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Interactive comment on "Reliability-based design optimization of offshore wind turbine support structures using analytical sensitivities and factorized uncertainty modeling" *by* Lars Einar S. Stieng and Michael Muskulus

Anonymous Referee #1

Received and published: 23 September 2019

The paper is of high quality, well structured. It demonstrates a methodology for efficient reliability-based optimization of offshore wind turbine support structures (applied to monopile structures), including uncertainty aspects together with the design optimization.

General comments:

The paper is well written with high-qualitative formulations. The paper is also well structured, however, the reviewer suggests to add a paragraph at the end of the introduction

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Discussion paper

section to introduce the structure of the paper.

Specific comments:

- At several points, the gradient-based and gradient-free approaches and differences are discussed. The reviewer suggests to mention directly within the abstract why specifically gradient-based design optimization is addressed and applied within the approach demonstrated in this paper. The benefit of gradient-based methods over gradient-free methods is mentioned just on page 6 (lines 3 and 4) - this should be mentioned already at an earlier point in the paper. Furthermore, the argumentation and presentation of the shortcomings of gradient-based methods, mentioned in lines 12-15 on page 6, brings up again the question why not gradient-free methods are used, if gradient-based methods are faster converging, but might not converge at all or present inaccurate solutions. Thus, the argumentation for the decision to use gradient-based methods in this approach should be clearer and more straightforward.

- In the introduction section (lines 12 and 13 on page 2), the main distinction between robust and reliability-based design optimization is highlighted, however, a short explanation what the differences are is missing.

- Please provide numbers to support your comparisons in the introduction (e.g. for lines 19-21 on page 3).

- Missing details:

o Which finite element tool is used (mentioned in section 3 on page 16)?

o For the constraints of the diameters and thicknesses the specific values (70% and 150%) are mentioned based on manufacturing/transportation/installation constraints as well as simulation constraints. However, 150% * 6m = 9m is no manufacturing/transportation/installation constraint. The constraint for ill-behaved simulations is not defined in more detail. Thus, the reviewer recommends to include a table, presenting the limits for the practical (manufacturing/transportation/installation) and finite

element constraints (simulation feasibility), so that it is clear to the reader where the 70% and 150% bounds come from.

o For the constraints upper bounds on the accumulated 20-year fatigue damage and on the maximum bending moment are mentioned in section 3.2 (lines 11 and 12 on page 18), however, no values or any information on how these bounds are derived are stated.

o For the additional constraints, presented on page 20, equations with further parameters are presented and used. Some values for some parameters are discussed and indicated, however, several values are not specified (e.g. the constants a_i, the used Wöhler exponents w_i, the applied reference thickness t_ref with corresponding thickness correction exponent k, the selected fatigue resistance Delta_F, as well as the constant r for controlling the accuracy of the approximation).

- In section 3.1 on page 17 the models and loads are introduced. However, the author should present more clearly, if the externally calculated loads are determined for each geometry anew. Based on the descriptions in section 3.1 the question arises, what happens with diameter-dependent loads, when the design is changed, especially in the not-connected case, as a tapered structure or a structure with jumps in the diameter has other load effects than a straight cylinder. Based on the descriptions within the example on page 28 (lines 3-5), it seems that the loads are calculated for each geometry investigated within the optimization. This fact should be mentioned clearly in section 3.1.

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