Reply by the Author to D. I. Greenwell

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GREENWELL derives the analytical expression for U_t, the tangential velocity of a semi-infinite helical vortex as determined from the Biot–Savart law. The derivation and the result are remarkably straightforward, in contrast to the difficulty in analyzing U_b, the binormal velocity, for example, Refs. 1 and 2. For helices of small pitch p, $U_b \sim p^{-1}$, and so is larger than U_t by the same magnitude, which partly explains the computational interest in the binormal velocity. Furthermore, U_b is the only significant velocity for a force-free helical vortex whose internal structure and velocity can be neglected, for example, Saffman.[3] Greenwell points out, however, a number of flows where it might be necessary to analyze the axial velocity within the vortex core, to which U_t might be a major contributor. Another helical flow in which the axial velocity is important is the wake of a wind turbine at runaway, where no power is produced but the thrust is maximised. Ebert and Wood[4] found that kinetic energy was extracted from the wake, but this was canceled by angular momentum within the tip vortex because of the axial flow.

References

[1]Boersma, J., and Wood, D. H., "On the Self-Induced Motion of a Helical Vortex," *Journal of Fluid Mechanics*, Vol. 384, 1999, pp. 263–280.

[2]Wood, D. H., and Boersma, J., "On the Motion of Multiple Helical Vortices," *Journal of Fluid Mechanics*, Vol. 447, 2001, pp. 149–171.

[3]Saffman, P. G., *Vortex Dynamics*, Cambridge Univ. Press, New York, 1992, pp. 218–221.

[4]Ebert, P. R., and Wood, D. H., "The Near Wake of a Model Horizontal-Axis Wind Turbine at Runaway," *Renewable Energy*, Vol. 25, No. 1, 2001, pp. 41–54.

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