RESEARCH ARTICLE OPEN ACCESS

STUDY OF MECHANICAL AND WEAR BEHAVIOR OF MOS_2 FILLED GLASS EPOXY COMPOSITES

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Abstract:

Glass fiber reinforced polymer composites find widespread applications these days in hostile environments due to their several advantages like high wear resistance, strength-to-weight ratio, and low cost. The performance of the composites can further be improved by adding particulate fillers to them. To this end, this work Molybdenum disulphide (MOS2) as a filler material in a polymer matrix to assess the wear resistance of polymer composite.

The present work includes the study of mechanical properties like tensile, flexure and hardness, sliding wear behaviors, and wear behavior of bi-directional glass fiber reinforced epoxy composites with and without filler. The wear of the composites with 0, 5, and 10% MOS2 filler have been evaluated.

The mechanical properties of tensile, flexure, and hardness of the composite material has no influence on tensile, flexural and hardness properties of the material and wear loss decreases with increases Molybdenum disulphide filler percentage.

.**Keywords: Composites, Fillers, Tensile strength, Wear behavior, Flexural and Hardness.**

I. INTRODUCTION

Composite Materials Are Engineering Materials Made From Two Or More Constituent Materials With Significantly Different Physical Or Chemical Properties, Which Remain, Separate And Distinct On A Macroscopic Level Within The Finished Structure.

There Are Two Categories Of Constituent Materials, Matrix And Reinforcement. At Least One Portion Of Each Type Is Required. The Matrix Material Surrounds And Supports The Reinforcement Materials By Maintaining Their Relative Positions. The Reinforcements Impart Their Special Mechanical And Physical Properties To Enhance The Matrix Properties. A Synergism Produces Material Properties Unavailable From The Individual Constituent Materials, While The Wide Variety Of Matrix And Strengthening Materials Allows The Designer Of The Product Or Structure To Choose An Optimum Combination. Engineered Composite Materials Must Be Formed To Shape. The Matrix Material Can Be Introduced To The Reinforcement Before Or After The Reinforcement Material Is Placed Into The Mold Cavity Or Onto The Mold Surface. The Matrix Material Experiences A Melting Event, After Which The Part Shape Is Essentially Set. Depending Upon The Nature Of The Matrix Material, This Melting Event Can Occur In Various Ways Such As Chemical Polymerization Or Solidification From The Melted State.

II. MATERIALS AND METHOD

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A. **Materials** Glass-reinforced polymer (GRP) is a composite material made of a Polymer reinforced by fine glass fibers. In composite materials, the two materials act together, each overcoming the deficits of the other. Polymer resins are strong in compressive loading and relatively weak in tensile strength, the Glass fibers are very strong in tension but have no strength against compression. By combining the two materials, GRP becomes a material that resists both compressive and tensile forces well. The two materials may be used uniformly or the glass may be specifically placed in those portions of the structure that will experience tensile loads.

Table 1

Material composition

	Matrix (wt %) Epoxy	**Fiber (wt %) Glass fiber**	**Filler (Wt %) MOS_2**
GE	(40)	(60)	(0%)
GE1	(35)	(60)	(5%)
GE2	(30)	(60)	(10%)

Fig 1 Glass +epoxy composite (GE)

Fig 2 Glass +epoxy composite +5% MOS_2

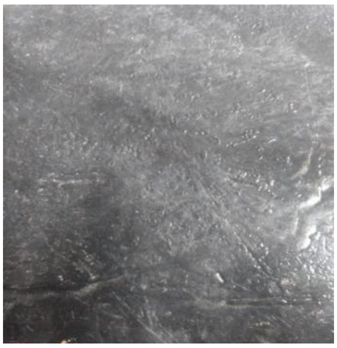

Fig 3 Glass +epoxy composite+10% MOS_2 (GE2)

B. FABRICATION METHOD

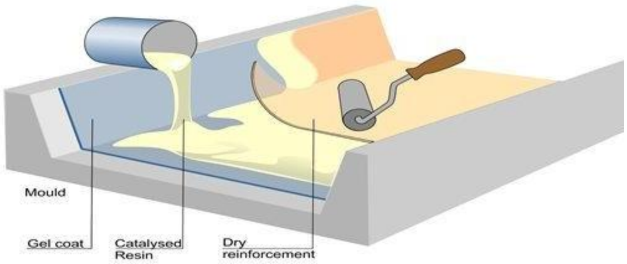

Fig 4 Schematic representation of Hand Lay Up technique

Materials

1. Each fiber laminate thickness= 0.5mm
2. Hardener= K6
3. Epoxy= L12
4. Resin = epoxy + hardener + filler
   40% resin = 105gm + 10gm + 0% filler
   35% resin =92gm+ 9gm+5% filler(13.66 gm)
   30% resin = 79gm+8gm+10% filler(26.3 gm)

