# WAVE CHARACTERISTICS OF SURFING WAVES

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In order to characterize the surfing waves, Iribarren(1950) suggested a non-dimensional physical number, which is the ratio of beach slope to the square root of wave steepness. The Iribarren number is widely used by coastal engineers for classifying the type of breaking waves and for estimating armor weight and run-up height. In the present paper new surf parameter is proposed by forming the ratio of beach slope to the wave steepness, which is called '2nd order Iribarren number - $J$', and the original Iribarren number '1st order Iribarren number - $I$'. Another set of surf parameters is developed by forming the product of the beach slope and the ratio of wave celerity to the square root of gravity acceleration times wave height. They are called '1st order wave action slope - $S_X$' and '2nd order wave action slope - $S_Y$'. When the values of wave length or wave celerity are taken from an offshore condition, $I$ is proportional to $S_X$ and $J$ is proportional to $S_Y$. When the values are taken from a local condition, however, they are not simply proportional to each other. The wave action slopes imply further effect of wave shoaling through dispersion relation.

The 1st order wave action slope is closely related to the 1st order Iribarren number and the 2nd order wave action slope is closely related to the 2nd order Iribarren number. It is, however, found that the relations do not have simple linear proportionality. Using dispersion relation, the wave action slopes are related to the Iribarren numbers as presented in Table 1.

Table 1. Relationship of wave action slopes and Iribarren numbers

| | $S_{Xo}$ | $S_{Xi}$ | $S_X$ | $S_{Yo}$ | $S_{Yi}$ | $S_Y$ |
|---|---|---|---|---|---|---|
| Definition | $\frac{C_o}{\sqrt{gH_o}}S$ | $\frac{C_o}{\sqrt{gH}}S$ | $\frac{C}{\sqrt{gH}}S$ | $\frac{C_o^2}{gH_o}S$ | $\frac{C_o^2}{gH}S$ | $\frac{C^2}{gH}S$ |
| Relationship | $\frac{1}{\sqrt{2\pi}}I_o$ | $\frac{1}{\sqrt{2\pi}}I_i$ | $\sqrt{\frac{\tanh kh}{2\pi}}I$ | $\frac{1}{2\pi}J_o$ | $\frac{1}{2\pi}J_i$ | $\frac{\tanh kh}{2\pi}J$ |

Note: $S$; beach slope, $C$; celerity, $H$; wave height, $h$; water depth, $k$; wave number, $I = S/\sqrt{H/L}$, $J = S/(H/L)$

Using the same data of Mase(1989), the total run-up height is related to the 1st order wave action slope $S_X$ as follows:

$$\eta_R = \xi\delta\,(0.32 + 6.9 S_X) \tag{1}$$

where $\eta_R = h_R / H$, $h_R$ is the run-up height, $H$ is the wave height, $\xi$ is the reduction factor to account for the roughness condition of slope, $\delta$ is the reduction factor of probability. When the slope is covered by concrete block such as TTP, $\xi$ is found about 0.4 by using the data of Ahrens(1988). $\delta = 1$ for the maximum reach, $\delta = 0.742$ for the 2% reach, $\delta = 0.688$ for the 10 % reach, $\delta = 0.568$ for the 1/3 reach, and $\delta = 0.359$ for the average reach.

The armor weights measured in the laboratory are related to the Iribarren number $I_i$ and the 2nd order wave action slope $S_Y$. The use of the 2nd order wave action slope gives the best correlation with the laboratory data. New empirical equation has been developed using the 2nd order wave action slope $S_Y$ as follows:

$$\eta_W = (s - 1)^{-3} K_Y S_Y \tag{2}$$

where $\eta_R = W / \rho_S g H^3$, $W$ is the armor weight, $\rho_S$ is the density of armor unit, $K_Y$ is a constant depending on percolation, degree of damage, and the reflection coefficient.

## REFERENCES


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