

## Scour around offshore structures - Analysis of field measurements

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### assignment

Offshore structures are often subject to scour around their foundations. Either scour protection measures need to be applied in order to avoid loss of stability of foundations or, alternatively, scour is tolerated up to a certain depth and taken into account in the design of the construction. Existing scour prediction formulae often have a limited range of applicability and are based on small-scale model tests.

Therefore, data from field measurements are a valuable source for engineers and researchers to verify scour predictions and scour formulae. These data are obtained from annual seabed inspections which have to be carried out by platform operators.

WL | Delft Hydraulics set up research projects in close cooperation with the Nederlandse Aardolie Maatschappij (NAM) and Woodstork to analyse bathymetry measurements of different types of offshore foundations in the southern North Sea: monopile (location N7), jacket structure (L9) and gravity based foundation (F3). Furthermore, spudcan penetration surveys of jack-up rigs were studied. These studies were supported financially by the Dutch Ministry of Economic Affairs.

The measurements gave a unique insight into scour development around complex structures. Empirical scour prediction formulae, which are usually based on small scale model tests, for vertical cylindrical piles and gravity based foundations were verified.

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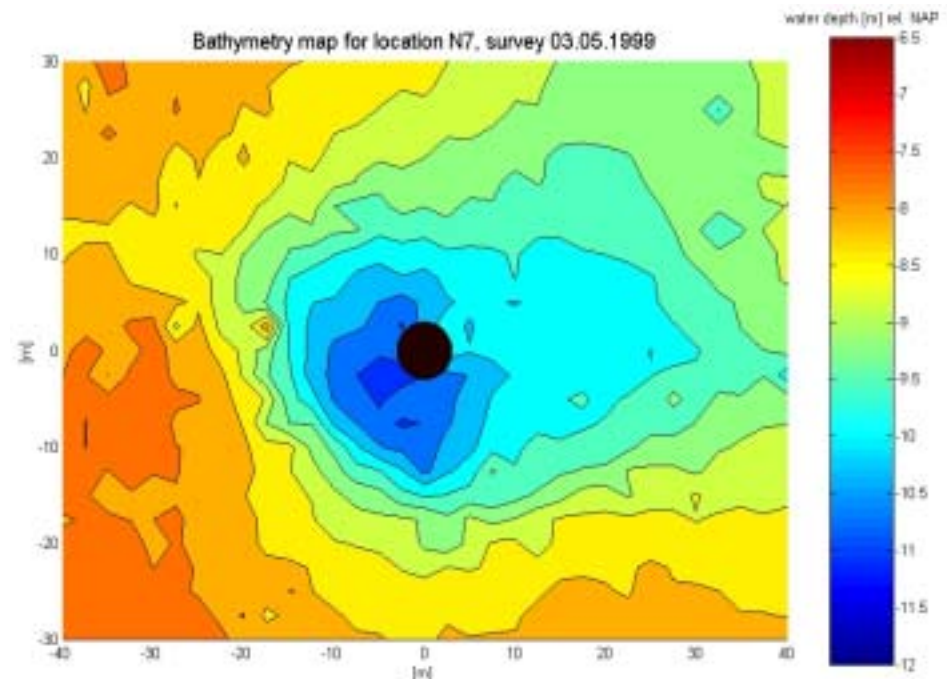
### client

WL | Delft Hydraulics, NAM

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### period

October 2002 - December 2003



*Bathymetry around the monopile at location N7 two years after installation*

keywords:  
scour  
offshore platforms  
field measurements

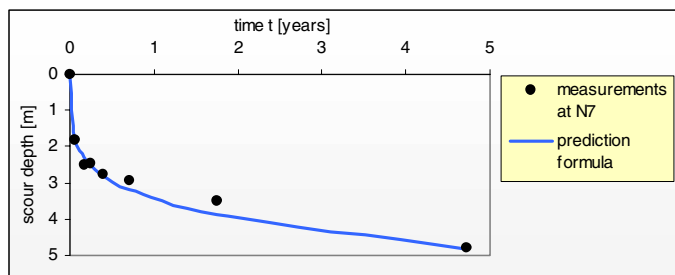


## challenges

The main tasks were to postprocess raw data, to evaluate measurements of different sources (diving inspections/ ROV/multibeam echosounding) with respect to consistency, to determine site-specific metocean conditions which induce scour and to verify empirical formulae for scour prediction.

## study results

At location N7 a monopile (diameter  $D = 6.0$  m) is located in a water depth of 7 m (rel. NAP). It has not been protected against scour. Five years after installation a scour depth of up to 4.8 m has occurred. The horizontal extent of the scour hole exceeds more than 100 m. It was concluded that the development of scour around a large cylindrical vertical pile in a shallow tidally dominated environment (such as the southern North Sea) can be predicted with good accuracy. Using empirical prediction formulae the equilibrium scour depth (after 25 years) is expected between 7 and 7.5 m.



Scour development around the monopile at location N7

Jacket structures at location L9 consist of a production platform (6 legs) and a wellhead platform (4 legs), situated in a water depth of 24 m (rel. LAT). Scour protection was not applied. Scour patterns around the jacket structures were very complex and subject to changes with respect to time. Bathymetry charts indicated that some multibeam echosounding contained misreflections close to structures. Maximum scour depths reached up to 4.6 m. The horizontal extent of morphological changes was up to 100 m. Existing scour prediction formulae clearly underestimated the observed scour.

Numerous videos from ROV surveys were analysed for three different types of jack-up rig spudcans. The development of scour was compared with metocean conditions at the sites.

This research project demonstrated the importance of the spudcan shape and spatially varying seabed material on scour development.



Wellhead and production platform at location L9

The gravity based structure at location F3 (water depth  $h = 42.3$  m) is protected by gabion mattresses. Since installation in 1992, a maximum scour depth of 3.9 m was observed at the south western corner. This is in good agreement with physical model tests (carried out by WL | Delft Hydraulics in 1991) and predictions with analytical models. The scour protection system performs as designed and expected.

## conclusions

Scour around structures with simple geometry (cylindrical piles) can be predicted with good accuracy particularly in shallow tidally dominated environments. Scour prediction around complex structures needs to be based on a combination of existing scour formulae, engineering judgement and if possible physical model testing. Ongoing research will further improve and validate scour prediction formulae.

### WL | Delft Hydraulics

Decisive advice: from multidisciplinary policy studies to design and technical assistance on all water-related issues.

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