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Research of Flow Characteristics on Spilling Waves

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Abstract

This paper uses ADV to measure the characteristics of velocity field near breaking wave over a gentle slope (1/200) in a wave flume. The result indicates that: The phase difference of the maximum velocity of vertical direction and horizontal direction is about T/8. The maximum velocity in the horizontal direction is several times larger than that in the vertical direction. The velocity in the wave crest is larger than that in the wave trough. The smallest maximum velocity around breaking wave happens in the wave breaking point. At the breaking wave point and after wave breaking, the asymmetry is obvious.

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Key words: wave flume ; gentle slope; breaking wave; velocity

1. Preface

China has nearly 3,000,000km^2 sea area and 18000km coastline. According to the material composition and dynamic characteristics, coastline can be divided into sand coast, silt muddy (10500 km) coast and the bedrock coast. 58.5% of the length of the mainland coastline is silt muddy coast. The beach is flat and wide along the silt muddy coast. Its bank slope is extremely gentle and the gradient is about 1/500 ~ 1/2000. Many harbors, channels and other offshore constructions are built. Breaking wave's propagation in flat beach increases sediment

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concentration in water.It causes the sediment siltation increasing in ports and channels. The surf zone is wide. The other coastal engineering may also be affected. The characteristic of breaking wave has been attracting the attentions of experts and scholars. Wright（1982）, Nadaoka and Kondoh(1982，1989), Roelvik and Stive（1989）, Thornton, Ting and Kinby（1996）, Okayasu（2002）, Serio(2006) studied circumfluence, velocity of water particles, turbulent stress and others caused by the breaking wave in the field or laboratory respectively. In this paper, we study the velocity characteristics of breaking deformation, before and after breaking during wave's propagation over the gentle slope (1/200) to provide reference for the protection and study of the characteristics of sediment movement in the coastal zone.

2. Experimental equipment and groups

The experiment is conducted in the wave flume (175m×1.2m×1.6m) in Nanjing Hydraulic Research Institute. There is a paddle wave maker on one side of the flume and a wave-absorbing device on the other side. The wave maker system can create regular wave (period between 0.5s and 5s) and irregular wave. The paddle wave maker is driven by servo generator and creates waves by paddle which controlled by oil pressure. The wave height collection adopts CBY-II type system and the velocity is collected by ADV which can measure the 3D flow velocity untouched and with the function of locating within 20cm and the accuracy is 0.1mm.

In the flume, a gentle slope is built 30m away from wave paddle. The slope gradient of the first 10 meters is 3/200 while the last 40m is 1/200. The experiment uses 10 wave height sensors. The distance between wave height sensor W1 and the paddle, W2 and W1, W3 and W1, W3 and W9, W9 and W10 is 25m, 10m, 18.5m, 2m and 12.5m respectively. The controlled wave breaking point is between W7 and W8. Each vertical line has 3 flow velocity measuring vertical lines and line V2 is 1m away from W7. Each line has 5 measuring points and the distance between point and bottom is 10cm、5cm、1cm、0.5cm and 0.2cm respectively. The gentle slope and measuring positions are shown in Figure 2.

The experiment has 12 groups. The water depths are 45cm, 50cm and 55cm. The input waves are regular waves, periods of which are 1.4s and 1.8s. Each period has two wave heights. Type of breaking wave in this research is spilling breaker which is determined according to non-dimensional parameter $\xi = \tan\beta/(H/L_0)^{1/2}$ introduced by Battjes. Battjes considered that, the wave is collapsing wave when ξ_0 is larger than 3.3. The wave is spilling wave when ξ_0 is smaller than 0.5. The rest is plunging wave. The experimental groups and incident wave parameters are shown in table 1.

Fig.1 Experimental flume