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Experience obtained with Structures Executed in Norway.

Erfahrungen bei ausgeführten Bauwerken in Norwegen.

Observations sur les ouvrages exécutés en Norvège.

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Regulations for welded structures are at present in course of preparation and will be brought forward for approval during the present year. Hitherto the execution of welded structures has been based mainly on German and Belgian regulations and experience. In the last few years heavily covered electrodes have been used to a constantly increasing extent. The material hitherto used has almost exclusively been St. 37.

The following may be mentioned among the welded structures carried out during the last few years.

1. Roof trusses and steel skeleton structures, to the greatest part in the workshop welded then riveted together at site. Storage tanks of up to 120 m^3 capacity, completely welded.

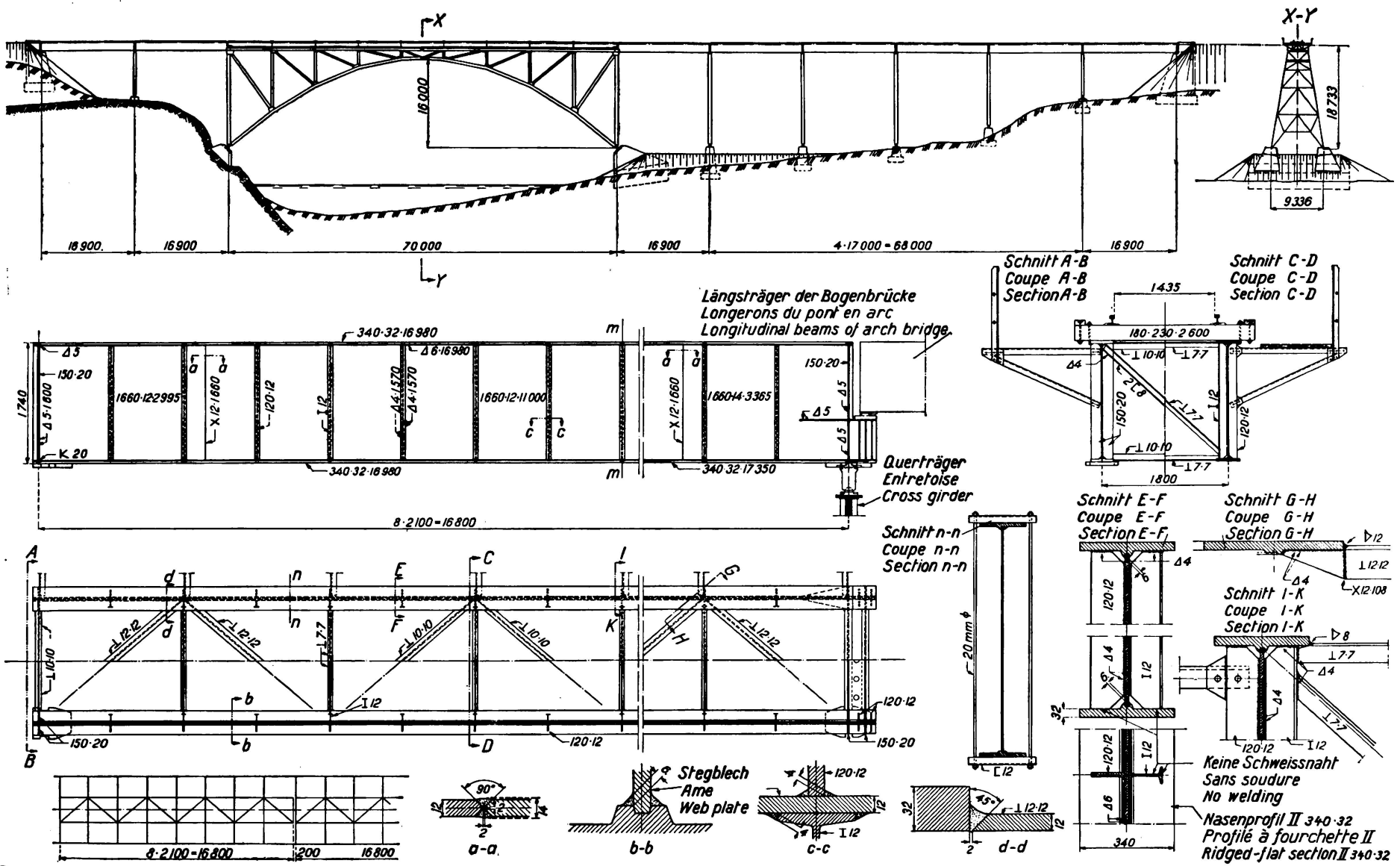
2. For hydraulic work a roller weir 14 metres long, a sector weir 17 metres long and a girder 20 metres long for a needle weir, and several sluices have all been welded.

