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Wave Breaking Termination on Bar-trough Shaped Beaches

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ABSTRACT

The wave tank experiments were conducted to determine the effect of the bottom slope on the termination condition of the wave breaking. It was tested on simplified bar-trough shaped beaches with three different back slope conditions. The experimental results were analyzed to understand the conditions of the wave in the trough region. It was found the evolution of the wave on the inversely sloped bottom gave very similar tendency to the cases on the horizontal bottom. The effect of the bottom slope can be found in the results but it was very small.

KEY WORDS: Wave breaking termination; Wave tank experiments; Relative Trough Froude Number; Bottom slope effect

INTRODUCTION

The determination of the wave breaking region is an important factor in wave transformation studies because the mechanism of wave breaking is completely different from potential flow wave motion. However, the termination of wave breaking is not fully understood. This is because wave breaking occurs very close to the shoreline and continues until the wave dissipates almost all its energy at the shoreline. In this case knowing the initiation location of wave breaking defines the wave breaking zone. But on bar-trough shaped beaches and at inlets/river mouths, wave breaking ceases before the wave dissipates all its energy. Under these circumstances, the determination of the wave breaking termination location is as important as the determination of the initiation location to define the wave breaking zone. If the termination location of wave breaking is not correctly determined, the wave condition after wave breaking will be different from actual conditions.

It is also important to understand how the wave breaking index changes during the wave breaking process in numerical models. The numerical model calculates the index value and compares it to the termination condition to determine if the wave is still breaking. If the index value comes very close to the termination condition far before the wave reaches its actual termination location, it may cause a false decision by the slightest error in the calculation. However, the index value decreases soon after the wave breaking initiation in most of wave breaking mode and it is stabilized at very close to the termination condition in the most of the part of wave breaking. The Relative Trough Froude Number (RTFN), introduced by Utku and Basco (2002), is a wave breaking index based on the moving hydraulic jump concept. Because of the characteristic of wave celerity change during the wave breaking, the RTFN approaches to the termination condition more gradually than the other indexes.

Okamoto and Basco (2004) determined the termination value of the Relative Trough Froude Number (RTFN) as 1.2 from the theoretical analysis and wave tank experiments with horizontal bottom configuration. Okamoto et al. (2006) made a comparison of the index behavior during wave breaking on a horizontal bottom and found that the RTFN index approaches the termination condition more gradually than other indexes. But, as known that the initiation condition of wave breaking changes with the bottom slope, the termination condition may also be affected by the bottom slope.

In this paper, we conduct wave tank experiments on simplified bar-trough beach formations. Three different slope angles on the lee side of the bar are tested. The free surface elevation and the particle velocity are measured during and after the wave breaking to calculate the RTFN and other indexes. Results are compared to find the bottom slope effect on the termination condition and to see the difference in the index behavior during the wave breaking.

WAVE BREAKING TERMINATION

Many studies on the post-wave-breaking phenomena have been undertaken on plane sloping beaches or monotonically decreasing water depth case. This is because the wave height decay is closely connected to the energy exertion and the energy drives various nearshore hydrodynamic phenomena such as set-up/down, longshore current, nearshore circulation, and so on. The wave height decreases rapidly over a short distance after initiation, then wave breaking continues while the wave height decreases more slowly. Svendsen et al. (1978) defined two regions; (1) the radically changing “outer breaking region”,