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The Study of the Bed Shear Stress on the Irregular Waves

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ABSTRACT

In this paper, shear plate was mounted on the bottom of a wave flume and direct measurements of the smooth and rough bed shear stress under waves were done in the term of the horizontal force exerted on the shear plates by the bottom shear stress in the wave boundary layer. It was conducted under immobile bed condition; grains of sand were glued uniformly and tightly onto the shear plate, which prevented the movement of sand with currents and the generation of sand ripples. The distribution of the bottom mean shear stress varying with time was measured by the interaction between the shear plate and shear transducers. The relationship between the force measured by the shear transducers and the voltage shown was linear. Simultaneous measurements of the bottom velocity were carried out by ADV. While the whole process was completely controlled by computers, bottom shear stress and velocity were measured synchronously. The 1/3 characteristic shear stress value under irregular waves was considered as the main factor for analysis. Compared with theoretical results and previous experimental data, it is shown that the experimental method is possible and applicable to the laboratory studies on the initiation of sediments and the measurement of the shear stress when sediments initiate.

KEY WORDS: irregular wave; boundary layer; friction factor; stress plate; smooth bed; rough bed; shear stress.

INTRODUCTION

Research on the wave boundary layer at present mainly focuses on the regular waves. You et al.(1991, 1992), You(1992, 1994, 1995) studied on velocity profile, bottom shear stress and friction coefficient inside the turbulent wave boundary layer. Research on irregular waves is relatively less but actually in the ocean area real waves are mostly irregular. Sledth et. Al(1987) and Jensen et. Al(1989) made measurements on the bed friction coefficient in the rough and smooth turbulent bottom boundary layers respectively. Myrhaug(1995) studied on the distribution of the maximum bottom shear stress under irregular waves in the term of the probability. Qin Chongren, et al.(1999), taking a spectral wave as the input wave spectrum condition ,determined the bottom shear stress spectrum as a output under the stochastic waves via a transfer function. In this paper, shear plate was mounted on the bottom in wave flume and direct measurements of the smooth and rough bed shear stress under waves were done in the terms that the horizontal force exerted on the shear plates by the bottom shear stress in the wave boundary layer.

EXPERIMENTTAL SET-UP

This paper utilized the horizontal acting force of the shear stress onto the stress plate in wave boundary layer to give the distribution function of the averaged bed shear stress varying with time, the shear stress and the synchronous velocity profile were measured via shear transducers and ADV. Fig. 1 shows the longitudinal section of the experimental set-up and the data collection section is given as Fig. 2. ADV and wave altimeter were set just onto the shear plate. Sediment grains of the identical diameter were laid uniformly on the surface of the shear plate. Shear transducers played the main role in this experiment which was fixed on the bottom support beneath the shear plate. The shear plate and its supporting structure were mounted in the flume. According to their height, the height of the elongated plates on two sides was given as 20cm. The shear plate and the elongated plates should be kept in the same height when being installed. The length of the elongated plates on the two sides was 3m respectively and there was a slope of 1:10 in front of the elongated part in order to diminish the deformation of the wave as much as possible. In order to enhance the stability of the elongated plates and prevent its energy dissipation function from happening, through practical observation, the bottom of the elongated plates could not adopt the supporting structure but be filled and bonded with the cement tightly. For the sake of the free motion of the shear plate and the decrease of the flow turbulent beneath the shear plate, the smaller the gap between the shear plate and the flume side walls was, the better result it performed. But if it was too narrow, the sand particle would easily get stuck by the shear plate. Therefore, the gap in this experiment was taken as 5mm. Secondly the shear plate was connected to the supports with the slipway. If it was only horizontally laid on the

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