Experience obtained with structures executed in Holland

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Experience obtained with Structures Executed in Holland.

Erfahrungen bei ausgeführten Bauwerken in Holland.

Observations sur les ouvrages exécutés en Hollande.

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In Holland the use of gas-fusion and electric welding is greatly on the increase. Both methods have aroused active interest, yet each system has its own field of application.

At the present moment perhaps electric arcwelding is the only method of importance in bridge and structural engineering. It is carried out both with alternating and direct current with welding apparatus working on amperages of from 15 to 500 and 600, and almost exclusively with covered electrodes.

In many cases the autogenous cutting process is employed for conditioning the parts to be welded. It should be noted in this connection that perfect conditioning can only be done by *mechanical* cutting.

Excellent results are being achieved with automatic welding apparatus, a recent innovation manufactured in Nimwegen by "Willem Smit en C°'s Transformatorenfabriek N.V.". This welder, which functions with heavily covered electrodes, eliminates the usual hand-welding mistakes and produces a high-grade weld. Great strides are sure to be made in this direction during the coming years.

The use of arc-welding in Holland has proved clearly that certain official authorities are not yet convinced that riveted and welded joints are, to say the very least, in every way equal as regards quality. Doubts are expressed in many official quarters on account of the important influence of the welder's skill on the quality of the joint, and owing to the difficulty of testing the quality of the weld in a simple and reliable manner. Even a skilled welder who has passed his tests cannot do perfect work under all conditions; he will work best with the type of current, welding apparatus and electrode to which he is accustomed.

However, most engineers — and particularly steel constructors — have been convinced by the trials carried out and experience made that confidence can really be placed in welded joints provided the work has been done with first-class electrodes by firms having experience, a well-equipped workshop under the charge of a welding engineer or technical expert, and trustworthy, skilled workmen.

Two questions are of predominant importance in welding, namely:

1) the temperature stresses, and 2) the fatigue strength of the welds.

As regards temperature stresses, whin can easily cause warping of constructional parts, an efficient technical works manager knows by experience how to eliminate their effects by a counter-warp, or by subsequent, moderate heating, though under certain circumstances this may involve substantial expense.

The question of fatigue strength of the welds has not yet been definitely settled. On this account many engineers are still afraid to use welding in steel constructions liable to great alternating stresses. It is possible for this reason that welding is employed much more frequently in structural work subjected only to small stress alternations, than in bridges — and then solely in road bridges in which alternating stresses may ensue but only attain a high value in exceptional cases, the effect of impact stress for a movable load being less important here than with railway bridges.

Meanwhile, every endeavour is being made in Holland, too, to solve the problem of fatigue strength; the results so far obtained have been very encouraging. In the laboratory of the Dutch Railways in Utrecht, tests on the fatigue strength of welded joints are being carried out almost continuously, both with *Schenck*'s and with the pulsator machine. During a series of dynamic tests with pre-stressing, using St. 37 and "Resistens" electrodes supplied by "Willem Smit en C°'s Transformatorenfabriek N. V." in Nimwegen, the values given in the following table were found for T different types of seam.

From this it is clear that the X-weld behaves most favourably by comparison. No signs of fracture appeared in this seam even when more than 2 million loading repetitions from 1330 kg/cm^2 to 2470 kg/cm^2 had been applied.

The Dutch Railways are about to have two entirely welded structures built — a small auxiliary lifting bridge and a small fixed railway bridge.

The following examples of completed structures will give some idea of the present stage of development of arc-welding in Holland:

1) The road bridge over the railway line near Nuth, already described in Bulletin N° 3, June 1st 1935. Data: Span 53 m, road width 6 m, two outside footpaths, each 2.50 m wide; Vierendeel main girders with parabolic top boom; decking of reinforced concrete, with longitudinal beams which act in combination with the decking (Alpha-System). "Arcos Stabilend" electrodes.

2) The road bridge at Buchten Ralway Station. Solid web, articulating bridge (Gerber type) constructed by the "Nederlandsche Electrolasch Maatschapij N. V.", Leyden. Over-all length 96 m width of road 6 m, two 1.20 m footpaths. Weight of steel 225 tons, decking of reinforced concrete, Alpha system. Electrodes-"Resistens", supplied by "Willem Smit en C°'s Transformatorenfabrik N. V.", Nimwegen. The welding effected a saving of 30 % in the weight of steel used in comparison with riveting. Designed by Rijkswaterstaat.