3. For cellulose and paper factories, between 80 and 90 peeling drums of different sizes have been welded. The largest of these has a diameter of 6 metres, a length of 24 metres and a weight of 105 tons.

4. Many large and small cranes of various types have been completely welded. A 20-ton travelling crane of 19.4 metres span and a traverser of 20 metres span for the Norwegian State Railways may be mentioned as examples.

5. For use in a large road bridge in Drammen, 18 plate girders of 16 and 24 metres lengths were welded; in this bridge the heavy reinforcing rods were also spliced with butt welds. For the Norwegian State Railways, five spans of 11 metres length and 8 spans of 17 metres length for single-track railway plate girder bridges were welded. The girders for the crane and gantry mentioned above, and also all the bridge girders, were built as plate girders with their flanges formed from nose sections manufactured by the "Dortmunder Union".

The 17-metre bridge-deck girders will now be described in greater detail.



Fig, 1. Welded plate girders for the Railway bridge over the River Namsen (Norway).

The Bridge over the Namsen.

This bridge, on the "Nordlandsbanen", consists of a three-hinged arch structure of 70 metres span and the 8 plate girder bridges mentioned above carried on hinged stancheons (see the general arrangement in Fig. 1). As the erection was accomplished without falsework the arch-girder and the supports were riveted. Complete working drawings were prepared for the eight plate girder bridges both in riveted and in welded construction, and the respective weights and cost estimates worked out at 158.5 tons costing 50 100 Kr. for the former alternative, as against 124.2 tons costing 40 600 Kr. for the latter. The girders were welded in the bridge-construction workshops of the Vulkan Company in Oslo; they were transported a distance of 775 km on railway trucks to the site, and erected by means of a 20 ton crane. Brackets and railings were riveted at site.

The method of construction may be seen in Fig. 1. The flanges are formed from nose sections N° II (340 × 32 mm) approximately 17 metres long. The web plates are joined by X-welds, the splices being situated only three metres from the bearings so as to keep the tensile stresses in the welded joints low. The stiffeners over the bearings on each side consist of plates 150 × 20 mm, and the remaining web stiffeners are formed of 120 × 12 mm plates on the outer face and I-beams N° 12 on the inner face, thus avoiding the welds falling in the same line (section c—c). The bracings are of T sections, and are connected where possible by butt weld.

The joints were welded with heavily covered "Fonas" electrodes — a Norwegian make. The more important joints were all welded in horizontal position, they form continuous welds. The web splices were the first to be welded, in four passes forming an X-shaped butt weld, after the gap had been bevelled by means of a cutting burner; the initial layer was deposited against a copper strip after which the web plates were turned over and the root of the weld was carefully worked with a chisel before the second layer was applied. In welding the third and fourth layers it was tried to obtain a flat and smooth surface, merging gradually into the plate. From the lower edge of the web plate up to a height of 40 cm each X-weld was examined by taking two X-ray photographs, the rays penetrating along the contact areas of weld-metal and plates. After it was proved that the welds were good, the edges of the web plates were cut-off with a cutting burner and were fitted into the grooves of the nose plates (section b—b). Triangular gussets were welded on to the under-side of the upper flange to connect later with the webs of the diagonal wind bracings (section G—H).

The plate girders were then erected, by means of, 1.5 m from one another spaced spanners (section n—n); the stiffeners were fitted into the lower boom, and spot welded to the web plate.

The girders were turned by means of cranes and all intermediate stiffeners were welded to the web plate. The molten weld metal showed a tendency to run out, which was looked upon as an advantage. The fillet welds connect with the web plate at about 30° and merge gradually into it (section c—c). The shrinkage in the web plate resulting from the presence of these fillet welds amounted to between 10 and 12 mm in a longitudinal direction, the necessary

creeping being taken up by sliding in the grooves of the flange plates. The welding of the flanges to the web plate was started at the lower flange. The fillet welds, 6 mm thick (section b—b), were deposited in a single layer in alternate 2.1 metre lengths by two welders, working on the same side, from the middle of the girder towards the ends. The girder being tipped to an angle of 45°. The stiffeners were provided with cut-off corners so as to render the welds continuous (section E—F). The girder was then turned and the upper flange welded in the same way, after which the intermediate stiffeners were welded to the flange. Finally, after precise measurement, the stiffeners over the bearings were placed in position and welded to the flanges and to the web plate.

The erection of the plate girder bridges was accomplished by arranging the finished girders in their proper positions and drawing them against the ends of the cross bracings by means of tie rods, the cross bracings having previously been arranged at the correct centres so as to act distance pieces. After connecting these cross bracings the diagonal bracings were fitted in and welded. The V joint between the flanges (section G—H and d—d) was formed first, and the webs of the diagonal bracings then connected by vertical X-welds to the triangular gussets previously fitted (section G—H).