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Some critical issues on the distribution of the maximum value of the wind-excited response of structures

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ABSTRACT

Most verifications at the ultimate and serviceability limit states involve the evaluation of the maximum value of a structural parameter and its comparison with a threshold. This evaluation has thus a dominant impact on engineering, design and codes that reflects on the safety and economy of built environment and society. The distribution of the maximum value of the wind-excited response of structures is usually determined by the Davenport's model assuming that the structural response is a random stationary Gaussian process and the up-crossings of high response thresholds are rare independent events. The hypothesis that wind actions are stationary limits the analysis to synoptic phenomena. The hypothesis that wind actions are Gaussian implies that turbulence is small and the atmospheric stratification is neutral. The hypothesis that the up-crossings of high response thresholds are rare independent events raises some doubts on its application to flexible and low-damped structures, just those structures most susceptible to dynamic wind actions. This paper aims at inspecting this topic with special regard for some aspects almost ignored in literature, namely the properties of real wind velocity records and their influence on the distribution of the maximum value, the simulation of wind velocity histories with particular concern for the length of the signals, and the classic use of some theoretical models of the maximum value with special attention to the aprioristic acceptance of the representativeness of its mean value. Analyses are here carried out in the classic framework of stationary Gaussian processes. The results achieved point out some shortcomings in the classic engineering practice and provide some remarks for future research.

Keywords: Distribution of the maximum value; Dynamic response; Monte Carlo simulation; Real wind velocity records; Stationary Gaussian process; Wind engineering.

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