AN EXPERIMENTAL INVESTIGATION ON THE MECHANICAL PROPERTIES OF GFRP REINFORCED WITH SUGAR CANE

AJITH KUMAR. R[1], DINAKARAN.M [2], GOWRISHANKAR.T[3], LOGESH KUMAR.M[4], LOGESH.G(A.P)[5]

[1]Ajith kumar.R , Department of Mechanical, SRM Valliammai Engineering College, Tamilnadu, India

[2]Dinakaran.M, Department of Mechanical, SRM Valliammai Engineering College, Tamilnadu, India

[3] Gowri shankar.T, Department of Mechanical, SRM Valliammai Engineering College, Tamilnadu, India

[4]Logesh kumar.M Department of Mechanical, SRM Valliammai Engineering College, Tamilnadu, India

[5]G.Logesh.,M.E.,(Ph.D.) Assistant professor, Department of Mechanical, SRM Valliammai Engineering College, Tamilnadu, India\

ABSTRACT

Glass fiber-reinforced polymer composites may be made using a variety of production techniques, and they find widespread usage in a broad range of industries and applications. At first, the Egyptians constructed their vessels from of glass fibers that were extracted from heat-softened glass. The production of continued glass fibers began in the 1930s and was first targeted at high-temperature electrical applications. In modern times, it has found use in a variety of fields, including electronics, aircraft, automobiles, etc. Glass fibres have a number of desirable qualities, including high strength, flexibility, and stiffness, as well as resistance to the damaging effects of chemicals. It is possible for it to take the shape of roving, chopped strands, yarns, textiles, or mats. In the form of polymer composites, each kind of glass fibre has qualities that are distinct from the others and may be utilized for a variety of purposes. There was some reporting done on the mechanical characteristics of composites that included glass fiber-reinforced polymer.

Keywords: *Glass fibre, Mechanical properties, Composites, Automobiles*

1.INTRODUCTION

In recent years, fibre reinforced polymers, often known as FRPs, have grown more popular, which has led to an increase in the amount of scholarly investigation into the material (FRPs). The high cost of the material results in a prohibitively costly production process for synthetic fiber-reinforced polymers. The excessive cost of these polymers' manufacturing renders them unattainable to a large number of individuals, despite the fact that they possess outstanding qualities. However, composites manufactured from natural fibres may be produced at a lower cost and in a manner that is less harmful to the environment. This is the case despite the fact that composites made from natural fibres have much worse mechanical qualities than those made from synthetic fibres. As a direct result of this, scientists from all around the world have started looking at hybrid composites, which are produced by interlacing natural and synthetic fibres in the same matrix. These composites perform very well when compared to the same quantity of separate fibres. According to the findings of current study, the transverse compressive strength of jute-glass hybrid composites is even lower than that of standard jute composites.

2.OBJECTIVES

Glass fiber-reinforced plastic, sometimes known as fiberglass in American English and fiberglass in Commonwealth English, is a popular form of fibre-reinforced plastic. It is possible to weave the fibres into glass fabric, arrange them in a random pattern, or flatten them into a sheet known as a chopped strand mat. The plastic matrix may be made of a thermoset polymer, which is often based on thermosetting polymers like epoxy, polyester resin, or vinyl ester resin; alternatively, the plastic matrix may be made of a thermoplastic.

It is less expensive and more flexible than carbon fibre, it is stronger than many metals by weight, it is non-magnetic and non-conductive, it is transparent to electromagnetic radiation, it can be molded into complicated forms, and it is chemically inert in many different settings. Applications for this material include airplanes, boats, vehicles, bathtubs and their enclosures, swimming pools and hot tubs, septic tanks and water tanks, roofs, pipelines, cladding, orthopaedic casts, surfboards, and exterior door skins.

3.MATERIAL CHOOSEN

GENERAL DESCRIPTION

Glass fiber-reinforced plastic, sometimes known as fiberglass in American English and fiberglass in Commonwealth English, is a popular form of fibre-reinforced plastic. It is possible to weave the fibres into glass fabric, arrange them in a random pattern, or flatten them into a sheet known as a chopped strand mat. The plastic matrix may be made of a thermoset polymer, which is often based on thermosetting polymers like epoxy, polyester resin, or vinyl ester resin; alternatively, the plastic matrix may be made of a thermoplastic.

