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The Bridge at Prato.

Die Brücke von Prato.

Le pont de Prato.

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The arch is, of all forms of construction, that which makes the best use of the material, but for the purpose of bridging wide spans there are many cases in which it is not the best form to use. Where the conditions of the foundation are such as to preclude any large horizontal thrust, while at the same time the use of an arch with a tie is out of the question, the natural tendency is to consider some system of girder or frame, and to exemplify this a description will now be given of the foot bridge over the Bisenzio near Prato in Tuscany which has a span of 60 m and was carried out under contract for the municipality of Prato by the Società Ferrobeton of Rome.

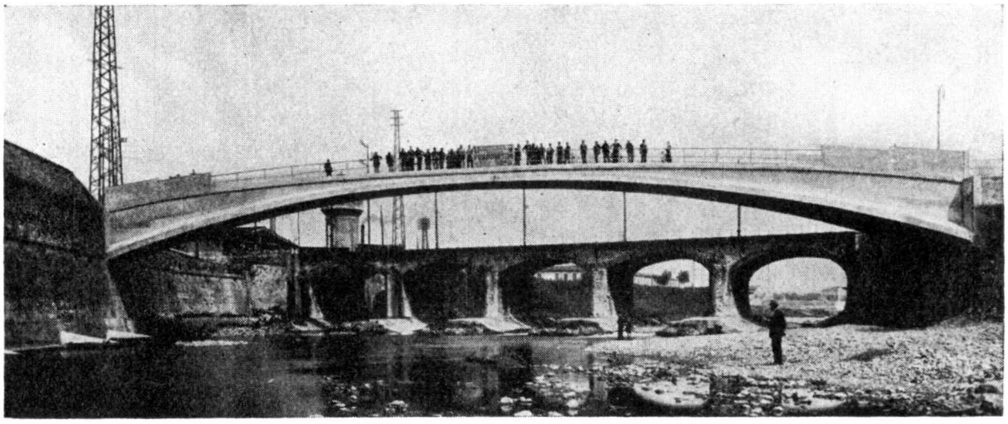

Fig. 1.
Bridge over the Bisenzio at Prato. (View of completed work.)

Fig. 1 shows the completed work, while Figs. 2 and 4 are plans. The structure was required to satisfy the following conditions: in view of possible floods the river was to be bridged by a single span of statically determinate construction, and the soffit under the crown was to correspond in height with the rail level of a railway bridge existing upstream.

Since the suitable foundation lay more than 10 m below the level of the abutments the adoption of an arch design was not feasible, and at the same time

