If structural-steel members—I-beams or trusses—are used to support the forms during the placing of the concrete, the stresses resulting from this dead load must be computed and deducted from the allowable stress in the steel, the remainder being the stress that is available for the steel as reinforcement in the concrete. For instance, if such dead loads caused a tension of 9,000 lb. per sq. in the I-beam of this problem, for which the allowable stress is 20,000 lb. per sq. in., then 11,000 lb. per sq. in. would be the maximum that could be used in the composite section. However, the dead load that is already carried by the I-beam should not be included again in computing the loads that cause bending moments and shears in the composite beam.

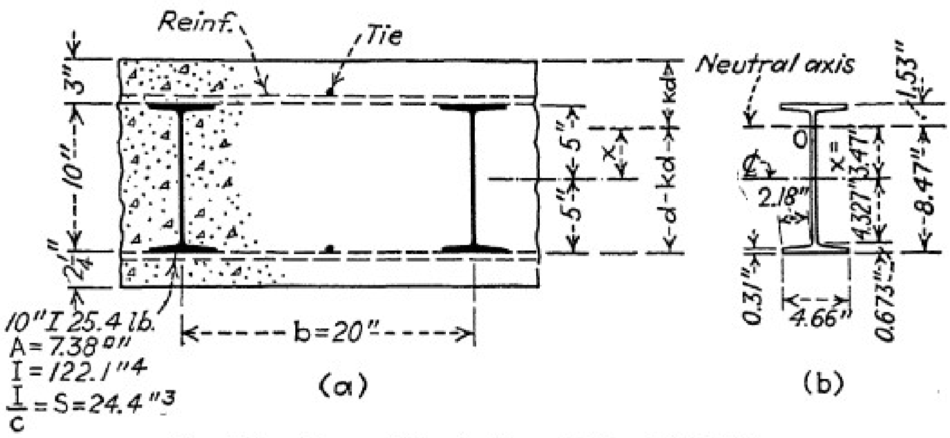

FIG. 5-4.—Floor of Lincoln Tunnel, New York City.

When composite beams frame into steel girders or columns, special care should be taken to avoid cracking along the top flanges because of deflection of the beams. Where feasible, the steel beams should be made continuous with tension plates and bottom thrust angles; otherwise use rods in the slab to carry tension across the girder or past the column. The whole framework should be looked over to find the places where deflections under live loads will be likely to cause cracks; then, if it is not practicable to make the steelwork continuous, it may be advisable to make definite joints or cuts in the concrete so that the cracking will occur at such predetermined locations.

5-3. I-beams Completely Encased in Thick Slabs. In some cases, small I-beams may be completely encased in thick concrete slabs as shown in Fig. 5-4. In such cases, it is reasonable to assume that, with proper inspection in the field, the bond and shearing stresses will be sufficient to make the structure act as a composite unit. The sketch shows the floor of the Lincoln Tunnel which is of this type of construction (see Fig. 5-4A).

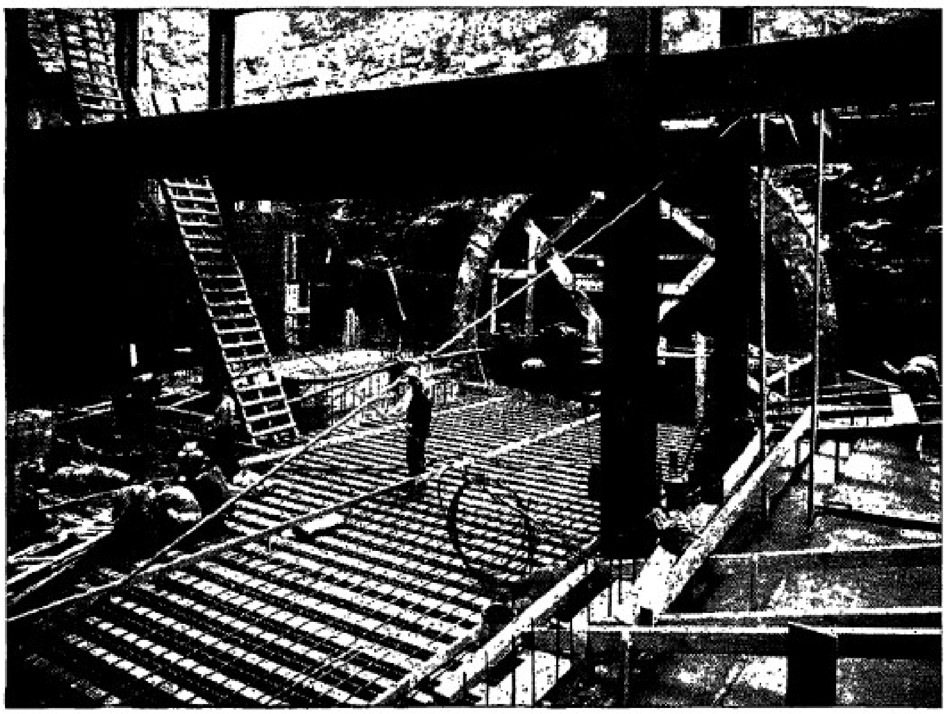

FIG. 5-4A.—Construction of the roadway slab of the Lincoln Tunnel at the New Jersey shaft.

The slab of Fig. 5-4(a) will now be analyzed, using $n = 8$ and f_s, f_c, and u = 20,000, 1,200, and 150 lb. per sq. in., respectively. The tie rods will be neglected.

$$nA_s = 8 \times 7.38 = 59.04.$$

Assuming $b = 20$ in., and taking the static moments about the neutral axis'

$$\frac{20(kd)^2}{2} = 59.04(8 - kd).$$

$$kd = 4.53 \text{ in.,} \qquad \text{and} \qquad d - kd = 8.47 \text{ in.}$$

If I equals the moment of inertia of the I-beam and x = the distance from its center to the neutral axis of the composite section, then

$$I_c = \frac{b(kd)^3}{3} + nI + nA_s(x)^2$$

$$I_c = \frac{20 \times 4.53^3}{3} + 8 \times 122.1 + 59.04(8 - 4.53)^2 = 2{,}307 \text{ in.}^4$$

$$S_c = \frac{2{,}307}{4.53} = 509 \text{ in.}^3 \qquad S_s = \frac{2{,}307}{8 \times 8.47} = 34 \text{ in.}^3$$