It is less expensive and more flexible than carbon fibre, it is stronger than many metals by weight, it is non-magnetic and non-conductive, it is transparent to electromagnetic radiation, it can be molded into complicated forms, and it is chemically inert in many different settings. Applications for this material include airplanes, boats, vehicles, bathtubs and their enclosures, swimming pools and hot tubs, septic tanks and water tanks, roofs, pipelines, cladding, orthopaedic casts, surfboards, and exterior door skins.

Glass-reinforced plastic, also known as GRP or GFRP, and glass-fiber reinforced plastic, sometimes known as GFK (German: Glasfaserverstarkter Kunststoff), are all frequent alternative names for fibreglass. Because the term "fibreglass" may also be used to refer to the glass fibres themselves, the composite material can also be referred to as fiberglass-reinforced plastic (FRP). This article will adhere to the norm that "fiberglass" refers to the full material that is fiber-reinforced composite, and not just the glass fiber that is included inside it.

Similar to other types of composite materials, carbon-fiber-reinforced polymers include carbon fibres serving as the material's reinforcement. In contrast to the glass fibres that are used for insulation, the surfaces of the fibres that are utilized in the construction of the final structure need to be nearly totally free of flaws in order for the fibres to achieve gigapascal levels of tensile strength. It is often impossible to make and maintain bulk material in a defect-free state outside of laboratory circumstances. However, if a large piece of glass were flawless, it would have the same level of strength as glass fibres. Pultrusion is the term used to describe the process of fabricating fiberglass. Large furnaces are used in the production process for glass fibers that are ideal for reinforcing. During this process, the silica sand, limestone, kaolin clay, fluorspar, colemanite, and dolomite, along with other minerals, are progressively melted until a liquid is formed. After that, it is forced through bushings, also known as spinnerets, which are bundles of very minute orifices (typically 5–25 micrometers in diameter for E-Glass, 9 micrometers for S-Glass).

After that, these filaments are coated with a chemical solution that gives them their size. Now that the individual filaments have been bundled together in huge numbers, a roving has been produced. Its weight, which is commonly stated using one of two measuring methods, is determined by the diameter of the filaments as well as the number of filaments that are present in the roving:

After that, these rovings are either utilized directly in a composite application such as pultrusion, filament winding (pipe), or gun roving (in which an automated gun chops the glass into short lengths and drops it into a jet of resin, projected onto the surface of a mould), or they are utilized in an intermediary step to manufacture fabrics such as chopped strand mat (CSM) (made of randomly oriented small cut lengths of fiber all bonded together), woven fabrics, knit fabrics

Composites are classified by

1. the geometry of the reinforcement as particulate, flakes and fibers
2. the type of matrix as polymer, metal, ceramic and carbon

The most commonly used advanced composites are polymer matrix composites. These composites consists of a polymer such as epoxy, polyester, urethane etc., reinforced by thin-diameter fibers such as carbon, graphite, aramids, boron, glass etc. Low cost, high strength and simple manufacturing principles are the reason why they are most commonly used in the repair of aircraft structures.

Natural Fiber

Natural fibre based composites are quickly becoming key composite materials in the architectural and civil engineering disciplines due to their low weight, high strength to weight ratio, and resistance to corrosion. Other benefits include the ability to resist corrosion. In the case of composites made from synthetic fibres, recycling them after they have served their intended purpose might be challenging despite the fact that they are valuable in service. Natural fiber-based composites, on the other hand, are environmentally benign to a significant degree. Following is a brief overview of some of the most significant composites that were developed via a significant amount of research and development work. These composites are based on natural fibers.

More and more emphasis is being paid to the use of natural fibers as a reinforcing agent in composite matrices (such as cement and polymer), and this attention is being focused on a variety of low-cost construction materials. The natural fibers are easily accessible in large quantities in the area and are derived from sources that are continually replenished. At the moment, India's output of natural fibers totals more than 400 million tonnes. Table 1 provides an approximation of the production of the many different types of natural fibers.

