EXPERIMENT STUDY ON EFFECTS OF OFFSHORE PILE DIKE FOR BEACH PROTECTION

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Wave is one of the main dynamic factors causing beach erosion, especially in the surf zone. The key point of beach protection lies on wave dissipation. To protect a beach in Shanghai, an offshore pile dike consisted of a row of closely spaced piles was developed recently. Such structure was widely employed as breakwaters in many harbors (Herbich 1990). They were usually built in deep water and unsubmerged (Wiegel 1961, Truitt and Herbich 1987). On the contrary, the dike for beach protection was arrayed in the surf zone and submerged due to economical reason. In this paper, both field and flume experiments about the offshore pile dike were introduced. Special emphasis was laid on the impacts of water depth d, pile height h, and pile spacing b on wave dissipation. And the bed velocity behind the dike was analyzed, too.

Generally, the effect on wave dissipation of an offshore pile dike can be decided by d, h, b, D (pile diameter) and H_i (incident wave height). A transmission coefficient K is defined as the ratio of the height of the transmitted wave H_t to that of the incident wave H_i, namely

$$K = \frac{H_t}{H_i} = f\left(\frac{h}{d}, \frac{H_i}{d}, \frac{b}{b+D}\right) \tag{1}$$

where h/d = relative pile height; H_i/d = relative wave height; $\eta = b/(b + D)$ = relative pile spacing, which denotes the gap ratio of the pile.

For a constant of h/d and η, the larger H_i/d, the smaller K, meaning the better effect on wave dissipation (as shown in Figure 1). The smallest K occurs when an incident wave breaks (where breaking index chosen to be 0.70). For a submerged dike, the effect become better when the relative pile height approaches to 1.0 (as shown in Figure 2a). For an unsubmerged dike with small gap ratio, it has better effect on wave dissipation than the submerged one. But for that with large gap ratio, the pile height beyond the tidal level does not improve the effect (as shown in Figure 2b). Although the effect of the non-spaced pile dike is the best, the difference among the others is not very large (as shown in Figure 3). Therefore, the relative larger pile spacing was chosen to be 0.40 in the field experiment.

For obliquely incident waves, the effective pile spacing will decrease compared with forward waves in the experiment, and this will improve the effect on wave dissipation.

Experimental results show that the incident wave will break more easily before the dike and the transmitted wave will become a shallow water wave. So the sediment on the beach is uneasy to be suspended like that under the condition of breaking waves.

It can be concluded from the study that the offshore pile dike not only can effectively reduce wave height, but also can change the wave status from a breaking wave to a shallow water wave in a large region behind the dike. This can decrease the wave power and prevent the beach from erosion. Obviously, the offshore pile dike is an effective new structure for beach protection.

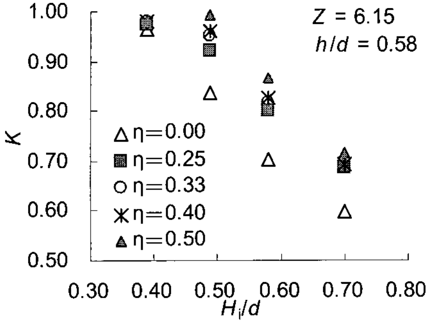


Fig. 1 Relationship between transmission coefficient K and relative wave height H_i/d

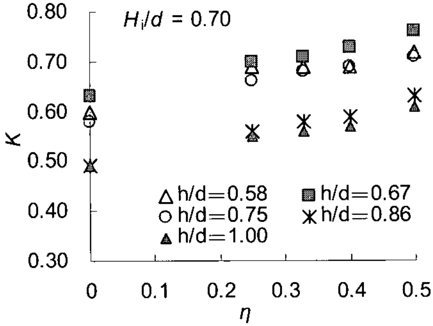
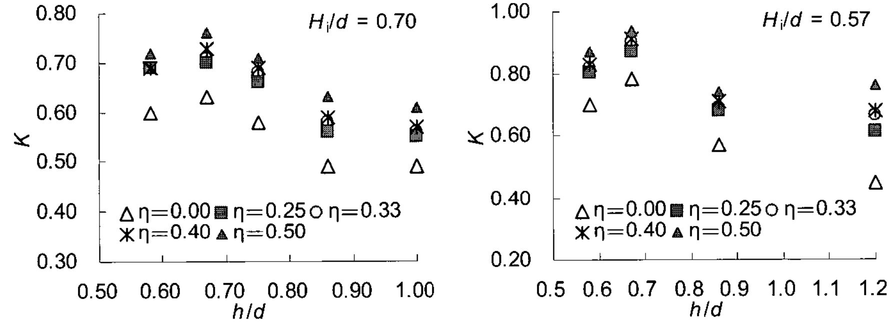


Fig. 3 Relationship between transmission coefficient K and relative pile spacing η



(a) (b)

Fig. 2 Relationship between transmission coefficient K and relative wave height h/d

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