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An Experimental and Comparative Analysis of Glass Fibre Reinforced with Mobile Phone Display (Powder) with Epoxy Resin

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Abstract. The impact of the widespread use of electronic products in the information technology era is known as e-waste. Electronic waste increased as a result of the rising use of electronic products. These wastes polluting the environment leads to degradation of soil and water. By converting electronic waste into useful materials will reduce the electronics wastes. In this research work the composite materials were prepared with the mobile phone display powder mixed with 5% and 10 % to the epoxy resin act as matrix material glass fibers as reinforcement. The mechanical properties of the composites were tested, the tensile strength has been improved more than 10% and compressive strength has been improved more than 35%. Regarding the application of powdered particles to enhance the resistance to delamination initiation and propagation of fiber-reinforced polymer composite materials.

1 Introduction

Electronic scrap, or e-waste, is made up of discarded electrical and electronic parts and devices such printed circuit boards, computers, refrigerators, mobile phones, and refrigerators. One of the wastes with the fastest global growth is e-waste. The main sources of e-waste in our nation are huge household appliances, communication gadgets, electronics, and technological equipment. In India, the current yearly growth rate of e-waste is between 7 and 10%. Mumbai is not just the nation's financial center, but it also produces the most e-waste of all the emerging cities in India [1–3]. Therefore, it is imperative to address the issue of e-waste creation in a way that both upholds pollution control board requirements and does not contribute to waste disposal, as this will be highly compatible with the current ecosystem. Due to the availability of inexpensive labour, the lax enforcement of laws, and the sudden increase in the volume of e-waste, the majority of industrialised countries export their electronic garbage to developing nations like India. Due to this, emerging nations are dealing with serious problems including how to dispose of these wastes and also health risks to

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people. We need to reuse and recycle this trash to create practical composite materials with a range of compositions in order to solve this disposal issue [4–7].

E-waste disassembly is neither a practical or cost-effective process when done manually. We've talked about techniques like physical separation and pulverisation. Both techniques were used by the authors to recycle electronic garbage, mainly old mobile phones. The findings indicated that rough pulverisation procedures would be a more advantageous choice for material recycling that is both inexpensive and of excellent quality [8–10]. Designing a prototype model is important after cost reduction and the separation of electronic components. E-waste is increasing at a pace of roughly 3-5% every year. Recycling e-waste reduces environmental contamination while also reducing the consumption of virgin resources. The European Union has been working to create a thorough framework for the processing of electronics waste materials over the past few decades. The main sources of e-waste are polymer cabinets and printed circuit boards. Electronic components can remain unchanged even while metallic components can be physiologically or chemically leached off. The PCBs frequently get up in landfills as a result of acidic leaching, open burning, and other methods used to recover important metals. The authors took into account both major and little electrical and electronic waste. The latest developments in metal recycling technology demonstrated that there is enormous potential for recycling used printed circuit boards [10,11].

Waste printed circuit boards are grinded and mixed with Polypropylene made as a composite and has been extruded by injection moulding. This increases the strength of the composite more than 30%. The e-waste material has been grinded and added with fly ash mixed in the ball milling. The mixed reinforcement has been added into the aluminium matrix and casted as composite materials, the strength of the material has been improved more than 25% due to the reinforcement.

When creating rHDPE/PCB composites, recycled HDPE (rHDPE) is recovered from waste printed circuit boards and used as a filler material. For the system with 30% wt PCB, a satisfactory balance between stiffness, strength, and toughness was attained. Non-metallic powders made from printed circuit boards that have been treated with additives to polyvinyl chloride (PVC) are analyzed, along with the physical characteristics of the PCBs. Although the toughness of PVC is increased by the combination increases the strength, the materials' The temperature is not significantly raised in comparison to PVC alone. By adding recycled nonmetals from PCBs, the PP composites' flexural strength and flexural modulus are enhanced. Most PCB nonmetals contain 50–70% glass fiber with a high elastic modulus, low elongation, and length-to-diameter ratio. Therefore, adding this nonmetallic waste to polypropylene or other polymers increases the plastics' strength [12–18]. The mechanical properties of polymeric composites made using TREPREG materials make them valuable for a wide range of applications where high strength, stiffness, durability, and design flexibility are essential. These materials are continuously being developed and improved, leading to their increasing adoption in various industries. Polymeric composites made using TREPREG materials offer a range of mechanical properties that are advantageous for various applications.

