MECHANICAL CHARACTERISATION OF GLASS FIBRE COMPOSITES BY USING RECYCLED PLASTICS: A REVIEW

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Abstract-*Plastics have a wide variety of usage ranging from car interiors to containers of almost every product found in the market. Although, plastics are used in various sectors due to its low cost, great versatility, excellent strength to weight ratio, durability and corrosion resistance, it cannot be degraded, leading to increase in pollution rates. Plastics can be recycled either chemically, mechanically, or thermally and can be used again effectively. It is the process of recovering scrap or waste plastic and reprocessing the material into useful products. Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. Glass fibre composites are known for their high strength to weight ratio and hence are widely used in industries. Successful application in practice may produce a composite having comparatively higher strength to weight ratio.*

Keywords-**plastics, recycle, glass fibre, composites, strength, environment.**

I. INTRODUCTION

The sudden increase of non-biodegradable plastic waste in a number of countries has become a growing threat to the environment. Thus, recycling of plastic solid waste is the topic of focus for a few years now. Plastics are used in a wide variety of applications ranging from greenhouses, packaging, films, covers to containers and car interiors and bodyworks. These plastic materials can be classified as thermoset and thermoplastic polymers. Thermoplastics polymers include low density polyethylene (LDPE), high density polyethylene (HDPE), polyethylene terephthalate (PET), polypropylene (PP) and polystyrene (PS) which can be recycled. Hence these contribute to majority of the manufactured plastics. On the other hand, thermoset plastics are largely unsuitable for recycling due to the crosslinking of polymer chains upon heating. However, these plastics need to be sorted manually to avoid phase separation and degradation in its properties, before sending it for recycling. After this wate is filtered, it is sterilized, dried and crushed into small chips. The chips are heated and are either passed through a spinneret to form strings of yarn or passed through injection moulding or pressing machines. So, even recycled plastic has new plastic material added in. The same piece of plastic can only be recycled about 2–3 times before its quality decreases to the point where it can no longer be used. The yard is wound up in spools. The fibre is then passed through a crimping machine to create a fluffy texture. This yarn is then baled, dyed and knitted into polyester fabric. The moulded plastics may be again used for various applications.

Fig -1: Recycling of plastic into yarn

Composites are materials composed of two or more different materials, the properties of resulting material being superior compared to that of individual materials. Industries have seen enormous growth in the use of composites due to its low weight and high strength. A variety of different fibres may be used such as Aramid, Basalt and Glass with Glass fibre being used majorly due to its excellent surface finish and high strength to weight ratio. The fibres act as principle load carrying segment whereas the polymer matrix transfers the load between fibres as well as provides corrosion resistance and thermal environment stability. Glass fibre is preferred over Carbon Fibre due to the high brittle nature and high cost of the latter. Various studies show that the mechanical properties of GFRP are dependent on the proportionality of the cloth resin constituents, orientation of the fibre and number of layers of the fibre which determines specimen's thickness.

II. METHODOLOGY

1. PREPARATION OF POLYESTER FABRIC USING PSW

PET is widely used in plastic bottles and caps. These PET bottles are collected from waste, sterilized, dried and crushed into small chips. The chips are heated and passed through a spinneret to form strings of yarn. This yard is wound up in spools. The fibre is then passed through a crimping machine to create a fluffy texture. This yarn is then baled, dyed and knitted into polyester fabric.

Fig -2(a): Preparation of fabric by recycling plastic

2. FABRICATION OF THE COMPOSITE LAMINATE

The composite formed using recycled plastic and glass fibre is fabricated using the conventional hand layup technique. The resin adopted was Epoxy Resin. Hardener is a highly

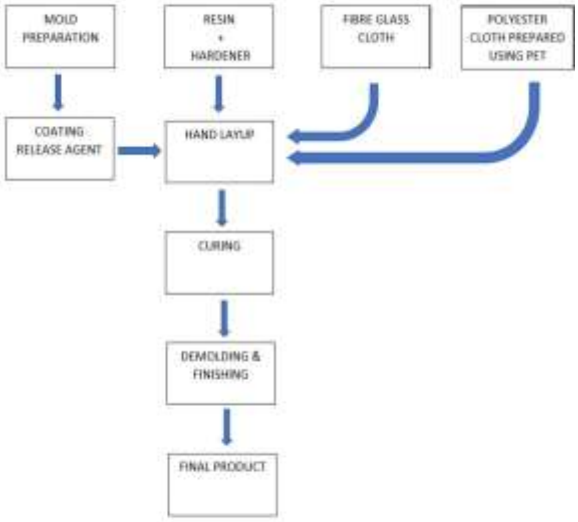

Fig -2(b): Fabrication of composite

viscous liquid, mixed with resin in suitable proportion during the process of preparation of composites which helps in the solidification of the wet, smooth composite. The mixture of resin and the hardener is generally in the ratio of 9:1 by weight.