3) Lever drawbridge for road traffic over the River Vecht near Zuilen. Clear width 9 m, road with 5.50 m, two 0.80 m wide footpaths. The authorities had specified a welded construction, but on the initiative of Messrs. "N. V. Werkspoor", Zuilen, who were entrusted with its execution, the bridge was carried out in an entirely welded form. "Smit Resistens" electrodes.

4) Lever drawbridge for road traffic over the "Wijnhaven" in Rotterdam (Fig. 1). Span 10.80 m, road width 6.00 m, with two cantilevered footpaths 1.75 m wide and borne on brackets. Steel 37, weight of steel construction 39.5 tons,

counter-weight 41 tons. Owners: Rotterdam Corporation, designer *J.F.W. Burkij*, execution by the "Nederlandsche Dokmaatschappij", Amsterdam. "Smit Resistens" electrodes.

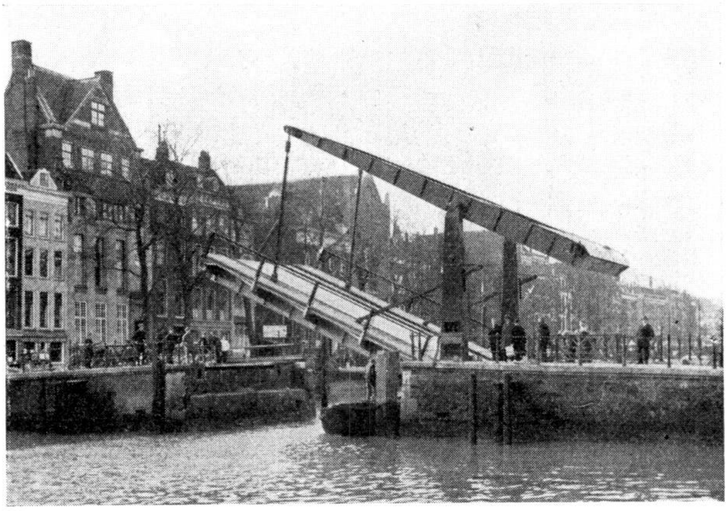

Fig. 1.

5) The "Noorderbrug" in Utrecht. Drawbridge with overhead counterweighted lever-arm. Clear length 10 m, road width 12 m; two footpaths each 3 m wide. The main girders are I-sections with flanges of 300 by 30 mm, and composed

