# STABILITY OF SLOPING SEABED SUPPORTING MARINE HYDROKINETIC DEVICES

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Wave-induced instability of seabed is one of the significant considerations in designing the anchoring foundation elements of near shore and offshore structures. Such instability can result in the failure of the foundation system and the supporting structures [1, 2]. Such instability issue has been studied mostly for flat or slightly sloping bathymetry (slope less than five degrees) based on decoupled or one-way coupled approach [3, 4]. 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 work presented herein, the effect of coupling between fluid and soil regions on the response for sloped seabed is investigated. In addition, seabed instability due to momentary liquefaction caused by wave action is analyzed assuming the full interaction between fluid and the soil domains. The correlation between seabed slope and development of potential liquefied zone (width and depth) is analyzed. Equations governing the response of poroelastic seabed with those of structure and fluid, considering the fluid-soil-structure interactions (fully coupled approach), are solved using finite element method. Results indicate that for the sloping bed (in wave-seabed interaction problem), the difference in the response from coupled and uncoupled analyses is slightly greater as compared to those for the flat bed (Fig.1). Within the range of slopes studied, this implies that for the evaluation of wave-induced response of sloping seabed, a coupled analysis of wave-seabed interaction may not be necessary. Moreover, the results show as the magnitude of the seabed slope increases, the sediment response and the size of liquefied zone decrease (Fig. 2). Details related to the effect of the slope on the seabed response and the consequent zone of liquefaction are presented.

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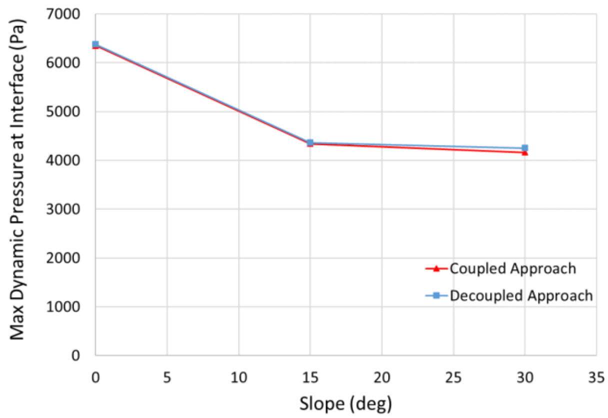


**Figure 1. VARIATION OF MAXIMUM HYDRODYNAMIC PRESSURE WITH RESPECT TO SLOPE FOR COUPLED AND DECOUPLED APPROACHES**

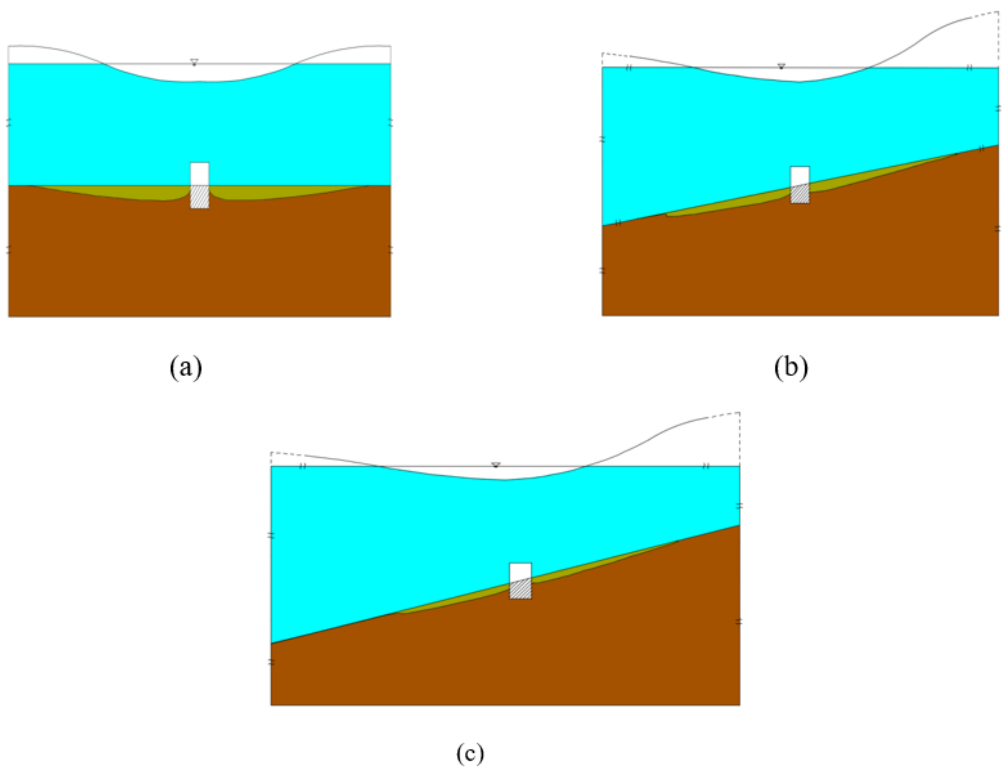


**FIGURE 2. EXTENSION OF INSTANTANEOUS LIQUEFACTION ZONE APPEARS TO DECREASE FOR STEEPER SLOPES:**

**A) SLOPE = $0^0$, AREA = $23\ m^2$, B) SLOPE = $10^0$, AREA = $20\ m^2$, AND C) SLOPE = $15^0$, AREA = $12\ m^2$**

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**REFERENCES**

[1] Silvester, R. and Hsu, J.R.C. "Sines Revisited." Journal of Waterways, Port, Coastal and Ocean Engineering, A.S.C.E 115 (3), 327–344, 1973.

[2] Lundgren, H., Lindhardt, J.H.C. and Romhild, C.J. "Stability of breakwaters on porous foundation." Proceedings 12th International Conference Soil Mechanics and Foundation Engineering 1, 451–454, 1989.

[3] Okusa, S. "Wave induced stress in unsaturated submarine sediment." Geotechnique 35(4), 517-532, 1985.

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

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