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Review and rebuttal of the paper

Experimental study on a breaking-enforcing floating breakwater

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Editor handling the paper: Eva Loukogeorgaki

The reviewers remain anonymous.

Reviewer A:

In the present paper the authors are presenting an experimental study of a novel floating breakwater type that was developed to have good attenuation performance while keeping wave drift loads at a reasonable level. Tests have been conducted in a 3D shallow-water wave basin in captive and moored setups for regular and irregular wave conditions. Attenuation performance, motions, and (mooring) loads results have been presented. The paper is well written, easy to read and follow, and original. The paper worths publication after its revision. The largest drwback of the paper is the uncertainty related to the physical model and its properties when tests performed; the increase of the weight for 6% during experiments (water absorption) generates huge uncertainty about the corectness of the results as well as about if those data can be used by rest researchers. Below are suggestions to the authors in order they to improve the paper.

We are grateful to the reviewer for the constructive feedback on the submitted manuscript. A detailed response on the specific points raised by the reviewer is provided below. - Sections 5 and 6 are complete to my view and there is no need for further improvement.

- It will be nice if you can add the decay curves performed for the calculation of the natural frequencies.

Figure R1 below presents the measured motions during the decay tests that were used to establish the damping values in Table 3 of the manuscript. A decay function that assumes linear and quadratic damping contributions was fitted through the measured motions based on a least square fitting approach. Good agreement between the decay fit and the measured motion is observed, which justifies the adopted approach.

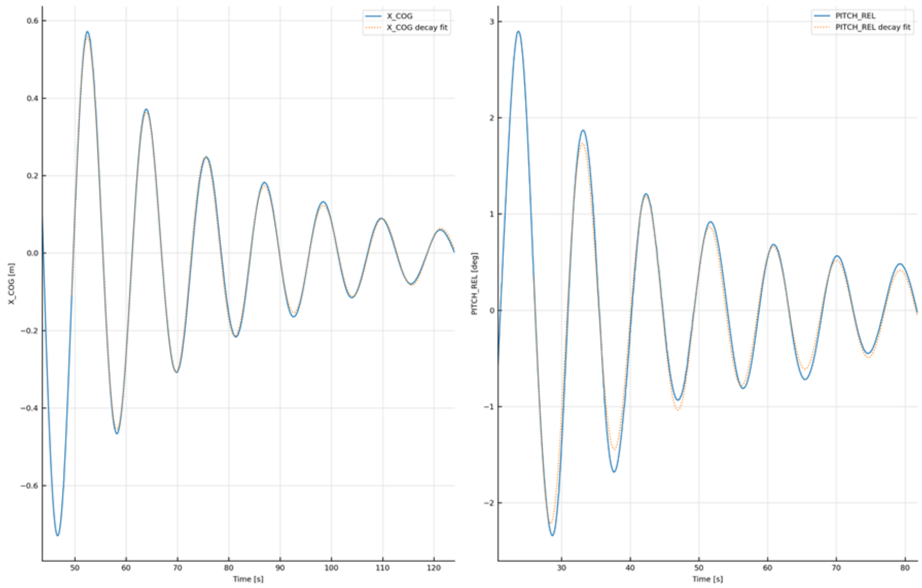

Figure R1: Results of motion decay tests in surge (left) and pitch (right) directions: measured (blue solid) and decay fit (orange dashed).

We aim to restrict the paper to the key findings (figures and tables) of the study. For brevity, we decided not to include these decay fits in the manuscript.

- Please inform if all downscaling of the properties (most of quantities are presented in Table 1) made according to the Froude laws.

Thanks for the suggestion. The scaling approach was explained in Section 3.2.1, but an additional clarifying comment was added to the caption of Table 1.

- The authors used three models and instrumented only the one. This should be emphasized in the paper. the possible hydrodynamic interaction between the three models should be numericaly reported. Did you perform tests only with one model? (If yes, please provide the data and compare with the already presented data).

We agree that the hydrodynamic interaction between the three models has implications for the results. Unfortunately, no tests were performed with only one model in the basin. We therefore analysed the hydrodynamic interactions numerically through wave diffraction calculations involving a single floater and involving three floaters (copying the basin set-up).

Figure R2 presents the measured and calculated motion RAOs. The solid gray and dashed black lines mark the numerical calculations for a single floater and a 3-body numerical set-up, respectively. These two approaches result in generally similar motion RAOs. Only in heave direction, for low wave frequencies ($L_f/L_{wave} < 0.6$), clear differences are observed between the both numerical approaches. The mores spiky behaviour for the 3-body calculations relates to the hydrodynamic interaction between models. Note that this behaviour is also observed in the experiments (see blue line in center panel).

