Method

In this thesis, an empirical, vertical soil degradation model is implemented. The model is based on the non-degradation model developed by [1] which is illustrated in Fig. 3. The P-y curve considers the plastic penetration into virgin soil and the suction forces due to the cohesive soil.

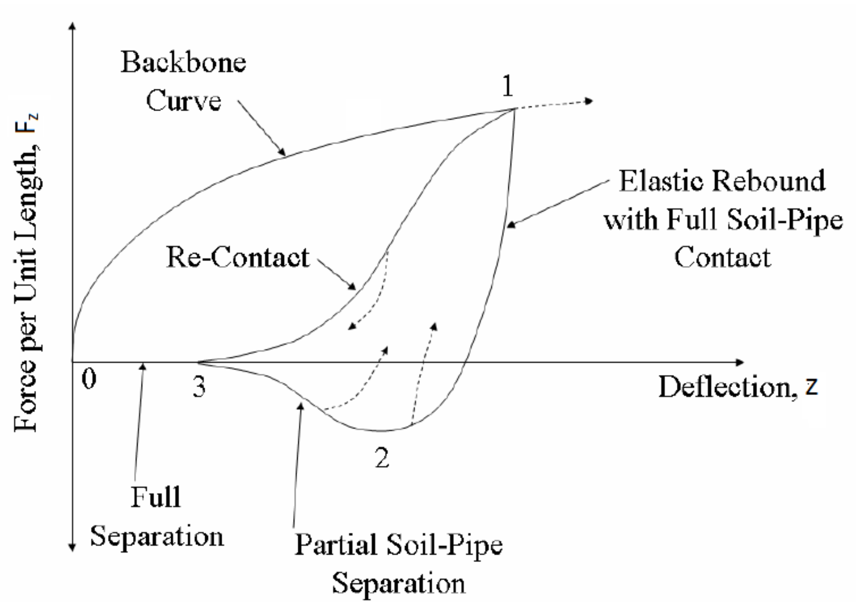

Figure 1: Non-Degradation P-y curve [1]

However, the soil stiffness reduces due to cyclic loading. Consequently, there is a formation of a trench. A trench has a positive effect on the fatigue life of an SCR. It reduces the curvature of the riser at TDP and consequently leads to a reduction of bending moments.

To account for the soil stiffness reduction under cyclic loading, an empirical formulation is proposed. The accumulated deflection, λ_n , is computed by [3]:

$$\lambda_n = \sum_{i=1}^{n} |\Delta z_i| \tag{1}$$

This expression is a measure of energy dissipation.

Conclusion

The literature contains few illustrations of other ways/directions the load-deflection curve can take. The specified boundary requirements during unloading outside the bounding loop (i.e. a full loading cycle) should only be considered tentative until validation is conducted. It is assumed that the soil degradation influences the backbone curve. Hence, the curve is given a load correction. This way of calculating further penetration into the virgin soil needs to be validated.

References

[1] Charles P Aubeny, Giovanna Biscontin, and Jun Zhang. Seafloor interaction with steel catenary risers. *Final Project Report to Minerals Management Service, Offshore Technology Research Center Industry Consortium, Texas A&M University, College Station, Houston, TX, OTRC Library*, (9/06A173), 2006.

[2] Thomas Langford, Charles Paul Aubeny, et al. Model tests for steel catenary riser in marine clay. In *Offshore Technology Conference*. Offshore Technology Conference, 2008.

[3] C. P. Aubeny, J. You, and G. Biscontin. Seafloor interaction with steel catenary risers. In *The Eighteenth International Offshore and Polar Engineering Conference*. International Society of Offshore and Polar Engineers, 2008.

Validation

The validation process of the vertical soil model is necessary in order to check that the physical behavior is described correctly. The model is validated by means of existing illustrations of P-y curve established by model tests or in combination with numerical simulations.

Vertical Non-Linear Degradation Model

NGI performed large-scale model tests of soil-riser interaction in marine clay in the Gulf of Guinea [2]. Fig. 4 shows the result of large-cycle penetration tests for two different penetration velocities and penetration rate. For each loading cycle, the pipe was given a deflection under load-controlled response.By defining a constant level of soil resistance, the implemented soil model showed a similar trend in Fig. 5. The bounding loop are translating along the horizontal axis for each loading cycle. The load-deflection loops are almost identical except for the deformation of the soil.

