

Keynote Speech Title:

Transmission Line Structures under Tornadoes and Downbursts - Numerical Development, Testing and Code Implementation

Abstract:

Downbursts and tornadoes belong to a category of windstorms called High Intensity Wind (HIW). It was reported that more than 80% of weather-related transmission line failures have been associated with HIW events. An extensive research program was initiated about 15 years ago at the University of Western Ontario, Canada, focusing on this problem. This research was triggered by the failure of a number of towers in the provinces of Manitoba and Ontario in Canada and was supported by the two major Canadian electrical utility companies Manitoba Hydro and Hydro One Ontario. The research covered various aspects related to this problem. These include the development and experimental validation of computational fluid dynamics models to simulate downbursts and tornadoes. The HIW wind fields were incorporated into a nonlinear finite element program developed in-house that is capable of simulating all components of a transmission line system including the towers, the conductors and the insulators. The localized nature of HIW events introduces more complications as the response of long structures, like transmission lines, will vary significantly depending on the location and size of the wind event. The developed numerical model was used to conduct extensive parametric studies to assess the behavior of various guyed and self-supported towers under downbursts and tornadoes. The numerical model was also used to conduct progressive failure analyses for transmission systems to predict failure loads and modes, which were shown to coincide with field observations. The first aero-elastic tests conducted in the world on multi-span transmission model under simulated downbursts and tornadoes were carried out in this research program at the unique WindEEE dome facility recently established at the University of Western Ontario. A major outcome of this research program was the development of a set of load cases simulating the critical effects of downbursts and tornadoes on transmission line structures, which are in the final stage of implementation in the ASCE-74 guidelines, representing the first specifications available in the world to account for the effect of localized wind storms on transmission line structures.