Robustness Assessment of Stiffened Thin-Walled Composite Structures in Post-Buckling

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Abstract

This work presents the robustness assessment of stiffened thin-walled composite structures in post-buckling, which is based on a new design strategy that satisfies weight, load-based performance and energy-based robustness requirements. In this approach, robustness is understood as collapse insensitivity due a local failure, where global buckling for instance is assumed as a local failure, once the stiffness reduction after this event can lead to a sharp collapse. Following this concept, robustness measures are derived from the structural energy, the area under the load-shortening curve obtained from geometrical nonlinear finite element analysis with material progressive failure. Since inherent uncertainties in geometry, material properties, ply orientation and thickness affect the structural performance and robustness, those variations are accounted for. As a result, a new argument is given to shift collapse closer to ultimate load, so that lighter structures are achievable with both performance and robustness requirements satisfied. This trade-off is valuable to aerospace applications, where light weight and safety are mandatory. Finally, this innovative strategy is demonstrated for stiffened thin-walled composite structures in post-buckling, and its results compared to others obtained from current practice.

Keywords robustness, stiffened thin-walled composite structures, post-buckling.

Purpose –

This work presents the robustness assessment of stiffened thin-walled composite structures in post-buckling, which is based on a new design strategy that satisfies weight, load-based performance and energy-based robustness requirements.

Design/methodology/approach –

In this approach, robustness is understood as collapse insensitivity due a local failure, where global buckling for instance is assumed as a local failure, once the stiffness reduction after this event can lead to a sharp collapse. Following this concept, robustness measures are derived from the structural energy, the area under the load-shortening curve obtained from geometrical nonlinear finite element analysis with material progressive failure. Since inherent uncertainties in geometry, material properties, ply orientation and thickness affect the structural performance and robustness, those variations are accounted for.

Findings –

As a result, a new argument is given to shift collapse closer to ultimate load, so that lighter structures are achievable with both performance and robustness requirements satisfied.

Practical implications –

This trade-off is valuable to aerospace applications, where light weight and safety are mandatory.

Originality/value –

Finally, this innovative strategy is demonstrated for stiffened thin-walled composite structures in post-buckling, and its results compared to others obtained from current practice.