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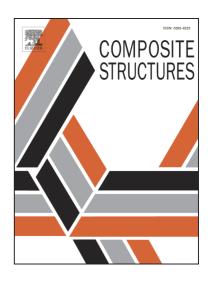
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Stress redistribution as an effect of non-uniform in-plane laminate stresses in laminate composite plates

Yoshiki Fukada^{a,1,*}

^a Toyota Motor Corporation, 1200 Mishuku, Susono-shi, Shizuoka-ken, 410-1193, Japan

Abstract

This paper describes a phenomenon that significantly affects the stress distribution in notched laminate composite structures. Ply-to-ply interactions under non-uniform laminate stress fields induce interlaminar and in-plane stresses that are not described in classical laminate theory. The theory is consist of a power series expansion along the thickness-wise coordinate. The most prominent influence of this effect is a substantial reduction in stress concentrations around notches. This may explain various experimental facts that conflict with classical laminate theory. Although this phenomenon appears to be a derivative of the so-called free-edge effect, it is not based on free-edge boundary conditions. For verification of the theory, this paper also presents finite element analysis cases for 5 mm diameter open hole [90/0]s cross-ply laminate plates. Reductions in stress concentration around hole edges were up to 10% of the far field stress. Insertion of low elasticity layers between 90 and 0 degree plies, the use of thick plies, or the adoption of ply materials with low transverse shear moduli were identified as effective means of reducing stress concentration around a hole. These findings may enable the application of new design principles. to deal with stress concentrations for notched composite structures.

Keywords: A. Layered structure, B. Delamination, C. Laminate theory, C. Plate theory, C. Finite element analysis (FEA)

^{*}Corresponding author

Email address: yoshiki_fukada@mail.toyota.co.jp (Yoshiki Fukada)

¹TEL:+81-55-997-7546, FAX: +81-55-997-7884

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