INTE RLAMINAR CRACK OF SPACE COMPLEXES ELEMENTS

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Abstract:

Aerospace components are subjected to impact loading. the loads under various load conditions. Epoxy resin adds stiffness to composite materials there by changing the behavior of composite ply to optimized brittleness with transition stage. Mode, I depict brittle nature and Mode II depict ductile nature of stiffness. Hence Mode I failure generate more catastrophic failure than Mode II in composite parts. The manufacturing method used to create laminated composite materials is a significant disadvantage. When fabric or fibers are arranged in strata to create the desired architecture, resin-rich layers can form in the spaces between the fabric layers. These areas lack reinforcement and are vulnerable to discontinuities.

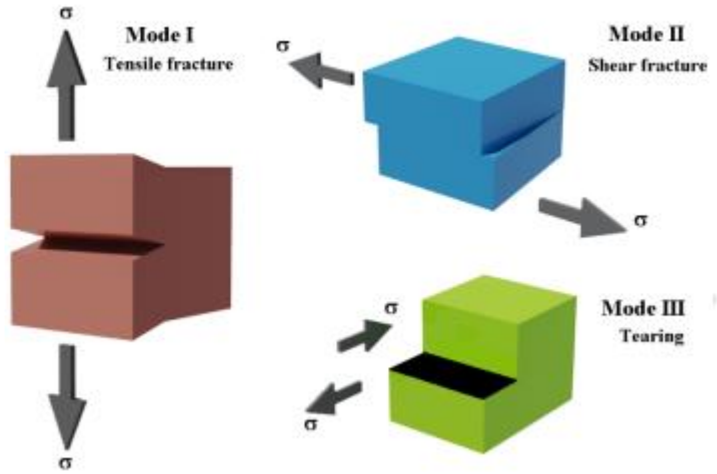
Keywords: Interlaminar fracture, Composites, Aerospace structures.

Introduction

Standard isotropic materials are being replaced by fiber reinforced composite materials in many applications. Currently, these composite materials are used to build aerospace vehicles, aircraft, marine equipment, and everyday objects like sports equipment, civil structures, and prosthetic devices. The main benefit of composite materials is that they can already be specifically tailored to a given design situation. To create the ideal material composition, different combinations, dosages, and architectural arrangements can be used with components like fibers and matrix material. The manufacturing method used to create laminated composite materials is a significant disadvantage. When fabric or fibers are arranged in strata to create the desired architecture, resin-rich layers can form in the spaces between the fabric layers. These areas lack reinforcement and are vulnerable to discontinuities.

Modes of fracture

A normal stress field induces an opening or “wishbone” effect. This type of behavior is common in structure and substructures such as skin stiffeners, I beam, or bonded connections of separate structures [Broek (1996)]. Brittle metals such as cast iron typically fail from mode, I type fracture in service. This is one reason that some homogeneous materials possess a compressive strength that is significantly greater than their tensile strength. For engineering polymers and metals, an ASTM standard compact tension sample (similar to Figure) is used [ASTM E 399-90 (1992)].



Mode of fractures.

Ultimately KIc is obtained based on initial crack length and remote stress field. KIc is a stress intensity factor that accounts for the reduced load Opening Mode Sliding Mode Tearing Mode Figure This type of analysis is usually only valid for high strength-brittle materials and homogenous materials in general.

Modal analysis for Mode I and II

With above set analysis it is evident epoxy plays an important role in material stiffness and strain energy. Hence modal analysis is carried on epoxy-based carbon fiber composites.

Analysis

Two set of analysis is carried out as follows:

