CHAPTER 39

On the maximum runup of cnoidal waves.

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This is a study of the maximum runup of cnoidal waves on plane beaches. An approximate theory is described for determining the maximum runup of non-breaking cnoidal waves. It is shown that the linear and nonlinear theory predict mathematically identical maximum runup heights. An asymptotic result is derived for the maximum runup of solitary waves, which are one limiting form of cnoidal waves. A series of laboratory experiments is described to support the theory. Other numerical results are presented that suggest that the runup of cnoidal waves is significantly higher than the runup of monochromatic waves with the same waveheight and wavelength. Preliminary laboratory data are also presented which suggest that, for certain cnoidal waves, the maximum runup is not a monotonically varying function of the normalized wavelength.

1. Introduction

The problem of determining the runup and reflection of cnoidal waves on plane beaches usually arises in the study of the coastal effects of tsunamis. Tsunamis are long water waves of small steepness generated by impulsive geophysical events on the ocean floor or at the coastline. Cnoidal waves are believed to model important aspects of the coastal effects of tsunamis well.

The process of long wave generation and propagation is now well understood. The process of long wave runup and reflection is not. However, there is consensus that one suitable physical model for this process is the formalism of a long wave propagating over constant depth and encountering a sloping beach. The studies of long wave runup have concentrated either on solitary waves or on monochromatic waves, i.e., at the two extremes of cnoidal waves. (For a comprehensive review of studies on solitary wave runup see Synolakis (1986).) To date, there appear to have been only three studies on cnoidal wave runup, one unpublished study by Pedersen and Gjevik (1983), the study of Ohyama (1987) – in Japanese – and the study of Synolakis et al (1988).

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