















of the conductor forces due to the dynamic excitation. The results of the aero-elastic experiment conducted recently at the WindEEE dome showed an increase of 10~15% in the response due to the dynamic excitation for the tower and the conductors at the typical range of downburst velocities.

## 2.6 Link 6: criteria

Based on several numerical and experimental studies conducted at The University of Western Ontario to assess the behaviour of transmission line structures subjected to downburst loads, El Damatty and Elawady (2015) proposed a set of downburst velocity profiles that are believed to cause the maximum internal forces in the tower and conductors. Those load cases are summarized as following:

1. **Maximum transverse loads:** this configuration represents the maximum velocity profile acting on the tower and the conductors in the direction parallel to the line direction. The critical velocity profiles along the height of the tower as well as the spans adjacent to the tower of interest are given in Figure 10 and 11, respectively.
2. **Maximum longitudinal loads:** this configuration represents the maximum velocity profile acting on the tower in the direction perpendicular to the line direction. The maximum velocity profile along the height of the tower is provided in Figure 12. No forces act on the conductors due to this load case (see Figure 13).
3. **Maximum oblique loads:** this configuration represents the maximum oblique velocity profile acting on the tower and the conductors. Figure 14 shows the radial velocity distribution along the tower height for both the transverse and the longitudinal directions associated with this load case. Figure 15 shows the radial velocity distribution of the downburst critical oblique configuration along the line spans associated with this load case. The unsymmetrical distribution of the velocity along the line spans adjacent to the tower of interest results in nonlinear longitudinal forces developing in the conductors (Shehata et al. 2005). Charts were developed by El Damatty and Elawady (2016) enabling the evaluation of those forces.

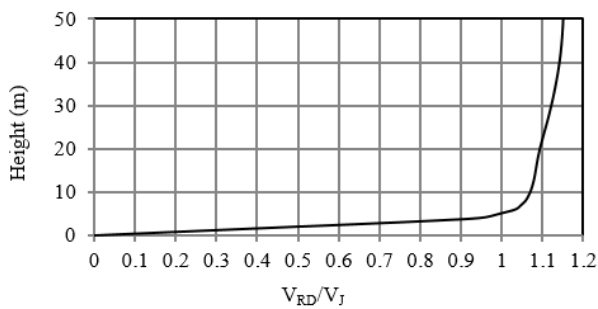


Figure 10 Radial velocity distribution along tower height at  $R/DJ=1.3$  and  $\Theta=0^\circ$

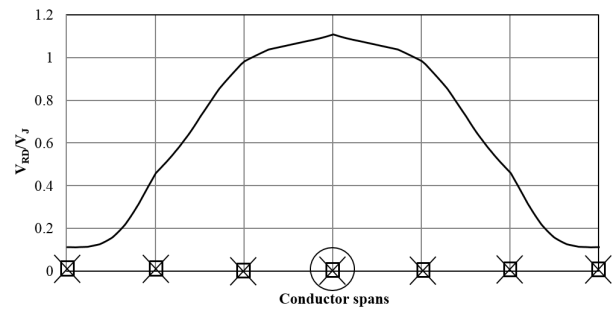


Figure 11 Radial velocity distribution over six conductor spans at  $R/DJ=1.3$  and  $\Theta=0^\circ$



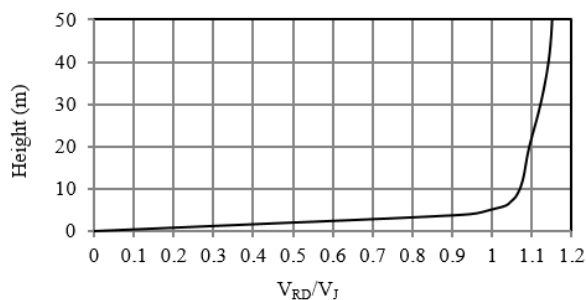


Figure 12 Radial velocity distribution along tower height at  $R/D_j=1.3$  and  $\Theta=90^\circ$

