ANALYSIS OF WAVE-INDUCED GLOBAL SHEAR FAILURE OF SLOPING SEABED USING STRENGTH REDUCTION TECHNIQUE

AMIN RAFIEI[1], M.S. RAHMAN[2], AND M.A. GABR[3]

[1]*Amin Rafiei, PhD Candidate in Civil and Environmental Engineering at NC State University, 2501 Stinson Drive, Raleigh, NC, 27695, USA, arafiei@ncsu.edu*
[2]*M.S. Rahman, Professor in Civil and Environmental Engineering at NC State University, 2501 Stinson Drive, Raleigh, NC, 27695, USA, rahman@ncsu.edu*
[3]*M.A. Gabr, Alumni Distinguished Professor in Civil and Environmental Engineering at NC State University, 2501 Stinson Drive, Raleigh, NC, 27695, USA, gabr@ncsu.edu*

Instability of sloping seabed due to wave action is one of the significant considerations in the safe design of the anchored foundation elements of near shore and offshore structures. In addition to local failure of sediments near the structures (e.g. due to liquefaction-induced scour), global shear failure of the slope caused by gravity and wave forces needs to be considered [1]. The wave-induced sliding of sloping seabed was first reported after Hurricane Carla damaging South East of US [2,3]. The related studies of global failure evaluation of sloping seabed have been focused mostly on slightly inclined bathymetry (inclination angle less than five degrees) based on decoupled approach. However, some of the marine structures are founded on steeper slopes of seabed such as, for example, foundation supporting Marine Hydrokinetic devices to be deployed near the edge of the Continental Shelf. In this study, the effect of wave action on instability of the sloping seabed is evaluated. The coupling of fluid and soils within a sloping seabed is considered assuming that the wave profile is not influenced by fluid-seabed interaction. In addition, the progressive generation of pore water pressure due to cyclic plasticity of sediments is included in the analyses and its contribution to instability of the sloping seabed is investigated. Results indicate that the presence of wave action reduces the stability of the slope. As shown in Fig. 1., for a generic point near the shallower water at 1m below the bed surface the Mohr circle representing the stress state (for the combination of wave and gravity forces) is closer to the failure envelope in comparison to that for geostatic condition, implying the decrease in the factor of safety of the slope. The effects of wave and sediment characteristics on the stability of the sloping seabed are evaluated and discussed.

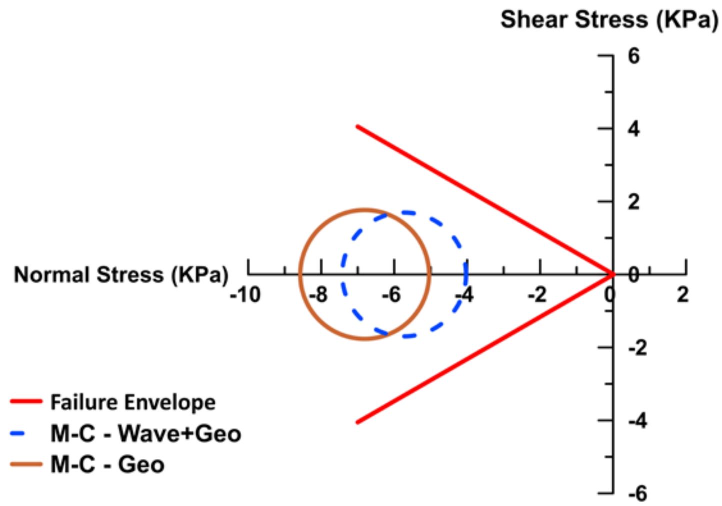

Figure 1. COMPARISON OF MOHR-COULOMB CIRCLES OF STRESS STATES FOR A GENERIC POINT INSIDE THE SLOPING SEABED: COMBINATION OF WAVE AND GEOSTATIC STRESSES VS. GEOSTATIC STRESSES

ACKNOWLEDGEMENTS

This study is supported by a grant from coastal study institutes of North Carolina (CSI) and North Carolina State University.

REFERENCES

[1] Rahman, M.S. “Wave-induced instability of seabed: Mechanism and conditions.” Marine Geotechnology 10(4), 277–299, 1991.

[2] McClelland, B. and Cox, W.R., “Performance of pile foundations for fixed offshore structures”, Int. Conf. on Behavior of Offshore Structures, Vol.2, Norway: 528-544, 1975.

[3] Nian T.K., Liu B., Wang, D. Yin P., “Stability assessment of submarine slope subjected to wave loading”, Advances in Soil Dynamics and Foundation Engineering GSP 240, ASCE, 2014.