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Comparison of Mechanical Properties of Epoxy-Filler Composite Materials

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Abstract *:* This study aims in comparison of various mechanical properties of epoxy composite materials reinforced with different fillers in various percentages. The fillers used were calcium carbonate powder with various percentages. Specimens werer manufactured following ASTM standards. Mechanical tests like tensile test and bending tests were carried out and corresponding properties were determined and the same for different composite materials were compared. Also effect of heating epoxy resin is also analyzed experimentally. After testing fractured specimens were analyzed for microstructure using optical image analyzer with resolution range from 100X to 1000X.

IndexTerms - Epoxy, calcium carbonate, ASTM standards, heating epoxy resin etc.

1. INTRODUCTION

Composite materials are finding huge amount of scope in recent advancement of technology. They have the properties which are enhanced artificially by using various manufacturing techniques. Composite materials may be regarded as material with various phases, exhibiting properties of each phase with the enhancement of overall properties.

Electrical products, home appliances etc are fond of use of composites mainly, particulate reinforced composites. Polymer composites reinforced with fillers have also become worthy targets for the researchers to work for. Various polymers and fillers can be used in combination to get the desired composite materials with utmost desirable properties.

Commonly used polymer is epoxy resin. Fillers may be metallic, mineral or ceramic fillers. Mineral fillers include calcium carbonate, silica and mica etc.

Composites are much needed in trendy days for the fact that in several applications we will not be able to get the properties that we wish to by the application of ordinary materials like metals, ceramics and so forth. What we have an actual tendency to truly need is a material with blended characteristics wherein composites have an important role to play. One case of such application is innovation of flying machine where solid, light, disintegration (erosion) safe materials are needed to satisfy such particular requirements; composites are needed to be developed.

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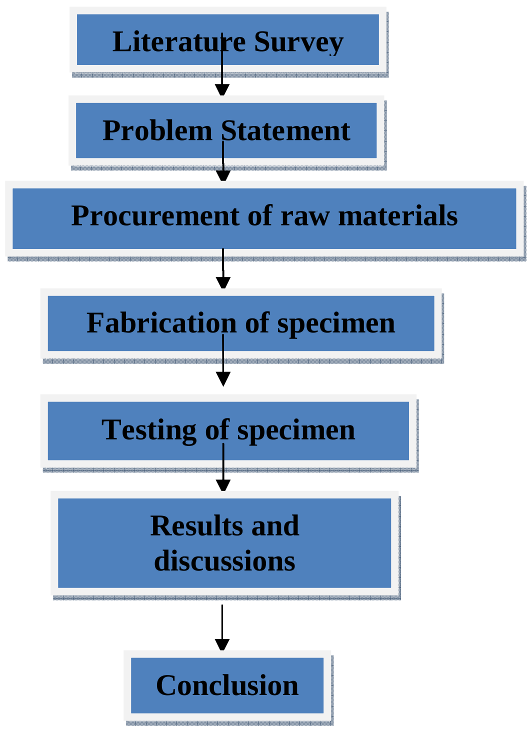
2. METHODOLOGY



3. SPECIMEN MANUFACTURING

1. Materials

Materials used for the manufacturing of composite materials are listed in the following table.

Table 1: Materials

Matrix	Lapox T-22 resin
Hardener	K-6 Hardener
Filler	Calcium Carbonate

In present work, concentration is on mineral fillers rather than on ceramic and metallic fillers. Mineral fillers such as calcium carbonate and silica can be used as fillers in making polymer composites that can be used in capacitor applications. Mineral fillers are commonly used fillers in polymers because of their low cost and easy availability. Mineral fillers can improve mechanical and thermal properties of polymers. Mineral fillers are cheaper than ceramic fillers.

As compared to other resins epoxy resin is having better properties. Also epoxy resin is having low cost and is easily available. Also epoxy resin has better adhesive properties, good fatigue resistance and withstanding capacity towards degradation from water.

Hardener used in combination with epoxy Lapox T-22 is K-6 hardener that is supplied by Atul Limited., Gujarat. K-6 hardener is liquid hardener which is having low viscosity and it can be cured at room temperature. It is so reactive that it helps in rapid curing at normal room temperatures.

Table 2: Codes for specimens

Code	Epoxy-filler composition
M1	Pure epoxy
M2	10% $CaCO_3$(neat epoxy)
M3	20% $CaCO_3$(neat epoxy)
M4	Heated epoxy
M5	10% $CaCO_3$(Heated epoxy)
M6	20% $CaCO_3$(Heated epoxy)

2. *Fabrication & Testing*

Specimens were manufactured using open mould technique following ASTM standards for different tests.

