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Identification of Composite Materials used in Automobile Carpet Reinforced with Glass Fiber and Determining Its Mechanical Properties

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Abstract

In automobile industries different carpets are used for different purposes. Carpet is a dense full wrapper for a floor that has been generally made of cotton or artificial fibers, particularly one that covers the complete floor surface. Carpet is a fabric floor wrapping which usually comprises of a top layer of stack connected to a back rest. Molded carpet denotes commonly to carpets used in car insides. Two types of backings are used in carpet, poly backing and mass backing. In most cars mass backing is used. Mass backing is thick and having rubber-like structure. Poly backing is light in weight, easier to bend. It is very important to know the material properties of carpet so as to determine suitable parameters for carpet forming. Tensile strength and Poisson's ratio are some of the important properties which are required to determine forming parameters such as blank holding force, press tonnage etc. This paper is mainly focusing on identifying the material of carpet and determining its mechanical properties

Keyword: Automobile carpet, blank holding force, Poisson's ratio tensile strength

INTRODUCTION

Carpets are used for different of reasons, it insulates a person's feet from a cold surface, to make room more relaxed as a place to sit on the floor as well as reducing walking sound and also for decoration purpose. Multitude of reasons are there to use carets, which consist isolating feet of persons from a cold grit or concrete surface, making an area extra convenient as a location to sit on the ground, and decreasing walking noise (especially in apartment houses) and adding beautification or shade to a room. Most choices are produced in an sector as competitive and innovative as cars for very excellent reasons. Carpeting is made of thousands of small fabric loops at its most fundamental point, whether it is wool, rayon, nylon or anything else completely. This structural quality implies that a wider variety of sound waves will be able to communicate with separate loops of variable sizes, dimensions, angles and spirality. This is very important in a vehicle, as a motor can create a lot of noise, as can all the vital components of a vehicle under the ground. It operates as an exceptional noise dampener with carpeting on all surfaces, as the undercarriage clanging and knocking of the car is mostly absorbed by the carpeting. By applying carpeting, as opposed to the irritating clanging of early vehicles with wooden or metal floors, as much as 40% of the car's noise can be eliminated. The carpeting offers not only sound insulation, but also temperature control. Imagine driving through wintery hills for a long time, when the outside temperature is 20 degrees Fahrenheit.

1. MATERIAL LAYER IDENTIFICATION

The carpet material is a composite type material which consists of different layers of materials. The following chemical tests are carried out to identify the carpet material layers. The below table shows that Polyester can be soluble in strong NaOH and similarly all of below lited material are soluble in their respective solvent. From this chemical tests one can recognize the material of carpet. Below figure shows the carpet material layers.

1.1 Chemical testing:

Table 1: Chemicals used for carpet material identification

Sr. No.	Material	Chemical Used
1.	Polyester	Strong NaOH Dissolves Polyster
2.	Glass fibre	Hydrofluoric Acid
3.	Polyurethane	Acetone or denatured alcohol to dissolve polyurethane glue
4.	Paper	70% H_2SO_4 by volume + 30% water

