PRODUCING 1/100 AND LARGER SCALE TORNADOES IN A WIND SIMULATOR

Arash Ashrafi [1], Djordje Romanic [1]*, Jubayer Chowdhury [1], Horia Hangan [1]

[1] WindEEE Research Institute, Western University, London, Ontario, N6M 0E2, Canada

*dromanic@uwo.ca

With the increasing frequency of intensive tornadoes, the study of tornadoes is one of the most pressing research needs in the wind engineering community due to killing people and left more homeless. These recent catastrophes have led researchers to investigate the characteristics of this phenomenon in more depth.

The proper scaling of tornadoes is a quintessential part of any experimental or numerical study on the effects of tornadic winds on buildings and structures. That is why, physically simulated tornadoes need to satisfy the proper geometric, kinematic, and dynamic similarities with the real events. Some of the main parameters encountered in tornado scaling are the geometric ratios of the radii and heights of the maximum tangential velocity of the full scale and modelled tornadoes. Therefore, the scaling procedure requires the detailed wind speed measurements of tornado flow fields in both wind simulators and real atmosphere. The former is presented in this paper.

Laboratory simulations of tornado-like vortices have the advantage of controlled conditions and repeatability. The Wind Engineering, Energy and Environment (WindEEE) Dome at Western University is a large-scale and three-dimensional wind testing chamber capable of producing highly transient and non-synoptic winds such as tornadoes and downbursts. In the WindEEE Dome, a variety of wind systems can be generated by manipulating a system of 100 dynamic fans and louvers installed on the peripheral walls of the hexagonal test chamber, as well as by using the 6 large fans situated in the upper plenum above the test chamber.

Up until now, all tornados produced in the WindEEE Dome have been characterized with the length scales in the range between 1/300 and 1/150 by just using upper 6 fans and louvers. This paper introduces a new experimental method for creating the larger scale models in the range of 1/150 to 1/50 by using the first method and peripheral fans.

The simulated tornadoes in the WindEEE Dome from scaling point of view are compared against six volumes of single-Doppler radar data obtained from tornado events. Moreover, the overall flow structure of the experimentally produced tornadoes is compared against the full-scale data. In this regard, the WindEEE is capable to simulate real tornadoes with lower heights for maximum tangential velocity ($z_{max}\ |V_{t,max}$) with length scale around 1/50. On the other hand, by using roughness elements on the floor of chamber, other events can be simulated for length scale around 1/100. It was concluded that the WindEEE Dome large-scale tornadoes correspond to EF0- to low-end EF2-rated twisters in nature. These finding are of particular importance in the field of experimental investigation of tornado actions on structures.