Sensitivity Study of SCR Fatigue at Touch Down Point: Effect of Marine Growth

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ABSTRACT

The estimation of the fatigue damage of touch down point (TDP) of steel catenary risers (SCRs) is crucial to the design of SCRs. However, there are some factors that contribute to the movement of TDP, which may spread fatigue damage of TDP. In this paper, the effect of marine growth on the TDP of SCR in two different water depths (600m and 400m) is investigated through sensitivity study of strength analysis and fatigue analysis. The variation of TDP of SCR is presented due to marine growth and the fatigue life in the touch down zone (TDZ) is compared and discussed.

KEY WORDS: SCR fatigue; TDP; Orcaflex; Sensitivity study; Marine growth

INTRODUCTION

The exploration of oil and gas has been going into deepwater and ultra-deep water in recent years as the available resource in shallow water becomes less. The deepwater determines that the fixed platforms are not feasible and floating vessel together with risers is dominant for store and transport oil and gas. Yue et al. (2011) discussed that flexible risers generally have better dynamic response, but are often limited in size, pressure, and price. Steel catenary risers (SCRs) are recognized widely for deep and ultra-deepwater oil and gas production due to their relatively low cost, conceptual simplicity, significant structural capacity, and ease of fabrication and offshore installation. However there are still challenges for the application of SCRs in deep and ultra-deepwater. Among the challenges, the fatigue design is the greatest challenge given that SCRs are subjected to sever environments. It has already attracted attention from researchers. Huang et al. (2008) investigated VIV induced fatigue of SCR used CFD methodology. Yang & Li (2010) presented the work of optimization design for SCR with fatigue constraints.

It is well known that the fatigue damage of SCR at the hangoff point and touch down point (TDP) are crucial. Clukey et al. (2007) discussed the fatigue problem of SCR at TDP. In reality, the TDP changes over a zone during the lifetime of SCRs due to the influence of vessel motion, the riser mass variation and wave direction et al. This zone is generally known as touch down zone (TDZ) and TDP is the normal position of the TDZ. Without taking account of the variation of the TDP in the riser fatigue analysis, the fatigue damage at the TDZ of the SCRs can be overestimated (DNV, 2005). With respect of the uncertainty of riser fatigue, some researchers have presented their work, including Chezhian et al. (2003), Larson and Lute (1991), and Mfkrk et al. (2001). The marine growth has a significant effect on offshore structures. Mangal et al. (2001) presented that due to marine growth even a trained diver cannot easily detect damage in the offshore platform. The effect of marine growth on the corrosion of offshore structure was investigated by Melchers (2003) using probabilistic model. Schoefs and Boukinda (2004) proposed a probabilistic modeling of marine growth effects based on both Response Surface Methodology and the panel of available tests in laboratory. Schoefs et al. (2005) presented the work about marine growth effects in case of fatigue of jacket offshore structures and also suggested that the effect of marine growth on dynamic behavior of riser must be investigated. Hung et al. (2004) presented the estimation of the jacket platform fatigue in tropical climate Asia country, Vietnam taking accounts of marine growth. Kiu et al. (2011) considered the effect of marine growth on vortex-induced vibration (VIV) in terms of the cylinder roughness. Skaugset and Baarholm (2008a) suggested that marine growth can significantly alter the hydrodynamic behaviour of risers. Skaugset and Baarholm (2008b) presented the test results of marine growth affecting the effectiveness of the helical strakes.

However, the effect of marine growth on the recently developed risers has not yet been investigated. The direct effect of marine growth is that it increases the diameter of risers, which has two effects on riser. First of all, the added mass will increase the top tension that will burden the floater connected to the riser. Secondly, the thickness of marine growth has a significant effect on hydrodynamic drag coefficients. This will result in more challenge on the riser strength. Moreover, the distribution of marine growth along riser is usually from thick to thin with water depth increasing. It is obvious that the existence of marine growth will change the configuration of risers in water. However, it is not clear how it affects the riser fatigue. Hence, in this paper the analysis begins from the variation of TDP due to the effect of marine