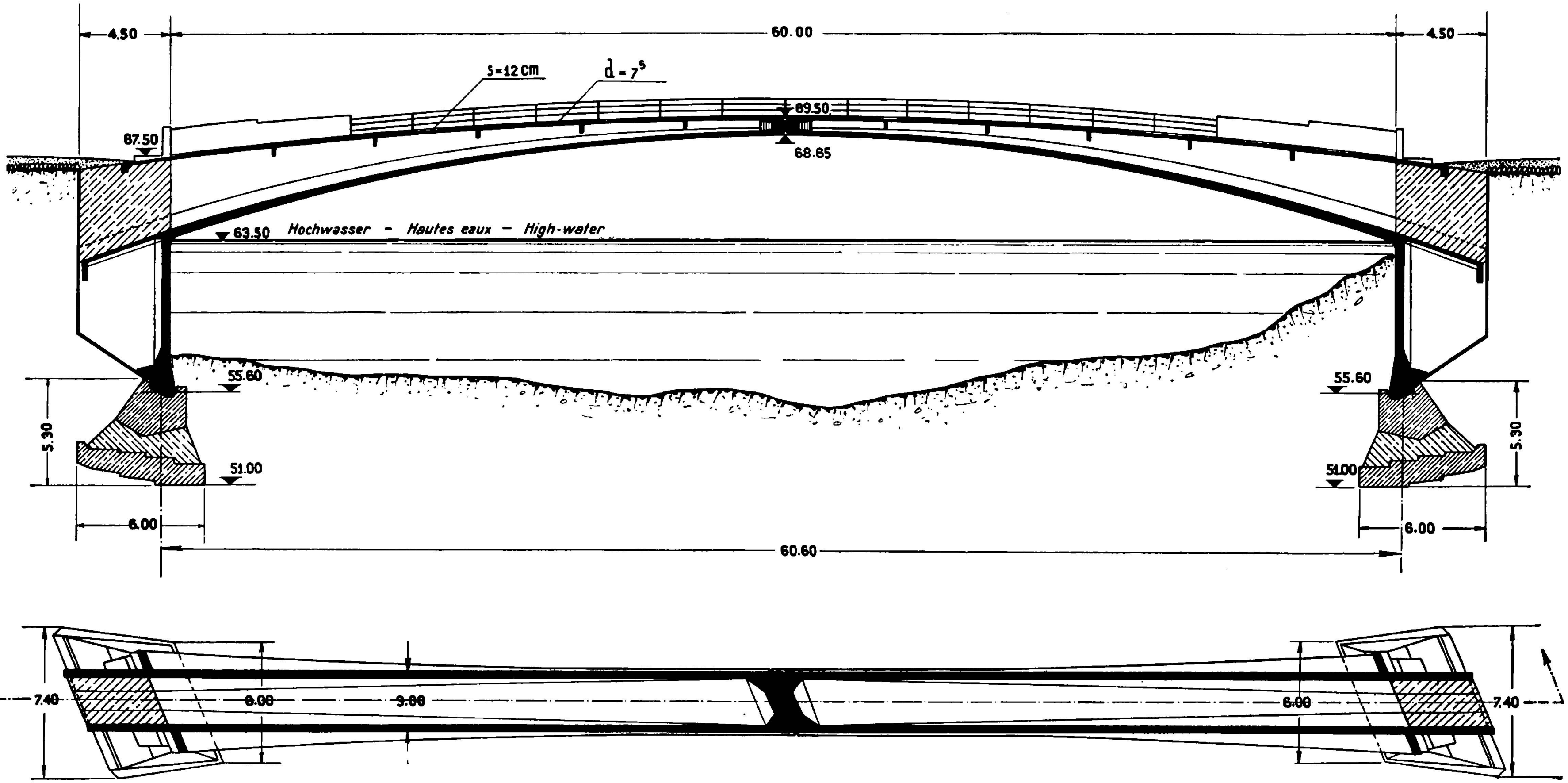

Fig. 2.

Plan and elevation.

a built-in beam construction was ruled out straight away by the fact that it would have been statically indeterminate. Neither would an arch with a tie have been practicable, and in the present case this would not have been a suitable design having regard to the limited width of the bridge and to aesthetic considerations. In these circumstances it was decided to adopt a three-hinged frame design, which allowed of very small foundations while, at the same time, the permissible foundation pressure of 1.5 kg/cm^2 would not be exceeded.

The effective width of the roadway is 2.50 m and the constructional width 3.00 m, so that the width of the bridge amounts to $^1/_{20}{}^{\mathrm{th}}$ of the span. For various