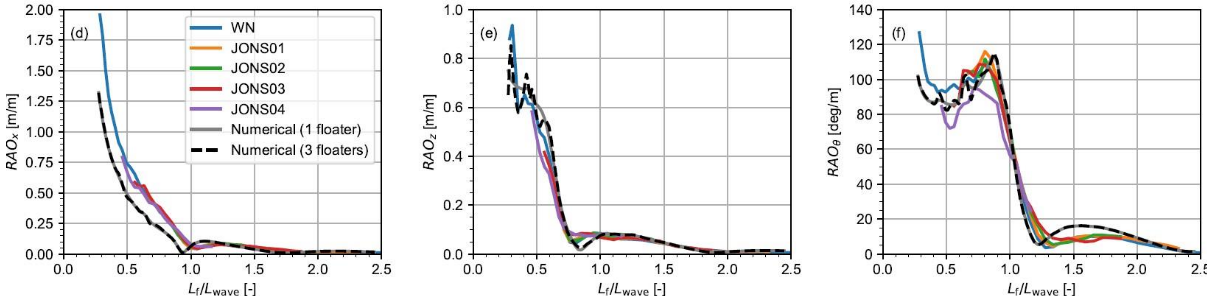

Figure R2: measured and calculated motion RAOs in surge (left), heave (center), and pitch (right) directions. Distinction is made between calculations for a single floater (solid gray line) and for 3 floaters (black dashed line).

The hydrodynamic interaction was further explored in terms of the wave field around the breakwater(s). Figure R3 presents a comparison between the numerically calculated wave field for a single-body (top panels) and 3-body set-up (bottom panels). The wave field is largely similar, though notable differences can locally be observed. Specifically, more nodes and anti-nodes are observed for the 3-body calculations.

In the manuscript, Figures 5 and 7 have been updated and now include the results for both the single body and the 3-body numerical calculations to show the effect of the hydrodynamic interaction to the readers. In addition, Figure 8 was updated with the results for a 3-body setup. Any clarifying remarks in the manuscript were updated in line with these revised figures.

