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7. Off Ramp of Hanshin Expressway in Osaka (Japan)

Owner:	*Hanshin Expressway Public Corporation*
Consultant:	*Prof. Dr. K. Horikawa*
Contractor:	*Takara Giken Co. Ltd.*
Work's duration (Field work):	*4 months (2 weeks)*
Repair date:	*1985*

Reshape of End Part of Plate Girder Bridge

Corrosion is one type of damages in steel bridges in service and is apt to occur near expansion joints, bearing shoes and so on. In these parts, the thickness of members decreases by corrosion. In an extreme case, the fillet welds between web and lower flange are lost, as shown in Fig. 1. The cause of this example was considered to be the leakage of water with free lime beacuse stalagmite was found on the lower surface of slab and water dropped even on a fine day.

For the repair of the bridge, following three procedures were discussed as alternatives.

1) Cutting off the corroded part, then a new member with T section is connected using H.T. bolts.
2) Cutting off the corroded part, then a new member with T section is connected using welding at site.
3) Cutting off the corroded part, then only a new lower flange is connected using welding at site. As a result, the plate girder is reshaped from uniform section to non-uniform section.

These procedures have both merits and demerits. However, procedure 3) has merit for repair of bearing shoes, because the working space is secured after the reshape work, and the safety of structure is maintained during the repair.

The safety of structure during the repair and the ultimate strength after the repair should be examined in the case of heating process under loading.

Fig. 1 An example of corrosion

Before the actual repair, a model plate girder was reshaped from a uniform section to a non-uniform section by gas cutting and welding under loading. The safety of structure during the repair and the deformation after the repair were studied and also the ultimate strength after the repair was measured. Through these experiments the possibility of the repair and the cares to be paid in the actual repair were examined.

From the above results, the procedures for the repair to be recommended are as shown in Fig. 2.

1) Firstly, welding of vertical stiffener
2) Secondly, welding of horizontal stiffeners
   It is desirable that the stiffeners marked by * in Fig. 2 is welded on the same level as the lower flange fixed in stage 5) and welded to the next vertical stiffener.
3) Then drilling of a hole
4) And gas cutting
5) Finally, welding of lower flange

Assuming an existing girder with the same proportion as the model, the stresses on each stage are considered to be as shown in Fig. 3.

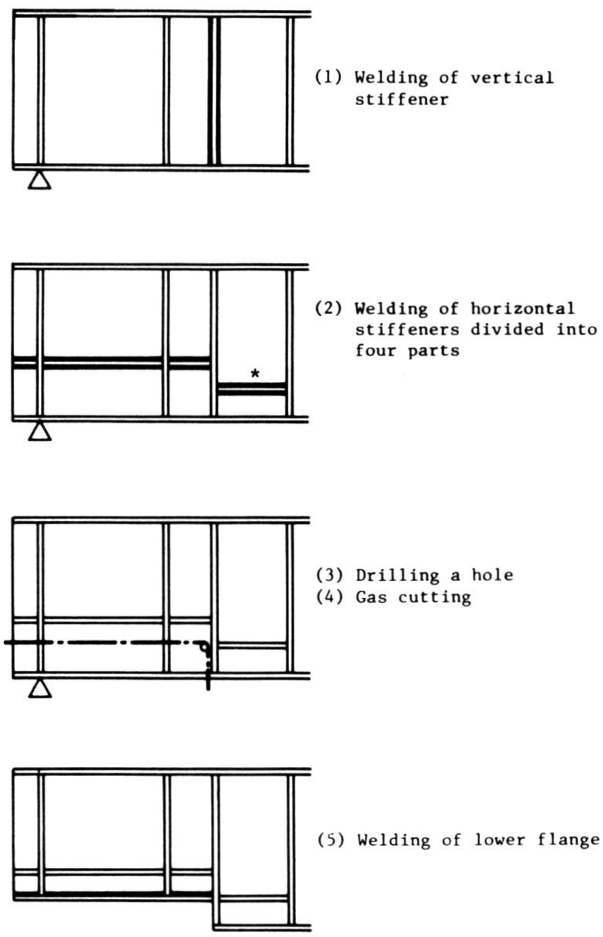

Fig. 2 Recommended procedures

Stage I: Original section.
Assume the stresses due to the dead load and the live load as shown in the figure.

Stage II: Welding of stiffeners.
The live load is not considered, because there is no traffic. The stress due to the dead load does not change.

Stage III: Gas cutting.
The stress, that exists in the section to be cut off, is redistributed. Also, the force is shared by horizontal stiffeners. The stress after redistribution can be calculated from the following three conditions.
1) Difference of strains exists between stiffeners and web.
2) The integral of moment by the stresses equilibrates with the external moment.
3) The integral of the stresses is equal to zero.

Stage IV: Welding of lower flange.
The stress due to the dead load does not change. The entire section is effective to resist the live load.

