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Fatigue Strength of Butt Welded Trough Joints with a Tack Welded Backing Strip in Steel Deck Panels

Tokyo Institute of Technology Jorge Muller
Tokyo Institute of Technology Toshio Takebuchi
Tokyo Institute of Technology Chitoshi Miki

1.- Introduction

Tensile fatigue strength of transverse butt welded trough joints that have a tack welded backing bar in steel deck plates were examined by a bending fatigue test. A total of 26 specimens with 5 different tack weld details of backing strip were tested and compared. Nowadays, butt welds are widely used in the deck plate of orthotopic decks, and under repeated transverse loading, the fatigue strength of such joints is usually critically dependent on the root weld condition. The main aim of this research is to find the best tack weld detail of backing strip and each connection detail.

2.- Fatigue Test

Figure 1 shows shapes and sizes of test specimens. The characteristics of the 5 different weld types of the specimens are as follows: Type A: Temporally welded at the butt welding side. This is a British standard type, and it is currently being used in the Tsing Ma Bridge located in Hong Kong;
Type B: Tack welded backing bar to the internal or opposite side of the trough as well;
Type C: Fillet welded backing bar. This type and type B are Japanese standards;
Type D: Tack welded backing bar on both sides. It cannot be used as the detail of field joint.
Type E: Random short bead welded backing bar.

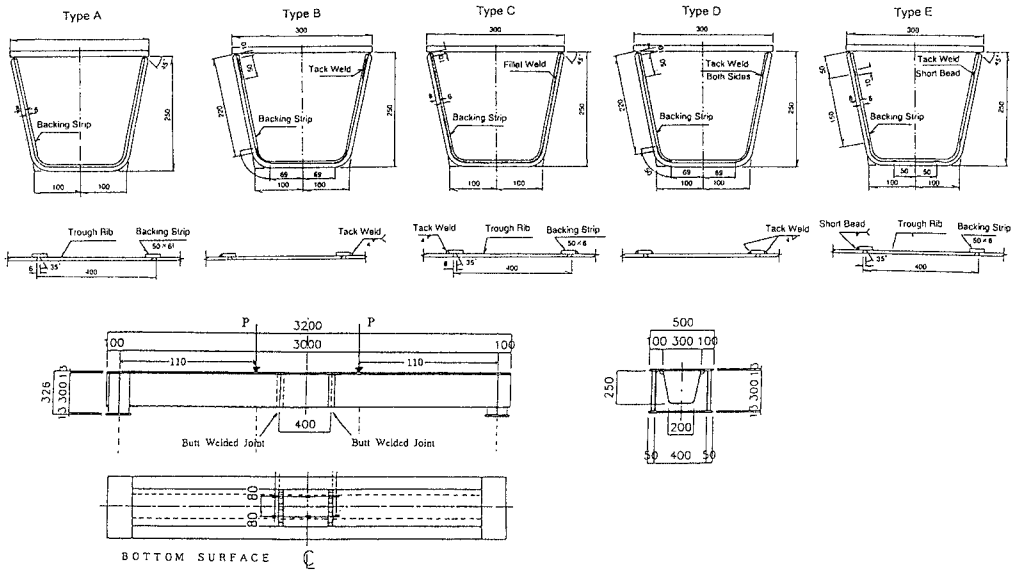
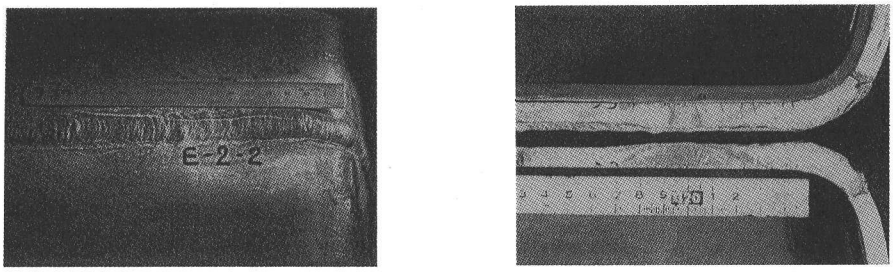


Fig.1 Test Specimens Welding Types

The detection of the crack occurrence was achieved by following the changes of the strain and by optical checking through a magnetic particle test (Photo 1a).

A detailed study of the fatigue failure surface has been carried out. This observation is made by immersing of the failed pieces of the specimens into liquid nitrogen and then breaking them. This allowed the fatigue fracture surface to be seen. These observations led to the determination of the crack initiation point (Photo 1b).



a Photo 1 b

3.- Test Results

The results are best illustrated by a graph of the S-N curves (Fig.2). The cycles to failure denotes when an initial crack was detected on the specimen surface.

From Figure 2 it can be said that all results of types A,B,C,D and E with the exception of Type A-1 and E-2 are plotted between curves B and D of the JSSC. In the case of Type E, all results can be plotted between curves B and C, indicating that it has the highest fatigue strength. However, this short bead welding has a high probability of failure and, therefore, its use can not be recommended.

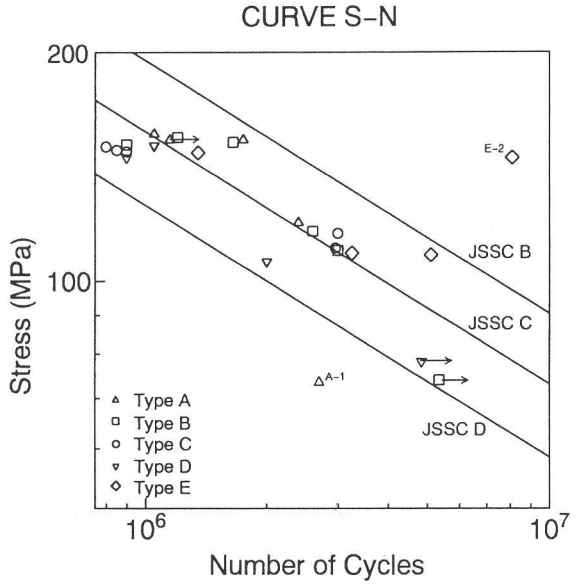


Figure 2

Most of the cracks are located in the vicinity of the round corners of the troughs. There is no indication of cracks emanating from the toe of the tack fillet weld and no cracks were detected in the welded joints between the deck plates and also between the trough and deck plate. Additionally, there were no difference of the rate of crack propagation among the specimens. The results of the study of fatigue fracture surface indicate that all crack initiation points are located in the weld root, and many of them in the vicinity of the tack weld.

4.- Conclusions

1.- There is almost no difference in the fatigue strength of the butt welded trough joints methods.

2.- The occurrence of the fatigue crack is from the weld root, moreover, those cracks are concentrated in the vicinity of the tack weld.