adaptation to railway structures will be brought out in subsequent description and illustrations of actual examples. There is, however, one outstanding feature of the flat-slab system which in the writer's opinion is of most vital importance in reinforced-concrete construction. By reason of its uniform cross-section and continuity of the reinforcement, there is no other type of reinforced concrete that is better proportioned to resist shrinkage and thermal changes. Structures of the flat slab have

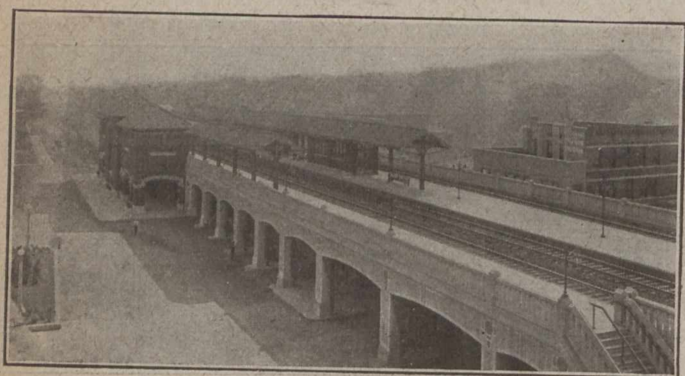

Fig. No. 3—Flat-Slab Bridge Carrying Lackawanna at South Orange Station

been built in surprisingly great lengths without the incorporation of a single expansion joint and have successfully resisted the very severe strains of these stresses. By the insertion of an additional amount of reinforcing steel across construction joints, a constant tensile resistance can be maintained which has the effect of preventing cumulative action of the stresses at any particular section; the strain is distributed uniformly throughout, resulting in an infinite number of minute cracks that do not impair the strength of the structure.

Our experience does not extend over a sufficient length of time to ascertain definitely what effect the repeated action due to temperature changes will eventually have on the strength of the structures. However, very close observation of existing flat-slab structures, in service from three to six years, have disclosed no deleterious effect due to these causes. The minute cracks found were of no greater concern than those developing on the tension side of a beam long before the steel has reached full working stress

By way of comparison in this regard, to show the difficulties encountered in other types of concrete construction, consider the special arrangements in the manner of expansion and sliding joints that are necessary and not always efficacious in large concrete-arch viaducts or in viaducts of the column, beam and slab design. In the viaducts consisting of a series of large main arches surmounted by transverse spandrel walls supporting a floor system, the vertical movement of the heavy arch ring, for a rise and fall of temperature, is transferred to the floor system. This very appreciable vertical movement must be resisted by the comparatively light floor in addition to its own changes in a horizontal plane. In the case of the beam and slab design the constituent members have different sections and therefore offer varying degrees of tensile resistance. There arises the difficulty of transferring the movement from the larger through the smaller members, as from the deep beams through the thin slab, which is not always satisfactorily controlled.

Soo Line Terminal at Chicago

In 1912-13 the first and so far the most extensive application of the flat-slab system for carrying railway loadings was made in Chicago with the erection of the Soo Line Freight Terminal.

The yard area required for this improvement amounted to 18½ acres, comprising eleven city blocks located near the business and manufacturing centres. This entire layout for handling freight is carried on an elevated structure to meet the municipal requirements that no grade crossings should exist. Deck construction gave the greatest possibilities of storage development, making available 520,000 sq. ft. on the ground surface underneath the deck for this purpose. The flat slab showed advantages of lower cost, lower maintenance and greater permanence as compared with structural steel. From a railroad point of view the outstanding feature of the design is

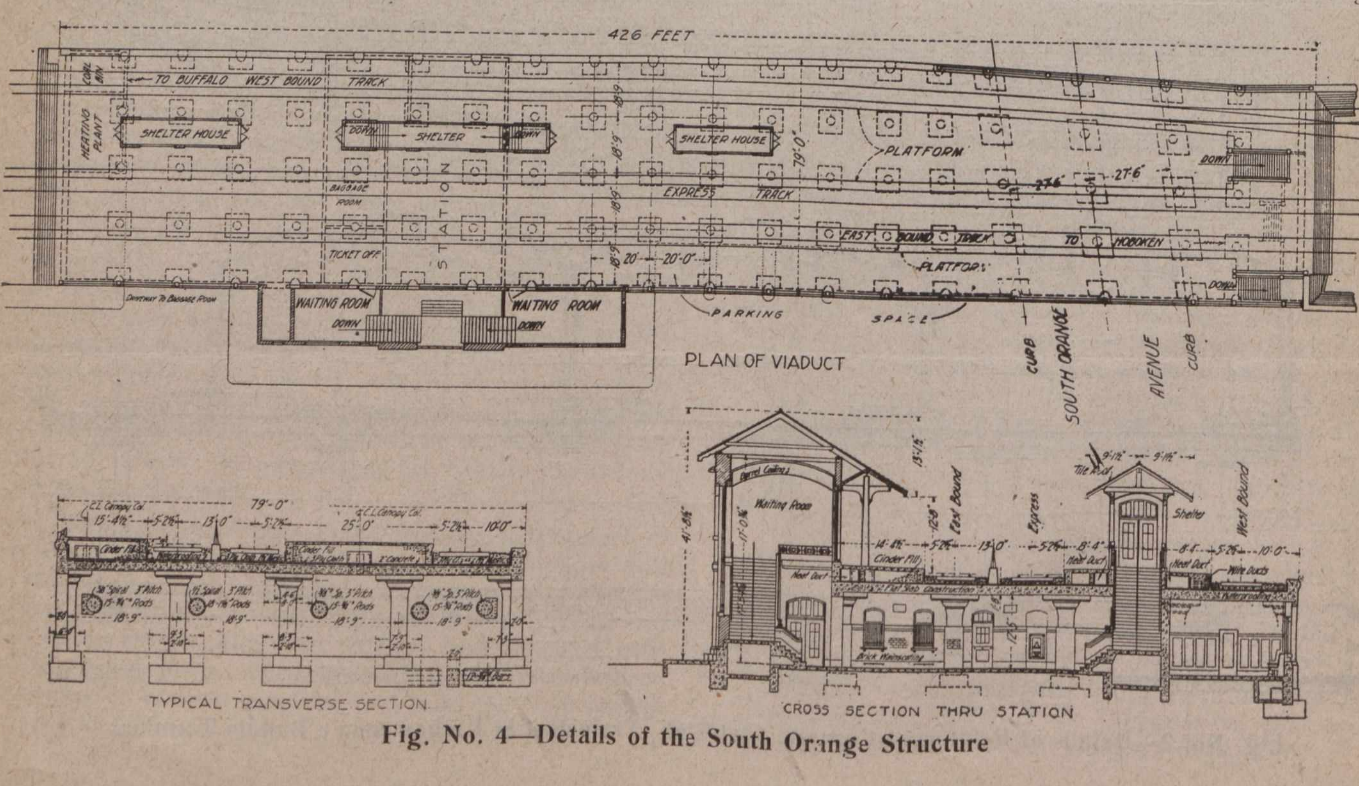

Fig. No. 4—Details of the South Orange Structure