

CHAPTER 9

CENTRING AND SHUTTERING

SPECIFICATION NO. 9.1—Centring and Shuttering
(Technical Specifications)

1. Forms for concrete shall be used, wherever necessary, to confine and mould the plastic concrete to the required shape, or to ensure against contamination of the concrete by materials, caving of sloughing in from adjacent excavations or other adjoining features of the work. Forms may also be necessary in order to produce a desired type of finished concrete surface.

Purpose.

All exposed concrete surfaces having slopes of 1 to 1 or steeper shall be formed unless otherwise directed.

2. Of the total cost of reinforced concrete structure, the cost of shuttering and centring may be anything upto 30 per cent and may be considerably in excess of this proportion in bridge work and high level roofs where extensive centring is required. Thus any economy made in shuttering can affect overall costs appreciably and such economy should be made in the following directions :—

Economy in shuttering.

- (i) By making calculations to determine adequate sizes for the various components of the forms and supports. This avoids both waste of materials and the use of undersized boards and props that due to distortion or collapse may lead to expensive replacement.
- (ii) By constructing the shuttering in such a way, that there is the least amount of wastage in fabrication and that the shuttering can be reused and has a good salvage value at the completion of each stage.
- (iii) By arranging for as many uses of one set of forms as possible. The designer can considerably assist in this direction by reducing variations of section to a minimum, by avoiding superfluous breaks, and by providing simple profiles that even at the expense of a little more concrete, may lead to economical shuttering.

3. Before the type of form work is selected for a big job involving large quantity of concrete work, thorough consideration shall be given to factors like total square feet (square metres) of coverage, square

Selection of type.

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feet (square metres) of uniform surface, form handling facilities, capacity of the concrete placing plant and expected output, the height of lift, pressure against forms based on the consistency and the rate of rise of concrete, and the cost of labour. The type of forms shall finally be selected in the light of merits and demerits of various types of forms, the extent to which various panel forms can be used and reused and the surface finish desired.

Striking forms. 4. The correct stage for striking forms is when the concrete has reached a strength of at least twice the stress to which it may be subjected at the time of striking. On this principle the periods given below are specified for general guidance.

Forms carrying structural loads. 5. In the case of structures carrying structural loads during construction, forms shall not be disturbed until the concrete has adequately hardened nor shall the shores or supporting braces be removed until the structure has attained its full designed strength, and all excess construction load removed.

Forms carrying construction load. 6. The proper time for the removal of the form shall be determined by the engineer for each case on its merits. As a rule for structures carrying construction loads, side timbers shall not be removed within 7 days and supporting timbers within 28 days of the placing of the concrete.

Striking other forms. 7. In the case of structures not carrying structural loads during construction, forms may be struck after the following periods have elapsed after placing the concrete :—

- (a) Vertical side of slabs and beams .. 48 hours.
- (b) Vertical sides of walls and columns (provided 48 hours
the beams or slabs resting on them are supported to prevent an appreciable load coming on them).
- (c) Bottoms of slabs up to 15 feet (4.6 metres) .. 7 days.
span
- (d) Bottoms of slabs above 15 feet (4.6 metres) .. 14 days
span, and bottoms of beams upto 20 feet
(6.0 metres) span.

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- (e) Bottoms of beams above 20 feet 21 days
(6.0 metres) span.

Note:—For cantilever slabs or beams, the centring shall remain till structures for counteracting or anchoring down have been provided and have attained sufficient strength.

8. The above periods are for normal weather conditions in plains when temperature is above 21°C (70°F). In cold weather conditions, when temperature is below 10°C (50°F) the above periods may be doubled. For temperatures 10°C to 21°C (50°F to 70°F), the above periods may be increased proportionately.

9. The above periods are for ordinary cements, when rapid hardening cements are used, the above periods may be reduced to $3/7$ th of these, except for the vertical sides of slabs, beams, Columns and walls, which must be retained for 24 hours.

**SPECIFICATION No. 9.2—Centring and Shuttering
(Contract Specifications)**

General requirements.

1. Forms for concrete shall meet the following general requirements:—

- (a) Forms shall conform to the shape, lines and dimensions of the concrete, as shown on the drawings. Forms shall be substantial and properly braced or tied together to maintain position and shape.
- (b) Forms shall have sufficient strength and rigidity to withstand the weight of concrete and the necessary pressure in ramming and vibration of concrete and the movement of men, material and plant without excessive deflection from the prescribed lines.
- (c) The surfaces of all forms in contact with the concrete shall be rigid and tight to prevent leakage of mortar. Suitable devices shall be used to hold corners, adjacent ends, and edges of panels of other forms together in accurate alignment.
- (d) The form lining should be such that the concrete surface shall have the desired type of finish.
- (e) Ready access should be provided for proper placement, working and vibration of the concrete and for inspection of these operations.

