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Development of Code Provisions for Transmission Lines under Downbursts and Tornadoes Using Numerical Modeling and WindEEE Testing

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Abstract

Failure incidents of transmission lines during localized wind events, in the form of downbursts and tornadoes, have been observed frequently in various locations around the globe. A research program focusing on this problem started more than a decade ago at the University of Western Ontario, Canada. A summary and the main findings of this research program are presented in this paper. The research involved development of computational fluid dynamics models to simulate and characterize the downburst and tornado wind fields. Those were incorporated into an in-house developed nonlinear finite element model forming a unique package that can predict the behaviour and the failure modes of a transmission line structure under both downbursts and tornadoes. The numerical analysis is conducted by varying the localized wind events in space in order to predict the locations leading to peak internal forces in various members of a transmission tower. A novel experiment was conducted in this research program at the recently established WindEEE dome facility. The experiment involved testing a 1:50 multi-span aero-elastic model under a simulated downburst. The experiments served to validate the numerically predicted wind field and to estimate the turbulence characteristics of downbursts. The tested aero-elastic model was also used to validate the finite element model. A major outcome of this research program was the development of a set of load cases that simulate the critical effects of downbursts and tornadoes on a generic transmission line structures. Those load cases, which were recently presented to the ASCE-74 committee, will be discussed in this paper.

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