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Deterministic and probabilistic approaches for aeroelastic design optimization of long-span bridges

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ABSTRACT

The last decades have witnessed the construction of a number of long span bridges. Suspension bridges have reached main spans of more than 2000 m and cable stayed bridges of more than 1100 m. In addition to that, more challenging proposals are under steady. The main difficulty for these structures is to undergo the effects of earthquakes or aeroelastic phenomena and this paper is devoted
to the latter class of loads, generated by wind flow. Giving the social relevance and cost of these constructions it is very important to use during the design the best technologies and numerical optimization methods are a powerful design tool. They have been applied since many years ago in other fields as aircraft or mechanical engineering but the idea of design optimization of long span bridges considering aeroelastic constraints is very recent. The optimization problem can be formulated as deterministic,-that means that all mechanical bridge properties and also the values assigned to loads, including wind related excitations, have fixed values-, or as probabilistic, which means that a level or uncertainty is included in the formulation, given the random nature of wind speed and the possible inaccuracies in the definition of bridge properties. This paper describes the formulations of aero-structural optimization of long span bridges considering flutter in both deterministic and probabilistic approaches. A long span cable stayed bridge and two suspension bridges, the Great Belt and the Messina bridges, are used as application examples of this methodology of design.

Keywords: Long span bridges, flutter speed, design optimization, Great Belt Bridge, Messina Bridge.

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