PMC2000-295

EQUIVALENT STATIC WIND LOAD DISTRIBUTION OF COUPLED BUFFETING RESPONSE OF BRIDGES

Xinzhong Chen, and Ahsan Kareem, M. ASCE
University of Notre Dame, Notre Dame, IN 46556
xchen@nd.edu, kareem@nd.edu

Current wind resistant design practice requires the stochastic dynamic wind loads to be represented in terms of the equivalent static wind loads. The gust response factor (GRF) approach that assumes the equivalent static loads having the same distribution of the mean static wind loads is widely used in the current design codes and standards. The gust loading factor or gust response factor is defined as the ratio of the maximum expected wind load or response to the mean time averaged value. The GRFs are generally different for different responses and may vary in a wide range depending on the structure, wind load properties and the influence functions. This GRF approach will not provide useful information in the cases with zero mean load or zero mean response.

Comparing with the GRF approach, the equivalent static loads based on the external wind load and the inertial load distributions provide more physical meaning and lead to realistic load distributions. These can be represented in terms of their separated background and resonant components in each natural mode. The total response is then calculated by combining their background and resonant responses using the square root of the sum of squares (SRSS) combination approach or complete quadratic combination (CQC) approach. Alternatively, the equivalent static load associated with a specific response can be provided as a linear combinations of its background and resonant components, which facilitates the wind load combinations with other loads and is more suitable to the current design procedure. Several studies have been performed on the methodology of the determination of these weighting factors, in which the modal response correlations have been neglected. However, for long span suspension bridges, significant coupling among modal responses exists at higher mean wind velocities. Neglecting the contribution of these correlations will lead to an underestimate of the responses and the equivalent static load distributions.

In this paper, a general methodology for calculating the equivalent static load distribution for buffeting response of bridges is presented, in which the correlations among modal responses due to structural and aerodynamic coupling effects are fully accounted for. The applications of the equivalent static load approach to the wind load representation and the response analysis for buffeting response of bridges are discussed. The applications of this approach to a long span suspension bridge with a main span of approximately 2000 m is presented to illustrate the effectiveness based on the dynamic response of displacement calculated by a three dimensional multimode coupled analysis approach.