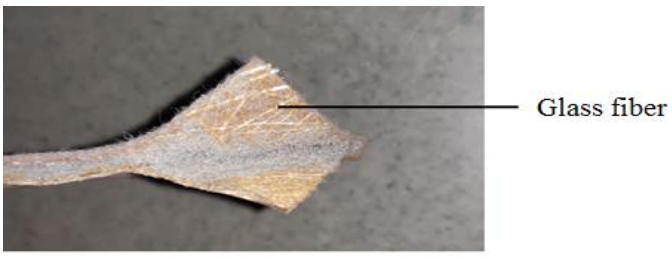

Fig.1 Glass Fiber

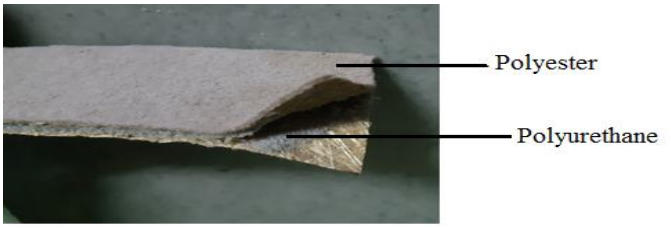

Fig.2 Polyurethane and Polyester

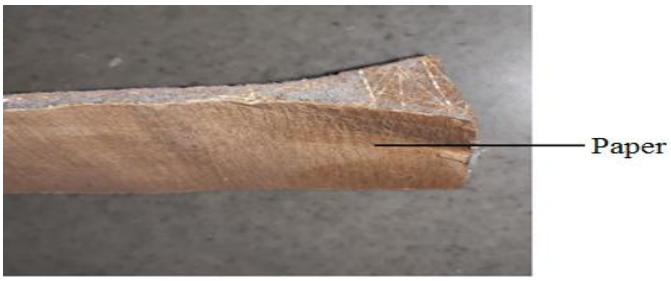

Fig.3 Paper

1.2 Materials used in carpet

1. Polyester

It is also documented as "PET" (polyethylene terephthalate) is used in carpet built-up in spun and filament buildings. Polyester is stain-resistant because it is hydrophobic. It can be colored in molten state.

2. Glass fiber

Glass fiber is a substance containing of very fine fibers of glass. It has approximately similar mechanical characteristics to other fibers, such as polymers and carbon fibers.. But it is not strong like carbon fiber; it is less costly and less brittle when used in composites. So it is used as a reinforcing member. It is also used to manufacture high strength and low.

3. Polyurethane

Polyurethane is a leading member of the wide-ranging and highly diverse family of polymers or plastics. Polyurethane can be a solid or can have an open cellular structure, in which case it is called foam… and foams can be flexible or rigid. Flexible PU foams are also moulded, especially for use in the automotive sector, mainly for car seats. Rigid foams are mainly used for thermal insulation of buildings.

4. Paper

Paper is used as a backing material in carpet to support and add rigidity to the composite sheet

2. MECHANICAL TESTING

Mechanical properties such as Young's modulus, tensile strength, bending strength and Poisson's ration plays very important role in selection of Punch and die material , to decide press capacity etc. So the composite material is tested mechanically to find out its properties.

A. Tensile test

The glass fibre reinforced polyester composite cut into required size. The tensile test was carried out on INSTRON 5565 with load cell capacity of 5KN with a cross head speed of 5 mm/min as per the ASTM standards. The test specimens were prepared as Per ASTM D638 (165 x 19) mm; thickness is 6 mm, shown in Figure 4. The three specimens were subjected to tensile test and their values were recorded.

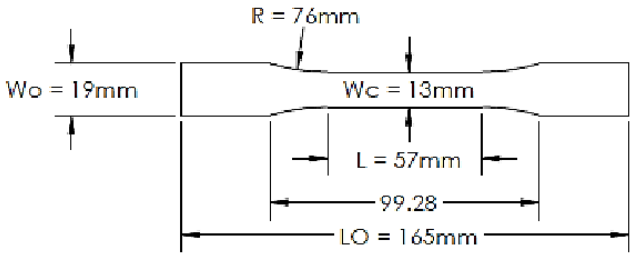

Fig.4 Geometry and dimensions of the specimen (ASTM D638)

Fig.5 Tensile test specimen before testing (ASTM D638)