Table 1 Availability of natural fiber in India and its applications

Item	**Source**	**Qty. in Mt/Yr.**	**Application in building material**
Rice Husk	Rice mills	20	As fuel, for manufacturing building materials and products for production of rice husk binder, fibrous building panels, bricks, acid proof cement
Sansevieria Trifasciata and palmyra sprout leaves/stalk	Sansevieria Trifasciata and palmyra sprout plants	0.20	In the manufacture of building boards, fire resistance fibre board
Coconut husk	Coir fibre industry	1.60	In the manufacture of building boards, roofing sheets, insulation boards, building panels, as a lightweight aggregate, coir fibre reinforced composite, cement board, geo-textile, rubberized coir
Groundnut shell	Groundnut oil mills	11.00	In the manufacture of buildings panels, building blocks, for making chip boards, roofing sheets, particle boards
Jute fibre	Jute Industry	1.44	For making chip boards, roofing sheets, door shutters
Rice/wheat straw	Agricultural farm	12.00	Manufacture of roofing units and walls panels/boards
Saw mill waste	Saw mills/wood	2.00	Manufacture of cement bonded wood chips, blocks, boards, particle boards, insulation boards, briquettes
Sisal fibres	Sisal plantation	.023 (Asia)	For plastering of walls and for making roofing sheets, composite board with rice husk, cement roofing sheet, roofing tiles, manufacturing of paper and pulp
Cotton stalk	Cotton plantation	1.10	Fibre boards, panel, door shutters, roofing sheets, autoclaved cement composite, paper, plastering of walls

Lamination Preparation:

- The laminate size is 300mm × 300mm x 3.5 mm
- Laminate is a symmetric because the no of layer is 6.
- The stitching direction is perpendicular to the fiber direction of the 0˚ surface layers of the laminates.
- An ensuing volume fraction of stitch threads material of about 0.3%.

4.3.2 RESIN

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

4.3.3 Types of hardeners

- HY951 – at room temperature.
- HT927 – temperature ranging from 80˚C - 130˚C
- HT974 - temperature ranging from 70˚C - 80˚C
- HZ978 - temperature ranging from above 100˚C

4.3.4 Preparation of Epoxy and Hardener

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

4.3.5 Specimen preparation for glass fiber

- 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.

CHAPTER-5

5.1 Lamination:

Fig 5.1 GFRP

Fig 5.2 Epoxy Resin

Fig 5.3 Hardner

Fig 5.4 Mixture of resin and hardener

Fig 5.5 Layer arrangement

Fig 5.6 Surface Rolling

CHAPTER 6

RESULTS & DISCUSSION

6.1 Tensile test

TABLE: 6.1 Sample 1 tensile test of UTL (KN)

Tensile test	
Glass fiber epoxy laminated without sugarcane fiber UTL (KN)	**Glass fiber epoxy laminated with sugarcane fiber UTL (KN)**
8.4	10.33

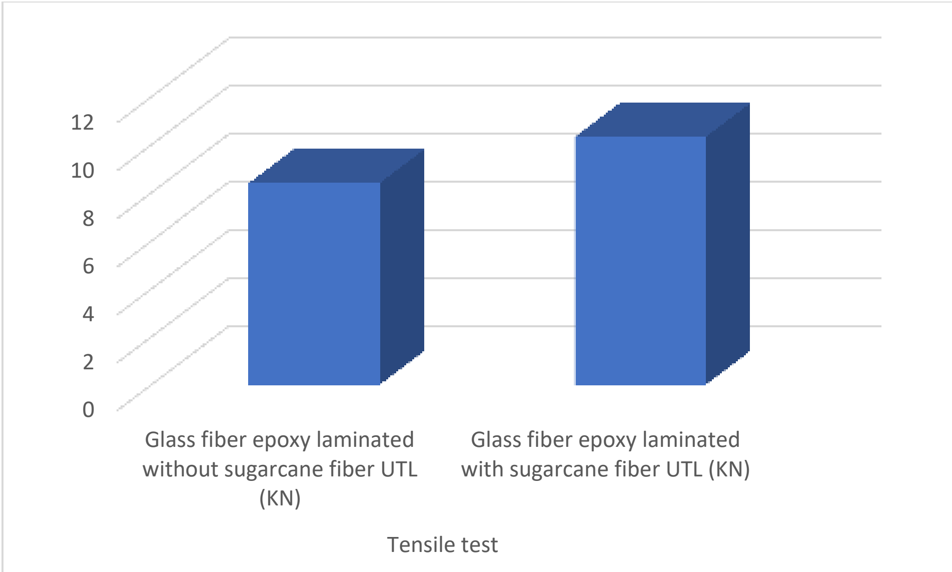

Fig. 6.1 Sample 1 tensile test of UTL (KN)

