Recorded failures of electrically welded wrought iron and mild steel bridges

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Recorded Failures of Electrically Welded Wrought Iron and Mild Steel Bridges.

Versager bei elektrisch geschweißten Brücken aus Schmiedeeisen und Flußstahl.

Ruptures enregistrées sur des ponts en fer forgé et en acier doux soudés électriquement.

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In connection with welding work on existing bridges, I have searched for but failed to discover any paper describing failures of welding, and as failures have been experienced in the carrying out of bridge welding by my Chief, Mr. *John Miller*, Engineer of the North Eastern Area of the London and North Eastern Railway, England, I submitted my paper "Recorded Failures of Electrically Welded Wrought Iron and Mild Steel Bridges" to this meeting in the hope that not only failures experienced by others might be brought to the attention of the International Association of Bridge and Structural Engineers, but that these failures as well as those described by me might be considered and their true nature and portent be determined, and if considered of sufficient importance, that the correct procedure to be followed and the necessary precautions to be taken to avoid similar failures be agreed on and laid down.

Since submitting my paper, failures somewhat different from those described by me have been recorded, and I am therefore taking this opportunity, so generously extended to me, to describe these.

The failures occurred in the course of carrying out the repairs to an old Wrought Iron plate girder bridge in the City of Leeds, which, apart from having suffered very badly from corrosion needed to be strengthened, as it was considered of inadequate strength to carry modern traffic.

When constructed in 1867, the local authorities insisted that the bridge should be given an ornamental appearance, as it was situated close to the chief centre of worship of the City and spanned the main approach to it. The main girders, of box construction, were therefore encased with ornamental C. I. plates in the then prevailing Gothic style of architecture, while the underside, until recently, was similarly boxed in with ornamental Gothic panelling. As a consequence, large portions of the bridge had remained inaccessible for painting and inspection since it was constructed, and when recently the casing plates were removed the ravages from corrosion were found to be serious and extensive.

There were two alternatives:

a) To renew the bridge, which would have been very expensive, as it was hemmed in on all sides with valuable business property, as a stoppage of traffic for even a short period was out of the question, it being one of the most important railway lines in the North of England.

b) To repair and strengthen the old bridge by electric welding, which method was adopted.

The observed failures of the welding occurred in the cross girders, which were of box type construction. They were badly corroded and had also suffered distortion of the webs due to overloading. This was caused by the removal, at some time, of certain rivets and their substitution with bolts which had rusted

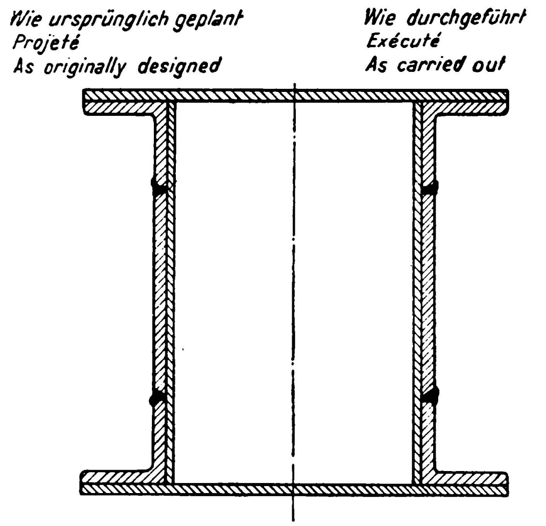

Fig. 1.
Section of Cross Girder.

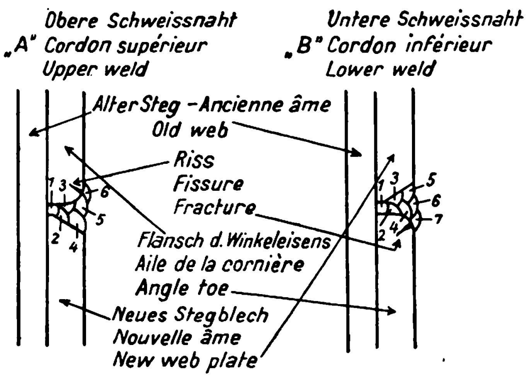

Fig. 2.
Details of Web Butt Welds as designed.

away. The work, therefore, became more extensive than anticipated, and of a very difficult nature.