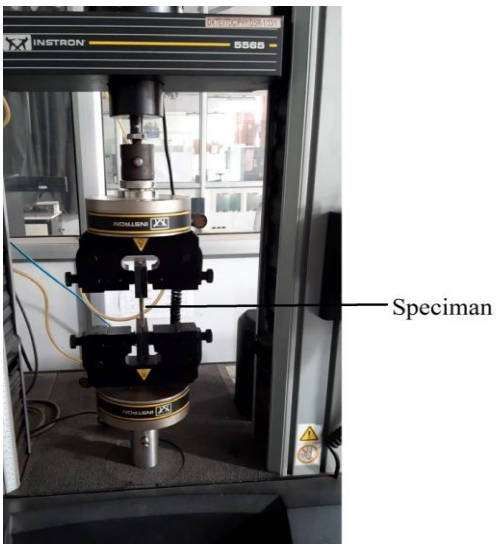

Fig.6 Tensile test setup on INSTRON 5565 machine

Fig.7 Tensile test specimen after testing

Graphs

Load vs. Elongation

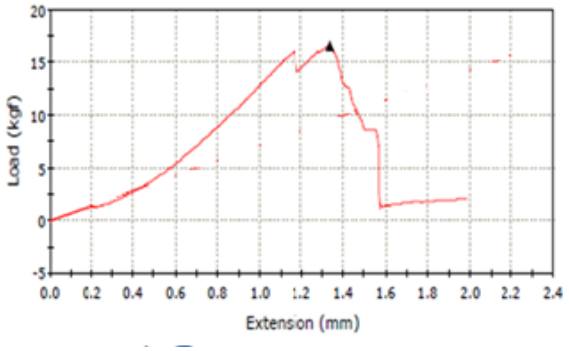

Fig.8 Load vs. Elongation-Specimen 1

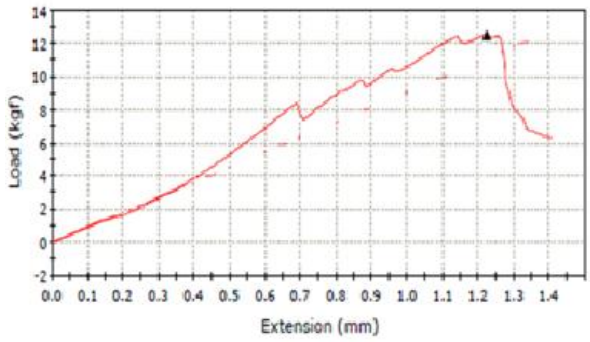

Fig.9 Load vs. Elongation-Specimen 2

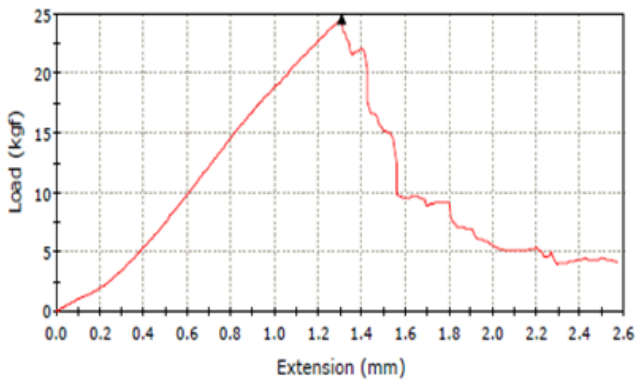

Fig.10 Load vs. Elongation-Specimen 3

Stress-Strain Curve

The values of load-elongation are converted in stress-strain and following graph is plotted as a mean of above three load-elongation graphs.

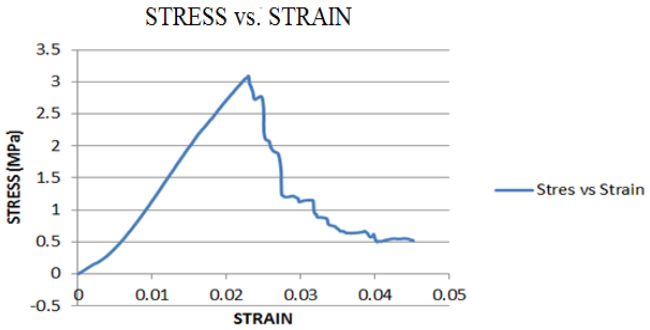

Fig.11 Stress-Strain Curve

Calculation:

Poisson's ratio = Lateral strain / Linear strain

Linear strain = Change in linear dimension / original dimension

= 1.3 / 57 …… (Change in linear dimension-from graph)

Linear strain=0.0228

Lateral strain = Change in lateral dimension / Original Dimension

= 0.08 / 13 (Change in lateral dimension - actual reading using vernier caliper)

Lateral strain = 0.006

Poisson's ratio= 0.006 / 0.0228

=0.263

B. Three point bending test

To calculate flexural strength of the composite material this test is conducted. It was carried out on INSTRON 5565 with load cell capacity of 5KN with a cross head speed of 5 mm/min as per the ASTM standards D-790 (80 mm x 12.5 mm), thickness is 6 mm.

