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## Composites

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# Flexure of simply curved composite shapes

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## Abstract

Numerous instances of premature failure of laminated composite components have occurred due to a general lack of appreciation for the low short transverse tensile strength; this strength can be typically less than 3% of the in-plane strength of a composite laminate. The subject has been addressed in earlier publications for curved beam elements and cylindrical tubes of moderate wall thickness. However, this paper focuses on illustrations of failures that have occurred in composite hardware development programmes due to the presence of generic curved regions at which significant transverse tensile stresses have developed due to detail design oversights. Examinations of the generic curved beam, plate and cylindrical tube configurations are presented using finite element methods, classical elasticity theory and a simplified strength of materials approach. The acceptability and utility of the latter approach is assessed by drawing comparisons with the former two approaches. Effects of mechanically and thermally induced loadings are considered. It is indicated that the necessity for detailed and expensive finite element analysis can be circumvented by the use of simple approximate methods at an early stage of the hardware development. The

discussion is extended to an evaluation of candidate test methods for characterizing the phenomenon and providing a vehicle for studying failure criteria for use in design.



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## Keywords

failure; localized curvature effect; finite element analysis; design

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