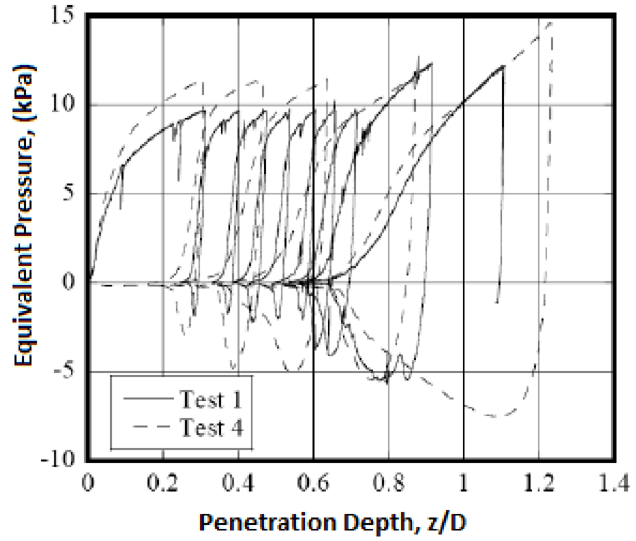

Figure 2: Load-Control Response[2]

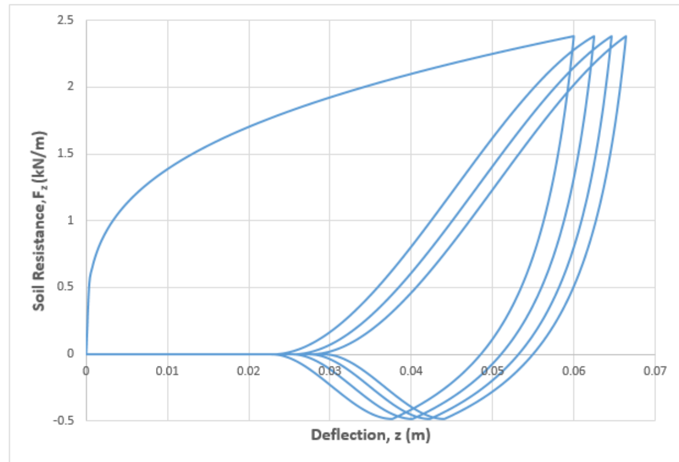

Figure 3: Load-Control Response

[3] used the degradation rule to simulate displacement controlled loading cycles. The result of the work is shown in Fig. 6. By fitting the input parameters, the implemented soil model shows an almost similar behavior shown in Fig 7. However, there are some differences.

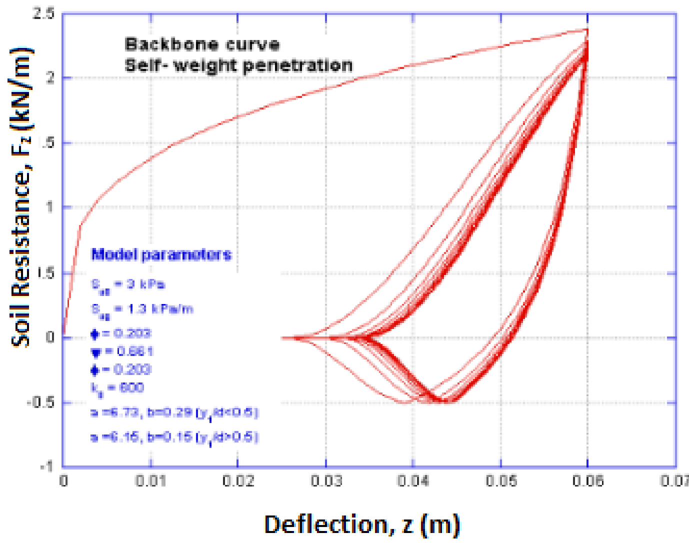

Figure 4: Displacement Controlled Loading [3]

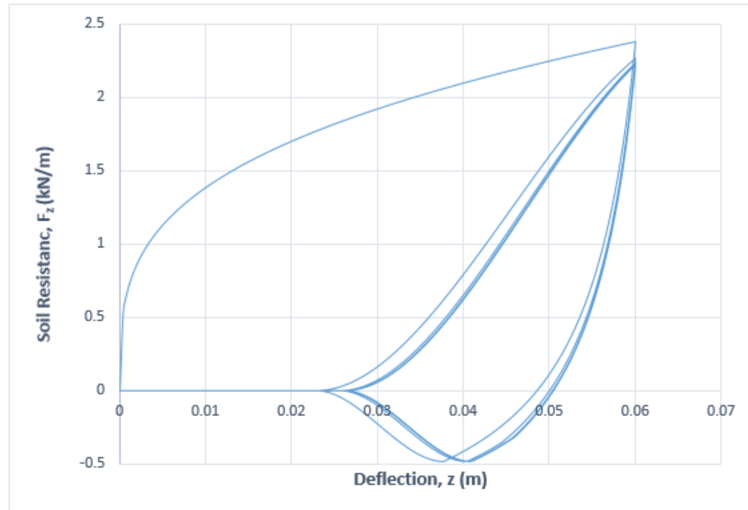

Figure 5: Displacement Controlled Loading