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Enabling Delta Life

Project Description

JIP OSCAR

Offshore Scour Assessment and Remedial Measures

Introduction

Scour (erosion of soil around structures) is one of the main causes for foundation failure during drilling operations with jack-up platforms. Particularly in shallow areas with sandy seabed conditions, strong tidal currents and/or a harsh wave climate, scour is an imminent threat. In spite of being regarded as a critical issue, there is a lack of guidelines and/or validated tools to predict scour and design scour protection at the foundations of jack-ups. This is partly due to the complex nature of scour, but also a result of the large variety of foundations (spudcan shapes) and associated scour behaviour. Until recently, scour assessments for jack-ups were either performed based on 1) rules of thumb with limited accuracy or 2) experience with a particular site from previous operations or 3) physical model test results for one specific structure and one specific location.

Offshore jack-up deployment

Scour at model of jack-up foundation

Objectives

Joint Industry Project OSCAR was launched in 2008 as an initiative to improve the general understanding of scour around jack-up foundations and to obtain practical tools and guidelines for scour assessments, scour protection design and scour friendly jack-up design. Among the participants were drilling rig owners, oil&gas companies and drilling rig designers.

The scope of work comprised four work packages (WP):

- **WP 1:** Desk Study
- **WP 2:** Physical modelling of spudcan scour and scour protection
- **WP 3:** Development of software package “OSCAR – the scour manager”
- **WP 4:** Field case workshop

Keywords: *scour, offshore, jack-up, OSCAR*

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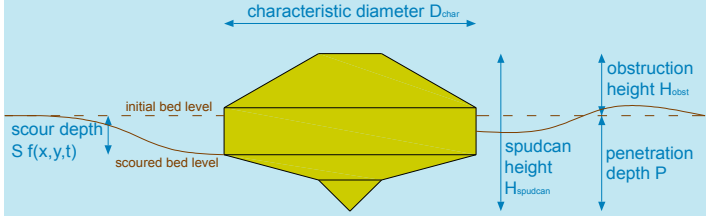
Overview of results

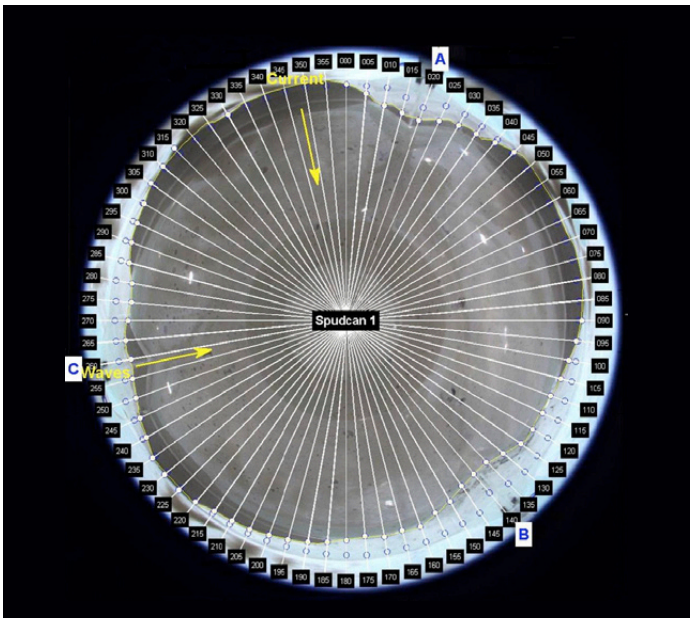
Work package 1

Desk study

A literature review was performed with a focus on jack-up related scour research. The results contain broad descriptions of scour and all related phenomena (e.g. waves, currents, soil conditions and structural influences). Rules of thumb were provided that can be used for a first assessment of the prevailing hydrodynamic forces and associated scour potential. Recent literature was summarized (results of laboratory experiments and field data analyses) and a broad range of scour mitigating measures was discussed. Finally, a standard approach was defined for scour site-assessments.