TABLE: 6.2 Sample 2 tensile test of UTL (KN)

Tensile test	
Glass fiber epoxy laminated without sugarcane fiber UTL (KN)	**Glass fiber epoxy laminated with sugarcane fiber UTL (KN)**
8.4	9.68

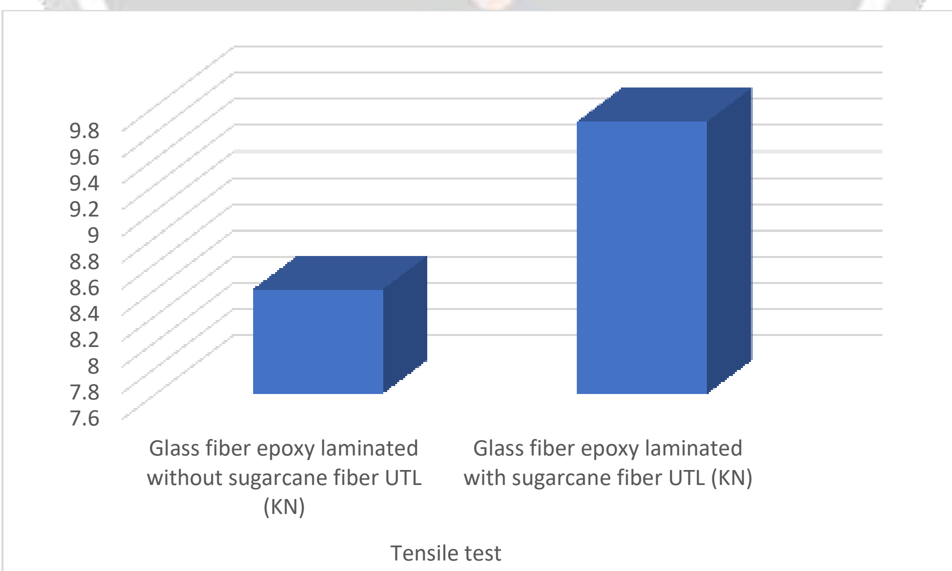

Fig. 6.2 Sample 2 tensile test of UTL (KN)