Props, supports and shores.

2. The forms shall be provided with sufficient number of props, supports, shores or braces to keep them in position by means of wedges or similar means and to allow of the load being eased and the forms being removed without shock to the work and without any hammering, knocking and prising. If adequate foundation can not be secured for supports or shores, trussed supports shall be provided.

Materials.

3. Form work shall be made of timber, metal (usually steel), precast concrete or rough masonry separately or in combination. When timber is used for form work, it shall be such as to be proof against deformation when wetted. It shall be free from loose knots and well seasoned especially if it is liable to be exposed to the weather for any length of time after it is made up. Unseasoned or very soft timber shall not be used as distortion at bolted connections may occur.

Erection accessories.

4. For easy removal, bolted and wedged connections should be preferred to nailed joints. Wherever nailed joints are provided, just sufficient number of nails should be used and indiscriminate use of nails shall be avoided.

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5. Metal rods or bolts are used as form-ties to hold the forms in position and to prevent bulging during concreting. Normally mild steel bolts are used varying in diameter from 3/8 inch to 3/4 inch (10 mm to 20 mm), the smaller sizes being generally sufficient for bolts in direct tension in column and wall shuttering while the larger sizes are used for bolts subject principally to transverse loading. The threads of the bolts should be well-greased and any adhering concrete spillings cleaned from them as often as practicable. The diameter of holes through the timber should not be more than 1/16 inch (1.5 mm) greater than the diameter of the bolt. The bolts are removed when the forms are struck. Removal of bolts passing through set concrete can be made easier by well-greasing the bolt or by giving the bolt half a turn while the concrete is only partly set. These bolts to be used as ties should be ordered in generous, overall lengths with ample threaded length. Excess lengths can be readily taken up by packing and this enables us to use the bolts in any type of work. Some times wire ties are also used but their use is restricted to such places where the concrete surface is to be covered by subsequent finishing materials as the ends of wire are liable to give objectionable rust stains if the concrete surface is left uncovered. The wire ties are drawn taut without exhibiting spring and are left in the concrete, the projecting ends being clipped off after removing shuttering. Wire ties are made of black annealed iron wire No. 9 to 16 gauge.

Ties.

6. Spreaders are provided in the forms to prevent the sides being forced in when the ties are tightened. There are many types of spreaders and most common of these are old fashioned wooden spreaders made by ripping of one inch (25mm.) boards. Wooden spreaders are removed as the concreting proceeds. Concrete spreaders are also quite common and these are cast in lengths equal to the thickness of wall, column or beam. They are usually 2 inches x 2 inches (50 mm x 50 mm) in cross-section and have a hole in the centre to allow the tie bolt to pass through. The advantage of these spreaders is that they need not be removed while the concreting proceeds and the removal of tie is very easy.

