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The Generalized Wind Loading Chain and Beyond

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Abstract: A generalized wind loading chain to describe a complete relationship among wind, force, and response induced by nonstationary wind events such as tropical storms and downbursts to complement Davenport wind loading chain has recently advanced by the NatHaz Modeling Laboratory. In the proposed chain, nonstationary winds are represented as a nonstationary model in terms of time-varying mean and nonstationary fluctuating wind components similar to a stationary model involving constant mean and stationary fluctuating wind components. Specifically, the five chain components of the fluctuating wind in the Davenport's chain such as gustiness of wind, aerodynamic transfer/admittance, aerodynamic force, structural transfer/admittance, and response statistics are redefined as time-dependent counterparts in the time-frequency domain to capture nonstationary winds effects on structures. These components are primarily formulated using evolutionary power spectral density as a form of time-frequency representation for capturing salient features of the nonstationary tropical storm and downburst winds. As an alternative, a wavelet-based representation is also offered. A numerical example demonstrates the estimation of nonstationary response using the proposed generalized chain. Finally, the presentation discusses avenues beyond the classical along wind-based loading chain to a comprehensive 3-D dynamic wind loading chain by capitalizing on the data-driven surrogate models using CFD.