Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2019-59-RC2, 2019

WIND ENERGY SCIENCE DISCUSSIONS

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 #2

Received and published: 26 September 2019

The motivation of this work is highly relevant to wind energy. It is common place for beam-like models to be used, due to their balance between computational efficiency and accuracy. One limitation to these theories is the assumption of prismatic geometry. The closest example of relaxing this constraint is that of Hodges and Yu with VABS, where the beam can be curved and twisted, yet, cannot taper. Ignoring taper has some consequences for wind energy, near the root region where the loads are highest. So, the taper region can be important for structural design, while contemporary models cannot properly model these complex stresses.

Although the ambition of this work is important to wind energy, I cannot recommend

that this article is published in it's current form. A critical weakness is that the solution to the warping field is not well developed. Only a simple analytical example is given, which makes this contribution only valid for special cases. Thus, it cannot be used for wind turbine blades in general.

Currently, the state of the art are the contributions of Hodges, Yu and Giavotto. They have already developed general purpose beam models and cross section solvers. So this is the ultimate level of ambition that is needed to make a contribution to wind energy in this area. However, the key aim of this work, to incorporate taper, will be an important improvement over these earlier contributions. So I would strongly encourage the author to continue this important work.

I can recognize that getting to the level of these earlier contributions will be difficult. I think this particular manuscript can still maintain an analytical approach and be improved by expanding greatly on the example. There is still an open question on what effects a beam model with taper could capture. So, the author could demonstrate the stresses and strains that this solution gives, that are not present in a more conventional beam formulation. Furthermore, the author could also make comparisons to FEM models to highlight the effects that are not captured. This I think is possible at this level and results like this would greatly improve the manuscript. Furthermore, if you had an tapered elliptical blade, how does taper affect things like frequencies or tip deflection? Again, these results will shed light on what more we can expect from simple engineering models if this limitation was relaxed, yet although simple and analytic, it would have relevance to wind energy.

The authors did a well at explaining the motivation of their work. It could be made more widely applicable by explaining current engineering design challenges that this would help overcome. I have highlighted some points at the beginning of this review.

This is a very mathematical paper written in a concise manner, using a lot of terminology that is typically not familiar outside of the continuum-mechanics community. To make this article accessible to wind energy readers I recommend several points where the author expand on the terminology.

The authors should further develop their techniques for solving the warping solution so it can be applied to general cross section shapes that are typically found in wind turbine blades. The authors should aim to solve the structural dynamics of real wind turbine blades. Furthermore the explanation of this work should be expanded so it is more clear.

There are several minor points that can be improved: ——————————————-

Equation 15 with sub-equations would be more clear

A general comment as with a theoretical development, please elaborate on the assumptions taken and the limitations of this approach.

Generally speaking the wind energy community is not familiar with continuum mechanics. The author should explain verbally what all the terms mean. I personally have read about all these terms from my text books, but it would be nice if I didn't have to dust off my old texts to understand this article.

In the equations, the time rate of change is indicated by a dot. Typically this is given by a dot over the variable, however in this work it appears to be a super-script. This can be a little confusing because they use the same dot for dot products. If you use latex, \dot{x} would be the command that you would use.

The '^' operator is used in the equation. It is not clear that the '^' operator is in many of the equations. The authors should elaborate more on the formal definitions of the mathematics.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2019-59, 2019.