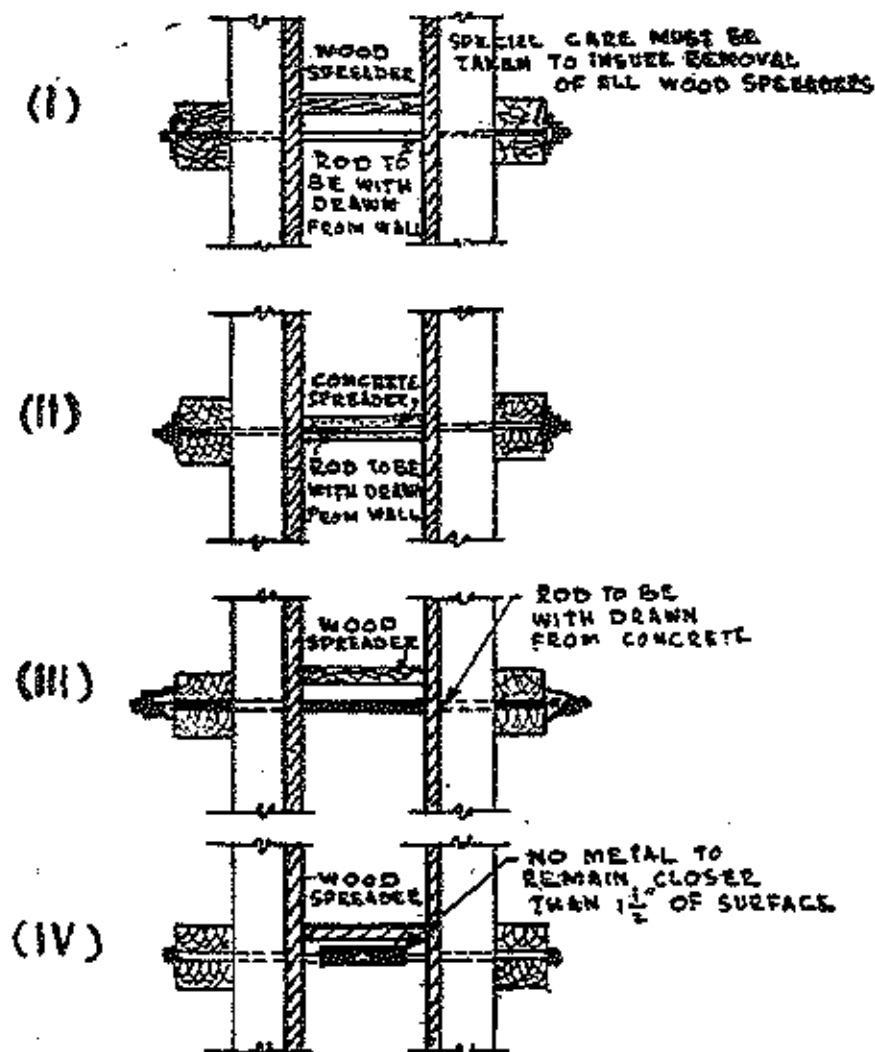
Spreader.

Where walls are subjected to water pressure on one side and are required to be water-tight, the ties are not removed and they are so provided that the clearance between their ends and the concrete surface is not less than 1½ inches (32 mm).

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Arrangements of ties and spreaders.

7. Different arrangements of ties and spreaders are shown in arrangements of ties and spreaders are shown in the sketches given below :—



Type I is the common form of threaded rod provided with a nut and plate at each end. Wooden spreader is used and the rod is entirely withdrawn from the wall when the forms are stripped.

Type II shows a tie consisting of standard threaded rod provided with a nut and plate at each end like type (I) but with a concrete spreader.

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Type III shows a tie consisting of straight unthreaded pencil rod with "buttons" or clamps which are slipped over the rod and bear against walls. The clamps grip the rod by means of a set screw which puts a crimp in the rod to prevent the form from spreading. A wooden spreader is used with this kind of tie, which is removed as the concreting proceeds. The rods are entirely withdrawn from the wall when the forms are struck.

Type IV shows a tie consisting essentially of two lag screws which are removed from the wall when the forms are stripped and a part that remains in the wall into which the lag screw are threaded. This inner part must be short enough so that no metal will remain closer than $1\frac{1}{2}$ inch (38 mm.) of the outside wall surface when the lag screws are removed. A wooden spreader must be used with this tie which is withdrawn as the concreting proceeds. The holes left by the removal of lag screws are immediately reamed with suitable toothed reamers, so as to leave the surface of the holes clean and rough. The holes are then completely filled with mortar and the surface is finished to match the adjacent concrete.

8. For rough work, unexposed surfaces or such surfaces as are to be finished with plaster, undressed timber may be used, or when using other types of form work, smooth surface may not be insisted upon. In case of exposed concrete surfaces which are not to be plastered over but are to be left untouched as they come out of form work, properly planed timber or steel shall be used in making the form work, or the form work may be lined with a suitable lining material like water-proof building paper, plywood, hard board, sheet metal etc. so that the form work has a clean and smooth surface; such form work being paid for at a higher rate as mentioned in note (ii) of Chapter No. 9 of the Common Schedule of Rates Volume I.

Surface of form work.

Sometimes shuttering pattern for exposed concrete surface is specified by the architect. This can be formed by providing form work in panels of required sizes at the required place so that the joints between the panels leave a clear impression of lines on the exposed concrete surface according to the pattern specified by the architect in drawings. Such a concrete surface is left untouched as it comes out of form-work. As special form work with smooth surface is required, a separate rate is allowed on the basis of superficial area, over and above the rate for normal form-work.

