Coastal Engineering 55 (2008) 820–822

Contents lists available at ScienceDirect

Coastal Engineering

journal homepage: www.elsevier.com/locate/coastaleng

Discussion

Response to reply by J.P. Le Roux

Merrick C. Haller [a,*], Patricio A. Catalán [a,b]

[a] School of Civil and Construction Engineering, Oregon State University, 220 Owen Hall, Corvallis, OR, USA
[b] Departmento de Obras Civiles, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile

ARTICLE INFO

Article history:
Received 3 January 2008
Accepted 13 February 2008
Available online 18 March 2008

ABSTRACT

In the response given by Le Roux [Le Roux, J.P., 2008. A simple method to determine breaker height and depth for different deepwater wave height/length ratios and sea floor slopes — Reply to discussion by M.C. Haller and P.C. Catalan, Coast. Eng. 55, 185–188] to the discussion of Haller and Catalán [Haller, M.C., Catalan, P.A., 2008. Discussion of "A simple method to determine breaker height and depth for different deepwater wave height/length ratios and sea floor slopes", by J.P. Le Roux [Coastal Engineering 54 (2007) 271–277], Coast. Eng. 55, 181–184], the author presents a defense of the large number of inconsistencies/errors that we pointed out in regards to the earlier work of Le Roux [Le, Roux, J.P., 2007. A simple method to determine breaker height and depth for different wave height/length ratios and sea floor slopes, Coast. Eng. 54, 271–277]. We appreciate the response for the fact that it further clarifies the lines of reasoning used in the previous work. Unfortunately, we are not convinced by the defenses offered and still posit that the original work contains many inconsistencies and downright calculation errors. We try to avoid repetition herein, and instead of rehashing all of the points made in our previous discussion, we will concentrate on a few fundamental problems that undermine the whole premise of the original paper. We feel it is important to make these clear to the readers of *Coastal Engineering*.

1. Inconsistent methodology

One of the fundamental problems with Le Roux (2007), (hereafter LR07), is that it presents an inconsistent comparison of different breaker height and depth formulas. As a primary defense of our criticism of his method, Le Roux (2008) (hereafter LR08) argues that "there is no logical reason why the breaking depths [d_b] cannot be calculated first and then the breaker heights [H_b] derived from the equations given by the different authors". Furthermore, he states "If H_b is used to compute d_b, it is obvious that different values will be obtained than if d_b is used to calculate H_b, which is why these equations have their limitations and depend on the results of the shoaling model, which may yield either d_b or H_b". Here we shall demonstrate: a) that there is a logical reason why d_b and H_b cannot be determined independently (for most of the breaking criterion considered) and instead must be determined simultaneously, b) why there is only one unique pair (H_b, d_b) when a consistent methodology is used for each breaking criterion, and finally c) why the shoaling model (coupled with the chosen breaking criterion) yields *both* H_b and d_b.

Paraphrasing LR07: the deepwater values H_0 and L_0 are fixed by the deepwater wave climate, so that only the local depth, d, and wave height, H_w, can change as the wave moves into shallow water, until the breaking limit is reached and $H_w = H_b$. The value of H_b "would lie along the trajectory of any specific H_0/L_0 ratio…". We agree with this statement.

Let us now consider the comparison that was given in detail by LR08. Shown here in Fig. 1 (solid line) is the shoaling trajectory calculated from Eqs. (20)–(24) (all equation numbers are from LR07) for the deepwater wave condition $H_0 = 0.14$ m, $T = 1.6$ s, $L_0 = 4.0$ m, and a bottom slope of 1×10^{-6}. The empirical breaking condition preferred by LR07 was given in Eq. (25) and is shown here as the dashed line in Fig. 1. LR07 also considered a number of other breaking conditions, as further example the condition given by Eq. (2) is shown as a dotted line in Fig. 1. Conceptually, there is nothing different between Eqs. (25) and (2). They are both equations that can be written in a form such that H_b/d_b is equal to an algebraic function of the bottom slope. For a bottom slope of 1×10^{-6}, Eq. (25) gives $H_b/d_b = 0.835$ and Eq. (2) gives $H_b/d_b = 0.72$. There is no logical reason to justify why LR07 has treated them differently.

Using the intersection between Eq. (25) and the shoaling trajectory to determine the location of the onset of wave breaking is the method preferred by LR07. However, LR08 claims that this method "may yield either d_b or H_b", when it fact it must yield both. In fact, the pair of values calculated from the author's preferred method, can be found in the columns labeled "LR − H_b" and "LR − d_b" in Table 2 of LR07. For the deepwater wave conditions listed above the determined values are $H_b = 0.17$ m and $d_b = 0.20$ m; we do not now suggest (and have not previously) that there are any errors in these particular columns of Table 2. However, in order to compare Eq. (2) with Eq. (25), LR07

DOI of original article: 10.1016/j.coastaleng.2007.09.012.
* Corresponding author. Tel.: +1 541 737 9141.
E-mail address: hallerm@engr.orst.edu (M.C. Haller).