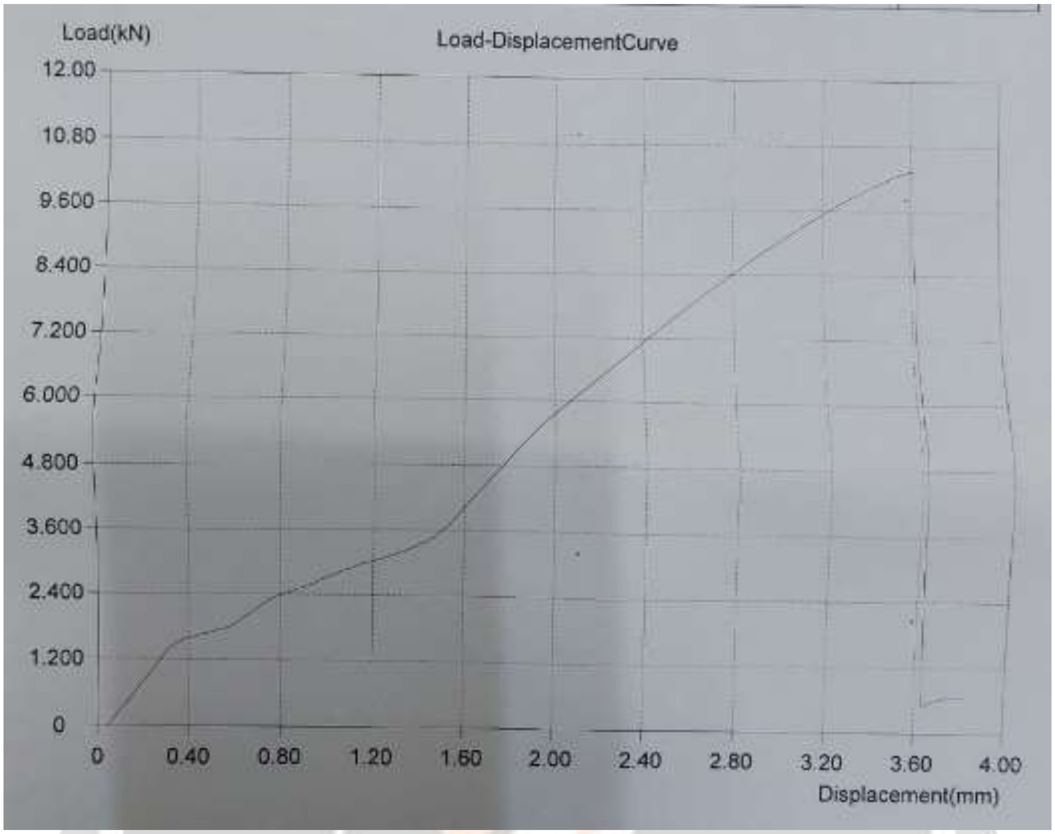

Fig. 6.3 Graph of tensile test sample 1

TABLE: 6.3 Sample 1 tensile test of UTS (N/mm2 or Mpa)

Tensile test	
Glass fiber epoxy laminated without sugarcane fiber UTS (N/mm2 or Mpa)	**Glass fiber epoxy laminated with sugarcane fiber UTS (N/mm2 or Mpa)**
75	97

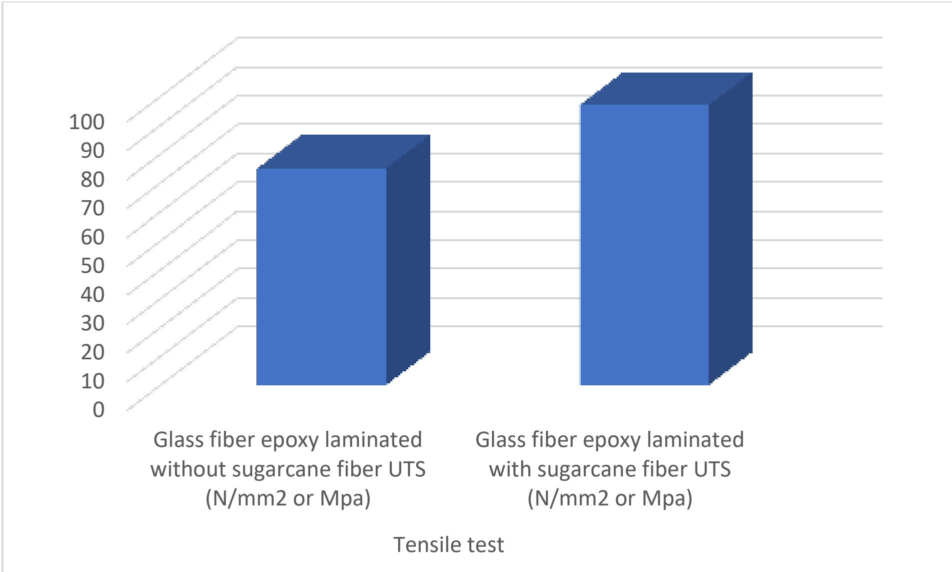

Fig: 6.4 Sample 1 tensile test of UTS (N/mm2 or Mpa)

TABLE: 6.4 Sample 2 tensile test of UTS (N/mm2 or Mpa)

Tensile test	
Glass fiber epoxy laminated without sugarcane fiber UTS (N/mm2 or Mpa)	**Glass fiber epoxy laminated with sugarcane fiber UTS (N/mm2 or Mpa)**
75	80