Definitions with respect to scour at spudcans

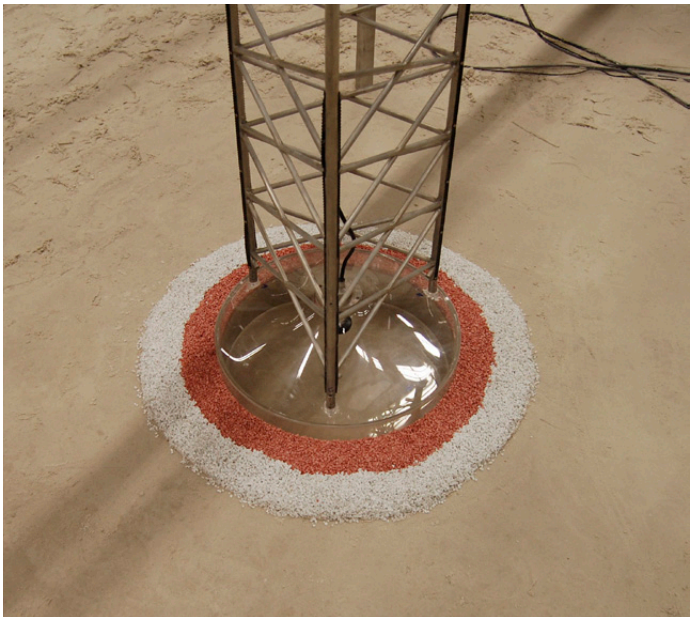


360°-camera image from inside model

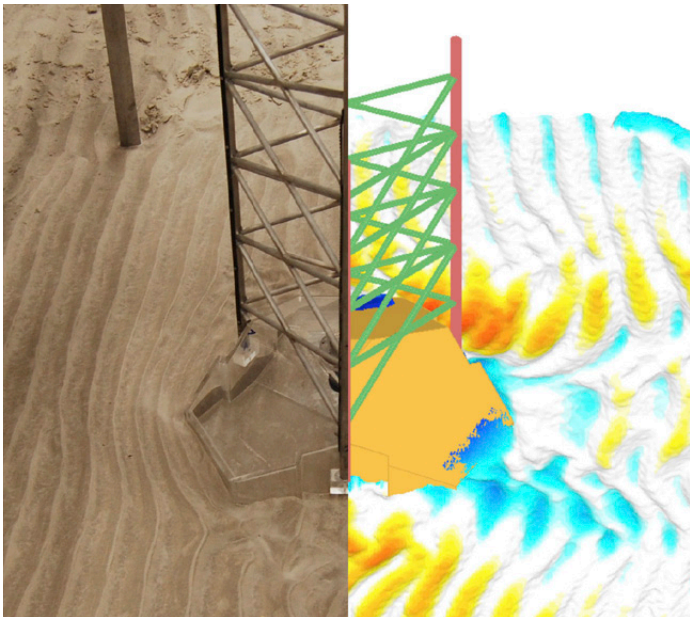
Work package 2

Physical model tests

The second work package contained an extensive systematic physical model test program (>100 tests). The program aimed at finding relations between scouring, hydraulic load, structural parameters, site conditions and time. Tests were performed with increasing hydraulic conditions in order to obtain functions of hydraulic load vs. scour development. Next, tests were performed with varying structural parameters (penetration depth, orientation) and hydraulic parameters (water depth, angle between current and waves) to determine their relative effect on the scour development. Finally, the performance of several layouts for scour protection consisting of loose rock was evaluated. During the tests, the time evolution of scouring was monitored from high-resolution cameras within the transparent spudcan models. The scour depth was derived from the camera images based on colour gradients. Stereo photography was applied to study 3D scour patterns. The tests were performed for three spudcan types, defined based on characteristic features of common spudcan designs. After the tests, a non-dimensional analysis was performed in order to obtain scour prediction formulae for each considered spudcan type to translate the model results to field scale.



