AN INVESTIGATIONS OF MECHANICAL AND THERMAL PROPERTIES OF COMPOSITE PIPE

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Abstract—*The industrial use of Synthetic fibre has been continuously increasing. In the interior of cars, pipelines, the percentage of fibre-reinforced multi-material parts may reach 40%.Synthetic fibres are important reinforcement materials in modern composites for high performance applications primarily due to their high specific strength and high specific modulus. However, the environmental unfriendly production method of synthetic fibres is an area of concern. Amid the growing global awareness and push for environmentally friendly products, the need to seek viable alternatives materials for synthetic fibres has been rising. Modification of natural fibres to rival the mechanical performance of synthetic fibres has been looked into by many research.*

Keywords— Fibre Reinforced Polymer (FRP), Glass Fibre

1. INTRODUCTION

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. It is obvious, especially for composites, that the improvement in manufacturing technology alone is not enough to overcome the cost hurdle. It is essential that there be an integrated effort in design, material, process, tooling, quality assurance, manufacturing, and even program management for composites to become competitive with metals. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses becomes prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an expected reduction in costs. High performance FRP can now be found in such diverse applications as compos ite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers.

Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form[1]. The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings[2]. composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale. They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property[3].

1.1 GLASS FIBER

Glass fiber is one of the most generally used artificial fibers, manufactured with the raw materials such as limestone, silica, clay and dolomite. These ingredients are melted and extruded through bushings which have multiple small orifices to obtain filaments. The extruded filaments are coated with chemicals to obtain required size. The filaments are wounded together to form roving. The diameter of the filaments and the number of filaments in a roving determine its weight. The chopped fiber (25mm length) selected for this work is E-Glass of (420.GSM).

1.2 EPOXY RESIN

Epoxy resins are intensively used in underwater application than other resins for its anti-corrosive performance and durability [8]. Water activated and water repelling in site-cured resins demand further research to be applied for high pressure conditions.

T ABLE 1 PROPERTIES OF EPOXY

PROPERTY	VALUE
Density	1.20 - 1.25gm/cm3
M odulus of elasticity	3.075 GPa
Shear modulus	0.610 GPa
Poison ratio	0.35
Tensile strength	48 M Pa
Elongation at break	1-2 %
Water absorption after (24 hours)	0.15-0.2%
M ax. service temperature	85˚c
Flexural strength	115 M Pa
Barcol hardness	39

2. RESULTS AND DISCUSSION

2.1 TENSILE STRENGTH

Figure graphically shows the results of tensile strength and percent elongation under tensile loading condition. As shown, the relationship between th e two parameters with increased fibre length follows fairly the same pattern.

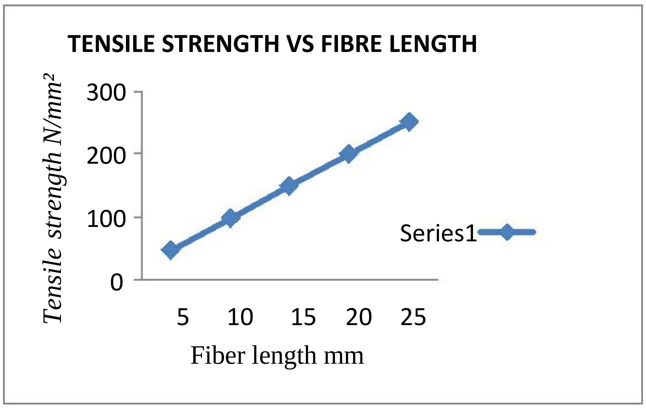

Figure 1 tensile strength vs Fibre length

Cantero et al. (5) in their paper observed that the elongation at break of short glass /epoxy composite increased consistently with fibre length between 3mm and10mm. This is in agreement with the result obtained whereby the percentage elongation increased from 2.4% to 5.7% with increased fibre length from 5mm to 15mm respectively. Subsequently, the tensile strength and % elongation decreases with increasing fibre length of up to 25mm.

