Effect of The Stacking Sequence and Number of Ply Orientation in a Quasi-Isotropic Laminated Plate on in plane Shear Modulus and Failure Modes

A Master's Thesis Defense in Mechanical Engineering

California Polytechnic State University, San Luis Obispo

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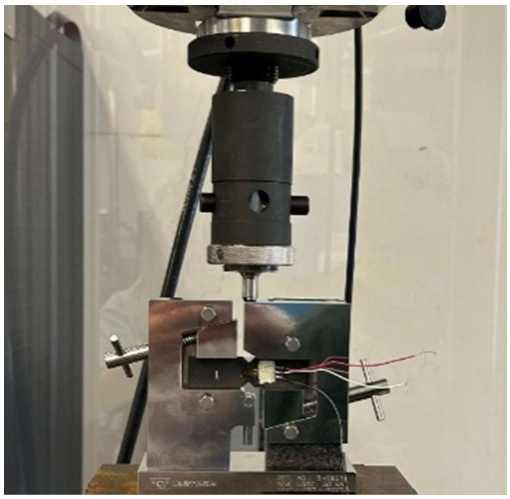
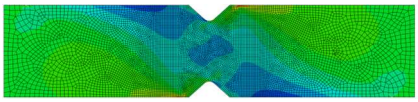
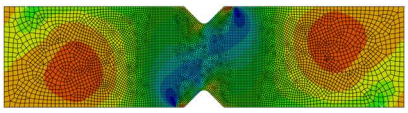
Friday June 5th, 2:30 PM, Zoom Meeting ID: https://calpoly.zoom.us/j/86103685660

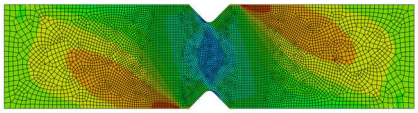




(A) Layup 1 Results (Shear Stress)



(B) Layup 2 Results (Shear Stress)



(C) Layup 3 Results (Shear Stress)

Maximizing the shear modulus and strength as well as predicting failure mode and location when designing a stacking sequence of quasi-isotropic carbon fiber laminated plates is essential to predict stability, resistance to deformation, and overall stiffness of the structure. This research will study the effect of the stacking sequence of quasi-isotropic laminated composite plate materials in accordance with ASTM D5379: Standard Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method.

In this research, experimental testing and Finite Element Modeling (FEM) of aluminum validated the simulation and experimental process by obtaining strong agreement of shear modulus calculation. The FEM model was then applied to four quasi-isotropic unidirectional laminated carbon fiber composites with different stacking sequences and layup orientations to study the effect of ply location and quantity on shear modulus and strength. Five coupons of each laminate were fabricated and experimentally tested for modulus of rigidity and failure mode using a shear fixture attachment on a tensile testing machine.

There was strong agreement for shear modulus between Classical Laminate Plate Theory calculations, MATLAB, FEM, and experimental results. This suggests that the Iosipescu fixture is a valid shear measurement technique and justifies elastic and failure trends to be drawn about the four laminates. Although the three laminates with varied stacking sequences of ply location had similar shear modulus and strength, certain ply orientations had more drastic failure modes when on the outside of the laminate. Understanding shear modulus and strength as well as failure mode and location will help guide engineers when designing laminated structures. The learnings from this thesis will be the backbone of a new composite shear testing lab at Cal Poly SLO.