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Strengthening of the Ill Bridge near Strasbourg.

Die Verstärkung der Illbrücke bei Straßburg.

Le renforcement du pont sur l'Ill près de Strasbourg.

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In a paper presented before the Congress M. *Bastien* has referred to bridge works recently carried out by the French railways. The present writer wishes to give some details of one of the works there mentioned, namely, the strengthening of the bridge over the River Ill near Strasbourg, by means of a new method of great interest. He feels the more free to do this as the work in question was the idea not of himself but of M. *Goelzer,* whose name will already be familiar to readers.

The bridge over the Ill comprises two identical independent spans of 52 m each, and was erected some sixty years ago to carry the double line of railway from Strasbourg towards Germany. In each of the spans there are two main girders

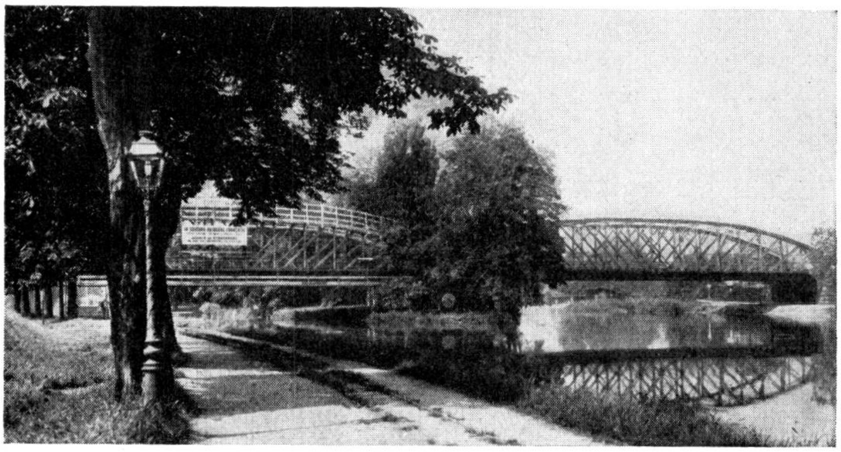

Fig. 1.

of the Howe truss type with the verticals in compression and the diagonals in tension (Fig. 1). The existing bridge was inadequate to carry the heavy locomotives now in use, and its weakness may be judged from the stresses as calculated in accordance with the current rules, which work out as follows:

Upper booms in compression	15.85 kg/mm^2
Lower booms in tension	16.40 kg/mm^2
Verticals in compression	18.27 kg/mm^2
Diagonals in tension	18.29 kg/mm^2

whereas a limit of 11 kg/mm² ought not reasonably to be exceeded in an iron structure.

One solution would have been simply to replace the bridge, but this, while psychologically simple, was in fact complicated by the need to keep traffic open, and it would moreover have been extremely costly, and also regrettable because the decking of the bridge, although weak, was in a very good state of preservation. For strengthening the bridge, recourse might have been had to direct reinforcement of the girders by the addition of cover straps to the booms, and angle bars to the verticals and diagonals. This again appeared to offer a simple solution but was found to be impracticable in view of the extreme weakness of the connections in the existing structure, consisting as it did of girders wherein the quest after lightness at the time of construction had been carried to extremes and far beyond what was reasonable, especially in the shaping of the gussets which left no room even for the addition of even a single rivet. The difficulty was especially apparent in the neighbourhood of the connections of the cross girders, and neither the engineers consulted on the matter nor the designing staff of the administration concerned were able to put forward any satisfactory proposal. Moreover it was an essential condition for the execution of the work that no portion of the existing construction should be dismantled under load, even under dead load, so that no new strains should arise on account of adaptation when the member in question was being replaced — strains such as might normally be acceptable in a new construction, but not in one which was already old.

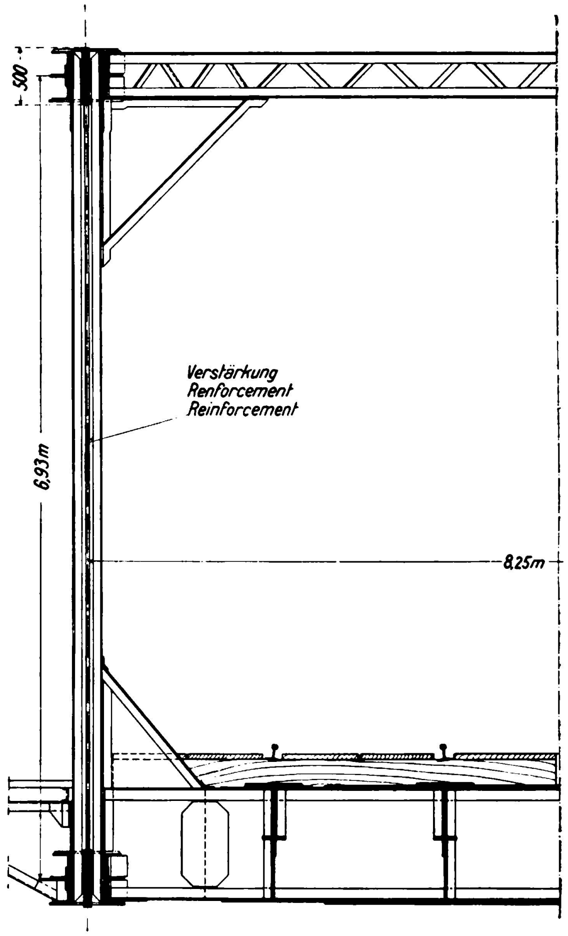

Fig. 2.