0378-3839/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.coastaleng.2008.02.004

proposes we take the value of d_b=0.20 m determined from Eqs. (20)–(25) and plug this into Eq. (2) giving H_b=0.72(0.20 m)=0.14 m (see the symbol * shown in Fig. 1). This is logically inconsistent and the calculated breaking height of 0.14 m is not meaningful because it implies that Eq. (2) would predict the onset of breaking at d_b=0.20 m and H_b=0.14 m. Although those conditions correctly preserve the H_b/d_b ratio of 0.72 for Eq. (2), *those conditions do not exist along the shoaling trajectory for the given wave condition*. Thus in Fig. 1, the breaking conditions attributed to Eq. (2) by LR07 lie below the given shoaling trajectory. In an analogous fashion, the values in the column labeled "Weg−d_b" in LR07 were calculated by taking the H_b values and plugging them into Eq. (4) and calculating d_b. These mismatched pairs will lie above the proper shoaling trajectory. This problem is solely due to the author's improper use of the breaking criterion equations, it is not inherent to the equations themselves. Instead, the proper way to use Eq. (2) is to find the point where the shoaling trajectory intersects the line representing Eq. (2). This point corresponds to H_b=0.16 m and d_b=0.22 m (as listed in Haller and Catalan 2008, Table 1; hereafter HC08) and is shown with the star symbol in Fig. 1. This point is determined from a consistent methodology that properly shoals the waves up to the breaker line where the specified H_b/d_b ratio is reached.

The above argument is merely a more detailed illustration of that given in HC08. We would point out that in HC08 Table 1 we provided "corrections" to several columns in LR07 Table 2. It is possible that in HC08 we did not clearly identify the tabulated values (from LR07, Table 3) that were incorrect due to computational errors versus those that were simply incorrect because the underlying methodology was incorrect. We note that Eqs. (3),(7) and (8) are a special case as they have only one unknown, so they are uncoupled from the shoaling model; hence, their values in LR07 Table 2 do not need to be corrected. The corrections given in HC08 Table 1 are based on the fact that the methodology used for LR07 Table 2 was incorrect (for some columns) as described above. The errors due to the inconsistent method tend to increase with wave period.

2. Calculation errors

LR08 states that "the fact that the wave periods used in Table 3 are the same is in Table 2 is irrelevant" and that the "misunderstanding

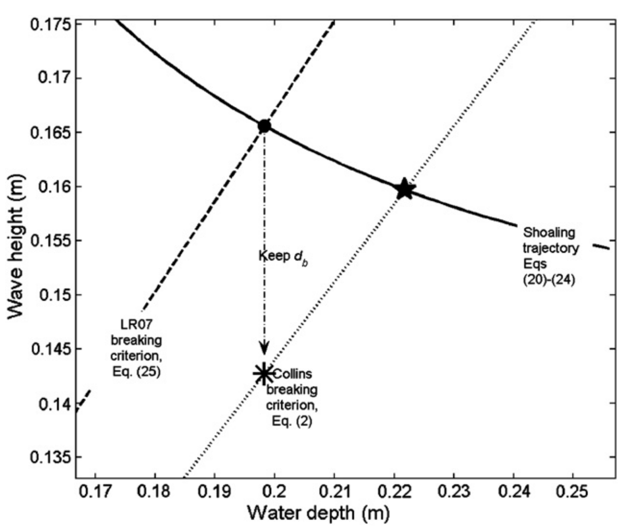

Fig. 1. Shoaling trajectory (solid line) calculated using Eqs. (20)–(24) and deepwater conditions: H_0=0.14 m, T=1.6 s, L_0=4.0 m, and a bottom slope of 1×10^{-6}. Breaking criterion of Collins, Eq. (2), (dotted line); breaking criterion of LR07, Eq. (25), (dashed line); breaking conditions from LR07 preferred method (large dot), from proper use of Eq. (2) (star), and from the inconsistent use of Eq. (2) (asterisk). Asterisk does not lie on the shoaling curve.

