Scour below pipelines and around vertical piles in random waves plus current

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Introduction

Background: When a marine structure is placed on sandy seabeds, the presence of the structure causes an increase in the local sediment transport capacity , leading to scour.

Objective: Provide a practical stochastic method by which the scour below pipilines and around vertical piles exposed to random waves and current on mild slopes can be derived.

Seabed conditions:

As seen in Fig.1, Slope = 1/50;

Length L= 600m; Water depth h= 15m

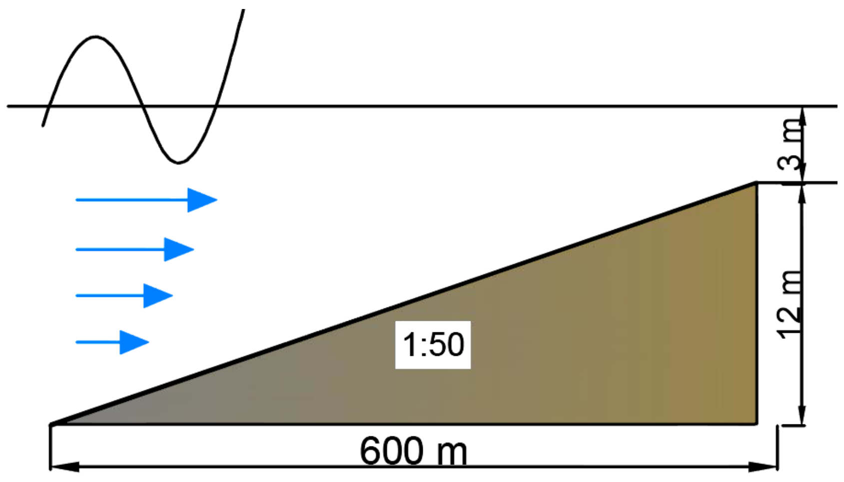


Fig. 1 Sketch of the seabed

Method

Stochastic method:

Sumer and Fredsøe formulas for horizontal seabeds + Battjes and Groenendijk wave height distribution for mild slopes

The expected scour depth caused by the (1/n)th highest waves:

$$E(\tilde{S}(\tilde{H}) \mid \tilde{H} \geq \tilde{H}_{1/n}) = n \int_{\tilde{H}_{1/n}}^{\infty} \tilde{S}(\tilde{H}) f(\tilde{H}) \, d\tilde{H}$$

$\tilde{H}$: non-dimensional wave height, H /Hrms ;

$\tilde{H}_{1/n}$: non-dimensional highest waves exceeding the probability 1/n.

$\tilde{S}$: non-dimensional equilibrium scour depth, S/D;

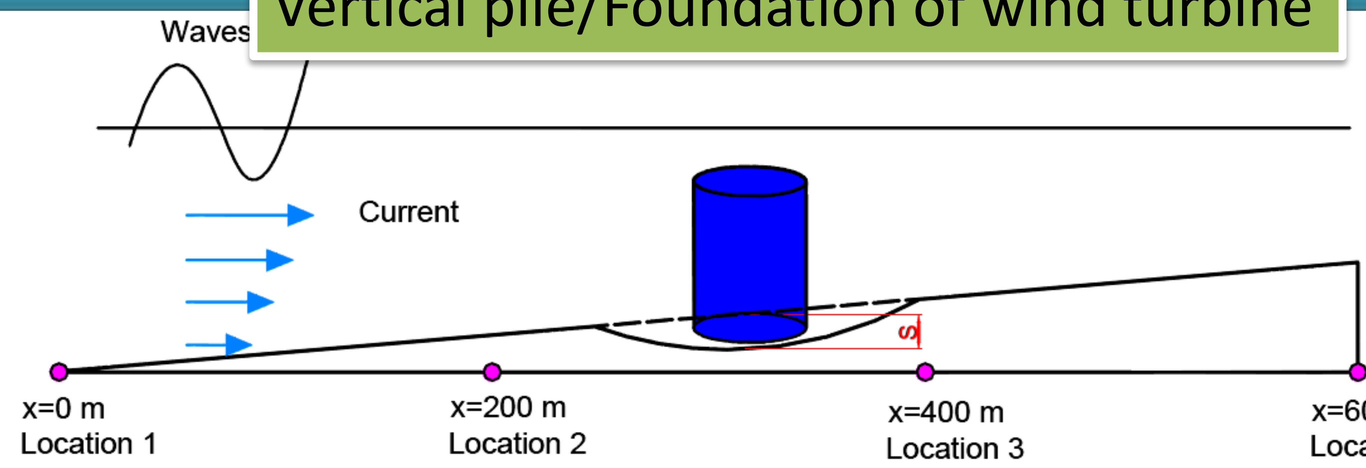
$\tilde{f}$: probability density function.

