Dynamics of Sand Ripples Generated by Irregular Waves

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When we want to reproduce transport of sediment in the fields in a laboratory , we have to establish a similitude law. A similitude law is necessary when sediment transport of field is reproduced in a laboratory. When we apply our knowledge about sediment transport obtained in the laboratory to predict sediment transport in the field , we can apply Froudian law to a fluid motion that becomes agitation agency and transporting flow of sediment movement. However, we can not apply Froudian law to sediment movement. When we scale down the size of sediment in the field in the laboratory , it become too small to be cohesionless sediment. Many researchers have already carried out studies regarding similitude law of bed material. However, universal similitude law has not been established yet.

The difference of ripple scales in the field and the laboratory is one of the important problems to establish similitude law of sediment transport, because ripple plays an important role in suspension of sediment. The difference of ripple scale may cause the scale effects in suspended sediment and occurrence of sheet flow.

The followings are conceivable causes that bring about these scale effects.

(1) Ripples in the field are generated by irregular waves, but ripples in the laboratory are usually reproduced by regular waves.

(2) The difference between the Grain Reynolds number and the KC number are large.

(3) Ripples are generated as a result of ever-changing waves in the field. That is , the existing ripples in the field received effects of time history of incident waves. But ripples in laboratories are usually generated directly from a flat bed by incident waves of unique characteristic.

The points at issue listed in (1) and (2) have already been examined by many investigators through experiments. However, the effect of time history of incident waves on ripple geometry is not yet studied fully.

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A transformation of bed configuration according to the increase of wave action is shown in Fig.1.

Generally, modes of sediment movement are related to the above mentioned microscopic bottom topography and be classified into bed load, suspended load and sheet flow as illustrated in Fig.1. Although the initiation of 2-D ripples has been studied by many investigators , only a few studies have been carried out about the occurrence and characteristics of 3-D ripples.

In this research we examined the effect of time history of incident waves on ripple geometry by using regular waves and irregular waves. The occurrence limits of 3-D ripples are also investigated.

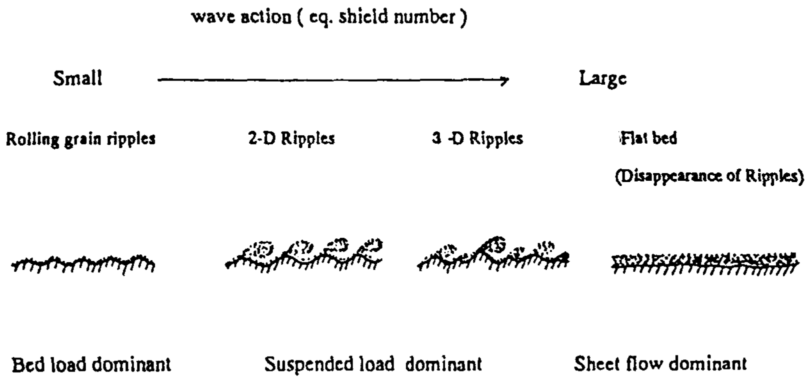

Fig. 1 Bottom topography and mode of sediment movement.

The main conclusions obtained in this study are summarized as follows:

1. Non-dimensional length λ/d_0 of ripples generated in the decreasing process of incident waves became larger than that formed from a flat bed by one wave train.

Especially non-dimensional ripple length in a decaying process of wave height became very close to the field ripples. Therefore, the effect of initial condition of ripple generation is one cause of a scale effect between the field and the laboratory.

2. The characteristics in the geometry of 3-D and 2-D ripples are able to be expressed very well by the spectrum band parameter ε .

3. The occurrence region of 3-D ripples is predicted very well by Shields parameter where the effect of a ripple geometry together with the grain size are taken into account in the evaluation of shear velocity.

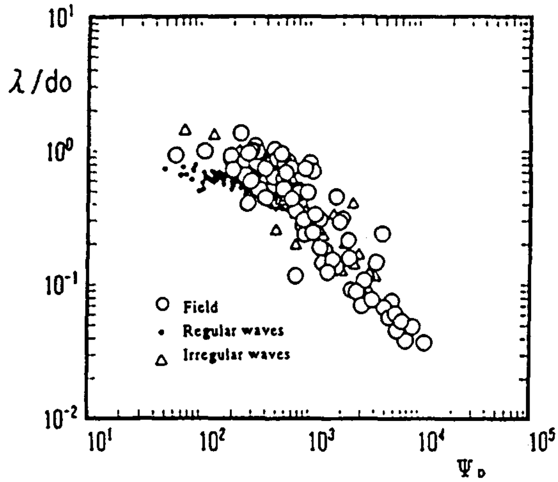

Fig. 2. Relationship between λ/d_0 and Ψ_D for ripples in laboratory and field.(I)

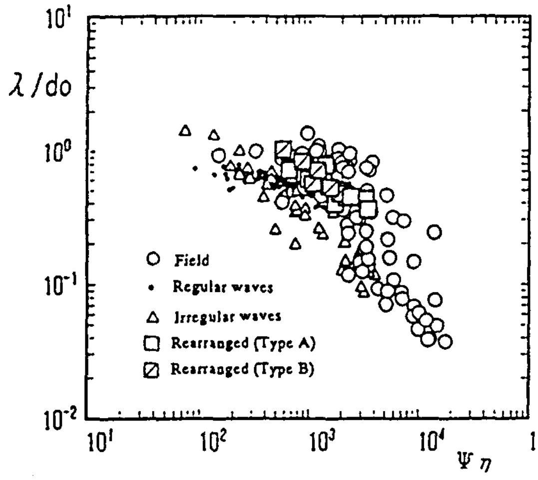

Fig. 3. Relationship between λ/d_0 and Ψ_η for ripples in laboratory and field. (II)

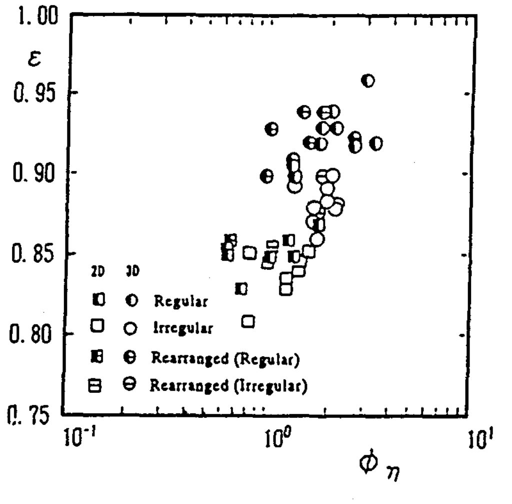

Fig. 4. Stochastic characteristics of geometry of regular and irregular wave-generated ripples.

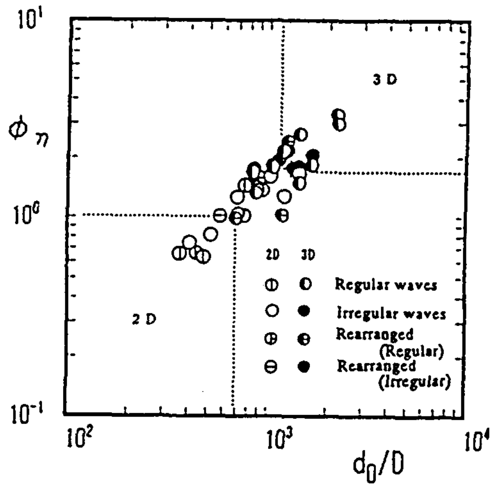

Fig. 5. Transition of ripples in regular and irregular waves.