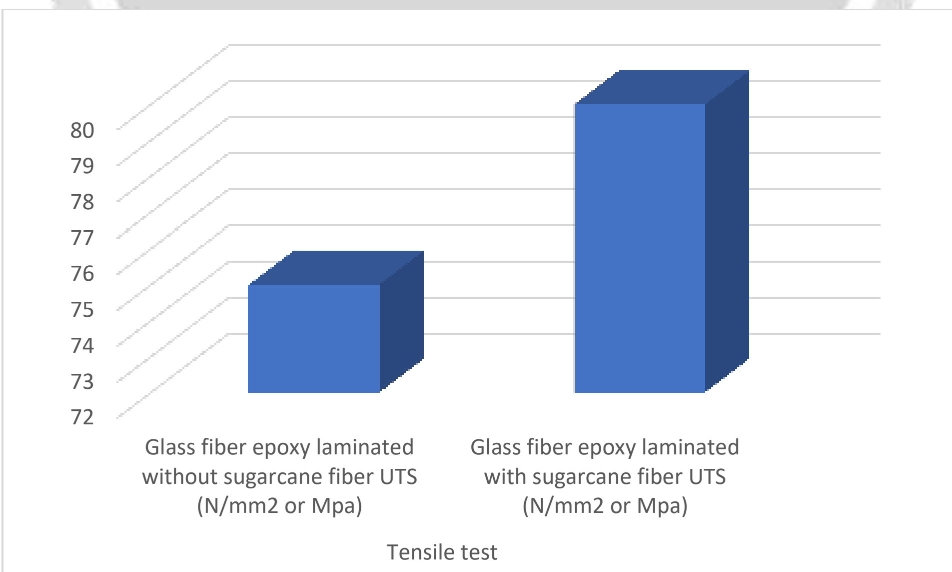

Fig: 6.5 Sample 2 tensile test of UTS (N/mm2 or Mpa)

