Yaw-modelling using a skewed vortex cylinder

The cylindrical vortex wake model presented in Chap. 17 for the case of uniform inflow is extended in the current chapter to the case of yawed inflow. Generalities regarding yaw are presented in Sect. 6.1 and only the skewed cylindrical vortex model is presented in this chapter. The chapter starts with a literature review on the topic of yaw-models and vorticity-based methods. The description of the model follows. The novelty of the current model is that the assumption of infinite tip-speed ratio is relaxed. The bound vorticity is assumed to be identical to the case of uniform inflow but the vortex cylinder and the root vortex are skewed with respect to the normal of the rotor disk. Closed form formulae for the induced velocities are provided. They can only be evaluated analytically for a limited part of the domain. A numerical integration is required to obtain the velocity everywhere in the domain. The numerical integration poses no difficulty for modern computers. Semi-empirical models are established to obtain the velocity at the rotor disk. The contribution from each vorticity components to the induced velocity at the rotor disk is investigated. The content of this chapter is based on the publication of the author titled Cylindrical vortex wake model: skewed cylinder, application to yawed or tilted rotors (Branlard, Gaunaa, Wind Energy, 2015, [1]). Details on the mathematical derivations used in this chapter are provided in Chap. 38. Results from this chapter are applied in Chap. 22 to derive a new yaw-model applicable to a BEM code. The induction zone in front of a yawed wind turbine or rotor is investigated in Chap. 24 based on the results from the current chapter. A Matlab source code to evaluate the induced velocity field in the entire domain due to the main vorticity component is provided in Sect. 38.1.4.

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