WAVE-INDUCED EFFECTIVE STRESS IN SEABED AND ITS MOMENTARY LIQUEFACTION[a]

Discussion by Chia Chuen Kao[4] and Heng-Haur Chow[5]

The authors have pointed out a very important problem in shore protection work: The shaped concrete armor units on beaches settle gradually into the seabed. In Taiwan, we have to face the same problem. To protect the sea dike from direct wave attack, concrete armor blocks are often set about 20–40 m in front of the dike toe, usually in two or three rows. The effectiveness of the armor blocks depends largely on the dike's top height. As the blocks settle into the sand and thus reduce the dike's height, the protection function of the dike reduces drastically. Unfortunately, in almost all cases, the concrete armor units will settle into the sand if any additional measures are not taken, such as the use of the geotextile to improve the sand bed. In the most critical case, a 5-Mg armor unit has been observed to submerge totally into the sand in only three years.

The authors suggest that the increase of the pore-water pressure in the sand and ultimately the liquefaction of the sand due to the wave cyclic loading is the main cause for the block settlement. They use the boundary-layer approximation solution proposed by Mei and Foda (1981) to calculate the wave-induced potential liquefaction water depth. By using the Airy theory to determine the wave pressure on the seabed, they conclude that the maximum water depth for wave-induced liquefaction is about half the wave height.

The writers, however, believe that the critical depth may be larger than that suggested by the authors. In shallow water, the Airy theory will underestimate the pressure on the bottom as the wave nonlinear effect is not negligible. As an example, Stokes' theory for the third order can be used to encounter the nonlinear effect and take typical wave conditions in shallow water, with the following conditions: wave height H = 1 m and 3 m, and wave period T = 4 s, 6 s, and 8 s. Figs. 2 and 3 show the ratios of the pressure on the bottom predicted by the Airy theory and by Stokes theory, respectively. It is obvious that the pressure predicted by the Airy theory is smaller than that from Stokes' theory, and the difference increases with decreasing water depth. The writers therefore suggest that (2) should be replaced by a proper expression to include wave nonlinear effect. Besides, the authors have presented the results for the condition without the presence of armor units on the beach. If the settlement of the armor unit is concerned, the reflection of the waves in front of the structure should be encountered in the calculation of the pressure at the structure toe, thus pushing the critical depth toward an even larger value.

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[a]March/April 1992, Vol. 118, No. 2, by Tetsuo Sakai, Katsuya Hatanaka, and Hajime Mase (Paper 171).

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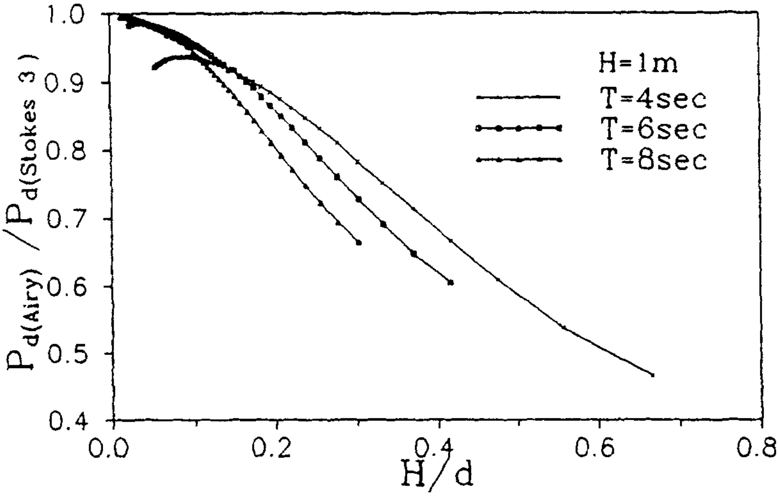

FIG. 2. Difference of Pressures Calculated from Different Wave Theories (H = 1 m)

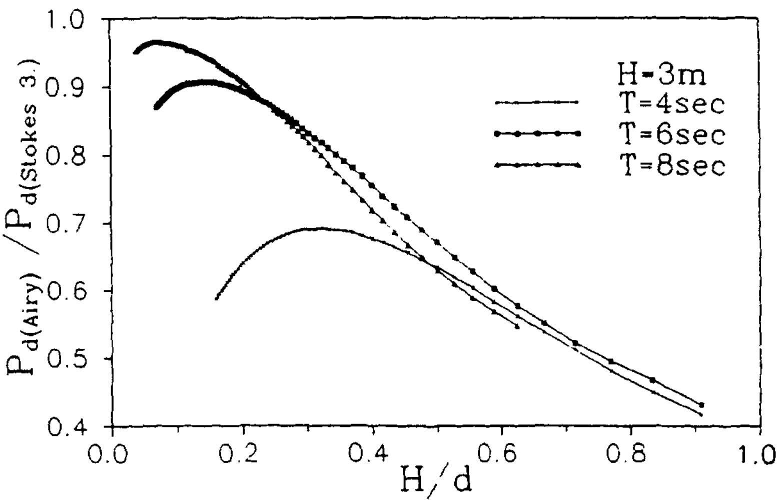

FIG. 3. Difference of Pressures Calculated from Different Wave Theories (H = 3 m)

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