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NOVEL COST EFFECTIVE UTILIZATION OF GFRP FINE DUST AND HDPE WASTE FOR ALTERNATIVE APPLICATION

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Abstract: The main purpose of the project is to utilize the waste Glass fiber reinforced plastic (GFRP) and High Density Polyethylene (HDPE) for different applications under mechanical recycling process. Fiber reinforced polymer (FRP) and High Density Polyethylene (HDPE) materials are being increasingly used in several applications, but especially in the construction and transportation industries. The waste management of FRP materials made with thermosetting resins is a critical issue for the composites industry because these materials cannot be reprocessed. Therefore, most thermosetting FRP waste is presently sent to landfill, in spite of the significant environmental impact caused by disposing of it in this way. Because more and more waste is being produced throughout the life cycle of FRPs, innovative solutions are needed to manage it. In this work a new composite material was fabricated by compression moulding process then the composite material was studied and tested based on fiberglass waste mixed with High Density Polyethylene Waste in different ratios of 85:15, 90:10, 95:5 (H:G). The newly fabricated composites were characterized for their mechanical properties such as compressive strength, Wear and Water absorption test as per ASTM standards. The results demonstrate the possibility of using an unexplored waste stream (glass fiber waste) as a reinforcement agent in High Density Polyethylene, which may reduce the amount of waste in landfill, while simultaneously contributing towards the circular economy.

Keywords: Glass fiber reinforced plastic (GFRP), High Density Polyethylene (HDPE), compression moulding process, circular economy.

I. INTRODUCTION

Composite materials formed by combining of two or more materials with different properties together at macroscopic level to increase the property of newly fabricated composite. Composite materials are consists of two phases: the matrix phase and reinforcing phase.

In this work, glass fiber dust reinforcement in High Density Polyethylene matrix was produced by compression moulding technique with varying fiber dust percentages (5%, 10%. 15% by weight percent). Compression, Wear and Water absorption tests were carried out and their performances were evaluated.

Plastics are a type of resin that can be easily molded and are often used as a cheap packaging material. There are several major varieties of plastics commonly in use. Some plastic items are made of a mixture of various resins. High-density polyethylene, also known as HDPE, is a strong plastic used to make can and bottles for short-term storage. It has high tensile strength.

II. MATERIALS AND METHODS

2.1 HIGH DENSITY POLYETHYLENE (HDPE)

High-density polyethylene (HDPE) shown in Fig 1 is a thermoplastic polymer material produced from ethylene monomer. When used in HDPE pipes, it is also called "alkane" or "polyethylene". HDPE has high strength to density and can be used to produce plastic bottles, wear, resistant tube sand plastic wood.

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Fig. 1 HDPE Waste

2.2 WASTE EXTRACTION

Fig. 2 shows the processes involved in extracting GFRP and HDPE waste in this study. The raw GFRP waste produced from the fiber products like automobile accessories, doors, windows, wind mill blades and marine applications was collected from the industry. In general, mechanical recycling is a technique used to reduce the size of scrap composites into smaller pieces known as recyclates. The waste pulverised using shredding machine. Now the mixed GFRP containing fiber waste and powder waste was obtained. The above waste are separated by sieving method. The fiber dust waste was settled in a sieve and it was separated physically by hand

