E. Fatique Performance Of Butt Joints By The Electro-Gas Welding Precess For Offshore Structures

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Introduction

The fabrication practice of structural butt welding for offshore units is traditionally to weld from both sides with back gouging of the root area formerly deposited since the fatique strength as well as the fabrication accuracy of the double-sided weld joint appear to be more reliable than those of the single-sided one. Other concern about one-sided welding may be associated with the toughness of the weld including the HAZ expecially when the weld is made with a high heat input welding processes.

On the other hand, single-sided, high heat input welding processes have attracted much attention due to extensive optimisation benefits to schedule, safety as well as fabrication cost.

In this study, fatique strength, toughness, and joint accuracy of butt joints fabricated by the electro-gas one-sided welding process in the vertical position (3G-up) was evaluated to prove the process feasibility and alter the joint design initially contracted.

Procedure

Fatique tests were conducted with the butt joint specimen welded by the electro-gas welding process (EGW). The axial direction of the specimen was perpendicular to the weld centerline and the stress ratio during the test remained approximately at zero level. The degree of welding distortion and joint misalignments was examined prior to the fatique test. The fatique life of the specimen was defined as the number of cycles to failure.

The toughness of the weld metal and the HAZ was also examined through both the absorbed evergy and the CTOD test.

Results and Discussion

Fatique data were plotted with both nominal and hot spot stresses, and test results showed that the fatique strength of the specimen welded with the EGW process lays on or above that of the equivalent joint configuration. The weld profile of the misaligned specimen was maintained good in shape, and no repair was generally needed to correct the weld profile. All the fatique cracks were initiated at the weld toe region even though the local shape at weld toe region was smooth and has no abrupt change.

Local stresses by strain gages have been acquired to estimate the hot spot stress of the joint. Allowing that the different degree of geometrical imperfection may exist in each test specimen, high variation in the hot spot stress depending on measuring location and loading condition was observed especially from the specimens subjected to a relatively high load level. The source of the variation was examined from several aspects, and it was surmised that welding residual stresses remaining in the test specimen might be associated with the variation.

Facture toughness at the weld metal and the HAZ was stable, and the ductile failure mode occurred at the test locations. Absorbed energy of the V-notched specimen was also high enough to validate the fracture toughness value

Conclusions

To date, the EGW process has not been recognized as a standard practice for the offshore units, and in some specifications it has been written that the process should not be used even though the process for commercial ship has become fairly common. This may partly in the offshore industry be due to lack of experience for the process as well as concerns regarding fracture toughness and fatigue properties.

In the study, fatigue and fracture performance of the joint by the EGW process were thoroughly examined to validate the capability of the process for the intended application, and consequently the process was successfully applied to the structural offshore unit without major concerns regarding to the weld quality.