Simple Numerical Model for a Configuration Analysis of Subsea Flexible Pipelines and Risers

Pavel A. Trapper

Ben-Gurion University of the Negev, Beer-Sheva, Israel
E-mail: trapper@bgu.ac.il

ABSTRACT

Flexible pipelines and risers nowadays are essential elements of the oil and gas industry. While pipelines are usually being subjected to the most severe loading during their installation phase and thus their configuration during the installation is of a great interest, risers are stationary structures, which connect between the subsea units at the seabed and floating production platforms on the sea surface, and being subjected to environmental loading periodically [1]. Nevertheless, those configurations are quite similar, varying mostly in loading and boundary conditions, and consequently, can be analyzed with the same analytical and numerical tools.

In the present study, we present a simple numerical model for pipeline and riser configuration analysis, which accounts for large deformations of the pipe, pipe-seabed contact detection, pipe's interaction with uneven seabed with nonlinear stiffness [2], environmental loading such as drag forces applied by the sea water, water level changes and incorporation of buoyancy modules. The solution technique is based on a direct minimization of the total potential energy of the deformed pipe discretized as a Riemann sum [3], which results in a system of nonlinear algebraic finite difference equations that is solved in an incremental/iterative manner. At each increment, the total potential energy is being updated, thus accounting for energy dissipation due to irrecoverable plastic deformation of the seabed and hydrodynamic drag forces. The whole pipe is treated as a single, continuous segment.

To demonstrate the method, examples with several riser configurations and pipe-lay scenarios are presented. It is shown how on-bottom unevenness, including pits and hills, or incorporation of buoyancy modules can affect pipeline or riser configurations and their internal forces. Results are compared to those obtained from Abaqus and appear to be in an excellent agreement. Sensitivity studies are performed to emphasize the the key roles of various parameters.

The model presents simple and computationally efficient way to analyze the pipe-lay or riser configurations with various boundary and loading conditions. The proposed model, contrary to time-consuming commercial packages, allows for performing the analysis in reasonable time on standard engineering computers.

REFERENCES

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