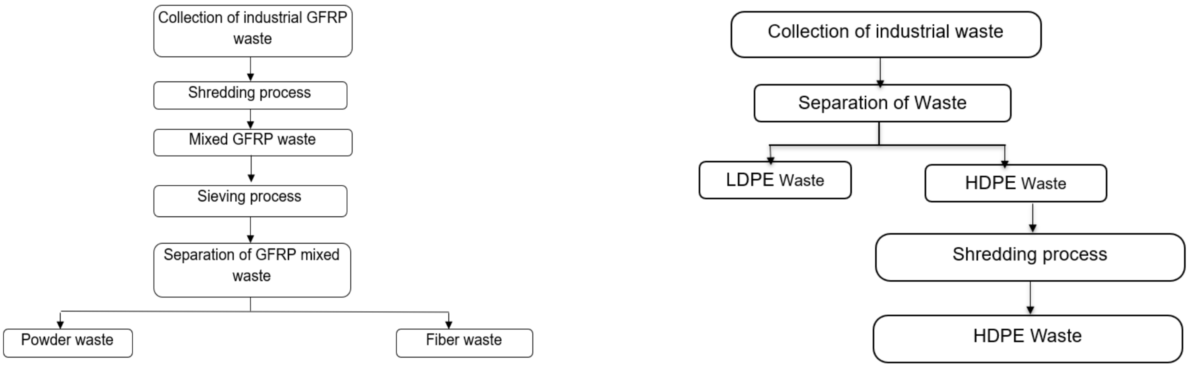

Fig. 2 Waste Extraction of Fiber Dust and HDPE Waste

2.3 SAMPLE PREPARATION

Fig 3 shows the stages of sample preparation of GFRP and HDPE waste product. From the extracted GFRP waste, the powder waste only taken for sample preparation. The fiber waste and HDPE waste is taken in a various proportions like 5:95, 10:90 and 15:85 (Fiber waste : HDPE waste).The fiber waste and HDPE waste was completely mixed and laid on the mould. The mixture was evenly spreaded by hand layup process. Then it was compressed in a compression moulding machine with a pressure of 175 bar and 250°c temperature.

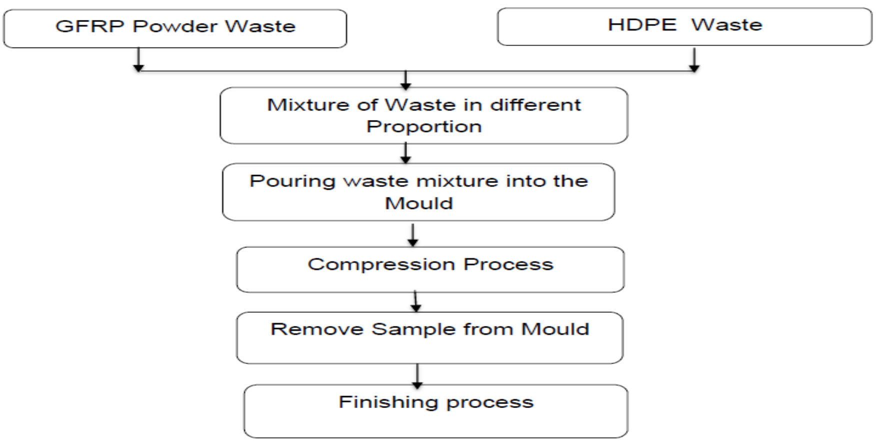

Fig 3 Stages of Sample preparation

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III. RESULT AND DISCUSSION

3.1 COMPRESSION TEST

The compressive strength for the prepared samples with different ratios were tested and the results are shown in Table 1

Table 1 Compression Test

SI.NO	Sample	Applied Load (kN)	Area of Cross Section (mm^2)	Compressive Strength (N/mm^2)
1	G5:H95	43.6	2025	21.53
2	G10:H90	47.8	2025	23.60
3	G15:H85	51.2	2025	25.28

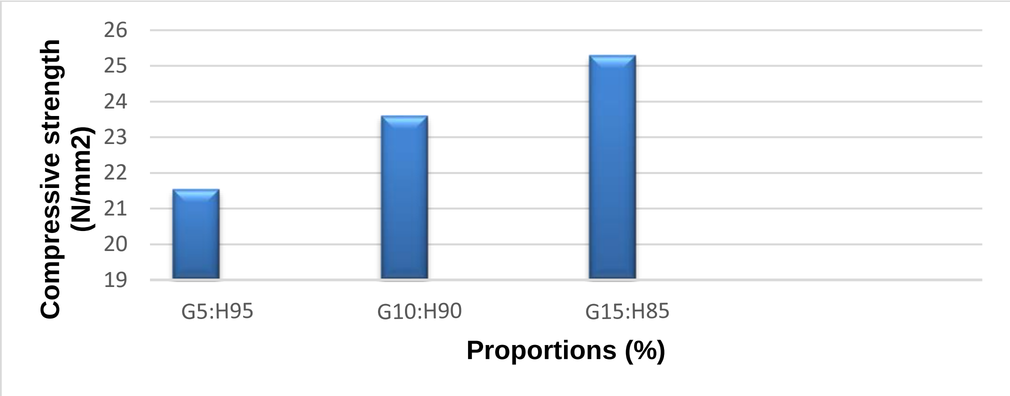

Fig 4 The variation in compressive strength with glass fiber dust and HDPE content

The compressive strength shown in Fig 4 was increased with respect to increase in Glass fiber dust content with the selected ratios. If the fiber content ratio is more than the selected one, it will not give better bonding strength. These ratios were selected by conducting trial and error process. The Glass fiber dust act as a matrix material and generally matrix material takes compression. From the above results it was inferred that maximum fiber content will give maximum compressive strength.