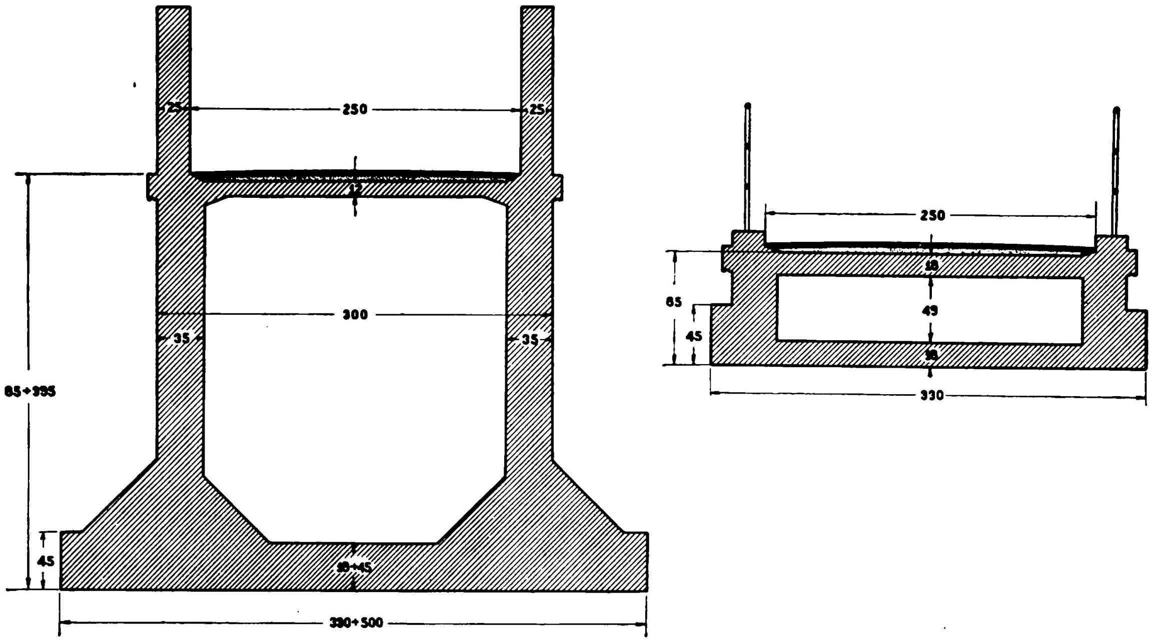

Fig. 3.

Cross section.

reasons, and particularly in order to prevent the development of lateral or overturning forces, the lower slab was widened to 5.50 m at the springings; this had the effect of strengthening the supports, increasing the lateral resistance and improving the appearance of the structure. The skew position of the bridge, as laid down in the specification, involved difficulties in so far as it was proposed to construct the hinges on the Considère system using flat steel reinforcement, and on this account it was decided to adopt a type of hinge which would permit a sliding motion along an axis at right angles to the plane of loading in addition to rotation about that axis. As, however, the construction of such a roller bearing in steel would have been too costly, and its construction in reinforced concrete too difficult, the idea of introducing roller hinges was abandoned and the erection was carried out with the aid of hydraulic jacks supported on well greased plates in such a way as to allow at any rate some degree of sliding to take place. In this way the effect of the permanent load and of the settlement of the supports could be taken up by mutual adjustment of the two portions of the bridge before the hinges were built in.

