JOURNAL OF COASTAL AND HYDRAULIC STRUCTURES

Review and rebuttal of the paper

Standing wave impacts on vertical hydraulic structures with overhangs for varying wave fields and configurations

De Almeida and Hofland

Editor handling the paper: Jeremy Bricker

The reviewers remain anonymous.

Second review round

Answer to reviewers - Manuscript JCHS_2021_5965 – Second round of review

Once again, we would like to thank the reviewers for their time and the constructive comments on the article. The outline of the changes made is presented below and highlighted on the attached manuscript PDF with changes, named as document #2. **The line numbers below refer to the new changes tracking document #2.**

Answer to comments from Reviewer A: Comment 0:	Answer to Comment 0:
I appreciate that my previous comments have been addressed carefully. In particular, this revision has made it easier to understand the connection among various experiments. There are some figures that are still not easy to understand. I think it would be better to improve them a little more, such as:	*Thanks again for your review and comments. Your last comments have been addressed as described in the rows below.*
Comment 1:	Answer to Comment 1:
Figures 8 & 10: There seems to be a big scattering between the experimental approximation line and the plots. It's also not clear which line (the second order polynomial fit) represents which plot. Better to add the legends. Or it may be easier to understand even without quadratic polynomial fitting. Anyway the plot should be a bit larger.	*Thanks for this comment. The second order polynomial fits shown in Figures 8 and 10 have been described in the text, see Lines 317-319 regarding Figure 8 and Lines 341-343 regarding Figure 10. Also, the size of all the figures in the manuscript was increased as suggested by the reviewer.*
Comment 2:	Answer to Comment 2:
Figure 20: The three different plots overlap and are not clear. It would be easier to understand if one type of plot was placed on one figure and the three figures were placed separately.	*Also thanks for this second comment. Following your feedback, Figure 20 has been divided into two figures, one for the shorter overhang and another one for the longer overhang (see also Lines 524-526).*

Answer to reviewers - Manuscript JCHS_2021_5965 – Second round of review

Once again, we would like to thank the reviewers for their time and the constructive comments on the article. The outline of the changes made is presented below and highlighted on the attached manuscript PDF with changes, named as document #2. **The line numbers below refer to the new changes tracking document #2.**

Answer to comments from Reviewer B: Comment 1:	Answer to Comment 1:
Thank you for your dilligent revisions - most of the comments of the reviewer have been addressed favourably with one exception (see previous comment 17 and your reply). The reviewer has asked for a clear section/pragraph indicating the scope (boundaries) and limitations of the current study. Your reply to comment 17 was only partial so the reviewer urges the authors to please include this aspect in their manuscript.	*Thanks once more for your comment. This remark has been addressed in the new version of this manuscript, see first the modified text in Lines 76-102. There, the use of the literature related to previous comment 17 is addressed, followed by a more clear description of the scope of the study. Furthermore, a new text is added to the conclusions in Lines 581-587 addressing the boundaries and limitations of this study.*

First review round

Answer to reviewers - Manuscript JCHS_2021_5965

First of all, we would like to thank the reviewers for their time and the constructive comments and recommendations on the article. The outline of the changes made is presented below and highlighted on the attached manuscript PDF with changes, named as document #2. **The line numbers below refer to the new changes tracking document #2.**