Table 3: Test details

Sl. No.	Test	ASTM Code	Specimen Size(mm)
1	Tensile	D638	115x13x4
2	Bending	D790	110x25x6

Tensile test and bending tests were carried out in a computerized universal testing machine.

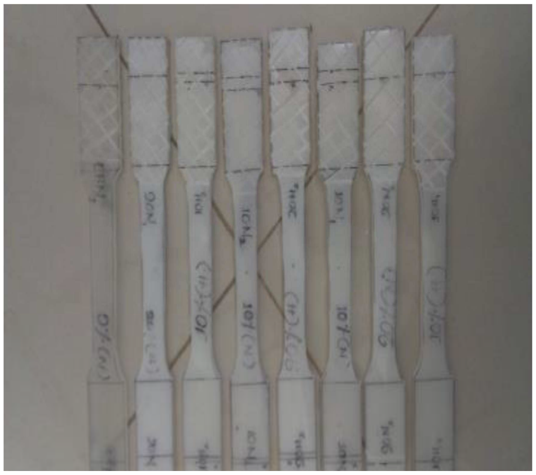


Fig 1: Tensile test specimens

Fig 2: Bending test specimens

Fig 3: Tensile test specimen loaded in UTM

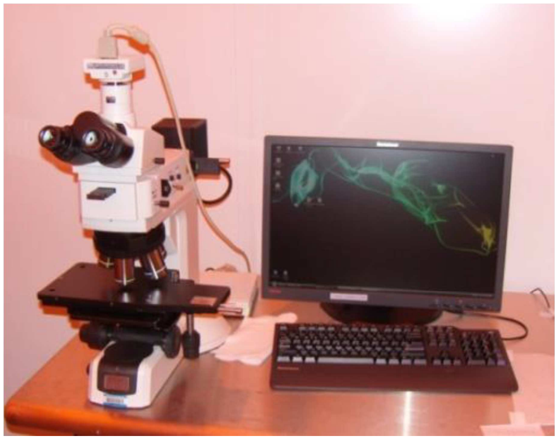


Fig 4: Optical image analyzer

4. RESULTS AND DISCUSSIONS

1. Tensile Test Results:

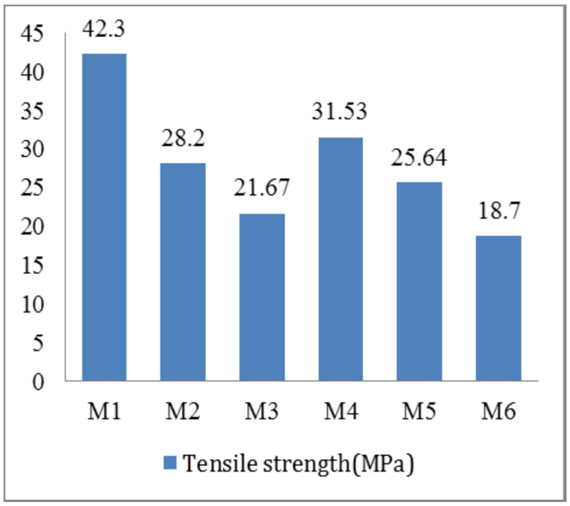