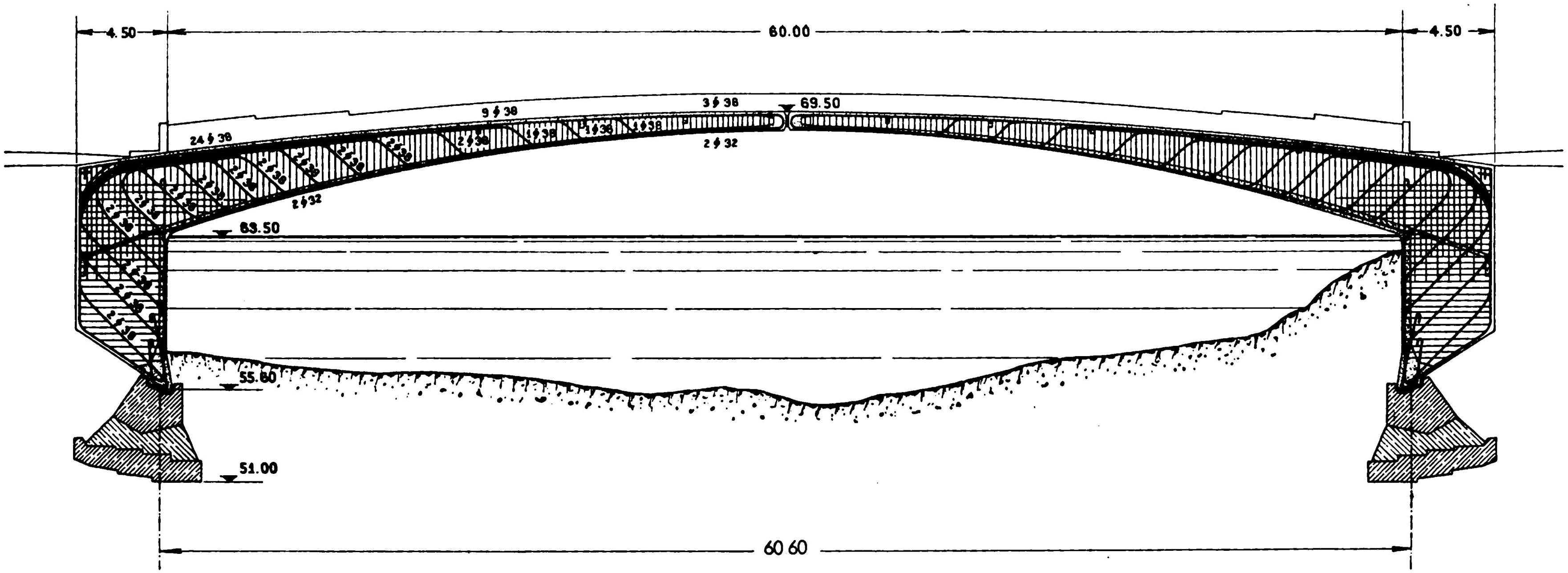

Fig. 4.

Details of reinforcement.

The jacks adopted (which were constructed in the Monteverde works of "Ferrobeton") have the advantage that they can be blocked in any position by the use of set screws, so that when the reinforcement is completed a constant control can be exercised over the moments. In the case of the bridge here described there was no necessity to measure the lateral pressure as the design was a three-hinged one and any such lateral thrust would become independent of the movement once the bridge has been separated from its centreing; such, at any rate, is theoretically the case where small displacements are concerned, assuming ideal hinges at the springing and free supports.

The concreting of the hinges had to be undertaken with great care after the scaffolding had been struck since in this case — by contrast with a built-in

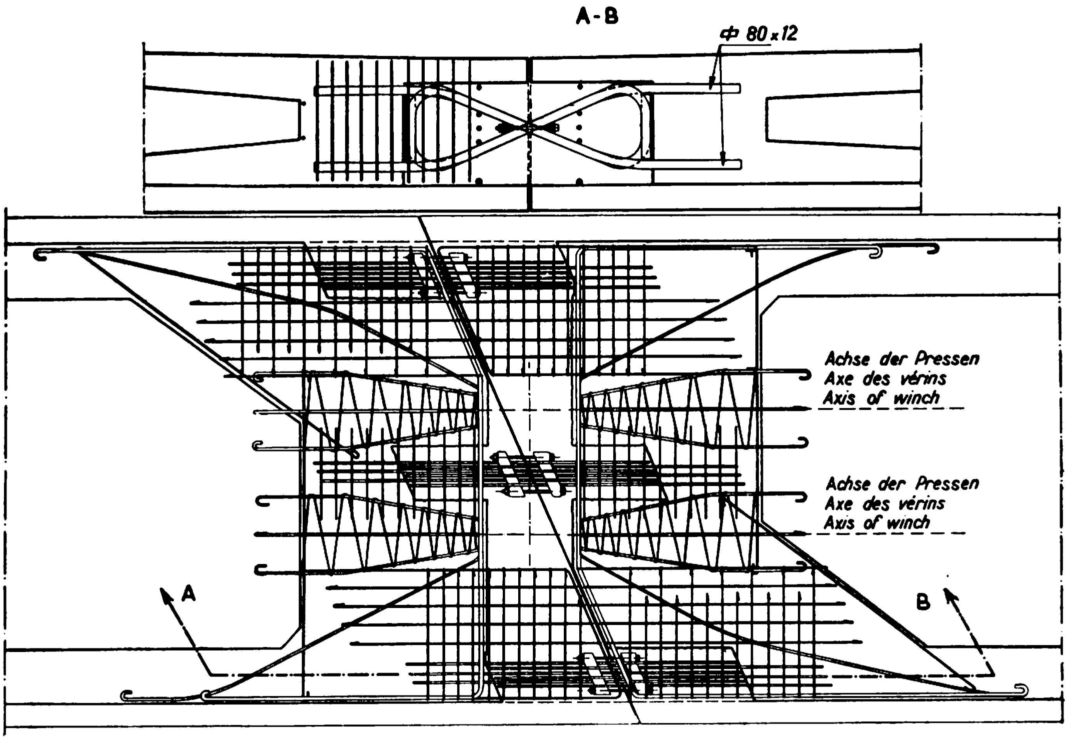

Fig. 5.

