OTC 19493

Interaction Model for Steel Compliant Riser on Soft Seabed

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Abstract

The use of catenary steel compliant riser (SCR) systems has increased as hydrocarbon production has progressively moved further offshore and into deeper waters. The issue of fatigue damage caused by cyclic interaction of the riser with the seabed has gained prominence with the widespread use and lengthening of the spans. The problem involves a number of complex factors including trench configuration, non-linear soil stiffness, breakaway of the riser from the seafloor, and degradation of soil resistance during cyclic loading. This paper presents a soil-interaction model capable of modelling these complexities, using input parameters that can be obtained with reasonable expenditure. Model simulations for typical offshore soft soil conditions indicate that the model is capable of realistic predictions of cyclic bending moments. Degradation of soil resistance has a major effect on cyclic bending moment, particularly when uplift motions at the riser touchdown point are large.

Introduction

The introduction of these compliant floating systems for offshore hydrocarbon production has led to the development of new designs for the riser pipes, with the catenary steel compliant riser (SCR) often being system of choice. Fatigue stresses associated with extreme storms, vessel movements, and vortex-induced vibrations are critical to SCR performance. The zone at which the SCR contacts the seabed, the touchdown zone (Fig. 1), often proves to be a spot where bending stresses are largest and therefore a critical location for fatigue (Bridge et al., 2003; Bridge et al., 2004). Analyses typically show fatigue damage to be sensitive to seafloor stiffness, which at present cannot be estimated with a great deal of reliability. It should be noted that the vertical scale in Figure 1 is exaggerated for illustrative purposes and typically ratio of trench depth to trench length is small (say 1%) so the problem may be reasonably treated within the framework of a small deflection beam analysis. However, uplift at the touchdown point (TDP) is sufficiently large that the end moment associated with axial tension in the riser should be considered in the analysis.

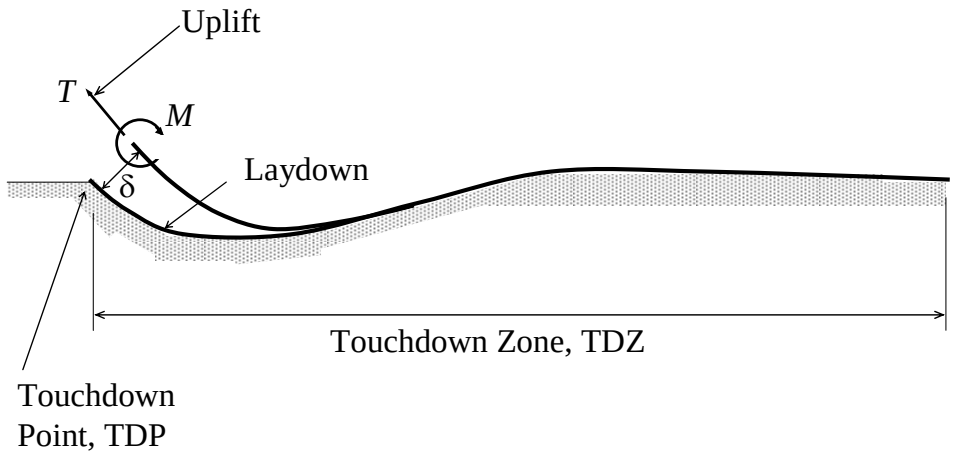

Figure 1. Steel Compliant Riser in Touchdown Zone