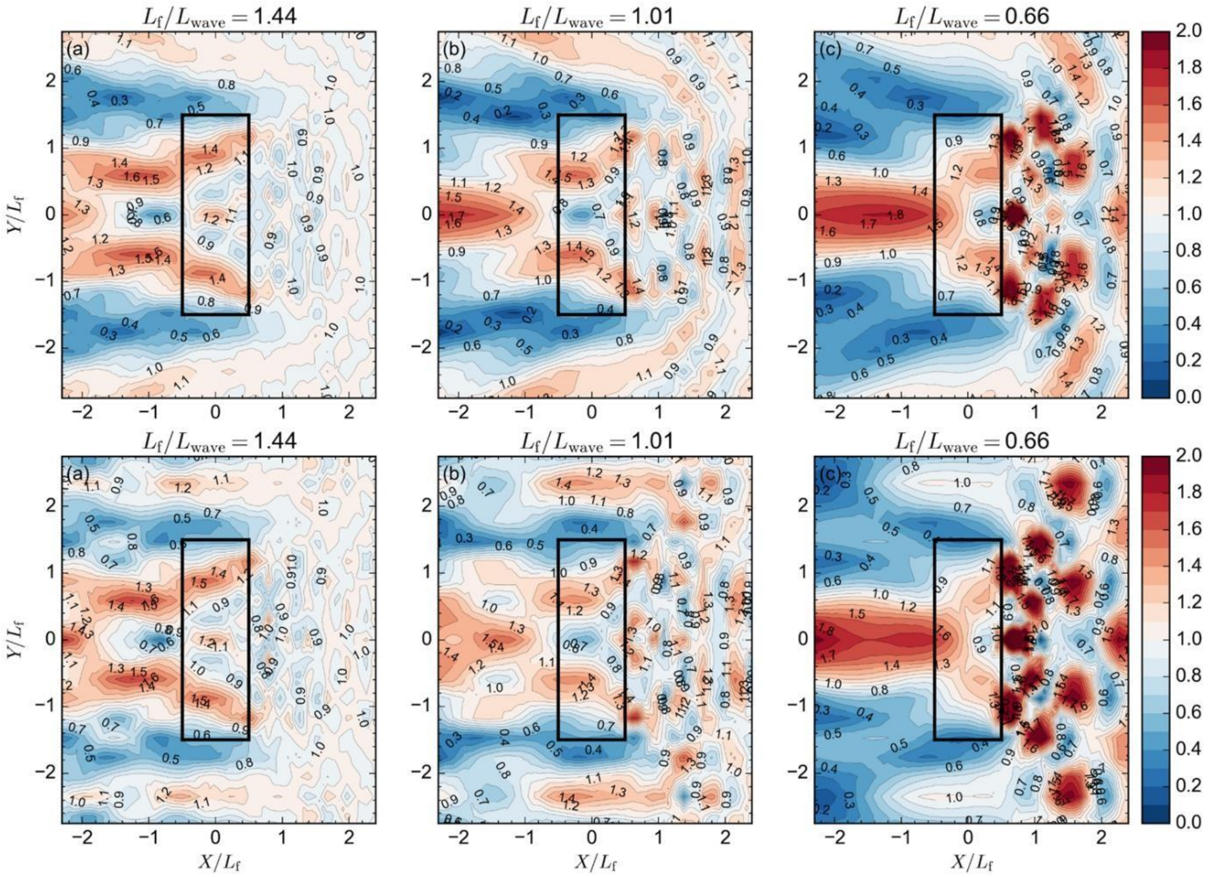

Figure R3: colour contour of normalized wave amplitude around the captive breakwater. Top: calculations for a single floater; bottom: calculations for three floaters.

- Why the draft between the captive and moored setup is different (provide calculations as far as the 6% increase of the mass due to water absorption?

The mooring configuration and pretensions were designed and calculated based on the measured mass of the floater prior to the experiments (m = 134 kg). During the basin tests, the model was first tested in a captive set-up at a draft T = 0.176 m. Next, the mooring lines were added and the pretension was calibrated with the model still in captive set-up and at T = 0.176 m. Upon releasing the model from the captive frame, it was observed that the draft increased by 11 mm to T = 0.187 m. It was decided to accept this difference in draft between captive and moored set-ups, whilst carefully documenting the results.

The model mass was measured prior to the tests (m = 134 kg) and directly after the model tests (m = 139 kg). This corresponds to an increase in weight of 50 N. Combined with the heave stiffness of 5.5 kN/m, this increase in weight corresponds to a draft increase of 9 mm, which is very close to the measured increase in draft (11 mm). The increase in model mass is included in the revised manuscript (Section 3.2.2).

- The authors should check the hydroelasticity of the model (was the model rigid enough during tests or the floater had oscillations due to theor eigenmodes). Authors should provide eplanations on this and calculations related (dry and wet) eigenvalues.

The measured frequency corresponding to the first bending mode of the floater was 3.6 Hz at model scale (underwater). In order to check whether the natural frequency affects the motion response, the measured accelerations during the tests in waves were explored in more detail. Figure R4 presents the measured accelerations. It follows that the variance in accelerations is dominated by the wave frequency excitation and response (97.5% of the variance) while the energy at the first bending mode is minor (2.5% of the total variance in acceleration).

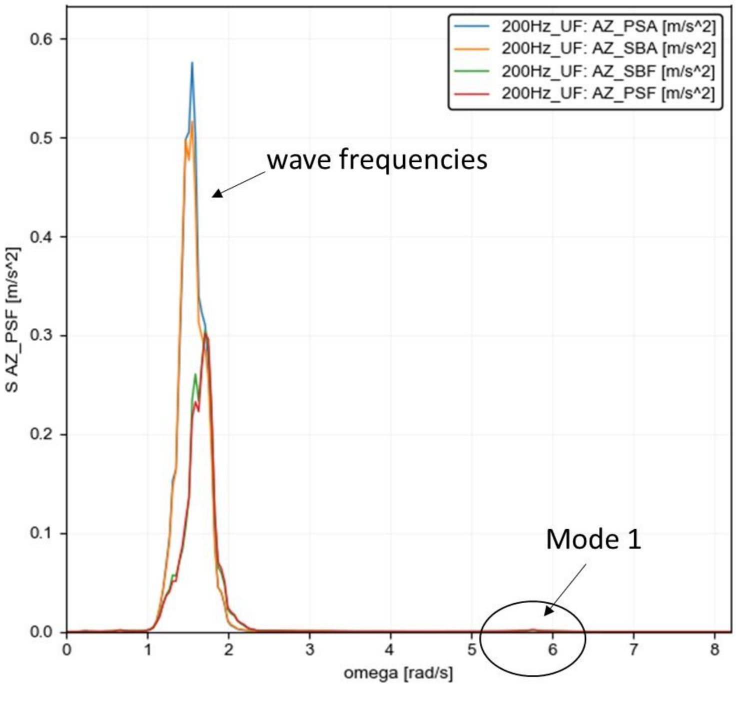

Figure R4: Measured vertical accelerations at four corners of the floater during a test in moored set-up. Note that the presented values correspond to a prototype scale 1:15.

The revised manuscript includes a better explanation of the material properties and a concise paragraph on the floater's natural frequency and its implication for the test results (Section 3.2.2).

- Water absorption peoblem is huge. Maybe someone can just say that experiments failed and all presented data should not be published. The authors should try to provide reasons for water absorption and redo some tests or check the physical model.

A detailed response to the water absorption issue was provided in response to an earlier comment (see above). In terms of quality control checks, the floater mass before and after the tests was logged and compared (see also above).

