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TIME DOMAIN ANALYSIS OF STEEL CATENARY RISERS WITH NON-LINEAR SOIL INTERACTION

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A significant amount of uncertainty is associated with soil-pipe interaction modelling in steel catenary riser (SCR) dynamics. Complex interactions of the seabed soil composition, its nonlinearity and the random and cyclic nature of loading make predictions about SCR behaviour difficult. However, fatigue at the touch down point (TDP) of a SCR is the governing factor in a SCR's durability. SCR fatigue at TDP is proportional to the soil reaction force which itself increases with soil rigidity. It has always been known that the soil softens under repeated loading however this phenomenon has been ignored in previous modelling attempts. The soil has been modelled as either a rigid or linear surface which introduces significant conservatism. This approach has not been an obstacle in shallow and medium water depths since SCRs have been designed for the required fatigue life.

Deep and ultra-deepwater development of oil and gas fields has revived the issue of soil-pipe interaction modelling since the simple rigid or linear seabed models do not allow SCRs to pass minimum fatigue life requirements. There is an ample safety margin in SCR designs with rigid or linear soil models which can be reduced by more accurate modelling of soil-pipe interaction in ABAQUS finite element analysis software.

This paper details a soil-pipe interaction model that has been developed based on the published CARISIMA JIP results. The model is valid for cohesive soils and takes into account suction as a function of loading history, nonlinear stiffness as a function of number of cycles and frequency and development of a trench. This allows the model to capture hysteretic soil behaviour. The soil response has been calibrated against the cyclic test results.

The new method was applied to a 24 inch riser in 4380 ft water. The fatigue life of the SCR was compared to one obtained using an existing approach and the differences discussed and conclusions drawn.

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