Wave breaking is an important phenomenon in coastal engineering. In shallow water, the wave height increases as the wave length decreases, causing wave steepness defined as H/L to increase rapidly until the wave profile becomes unstable, i.e., when the wave starts to break.

To visualize the concept, a breaking and non-breaking wave are shown in Figures 1.a and 1.b, respectively.

(a) Breaking Wave (b) Non-Breaking Wave

Figure 1: Breaking and Non-Breaking Waves

In order to design the coastal structures, height of the breaking wave height needs to be determined precisely. Since the force exerted by a breaking wave is much greater than that of a non-breaking one. Thus, coastal structures are usually not located at water depths where the waves may break.

To find height of breaking wave, one need to solve the following equation (CEM, 2002), where breaking wave height is denoted as H_b:

$$f(H_b) = (H_b)^2.(H_0)^{4/5}.\left[Cg_0.\cos(\alpha_0)\right]^{2/5}.\left[\frac{g}{\gamma_b} - \frac{H_b.g^2.\sin^2(\alpha_0)}{\gamma_b^2.C_0^2}\right]^{-1/5} - H_b^3$$

The other known parameters of the above equation, are given in Table below along with their definitions and typical values:

Table 1: Parameters of Equation for Breaking Waves

Parameter	Definition	Value
γ_b	Breaker Index	0.78
H_0	Deep water wave height	4.5 m
Cg_0	Group velocity at deep water	6.24 m/s
C_0	Wave celerity at deep water	12.48 m/s
α_0	Deep water wave approach angle	30^o
g	Gravity of acceleration	9.81 m/s^2

The *CE305 Ltd*. is a company whose one of the working area is to design marinas. The company is currently working on the project named *Marina World*. Your task in this project is to find breaking wave height (H_b) to design the breakwater of the marina. Write a MATLAB code that finds breaking wave height using:

a) Bisection Method in the interval [3.5,4.5].

b) Newton-Raphson method. (Your initial guess can be $H_b^0 = H_0$.)

Use absolute relative error definition and take error tolerance as 10^{-5}.

$$\varepsilon_R = \left| \frac{x_{i+1} - x_i}{x_{i+1}} \right|$$

References

- U.S. Army Corps of Engineers. 2002. Coastal Engineering Manual. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).