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Non-Linear Velocity Fields in Turbulent Wave Boundary Layer

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Abstract : The objective of this paper is to present the detailed analysis of the turbulent wave boundary layer produced by progressive finite-amplitude waves theory. Most of the works have done for the mass transport in the turbulent boundary layer assuming the eddy viscosity is not time varying, where the sediment movement is induced by the mean velocity. Near the ocean bottom, the waves produce a thin turbulent boundary layer, where the flow is highly rotational, and shear stress associated with the fluid motion cannot be neglected. The magnitude and the predominant direction of the sediment transport near the bottom are known to be closely related to the flow in the wave induced boundary layer. The magnitude of water particle velocity at the Crest phase differs from the one of the Trough phases due to the non-linearity of the waves, which plays an important role to determine the sediment movement. The non-linearity of the waves become predominant in the surf zone area, where the sediment movement occurs vigorously. Therefore, in order to describe the flow near the bottom and relationship between the flow and the movement of the sediment, the analysis was done using the non-linear boundary layer equation and the finite amplitude wave theory was applied to represent the velocity fields in the turbulent wave boundary layer. At first, the calculation was done for turbulent wave boundary layer by two-dimensional model where throughout the calculation is non-linear. But Stokes second order wave profile is adopted at the upper boundary. The calculated profile was compared with the experimental data. Finally, the calculation is done based on various modes of the velocity and turbulent energy. The mean velocity is found to differ from condition of the relative depth and the roughness. It is also found that due to non-linearity, the absolute value for velocity and turbulent energy as well as Reynolds stress are asymmetric. The mean velocity of the laminar boundary layer is always positive but in the turbulent boundary layer plays a very complicated role.

Keywords : wave boundary, mass transport, mean velocity, shear stress
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