

## Experimental Study of Mechanical Behavior of Glass Fiber Composite Plate With and Without Fiber Orientation



### Engineering

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### ABSTRACT

*In general strength of a fiber along its axial direction will be more against its normal direction. The same factor will affect the quality of the composite plate made of it. With respect to orientation of fibers there is a greater variation in the mechanical property of the composite plate. There are many studies going on the same and this paper discuss about the properties of the laminates with respect to its fiber orientation, which are taken from experimental data.*

### INTRODUCTION

Over the past three decades, application of composite materials are continuously increasing from traditional application areas such as military aircraft, commercial aircraft to various engineering fields including automobiles, robotic arms and even architecture. Due to its superior properties, composites have been one of the materials used for repairing the existing structures. In such applications and also for joining various composite parts together, they are fastened together either using adhesives or mechanical fasteners. Nowadays, a novel method called hybrid joint is also being employed, where a combination of both adhesive and mechanical fasteners is used.

Composite structures, used to meet the demand for lightweight, high strength/stiffness and corrosion-resistant materials in domestic appliances, aircraft Industries and fields of engineering composites have been one of the materials used for repairing the existing structures owing to its superior mechanical properties. Applications of composite materials have been extended to various fields, including aerospace structures, automobiles and robot systems.

### RESEARCH METHODOLOGY

#### OBJECTIVE

To investigate the mechanical properties like Tensile, Flexural and Impact Strength of glass fibre epoxy laminates with and without orientations. Such orientations are [0°, +45°, -45°, 90° and etc].

#### METHODOLOGY

The specimens were prepared with the glass fibre epoxy laminates according to the ASTM standard. The specimens were undergoing for mechanical testing by Universal testing machine and Impact testing machine. These results were compared with and without orientation.

### EXPERIMENTAL WORK AND MATERIAL PREPARATION

#### LAMINATE PREPARATION

- The laminate size is 300mm × 300mm x 4 mm
- Laminate is a symmetric because the no of layer is 6.
- The stitching direction is perpendicular to the fibre direction of the 0° surface layers of the laminates.
- An ensuing volume fraction of stitch threads material of about 0.3%.
- In order to reduce fibre distortion in the interior of the laminate. A modified lock stitch adopted for stitching by

easing the tension of the needle thread.

#### RESIN

- Resin is to transfer stress between the reinforcement fibres, act as a glue to hold the fibre together.
- Commonly used resin are:
- Epoxy, polyester and vinyl ester
- Epoxy LY556 is selected.

#### MOULDING PREPARATION

- Two rectangular mild steel plate having dimensions of 100m
- 100mm × 100mm x 4 mm.
- Chromium plated to give a smooth finished as well as to protect from rusting.
- Four beading are used to cover compress the fibre after the epoxy is applied.
- Bolt and nuts are used to lock the plate.

#### PREPARATION OF EPOXY AND HARDENER

- Epoxy LY556 and it mixed with Hardener HY951.
- Ratio of mixing epoxy and hardener is 10:1

#### SPECIMEN PREPARATION FOR GLASS FIBRE

- The mould should be well cleaned and dry.
- Release agent is applied.
- The epoxy mixture is uniformly applied.
- First woven mat is laid into the moulded.
- Apply the resin on mat by brush.
- Second mat is laid to first mat
- Repeated the process up to 6 layers
- Mould is closed.

### RESULTS AND DISCUSSION

#### TABLE – TESTS VALUES

S. NO	TEST DESCRIPTION		WITH ORIENTATION (N)	WITHOUT ORIENTATION (N)
1	Tensile	Sample 1	26.40(90degree)	2.74
		Sample 2	6.5230degree)	2.80
2	Compression	Sample 1	0.94(90 degree)	0.12
		Sample 2	0.44(30 degree)	0.12
3	Impact	ENERGY – Joules		
		Set 1	20(90degree)	4
		Set 2	19(90degree)	4
		Set 3	4(30 degree)	4

### CONCLUSION and DISCUSSION: EFFECT OF FIBRE ORIENTATION

When composite materials are designed, the reinforcements are always oriented in the load direction. However if the load direction is variable and not parallel to the fibres it becomes more important to investigate the laminate mechanical behaviour. To investigate the effect of fibre orientation,  $\pm 30^\circ$ ,  $\pm 45^\circ$  and  $\pm 90^\circ$  were selected under this study. Specimens with different fibre orientations were prepared under the same conditions as discussed earlier.

The experimental results show that the tensile strength is affected by the fibre orientation significantly as summarized below:

a) The tensile strength is superior in case of  $30^\circ$  orientation. b) More load is required for fracture of laminates in case of  $90^\circ$  orientation. c) More elongation is observed in  $30^\circ$  orientation. The elongation is minimal in case of  $90^\circ$  orientation d) Maximum load at high yield point in case of  $45^\circ$  orientations. e) Young's modulus is more in case of  $90^\circ$  orientations.

The experimental investigations used for the analysis of tensile behaviour of glass fibre reinforced polymer laminates leads to the following conclusions.

- The laminated specimens with lesser thickness leads to more ultimate tensile strength irrespective fibre orientations
- Specimen sustain greater load in  $90^\circ$  orientation specimens than in other orientations.
- Young's modulus of specimens increases with decrease in thickness.
- Extension is minimum in case of  $90^\circ$  orientations and maximum in case  $30^\circ$  orientations.
- From the obtained results and graphs which is discussed in previous chapter, it was found that the woven glass epoxy laminator with orientation plate strength is higher than the normal fabricated laminates.
- This cause will affect the application such as automotive,

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