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified. The Glass fiber reinforced Polymer Matrix Composite laminates were manufactured by Hand Lay-Up technique. The glass fabric was placed on a Teflon sheet over which the epoxy resin mixed with filler, hardener and Catalyst was applied. The bidirectional glass fiber mat is placed on it and one coat of resin is applied over which another layer of glass fiber mat is place and rolled. To ensure uniform thickness of the samples, a 3mm spacer was used. The mould is prepared with either polyvinyl alcohol or non-silicon wax to aid release of the component. Release of the component is achieved by either tapping wedges between mould and component or by the use of compressed air to gently force the pieces apart.

A gel coat is applied to the mould surface to produce a resin rich smooth surface for appearance and protection purposes. Whole assembly was kept in a hydraulic press of 0.5 MPa and allowed the resin to cure at room temperature with the use of catalyst for a day. Test samples were from 304 mm× 304 mm ×3mm slab, as per the ASTM standards.

C. TENSILE TEST

The term tension test generally refers to tests in which a specimen is subjected to gradually increasing axial load until failure occurs. In a tension test, the test specimen elongates in a direction parallel to the applied load. In a simple tension test, the load is applied by gripping opposite ends of the specimen and paralleling it apart. The static tension test is the most commonly conducted among all mechanical tests and commonly conducted among all mechanical tests and it has well established procedure. Tensile test is to be conducted in universal testing machine according to ASTM international (American society for Testing and Materials) standard. The specimen is cut according to ASTM D-638.

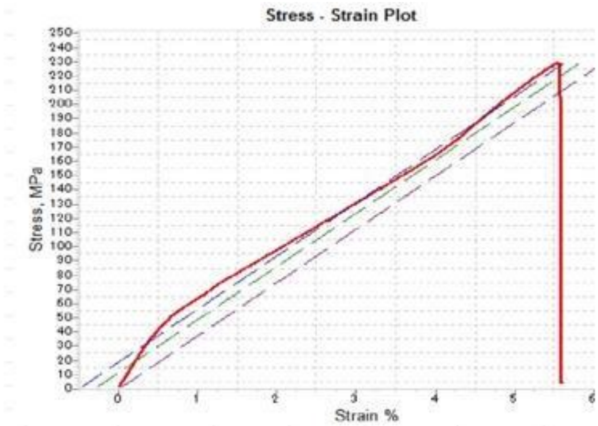

Fig 5 Performance Tensile tested material GE

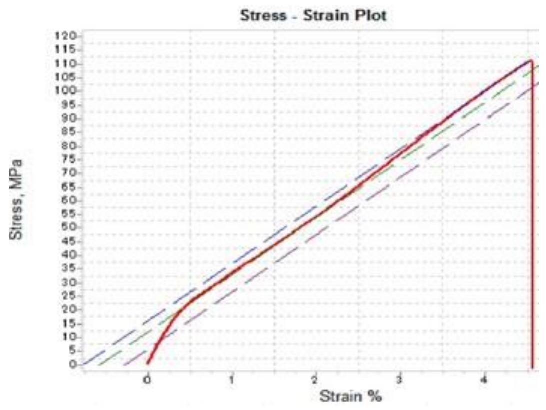

Fig 6 Performance Tensile tested material GE1

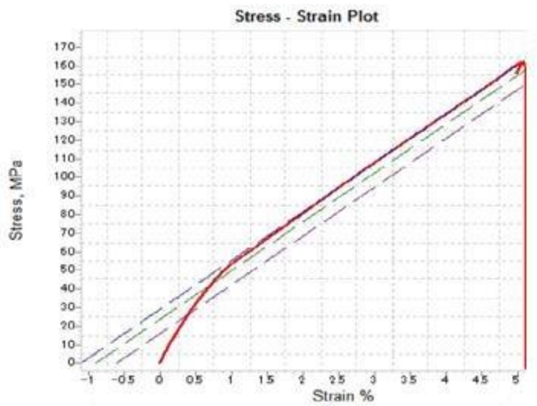

Fig 7 Performance Tensile tested material GE2

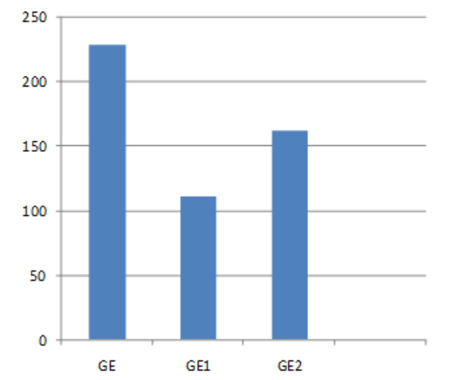

Fig 8 Ultimate strength v/s Material composition

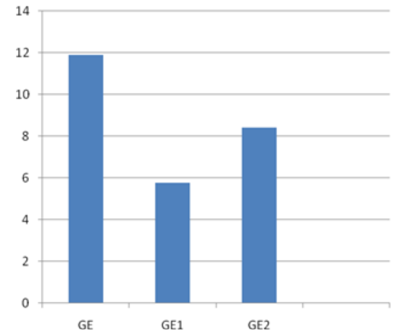

Fig 9 Ultimate load v/s Material composition

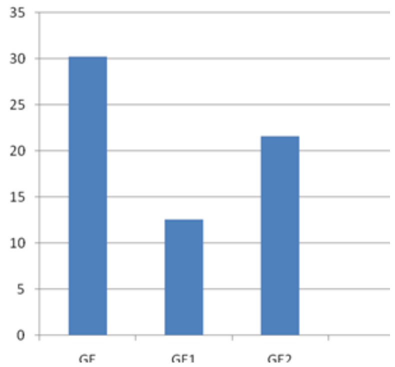

Fig 10 Energy under plastic region v/s Material composition

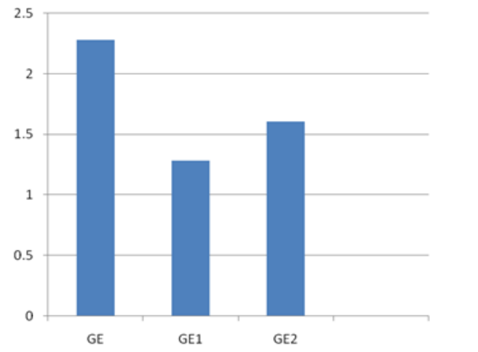

Fig 11 Stiffness v/s Material composition

It can be observed from the results that ultimate strength, Breaking strength, Young's Modulus increases with increase in percentage of filler content in the composition. Comparing the results it can be seen that GE2 composite showed the highest tensile strength value, confirming the effect of incorporation of MOS_2 filler, which improves the fiber–matrix interface in the composite. The tests showed linear elastic behavior and brittle fracture for the test samples. Also, the fibers in a composite fail at different stress levels as the applied tensile load increases. In the present test, the GE composite showed the lowest tensile strength values and the main failure mode was fiber– matrix debonding.

D. FLEXURE TEST

The flexure test method measures behavior of materials subjected to simple beam loading. It is also called a transverse beam test with some materials. Maximum fiber stress and maximum strain are calculated for increments of load. Results are plotted in a stress-strain diagram. Flexural strength is defined as the maximum stress in the outermost fiber. This is calculated at the surface of the specimen on the convex or tension side. Flexural modulus is calculated from the slope of the stress v/s deflection curve. If the curve has no linear region, a secant line is fitted to the curve to determine slope.

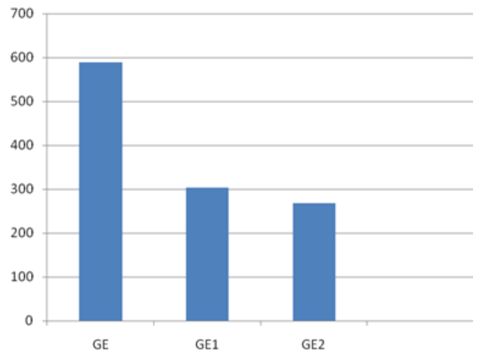

Fig 12 Maximum load v/s Material composition

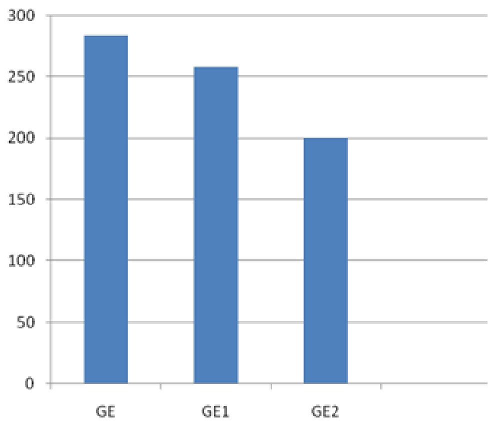

Fig 13 Maximum Flexural t v/s Material composition

The results clear that the introduction of MOS_2 filler in thermoset composites increases the flexural strength. Comparing the results it can be seen that GE2 composite showed the highest flexure strength value, and GE showed lower flexure strength value confirming the effect of incorporation of MOS_2 filler, improves the fiber–matrix interface in the composite. The presence of MOS_2 fillers improved adhesion and it has been proved to be beneficial in thermoset composites.

E. HARDNESS TEST

Hardness is the property of a material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion or cutting. Hardness is not an intrinsic material property dictated by precise definitions in terms of fundamental units of mass, length and time.

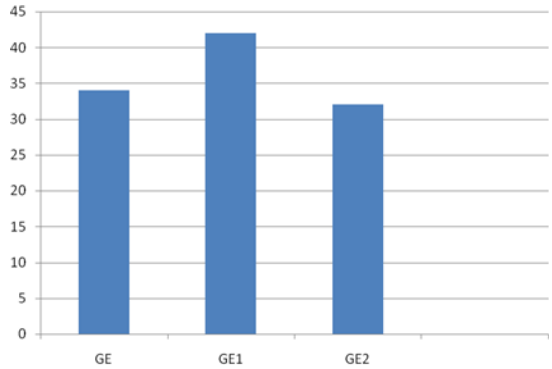

Fig 14 Hardness comparison of the composite material

The surface hardness result of composites fig 9.2 shows that that the GE2 composite showed the higher hardness and GE showed lower hardness value. The hardness of the composite material was increased has the filler content was increased. This shows that the filler silicon dioxide has the influence in improving the hardness of the composite.

F. WEAR TEST

Several standard test methods exist for different types of wear to determine the amount of material removal during a specified time period under well-defined conditions. ASTM International Committee G-2 standardizes wear testing for specific applications, which are periodically updated. The

Society for Tribology and Lubrication Engineers (STLE) has documented a large number of frictional, wear and lubrication tests. Standardized wear tests are used to create comparative material rankings for a specific set of test parameter as stipulated in the test description. To obtain more accurate predictions of wear in industrial applications it is necessary to conduct wear testing under conditions simulating the exact wear process. An attrition test is a test that is carried out to measure the resistance of a granular material to wear.

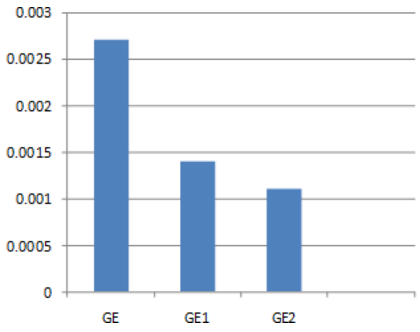

Fig 15 Wear loss for 1kg load

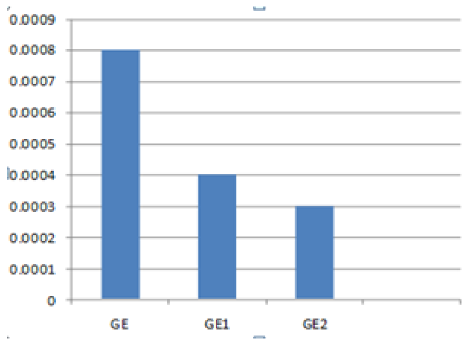

Fig 15 Wear loss for 2kg load

Two body abrasive wear characteristics of MoS_2 filled composites are analyzed using Pin on disk Wear testing machine. From the results and plots obtained from the results it is clear that as the percentage of Filler material increases the amount of wear is considerably decreased for both 1kg and 2kg's of Load.

III. CONCLUSIONS

In this project glass fiber reinforced polymer matrix composite with varying percentage of Molybdenum sulphide fillers were fabricated by hand layup process. The varying weight percentage of Molybdenum disulphide (MoS_2) was 0%, 5% and 10%. The fabricated polymer composite was subjected to various test to study the effect filler on the mechanical and wear behavior of the composite.

Mechanical Properties

- The mechanical behavior tests i.e. Tensile test, flexural test and hardness test were conducted
- The test results show that the filler has no influence on tensile, flexural and hardness properties of the material.
- As per the result Glass Epoxy Composite with 0% MoS_2 exhibit high tensile strength, flexural strength.

Wear Properties

- Two body abrasive wear characteristics of MoS_2 filled composites are analyzed using Pin on disk Wear testing machine.
- The test results reviles that the wear loss decreases with increases Molybdenum disulphide filler percentage.
- This significantly shows that Molybdenum disulphide filler influence in decreasing wear loss because of its lubricating property.

ACKNOWLEDGMENT

The authors wish to acknowledge the support provided by our esteemed institutions JSSSTU, GMIT and JSSATE in various ways and also we extend our thanks to the laboratories for providing sufficient facilities needed for our research.

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