3.2 WEAR TEST

The wear strength for the prepared samples with different ratios were tested and the results are shown in Table 2

Table 2 Wear Test

S. No	Sample	Track Diameter	Load	Speed	Initial weight	Final weight	Change in weight	Wear rate
		Mm	N	rpm	Gm	Gm	Gm	µm
1	G5:H95	60	20	500	6.10	6.05	0.05	48
2	G10:H90	60	20	500	6.15	6.12	0.03	46
3	G15:H85	60	20	500	5.70	5.67	0.03	46

In these results the specimen shown in Fig 5 containing higher glass fiber content showing lesser wear rate comparatively specimen having lesser glass fiber content. A layer of plastic was formed in top surface during the compression process while making specimen. Because of that, there is no major difference in the test results.

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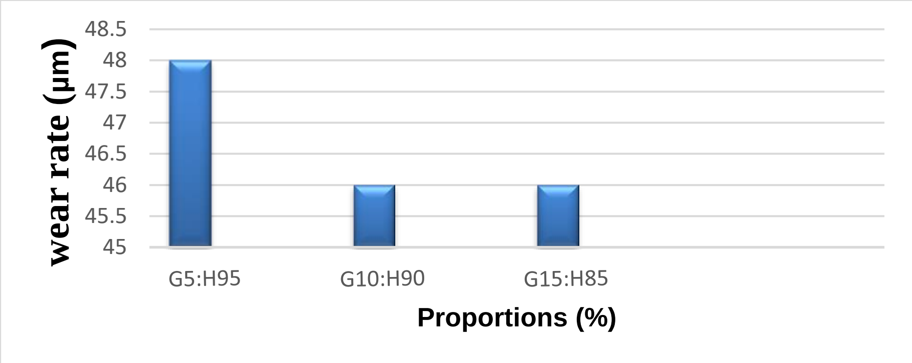

Fig 5 The variation in wear strength with glass fiber dust and HDPE content

3.3 WATER ABSORPTION TEST

The water absorption for the prepared samples with different ratios were tested and the results are shown in Table 3

Table 3 Water Absorption Test

SI.NO	Sample	weight of dry specimen W_1 (gm)	weight of water absorbed specimen W_2 (gm)	% Water Absorption
1	G5:H95	125.10	125.10	0
2	G10:H90	99.95	99.95	0
3	G15:H85	117	117	0

From the above results it is inferred that the water absorption is zero. Generally, fiber absorbs the water, but when it mixed with HDPE it turns into a non-absorbent material.

3.4 APPLICATION

I have chosen certain applications like Paver blocks, Wash basin and Overhead water tank. From the above test results, it is inferred that Compressive strength, Wear rate and Water absorption results are good in the specimens having higher ratio of glass fiber dust content.

For **Paver blocks**, compressive strength and wear rate is the important parameter. This material gives better compressive strength and lesser wear rate. And the product is eco-friendly and cost effective too, so it will give good productive results when applied in real time.

IV. CONCLUSION

This work mainly concerned with the utilization of GFRP and HDPE waste produced in industry. Thermosetting FRP products are being increasingly used in several industrial applications. GFRP and HDPE waste will not get degraded or decomposed because of its inert nature while dumping in landfills. Using GFRP and HDPE waste a new product is manufactured and several tests like Compressive strength, Wear rate and water absorption test were conducted. Compressive strength was increased when the GFRP dust content was increased. Wear rate was increased when the HDPE content was increased. Considering the test results and cost effectiveness it is decided to manufacture Paver block among another applications. The product was manufactured with different ratios GFRP dust and HDPE waste. Among the three proportions G15:H85 was effective in both mechanical properties and economic consideration. In this work 60% of total waste which contains only glass fiber dust and 100% of HDPE waste was utilized.

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