3. MOULD PREPARATION

Before starting the process, a mould is prepared which is of a negative shape to that of the shape required. This can be prepared using a thermocol or plastic. A releasing agent is applied on the mould so as to ease the process of demoulding.

Fig -2(c): Mould Preparation

4. HAND LAYUP METHOD

A layer of Epoxy is uniformly spread on the surface of the mould and alternate layers of fabrics of glass and polyester are laid with epoxy in between each layer. The epoxy and cloth must be spread uniformly such that there are no air bubbles present which results in good surface finish.

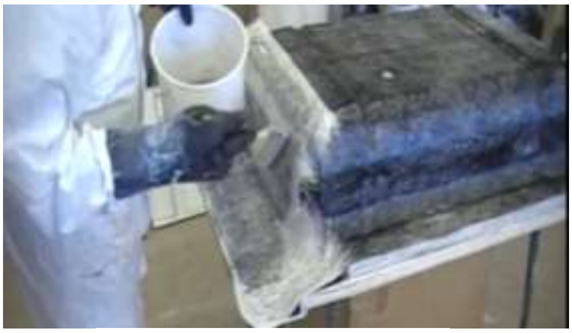

Fig -2(d): Glass Fibre

5. CURING AND DEMOULDING

Curing is generally done at room temperature. This might also be achieved by heating the specimen in an oven at constant temperature. Curing in these machines results in excellent surface finish and material strength. The specimen may finally be detached from the mould.

Fig -2(e): Demoulding

III. TEST PROCEDURES AND RESULTS

A number of standard tests may be conducted to obtain the mechanical properties of the resultant composite. The tests conducted were specifically related to density, tensile stress strain, hardness and impact characteristics.

1. DENSITY

According to various studies conducted, average value of density of the resultant composite is tabulated.

From the graph it can be seen that the density of the GFRP produced from recycled plastics ranges from 0.94 to 1.17 g/cm^3 as the fibre content increases from 35% to 50% for different thickness considered.

Table -1: Average Density Values of GFRP from Recycled Plastic

Lamination thickness (mm)	Fibre content (%)		
	35	**40**	**50**
10	0.9	0.9	1.2
12	0.9	0.9	1.1
16	0.9	1.1	1.2

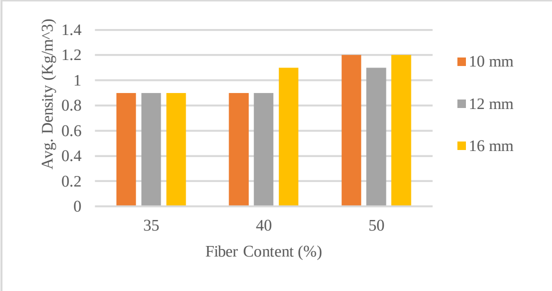

Chart -1: Average Density of GFRP from Recycled Plastic versus Fibre Content and Thickness of Laminate

2. TENSILE STRENGTH

Tensile test was carried out to determine the tensile properties. This test was conducted according to the ASTM 638 standards which specify that a minimum of five specimens must be used per sample.

From the graph, it was observed that the tensile strength for a given thickness increased with increase in fibre content. The tensile strength was obtained to be around 50 MPa which is similar to that of thermoplastics which ranges from 48-75 MPa. Hence there was no significant change observed in the tensile strength values for the range of values studied.

Lamination thickness (mm)	Fibre content (%)		
	35	**40**	**50**
10	42.3	50	42.8
12	44.3	52.2	45
16	48.1	56.8	50.3

Table -2: Average Tensile Strength of GFRP from Recycled Plastic

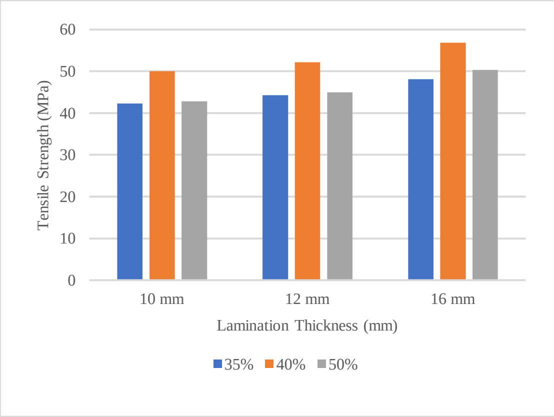

Chart-2: Average Tensile Strength of GFRP from Recycled Plastic versus Fibre Content and Thickness of Laminate

3. HARDNESS TEST

Brinell Hardness test was conducted according to ASTM E-10 standards. This method specifies the method of indentation of the test material within specified limits. The material is indented with a 10mm diameter hardened steel ball with a load of 2000 Kg for 15 seconds.

From the study it was concluded that increase in the fibre content increased the modulus of the composite, which in turn led to increase in hardness of the composite.

Lamination thickness (mm)	**Fibre content (%)**		
	35	**40**	**50**
10	62	72	64
12	16	20	16
16	20	26	21

Table -3: Average Brinell Hardness Number of GFPR from Recycled

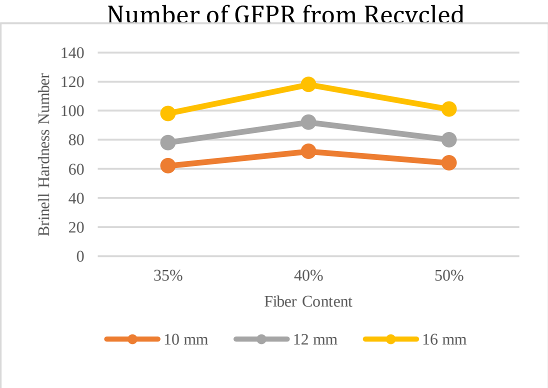

Chart -3: Average Brinell Hardness Number of GFRP from Recycled Plastic versus Fibre Content and Thickness of Laminate

4. IZOD IMPACT TEST

The specimen was clamped upright in the anvil with a 2mm V notch. The sample was clamped such that it is located just above the clamp and was hammered and the energy absorbed was measured.

From the study, it was concluded that the absorbed energy increased with increasing fibre content of up to 40%, beyond which a significant dip was observed. From another study conducted, fracture toughness was observed to be 20% higher for the resultant composite when compared to virgin GFRP.

Lamination thickness (mm)	**Fibre content (%)**		
	35	**40**	**50**
10	1.45	1.7	1.55
12	1.5	1.85	1.6
16	2.25	2.65	2.4

Table -4: Average Impact Energy of GFPR from Recycled Plastic

IV. CONCLUSION

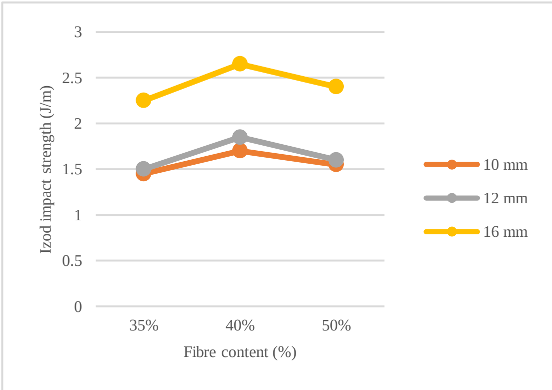

Chart -4: Average Impact Energy of GFPR from Recycled Plastic versus Fibre Content and Thickness of Laminate

The objective of this study was to observe the fabrication technique and the various mechanical properties of glass fibre reinforced polymer made using glass fibre and recycled plastics. The results obtained from physical testing assured that the material could be used for various structural applications. The resultant composite laminate showed good better characteristics when compared to only GFRP composite. Experimental results showed maximum values of various mechanical characteristics were observed at 40% fibre content. The use of plastics in improving a certain material leads to decrease in landfills of solid plastic waste. This in turn leads to better environmental conditions.

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