(I − 2) Fatigue Strength of Butt Welded Trough Joints with Tack Welded Backing Strip in Steel Deck Panels

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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 welding types were tested and compared. One of the welding types is being used for the orthotropic steel decks of the Tsing Ma Bridge located in Hong Kong. Nowadays butt welds are widely used in the deck plate of orthotropic decks, and under repeated transverse loading the fatigue strength of such joints is usually critically dependent on the root weld condition. In Japan, backing strips are often tack welded to one or both of the plates to be joined. The three sites that experience fatigue cracking in butt welds on permanent backing bars that are transverse to the direction of stress are mainly from the toe of the butt weld, or from the weld root through the weld metal, which is the most common mode of failure, or, if the backing bar is tack welded in position, from the toe of the tack fillet weld.

The main aim of this research is to determine what kinds of cracks occur in the differently welded specimens, and to compare their propagation behaviour during loading.

2. Fatigue Test

The characteristics of the 5 different weld types of the specimens are as follows:
Type A : Temporally welding at butt welding side; Type B: Tack welded backing bar; Type C : Fillet welding backing bar; Type D : Tack welded backing bar on both sides; Type E : Random short bead welded backing bar.(Fig.1)

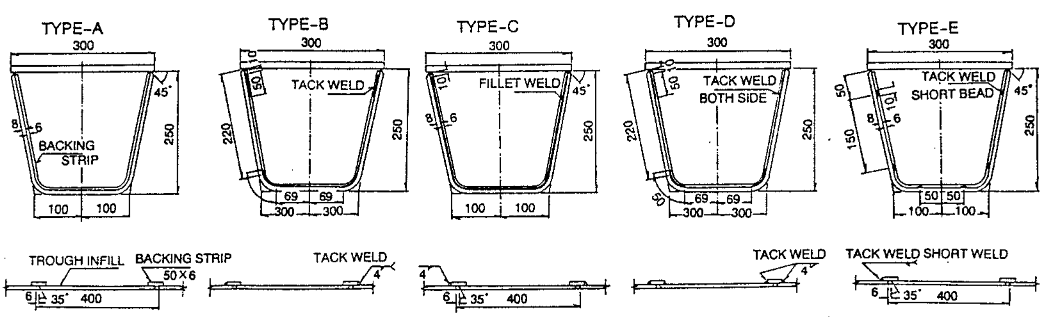

Fig.1 Butt welded trough joints

Simultaneously to the fatigue test(Fig.2), a detailed study of the fatigue fracture surface has been carried out. This observation is made by immersion 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 allowed for the determination of the initiation point of the crack.

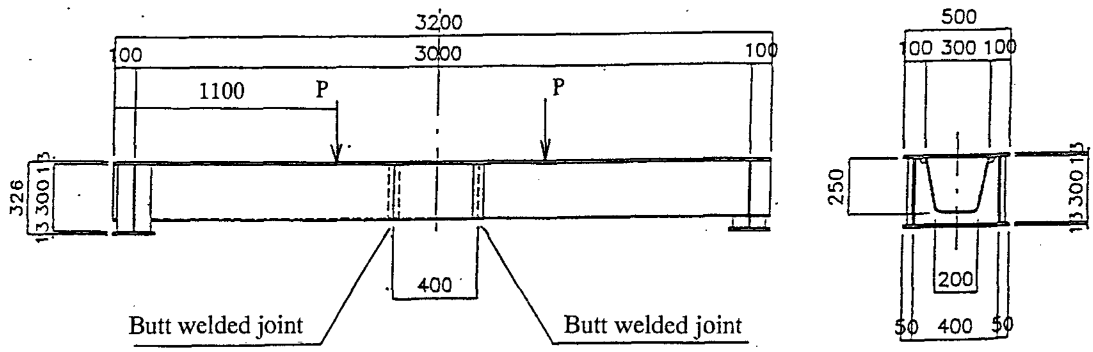

Fig.2 Specimens

3. Results

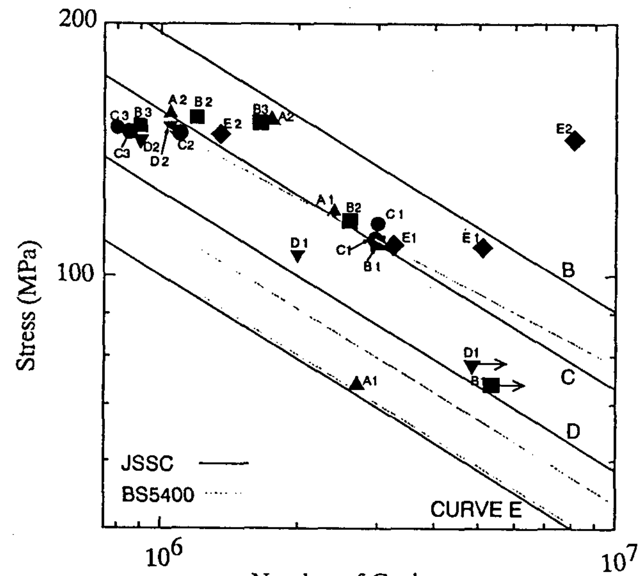

Fig.3 Test Results

At the beginning of November 1994, all the specimens had been tested. In three of them no cracks appeared. Another two specimens were tested in an "up side down" position in order to test the bottom surface in compression. Unfortunely, these samples failed before adequate data could be gathered.

The results may be better illustrated by a graph of the S–N curves (Fig.3), in which the number of cycles to failure for each specimen is plotted. The cycles to failure denotes when an initial crack was detected on the specimen surface.

From Fig. 3 it can be said that the detected cracks were located exclusively on the weld bead or the weld toe of the butt weld troughs. There is no indication of cracks emanating from the toe of the tack fillet weld. Most of the cracks are located in the vicinity of the round corners of the troughs. 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 D, all the results are between curves C and D. This means that specimens of Type D have the lowest fatigue strength. In the case of Type E, all results can be plotted between curves B and C, indicates that it has the highest fatigue strength.

No crack was detected in the welded joints between the deck plates and also between the trough and deck plate. The result of the study of fatigue fracture surface indicates that all the crack initiation point are located in the weld root.