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Reliability-based Design Optimization of Classical Wing Aeroelasticity

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Abstract. Flutter speed of aircraft is very important and needs to be firstly specified before a certification applying of a new aircraft by airworthiness regulator to make sure that the aircraft is free from flutter in its flight envelope. This speed is usually estimated from deterministic analyses in a design stage by assuming that physical and geometrical parameters are perfectly known. In practice, some parameters are finitely measured by observing, especially for the geometrical parameters, material properties and so on due to the random in nature, which causes uncertainty of information often called uncertainties. This paper focuses on the combination of structural reliability analysis with aeroelastic simulation to give a correct flutter speed evaluation in an optimum design process. The classical two-dimensional wing with a typical airfoil section is used as an example in this study. The discrete-time aeroelastic model and worst case scenario are applied to quantify an uncertainty in determination of flutter speed and to provide a comparison between design with and without reliability analysis. The results show the proposed technique leads to the flutter speed being more conservative and realizable compared with the traditional technique.
technique

Keywords: Aeroelasticity; flutter speed; uncertainties; reliability.