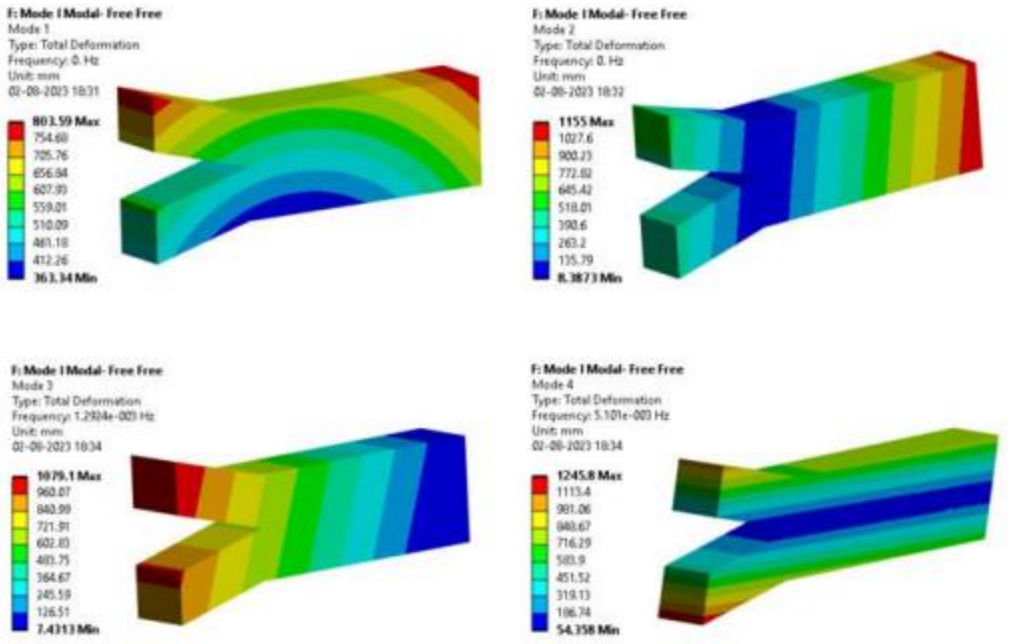
1) Free-free modal

2) Constrained modal

Symmetric model of 0/90/45/-45/90/0 composite ply DCB material is used to analyze Mode 1 fracture evaluation with respect to effect of load on stress, shear, and strain energy.

Material	Density	Youngs modulus- E- “Pa”			Poisson’s Ratio “v”			Shear Modulus -G- “Pa”		
		X	Y	Z	XY	YZ	XZ	XY	YZ	XZ
Carbon fiber -230	1800	$2.3e^{11}$	$2.3e^{10}$	$2.3e^{10}$	0.2	0.4	0.2	$9e^{10}$	$8.21e^{9}$	$9e^{10}$
Epoxy Carbon fiber -230	1490	$1.21e^{11}$	$8.6e^{9}$	$8.6e^{9}$	0.27	0.4	0.27	$4.7e^{10}$	$3.1e^{9}$	$4.7e^{10}$

Results Free modal analysis for Mode I - Epoxy Carbon 230



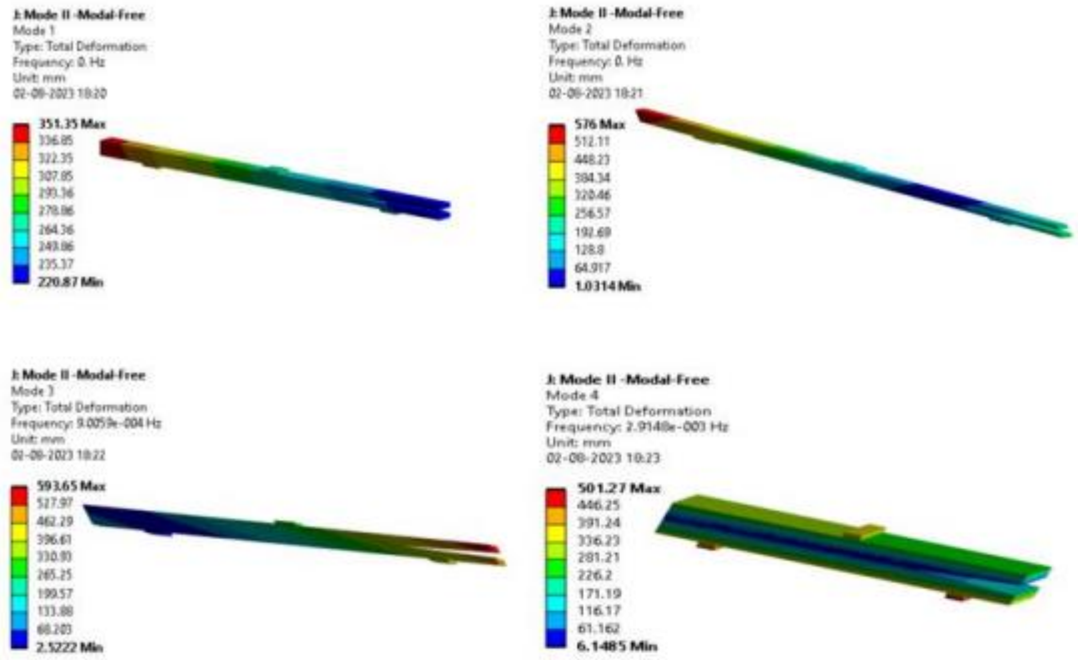
Free-free modal analysis all first six modes are below zero and shows rigid body motions.

