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Interactive comment on "Structural optimisation of wind turbine towers based on finite element analysis and genetic algorithm" *by* Lin Wang et al.

Anonymous Referee #2

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The manuscript under review presents the structural design optimization of the 5 MW NREL onshore wind turbine. Finite element technique is used to perform the evaluation of the design constrains and objective function. Genetic algorithm is use to search the design space for the optimal solution. Design variables of the tower are; top diameter, bottom diameter and thickness distribution. The design constraints are; deformation, ultimate stress, fatigue, buckling, and natural frequencies. Mass of the tower is introduced as the objective function. The optimization process resulted in 6% mass reduction of the tower, while satisfying all the design constrains.

The paper is well written in English, but it lacks several important features and details that a research paper needs to have. My recommendation is to accept the paper, but with major revision. Below are some comments for the authors to fully revise their paper:

Major comments:

- The paper lacks a critical literature review of wind turbine support structure optimization. There are several important papers in this field than need to be cited (and discussed) in the paper. Here are some examples:

- Muskulus, Michael, and Sebastian Schafhirt. "Design optimization of wind turbine support structures-a review." Journal of Ocean and Wind Energy 1, no. 1 (2014): 12-22.

- Zwick, Daniel, Michael Muskulus, and Geir Moe. "Iterative optimization approach for the design of full-height lattice towers for offshore wind turbines." Energy Procedia 24 (2012): 297-304.

- Chew, Kok-Hon, Kang Tai, E. Y. K. Ng, and Michael Muskulus. "Optimization of offshore wind turbine support structures using an analytical gradient-based method." Energy Procedia 80 (2015): 100-107.

- Schafhirt, Sebastian, Niels Verkaik, Yilmaz Salman, and Michael Muskulus. "Ultra-fast analysis of offshore wind turbine support structures using impulse based substructuring and massively parallel processors." In The Twenty-fifth International Ocean and Polar Engineering Conference. International Society of Offshore and Polar Engineers, 2015.

- Pasamontes, Lucía Bárcena, Fernando Gómez Torres, Daniel Zwick, Sebastian Schafhirt, and Michael Muskulus. "Support structure optimization for offshore wind turbines with a genetic algorithm." In ASME 2014 33rd International Conference on Ocean, Offshore and Arctic Engineering, pp. V09BT09A033-V09BT09A033. American Society of Mechanical Engineers, 2014.

- Schafhirt, Sebastian, Ana Page, Gudmund Reidar Eiksund, and Michael Muskulus. "Influence of Soil Parameters on the Fatigue Lifetime of Offshore Wind Turbines with Monopile Support Structure." Energy Procedia 94 (2016): 347-356.

- Haghi, Rad, Turaj Ashuri, Paul LC van der Valk, and David P. Molenaar. "Integrated multidisciplinary constrained optimization of offshore support structures." In Journal of Physics: Conference Series, vol. 555, no. 1, p. 012046. IOP Publishing, 2014.

- Ashuri, Turaj, Michiel B. Zaaijer, Joaquim RRA Martins, Gerard JW Van Bussel, and Gijs AM Van Kuik. "Multidisciplinary design optimization of offshore wind turbines for minimum levelized cost of energy." Renewable Energy 68 (2014): 893-905.

- Negm, Hani M., and Karam Y. Maalawi. "Structural design optimization of wind turbine towers." Computers & Structures 74, no. 6 (2000): 649-666.

- Lavassas, I., G. Nikolaidis, P. Zervas, E. Efthimiou, I. N. Doudoumis, and C. C. Baniotopoulos. "Analysis and design of the prototype of a steel 1-MW wind turbine tower." Engineering structures 25, no. 8 (2003): 1097-1106.

- Yoshida, Shigeo. "Wind turbine tower optimization method using a genetic algorithm." Wind Engineering 30, no. 6 (2006): 453-469.

- Uys, P. E., J. Farkas, K. Jarmai, and F. Van Tonder. "Optimisation of a steel tower for a wind turbine structure." Engineering structures 29, no. 7 (2007): 1337-1342.

- In the introduction section, it is not clear what the knowledge-gap is that the authors want to address in this paper. Typically, a literature review should show what the state-of-the-art is and what is still needed to be addressed. Please clarify what the contribution of this paper is to the state-of-the-art, based on the identified knowledge gap.

- Line 179: Why did the authors change the tower height to 80 m? Mesh sensitivity has a different height. Please explain.

- Line 204: Gravity is a body load, but the authors applied it to the tower top as a nodal load. Please explain why such a choice is made, and how accurate such an assumption will be. If gravity is used as a force, what is the corresponding mass? The authors could apply gravity as an acceleration in their model, and use an element type

that would consider gravitational acceleration.

- What values are used for equation 1 (and 2, 3 ...)? Please add them in the paper.

- What approach is used to do the fatigue analysis? What properties are used to find the damage on the structure? Please elaborate how the fatigue damage is obtained from iteration to iteration? Is there any time domain analysis performed? Is the Miner rule or Paris formulas used? Section 2.3.3.2. needs more details to allow other authors replicate the same analysis if needed.

- Line 262, “For ultimate load case, both gravity loads due to the weight of the tower itself and the wind loads due to wind passing the tower are taken into account as distributed loads on the tower ...”, is there any time-domain simulation used here or is this just a static analysis? How is the tower shadow considered in this work? Please clarify.

- Section 3: GA is a standard and routine approach and no need to spend 2 pages on that. Few citations to relevant paper would do the job. Please consider removing it and adding few citations instead.

- Section 4.2: Why does the tower geometry vary linearly? Is this done to save computational time? Such an assumption has increased the initial weight of the tower. Please explain by how much?

- Line 374: Such an assumption is not acceptable. To do an optimization of the 5 MW NREL tower, the authors should use the same deformation of the tower top as the original design. You can relax a constraints to always have a better design in an optimization study. This is a very crude approach used in the paper.

- Line 395: This is not an acceptable assumption. How do you know that the tower oscillates at the same RPM as the rotor to find the number cycles? Please clarify.

- Page 14, Fatigue constraint: How did you compute the fatigue damage? How did the authors find the cumulative stresses to be used in the S-N curve?

- Line 415: Please elaborate how the buckling is performed, and how is the design guard against buckling?

- Line 440: The rotor rotational speed is 12.1 RPM and not 11.2 RPM. I hope this to be a typo, otherwise the optimization has to be redone.

- I do not see an evaluation of the fatigue damage in the results section. Please add this, since it is important.

- Section 4.5: I expect this to be in the methodology section, particularly figure 7. Please consider making a new section named methodology to explain how you setup your research, and how the design constraints, objective function and optimization algorithm are defined.

- There is no soil-structure interaction considered. Please explain why and how you would this impact your results.

- How is the mesh perturbation done in this work? Please explain.

Minor comments:

- In table 1, please also add the Poisson's ratio.

- Line 175, "80m", add half-space.

- All the equations seem to be copied from somewhere instead of being typeset. Please consider typesetting them.

- Math symbol sub-indexes in Table 5, 6 ... are difficult to read. Please increase the font size.

- Table 8 to be left adjusted.

- Correct "force-aft" in line 151 and 160 to "fore-aft".

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