2.2 COMPRESSIVE STRENGTH

A Compression test is a method for determining the behaviour of materials under compressive load. During the test, the specimen is compressed, and deformation versus the applied load is recorded. In compression, it is usually known that the ultimate compressive strength of the composite is mainly dependent on the strength of the matrix and the extent of fiber/matrix adhesion

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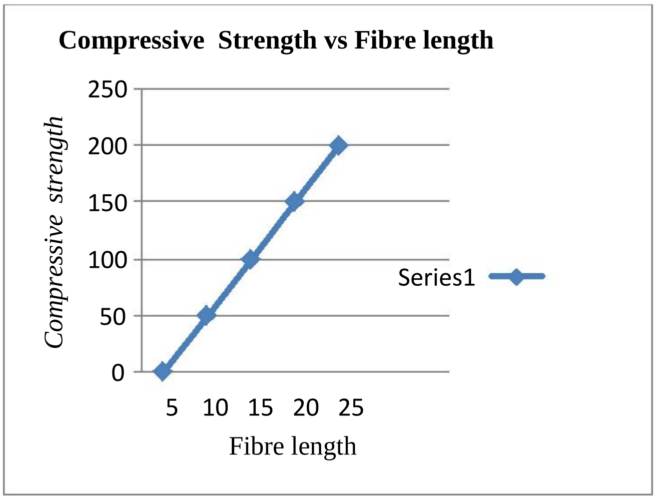

Figure 2 Compressive Strength vs Fibre length

The compressive strength of glass/fibre epoxy composite was enhanced with increasing the fibre length with the highest compressive strength (212.56 MPa) achieved with fibre length of 25mm.

2.3 FLEXURAL STRENGTH

As shown in Figure 3 the flexural strength and modulus of the composite increased proportionally with fibre length reaching a maximum of 90 MPa and 2.7 GPa respectively at 25mm fibre length

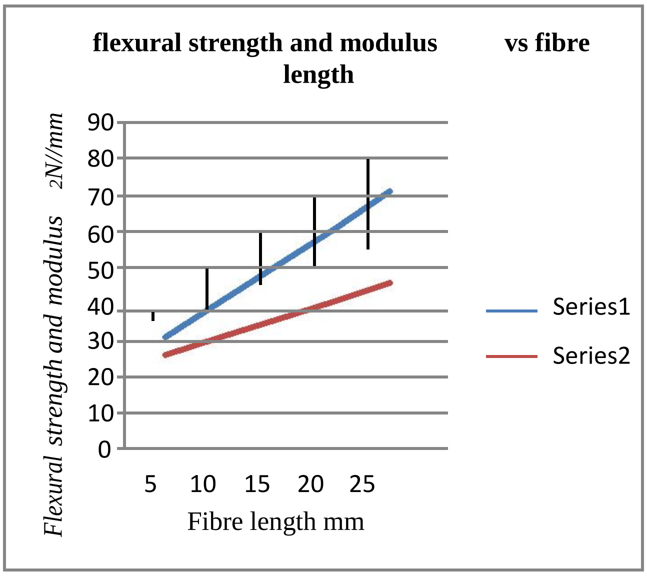

Figure 3 Flexural strength vs Fibre length

This result is in agreement with that obtained by [5] in functionally graded glass fibre compounds. attributed the increase in the flexural strength and modulus to the increasing fibre to- fibre contact when the fibres were impregnated. This suggests that for applications where the flexural rigidity is required, composite fabricated from longer fibre length is desirable.

CONCLUSION

The mechanical properties of the glass with epoxy composite studied in this work. The laminates were manufactured by the compression moulding process and tested according to ASTM standard. From the obtained results, the following conclusions are derived.

1) The maximum tensile strength of 151 MPa is observed for the glass epoxy composite
2) The compressive strength of glass/fibre epoxy composite was enhanced with increasing the fibre length with the highest compressive strength (212.56 MPa) achieved with fibre length of 25mm.
3) The flexural strength and modulus of the composite increased proportionally with fibre length reaching a maximum of 90 MPa at 25mm

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