FIBRE STEERING FOR COMPRESSION AND SHEAR LOADED COMPOSITE PANELS WITH CUTOUTS

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Key words: Fibre-Steering; Variable-Stiffness Laminates; Composites Design; Failure Criteria; Buckling.

Summary. The traditional approach to the problem of stress concentrations around cutouts for windows and doors in composite aeronautical structures is to locally increase thicknesses in order to smooth out the stress peaks. Often, this practice attracts more loads to the cutout region besides increasing the weight of the structure. A more effective solution, avoiding the mass increase, is to dissipate the stress concentrations by redistributing loads to supported regions such as frames and stiffeners by means of fibre-steered laminates with variable in-plane stiffness. The production of composites in this format is practical nowadays due to capabilities of advanced fibre-placement technology.

In this work, the potential of the fibre-steering concept for the purpose of stress alleviation around cutouts in composite laminates is explored. Numerical analyses are performed on compression and shear loaded variable-stiffness panels of different configurations and hole-to-panel size ratios. The optimal configurations in terms of buckling and postbuckling failure responses are identified and the maximum possible cutout size is determined.

1 INTRODUCTION

Previous investigations [1, 2] demonstrated the significant advantages offered by steered fibre panels in terms stiffness, buckling and failure responses. The improvements were attributed to the redistribution of the applied in-plane loads to the stiff support regions in order to avoid buckling in the critical central panel sections, or failure around centrally located cutouts. As
examples, the predicted critical buckling and first-ply failure loads of the family of panels under edge shortening, with configurations represented in Fig. 1, are shown in Fig. 2 (left and right respectively).

\[ \theta(x') = \phi + (T_1 + T_0) \frac{|x'|}{d} + T_0 \]

Figure 1. Variable-stiffness panel geometry and boundary conditions (left). Fibre path definition (right).

Figure 2. Comparison of variable-stiffness and traditional straight-fibre panels in terms of buckling (left) and first-ply failure (right) performances.

In the present work, the previous analyses are extended to explore the performance of the variable-stiffness concept under shear loads and the effect of varying the size of the cutout.

REFERENCES
