Flow induced by a skewed vortex cylinder

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The velocity field induced by a skewed vortex cylinder of longitudinal and tangential vorticity is derived in this chapter by direct integration of the Biot–Savart law. The derivation steps are provided in details. The results of Castles and Durham for the skewed semi-infinite cylinder of tangential vorticity are presented first. The results are then extended so that all the velocity components induced by the tangential vorticity are expressed. The derivation of Coleman et al. which focused on the velocity induced on the base axis is then detailed. The result of Coleman is relevant for the implementation of yaw-models in BEM codes (see e.g. Chap. 21, Sects. 6.1 and 10.3.3). A Matlab source code to evaluate the induced velocity field in the entire domain is provided. Results for semi-infinite and infinite skewed cylinders with longitudinal vorticity are provided in the next section of the articles. Properties for the infinite cylinder of longitudinal vorticity are essential for the understanding of the properties of the semi-finite cylinder. In particular, it is shown that the velocity is zero inside of the infinite cylinder, and the stream-lines are confocal ellipse outside of the cylinder. The content of this chapter is based on the publication of the author entitled "Cylindrical vortex wake model: skewed cylinder, application to yawed or tilted rotors" [1]. Results from this chapter are applied: in Chap. 21 to model a wind turbine (or rotor) in yaw, in Chap. 22 to derive a new yaw-model applicable to a BEM code and in Chap. 24 to study the induction zone in front of a yawed wind turbine (or rotor).

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