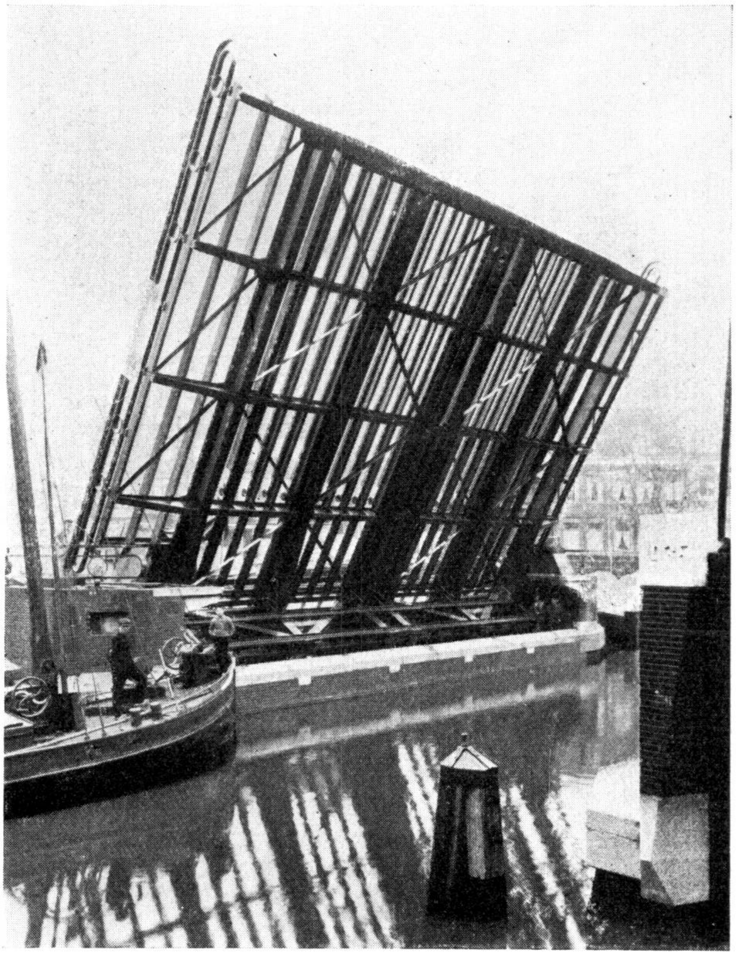

Fig. 2.

of two DIN 55 beams. Height of long lever-arm 628 mm, and counterweighted lever-arm 918 m resp. The weld is situated halfway up the web (Fig. 2). The construction of the pivoting sector is shown in Fig. 3. The piece is a combination of welded sheets and flats; the flange shown in a vertical position in the

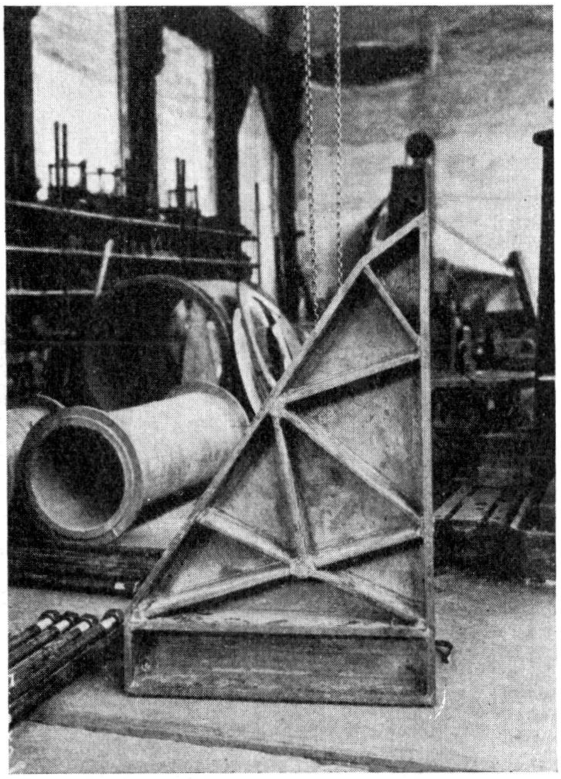

Fig. 3.

illustration is fastened to the bottom flange of the main girder. The cast-steel pivoting segment is bolted to the diagonal flange. The bridge was designed as a riveted construction by the Utrecht Municipality "Gemeentewerken", but was executed as a welded construçtion on the initiative of the contractor "N. V.

