Reinforced Concrete from the Contractor's Standpoint.*

The general problem before the contractor in reinforced concrete is to make the best possible reinforced concrete at the least possible cost. The first part of this discussion will deal with methods to be followed and precautions to be observed in order to attain excellence of workmanship; the second part, with methods to be followed in order to attain this excellence cheaply.

To make the best possible reinforced concrete it is necessary:

1. That the forms should be strongly built, smoothly finished, and as nearly as possible watertight; and should be left in place until the concrete is self-supporting.

2. That the reinforcement should be designed to relieve the concrete of all stresses which concrete cannot safely withstand, and to be amply protected from fire and weather by concrete on all sides; that the reinforcement should be so securely fixed in place before concreting that the concreting will not disturb it.

3. That the concrete should be mixed and placed in such a way that the final product will be homogeneous and without voids.

First.—Forms should be built of matched and dressed lumber and should be greased to make them part easily from the concrete. Their construction will be described in some detail in the second half of this paper. The length of time which should be allowed to elapse before removing forms depends upon two factors, the weather and the load to which the member in question will be subjected upon removal of the forms. The fact that the concrete sets more rapidly the warmer the weather needs no elaboration. It is, hewever, never out of place to utter a warning against taking risks with concrete in cold weather. I suggest that very valuable information might be obtained from compressive tests on a series of concrete blocks, No. 1 being kept at a temperature of 30 degrees for one month after making, and being tested; No. 2 at 35 degrees; No. 3 at 40 degrees, etc. Scratching concrete with a knife gives one a rough idea of its strength, providing one scratches often enough to become thoroughly familiar with the behavior of concrete under the knife. With regard to the second factor influencing the time which should elapse before removing forms, it may be said in general that the nearer the load to be sustained approaches the load for which the member was designed, the longer the forms must remain. Thus, the forms for an over-hanging cornice should remain in place longer than the forms for almost any other member, because the dead weight of the cornice is a very large percentage of the total weight which it is designed to carry. By similar reasoning, roof forms should remain longer than floor forms; floor forms longer than column forms; column forms in the top storey of a building longer than column forms in a lower storey; and column forms in general longer than footing forms.

It is very important that forms should be so designed that the column forms may be removed without in any way disturbing the supports of the beams and girders bearing on these columns. In this way a defect in a column may be detected and remedied before any load is brought to bear upon the column. In removing beam and girder forms, the posts should be removed from only one beam or girder at a time, and as soon as the form for this beam or girder is removed, the posts should be immediately replaced. By this procedure, danger of failure of concrete through poor workmanship is much diminished, as a defective member is supported by the members on either side of it until the defect may be remedied. The practice of removing all the posts under a floor at the end of a given period—one, two, or three weeks—without pausing to remove the forms one at a time, examine the workmanship, and replace the posts, cannot be too strongly condemned; both because of the possibility of defective workmanship, and because the concrete floor, even if not defective, may not be strong enough to carry in addition to its own weight the weight of the one or two floors which may, by the time the forms are removed, have been constructed above it.

There is less danger in taking down column forms when the concrete is thirty-six hours old, and floor forms when the concrete is five days old, if the posts of each member are removed separately, and as soon as possible replaced, than there is in knocking out all the posts under a large piece of floor in three weeks. Legislators who frame laws aiming at safety in concrete construction should bear this in mind.

It is of first importance that the foreman in charge of removing forms shoud be of a high order of intelligence, and a man who can be relied upon to obey orders literally, for the reason that a mistake on his part is more likely to cause damage to life and property than a mistake on the part of any other foreman.

Second.—Reinforcement should be designed to take all tensile stresses which occur in a reinforced concrete structure. Whether the reinforcement shall carry shearing or compressive stresses depends upon the conditions in each particular case.

Tensile stresses occur horizontally in the bottom of beams, and, in the case of continuous beams, in the top of the beams over their supports. They occur diagonally in every part of a beam except the top and bottom. The horizontal tensile stresses are best taken—as most authorities are now agreed—by diagonal bars. As the horizontal tension is less at the end of a beam than in the centre, it is obvious that if there are two or more bars in a beam, one of the bars which takes the horizontal stress at the middle of the beam may be deflected to take the diagonal tension near the ends of the beam, and in the case of continuous beams, the horizontal tension over the supports. Thus are developed the familiar bent bars now in common use.

Shearing stresses occur chiefly near

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