Reference

- Battjes and Groenendijk. (2000) Coastal Eng. 40, 161-182.
- Sumer and Fredsøe. (2002) World Scientific, Singapore.

Results

Vertical pile/Foundation of wind turbine



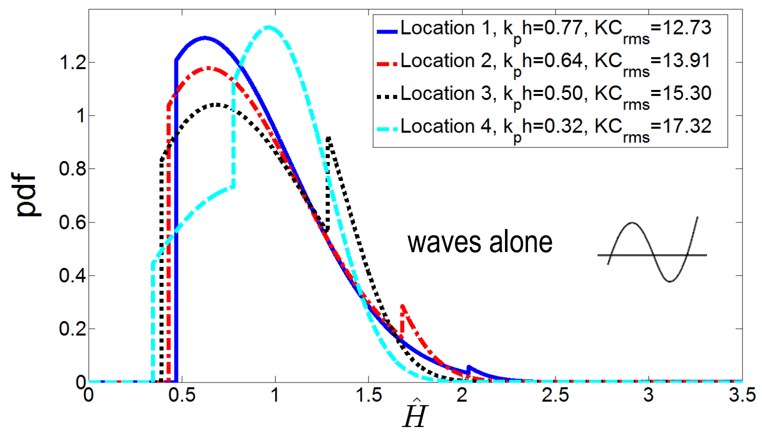


Fig. 2 Probability density function at four locations