Yet a third solution was considered and abandoned: namely, that of erecting new girders of similar construction alongside the existing ones. The result would have been both ugly and heavy, and as the new and old members would have been separate from one another the conditions under which they would have had to act would not have been very satisfactory.

It remains to describe the solution worked out by M. *Goelzer* and now in course of being carried into effect, one of the spans having already been completed. The old girders consisted of two booms of open box section with projecting flanges, connected together by plate-webbed verticals and by flats forming the diagonals (Fig. 2). Within each of these girders a new flat reinforcing girder of the same geometrical form is being built up, inserted between the walls of the old girders, and connected to these by means of flat welded plates.

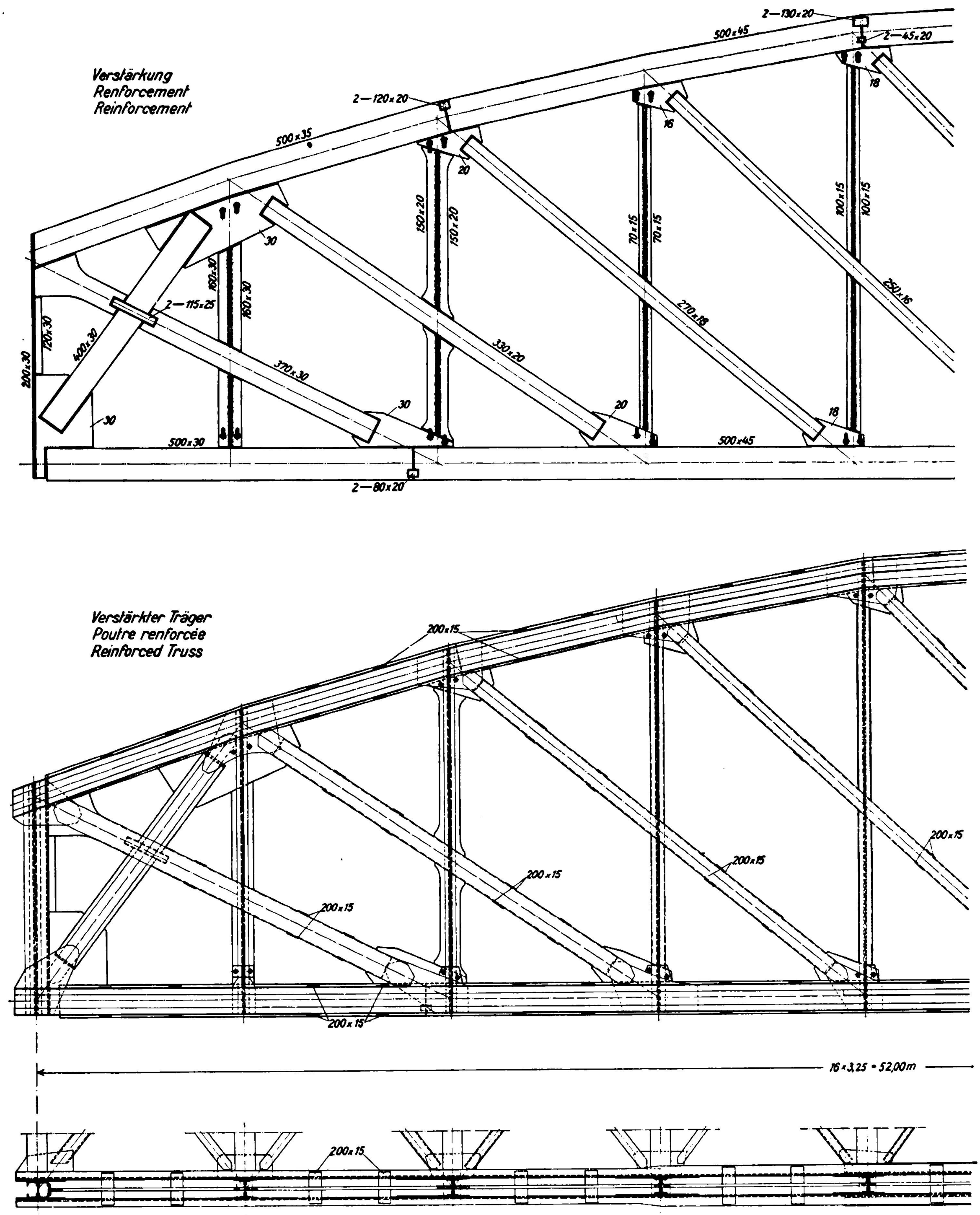

Fig. 3.