The existing bridge after the repair is shown in Fig. 4.

(K. Horikawa, H. Suzuki)

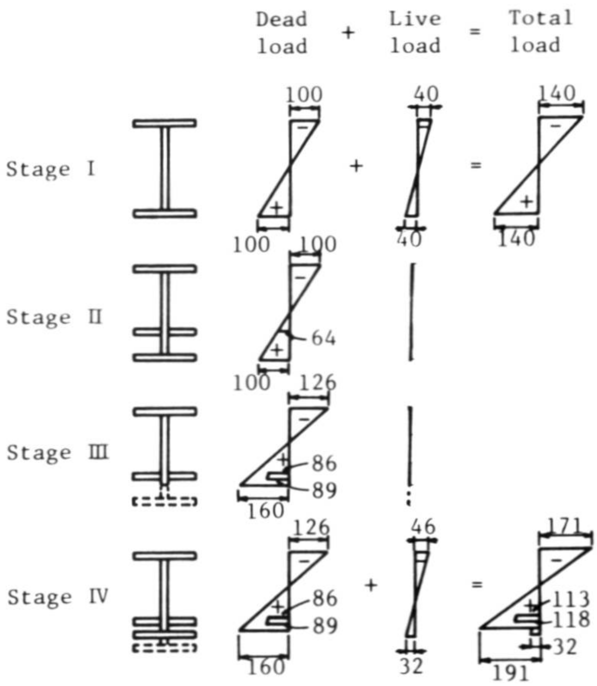

Fig. 3 Schematic example of stress (MPa)

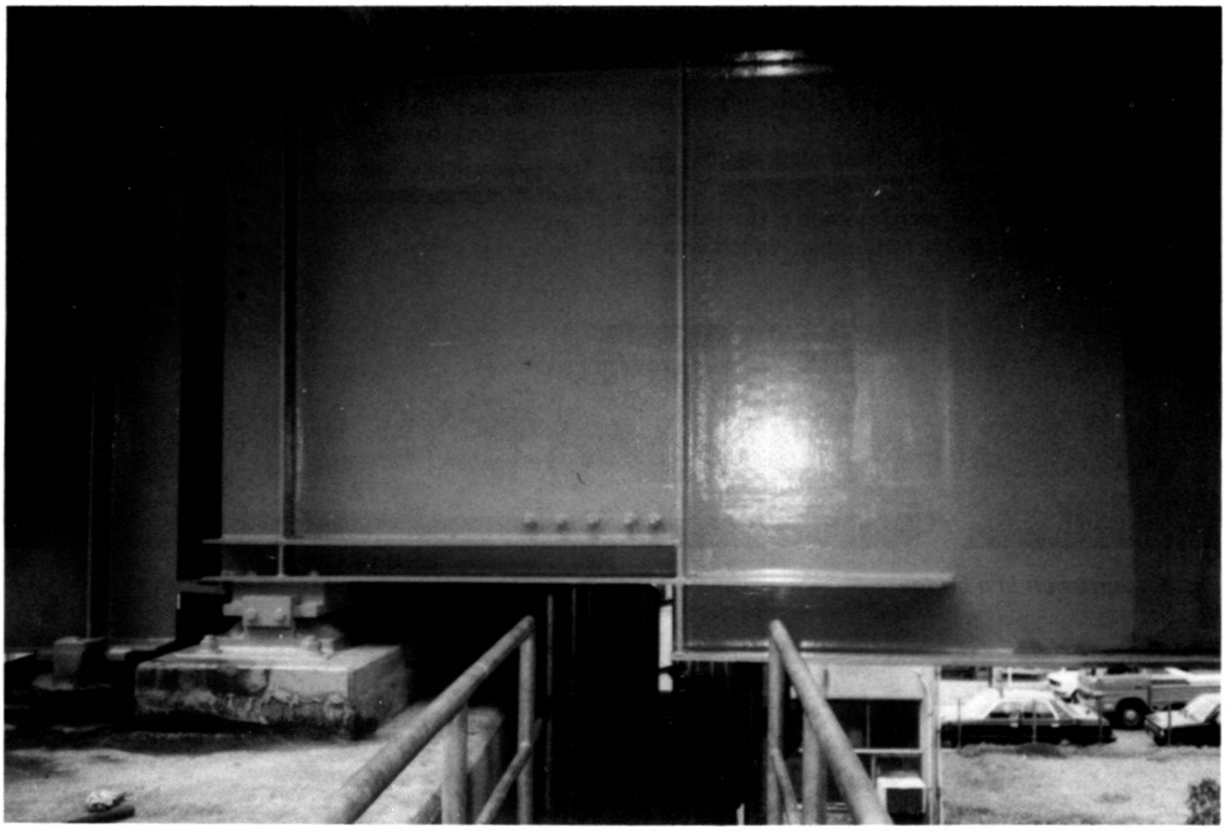

Fig. 4 Existing bridge after remedy