Box 4.7 *Brief overview of breaking criteria*

1 **Breaking caused by limiting steepness.** Breaking due to exceedance of the steepness criterion is the main limiting factor in deep and medium water. The steepness criterion is given by Equation 4.100 (Miche, 1944).

$$H/L \le [H/L]_{max} = 0.14 \tanh(2\pi h/L) \quad (4.100)$$

2 **Breaking caused by water depth.** The breaking criterion due to water depth is normally given by a useful non-dimensional parameter called the breaker index γ_{br}, defined as the maximum wave height to depth ratio H/h (see Equation 4.101) where the subscript b stands for **the value at the breaking point**.

$$H/L \le \gamma_{br} = [H/h]_{max} = H_b/h_b \quad (4.101)$$

For stable and progressive waves **over a flat bottom** γ_{br}, has a theoretical maximum value of 0.78 (McCowan, 1894). Note, however, that γ_{br} is not constant, but ranges roughly between 0.5 and 1.5 depending on the bottom slope and the wave period of the incident waves. Numerous criteria to predict the value of γ_{br} have been proposed. A comprehensive review and comparison of most of them can be found in Rattanapitikon and Shibayama (2000). For regular waves normally incident on a uniform slope, m (ie m = tan(α)), two criteria (see Equations 4.102 and 4.103) may be recommended for practical use:

Goda (1970b)

$$\gamma_{br} = \frac{H_b}{h_b} = 0.17\frac{L_o}{h_b}\left\{1-\exp\left[-1.5\pi\frac{h_b}{L_o}\left(1+15m^{4/3}\right)\right]\right\} \quad (4.102)$$

Weggel (1972)

$$\gamma_{br} = \frac{H_b}{h_b} = \frac{b(m)}{1+a(m)\frac{h_b}{L_o}} = b(m) - a(m)\frac{H_b}{L_o} \quad (4.103)$$

where $a(m)$ = 6.96 [1-exp(-19m)] and $b(m)$ = 1.56 [1+exp(-19.5m)]$^{-1}$

Other criteria and a comparison of them on a large set of data can be found in Rattanapitikon and Shibayama (2000) and in Rattanapitikon *et al* (2003), who also proposed a new criterion giving the best fit to the experimental points of the validation database (see Equation 4.104):

$$\frac{H_b}{L_b} = \left[-1.40m^2 + 0.57m + 0.23\right]\left(\frac{H_o}{L_o}\right)^{0.35} \quad (4.104)$$

where L_b = wavelength computed at the breaking point (depth h_b) by the linear wave theory.

For irregular waves (represented by the significant wave height H_s) typical values are found to be γ_{br} = 0.5 to 0.6. The actual limiting wave height ratio γ_{br} depends mainly on such parameters as ξ and may reach values as large as 1.5 for **individual waves**. Figure 4.39 gives a good impression of the relationship between γ_{br} and ξ_o (see Section 4.2.4.3) and the related scatter of the data.

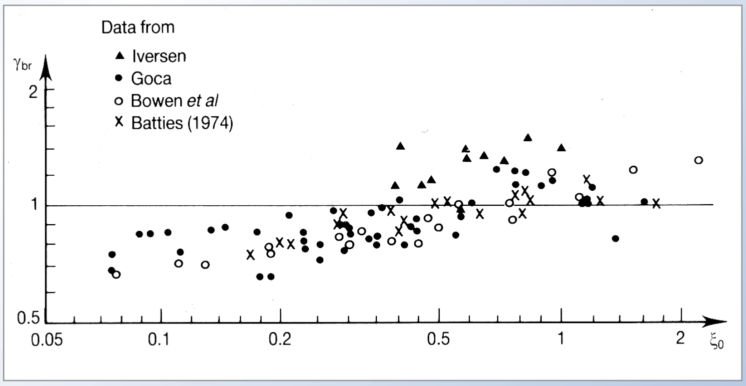

Figure 4.39 *Breaker index, γ_{br}, as a function of deep-water surf similarity parameter, ξ_o*

Depth-limited significant wave height for constant bottom slopes

Wave breaking becomes increasingly important in shallow water, and wave models accounting for breaking should be used. The main effect of wave breaking is a lower significant wave height. But there are other changes due to wave breaking which might have an effect on structures. These changes occur both in the time as well as in the frequency domain. The wave height distribution changes as well as the shape of the spectrum. This section describes the decay in significant wave height due to breaking, while the changes of wave height distribution and spectral shape are addressed in Sections 4.2.4.4 and 4.2.4.5 respectively.