

The Comparison of Various SCR configurations for Bow Turret Moored FPSO in West Africa

Mason Wu, Kevin Huang
Acergy, North America and Mexico
Houston, TX, USA,

ABSTRACT

This paper presents a high-level study of three different Steel Catenary Riser (SCR) configurations and the associated strength and fatigue requirements for Bow Turret Moored Floating Production Storage and Offloading (FPSO) system in West Africa environment. The three SCR configurations that have been studied are: simple SCR, weighted SCR and Mini-Lazy Wave (MLW) SCR. This study is intended to provide the performance comparisons among these riser configurations, particularly the dynamic response characteristics at the touch down point (TDP). The study results reveal that the MLW SCR has the best performance for both fatigue and strength, followed by the weighted SCR and then the simple SCR. For the strength assessment, MLW SCR provides satisfactory von Mises stresses, and completely eliminates the riser compression at the TDP, where high compressions for the Simple SCR and moderate compression for the weighted SCR are observed. For the fatigue assessment, comparing to the simple SCR, the MLW SCR significantly improves the fatigue performance at the TDP, while the weighted SCR provides marginally better fatigue performance as well. It is concluded that the MLW is a promising configuration for bow turret moored FPSO applications in West Africa environment, and deserves further assessment.

KEY WORDS: Steel Catenary Riser, mini lazy wave, FPSO, strength, fatigue.

INTRODUCTION

For the Deep Water riser applications, SCRs (Quintin et al. 2007), Hybrid Riser Towers (HRTs), and flexible risers are the most popularly used concepts. Flexible risers are generally motion tolerant, but costly and limited in size and pressure rating. Therefore, there is always an interest to extend the application scope for SCRs, and/or the variation version of SCRs. Some general comparisons between SCRs and HRTs have been performed by Alliot et al. (2005), Wu et al. (2006), and Blevins et al. (2007).

Recent years have seen the first uses of steel catenary risers (Legras, 2006, Nolop et al. 2007) with spread moored FPSOs for deepwater field developments in West Africa. The lessons learnt from the

installation of the SCR riser (Tenet, 2006), pull-in system (Judd, 2005) and FPSO (Xavier, 2006) are also shown in the literature. We have also carried out the conceptual evaluations for several SCR related configurations for Bow Turret Moored FPSO, which has gained more popularity in the latest deepwater field development in West Africa (Wyllie, 2006). Bow Turret Moored FPSO has a number of advantages, including high schedule flexibility, and possible parallel component construction resulting in lower total construction cost. One of its disadvantages is that the heave motion at the turret is relatively higher than that of the conventional FPSOs. This excessive heave motion could cause large quantity of high stress cycles within the riser. One possible solution is to use SCRs with high quality welds at certain critical locations to provide satisfactory fatigue performance. Consequently, this option would impose challenges on the welding procedures and quality control of the welds. Another potential design issue for SCR is the high compression load at the touchdown point for thermally insulated risers. A proven concept to solve both of the fatigue and compression problems is to use the full Lazy wave type of SCRs, with large quantity of buoyancy modules attached to the riser to decouple the FPSO motions from the riser TDP. However, this solution is also quite expensive due to the cost of buoyancy modules as well as the cost to install them. Thus, a mini-lazy wave type of SCR configuration is proposed as a candidate of more cost-effective solution. At the same time, a weighted SCR by clamping heavy collars near the TDP to mitigate the FPSO motions has also been studied. Comparing to the buoyancy modules, the clamp weights cost less in hardware and installation as well. To cover a wider range of FPSO applications, the riser assessment is carried out on both AFRAMAX and VLCC classes.

In this paper we first described the design basis and environmental criteria, followed by the riser modeling and analysis methodologies. Then we illustrated the details of the stress comparisons at the riser TDP, and provided the analysis result summaries. Last, conclusions were drawn. It is found that the MLW concept is very effective to decouple the FPSO motions from the riser touch down region, especially in extreme environments. It is also shown that the MLW concept could be further optimized to provide better fatigue performance when needed. Therefore, it has high potential for bow turret moored FPSOs in benign environments, such as in West Africa.