Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2020-98-RC1, 2020

Interactive comment on "A Method for Preliminary Rotor Design – Part 1: Radially Independent Actuator Disk model" *by* Kenneth Loenbaek et al.

Peter Jamieson (Referee)

peter.jamieson@strath.ac.uk

Received and published: 28 October 2020

This paper describes a method, RIAD (Radially Independent Actuator Disc), for preliminary rotor design based on the usual assumption in blade element momentum (BEM) theories of radial independence of the blade elements and their associated annular rings of fluid. It is shown to be equivalent to BEM but by focusing on the primary variables power and thrust at each radial location via their associated local coefficients it is more insightful and simpler to implement top level rotor optimizations that may include load constraints.

I am very much a a fan of this kind of approach as all too often more complex sophisticated design tools are employed too early without the confidence that a design is going

in the best direction that could be gained from wider explorations at a higher level with simpler tools and analytic or semi-analytic methods.

The quality of the paper in general is very good and I have only some specific points to raise regarding a few details.

Last sentence of Section 1 Introduction reads a bit strangely with word "where". I understand that this paper is Part 1 (describing the method illustrated with power maximization) and Part 2 will deal with use for load constraint. Is that correct?

I really like Equation 4.19. Its very nice to see the power and loss terms clarified here.

On Figure 4 maybe wake rotation loss at top of figure a) should be deleted or amended. The title "Significance of wake-rotation loss is fine" but what you are showing as correctly stated in the expanded title below the figures in a) is the wake rotation factor with 1 corresponding to no loss and zero to maximum loss.

Regarding Section 3.4 - line 249; "The novelty is the ease ...". You referenced Jamieson 2018 just before that - the equation provided there for Cp max (for present large horizontal axis turbines with design tip speed ratio above 6 and max glide ratios around or above 100) will enable quite accurate estimation of Cp max without solving BEM equations which is about as easy as you can get! This assumes only that peak performance of each blade element is achieved at max glide ratio which is an excellent approximation but not quite exact.

You continue in Section 3.4 " In all of the mentioned work the optimization method.....". Just to be clear are you still referring specifically to the optimization method to determine Cp max or more generally? I have not checked the other references but formulae for optimum blade design and Cp max in Jamieson 2018 include drag, rotational loss via tangential induction factor and Prandtl tip loss factor. They are admittedly not fully optimized results because the tip loss in effect couples the elements. I think that sentence " In all of the mentioned work the optimization method....." may need to be reworded or further explained.

"Common to them all is the exclusion of drag....". This is simply wrong for Jamieson 2018 if not for any of the others referenced. Drag is included in the induced flows and the equivalent of your equation 9 has additionally + dD/dr x sin phi.

Taking the paper as a whole I think the simplifications in dealing with local power and thrust coefficients and in using the gradient with complex step (with which I am not familiar) add up to a really nice way to do top level optimizations. The equivalence with BEM must hold since it is based on the same actuator disc theory and assumption of radially independent blade elements but it is good to demonstrate that analytically and computationally as a validation check.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2020-98, 2020.