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Stability analysis of a transmission tower-line system subjected to downburst loading

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ABSTRACT

Transmission tower-line systems are vulnerable to failure when subjected to downbursts. For the long-span structure in which towers and wires extend for many kilometers, the collapse of one tower probably triggers the progressive collapses of towers along the line. Therefore, this study tries to probe the progressive collapse mechanisms of a tower-line system by fully coupled dynamic simulations. The downburst wind field is generated based on the empirical model by Chen & Letchford. A refined brace element is developed to have capacities of considering several failure modes in a member, such as the inelastic compression buckling, tension yielding and fractures, which is helpful to accurately capture the nonlinear behavior of towers subjected to downburst loading. The motion equations of the system are solved through the explicit central difference method that is programmed using MATLAB. The reliabilities of the developed element and program are validated against experiments and commercial software ANSYS, respectively. To identify the effects of the movement paths of downbursts on progressive collapse patterns of tower-line systems, three load cases (LCs) with different downburst paths are defined. For each LC, the time histories of displacements at tower tops and the middle of each span are presented. Additionally, the collapse scenarios at representative moments are plotted. The results indicate that the progressive collapse patterns of tower-line systems are greatly affected by downburst center movement paths. Downbursts with the same intensity but different paths probably lead to the collapse of one or three towers in the system. The dynamic behavior of wires is also important, which could cause local failures of tower heads.

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