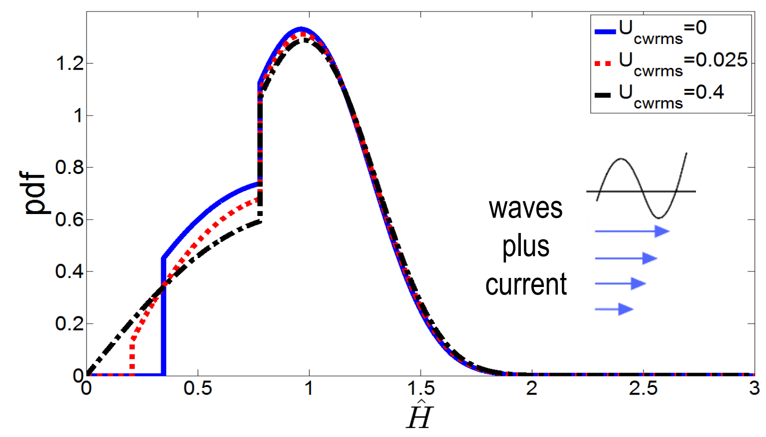


Fig. 3 pdf at Location 4 for different current velocity Uc

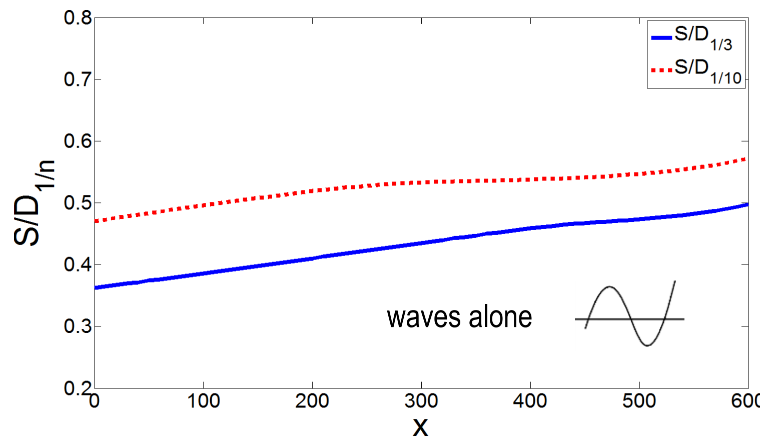


Fig. 4 Scour depth versus slope length

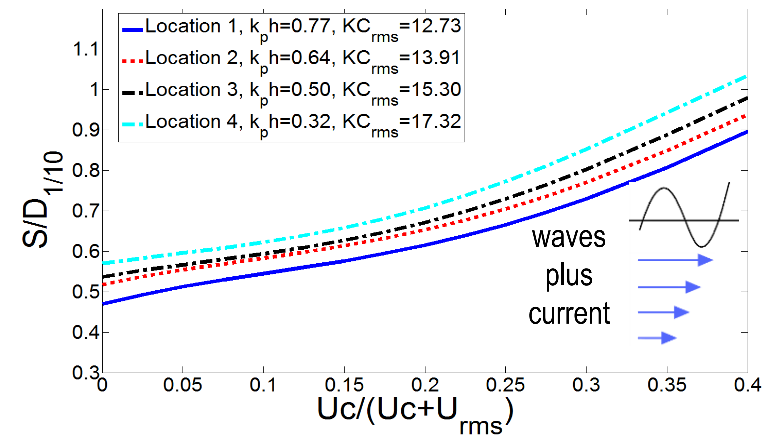
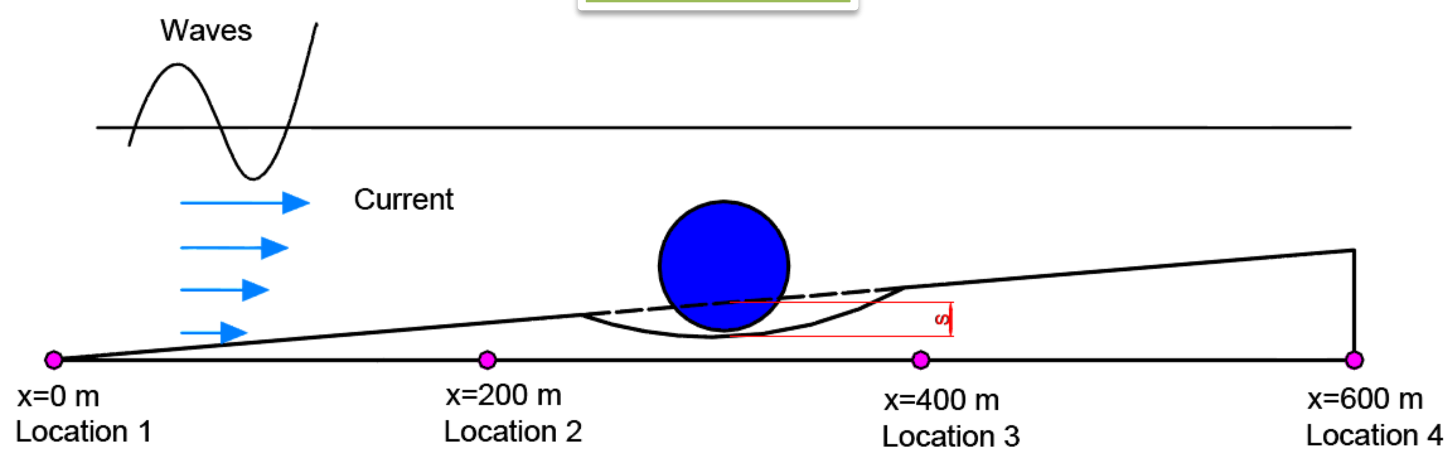
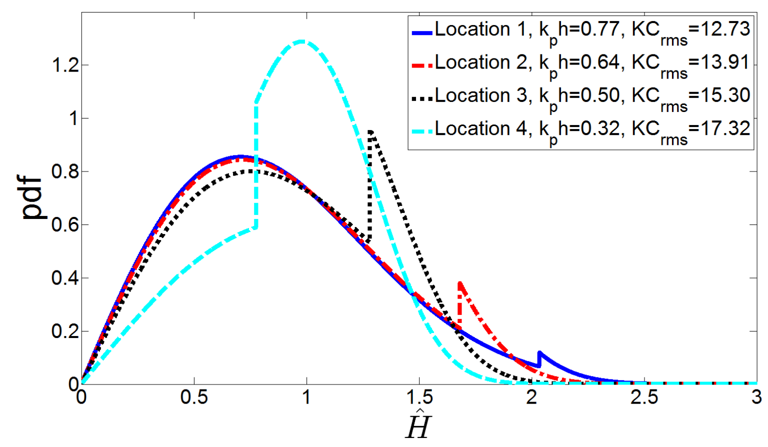