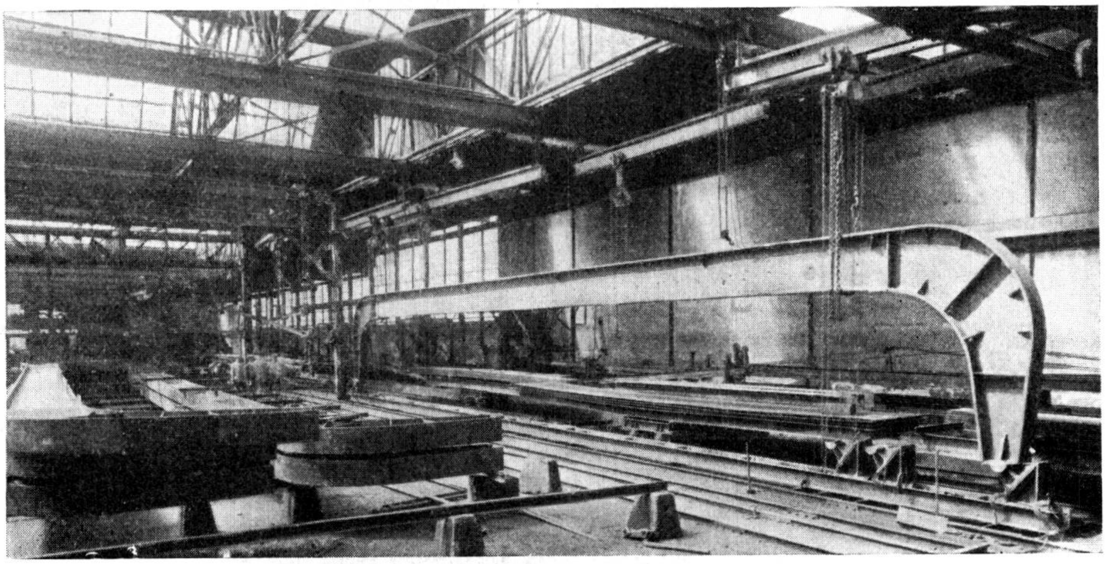

Fig. 4.

Paanevis", Utrecht. Weight of steel 89 tons, counterweight 88.6 tons. "Resistens" electrodes supplied by Messrs. "Willem Smit en C° 's Transformatorenfabriek", Nimwegen. The bridge was assembled in the workshop and conveyed to site on barges.

6) Fixed bridge in the "Laan van Meerdervoort", at The Hague. Span 19 m, length 31.50 m Main girders: two-hinged frames (Fig. 4) at 0.90 m intervals. Weight of single girder 5.8 tons, safe load 0.4 tons per sq. m, in addition to motor vehicles with 3 axle loads of 20 tons each, at intervals of 1.50 m and 6 m. Concrete decking. Owners and designers "Gemeentewerken", The Hague. Construction by Messrs "de Vries Robbé en C° N. V.", Gorinchem; "Smit Resistens" electrodes.

Examples of Welded Erect Structural works.

7) Tree goods-sheds for "Rotterdamsche Lloyd" in Rotterdam (Fig. 5). Respective dimensions 130 × 25 m, 170 × 25 m and 110 × 26 m. Three-hinged