Transparent model equipped with a high-resolution camera and scour protection

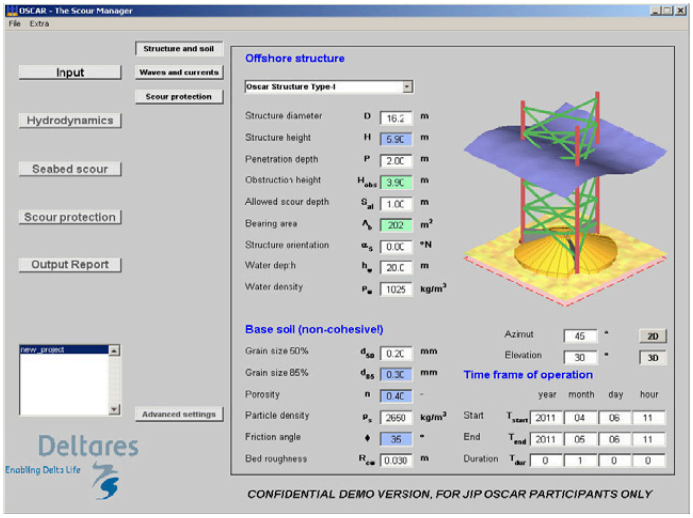


Scour pattern visualized with stereo photography

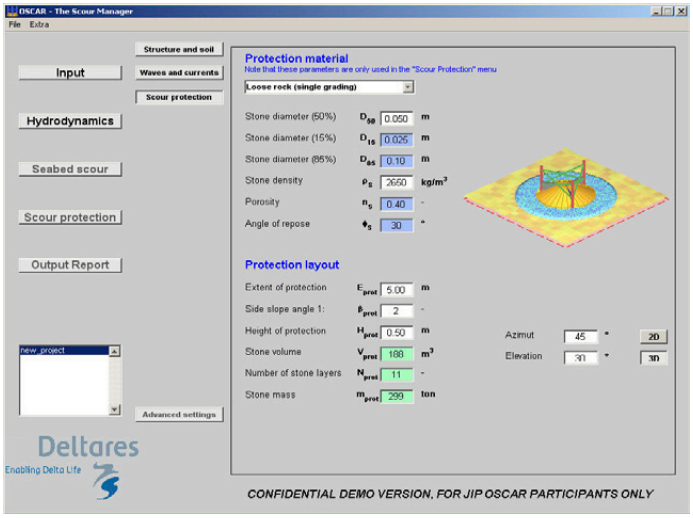
Work package 3

OSCAR – The scour manager

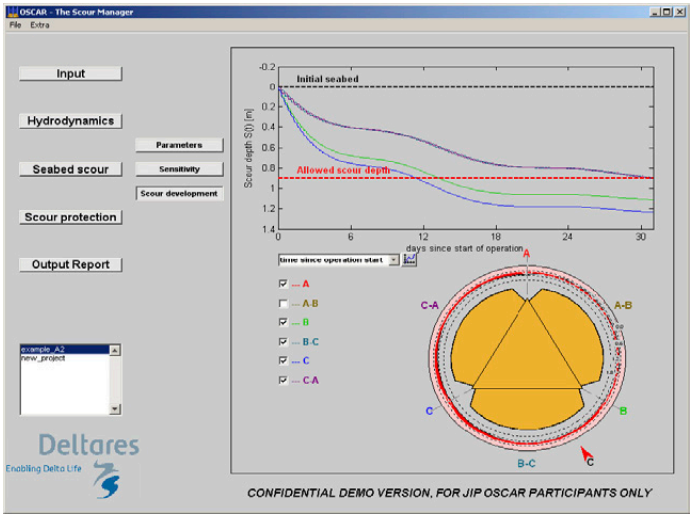
A software package called “OSCAR – the scour manager” was developed that incorporates all formulae and knowledge gained in the first two work packages.



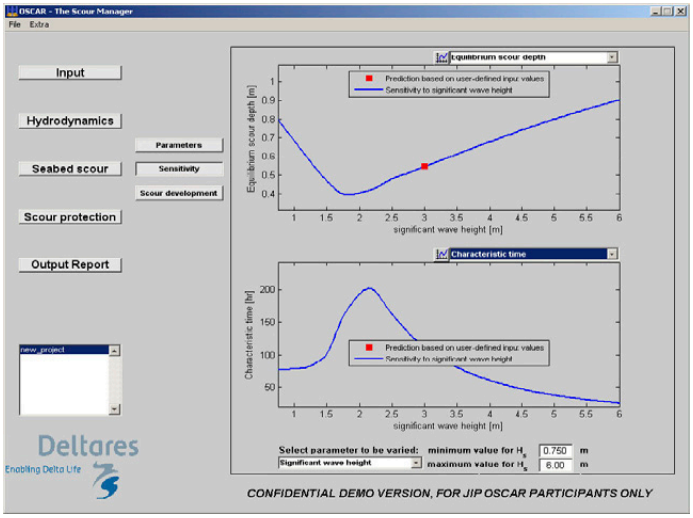
Input of structure and soil in GUI of OSCAR – the scour manager



Input of scour protection in GUI of OSCAR – the scour manager



Scour prediction with OSCAR – the scour manager



Evaluation of sensitivity with OSCAR – the scour manager

This program provides scour predictions for a number of positions around a selected jack-up foundation, based on a given duration of an operation, structural parameters, hydrodynamic conditions and soil parameters. The modern user interface allows the input to be specified as constant values or to be imported as time series. Computations typically take a few seconds. The results are visually displayed in well-organised graphs.

The program includes functionality to evaluate the sensitivity of the scour depth to selected input parameters. Finally, the results can be exported as standardized output reports. The application of OSCAR – the scour manager may support decisions to closely monitor scour during operations in scour-sensitive areas or to apply countermeasures (scour protection) beforehand. The performance of granular scour protection layouts (e.g. stone grading, layer thickness or extent) can be evaluated through the scour protection menu.

Work package 4:

Field case workshop

Finally, a field case workshop was organized. The field cases consisted of scour assessments for typical operations in a scour-sensitive area. First, the participants were challenged to make a rough scour prediction based on the rules of thumb described in WP1.

Next, these scour assessments were evaluated and optimized with OSCAR – the scour manager. In this way, the participants gained practical experience with the newly developed guidelines and software tool.

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Future research and applications

Future research

Although JIP OSCAR has greatly increased our understanding and prediction capabilities regarding scour at jack-up foundations, it has also raised awareness for additional research.

Future research may focus on:

- scour at different types of foundations
- evaluation of different types of scour protection
- scour at cohesive soils
- hydro-structure-soil-interaction
- field validations
- derivation of guidelines and standards

Example of application:

Operational scour forecasting

Recently, OSCAR – the scour manager was extended to be applied for operational scour forecasting. This extension (OSCAR operational) automatically imports and processes metocean data (water levels, waves and currents) from operational metocean models and calculates a forecast for the scour development. During an operation, the results provide the basis for a periodic assessment whether, how much and where scour protection is required and when surveys should be performed. After an operation, the hindcast results serve as calibration for the scour prediction model and as evaluation of the scour management strategy.

Operation in scour-sensitive area

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