Answer to questions/comments from Reviewer A

Comment 0:
I think this is a practically important study that starts from actual necessity. Many experiments have been conducted and the experimental outputs are very valuable. To be honest, however, it was difficult to understand the flow of the paper. This paper looks like a short version of a student's thesis. Many experiments were conducted with various conditions; e.g. regular and irregular waves, the shape of the cantilever, the shape of the entrance, the ventilation gaps, and so on (mixture of various experiments). The results are compared in a non-dimensionalized form. However, it is not very clear what the important results are. The reviewer got an impression from this paper that the experiments were done somehow randomly. It is also not sure whether the non-dimension form adopted by the authors is really optimal among many other possible forms. The structure and text should be revised so that readers can understand the primary objectives and results more readily.
First of all, we would like to deeply thank the reviewer for all the comments and suggestions. They have been considered and incorporated in the reviewed manuscript. Following your comments, the whole text and the structure of the manuscript have been adjusted in order to make it more clear and easy to follow. Thus, we would like to thank your contribution to improving the quality and the clarity of this study. Hereafter we address in detail the different comments:
Comment 1:
The sub-sections (e.g. 1.1 and 1.2) placed in Introduction look like a student thesis, not usual style of an academic paper. Better to incorporate them into the main section.
Thanks for the comment, this has been modified in the manuscript.
Comment 2:
L15-16: What specific predictions does the renovation project have for sea level rise?
According to the latest available data, the sea level forecasts for the Dutch Wadden Sea are the following up to 2100: +0.60 m (absolute), +0.70 m (relative). Nevertheless, for the precise case of the standing wave impacts, this sea level rise would lead to lower impact loads, as these wave impact loads are maximum for zero freeboard (i.e. water level at the same height of the overhang). For this reason, the designs for such structures for standing wave impacts are made considering current sea levels for wave impacts as the most unfavourable conditions, with design water levels around the level of the overhang. For this reason, the sea level predictions were not added to the manuscript
Comment 3:
1: Equations rarely appear in Introduction. Delete it or move to Section 2.
Thanks for the comment, we have moved the equation to Section 2.
Comment 4:
Why is it non-dimensionalized by the cantilever distance W? If the pressure and impulse act on the vertical wall, why are they not dimensionless with respect to the water depth?
Thanks for the question. The cantilever length W is used for making the model dimensionless because that is the length where the wave impact takes place. In other words, that is the length over which the water surface impacts the overhang. A short sentence about this has been added to the manuscript, see Lines 118-119. Furthermore, from the analytical solutions of the pressure-impulse theory, it appears that for short overhangs the maximum pressure-impulse (P) at the overhang varies with W. Hence it is the most logical parameter to scale P. In the scaling of the force-impulse (I) indeed also the gate height h could have been used, but as the force-impulse is a function of the ratio of h/W, both definitions are possible. So again, the overhang length W was considered as scaling magnitude.
Comment 5:
L146-147: I can't really understand the meaning of this sentence. Why does the velocity based on the linear theory and measurements fully agree?
Thanks for the remark and the question. This sentence has been modified in the manuscript, see Lines 165-167. In a previous study, the impact velocity has been studied in more detail, and the wave surface position/velocity measured in the laboratory was in agreement with the theoretical estimations with this method considering cr=1.
Comment 6:

8: An explanation is required for why the freeboard Rc is related to flow velocity.
In this case, this equation describes the wave surface impact velocity, thus at the instant when the wave surface hits the overhang. The maximum wave surface velocity takes place at the water level, so the maximum impact velocity will be observed for the conditions with zero freeboard. For growing freeboards, the velocity will be smaller at the moment of impacting the overhang. For freeboards larger than the wave height, this type of wave impact would not take place, To clarify this we added the word 'surface' to 'wave surface velocity' in the sentence above the equation, see Line 168.
Comment 7:
L151: It suddenly starts with an explanation of the Rayleigh distribution. More background explanation is needed.
Thanks for the comment, this has been extended in the manuscript, see Lines 171-173.
Comment 8:
Sec 3.2: Why did you need so many experimental cases? The more experimental data, the more reliable it is. However, if it is not used in a truly meaningful way, it makes it difficult to understand true phenomenon. Please explain why such so many experimental cases were required.
Thanks for this question and comment. This has been addressed in the manuscript in several parts. The description of the tests was made more clear in the text in Section 3 and Table 1. Also, the reason for the carrying the different tests were described in more detail in Lines 184-187.
Comment 9:
I wonder why the decimal point is the exactly same for both regular and irregular waves (e.g. 0.06, 0.08, 0.10 m, 1.3, 1.6, 2.0 s).
Thanks for the remark. Those were the input values for the wave generation (i.e. not measured values) that were used for both regular and irregular waves. Thus, these values were renamed as "target wave conditions" when described in the manuscript (i.e. Table A1 in the Annexes).
Comment 10:
L202, Fig.6: Although it was measured at 20 kHz, the change in Fig. 6 looks relatively smooth. It is necessary to explain what kind of filter was applied.
Thanks for the remark. This was addressed in the manuscript, as the filter used in the study for calculating impulses (low-pass third order Butterworth filter with cut-off frequency of 100 Hz) is described in the text, see Lines 248-250. This filter has been used as it allows to remove higher frequency components from the signal but it is sufficiently large to not affect the impulse measurements and the conclusions from this study. For calculating pressures and forces, the original non-filtered signal was used.
Comment 11:
7: The effect of water depth d is not apparent in this figure. It would be better to add a figure with the vertical axis non-dimensionalized by the water depth next to this figure.
Thanks for the remark, as it is an interesting one. Indeed, the effect of the water depth is not very apparent in this graph. More precisely, the water level does not have any significant effect in this case. Thus, the figure has been modified, removing the colours for the differences in water depth.
Comment 12:
Fig 8(a): Why is there so much variability in rBS cases?
The large variability in the peak pressures in rBS is explained by the larger presence of entrapped air during the wave impacts. Thus, during such wave impacts, there is a large air pocket below the overhang, which breaks down in smaller bubbles and leads to different load curves in each section along the width. Pressure sensors near a larger air bubble would measure longer and shorter impacts, while pressure sensors further from the air bubbles would measure shorter and higher impacts. Thus, a larger variability is found along the width. On the other hand, tests with no air pockets (e.g. rCS) show a more constant loading behaviour over the width, as at any position along the width the pressure sensors observe a more constant short and high pressure peak. A sentence was added on this, see Lines 358-360.
Comment 13:
Fig 8(b): Why is there so much variability in rAL cases?

In the case of the pressure-impulses, the same explanation holds. Nevertheless, the variations in pressure-impulses are much lower (-5% to 5% in comparison to 0-80% in the case of pressure peaks). And in the case of rAL a very large air bubble is present during the wave impact. The outlier that does not follow this explanation is rEL (low pressure peak variability and larger pressure-impulse variability). This is explained by the fact that this test (rEL) has a double peak impact. Thus, the first impact is a very constant short impact without air (thus, low pressure peak variability) while the second is a more variable one that leads to a larger variation of the total pressure-impulse.

Comment 14:

L309: Is the section on "lateral constriction" really necessary? It seem too specific.

L331: Is the section on "ventilation gaps" really necessary? It seem too specific.

Thanks for the comment, and this comment has been addressed in the new manuscript. The two sections have been merged into a combined section on the influence of variations to the standard configuration. The following text has been added in Lines 365-371: "Flood gates often consist of a series of gates that are bordered by pylons or similar lateral constrictions (e.g. Eastern Scheldt, Afsluitdijk, Haringvliet, Fudai or Pont-vannes du Millac). Consequently, those lateral constrictions represent an additional and often-occurring complication in the design of such flood gates. Also, ventilation gaps are present in front of vertical flood gates (e.g. Afsluitdijk), leading to the reduction of wave impact loads. Thus, these two variations of the standard configurations are studied in this section, given their importance for the design of such flood gates. Furthermore, these results also aim to highlight the applicability of the proposed loading prediction expressions to more realistic structural configurations."

This added text and the other modifications highlight the relevance of the constriction/gaps results for this paper and to the design of such structures. Thus, the authors propose to maintain them in this revised form.

Answer to questions/comments from Reviewer B

Comment 0:

The manuscript presents a comprehensive physical study about wave impacts on the scaled model which includes a variety of several experimental parameters: regular/irregular waves, presence of shorter/longer overhangs, ventilation gaps and so on. The authors have presented detailed results and discussions about the effects of these factors on the impacting loadings, mainly the pressure and calculated pressure impulse. I suggest improving the writing, use proper words, adversative conjunctions, and different sentence modes to get the paper well structured. Also, consider what kind of sentence pattern can describe the logics better, i.e. SOV, such as *this study uses…, this study analyses…* For the preliminary loading estimation on practical hydraulic structures, the author do have a significant element of novelty in the form of proposed loading prediction formula which was calibrated by the experimental data. I would suggest the acceptance of this paper, with comments as follows.