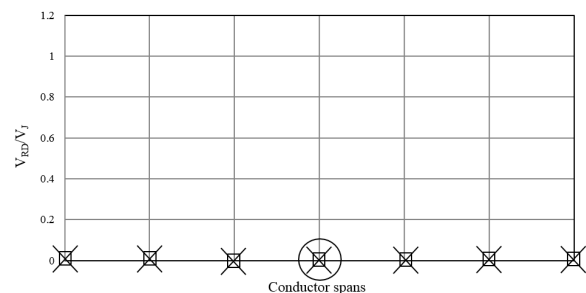


Figure 13 Radial velocity distribution over six conductor spans at  $R/D_j=1.3$  and  $\Theta=90^\circ$

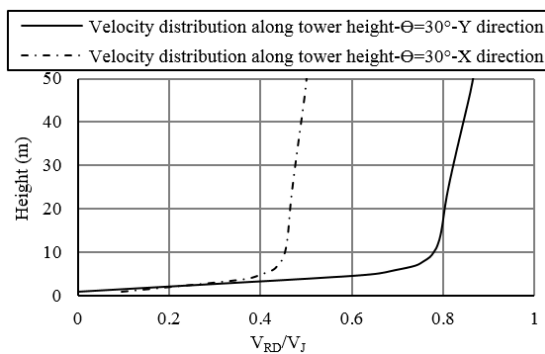


Figure 14 Radial velocity distribution along tower height at  $R/D_j=1.5$  and  $\Theta=30^\circ$

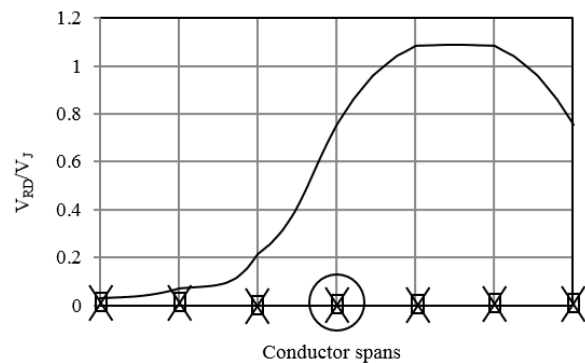


Figure 15 Radial velocity distribution over six conductor spans at  $R/D_j=1.5$  and  $L/D_j=0.5$ , and  $\Theta=30^\circ$

### 3 Conclusion

The current paper presented a novel contribution to the well-known Davenport's chain for wind engineering. The paper discusses the Davenport's chain for downburst studies on structures with a focus on transmission line structures. The following conclusions were made:

1. The Davenport's chain designed for synoptic wind studies requires one more link in case of localized wind events such as tornadoes and downbursts to address the localization aspects of those events in space and time.
2. Link 1: More metrological measurements are needed to fill in the gaps in the literature concerning the downburst intensities and sizes. Statistical analyses of large number of events in different places may help in building downburst velocity maps.
3. Link 2: comparative studies for the effect of different terrain exposures on structural response is needed for codification of terrain factors necessary in design guidelines.
4. Link 3: aerodynamic coefficients of tower sections subjected to downburst loads can be considered similar to those given in design manuals for synoptic wind calculations. More

studies are needed for tornado studies where a high vertical velocity component exists.

5. Link 4: Transmission tower response to downburst events varies based on the polar location of the event measured from the tower center. The numerical and experimental studies revealed that different tower members experience their peak response under different configurations of the downburst. Therefore, a parametric study considering all possible scenarios of the location of the event is needed in order to evaluate the peak internal forces in each of the tower members. Also, the tower response varies based on the structural system of the tower in addition to the conductor's properties.
6. Link 5: at the expected high downburst velocities, the dynamic response of the tower and the conductors is relatively small and is in the order of 10~15%.
7. Link 6: A set of downburst load cases has been proposed for the ASCE-74 committee in charge of updating the code manual. The proposed load cases simulate the critical loading scenarios of a downburst events acting on a generic transmission line system.

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