stems from the erroneous notion that the equation $L_0=gT_w^2/2\pi$ can be applied to developing waves". Here the author is arbitrarily applying linear water wave theory in an inconsistent fashion. While this equation for L_0 is arguably imperfect for nonlinear waves, there is no justification for the author utilizing it for the case of fully developed waves (Table 2) while also considering it "erroneous" for a developing sea (Table 3). Moreover, it appears that the author has made up this argument after the fact, because in LR07 the author *initially used this equation for developing waves* (p. 276 "the wave period in this [developing wave] case will be 2.2 s…, so that L_0 will be 7.56 m"). Furthermore, for the calculations in Table 3 the author admits in LR08 that he has used an "arbitrary" relationship between L_0 and T_w, i.e. going from Table 2 to Table 3 he has changed the L_0 values without changing the T_w values. Without acknowledging this as a mistake, in LR08 the author claims that in any case this is "irrelevant"; yet, it is most assuredly relevant to the calculation of d_b using Eq. (4) and H_b using Eq. (7), both of which depend explicitly on T_w. The author has used the incorrect T_w values in the calculations in Table 3, which is clearly evident from the fact that the tabulated values in the columns labeled "Kom−H_b", i.e. Eq. (7), are the same in Tables 2 and 3.

Even if we treat the wave periods as if they were correct, Table 3 has other calculation errors. For example, let us consider the tabulated values for Eq. (3) shown in columns "K&G−H_b" in Tables 2 and 3. As stated in LR07: "…[in Table 3] the same deepwater wave heights were used as in Table 2, but the H_0/L_0 ratios were increased to 0.05 by shortening the wavelength". We note that Eq. (3) depends only on H_0 and the H_0/L_0 ratio, and a shoaling trajectory is not required in this case (only one unknown). Let us walk through the calculation using the parameter values given in LR07. For the conditions T_w=11.8 s, H_0/L_0=0.0354, H_0=7.69 m, Eq. (3) gives $H_b=0.56H_0(H_0/L_0)^{-1/5}=(0.56)(7.69)(0.0354)^{-1/5}=8.40$ m. This correct value is listed in LR07 Table 2. However, in Table 3 the same value for H_b is listed, which, as stated in HC08, is "obviously incorrect" because the deepwater wave steepness is the one thing that has changed between Table 2 and Table 3. Hence, the correct value should be $H_b=(0.56)(7.69)(0.05)^{-1/5}=7.84$ m.

Lastly, quoting LR08: "The calculated H_b values for Eqs. (9)–(11) [in Table 3] agree with those in Table 2 (but *only* for a nearly horizontal bottom), because *both* sets of equations depend directly on the H_0/L_0 ratio" (emphasis in original). The interested reader will find that, in fact, the tabulated values (see column "S&B1−H_b" in Tables 2 and 3) do not change from Table 2 to Table 3 *for any value of bottom slope*. Moreover, although Eqs. (9)–(11) only depend on H_0 and H_0/L_0 and this ratio is the one supposed difference between the tables, the author seems completely oblivious to the fact that this means the values should be different between the tables.

3. Errors in physical reasoning

In many cases LR08 simply obfuscates our original criticisms. We will highlight just one further example. Quoting LR07 "On steep slopes, however, the breaker would be in shallow water while the next wave crest seaward thereof would still be in deep water. This crest would therefore be affected less by bottom friction, advancing faster than would be the situation on a nearly horizontal slope. L_b [the wavelength at the location of d_b] should therefore be shorter on steep slopes than on gentle slopes". Most of this quote was repeated in HC08 under the heading "Errors in physical reasoning". In the response of LR08 the author spends nearly a quarter page going through some calculations of wavelengths on mild and steep slopes and even provides an accompanying illustration. Then states that "this [set of calculations] shows that for a five degree slope L_w is longer than over a nearly horizontal bottom, but L_b is shorter, as I proposed in my paper". All of this detail does not address the point that it is an error in physical reasoning to claim that the reason that L_b is shorter on steeper slopes has something to do with the location of the next seaward wave crest or bottom friction. L_b is a local quantity (dependent on H_b, d_b, T_w, as given by LR08), and the fundamental reason why L_b ends up being a smaller value on a steeper slope in the calculations of LR07 and LR08 is because the chosen breaking criterion, Eq. (25), forces the waves to break in a shallower water depth when the bottom slope is steeper. We leave it to the reader to evaluate all other claims made in LR07 and LR08.

References

Haller, M.C., Catalan, P.A., 2008. Discussion of "A simple method to determine breaker height and depth for different deepwater wave height/length ratios and sea floor slopes", by J.P. Le Roux [Coastal Engineering 54 (2007) 271–277]. Coast. Eng. 55, 181–184.

Le Roux, J.P., 2007. A simple method to determine breaker height and depth for different deepwater wave height/length ratios and sea floor slopes. Coast. Eng. 54, 271–277.

Le Roux, J.P., 2008. A simple method to determine breaker height and depth for different deepwater wave height/length ratios and sea floor slopes—reply to discussion by M.C. Haller and P.C. Catalan. Coast. Eng. 55, 185–188.