SPECIAL CLASS OF QUASI-ISOTROPIC LAMINATES FOR AEROSPACE APPLICATIONS

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ABSTRACT

This paper discusses about special class of non-symmetric laminates, which offers quasi-isotropy behaviour without any extension-bending coupling behaviour in the laminate. These non-symmetric layup sequences are found helpful in enhancing the performance of the laminated structures. Analytical computations were carried out on symmetric quasi-isotropic layered structure, various special categories of and non-symmetric quasi-isotropic layered structure for combined static and stability analysis on different boundary conditions and the results are presented and well discussed.

Keywords: Non symmetric laminates, Composites, Buckling, Coupling behaviour.

INTRODUCTION

Aerospace, Wind energy and Ship building industries are attracted towards composite materials due to high strength and high stiffness to weight ratio properties. To replace the existing metallic structures, engineers prefer to choose the quasi-isotropic laminate sequence to reinstate the in-plane isotropy in the structure. As a rule of thumb symmetric layup sequence is much preferred to avoid the extension and bending coupling behavior in the laminate (Kollar et al. 2003). But due to the constraints of quasi-isotropy and no extension-bending coupling behaviour, further optimization cannot be done on the symmetric quasi-isotropic layup sequence.

Literatures reveal that quasi-isotropic, fully isotropic and quasi-homogeneous laminates can be obtained through common and uncommon ply orientations (Fukunaga, H. 1990, Grediac, M. 2001).But owing to non-symmetrical nature of laminates all these sequences result extension bending coupling elements. Methods have also been developed to generate fully isotropic laminate with approximations (Vannucci et al. 2002).However the approximated laminates offer coupling elements.

Buckling is one of the critical failure criteria in most of the aircraft structures. Since laminated plates are much more efficient carrying the buckling loads, they are mostly used in aircraft wing, fuselage and many other structural configurations. Lots of research has been done towards improving the buckling load capacity of unstiffened and stiffened panels and weight optimization using genetic algorithms, ant colony algorithm and differential evolution algorithms (Wang et al. 2010). However these laminates are generated by symmetrical laminate sequence and common ply orientations and hence, do not offer quasi-isotropy. Therefore in this paper, special classes of non-symmetric quasi isotropic laminates without coupling behaviour are proposed and their application towards buckling resistance is briefly illustrated with examples.
RESULTS AND CONCLUSIONS

The Eigen values for symmetric and non-symmetric quasi-isotropic structures are indicated in the Fig.1 and the percentage of enhancement is represented in Fig.2

![Fig. 1 - Eigen buckling factors for symmetric and non-symmetric laminates](image)

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![Fig. 2 - Eigen buckling factors enhancement representation](image)

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The results obtained for the non-symmetric quasi-isotropic layered structures are much encouraging compared with symmetric quasi-isotropic layered structures for stability analysis for the same strength criteria. The performance of the plate structures prepared by non-symmetric quasi-isotropic laminates for various boundary conditions is improved by 7% without any weight penalty. These laminates can be an alternate for regular quasi isotropic laminates in aero-structural and other industrial structural applications.

REFERENCES