Polymeric composites are significantly lighter than traditional materials like metals, while maintaining comparable or even superior strength. The composite reduces the weight mainly used in aerospace industry. Polymeric composites exhibit high stiffness, meaning they can withstand deformation under load without bending or breaking. This property is essential for structural applications where rigidity is a critical requirement. The mechanical properties of polymeric composites can be tailored to specific requirements by varying the fiber type, resin matrix, and fiber orientation. This versatility allows for the creation of materials with optimized properties for different applications. Polymeric composites exhibit excellent fatigue resistance, meaning they can withstand repeated cyclic loading without failure. This property is crucial for applications where components are subjected to frequent stress cycles. The composites can absorb and dissipate impact energy effectively, making them suitable for applications where protection against impact damage is important. Certain polymeric composites are biocompatible, meaning they can be implanted into the body without causing adverse reactions. This makes them suitable for biomedical applications.

2. Fabrication of Composites

Hand lay-up is the most basic method of processing composites. There is not much infrastructure needed for this strategy. The processing follows very simple steps. First, a release gel is sprayed on the mould surface to stop the polymer from sticking to it. Polished mould plates were used in top and bottom to get the good surface without any roughness. After the Perspex sheet has been applied to the surface of the mould, reinforcement mats is cut to fit the size of the mould. Then thermosetting resins were put on top of the powdered mobile phone display. With the aid of a mixer grinder, mobile phone displays were gathered and ground into particles. The powdered particles were mixed with the epoxy resins with 5% and 10%. Composites were prepared separately 5% & 10% GFRP composites. For the mechanical testing the composites specimens were prepared. (ASTM Standard)

Fig. 1. Mobile display powdered in Mixer and mixed in the epoxy resin and made up using hand layup method

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3 Testing and Experimental Results

3.1 Tensile test

The composites were tested in the UTM machine, the results were plotted. The tensile properties of the composites with the mobile display crushed powder have increased in strength. Normal GFRP composite having the strength of 256 MPa obtained. In powder mixed of 5% GFRP with 289 MPa strength and 10% GFRP composites have of 305 MPa tensile strength. The strength has been improved more than 10 percentage increase in percentage of powders. The increase in the tensile strength is due to the bonding strength. The addition of the power increases the bonding strength between the fiber and the resin. Addition of the powder restricts the movement of the matrix and bearing the load leads to increase in the strength. Fig shows the details of the increase in the tensile behaviour of adding the powers in the epoxy resin.

Fig. 2 Tensile Testing

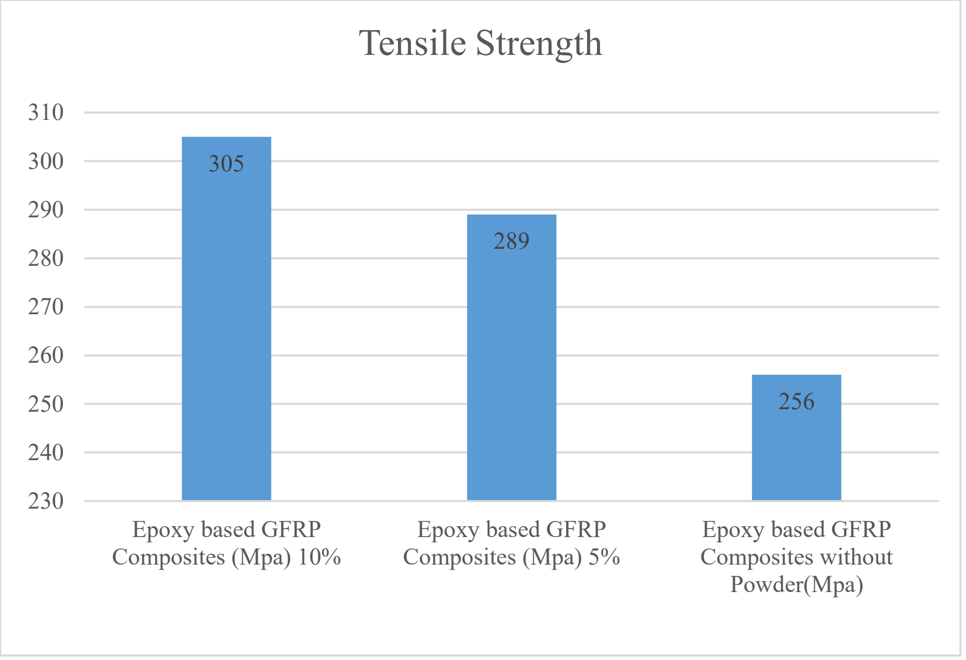

Fig. 3. Maximum Tensile Test of Composites

3.2. Compression Test

The compression tests were used to determine the compressive properties of composite materials. The compression strength of the composite is one of the critical parameter while used in the structural uses. The fiber/matrix interface is one of many intricate elements that define a composite material's compression strength. Compressive strength values for a composite can be significantly lower than tensile strength values. A material's behaviour or response is ascertained through a compression test. A material under compression can be evaluated to determine its properties, including its elastic limit, elastic modulus, yield strength, ultimate strength, and compressive strength. ASTM D6695-15 standard was adopted to prepare specimens. The size of specimen is 85mm ×25mm ×2.05mm.

