EF Standards Committee

Forensics Subcommittee

Key Players

- Peter Datin – RMS
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Chapter 5 Outline

- Section 5.1 Purpose
- Section 5.2 Scope
- Section 5.3 Definitions
- Section 5.4 Symbols and Notations
- Section 5.5 General Requirements
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Section 5.2 Scope

This chapter provides procedures for estimating wind speeds generated by tornadoes, hurricanes and other windstorms, based on forensic engineering analysis of data collected in field investigations. The wind effects from straight line winds are used as the primary input to the development of the wind speed and include wind-borne debris impact loading that caused or contributed to the observed damage. Where applicable, the special effects known about tornadoes, including static pressure drop, transient effects and other parameters are considered. Methods for developing probabilities of failure with associated ranges of probable wind speed to a defined confidence limit are provided. Data collection, analysis, report writing, and data archival requirements are provided so the findings and conclusions can be appropriately reported and the data appropriately archived for the end user of the information.

The velocity profile recommendation is based on these radar velocity profiles published in Kosiba & Wurman (2013)

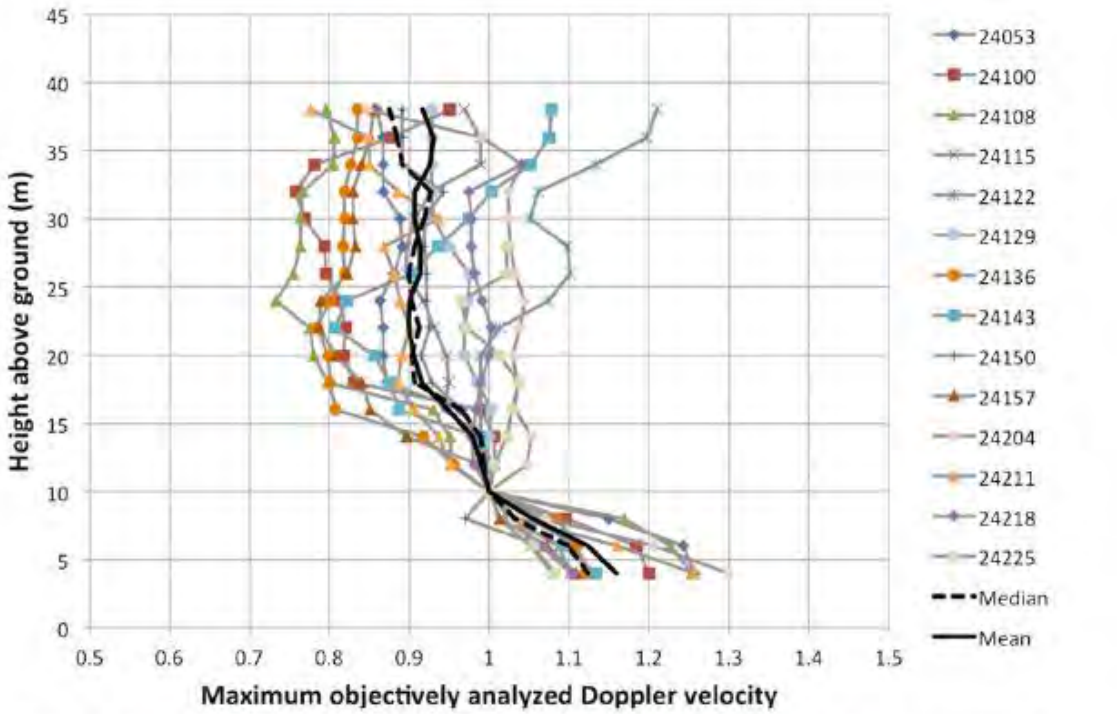

FIG. 4. (top) Maximum RSDOW Doppler velocity in the tornado as a function of height normalized by the 10 m AGL value and (bottom) maximum objectively analyzed RSDOW Doppler velocity as a function of height normalized by the 10 m AGL value for all 14 RSDOW volumes (time labels HMMss UTC, where H indicates hours). Stippled and solid lines depict the median and the mean for all times, respectively. Most intense winds are observed near 5 m AGL, decreasing about 15% by 10 m AGL, then decreasing about another 10% from 10 to 40 m AGL.

The general trend of very high, near-ground velocity is consistent with numerical simulations (e.g. Lewellen and Lewellen, 2007) and with profiles from the Iowa State simulator.

Section 5.8 con't

- 5.8.3 Random variables for wind loads
  - K_z – velocity pressure coefficient
  - GC_p – external pressure coefficient for C&C
  - G – gust effect factor for MWFRS
  - C_p – external pressure coefficient for MWFRS
  - GC_{pi} – internal pressure coefficient
  - K_d – directionality factor
  - R – component resistance
  - W_T – component wind load for tornadoes
- 5.8.4 Factors modified by wind effects
  - Internal pressure: +/- 0.55
  - Gust effect factor: 0.90
  - External pressure coefficients: use ASCE 7 coefficients
  - Topographic effects: K_{zt} = 1.0 unless modified

Section 5.8 con't

- 5.8.4 con't
  - Wind directionality: $K_d = 1.0$
    - For hurricanes and other wind types, K_d shall follow ASCE 7
  - Averaging time: Use 3-sec peak gust for all wind types
  - Exposure/terrain: exposure as determined by field investigation with wind speed always taken at the mean roof height unless modified by dwell time.
    - Exposure factor used for other wind types shall follow ASCE 7.
  - Wind tunnel analysis: Wind tunnel analysis is permitted but shall follow ASCE 7, Chapter 31. A tornado simulator shall also be permitted.

- 5.8.5 Wind speed range parameters
  - Wind speed range most likely to have caused damage shall be determined using eqn. (shown below). The reliability index β shall be set as 0 for the lower wind speed estimate and -1.2816 for the upper wind speed estimate. These indices represent a 50% and 90% probability of failure.
  - Commentary contains a table of β vs. probability of failure.

- 5.8.6 Wind speed determination

$$V_T = \sqrt{\frac{W_T}{0.00256 \cdot K_z \cdot K_{zt} \cdot \left(GC_p - GC_{pi}\right) \cdot TF}}$$

- Where

$$W_T = \exp\left[\ln\left(R\sqrt{\frac{COV_{W_T}^2 + 1}{COV_R^2 + 1}}\right) - \beta\sqrt{\ln\left[\left(COV_R^2 + 1\right)\left(COV_{W_T}^2 + 1\right)\right]}\right]$$

- COV_R determined using Section 5.7
- COV_{WT} = 0.25 unless other rational methods are used for this determination. COV_{WT} is largely determined due to variation in exposure coefficient
- β index corresponds to a specific probability of failure