Envelope approximation using equivalent static wind loads

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The concept of ESWL is largely used in design offices for structural design. Indeed, it simplifies notably the design procedure because the response under the ESWL leads to a static repartition of internal forces which is more convenient for checking all the design rules. Furthermore, the combination with other static loads defined by codes (snow, self-weight,...) is simplified.

First equivalent static wind loads (ESWL) extracted from turbulent winds were determined from the mean wind loads, and gust factors. The obvious simplicity of this method initially developed in [1] may suffer from some drawbacks, for example when considering a zero-mean response. Today codes request application of another method which amplifies the peak dynamic load by pressure coefficients. Nevertheless, these ESWL are not realistic representations of the effective loads which caused accurate peak responses in the structure. Obviously, they have been developed to represent global loadings on structures in such a way that internal forces in any element reaches (with various errors) its extreme value in a conservative way.

Base on strict mathematical developments, a refined ESWL was proposed in [2] [3], in conjunction with the load-response-correlation (LRC) method, in order to provide the most probable load pattern for a specified maximum response. It is however limited to static linear analysis. The LRC method was extended to dynamic linear analysis in the modal basis [4] and thus is able to produce dynamic ESWL. More recently Chen & Kareem have proposed [5] ESWL formulated in terms of weighted combination of the background and resonant load components.

In a structural design, some key elements are identified and a serie of ESWL is determined in order to reproduce with a static analysis the result of a stochastic analysis. However, considering only few ESWL can lead to an important underestimation of the envelope diagram of the disregarded responses of the structure. This paper aims at studying the error made (and its behavior) on the envelope diagram when using a limited number of ESWL. The significant results are criteria giving the number of ESWL necessary to consider for a required level of reliability depending on the analysis performed.

References

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