The new girder is formed of broad steel plates 40 to 50 mm thick (Fig. 3). It is entirely of welded construction using butt welds wherever possible, especially in the booms and diagonals, with welded fish plates where necessary. All the new pieces are of Martin steel. The booms have largely been welded in the shop, and the remainder of the welding carried out on the site before any part was erected (Fig. 4).

All that was necessary to enable the new members to be placed in position was to form a few slots beforehand in the web plates of the verticals so as to accommodate the boom members and the diagonals (Fig. 2).

It was desirable to load the new girder before connecting it to the corresponding parts of the old in order that the new dead load might not be carried on to the old girders (as frequently happens in reinforcing work), and so that on the contrary, part of the old dead load might be picked up by the stronger new girder. With this object the old girder was lifted on jacks before completing the connections, and was caused to bear upon the new one. The relief afforded

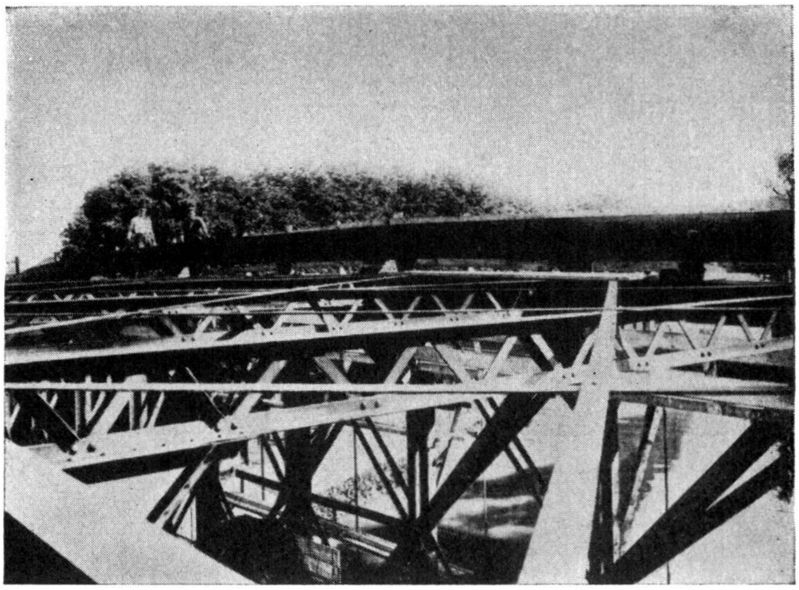

Fig. 4.

to the old girder in this way amounted to approximately one third of its weight, so that the stresses in the old members will not in future exceed 11 kg/mm^2. The amount of strengthening afforded is considerable, since the weight of the new girders is approximately 50 % that of the old.

It should be observed that the strengthening effect is rendered completely effective through the close union that has been obtained between the corresponding old and new elements (Fig. 5).

The operations were, of course, carried out without interrupting the railway traffic, the latter merely being confined to a single track under a reduced speed. The strengthening of the rail bearers, cross girders and bracings involved no special features.

The writer it not unaware of the criticisms which might, in principle, be advanced against a scheme of this kind, especially one in which iron and steel are associated with one another; but the number of essential welds between steel and iron is in fact limited, the three elements that make up each of the girders being connected mainly at their intersections. Moreover practice has shown that such work is successful as in the bridge at Brest and in the case of the Pont d'Austerlitz in Paris — and to the engineer that is what matters.

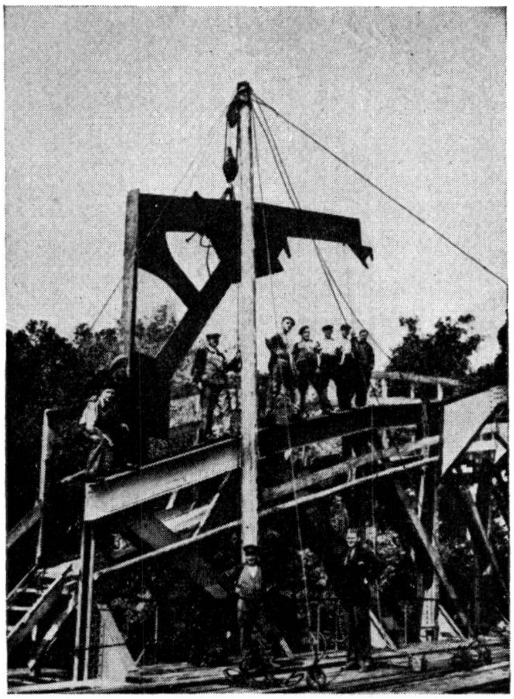

Fig. 5.