Fig.12 Bending test set up on INSTRON 5565 machine

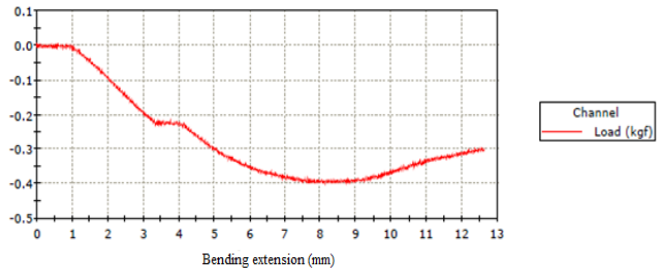

Fig. 13 Bending test graph-Specimen 1

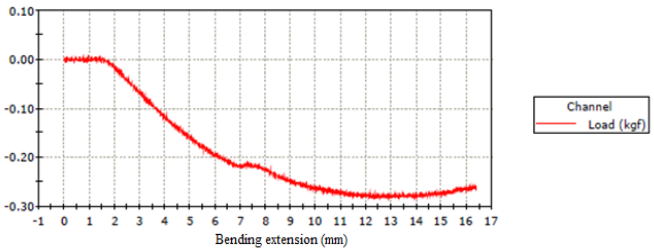

Fig. 14 Bending test graph-Specimen 2

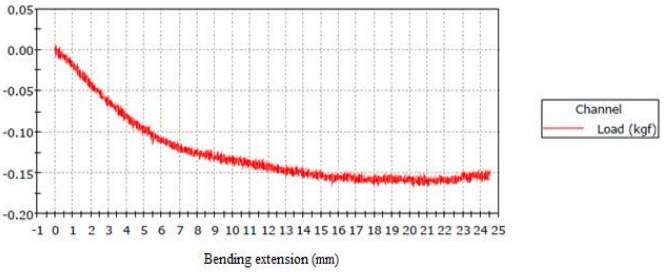

Fig. 15 Bending test graph-Specimen 3

Table 2: Bending test results

	Load at Maximum Compressive load (kgf)	Extension at Maximum Compressive load (mm)	Time at Maximum Compressive load (sec)
1	-0.40	-8.12	97.50
2	-0.29	-12.57	150.80
3	-0.17	-21.03	252.40
Mean	-0.28	-13.91	166.90
Standard Deviation	0.12	6.56	78.70
Coefficient of Variation	-41.13	-47.15	47.15

Flexural strength of the composites material was calculated according to following equation

$$\sigma_f = \frac{3FL}{2wt^2}$$

where F is applied load (N), L is support span (mm), w and t are width and thickness of the specimen (mm), respectively.

So, Flexural strength according to above formula by values from graph=4.38 N/mm^2

3.3 Weight density calculation:

Fig.16 Weighing Sample 1

Fig.17 Weighing Sample 2

Mean weight=12.86 grams

Carpet sample size=50cmx30cmx0.6cm

Volume=900cm^3

Weight density=0.0142 g/cm^3

PROPERTIES OF CARPET MATERIAL ACCORDING TO STREE-STRAIN GRAPG AND WEIGHT CALULATION

Table 3: Carpet sheet material properties

SR. NO.	PROPERTY	VALUE
1.	Yield strength	3.07 N/mm^2
2.	Young's modulus	139.5 N/mm^2
3.	Poisson's ratio	0.263
4	Weight Density	0.0147 g/cm^3

So, from the table 3 we can figure out different properties of carpet sheet, which are calculated by using tensile, bending and weight testing. These values can further be used for conventional die design calculation as well as for analysis purpose.

4. RESULT

In this research work explains method to identify the different material used in automobile carpet by chemical testing. The different properties composite material such as yield strength=3.07 N/mm^2, Young's modulus139.5 N/mm^2, Poisson's ratio=0.263, weight density=0.0147 is determined by doing experiment.

5. CONCLUSION

- Chemical testing is carried out to identify the material that can be further used for similar kind of material layer recognition
- The mechanical testing carried out here to determine the properties such as yield strength,

Young's modulus, Poisson's ratio, weight density is determined by doing experiment can

Further be used for forming related calculations such as to determine blank holding force, Press tonnage etc.

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