The authors would like to thank the reviewer for all its comments and suggestions. This was very important to clarify and improve the work presented in this study so, again, thanks for your time and effort. Hereafter all individual comments are addressed in more detail.

Comment 1:

I would encourage the authors to add informatioon explaining the selection of the employed scale of rhe model and also, add to the Discussion or Conclusion section a paragrah explaining the practical application/impact of the findings?

Thanks for these comments, they were both addressed in the revised manuscript. First, a short text was added on the scaling principles of the laboratory model, see Lines 197-200. Also, a short text was added in the conclusions on the practical implications of this study, see Lines 620-622.

Comment 2:

in figure 17 a, b, c, there are obvious discrepancies between the markers and predicted curves for CS-Rc=0.04m around nwaves=102, could this be explained in the paper?

Thanks for this comment and the question. The largest deviations between the measured and predicted loads are indeed found for the most energetic wave conditions, and is considered to be closely related to the variations in the air entrapment dimensions. This text has been added to the text, in Lines 493-495.

Comment 3:
Re. the negative pressure was recorded for the negative Rc case in figure 5, 6 case: could the pressure sensor measure negative values?
Thanks for the question. Indeed, the negative pressures are observed in Figures 5/6 because they are dynamic pressures, which means the hydrostatic pressure (i.e. the pressure before wave motion starts) has been removed. Thus, for the cases with negative freeboard, the initial water level (i.e. pressure) was higher than at the instant before the wave reaches the structure.
Comment 4:
Structure width *M*=80 cm is first presented in **figure 4**, but not described in the paragraph line 174-179.
Thanks for this comment. A description of M has been added to the text, see Line 207.
Comment 5:
figure 4(a) - I. Waves? Means irregular wave? Assume y starts from center to be consistent with figure 4c,d,e, but in 4a, it seems y starts from the left edge.
Thanks for these comments. The figure was modified accordingly correcting the naming and axis.
Comment 6:
Figure 5, 6 - Re. shorter and longer overhang: it is better to define the shorter and longer in the figure title, such as the ratio to W. What is the meaning of *s*? How was time td measured? Do authors use the same time origin for all cases in figure 5 and 6?
Thanks for the comments, and a few changes were made to these figures. Also, the figure titles were changed and the meaning of s (wave steepness) was described in the text in Line 215. Indeed, td was calculated as described in the text, see Lines 250-253. In Figures 5 and 6 the wave impact start (black dot) is placed at the same position (0.1s) for making easier the comparison between the tests.
Comment 7:
Figure 11, 12, the unit used in 11 is m, while in 12 it is cm - be consistent
Thanks for the comment, this has been modified in the manuscript.
Comment 8:
Line 20, should use "and" instead of “or”
Thanks for the comment, this has been modified in the manuscript, see Line 19.
Comment 9:
Line 19, 20, 21, it feels like “*caused by*” generates too much repetitions.
Thanks for the comment, this has been modified in the manuscript, see Lines 18-19.
Comment 10:
Line 21, 22, then sentence not clear, “*This study focuses on the last type of wave impact, on standing wave impact loading on vertical hydraulic structures with relatively short overhangs*.”
Thanks for the comment, this has been modified in the manuscript, see Lines 20-22.
Comment 11:
Line 24-27, sentence not clear.
Thanks for the comment, this has been modified in the manuscript, see Lines 24-28.
Comment 12:
Line 25, replace *made* by "conducted"?
Thanks for the comment, this has been modified in the manuscript, see Line 25.
Comment 13:
Line 26, *last years* or should be "past years"?
Thanks for the comment, this has been modified in the manuscript, see Line 28.
Comment 14:
Line 27-28, *standing wave impulse wave*? Should this be standing impulsive waves?
Thanks for the comment, this has been modified in the manuscript, see Line 29.
Comment 15:
Line 34, 35, suggest remove *observing*.
Thanks for the comment, this has been modified in the manuscript, see Lines 37-38.
Comment 16:

Line 41, suggest removing *other*
Thanks for the comment, this has been modified in the manuscript, see Line 44.
Comment 17:
Line 45-54, for the cited literature, those should clearly indicate their connection to your research, and what has been achieved in the past, what are the current the limitation and scope of the study.
Thanks for the comment. Following your comment, this paragraph has been reduced, limiting it to the previous work fully related to standing wave impacts on vertical structures with overhangs. Nevertheless, that cited literature was moved to Lines 86-89, as it gives an additional context on the study of similar impulsive wave impact problems on other types of structures.
Comment 18:
Line 68-70, sentence not clear, suggest rewriting
Thanks for the comment, this has been modified in the manuscript, see Lines 72-76.
Comment 19:
Line 85, suggest removing *the use of the*
Thanks for the comment, this has been modified in the manuscript, see Line 96.
Comment 20:
Line 98. Suggest improving the sentence .
Thanks for the comment, this has been modified in the manuscript, see Lines 109-110.
Comment 21:
Line 104, add "by" after *obtained*
Thanks for the comment, this has been modified in the manuscript, see Line 117.
Comment 22:
Line105, *making* → converting?
Thanks for the comment, the sentence has been modified in the manuscript, see Lines 120-122.
Comment 23:
Line 107, *conversion* → converted?
Thanks for the comment, the sentence has been modified in the manuscript, see Lines 122-124.
Comment 24:
Line 106-109, sentence not clear, please improve.
Thanks for the comment, this has been modified in the manuscript, see Lines 122-126.
Comment 25:
Line 116, *from* → by?
Thanks for the comment, this has been modified in the manuscript, see Line 133.
Comment 26:
Line 118, move *total* before *theoretical*?
Thanks for the comment, this has been modified in the manuscript, see Line 135.
Comment 27:
Line 126-127, sentence not clear.
Thanks for the comment, this has been modified in the manuscript, see Lines 143-145.
Comment 28:
Line 129, *described* → adopted?
Thanks for the comment, this has been modified in the manuscript, see Line 147.
Comment 29:
Line 139-141, *at the wall* seemed repetitive, as the situation has been stated in line 136.
Thanks for the comment, this has been modified in the manuscript, see Lines 157-158.
Comment 30:
Line 160-161, sentence not clear.
Thanks for the comment, this has been modified in the manuscript, see Lines 184-186.
Comment 31:
Line 179, what are the values of x1, x2, x3 - more detailed explanation should be added.
Thanks for the comment, this has been modified in the manuscript, see table A1.

Comment 32:
Line 180, *50 regular waves*? Not clear
Thanks for the comment, this has been modified in the manuscript, see table A1.
Comment 33:
Line 195, *obtained* → measured? Which physical property was measured? Wave height?
Thanks for the comment, this has been modified in the manuscript, see Line 234.
Comment 34:
Line 202, *these pressure* → dynamic pressure?
Thanks for the comment, this has been modified in the manuscript, see Line 244.
Comment 35:
Line 266-267, 268-269, sentence not clear, should be: *a limited variation in ** case*?
Thanks for the comment, this has been modified in the manuscript, see Lines 315-319.
Comment 36:
Line , better to clarify the I1%
Thanks for the comment, this has been modified in the manuscript, see Lines 468-469.
Comment 37:
Also, clarify the 1000 waves, 5000 waves, etc
Thanks for the comment, this has been modified in the manuscript, see Lines 421-422.
Comment 38:
Line 338-339, repetitive *measured*
Thanks for the comment, this has been modified in the manuscript, see Line 402.
Comment 39:
Line 389, the clear difference → clear difference?
Thanks for the comment, this has been modified in the manuscript, see Lines 455-457.
Comment 40:
Line 474, suggest changing the sentence pattern
Thanks for the comment, this has been modified in the manuscript, see Lines 545-548.