- Was the water absorbed at the beginning of the tests when the floater just submerged in the water or the absorption of water made in different time instances that are unkonown. This gives larger amount of uncertainty. The aithors should try to provide all those information.

  The floater draft was logged throughout the tests in moored set-up. At the end of these series of tests, the floater draft in still water equilibrium had approximately the same draft (1 mm difference) as at the start of the moored set-up tests. This indicates that the floater draft was approximately constant throughout the moored set-up tests. Hence, the majority of water absorption occurred during the tests in captive set-up, during which the floater was completely submerged for more than four days.

  This is now also addressed in Section 3.2.4.

- The grass used during experiments should be explained better. Did you use a kind of Froude law for the selection of grass (if yes, this is not correct because viscous damping issues should not be downscaled with Froude laws)? How did you select this value? Is the value reasonable or with the one that you used you produced a very large amount of damping? Please provide the rationality for the grass type not just by responding what you used but by relevant calculations. The daming generated with the use of the grass should be reported (as well as the additional damping and any possible hydrodynamic interaction).

  We agree that geometric scaling is not adequate for the roughness layer. Instead, the material was selected based on the wave conditions, targeting a hydraulically “very rough” flow regime following Jonsson’s (1980) classification.

  Note that the purpose of the grass cover is not to accurately represent an actual vegetation or shellfish species at basin scale; instead, the aim is to explore at high level to what extent an ecological side-function could improve the breakwater’s performance in terms of wave attenuation and/or motion behaviour. For this objective, we believe that it suffices that the selected roughness leads to a realistic flow regime.

  Our findings suggest that an enhanced roughness does not affect the breakwater’s performance but can help reducing the mooring loads. These findings could be followed up by research that explores different ecological side functions in more detail, following a more realistic down-scaling of the roughness layers for specific ecological side-functions/species.

  Additional clarifications on the selection of the grass properties are provided in Section 3.2.2 in the revised manuscript.

- How did you select the 8mm grass type? Please give more information (material, type rest properties). Also do a check if the water absorption happened because of the use of the grass material.

  The revised manuscript lists the used grass cover material (Section 3.2.2).

  Weight measurements of the breakwater with and without grass cover showed that the increase in breakwater weight was explained by an increase in the wooden floater’s mass, with negligible effect of absorption by the grass layer.

Recommendation: Revisions Required

Reviewer B:

This study interestingly presented a new floating/submerged breakwater design and its performance. It has important practical values and the reviwer opined that it can be accepted for publication in JCHS after clarifying the following comments:

We thank the reviewer for the efforts spent on reviewing our initial submission.

1. The material selected for the float is plywood as stated in section 3.2.2 and the overall proto dimension is very large. Have the authors considered its structural strength under the expected wave loads?

This is a good point that was not extensively addressed in the submitted manuscript.

Because the focus of the paper is on the hydrodynamic performance, the structural strength was mainly considered at basin scale. The floater tested in the wave basin was manufactured such that it did not deform under the simulated wave loads. Related to this, the description of material properties and natural frequency of the floater in Section 3.2.2 in the revised manuscript has been updated following a question by Reviewer A.

It is not evident up to which prototype scale the floater can be manufactured in a costeffective way whilst guaranteeing its structural integrity. The Discussion (Section 7) acknowledges that the design leaves room for further improvement beyond the scope of the present study. In the revised manuscript, the Discussion now reflects more extensively on ways to improve the structural integrity by either increasing the floater's depth or reducing its length, and discusses the implications of the altering of these design parameters for the attenuation performance, floater motions, and mooring loads.

2. On the top surface of the float, a parabolic shape is used. What is the desired geometric configuration for the parabola?

The theoretical formulation for the parabola is presented in Eq. (4). However, this theoretical formulation assumes that the parabola starts at waterline, while in the present study the floater was positioned below waterline to prevent large slamming loads due to waterline crossings when moving in waves (see Section 2.3).

Because the parabolic curvature is subtle, it is expected that a submerged plane slope would lead to a similar performance as the present parabolic structure. This is also addressed in the Discussion section.

3. Have the authors considered varying the mooring layout and stiffness to enable float motion to effectively dissipate the wave energy and find the most optimal mooring design?

The mooring stiffness has significant effect on the breakwater's performance, as illustrated by the present comparison between the tests in captive versus moored set-up: the captive tests lead to more intense wave breaking. Hence, we agree that improvements to the mooring layout can help to improve the breakwater performance. However, this was not pursued in the present study.

The results indicate that it's the total breakwater's design (floater and mooring lay-out) that determines its performance. In the Discussion section, we therefore promote a future design improvement following a decision framework that considers both the floater and the mooring aspects of the design.

Recommendation: Revisions Required
