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WIND ENERGY SCIENCE DISCUSSIONS

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Interactive comment

Interactive comment on "Beam-like models for the analyses of curved, twisted and tapered HAWT blades in large displacements" *by* Giovanni Migliaccio et al.

Anonymous Referee #1

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The authors are proposing a novel beam like model specifically developed for wind turbine blade structures. The authors motivate the need for development with computational efficiency required for design optimization in conjunction with aeroelastic analysis. The model is capable of considering lengthwise geometrical variations (LGVs) such as twist, curvature and pre-bend and is suitable for large deformation analysis.

General comments: The research significance of the proposed model is high and the authors are addressing two of the renowned challenges in wind turbine blade simulations namely computational efficiency and accuracy. Regarding the latter, the implementation of LGVs into blade beam models bears indeed a considerable research demand.

Concerning the introduction, the important contiguous contributions in the realm of this paper made by Giavotto and coworkers were not mentioned in the literature review. The model proposed in this paper is presented in a sole formal mathematical format. I am conceding the necessity of such a formal solution, albeit, the model can hardly be falsified in its current form. The authors mention that the model was indeed implemented and allude the intention to publish the procedure in a follow up paper. However, the complete absence of information concerning the implementation e.g. the pseudo code impedes reproducibility and judgement. With the information provided it is not possible to judge whether the model is a scientific breakthrough or not.

In Section 4 an analytical example is presented in which no tangible results e.g. stress/strain fields are presented that would be vital for corroboration. It would especially be pertinent (and straightforward) to compare the model predictions with analytical solutions of a tapered beam the third author published previously.

I recommend the paper for publication, provided that the solution is explicated in more detail with particular emphasis on the adopted numerical procedure. Moreover, the paper would gain credence by provision of concrete model predictions, which can be tried against analytical/other numerical solutions.

Specific comments/ questions: 1. P.2 line 40: Please define ‘beam like models (BLM)’ or provide a reference to its stipulation

2. P.4 line 95: Please more clearly define the meaning of ‘proper orthogonal tensor fields’ by preferably using a physical interpretation. The same pertains to the meaning and purpose of the skew tensor fields KA and KB. Alternatively, please provide references.

3. P.5 line 110: Please more clearly enunciate the meaning of ‘well-defined measures of deformation’.

4. P.5 line 115: Please define ‘proper manner’.

5. P.6 lines 150-155: The entire paragraph appears hard to follow. Can it be conflated in a more comprehensible way?

6. P.7 top: Please clearly state which higher order terms (from which order) are neglected.

7. P.7 line 170: In contrast to mathematics, I presume the majority of readers affiliated with wind energy might not be familiar with the rather specific terms stemming from differential geometry such as ‘pull back’ and ‘push forward’. Auxiliary explanations and additional references to relevant literature would be very helpful to follow the derivation.

8. The first author of one reference is misspelled: It should rather read ‘Stäblein’ with umlaut.

9. P. 8 ff: Is it correct that the general beam problem is decoupled into what is stipulated as ‘1D’ solution and into a ‘2D’ solution? If this is indeed correctly understood, on what grounds can the decoupling be justified? What is the error estimation of such an assumption?

10. P.9 line 210: If correctly understood, the 2D solution of the warping displacements must be obtained prior to the 1D solution. Yet, in equation 28 the analytical expressions for the cross sectional properties (moments of areas) of an isotropic, prismatic ellipsoid are used. It is not abundantly clear how exactly the general 6x6 cross section stiffness matrix is obtained in case of a wind turbine rotor blade.

11. A figure showing the cross section, CSYS and cross-section forces used in section 4 would help a lot to illustrate the matter.

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