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Review and rebuttal of the paper

Evaluation and validation of the spectral linear wave theory and ‘traditional’ formulae for pulsating wave loads for unimodal and bimodal seas

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Editor handling the paper: Rebekka Kopmann

Author's response to comments on manuscript JCHS-6538

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This document presents the reaction of the author of the manuscript JCHS-6538 on the remarks of reviewer A and B. A reaction on the remarks has been formulated in Table 1 and Table 2.

Table 1 Remarks of reviewer A

Remark of Reviewer A	**Author's response**
[R.01] P.1 • L.35-36 // This reference as is, is vague. Unless an actual citation was removed in order to safeguard the double-blind review process, the authors should consider revising this sentence.	**[R.01] P.1 • L.39-40 //** References have been added. The references refer to appendices of reports belonging to design and construct contracts of sea locks (Terneuzen and Ijmuiden) and a project awarded by the Belgium government to Arcadis. The documents are not available for third parties and therefore no reference was added.
[R.02] P.5 • L.1-3 // Please review phrasing, especially that of the second sentence.	**[R.02] P5 • L.33-36 //** Done. This outline section now reads: "The paper is structured as follows: Section 2 formulates the Spectral LWT. Section 3 presents the conducted experiments used to validate the spectral LWT. Section 4 presents the validation of the Spectral LWT and a comparison of the general wave formulae to the experimental results. Section 5 presents the results and discussion. Section 6 presents the conclusions."
[R.03] Section 2 // I always appreciate essential aspects of the theoretical background to be presented within a paper. In the way the argument in P5 • L.5-8 is phrased, though, one might wonder about the need of "repeating" the description of Spectral LWT to be found in Mulder (1980). Consider rephrasing and/or revising.	**[R.03] P.5 • L.38 - 43 //** The introduction has been changed. Sentence below has been added: *"The formulae are not widely known. For convenience and readability of this paper, the formulae are presented and explained in more detail in this section."*
[R.04] P.7 • Fig.3 // The authors should better justify the need for the right panel of this figure, given how force response is represented.	**P.8 • L.3 //** **P.8 • L.15 //** Rewritten to improve readability. The figure is split between two new figures. The first figure presents the response below SWL, the other only above SWL.

[R.05] P.8 • L.25-26 // The authors should elaborate on the specifics of this 20kHz-to1000Hz down-sampling of their dataset. As is, this statement might lead to ambiguity among the readers.	**P.9 • L.25-30 //** First section has been rewritten to point out the reason for down sampling of the dataset. In short: - De Almeida used a 20kHz sampling frequency for the investigation of impulsive short duration wave loads. 20kHz is required due to the short character (milliseconds)of impulsive loads.

Remark of Reviewer A	**Author's response**
	- For pulsating loads, a less high sampling frequency is sufficient detailed to investigate the pressure profiles. - The downsampled signal was obtained during the measurement process, by keeping only 1 sample out of 20. The signal was downsampled after a low-pass filter with cut-off at 500Hz was applied. - We do not expect any aliasing problems as energy above 500Hz cutoff was neglitible.
[R.06] P.11 • L.4-6 & Fig.6 // Could the authors elaborate on the validity of the statement *"...gives a higher contribution of low frequency wave variance density to the wave force variance density compared to a same amount of wave variance density at higher frequencies."* considering the results for Experiments 4 and 5?	**P.12 //** Extra text and a table showing the ratio between wave variance density and force variance density have been added to improve the validity of the statement.
[R.07] P.14-15 • L.5-9 & Table 2 & Fig.9 // The authors should elaborate on the rationale behind presenting/analysing together the results for P1/3 and P5%.	**P.14 • L.5-11 //** Added in paper: *The significant wave height Hs is a commonly used variable, therefore the F1/3 from the timeseries has been assessed as reference. Due to the duration of the experiments little data is obtained for the 'extreme' values of wave forces. Therefore, F5% is used as a representative 'high' force.*
[R.08] P.22 • L.10 // "depends" is probably a typo; "dependent" maybe?	**P.24 • L.20 //** Corrected

