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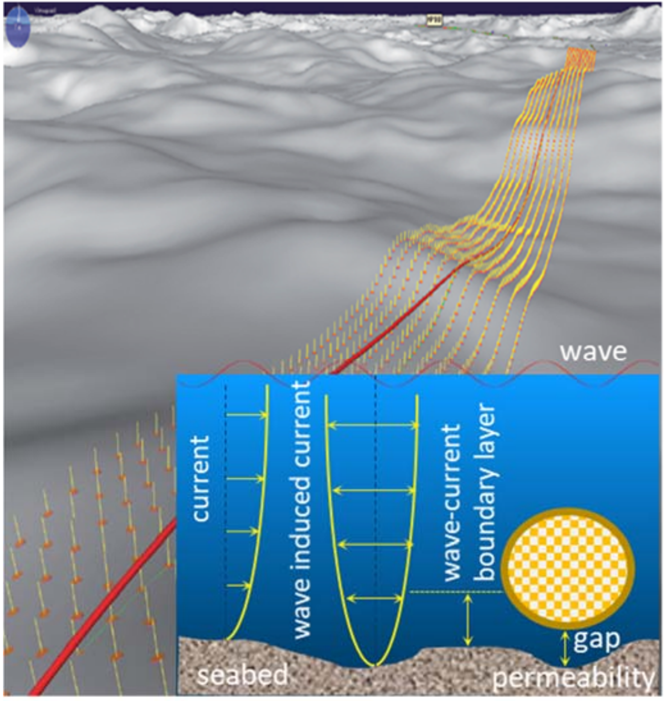
DROPS JIP Phase II

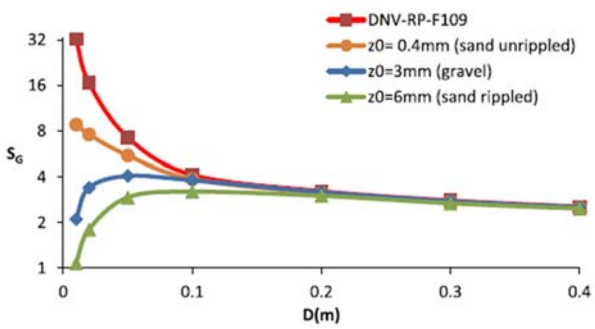
Q4/2021 - Q4/2023



Meeting engineering challenges in on-bottom stability assessment of small diameter pipelines and cables on 3D seabed also considering the influence of intermediate/shallow water depth

Power cables are vital components in the development of offshore wind projects by interlinking the turbines in the wind park and eventually exporting electricity to consumers onshore. One of the challenges in the design of offshore power cables is to ensure that the cables meet the stability criteria when exposed to complex environmental loads, including wave and current, during installation and operation. Particularly, owing to its smaller size (diameter below 20 cm) and lighter weight compared to medium and large diameter steel pipelines, existing 1D or 2D engineering tools may become either insufficient or even inappropriate in assessing the on-bottom stability of small diameter power cables.

Wave-current boundary layer is usually a few centimetres thick hence it has negligible impact on hydrodynamic response of the medium and large size cylinders. However, the boundary layer becomes increasingly dominant for small diameter power cables. It has been demonstrated through both numerical and experimental studies that design codes such as DNV-RP-F109 can become unrealistically conservative in estimating the specific gravity of small diameter cylinders [1].



The majority of all offshore power cables are deployed in typical intermediate/shallow water areas and accurate wave modelling becomes necessary. Two of the key tasks in the project are to implement a) an expanded second order Stokes wave as well as b) a modified JONSWAP wave spectrum to reflect such effects [2]. The spectrum needs to be verified with large number of observations such as the one proposed by Bouws et al. [3]. Finally, the wave models should also be eligible for implementation in the existing 3D numerical framework (SIMLA).

In addition, the following topics will tentatively be investigated in this project to extend the applicability range of the SIMLA software program for on-bottom stability analysis:

- Surface roughness including the effect of marine growth
- Seabed roughness and stiffness
- Pipe-soil interaction models for small diameter pipelines and cables
- Axial tension, free span and gap effects
- Reduction factor in hydrodynamic forces due to seabed permeability

Objectives for DROPS JIP Phase II

The main objective of DROPS JIP Phase II is to provide engineering solutions for assessing on-bottom stability of small diameter pipelines and cables also considering intermediate/shallow water effects by implementing the following models:

1) Second-order wave model applicable for intermediate/ shallow water depth taking due account of recent developments in the field, including waves, current and local seabed topography

2) Associated hydrodynamic load model and robust pipe-soil interaction model for small diameter pipelines and cables

The developed models will be made available to the industry through the SIMLA program system.

The work packages below are suggested, pending available budget and agreement in the JIP steering committee.

WP1: Second order wave model for finite water depth

- Implement the expanded 2nd order Stokes wave applicable for intermediate/shallow water depth for both short-crested [4] and long-crested waves [5]
- Enhance the hydrodynamic load models using the 2nd order Stokes wave time series

WP2: Load models for small diameter pipes

- Extend hydrodynamic load models to small diameter pipelines and cables, with particular focus on wave-current interaction and boundary layer effects

WP3: Hydrodynamic coefficients database

- Establish a database for gap-dependent hydrodynamic coefficients based on laboratory tests, CFD analyses or a combination

WP4: Pipe-soil models for small diameter pipes

- Evaluate the applicability of existing pipe-soil interaction models for small diameter pipes, identify gaps and propose and implement enhancements

Deliverables

1) A new SIMLA release capable of performing on-bottom stability analysis considering intermediate/shallow water depth and small diameter effects, including technical reports and case studies.

2) Technical report on gap-dependent hydrodynamic coefficients for small diameter pipelines and cables.

3) Guideline for on-bottom stability analysis considering intermediate/shallow water depth and small diameter effects.

4) One free SIMLA server license is provided to all sponsors during the project. All sponsors not having SIMLA at project kick-off will be offered licenses to further use of SIMLA after project termination by only paying the maintenance and support fee for the requested number of licenses.

Schedule and Participation Fee

Duration: Q4/2021 - Q4/2023

Sponsor fees per participant:

Sponsors being part of Phase I: 1000 kNOK for Energy companies, 500 kNOK for Contractors/Suppliers, 300 kNOK for Engineering companies.

Sponsors NOT being part of Phase I need to pay an additional fee of 300 kNOK regardless of company type. Hence the sponsor fees for such companies are: 1300 kNOK for Energy companies, 800 kNOK for Contractors/Suppliers, 600 kNOK for Engineering companies.

References

[1] G. Tang, et al. Effect of oscillatory boundary layer on hydrodynamic forces on pipelines. Coast. Eng. 140:114-123, 2018
[2] L. Cheng, et al. Effect of wave boundary layer on hydrodynamic forces on small diameter pipelines. Ocean Eng. 125, 2016
[3] E. Bouws et al. Similarity of the wind wave spectrum in finite depth water: 1. Spectral form. Journal of Geophysical Research: Oceans, 90 (C1): 975-986, 1985
[4] J.N. Sharma, and R.G. Dean. Second-order directional seas and associated wave forces. Society of Petroleum Engineers Journal, 21, 129-140, 1981
[5] T. Marthinsen and S. R. Winterstein. On the skewness of random surface waves. The Second Int. Offshore and Polar Eng. Conf. Int. Society of Offshore and Polar Engineers, 1992

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