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Keynote Paper

Advances in modelling the wind-induced response of long-span bridges

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ABSTRACT

Dynamic response to turbulent wind (buffeting) and flutter stability often represent severe constraints in the design of long-span bridges. In this regard, self-excited forces are commonly addressed with a linear approach based on aerodynamic derivatives, usually measured through wind tunnel tests. Nevertheless, already in the 90s Diana et al. (1995) remarked the dependence of aerodynamic derivatives on the angle of attack, and highlighted that such a nonlinearity can be activated by large-scale atmospheric turbulence.

In the present work, the transfer function associated with the self-excited forces is thought as a bivariate function of reduced frequency and slowly-varying angle of attack. A specific wind tunnel experiment has been conceived to validate the resulting model and understand its limits of applicability (Barni et al., 2021), obtaining very promising results. The time-domain self-excited forces are then combined with unsteady nonlinear buffeting forces, and the problem is formulated for a full bridge structure, considering many vibration modes and the partial correlation of the random turbulent wind field (Barni et al., 2022). The resulting nonlinear model is applied to the Hardanger Bridge, Norway, revealing a strong impact on its dynamic response compared to the classical linear approach, especially in terms of peak vibration amplitude and flutter stability.

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