

# Carbon Composite Flexural Test Program: Project Overview

## Program Objective

This project's objective is to design and document a controlled experimental program to determine and evaluate the influence of laminate stacking sequence on the flexural stiffness and failure mode of carbon/epoxy composites.

The study focuses on five symmetric laminate configurations manufactured using vacuum bag wet layup with plain weave 3K carbon fiber and US Composites 635 epoxy system.

The program includes:

- Custom 3-point bend fixture design
- ASTM-based test coupon geometry (modified width)
- Controlled laminate manufacture
- Fabrication procedure planning
- Analytical data translated into meaningful properties

The project is currently in the pre-execution phase pending material acquisition and laboratory approval.

## Standards Basis

The test configuration is based on ASTM D7264 – Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials (Procedure A – 3-Point Loading)[1].

Important parameters:

- Span-to-thickness ratio: 32:1
- Three-point bending configuration
- Carbon fiber composite focus

## Test Coupon Geometry

Target coupon dimensions:

- Length: 154 mm
- Width: 20 mm (modified from 13 mm standard for fabrication repeatability)
- Target thickness: 4 mm
- Support span: 128 mm
- Span-to-thickness ratio: 32:1

Thickness will be measured at three locations per coupon prior to testing, to ensure consistent testing dimensions.

## Laminate Construction

All laminate configurations use:

- 60/40 Fiber/Resin ratio (by weight)
- US Composites 5.7 oz/yd<sup>2</sup> Plain Weave 3K Carbon Fiber [2]
- US Composites 635 Thin Epoxy [3]
- 16 plies per panel
- Symmetric layup construction

| Panel Identifier | Stacking Sequence ID (Degrees from 0°reference; S=symmetric) | Actual Stacking Sequence (Degrees from 0°reference)   |
|------------------|--|---|
|                  |  |   |
| A                | [0]16  | 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0 / 0                                 |
| B                | [90]16   | 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90 / 90                 |
| C                | [0/90]4S   | 0 / 90 / 0 / 90 / 0 / 90 / 0 / 90 / 90 / 0 / 90 / 0 / 90 / 0 / 90 / 0                         |
| D                | [+45/-45]4S  | +45 / -45 / +45 / -45 / +45 / -45 / +45 / -45 / -45 / +45 / -45 / +45 / -45 / +45 / -45 / +45 |
| E                | [0,+45/-45/90]2S   | 0 / +45 / -45 / 90 / 0 / +45 / -45 / 90 / 90 / -45 / +45 / 0 / 90 / -45 / +45 / 0             |

All panels are designed to maintain constant ply count and nominal thickness while varying fiber orientation.

## Test Fixture Design

A custom fixed-span 3-point bend fixture was designed and modeled in CAD.

Key features:

- Fixed support span: 128 mm
- Precision roller supports ( $\varnothing 12$  mm)
- Centered loading nose
- Rigid adjustable base plate
- Dimensioned part drawings for manufacturing

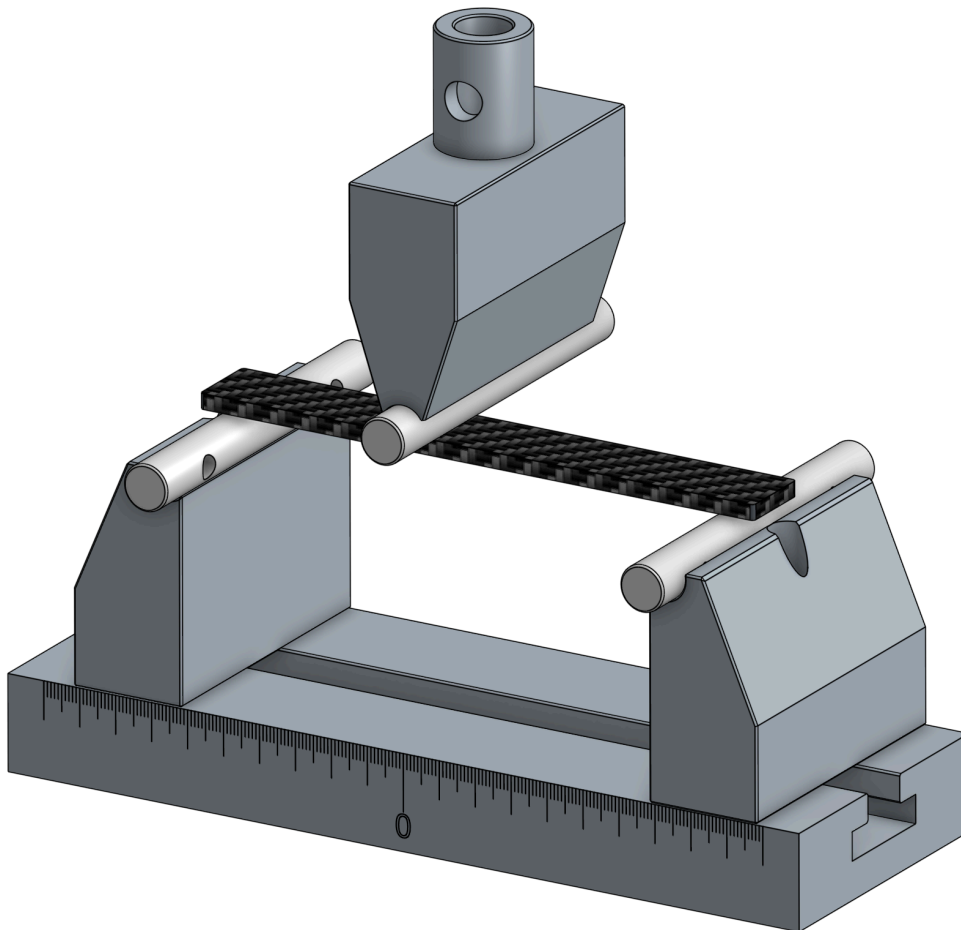


Figure 1: Test Fixture Render

## Flexural Stress Calculation

Flexural stress is calculated using:

$$\sigma = \frac{3PL}{2bt^2}$$

Where:

- P = Applied load
- L = Support span (128 mm)
- b = Specimen width (20 mm)
- t = Average measured coupon thickness (~4mm)

## Flexural Modulus Calculation

Flexural modulus is calculated from the linear slope of the load-displacement curve:

$$E_f = \frac{L^3 m}{4bt^3}$$

Where:

- m = Slope of the linear region of the load-deflection curve

## Execution Plan

Upon material acquisition and test approval:

1. Fabricate three sets of five laminate panels using vacuum bag wet layup.
2. Measure thickness and inspect panels for quality.
3. Cut and finish flexural specimens.
4. Perform 3-point bend testing at controlled displacement rate for each specimen.
5. Document failure modes photographically.
6. Process raw data using automated reduction scripts.
7. Compare flexural stiffness and strength across laminate configurations.

## References

[1] ASTM D7264 – *Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials*. ASTM International.

[2] US Composites. *635 Thin Epoxy System – Technical Data Sheet*.  
Manufacturer document, received via direct correspondence, June 2025.

[3] US Composites. *5.7 oz/yd<sup>2</sup> Plain Weave 3K Carbon Fiber Product Specification*.  
Available at: <https://www.uscomposites.com/epoxy.html> Accessed: January 2026.