

SOIL MODELLING AND FATIGUE OF STEEL CATENARY RISERS



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OBJECTIVES

The aim of this study is to examine the effect of soil degradation on bending fatigue of a steel catenary riser at the touchdown point in soft clay. The riser-soil interaction is complex due to effects of plastic degradation, soil suction, erosion, consolidation: effects which contribute to soil stiffness reduction. To gain a better understanding of how the degradation of the soil contributes to fatigue, the following questions are being investigated.

- To what extent does the degradation of the soil affects the fatigue life of a steel catenary riser?

The goal is achieved by developing a vertical soil degradation model. This model will be implemented inside the structural engineering program SIMLA. By use of the model and a hyper-elastic soil model, the riser bending moments will be compared.

INTRODUCTION

Steel Catenary Risers (SCR) are widely used in deep water areas only due to occurrences of large bending moments. In deep water the soil consists mainly of clay. Several full scale and small scale projects have been conducted to investigate the complex soil behavior. Based on model tests and numerical simulations, soil models are established for the riser-soil interactions which is represented by a load-deflection (P-y) curve.

The most critical to the fatigue life of an SCR is the pipe-soil interaction at the touchdown point (TDP). Thus, an appropriate soil model for the interaction is important.

The oscillations of the riser lead to change in TDP. Fig. 1 illustrates the contact zone of riser and seabed that is denoted the touchdown zone (TDZ).

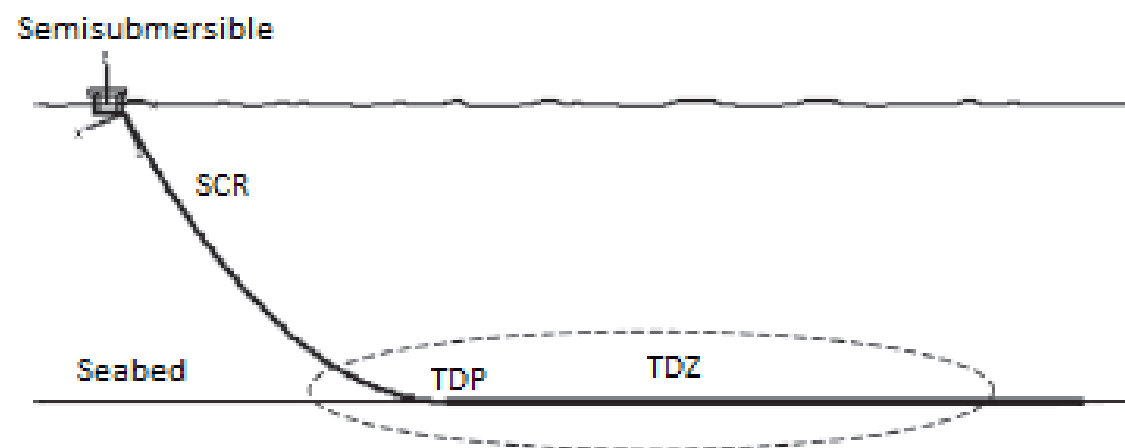


Figure 1: Steel Catenary Riser Configuration

IMPLEMENTATION

The flowchart of the vertical soil degradation model is shown in Fig. 2.

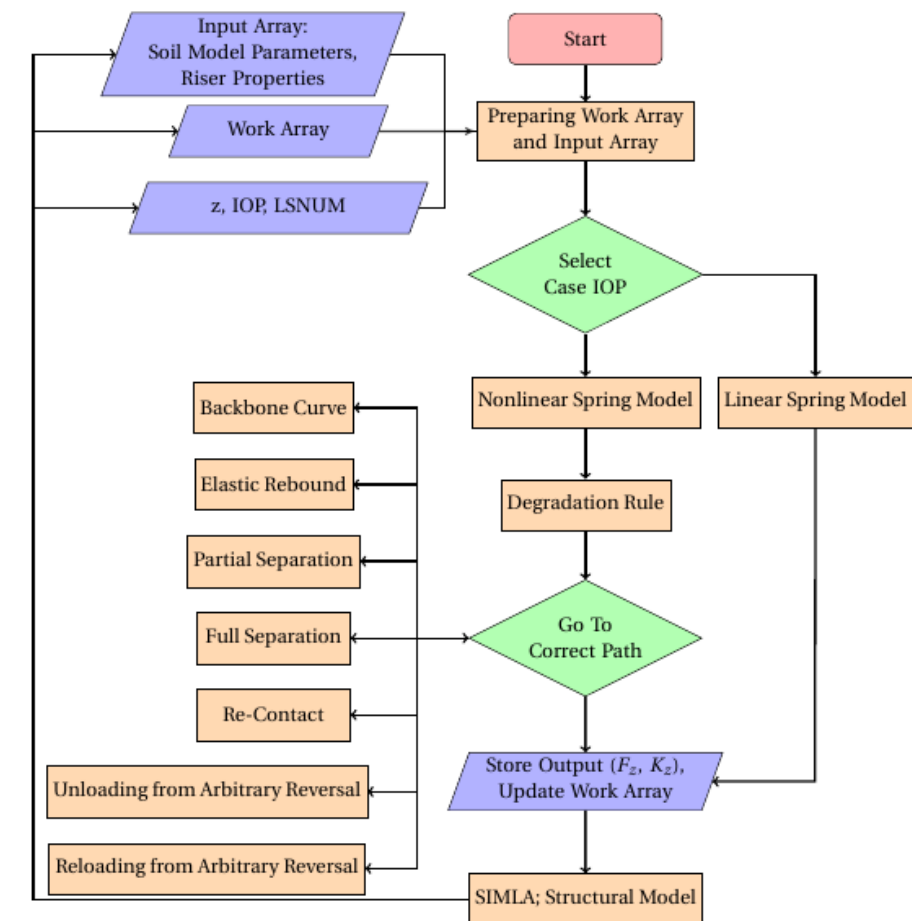


Figure 2: Flowchart of Vertical Soil Degradation Model

A summary of the code is described below containing these following steps:

- The code computes the soil resistance and stiffness by main inputs like z-coordinate of a riser, IOP and LSNUM. IOP is the identifier operator for deciding whether the self-embedment is linear or has the shape of the backbone curve developed by [1]. The linear case is only a simplification. It predicts the reality well as long as the soil is soft.
- Read the riser - and soil properties in the Input Array and the intermediate parameters stored in the Work Array. There is an exchange of data between the soil model and the riser motion mainly through the Work Array.
- The soil degradation is calculated based on the degradation rule.
- For each new loading load step, the code assumes that the previous path is governing. Requirements for each path decides whether or not the path is changed. Once one of the requirements are fulfilled there is a change of path.
- The soil force F_z and soil stiffness K_z are determined for each loading cycle and is stored in the Output Array.