UNCERTAINTY ESTIMATES FOR TORNADO-INDUCED WIND LOADS

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Estimating tornado-induced wind loads from laboratory tornado simulators is not yet a mature discipline. While many simulation issues have been addressed in recent years, several significant issue have yet to be settled definitively. With greater interest from practitioners for guidance on tornado loads and with tornado-induced wind loading being considered for the ASCE 7-22 standard, it is very important that we appreciate what is and what is not understood about them.

The study described in this paper analyzed the following effects: the velocity profile near the ground (both field data and laboratory data show that the profile is not a typical boundary layer profile), the effects of surface roughness, the effects of storm duration due to vortex translation speed (as discussed in Haan, 2017), the aerodynamic coefficients themselves, vertical velocity effects (and how they be accounted for using an elevation angle as discussed in Kopp & Wu, 2017), the static pressure drop in the vortex core, the internal pressure, and the effect of scaling (Gillmeier et al. 2017 show that laboratory simulator flow fields depend on more than just swirl ratio and aspect ratio).

This study attempts to delineate what we do and do not understand but also tries to estimate relative importance of each issue using an overall framework of uncertainty analysis. This framework uses an equation for roof and wall pressures (p) modified from ASCE 7-16.

$$p = 0.613 K_z K_{zt} K_d K_e V^2 \left(GC_p(\theta, \beta) - GC_{p_i} \right)$$

This equation can be used to calculate sensitivity coefficients for each parameter. These are then combined with uncertainty values for each parameter. These uncertainty values are derived from what current research says about how tornadoes might affect each parameter. The end result is a ranking of the relative importance of each effect and a suggested list of priorities for future research into these effects.

F.L. Haan, Jr., "An Examination of Static Pressure and Duration Effects on Tornado-Induced Peak Pressures on a Low-Rise Building." *Frontiers in Built Environment*, April (2017)

G.A. Kopp, C.-H. Wu, "A framework for the aerodynamics of low-rise buildings in tornadoes: Can boundary layer wind tunnels give us everything we need?" 13th Americas Conference on Wind Engineering, Gainesville, FL (2017).

S. Gillmeier, M. Sterling, H. Hemida, "A parametric study of the effect of a tornado generator's geometric design on the flow field." European and African Conference on Wind Engineering, Liege, Belgium (2017).