INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

DEPARTMENT OF AEROSPACE ENGINEERING

Aircraft Structures Laboratory - AE 314

INTER - LAMINAR SHEAR STRENGTH TEST

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1 Aim

To determine the **inter-laminar shear strength** of woven E-Glass Epoxy composites using the **D3846 double notched shear test**.

2 Equipment Used

- Universal testing machine (UTM) of 100 kN capacity with maximum 1% loading and displacement error
- Vernier Calipers

3 Materials Used

The test specimen is made up of

- E-Glass fiber
- Epoxy Resin (LY 556)
- Hardener (HY 951)

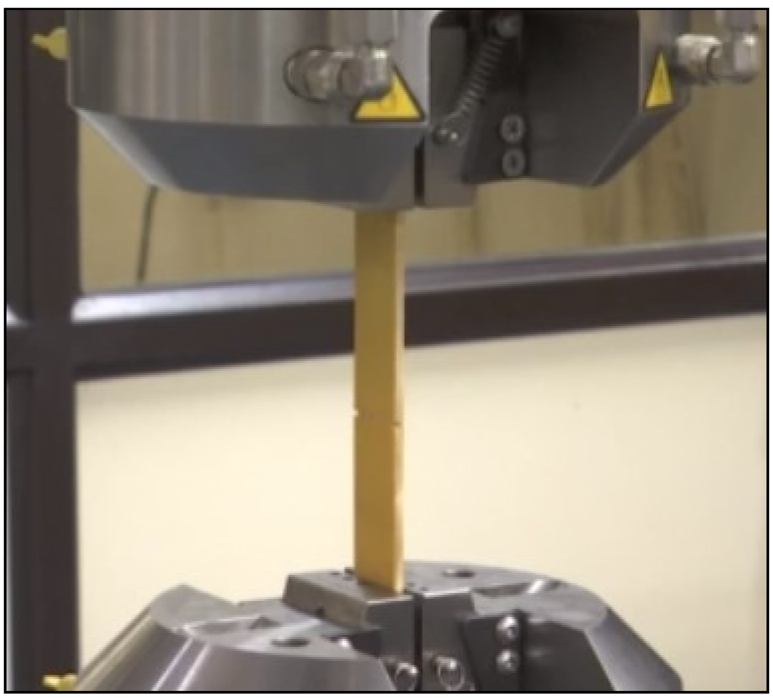


Figure 1: Sample mounted on UTM for ILSS test

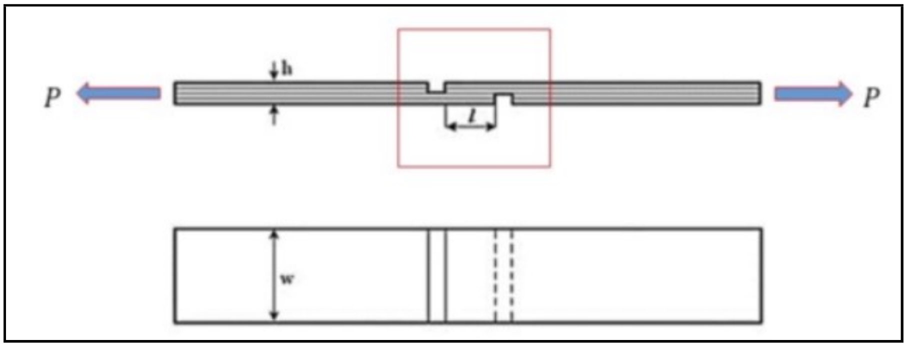


Figure 2: Double notched shear test

4 Observations and Calculations

4.1 Specimen Dimensions

Using Vernier calipers, we measure the specimen dimensions required for estimating the inter-laminar shear strength of the specimen.

Width (mm)	17.1
Distance between notches (mm)	6.65

Table 1: Specimen Average Dimensions

The test rate applied using the UTM was 0.5 mm/min.

4.2 Calculations

$$S = \frac{P}{ad} \tag{1}$$

$S =$ In plane shear strength
$P =$ Maximum load at the time of breaking (N)
$a =$ Distance between the notches (mm)
$b =$ Width of the specimen (mm)

note : Graphs and other calculations are on the last page

From the data obtained using the UTM, the maximum load comes out to be **2041.668 N**.

$$S = \frac{1703.2}{17.1 \times 6.65} = 14.97779 \text{ MPa}$$

Width (mm)	Distance between notches (mm)	Max Load (N)	ILSS (MPa)
26	14	2041.668	5.608979

5 Assignment Answers

1) **What is inter-laminar shear strength? What is the importance of ILSS?**
Laminated composites consist of multiple lamina stacked over each other to form a laminate. Inter-laminar shear strength (ILSS) in the **shear strength measured at the time of failure** in which the plane of fracture is along the **interface between two lamina**. ILSS is an important property in design of laminates subjected to transverse loads. **Delamination** is a critical failure mechanism observed for laminates, which is the failure at the interface between different layers. The resistance against delamination is characterized by the inter-laminar shear strength of the composite.