Mode, I Constrained Modal analysis	
Mode	Frequency-"Hz"
1	5259
2	7266
3	8732
4	20758
5	24679
6	26550

Constrained modal analysis for Mode I -Epoxy Carbon 230

Constrained modal analysis shows the material is stiff and shows correlation with strain energy and stiffness all first six modes are below zero and shows rigid body motions.

Free modal analysis for Mode II -Epoxy Carbon-230

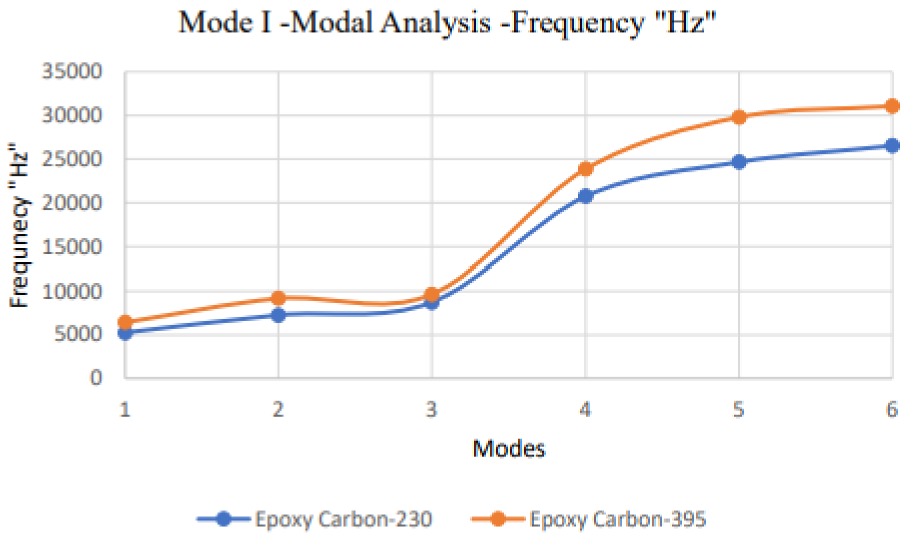


Mode II Free-Free Modal analysis – Epoxy Carbon Fiber 230

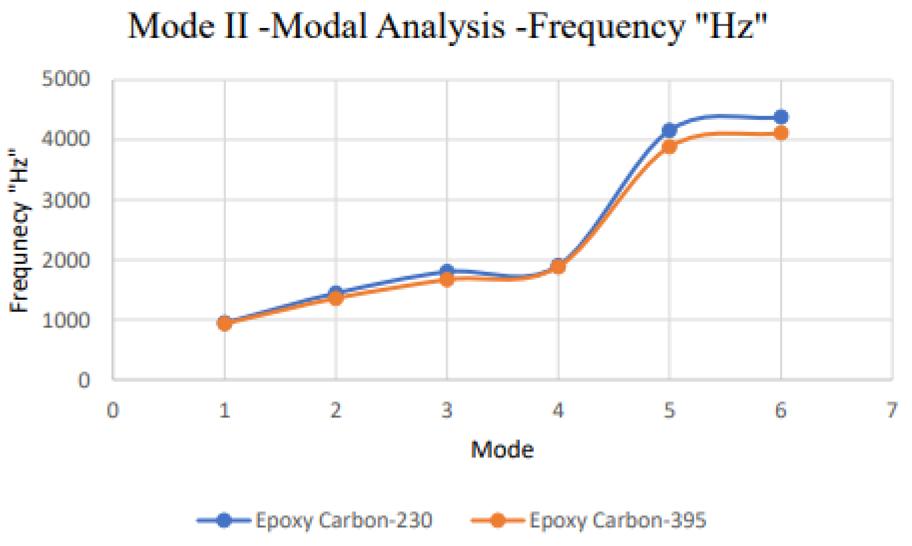
Free-free modal analysis all first six modes are below zero and shows rigid body motions.

Constrained modal analysis for Mode II-Epoxy Carbon-230

Modal Analysis - Data Interpretation



Graph 1 Mode I Mode I Constrained Modal analysis.



Conclusion

Epoxy resin adds stiffness to composite materials there by changing the behavior of composite ply to optimized brittleness with transition stage. Mode, I depict brittle nature and Mode II depict ductile nature of stiffness. Hence Mode I failure generate more catastrophic failure than Mode II in composite parts.

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