Evaluation on the Effect of Fabrication Tolerances on the Fatigue Performance of Critical Connections between Hull Structure and Topsides in Drillship

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ABSTRACT

With the continuous development of offshore oil and gas resources in deep-water, fatigue has become a major concern for structure safety. It was recognized that the topside and hull interface structures in drillship are critical for the structure integrity. Consequently, a proper estimation of fatigue life for these interface structures is of uttermost importance. On the other hand, at the design and approval stage, the evaluation of fatigue performance is based on assumptions regarding fabrication quality. Most shipbuilding standards include limits on fabrication tolerances such as misalignment, weld profile defect, etc. However, there is little information available on the extent to which these standards area actually met in practice. There is also limited understanding among most designers, builders and owners regarding to the extent to which fabrication tolerances may influence fatigue performance of structures. In this paper, the available data on fabrication tolerances is reviewed and compared to assumptions used in various fatigue analysis standards and guidelines. The impacts of various tolerances on the fatigue life of topside-hull interface structure details are evaluated and the techniques to improve fatigue performances are recommended.

KEY WORDS: Interface, Tolerance, Fatigue, Drillship, Topside

INTRODUCTION

Drillships are known as an attractive type of mobile offshore drilling unit because of their excellent mobility and large variable load capacity. With the continuous development of offshore oil and gas resources in deep water, there is an increased demand of ultra deep water drillship design, i.e., capable of operating in water depths of up to 12000 feet and drilling depths of up to 40000 ft, around the world. These new ultra deep water drillships present unique challenges in their design, construction and classification.

One of the major differences between these new generation drillships and those earlier generations lies in that they are constructed in modular blocks with mega block concepts, such as the mud module, substructures block etc (You et al, 2008). This modern construction method reduce the schedule constrains but also present challenges for interface design and evaluations.

It has been recognized that the interface structures between topside mega blocks and hull sides in drillship are critical for structure integrity and the fatigue performance of these interface is a major concern for structure safety (Gourdet, 2008). Thus, a proper assessment of fatigue life for interface structures is of uttermost importance. On the other hand, at design and approval stages, the evaluation of fatigue performance is mainly based on fatigue life (S-N) curves, which incorporate assumptions related to fabrication tolerances. These assumptions are often derived from other industry and do not necessarily represent shipbuilding practice. Although most shipbuilding standards include limits on fabrication tolerances such as misalignment, weld profile defect, etc., there is little information available on the extent to which these standards area actually met in practice. There is also limited understanding among most designers, builders and owners regarding to the extent to which fabrication tolerances may influence fatigue performance of structures. In this paper, the available data on fabrication tolerances of welded joint is reviewed and compared to assumptions used in various fatigue analysis standards and guidelines. The impacts of tolerances on the fatigue life of topside-hull interface structure are evaluated and the techniques to improve fatigue performances are recommended.

REVIEW OF FABRICATION TOLERANCES

Classification of Tolerances

Most interface structures between topside and hull are fabricated through welding. Welded joint cannot be perfect and all joints have flaws or imperfections that reduce the structural integrity or fatigue life of the joint. Imperfections lead to higher localized stress, thus fatigue cracks most always start at an imperfection.

For fatigue design it is important to know the effect of an acceptable imperfection on the fatigue life of the welded joint, and conversely when an imperfection becomes unacceptable within the analytical framework used as the design basis. To do this the imperfections must