Experiment 6: "Irregular wave breaking"

1. Background theory

Wave breaking on natural beaches occurs over a wide area due to the variable wave heights and periods of the incoming irregular waves. Bigger waves will break farther offshore than smaller waves. The percentage of breaking waves inside the surf zone varies across the surf zone.

To identify breaking waves from a free surface elevation time series, $\eta(t)$, two parameters can be estimated (Xu *et al*, 1986): (i) the rate of temporal variation $R(t)$ and (ii) the free-surface slope $s(t)$ (Figure 1), given by,

$$R(t) = d\eta(t)/dt, \tag{1}$$

$$s(t) = R(t)/C \tag{2}$$

where C is the wave celerity. An increase of $R(t)$ is expected for breaking waves (Longuet-Higgins and Smith, 1983). The maximum slope for regular progressive waves is 0.586 (Longuet-Higiins and Fox, 1977), and hence,

$$s_{max} = 0.586, \quad R_{max} = 0.586c$$

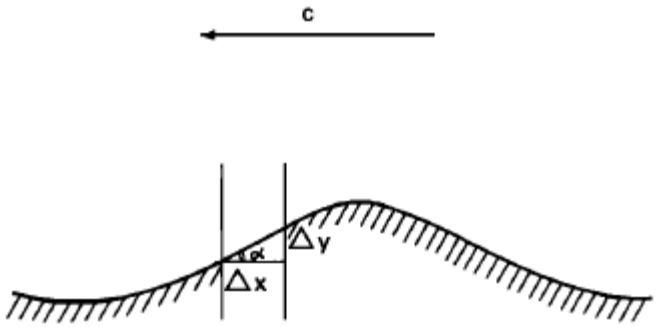

Figure 1. Interpretation of the rate of temporal variation R for a progressive wave (taken from Longuet-Higgins and Smith, 1983). $R=c\tan\alpha$; $s=\tan\alpha$.

Therefore, a wave is classified as broken if $R(t)>R_{max}$ at any point between the zero crossing. In some cases, this criterion is met in more than one place along the wave profile, but only one broken wave counts. This information is important as some breaking models (Thornton & Guza, 1983) predict the distribution of breaking and non-breaking waves in the breaking zone, requiring measurements for their calibration.

2. Objective

To investigate wave breaking characteristics of irregular progressive waves.

3. **Instructions**

Employ the virtual wave flume, testing two different wave conditions, to:

- Observe the irregular wave transformation for the two tests and identify the offshore limit of the surf zone.
- Deploy 10 wave gauge (WG) sensors along the flume with increasing resolution within the surf zone.
- Measure free-surface elevation time series during 300 s and export the measured data.

4. **Assignment**

For each case, use the zero-down crossing method to estimate the wave parameters (H and T) for each wave in the irregular wave train at the different cross-shore locations. Estimate the significant wave height H_s ($H_{1/3}$) and the root-mean square wave height H_{rms}. Plot H_{rms} and H_s vs h to determine the wave breaking index.

Compute R to separate between breaking and non-breaking waves at each cross-shore location using the linear dispersion equation to compute C. Plot the histograms of breaking and non-breaking waves at each cross-shore location for each test and the % of breaking and non-breaking waves vs x.

References:

Longuet-Higgins, M.S. and Fox, M.J.H., 1977. Theory of the almost-highest wave: the inner solution. *J. Fluid Mech.,* 80(4), 721-741.

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