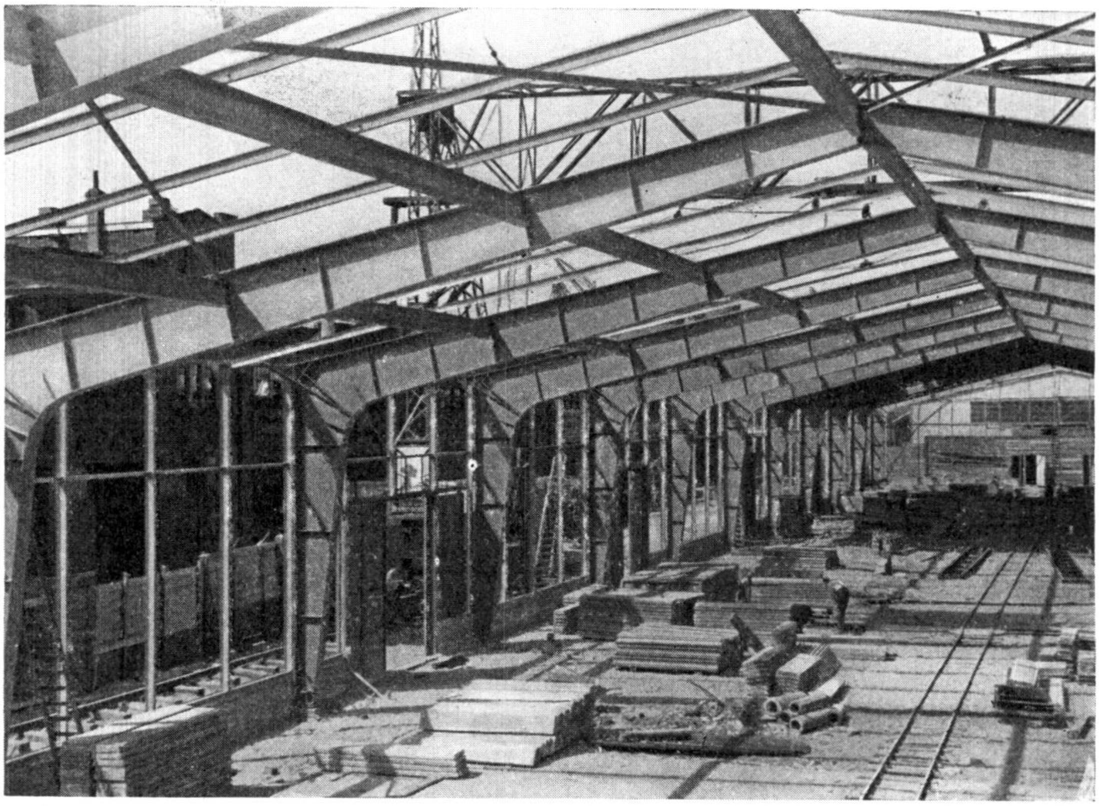

Fig. 5.

frames at distances of 9.90 m. Purlins at 4.20 m intervals. Pre-cast pumice stone concrete roofing slabs. Weight of single frame 5.3 tons. Constructed by Messrs. "de Vries Robbé en C° N. V.", Gorinchem; with "Resistens" electrodes.

8) Damming shields for the River Maas Weir near Lith. Each of the three 38 m wide openings is provided with a roller-weir on which a shield pivots (Fig. 6). The single shields are about 38 m long and 4 m wide, entirely welded and secured against torsion by 30 m long cylinders of 1 m diameter (Fig. 7). To

obtain good connection the shields had to be constructed with extreme accuracy. Welding enabled the shield to be given an absolutely smooth surface — a very important factor as regards the flow of water. Owner and designer: Rijkswaterstaat-Maasverbetering. Roller-weirs and shields were designed by the "Dortmunder

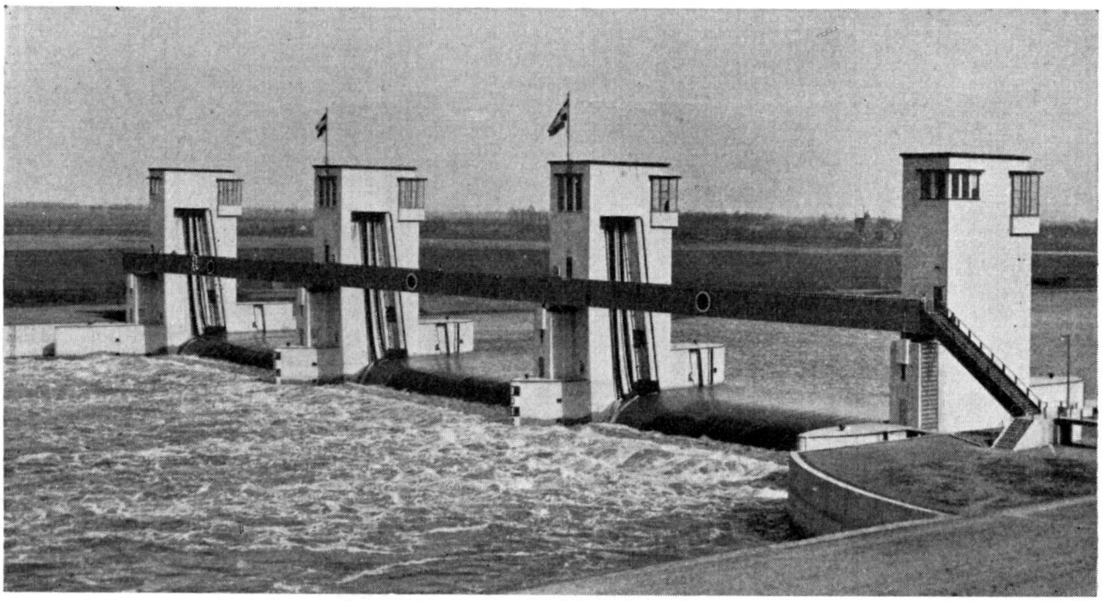

Fig. 6.

Union". The whole of the steel construction was carried out by the "N. V. Werkspoor", Zuilen near Utrecht. Further data in "de Ingenieur", N° 42, Oct. 18th 1935, pp. B 219—228, and in the papers of the three engineers *J. W. Vries*, *C. F. Egelie* and *P. Ph. Jansen* for the Sixteenth International Navigation Congress in Brussels, 1935.

