Three-dimensional wind correlation: Estimations from in-situ measurements

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ABSTRACT

Although extensive research including field measurements has been carried out in the past, there is still a lack of data that defines complete correlation between the components of wind. These correlations (known as wind coherence in frequency domain representation) are important for precise prediction of wind loads on flexible, line-like structures such as long-span bridges, telecommunication towers, and transmission lines. Whereas correlations in the along-wind mean direction are more or less clearly understood and well defined, there is a certain lack of full scale data in the cross-properties among along-, vertical- and across-wind directions. It is therefore desirable to obtain more information related to these important wind parameters based on field measurements.

The objective of this paper is to provide more information on this subject based on two in-situ wind measurements. One set of data was obtained during the measurements undertaken for the New Cooper River Bridge, Charleston, South Carolina (see Figure 1). The second set is the wind measured on the experimental line of Hydro-Québec Research Institute (IREQ), shown in Figure 2. The first site is characterized by open water for wind directions normal to the old bridges whereas the second site fits well to the definition of an open terrain.

For both wind measurements, three-dimensional ultrasonic anemometers were used. With the available wind data, we aim at obtaining correlations between along-the-wind (u), across-the-wind (v) and vertical (w) turbulence components at the same measurement point and as well, at separated measurement points. Since the vertical- and across-wind structural responses are proportional both to the turbulence fluctuations in the respective directions, knowledge of their cross-correlations would help for improved estimations of their influence on these responses.

In addition, the effect of separation distance will also be analyzed; laterally, longitudinally and vertically. With this information, evaluations can be attempted in order to define a more site specific wind loading over larger spans and tall structures than the one predicted using conventional methods.

The results containing the wind statistics such as the wind spectra and the coherence for three-dimensional wind will be presented. Comparison with the available wind models will be pursued.

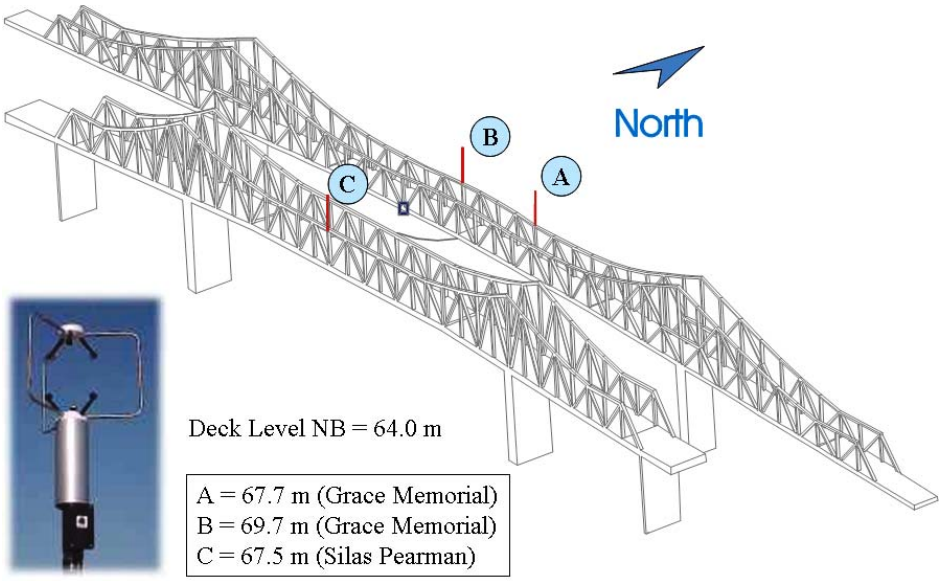

FIGURE 1 - SET-UP OF THREE SONIC ANEMOMETERS FOR WIND MEASURE ON THE COOPER RIVER SITE - THESE OLD BRIDGES WERE LATER DEMOLISHED (COURTESY OF PARSONS & BRINCKERHOFF AND SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION)

FIGURE 2 - SET-UP OF FIVE SONIC ANEMOMETERS FOR WIND MEASURE ON THE EXPERIMENTAL LINE OF IREQ