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COMPOSITE STRUCTURE DESIGN
NEW INSIGHTS INTO STIFFNESS MATCHING BETWEEN STANDARD AND DOUBLE ANGLE-PLY LAMINATES.
Christopher Bronn York
Aerospace Sciences, University of Glasgow, Glasgow, Scotland. (c.york@aero.gla.ac.uk)

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ABSTRACT

This article presents a methodology for matching bending stiffness between standard ply laminates (with $0^\circ$, $\pm 45^\circ$ and $90^\circ$ ply orientations) and double angle-ply laminates (with $\pm \psi$ and $\pm \phi$ ply orientations). The methodology is only possible through the development of a series of databases containing laminate configuration with specific mechanical coupling characteristics\(^1\), which also account for ply percentages and/or ply contiguity constraints\(^2\).

**Fig 1.** Lamination parameter design space ($\xi_1$, $\xi_2$) illustrating double angle-ply laminates with stiffness properties matched to standard ply designs in: (a) extension and; (b) bending.

Figure 1(a) demonstrates that the extensional stiffness requirements for a typical spar and stiffener can be closely matched by adopting the (40/60) ply percentages of a typical wing skin, with $\phi = 60^\circ$, and adjusting only the ply orientation, $\psi$, in the secondary angle-ply sub-laminate to give $\pm(\phi/\pm \psi =) \pm 60^\circ/\pm 5^\circ$ for the stiffener and $\pm 60^\circ/\pm 30^\circ$ spar.

Figure 1(b) demonstrates the variation in the in-plane properties ($\xi_1$, $\xi_2$) for stiffness matched laminates in bending; here, all possessing bending isotropy.

REFERENCES
