Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2018-43-RC2, 2018

Interactive comment on "Reducing the number of load cases for fatigue damage assessment of offshore wind turbine support structures by a simple severity-based sampling method" *by* Lars Einar S. Stieng and Michael Muskulus

Anonymous Referee #2

Received and published: 10 July 2018

General comments The authors have proposed a method to decrease the number of load cases to be evaluated during fatigue analyses in wind turbine support structures. The method is interesting and could be very useful especially for optimization applications. However, some comments and suggestions are given below with the aim of clarifying the advantages and possible limitations of the method as well as to improve the quality of the document itself.

Specific comments P1. L11-L12. I would suggest rewriting the sentence "The method as is can be used without further modification" because it sounds like the method can-

not be improved and there is always a possibility of improvement. P2. L6-L7. What would be the effect of considering other design situations besides the power production, such as parked conditions? I would suggest adding a short clarification about this. P3. L22. Considering normal stresses means that the damage is estimated assuming under uniaxial stress states. How real is this assumption for these type of structures which are normally subjected to multiaxial stress states? What would be the effect of considering multiaxial stress states in the proposed model?

P3. L26-L27. Do the authors mean: the maximum value of the total damage among the eight points after evaluating all possible load cases? If so, make a clarification.

Regarding Fig. 1-b Does the Normalized fatigue damage correspond to D_k/D_tot ? If so, add clarification in the figure. How was the proportion of total load cases calculated? How Fig. 1-b would look for the different evaluated points along the tower?

P4. L11. What does it mean "small" and "intermediate" values of k? How is that scale defined? P6. L18. How many random seeds were used for each load case in this study? What would be the effect of the number of seeds on the final number of load cases to be evaluated?

P6. L28-L31. Could the authors elaborate more about how was the scaling process of the element sizes carried out? Were the element sizes scaled only once or several times until the optimal solution was found?

P7. L3-L6. The statement "From the distribution shown. . ..." is not clear from Fig. 2-a. In this figure, no wind speeds are shown but load cases, which are not clear either. In addition, how can be proved that the load cases with highest normalized fatigue damage are those having the highest probability of occurrence? Is there any reference or way to show this? What does it mean "Normalized fatigue damage"? If you want to show the level of severity, why are you plotting the normalized fatigue damage instead of severity level? I would suggest explaining better this figure both in the figure itself and in the text.

P8. L10. Regarding the statement “However, this turns out to not be the case.”, is this statement for this specific case or in general? If it were for this specific case, what would be the consequences on the proposed model in those cases when the sampling sets are much larger than the number of load cases at each location? If it were in general, how can you prove this statement?

P8. L14-L16. It would be good to show Fig. 2-b for the three evaluated points. That would provide more veracity to the statement given in this paragraph.

P9. L25-L29. Regarding the statement, “We observe that the method seems to consistently over-predict the fatigue damage. . .” What is the consequence of this? Could there be cases in which the results obtained by the method can lead to under-estimated designs (which are not desirable in any structural design)?

Regarding Figures 3 and 4. If the error can have both negative and positive values, it means that the estimated damage value could be greater than the real damage value. How could be that possible? So, how would you choose the optimal sample set size which makes a balance between the number of loads to evaluate and the final accuracy? Would it be possible to find this value by implementing a simple optimization process? How is the behavior after 180 load cases? It would be good to show more results taking into account that the real number of load cases is larger than 3000. In this way, you could show with more confidence the accuracy of the model.

P9. L6-L7. Regarding the statement, “This in turn makes. . .” What would be a possible solution for this?

P10. L7-L12. Not sure how pertinent is this discussion for the purpose of this paper.

According to this section 3.3., the level of accuracy of the proposed model could decrease considerably when many points in the structure are analyzed since the sample set size could much higher than the number of load cases at each point (i.e. n»k). How could this limitation be controlled? This is especially important when the entire struc-

ture is analyzed under fatigue. Regarding Fig. 5, Add the location of the point along the tower at each plot of the figure. How is the error shown in Figure 5 for a greater number of load cases, e.g. 200, 500, 1000?

Regarding section 4.1, I would suggest analyzing the viability and the limitations of the proposed model in a general point of view instead of focusing only in the evaluated optimization methodologies (i.e. MD5, MD10, etc.). The readers might have other optimization methodologies and it would be useful for them to know when they can implement this method. P12. L10 to P13. L3. Elaborate more on these statements, they are not clear as they are now. P13. L6-L9. This is an honest and significant statement. P13. L19-L23. I do see important to consider in future works the uncertainty related to the chosen number of load cases k and, even more, the one related to the final sample set size n. It would be good to add a diagram summarizing the proposed model. I did not find any comparison or references to previous works during the discussion.

Technical comments P1. L13. Change “a few” for “some” P1. L15-L18. The two first sentences (i.e. “A central practical. . ..” and “In order to assess..”) could be rewritten in a shorter and clearer way. P1. L21. Commission P3. L13-L17. I would suggest deleting this paragraph. This information is not necessary. P3. L19. It is not clear what the authors mean in the first sentence. Rewrite it. P5. L2. “. . ..of some new designs of the same structure, with. . ..”

P6. L5-L7. Write the last sentence of this paragraph also in equations. That would make the idea clearer.

Regarding Fig. 2. Add a legend defining both the green points and the blue points What is the x-axis scale?

P7. L3. Change “in the left panel of Fig. 2” for “Fig. 2-a”

P8. L3. Make clearer which type of design is refereeing in “For each design,. . .”.

P8. L4. “Specifically, the performance of the method has been quantified. . .”

Regarding Eq. 7, define the variable in the text.

P8. L11. Change "...in the right panel of Fig. 2." for "Fig. 2-b".

P8. L11-L12. "It is reasonably linear, varying between n=7 for k=7 and n=181 for k=150."

P9. L18. "The relative errors δ(?) for various sample sizes n (?) is shown...."

P9. L18. Are the "designs" in this line related to the "new designs" mentioned in P4. L2.?

Regarding Figures 3 and 4. Add the name of the models (i.e. MD5, MI5, etc.) at each plot of these figures in order that each plot can be understood itself without the need for the reader to read the caption of the entire figure. Is the "Relative error" at the y-axis referred to δ from Eq. 7? If so, add δ in the y-axis, as well as the units.

P9. L3. Define "3P frequency"

P9. L9. "The relative errors δ(?)"

P10. L9. Double "observe" P10. L18. Use different notations for the value Ïţ_kshown in Eq. 3 and the actual one. Regarding Eq. 8, define in the text all variables of this equation. P12. L10. Change "given that" for "because". P13. L3. I would say "With regards to applications to design optimization, this method seems to be very promising". P13. L10. I would eliminate this title and add section 4.3 to section 4.2. P13. L28-L30. Elaborate more on this idea and change "(e.g.)" for ", e.g.," or ", for example,". The text is full of informal language, like the ones shown below. I would suggest using a more formal language (e.g. In other words, shown, etc.). Substantial machinery in place (P3. L19.) Effectively speaking (P5. L5.) In plain words (P5. L21.) That is to say (P7. L7.) this turns out (P8. L10.) displayed (P10. L18.) Put in another way (P13. L21.)

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2018-43, 2018.