LONG WAVES GENERATED BY SHORT WAVE GROUPS OVER A SINUSOIDALLY VARYING TOPOGRAPHY

DAE HEE CHO [1] and YONG SIK CHO [2]

[1]Civil Engineer, Engineering Development Team, Kukdong Engineering & Construction Co., Ltd., 60-1 Chungmuro 3-ga, Chung-gu, Seoul 100-705, Korea
(Tel: +82-2-2280-6132, Fax: +82-2-2275-0581, e-mail: alakong@kukdong.co.kr)
[2]Corresponding Author, Associate Professor, Department of Civil Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, Korea
(Tel: +82-2-2220-0393, Fax: +82-2-2293-9977, e-mail: ysc59@hanyang.ac.kr)

When a train of modulated wave groups propagates over a slowly varying topography and current field, two types of second-order long waves are generated due to refraction and shoaling. The locked long waves propagate with the wave envelopes at the group velocities of short waves. The free long waves propagate at the shallow-water speed. Because the governing equations of long waves generated by wave groups is represented as the second-order terms of Stokes' wave theory, it is named as the second-order long waves. The order of long waves is, so to speak, the second-order of the wave slope, $O((ka)^2)$. These (locked and free) long waves, although second-order quantities, play important roles in many coastal engineering problems, such as harbor resonances and coastal processes, if they are trapped and resonated in the nearshore area (Liu et al., 1992).

The governing equations of second-order long waves can be derived by using the perturbation method (Cho et al, 1996). The slow variables are introduced to use the perturbation method. The governing equations and boundary conditions of each order can be derived through the complicated mathematics and the governing equations of second-order long waves can be obtained from these equations. The two solutions of these governing equations are obtained. The first solution which is the solution of homogeneous equation means the free long waves and the second solution which is the solution of non-homogeneous equation means the locked long waves. Thus, the velocity potentials and free surface displacements of the second-order long waves are represented as two types (locked and free long waves). To determine the values of amplitudes in the equations of the velocity potentials of free long waves, two matching conditions are required. The first condition requires the continuity of the second free surface displacement. The second condition requires the continuity of the second-order flux (Liu et al. 1992).

The long waves generated by short wave groups over sinusoidally varying topography are investigated in this study. In Fig. 1, the value of k_1h_1 where the critical incident angle becomes the incident angle is 1.52 in the case of $Fr_j=0$ and the value of k_1h_1 is 1.35 in the case of $Fr_j=0.1$. Thus, Fig. 2 shows that the trapped free long waves are resonated at the point of $k_1h_1=1.52$ and $k_1h_1=1.35$ where the incident angle approaches the critical incident angle.

The conditions which the free long waves are resonated have relations with the critical incident angles determined by the depth of water and the velocity of currents. As the incident angle of waves approaches the critical incident angle, the free long waves are trapped and resonated.

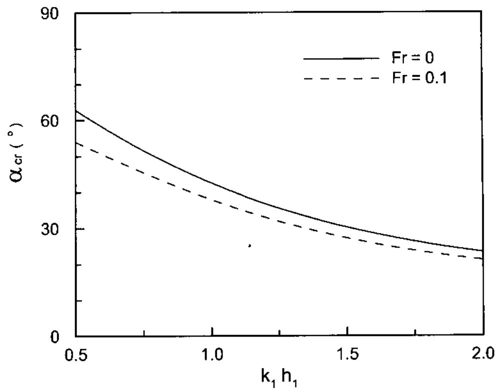

Fig. 1 The critical incident angles for $Fr = 0$ and $Fr = 0.1$ with $k_1 h_1$

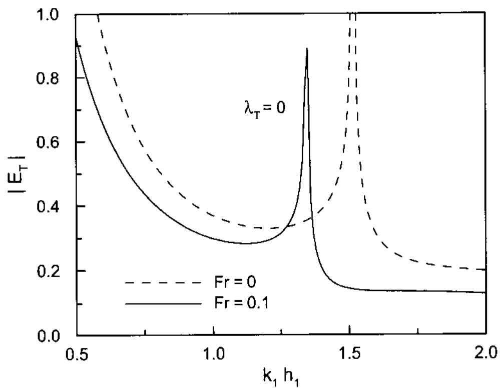

Fig. 2 The free long wave amplitudes for $Fr = 0$ and $Fr = 0.1$ with $k_1 h_1$ ($\alpha_I = 30°$, two rippies)

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