2) **What are possible sources of error in the experiment and what can be done to eliminate them?**
   - The specimen should be mounted on the UTM such that the **notches are at the center**, i.e. equidistant from the two ends of the holder. If a notch is placed very near to a holder, the shear stress induced will not be linear which will lead to errors in the measurements.

- The specimen must also be mounted **perfectly vertical** to avoid non-uniform loading which may again lead to measurement errors.
- The **fixture grips** used for mounting the specimen must be **identical**, otherwise error may be induced due to different grips at the 2 ends.

3) **How is the distance between two notches influencing your experiment?**
Inter-laminar shear strength along the midplane between the notches is non uniform, but becomes uniform as the distance between the notches is reduced.

$$S = \frac{P}{ad}$$

here a is the distance between the two notches, which when reduced will lead to a lower value of the failure load. Thus the inter-laminar shear strength measured will **almost remain constant** with decrease in notch separation. It is better to perform the test with lesser distance between the notches to keep the failure load low.

6 References

- ASTM D790-99 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- Engineering Mechanics of Composite Materials by Daniel, Ishai.

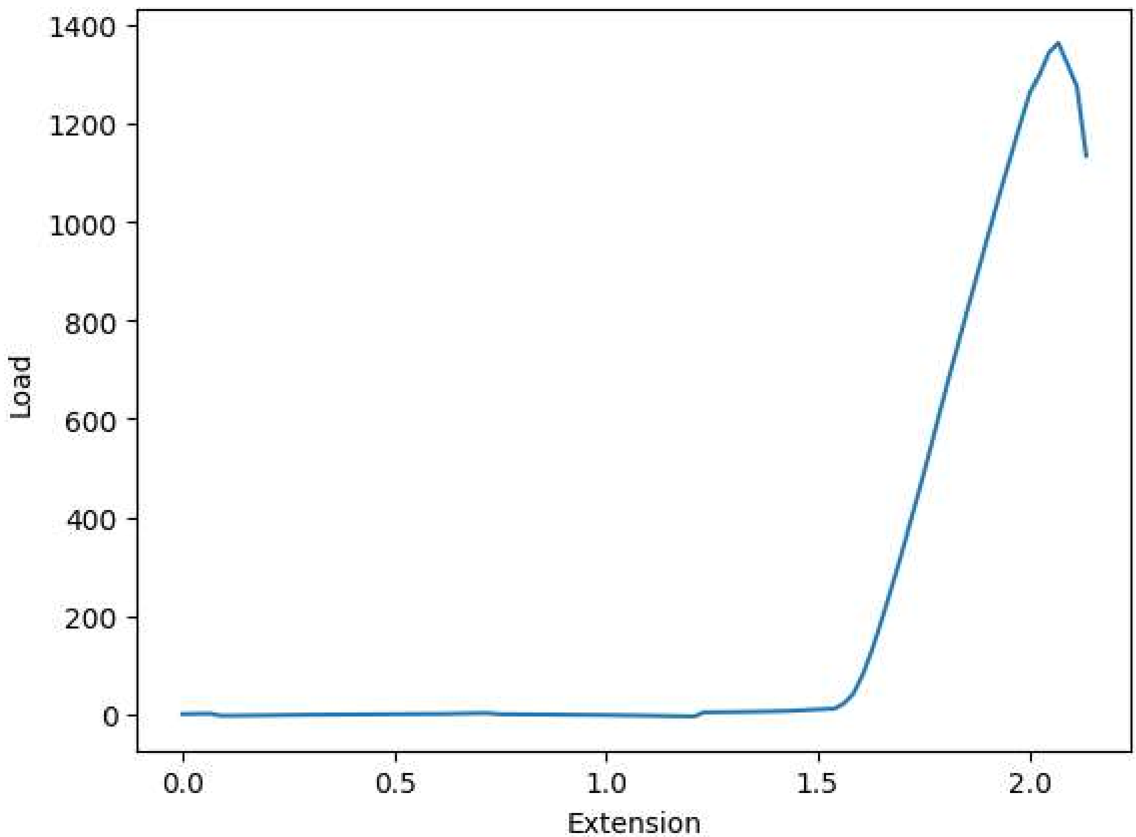
In [ ]:
```
import pandas as pd
import matplotlib.pyplot as plt
```

In [ ]:
```
df=pd.read_csv("ilss.csv")
```

x and y are reduced extension and load from data which are extension-extension[0] and load-load[0] respectively

In [ ]:
```
x=(df['extensionr'])
y=(df['loadr'])
```

In [ ]:
```
plt.plot(x,y)
plt.xlabel("Extension")
plt.ylabel("Load")
plt.show()
```



It is observed that the till 1.5mm the material is being extended very easily with minimum load while after that for small extensions we needed to apply very high loads which is varying linearly with a very high slope

*** The graph is showing reduced load as well as extension and because of this: $Load_{actual} = Load_{graph} + 339.85$

In [ ]: