to ensure that it does not hinder the shrinkage of concrete. The soffit of the formwork shall be so designed as to ensure that the formwork does not restrain the shortening and/or hogging of beams during prestressing. The forms may be removed at the earliest opportunity subject to the minimum time for removal of forms with props retained in position.
- (ii) Where necessary, formwork shall be so arranged that the soffit form, properly supported on props only can be retained in position for such period as may be required by maturing conditions.
- (iii) Any cut-outs or openings provided in any structural member to facilitate erection of formwork shall be closed with the same grade of concrete as the adjoining structure immediately after removal of formwork ensuring watertight joints.
- (iv) Provision shall be made for safe access on, to and about the formwork at the levels as required.
- (v) Close watch shall be maintained to check for settlement of formwork during concreting. Any settlement of formwork during concreting shall be promptly rectified.
- (vi) Water used for curing should not be allowed to stagnate near the base plates supporting the staging and should be properly drained.

1507. PREPARATION OF FORMWORK BEFORE CONCRETING

The inside surfaces of forms shall, except in the case of permanent form work or where otherwise agreed to by the Engineer be coated with a release agent supplied by approved manufacturer or of an approved material to prevent adhesion of concrete to the formwork. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not be allowed to come into contact with any reinforcement or prestressing tendons and anchorages. Different release agents shall not be used in formwork for exposed concrete.

Before re-use of forms, the following actions shall be taken :

- (i) The contact surfaces of the forms shall be cleaned carefully and dried before applying a release agent.
- (ii) It should be ensured that the release agent is appropriate to the surface to be coated. The same type and make of release agent shall be used throughout on similar formwork materials and different types should not be mixed.

- (iii) The form surfaces shall be evenly and thinly coated with release agent. The vertical surface shall be treated before horizontal surface and any excess wiped out.
- (iv) The release agent shall not come in contact with reinforcement or the hardened concrete.

All forms shall be thoroughly cleaned immediately before concreting.

The Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and approve the formwork, but such inspection shall not relieve the contractor of his responsibility for safety of formwork, men, machinery, materials and finish or tolerances of concrete.

1508. REMOVAL OF FORMWORK

The scheme for removal of formwork (i.e. de-shuttering and de-centering) shall be planned in advance and furnished to the Engineer for scrutiny and approval. No formwork or any part thereof shall be removed without prior approval of the Engineer.

The formwork shall be so removed as not to cause any damage to concrete. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

Where not specifically approved, the time of removal of formwork (when ordinary Portland Cement is used without any admixtures at an ambient temperatures exceeding 10 degrees Celsius) shall be as under :

a) Walls, piers, abutments, columns and vertical faces of structural members	:	12 to 48 hours as may be decided by the Engineer
b) Soffits of Slabs (with props left under)	:	3 days
c) Props (left under slabs)	:	14 days
d) Soffit of Girders (with props left under)	:	7 days
e) Props (left under girders)	:	21 days

Where there are re-entrant angles in the concrete sections, the formwork should be removed at these sections as soon as possible after the concrete has set, in order to avoid cracking due to shrinkage of concrete.

1509. RE-USE OF FORMWORK

When formwork is dismantled, its individual components shall be examined for damage and damaged pieces shall be removed for rectification. Such examination shall always be carried out before being used again. Before re-use all components shall be cleaned of deposits of soil, concrete or other unwanted materials. Threaded parts shall be oiled after cleaning.

All bent steel props shall be straightened before re-use. The maximum deviation from straightness is $1/600$ of the length. The maximum permissible axial loads in used props shall be suitably reduced depending upon their condition. The condition of the timber components, plywood and steel shuttering plates shall be examined closely for distortion and defects before re-use.

1510. SPECIALISED FORMWORK

Specialised formwork may be required in the case of slipform work, underwater concreting, segmental construction etc. Such specialised formwork shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Engineer. The site personnel shall be trained in the erection and dismantling as well as operation of such specialised formwork. In case proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc., in the form of manuals along with the formwork. Where specialised formwork is used, close co-ordination with the design of permanent structure is necessary.

For slipform the rate of slipping the formwork shall be designed for each individual case taking into account various parameters including the grade of concrete, concrete strength, concrete temperature, ambient temperature, concrete admixtures, etc. In the case of segmental construction, the concrete mix shall be normally designed for developing high early strength so that the formwork is released as early as possible.

In order to verify the time and sequence of striking/removal of specialised formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

For specialised formwork, the form lining material may be either plywood or steel sheet of appropriate thickness. Plywood is preferred where superior quality of surface is desired, whereas steel sheeting is normally used where large number of repetitions are involved.

1511. TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

1512. MEASUREMENTS FOR PAYMENT

Unless stated otherwise the rate for concrete in Plain Concrete or Reinforced Concrete or Prestressed Concrete shall be deemed to include all formwork required in accordance with this section and shall not be measured separately.

Where it is specifically stipulated in the Contract that the formwork shall be paid for separately, measurement of formwork shall be taken in square metres of the surface area of concrete which is in contact with formwork.

1513. RATE

The unit rate of the Plain Concrete or Reinforced Concrete or Prestressed Concrete as defined in respective sections shall be deemed to cover the costs of all formwork, including cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this section including properly supporting the members until the concrete is cured, set and hardened as required.

Where the contract unit rate for formwork is specifically provided as a separate item, it shall include the cost of all materials, labour, tools and plant required for design, construction and removal of formwork and supervision as described in this Section including properly supporting the members until the concrete is cured, set and hardened as required.