The most difficult portion of the work was the welding in of new web plates, as these had to be fitted in between the vertical flanges of the cross girder angles, which necessitated using fairly large butt welds. The procedure of carrying out this work was to tack weld the new web plates to the angle toes and then to weld alternately the top and bottom butts in runs of six inches, the number of runs being in some cases as many as seven. The butts when prepared were of the usual form adopted by my Chief for welds of this kind and the welding was as indicated in Fig. 2, A and B.

It was found that when the final weld had been deposited, a fracture developed along the parallel to it, as shown on the photograph (Fig. 3). It was considered that the deposition of further welds (Fig. 2, A 6 and B 7) would not of necessity guarantee that these would reach sound metal at the root of the fractures.

After a number of experiments it was found that the method indicated in Fig. 4 was most satisfactory.

The lower or bottom weld was run first the full length of the web and then the upper or top weld. As will be noted, there was no chamfer in the case of the top weld, and in the case of the bottom weld, there was no face to the chamfer, which was run to a sharp edge. The sharp edged type of chamfer has

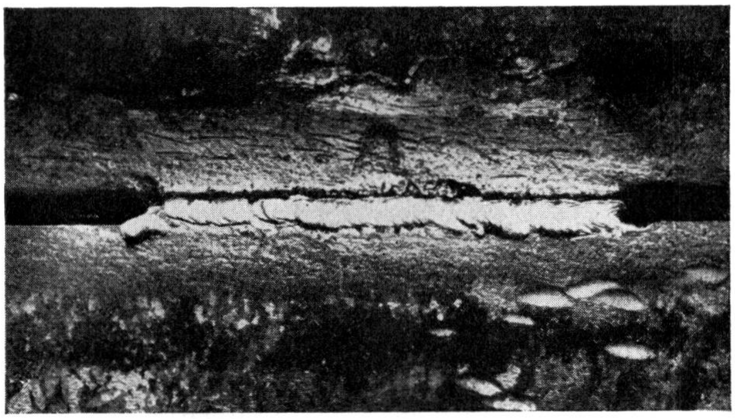

Fig. 3.
Fracture in angle parallel Weld.

since been adopted instead of the form shown in Fig. 2 above, as it secures better fusion at the junction of the plates.

The fractures seem to be caused by the contraction of the metal at right angles to the rolling direction extending as the welding proceeded. A piece of the

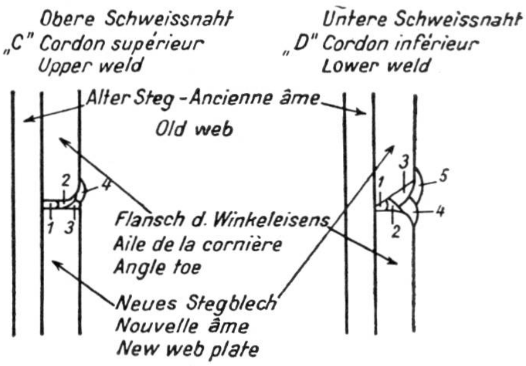

Fig. 4.
Web Butt Welds as carried out.

angle cut out disclosed a fibrous structure parallel with the length of the bar, such as wrought iron of good quality invariably shows.

The idea underlying the method finally adopted was to provide a coating weld (Fig. 4: C 2 and D 4) which would offer greater resistance to the contraction set up by the shrinkage of the welds (Fig. 4 : C 3 and C 4 and D 5) than the W. I. of the angles. After adopting the method described, no fractures have taken place when the welds were made, nor have any fractures developed since.