Fig 5: Comparison of tensile strength

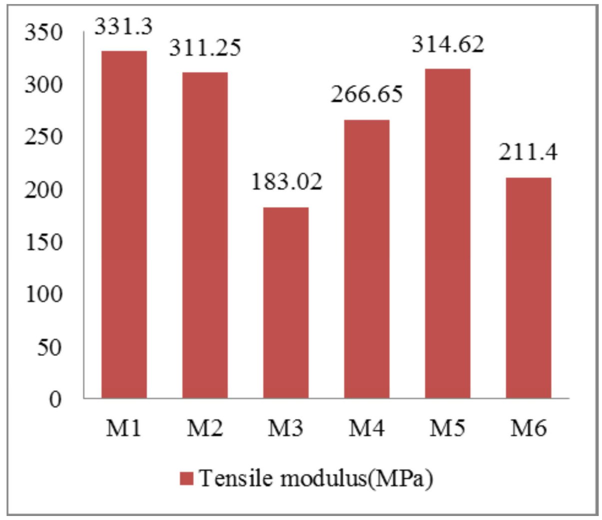


Fig 6: Comparison of tensile modulus

2. Bending Test Results:

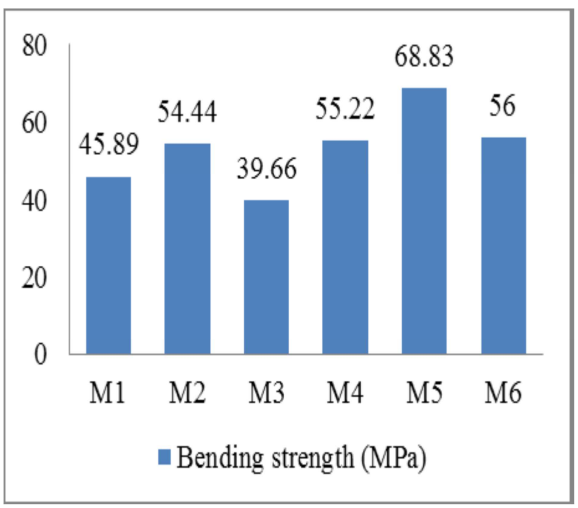


Fig 7: Comparison of bending strength

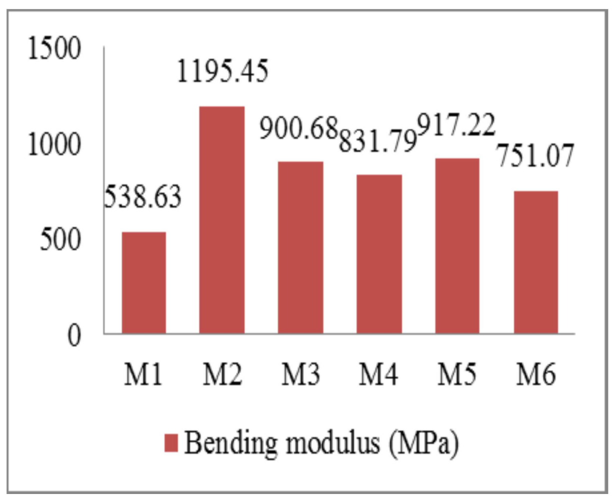


Fig 8: Comparison of bending modulus

3. Microstructure Analysis:

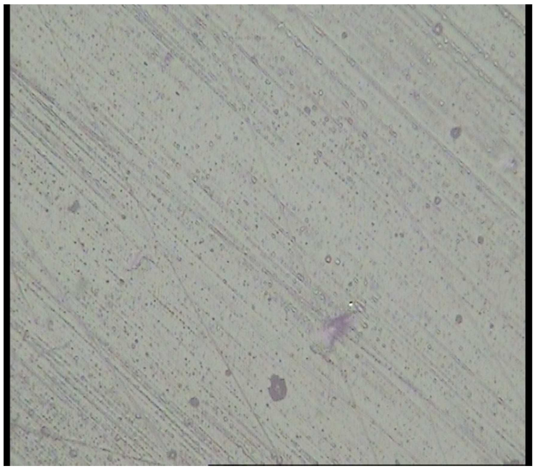


Fig 9: M1(before tensile test)

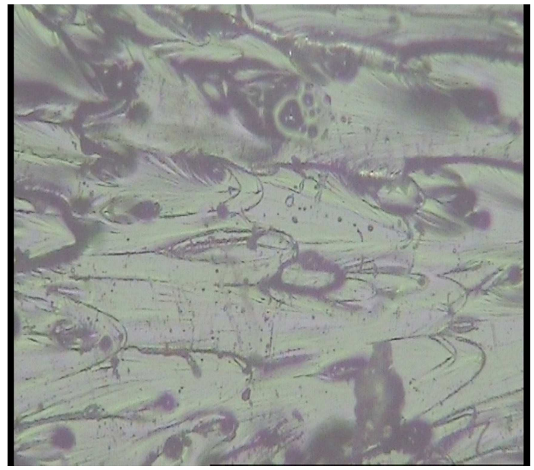


Fig 10: M1(after tensile test)

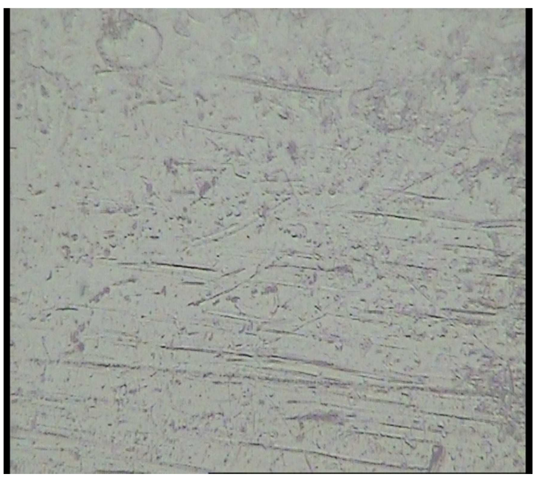


Fig 11: M1(before bending test)