Based on clearly-set assumptions and the limitations mentioned above, the authors do a good and thorough job in analysing their results and discussing the comparative performance of all tested approaches. Nevertheless, I believe that there is an issue worthy of further discussion when it comes - particularly - t o the comparisons with the Goda formula. Following the rationale behind the Goda formula (Goda, 2000; Sections 4.2 and 4.3), one can see that the author has a clear focus on the modes of major failure of vertical breakwaters. Along pressures p1, p2, p3 and pu (and the many empirical factors they include) he always refers to and/or calculates: (a) total forces and (b) total moments around the bottom of the upright section. These are essential to the two main modes of failure typically tested by coastal engineers, i.e. sliding and overturning, and of course depend on the geometric characteristics of the structure (total height, below and above SWL, and width).	**General //** The text in section 1 has been rewritten to emphasize the goal of the research which is the validation of pressure profiles below SWL for unimodal and bimodal seas and the total force not only for design sea states (low values of kh like valid for Goda) but also for higher values of kh. For the design of hydraulic structures (lock gates, weirs, barriers, drive mechanism), which is the main aim and background for the present paper, the pressure profile dominates the loads on steel parts, drive mechanism, gate supports, etc. A conservative global estimation of the force is not sufficient. Furthermore, during gate mission (opening and closing) deep water conditions are often present. However, the goal of Godas formula is to formulate a maximum force for global stability for high waves at limited depth (low values of $k_p h$) and is
Remark of Reviewer A	**Author's response**
Furthermore, the performance of the pressure formulae is evaluated on the basis of how well the safety factors against sliding and overturning (calculated using it) compare to actual vertical breakwaters, with the author's notes on observed discrepancies. Some of the implications of the issue raised in the previous paragraph are, understandably, beyond the scope of this work. The ones that are not, though, merit some discussion and a more clear presentation in text. Some insights on the eventual role structure geometry might play on such comparisons would be useful, along with a somewhat more detailed discussion of the presented approache's strengths and limitations. These, considering: (a) how pressures/forces above SWL are treated in this work, and (b) that the version of the Goda formula used in this work (by Paprota, 2021) only describes the case of regular headon waves reflecting at a vertical wall. *[Goda, Y., 2000. Random seas and design of maritime structures. 2nd edition. World scientific]*	therefore less applicable for the design of hydraulic structures. The limitation is also discussed in section 6 to point out the relevance of pressure profiles for hydraulic structures.

[R.10] Manuscript Structure* // The presence of many - relatively short - sub-sections might compartmentalize one's work, but at the same time it removes from the text (even in technical scientific writing) the feel that the authors build arguments towards their theses. Section 1 is a good example of what I am referring to. Are all subsections in this work considered to be essential (especially 3rd level ones)? **Understanding that this remark is related to writing-style preferences (and these do vary), the authors should consider it more of a suggestion than a remark that has to be addressed during the review process.*	**General //** Thanks for the feedback and good point. The text has been partially rewritten and the 3rd level of subsection has been removed to improve the structure and readability.

Table 2 Remarks of reviewer B

Remark of Reviewer B	Author's response
1. Although the English are in general OK, there are several corrections to be made; only some and not all of them are indicated directly on the pdf file of the manuscript.	The corrections made in the pdf file have been processed in the new word version. An extra second reader check for the use of English has been executed.
2. Equation (2) does not correspond to the widely-used Goda equation as included in the CEM and used in the design of breakwaters. The authors should use the	**P.3 • L.32-40, introduction, conclusion//** Goda formulae as presented in Goda 2010 have been applied as mentioned in the new version of the paper.
Goda equation in the CEM for their comparisons throughout the manuscript.	The author wants to note that the full set of formulae for the evaluation of p_1 reduces to equation 2 as presented in the paper. The alpha factors a_2 and a_3 become zero and are not relevant for normally incident waves and a horizontal bed without berm. a_1 becomes equal to 0.6 as given in equation 1. In many projects in which I was involved designers of steel structures thought, 'goda is conservative because you have an alpha for wave impact without looking at the values of a_2 and a_3. In this section I would like to make designers clear that this is not the case for hydraulic structures placed on a horizontal bed. Text has been added to lines … to make this more explicit. And the reference to a paper where this simplification is introduced is presented.
3. Page 5, line 29. The sentence "The pressure response at the bottom decreases to zero." is not clear what it means.	**P.6 • L.17-26 //** A more elaborated description of the pressure response had been added in the new version:

4. Page 7, lines 15-17. It should be mentioned that it is assumed r=1 for the results in Fig. 3.	**P.3 • L.3 //** **P.8 • L.15 //** Added in subscript of figure 3 and 4.
5. Page 12, line 8. What is the meaning of "student 1 distribution"?	**P.13 • L.11 //** The student t distribution can be used to give the confidence band of the mean value from a set of measured data points, that have an (assumed) unknown normal distribution. A reference to the literature of the student's t distribution is added.
6. Figure 8. Why the authors did not use the Seinflou equation as well?	**Figure 9 and full document //** Sainflou is not often used in engineering. Due to the background of the author (civil engineer hydraulic structures) the formula was not included in the paper. Sainflou has been added in figure 8 and other figures in the new version.
7. Page 13, line7. The authors should mention which kh value they used in the Goda equation.	**P.14 • L.11 //** Added in section 4.3 first paragraph. Kh ranges between 1.2 and 2.4
8. Section 4.3. This section needs to be rewritten providing better explanation of its objective and description of the results.	**Section 4.6 //** An introduction to this section has been added to the text. Section 4.3 of the old version is now section 4.6. In short: the validation of the probability distribution of wave forces has been made to validate the conclusions of Guedes Soares for bimodal sea states.