When metal sheets are used for lining forms, the sheets shall be placed and mounted on the forms with the minimum amount of

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wrinkles, lumps or other imperfections. Where water-proof building paper is used for lining forms, it shall be fixed by flat-headed nails either from the inside of the shuttering or by bending the paper over the edge and nailing from the outside. While placing and tamping or vibrating the concrete, care shall be taken not to tear the paper. When plywood lining is used, the plywood shall conform to Specification No. 3.16. The plywood shall have a uniform thickness not less than 3/8 inch (10 mm.). When tamped, water-proof pressed board or similar approved material is used instead of plywood, the thickness shall not be less than 1/8 inch (3 mm.). The joint between the plywood or pressed board-sheets shall be smooth and as nearly perfect as practicable. Absorptive form may be used where specified to obtain a smooth and dense concrete surface. The absorptive form lining shall be of approved type and quality.

Care shall be taken that form lining and any treatment employed in its manufacture, shall not discolour the concrete nor interfere with the normal chemical reaction of cement.

Rounding angles and corners.

9. Normally all angles in the concrete work shall be sharp and clean but wherever specified or shown in the drawings the angles may be chamfered or rounded by fixing suitable angle fillets to the forms and/or rounding or chamfering their edges.

Precautions against settlement.

10. Shores or brass placed against a compressible or yielding support must be so fixed on timber bearers as not to penetrate or cause injury to such support. Means for correcting any settlement shall also be provided.

Camber.

11. The bottom of all beam moulds shall have a camber of 1/360th of the span, or such other camber as is ordered by the Executive Engineer.

Sides of forms, Wall for ms.

12. Forms shall be so designed that the sides are easily removable without disturbing the bottoms supporting the concrete. One side of column and wall moulds must be left open and filled in plank by plank as the concrete is placed and is consolidated.

Plastered forms.

13. When rough masonry or similar work is used for forms, the surface shall be rendered with lime plaster or with mud plaster covered with paper. No damage must occur to the plaster during construction, and where this can not be guaranteed, such forms shall not be used.

Old forms.

14. Old forms or forms left long exposed to weather should be examined carefully before reuse.

Cleaning and oiling of forms.

15. Wherever specified, forms shall be treated with a suitable oil or other coating material which will prevent sticking of the concrete. Before the oil coat is applied, the surface of the forms shall

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be free from incrustations or mortar grout, or other foreign materials. The oil or coating should be applied by brush or spray and should evenly cover the forms without excess and should not be permitted to get on construction joint surfaces or reinforcement bars.

The oil or other forms of coating used should not cause softening or permanent staining of the concrete surface; it should not impede the wetting of surfaces to be water-cured.

Unless some other form of oil is specified, refined, pale paraffin mineral oil shall be used for wood forms. For steel forms, the oil shall consist of refined mineral oil suitably compounded with one or more ingredients which are approved for the purpose. Special care shall be taken to oil thoroughly the form strips for narrow grooves so as to prevent swelling of the forms, and consequently damage to the concrete prior to or during the removal of the forms.

16. No concrete is to be placed in or on forms until its design and construction have been approved by the engineer-in-charge, who shall be at liberty to pull down any forms as are in his opinion, not suitable for the work or are unsafe. Nothing in this shall be deemed to mean that the Government is responsible for safety of the work or workmen for which the contractor is solely responsible.

Approval of
engineer's .

17. The contractor shall be held responsible for any injury caused to the work during the removal and striking of moulds shuttering or supports.

Responsibilities
for injury to work .

18. Before placing the concrete, all forms shall be thoroughly cleaned and the space to be occupied by the concrete entirely free of debris. Wooden or plastered forms shall be thoroughly wetted before the concrete is placed.

Clean and wet
forms
before pouring.

19. Forms shall not be removed until the concrete has adequately hardened. The Sub-Divisional Officer shall decide when this condition has been satisfied, and will sanction the dismantling. Forms are to be removed without a shock and by purely static force. No external load shall be permitted to come on any structure for a period of 3 weeks from the removal.

Removal of debris.

20. Unless otherwise specified, centring and shuttering or form work shall be measured as the actual surface in contact with concrete. Centring and shuttering for arches of verandah openings and doors and windows shall be measured per rft. of clear span.

Measurement.

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Rate .

21. Labour rate includes the cost of labour for assembling erecting, maintaining and striking centring and shuttering and removal of the same from the site of work.

Through rates include the labour charges, cost of all materials at site of work including wastage and sawing charges of timber, if any.