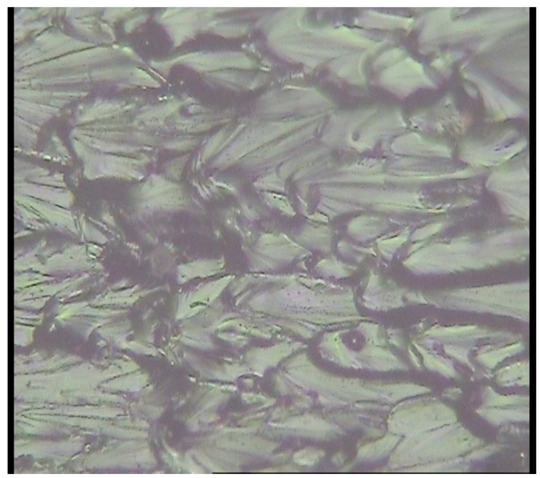


Fig 12: M1(after bending test)

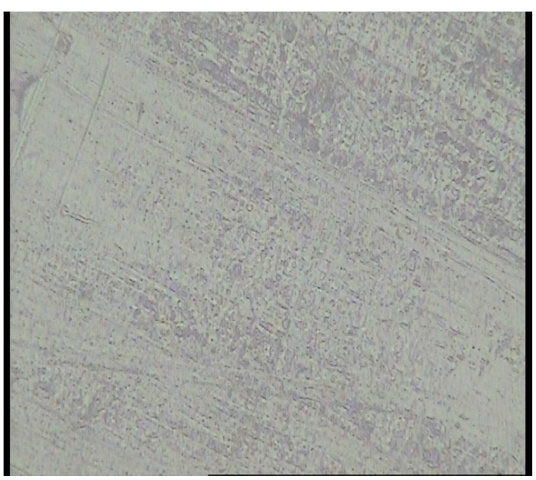


Fig 13: M2(before tensile test)

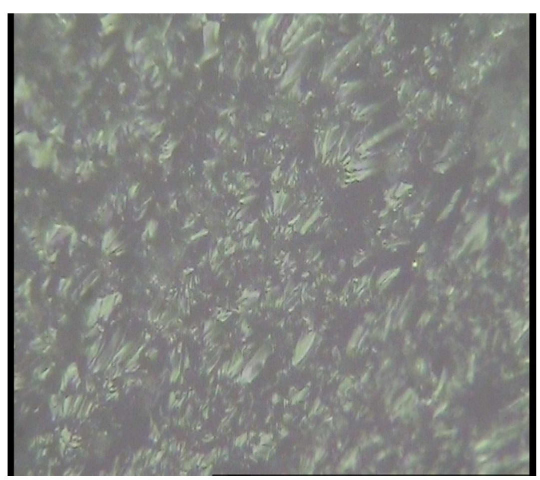


Fig 14: M2(after tensile test)

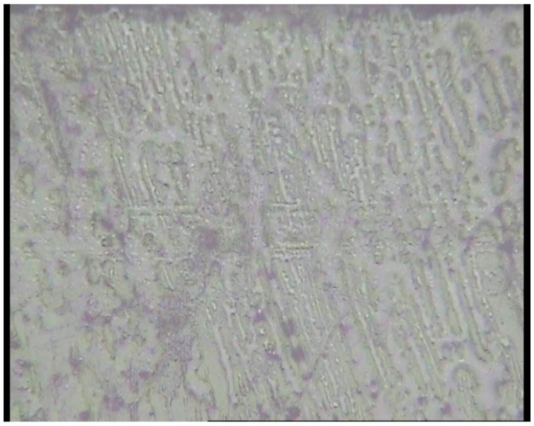


Fig 15: M2(before bending test)

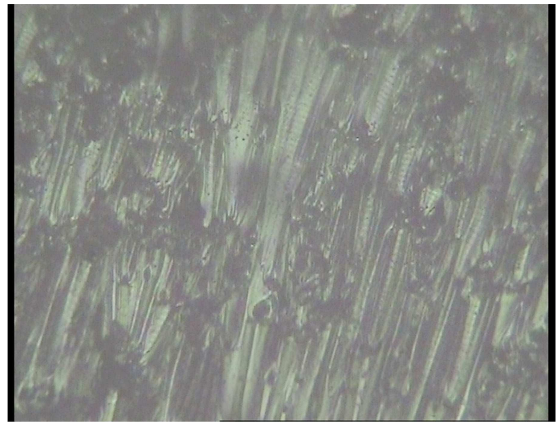


Fig 16: M2(after bending test)