Fig. 5 Scour depth versus Ucwrms=Uc/(Uc+Urms)

Pipeline





- Fig. 6 is valid for both waves alone case and waves plus current case.

Fig. 6 pdf at four locations

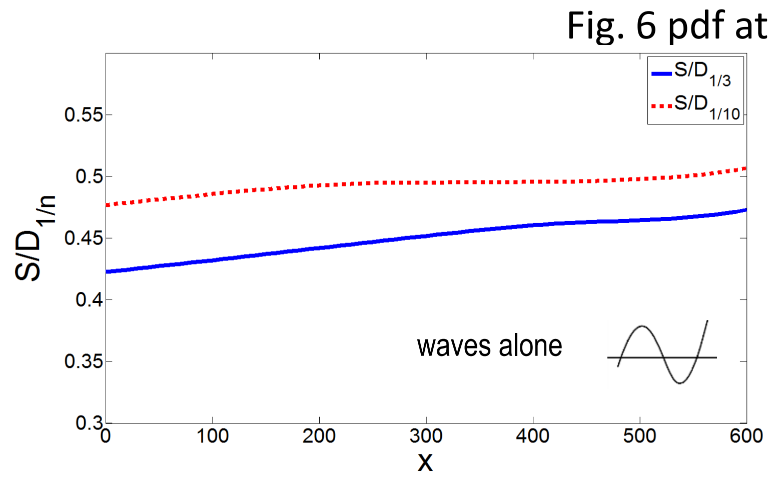


Fig. 7 Scour depth versus slope length

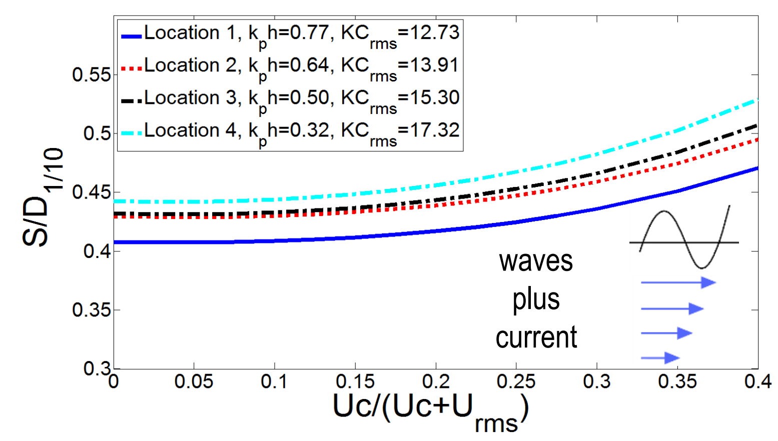


Fig. 8 Scour depth versus Ucwrms=Uc/(Uc+Urms)

Conclusions

- The effect of slopes increases scours.
- The effect of current increases scours compared with that for waves alone.
- The results are important for the assessment of scour and in scour protection work.