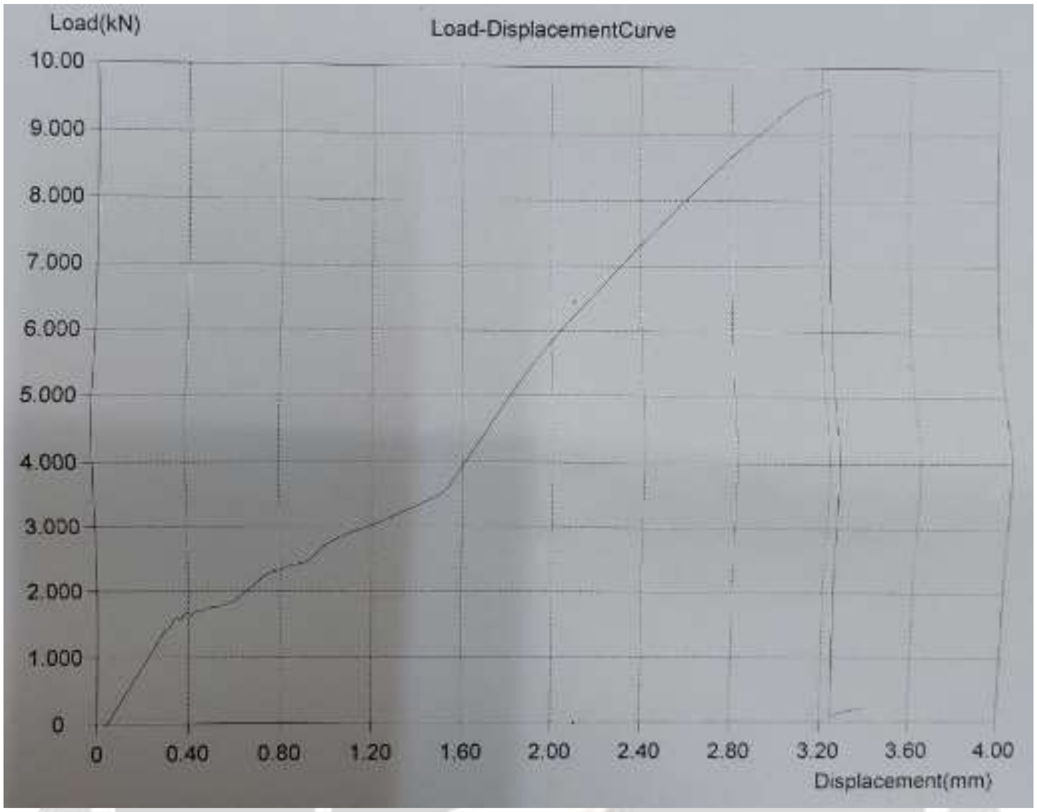

Fig. 6.6 Graph of tensile test sample 2

CHAPTER 7

CONCLUSION

It has been discussed how GFRP composites fare in terms of their mechanical, dynamical, tribological, thermal, and water-absorbing capabilities. Because of their significant use, these composites have come into focus.

- When it came to the preparation of the GRP composites, a variety of preparation methods were used, and the ambient conditions varied.
- Increases in fibre glass V_f of fibre weight fractions led to increases in the ultimate tensile strength and flexural strength of the fibre glass polyester composite.
- The composite's Young's modulus of elasticity rose in proportion to the volume fraction of fibre glass.
- Increasing the proportion of GF in the composite led to an improvement in the damping qualities of the GRP, and the natural frequency was determined for each and every circumstance.

Reference

1) C.A. Fuentes, L.Q.N. Tran, M. V. Hellemont, V. Janssens, C. Dupont-Gillain, A.W.V. Vuure, I. Verpoest,Colloids and Surfaces A: Physicochem. Eng. Aspects, 418 (2013) 7-15.
2) M.M. Thwe, K.Liao, Comp.: Part A, 33 (2002) 43-52
3) S.K. Nayak, S. Mohanty, S.K.Samal, Mater. Sci. and Eng. : A, 523 (2009) 32-38.
4) P. J. Roe, M. P. Ansell, J. of Mater. Sci. 20 (1985) 4015-4020.
5) A.C. Karmaker, J. of Mater. Sci. Letters 16 (1997) 462–464.

6) Yan Li, Yiu-Wing Mai, Lin Ye, Sisal fiber and its composites: A review of recent developments, Composites science and technology;2000;60:2037- 2055.

7) M. Jawaid , H.P.S. Abdul Khalil, A. Abu Bakar, P. Noorunnisa Khanam, Chemical resistance, void content and tensile properties of oil palm/jute fiber reinforced polymer hybrid composites, Materilas and Design;2011;12: 1014-1019.

8) M. Jawaid, H.P.S. Abdul Khalil, Azman Hassan, Rudi Dungani, A. Hadiyane, Effect of jute fibre loading on tensile and dynamic mechanical properties of oil palm epoxy composites, Composites:Part B;2012;xx:xxx-xxx. Article in press.

9) Kasama Jarukumjorn, Nitinat Suppakarn, Effect of glass fiber hybridization on properties of sisal fiber polypropylene composites, Composites: Part B;2009;40:623 627.

10) Maries Idicula, S.K. Malhotra, Kuruvilla Joseph, Sabu Thomas, Dynamic mechanical analysis of randomly oriented intimately mixed short banana/sisal hybrid fiber reinforced polyester composites, Composites Science and Technology; 2005;65:1077 1087.

11) N. Venkateshwaran, A. Elayaperumal, G.K. Sathiya, Prediction of tensile properties of hybrid-natural fiber composites,Composites:Part B;2012;43:793 796.

12) K. Murali Mohan Rao, K. Mohana Rao, A.V. Ratna Prasad, Fabrication and testing of natural fiber composites: Vakka, sisal, bamboo and banana, Materials and Design ;2010;31: 508 513.

13) N. Venkateshwaran, A. ElayaPerumal, A. Alavudeen, M. Thiruchitrambalam, Mechanical and water absorption behaviour of banana/sisal reinforced hybrid composites, Materials and Design;2011;32:4017 4021.

14) M.M. Kabir, H. Wang, K.T. Lau, F. Cardona, Chemical treatments on plant-based natural fibre reinforced polymer composites: An overview, Composites: Part B;2012;43: 2883 2892.

15) Panthapulakkal S, Sain M., Injection-molded short hemp fiber/glass fiber reinforced polypropylene hybrid composites mechanical, water absorption and thermal properties, Applied Polymer Science;2007;103:2432 2441.