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A Study on the Fatigue Life of Large-Scale Tubular K-Joint

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ABSTRACT

Large-scale tests of welded tubular K-joint under balanced in-plane bending brace were carried out to observe the fatigue behavior of API 2W Gr.60 steel plate produced by POSCO. Toe grinding and weld profiling were used to improve the fatigue life of tubular K-joint. The effect of steel grade and chord wall thickness on the fatigue life was also investigated. The test results were compared with the UK DEn design curve.

KEY WORDS: Fatigue life; weld improvement; toe grinding; weld profiling; chord wall thickness; API 2W Gr.50&60 steel plates.

INTRODUCTION

The most critical failure mode of offshore structures, which are subjected to varying loads such as wave, current, motion and so on, is fatigue failure. The fatigue crack primarily initiates at the weldments, where the stress concentrated. Good fatigue details, for example by substituting a lower class joint with one having a higher fatigue strength, can be employed to enhance the fatigue life of offshore structures. But when this is not practicable or this is insufficient, the fatigue performance can be improved by application of toe grinding, hammer peening and weld profiling etc. to the weldments (Kirhope et al., 1999).
One of the fundamental joint configurations often applied in offshore structures is the tubular Joint. In case of Japanese mills, studies on the tubular joint have been conducted from 1970's to 1980's (Kato, 1974; Takizawa et al., 1979; Ohta et al., 1987). Fatigue test of the large-scale tubular joint was also investigated (Amiot et al., 1982). Especially, fatigue tests of high strength cast iron insert that shifts the critical weldments from high stressed region at the tubular joint to a much less stressed area was investigated as well (Sonsino et al., 2003). Recently, new API provision against factors on the fatigue life for weld improvement techniques has been proposed (Marshall et al., 2005). Effect of steel grade on the fatigue life of tubular joints was investigated (Guanghai et al., 1992; Agerskov et al., 1998; Im et al., 2005).
In this study, the large-scale tubular K-joints were fabricated with API 2W Gr.60 steel plate produced by POSCO and the fatigue test was carried out under the balanced in-plane bending. The fatigue life of as-welded tubular joint fabricated with API 2W Gr.60 steel plate was compared with that of toe ground or weld profiled joint to confirm the effect of weld improvement on the fatigue life. The fatigue life of as-welded tubular joints fabricated with API 2W Gr.60 steel plate and API 2W Gr.50 steel plate was compared. Effect of chord wall thickness on the tubular joint fabricated with API 2W Gr.60 steel plate was also investigated. The test results were summarized with fatigue design curve of UK DEn based on the hot spot stress.

EXPERIMENTAL

Test Specimen

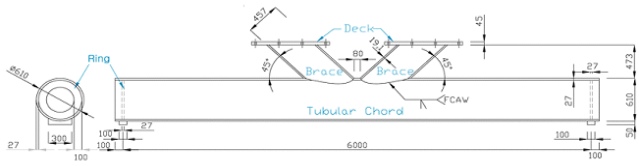

Fig. 1 Test specimen

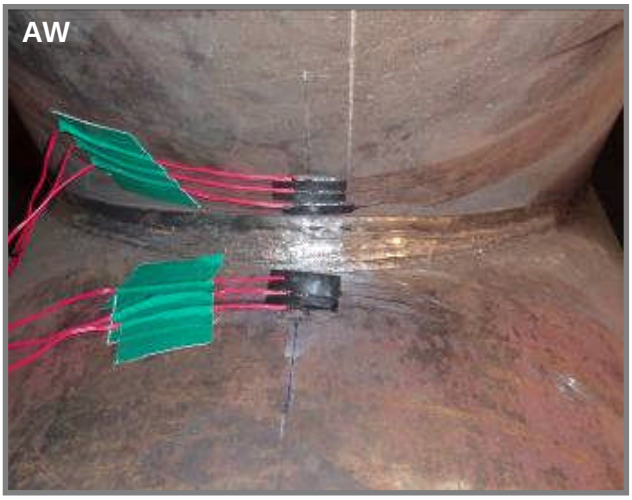

Fig. 2 As-welded specimen