STATICAL ANALYSIS OF REINFORCED CONCRETE ARCH BRIDGE

DESCRIPTION OF A RAILWAY BRIDGE OF SPECIAL DESIGN — AN ANALYSIS OF ITS STRESSES AND DEFLECTIONS — RESULTS OF TEST LOADING

By V. J. ELMONT, B. Sc., A.M. Can. Soc. C.E.

THIS bridge carries a single-track railway over the River Werra. In order to allow for future navigation it was found necessary to bridge the river in one span of 174 feet.

As will be seen in the illustrations (Figs. 1, 2 and 3) the bridge has two arches, arranged above the bridge floor; they are calculated and constructed as arches without hinges, for which kind of structure the soil (coarse gravel) was very well suited, the maximum pressure on it being only 5,000 to 6,000 lbs. per sq. ft. Above the clearance line of the cars the arches are stiffened sideways by T-shaped struts (see Figs. 2 and 4) which, together with the arches, form a strong truss. The free space between the arches is 14′ 5″, the depth of the arches at the crown is 5′ 3″ and at the springing line 8′ 2″; the rise is 34 feet.

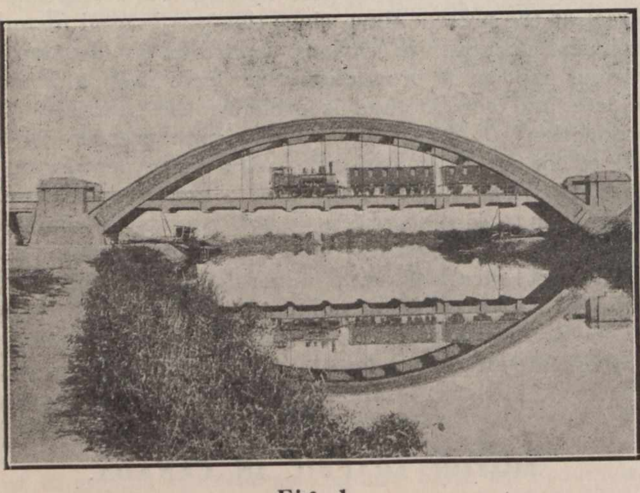

Fig. 1.

The bridge floor is suspended from the arches by means of rods, carefully anchored in the arches and floor beams. The slab which forms the direct support for the ballast, in which the cross-ties for the rails are embedded, is 5½″ thick and is carried by four longitudinal beams, which again rest on the floor beams spaced 13′ 7″ centre to centre. These are 2′ 7″ wide in the middle, tapering to 1′ 7″. This form was adopted in accordance with the requirements of the specification, viz., that the actual tension stress in the concrete should not exceed 275 lbs. per sq. in.

In order to avoid stresses in the floor produced by variations of temperature, it is divided into three parts, the two end sections being rigidly connected with the arches, while the middle section hangs freely and engages with the end sections by means of indentations; the floor will thus act as a horizontal cantilever girder for wind forces, having a simply supported part at the middle resting against two cantilever arms at the sides.

The abutments (Fig. 5) are formed by widening the arches below the bridge floor, and connecting them by a slab towards the river.

The falsework used in the construction of the bridge was given an overheight at the crown of the arches of 2″, diminishing towards the ends. It was found that the settlement of the falsework during the concreting amounted to 1⅜″ at the crown, and when the falsework was removed after the concrete had hardened for five weeks a further settlement of 7/16″ took place.

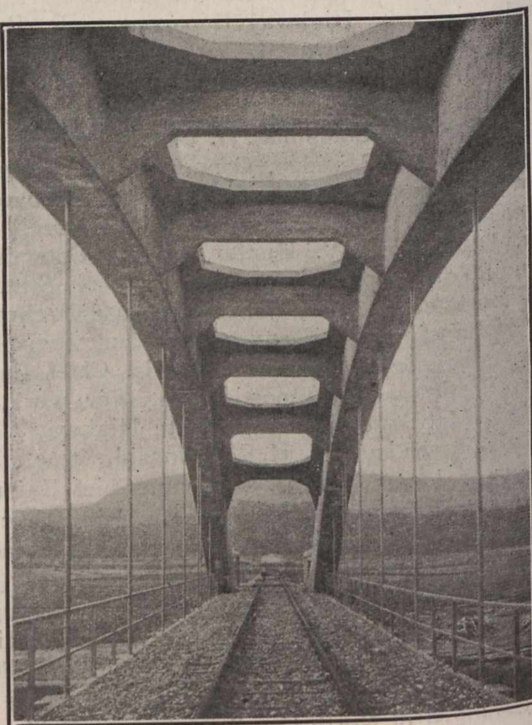

Fig. 2.

Statical Analysis.—The following maximum stresses were allowed: Concrete in compression, without regard to temperature stresses, 500 lbs. per sq. in.; concrete in compression, including temperature stresses, 650 lbs. per sq. in.; concrete in tension, including temperature stresses, 275 lbs. per sq. in.; steel in tension, including temperature stresses, 14,000 lbs. per sq. in. The calculation of the bridge floor does not include any special features.

The depth of the arches was first computed by repeated approximate figuring to d_c = 5′ 3″ at the crown and d_s = 8′ 2″ at the springing line, with a width of 3′ 7″, and then tested by the exact formulæ for arches without hinges. The dimension d_x for the interspacing point with the abscissa x measured from the crown was taken from the formula