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Fig. 4 Compression Strength

The compressive strength of the powdered composite increased. The restriction of the matrix leads to improved in compressive strength. The powders increases the matrix strength leads to improvement in the compressive strength. The resistance in delamination behaviour of the sheet act as an impact to the composites. Increase in the powder increases the bonding strength.

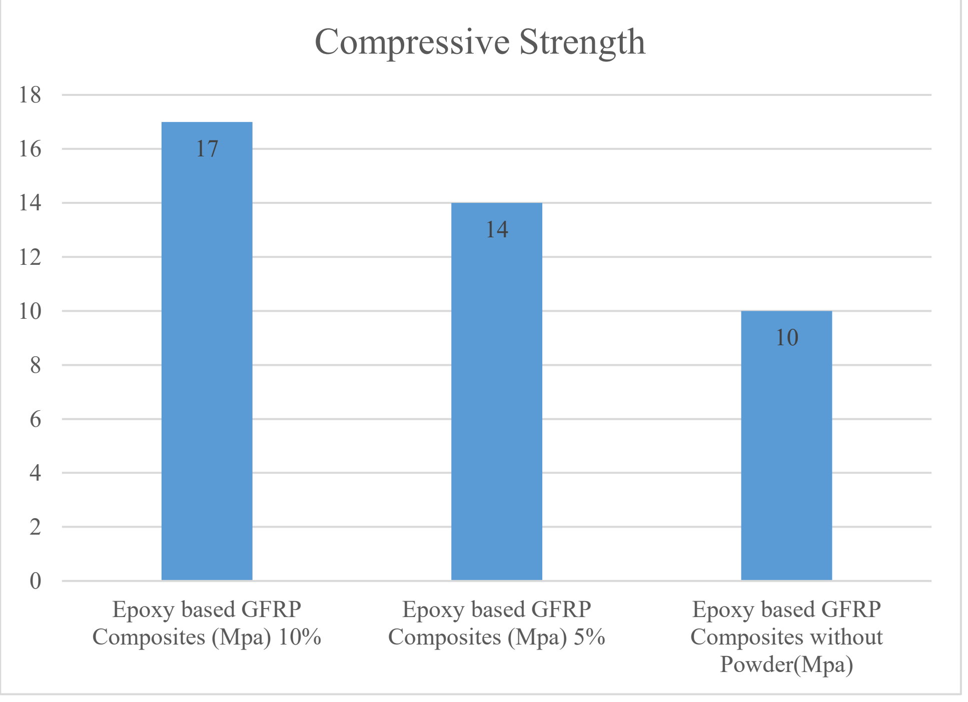

Fig. 5. Maximum Compression Results of the Composites

The results showed that inclusion of powders could significantly improve the shear strength because of the load transformation to the powders and resistance of the movement. The impact strength of normal composite 8 MPa. The composite added with 5% powder increases the strength to 8.67 MPa and 10% powder increases the strength to 9.32 MPa.

3.3 Impact Strength

The ability of a part to create an internal force multiplied by the deformation caused by impact determines the part's impact strength. An element's capacity to withstand impact can be improved by its shape. The ASTM technique D256 was used to assess the composite's impact strength.