Crown hinge.

arch — the hinges must be allowed the necessary freedom of movement. Fig. 5 shows the construction of the crossed hinge members from flat steel bars 80 × 12 mm, arranged in three groups each containing six such bars; after concreting the hinge each bar remained fixed on either side. Finally the two cavities at the jacks were concreted (see Figs. 5 and 6). These lightly stressed portions of the cross section either co-operate, or else the hinges which are only partially under compression enter into full operation.

By suitable calculation the positions for the jacks can be decided in such a way as to avoid any fixing effect, or in other words so as to ensure that the jacks are properly centred.

The loading test of the bridge was carried out with the live load of 650 kg/cm² in the most unfavourable position, with the load covering nearly the whole of the span, and the amount of elastic deflection at the crown was found to measure 6 mm. Dynamical measurements (which were not carried out in great detail and are not, therefore, worthy of description here) indicate that the structure attains some degree of stiffness through the concreting of the crown sections close to the hinges.

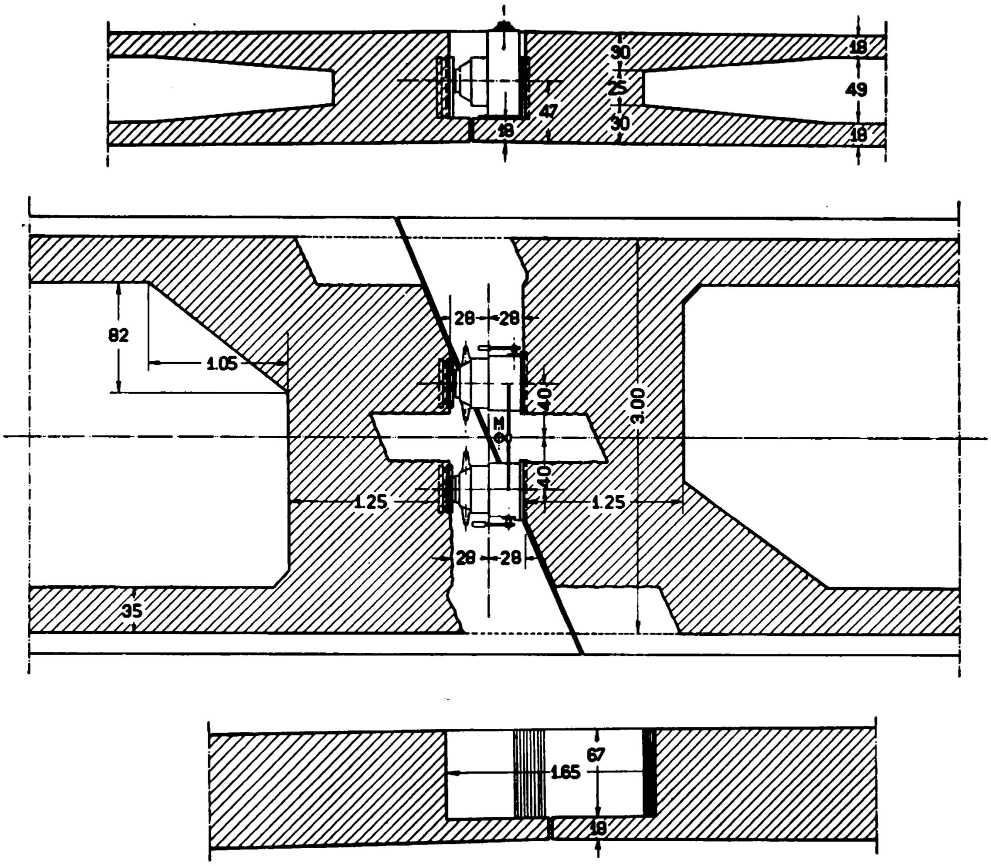

Fig. 6.

Jacks at crown.

It would have been desirable to erect the piers in masonry seatings in order to allow their free movement, but this precaution was excluded by considerations of cost. The total cost of the work amounted to 200000 lire.

From test results on the finished structure it may be concluded that the system of construction adopted was the best one for its purpose of covering a large span with a bridge of good appearance, carried on small foundations, at limited cost.