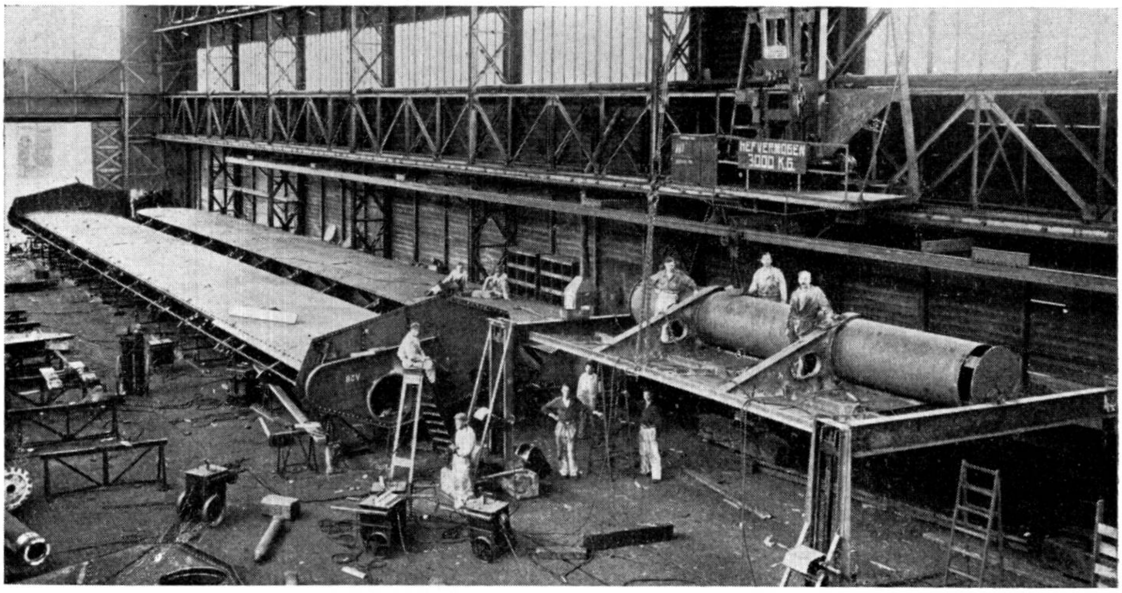

Fig. 7.

Department 1: Canal Traffic. "Smit Resistens" electrodes.

The experience gained in the construction of welded bridges and structural work may be summarised as follows:

> The use of arc-welding in bridge and structural engineering enables constructional work to be carried out which would not be possible with riveted joints.
>
> Welding, in comparison with riveting, affords a saving in weight and, in many cases, in cost.
>
> Welded constructions composed of sheets and flats combined can often be advantageously used instead of cast or wrought sections.

In this connection, however, it must be borne in mind that these advantages can only be achieved:

1) when constructions are designed which are suitable for welding. In general, the usual types of latticed work are unsuitable. The are mostly cheaper if its members are riveted together. In the case of solid web and frames the advantages of welding can better be realised. Pipes and cylinders, which are relatively seldom used in riveted steel bridges and structural works, can readily be formed by welded plates.

2) when the welding is restricted to those parts which can be entirely welded in the workshop or at least on the ground, i. e. can always be placed in a position suitable for welding. The joints which must be made at site with the assistance of special staging provided for the purpose, are best bolted in the case of structural work. For bridges bolted joints are in many cases not admissible. It is then necessary to carry out the welds on staging and in such a manner that vertical or overhead welding is avoided. This, however, often requires expensive conditioning of the joints beforehand, a fact which lessens the advantage of such welded joints.

Rain, strong wind and even moderate wind, very unfavourably affect the quality of welded joints. The places where welding takes places at site should therefore be suitably sheltered.

So far, arc-welding has not proved efficacious for welding rail joints on bridges. Tests made with Arcos-welded joints soon led to the appearance of cracks. Arcos-welded joints have therefore been replaced by aluminium termite welds, which up to now have proved satisfactory in every respect. They are, however, expensive. It is considerably cheaper to use electric resistance-welded rail butts, as the "Deli-Spoorwegmaatschappij" has recently been doing in Sumatra.

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