

Operational scour forecasting

for safe jack-up operations

Introduction

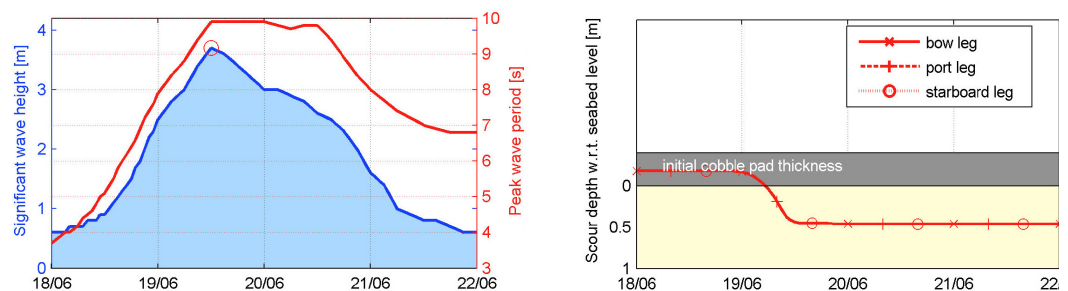
Scour is an imminent threat for jack-up operations in shallow waters with sandy seabed conditions, strong tidal currents and/or a harsh wave climate, such as the North Sea. Jack-up operations in scour-sensitive areas require jack-up operators to evaluate the risk of scour and to adapt a scour management strategy in order to safeguard against foundation failure. Jack-up deployments are characteristically short term operations. Often, the strategy is to monitor scour and take remedial measures if and when required.



Jack-up operation in scour-sensitive area

Operational scour management

In order to assist jack-up operators with their management of scour, an operational scour forecast and hindcast system was developed by Deltares. This system (OSCAR operational – an extension of OSCAR the scour manager) automatically imports and processes metocean forecast data (water levels, waves and currents) from operational metocean models and calculates a forecast for the scour development for a similar time span, usually about 3 to 5 days in advance. 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.



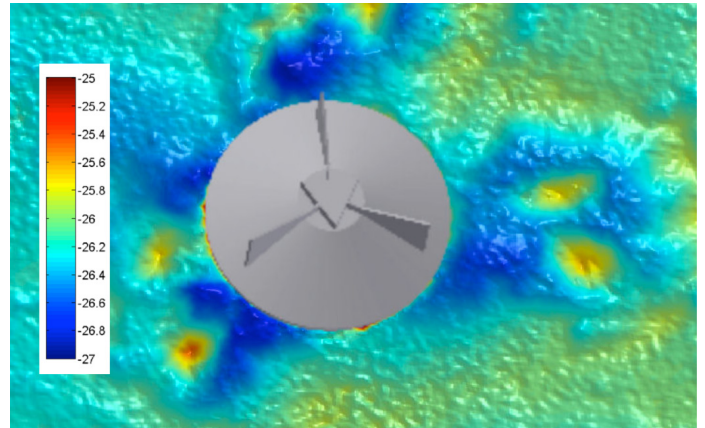
(Left) example of wave forecast in terms of significant wave height and peak wave period; (right) example of scour prediction. Until 19 June the predicted scour depth remained within the cobble pad, which was installed as scour protection, but during the storm of 19 June scour continues in the underlying seabed.

Keywords:

offshore, scour, jack-up, operational forecasting

Setup of operational scour forecast system

The system uses metocean data from frequently updated web servers. After downloading the hydrodynamic forecasts, the expected scour is calculated based on scour formulae. These formulae are generic for all foundation shapes. Their coefficients, however, are structure-specific. The scour formulae were derived by physical model tests as part of JIP OSCAR and contract research. The forecast output consists of figures showing the most important hydrodynamic parameters (water level, wave height, wave direction, current velocity and current direction) and scour parameters (scour development and, if applicable, the mobility of the rock protection). The output is distributed to the jack-up operators by email. In addition, a recommendation is given for scour countermeasures, maintenance and / or monitoring. After the operation, a hindcast is performed in order to evaluate the accuracy of the forecasts and calibrate the model for future operations.



Field survey after installation of scour protection



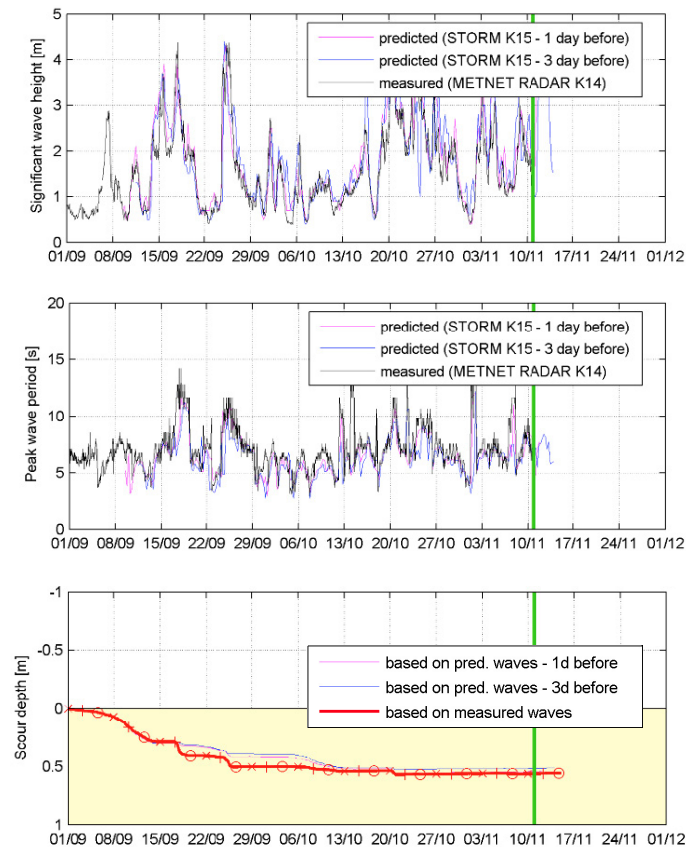
Example of physical model test with similar scour pattern

predicted. This over prediction was attributed to conservative assumptions for the water depth and the hydraulic roughness. It was concluded that future forecasts should include tidal elevations and consider a reduced value for the hydraulic roughness.

The second case comprised an operation in the southern North Sea for which no scour protection was applied. During the operation, the forecasts indicated that scour was developing mainly under the influence of tidal currents and that scour protection was required to prevent undermining of the spudcans. In response, the jack-up operator decided to apply scour protection halfway the operation. After the operation, a scour hindcast was performed including an analysis of bathymetrical surveys. It was concluded that both the predicted hydrodynamics and maximum scour depth showed a good correspondence with the measurements. No model calibration of the scour formulae was required.

The improved scour forecast system is an important milestone for scour management at jack-up foundations. The results provide the basis for strategies to deal with scour and efficiently plan and perform field surveys. Overall, it contributes to improved safety in future jack-up operations.

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Example of scour hindcast

Field evaluation

Recently, the system has been applied for two drilling operations in the southern North Sea. The first comprised a shallow water operation for which scour protection had previously been installed. During the operation, a summer storm occurred, for which the scour forecast system predicted severe scouring. The survey analysis performed after the operation revealed that rock deformation had occurred, but that the scour depth had been over