Fig. 6. Impact Strength

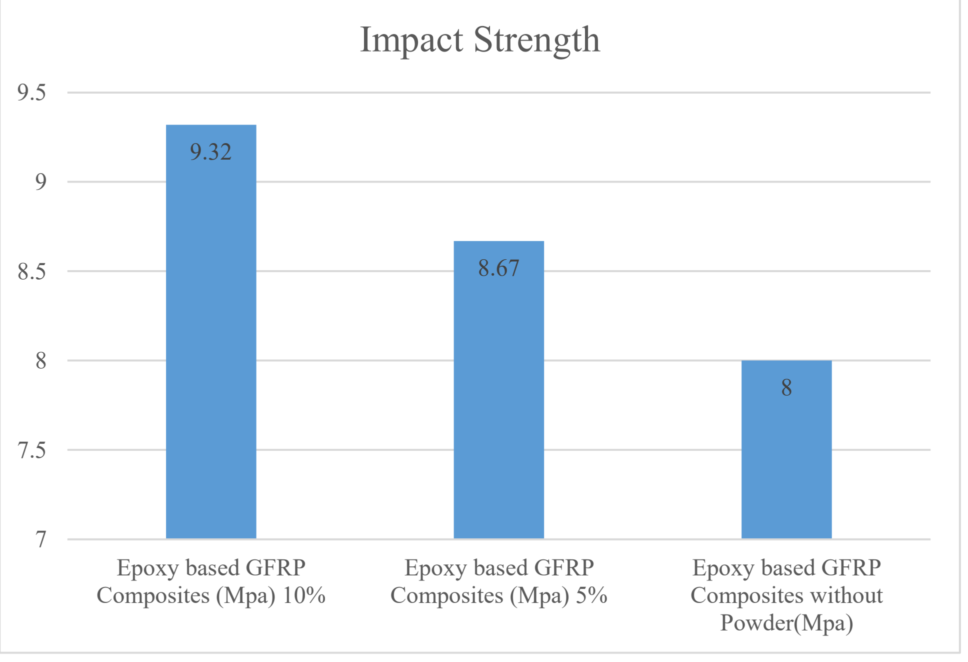

Fig. 7 Impact strength of the Composite

3.4. Hardness Test

The hardness test uses the depth of penetration of an indenter loaded on a material sample to assess the indentation hardness of various materials. The material hardness number (BHN) of the composite is ascertained through testing. ASTM E10 standard was adopted to prepare specimens. The size of specimen is 10mmm×10mm×2.05. The hardness of the GFRP composite were improved with mixing of powders with epoxy resin. Adding of powders improve the hardness in the matrix leads to the improvement in the hardness of the powder mixed composites.

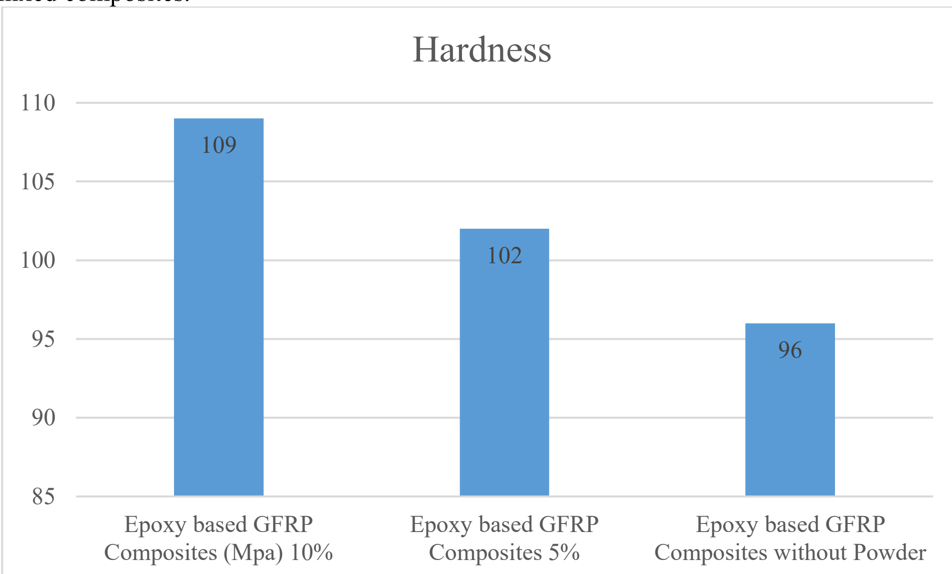

Fig. 8 Hardness of the Composites

4. Conclusion

In this experimental effort, reinforced epoxy matrix composites with electronic waste filler materials have been studied. It has been demonstrated that fiber-reinforced polymers have superior mechanical qualities. The tensile strength of the composites were improved more than 20 percentage for the 10% of powder in the matrix material. The results showing that the percentage of added powder increases the mechanical properties of the composite material. Hardness properties has been improved more than 10% due to the filler materials. The contribution of powder to the tensile, compressive, and hardness properties of polymers enhances due to the bonding strength given by the reinforced resins. These studies have demonstrated that, provided the powders are equally scattered throughout the matrix, adding a tiny quantity of powders to a polymer matrix can significantly improve the mechanical properties of the hosting matrix.

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