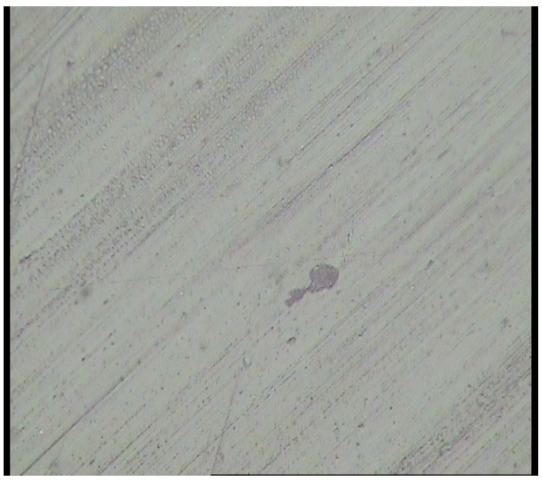


Fig 17: M4(before bending test)

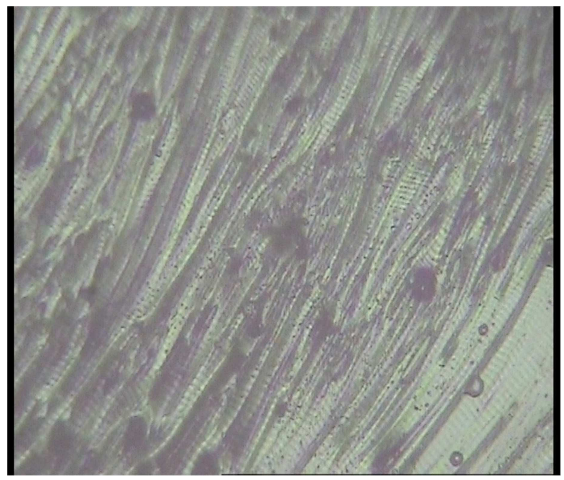


Fig 18: M4(after bending test)

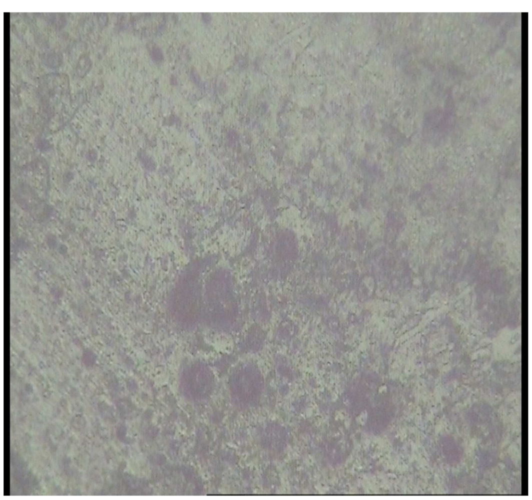


Fig 19: M5(before tensile test)

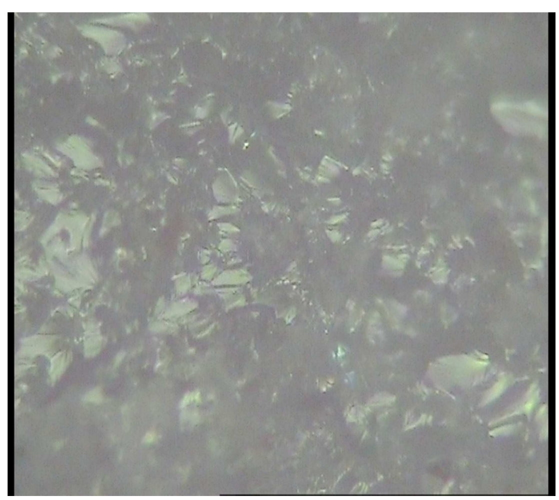


Fig 20: M5(after tensile test)

5. CONCLUSIONS

1. Tensile Test:
   Heating of epoxy resin has a noteworthy effect on tensile strength of composite. Heating of epoxy resin diminished the strength of the materials.
   Amount of filler also has important effect on strength of materials. As amount of filler increases in the material, strength of the material diminishes.

2. Bending test:
   Heating of epoxy resin has a noteworthy effect on bending strength also. When epoxy resin was heated and used in fabrication bending strength of the materials increased.
   Amount of filler in the material also affected the bending strength of the materials. As the amount of filler increased in the composition, strength of the materials also increased.

3. Microstructure Analysis:
   Microstructure analysis of specimens after fracture shows that tensile strength is very less in all the compositions.
   Microstructure analysis of specimens after bending fracture leads to conclusion that after bending load has been applied, there was more deflection of particles showing that resistance for bending was more. Hence bending strength was more.

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