Scientific Journal Impact Factor (SJIF) : 1.711
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

DEVELOPMENT AND CHARACTERISATION OF EPOXY RESIN BASED GRANITE POWDER AND GLASS FIBRE REINFORCED COMPOSITE

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ABSTRACT: Strength and durability plays an important role in composite material. Nowadays, environmental and economical concerns are stimulating research in the development of new materials for constructions, marine, military transportation and others. Granite quarry sludge is an abundant waste from granite rock processing. The use of this waste could be a valuable resource if properly engineered into a successful solution as partial cement replacement in concrete. The Thesis mainly gives importance on waste materials that is granite powder and flyash powder which is being reused for the composite material preparation, for the composite material preparation a small amount of E-glass fibre and the epoxy resin is used in the work carried out. In the present work first the granite powder, fly ash and the E-glass fibre is collected in a certain volume for the preparation of the specimens for testing and the samples were prepared and the tests carried are compression and the tensile test for finding out the strength of the material and after testing carried out it is found that the strength of the material is been increased by increase in the volume of E-glass fibre.

I. INTRODUCTION

Composites make a very broad and important class of engineering materials. These materials are extensively used in the variety of applications, like in aerospace industry. Applications are not only restricted to the field of aerospace but spread over a wide range that includes civil, construction, automobiles, chemical and other miscellaneous sectors[1-3]. Composites became very popular among material scientists as they provide ample scope to get modified properties by using varying components, different processing methods, and the expediency of replacing components with cheaper alternatives[4].

Currently the amount of garbage or waste material is increasing day by day as the population of the world increases. If we see closely, most of the wastes are from the things that we used daily such as paper and plastic. Due to the increasing number of mankind in the world, more products have to be manufactured to cater the needs of every human being. These cause natural resources such as wood, granite and petroleum to deplete fast. Realizing this, recycling is introduced as a way to curb the problems that arise. By recycling natural resources can be preserved for future use and in the same time protect the environment such as forest that gives oxygen for human to life. Recycling also reduces amount of waste produce and can help to encounter garbage accumulation problem. Recycling also reduces cost since manufacturing product from raw material to finished product is getting expensive as time passes. To overcome this problem, this study is done in order to develop composite from recycled material such as granite powder and fly-ash. By doing this research, a deeper study on the properties of GFRPs can be done in order to develop and improve the usage of this composite in the future.

The technique accustomed fabricate granite-epoxy stuff is Hand lay-up. It's the straightforward and oldest open moulding method. The Calculated volume of materials is mixed and uniformly compacted within the designed mould. The Calculated volume of materials is mixed and uniformly compacted in the designed mould. The set free agent has been applied for the aim of simple removal of specimen from the

mould[5-7]. The compacted material is allowed for curing at room temperature and about 48 hours. The mould is then being separated into parts and the specimen is taken out. The specimen is prepared according to ASTM standards. Compression and tensile testing of the fabricated samples are tested using the Universal Testing Machine. SEM analysis was carried out for specimens [8-13].

II. MATERIALS

In thesis the fiber reinforced plastic (GFRP) composite was used. In GFRP the matrix material used was a changed epoxy resin- LAPOX twelve & Hardener K6 and E-Glass fibre as reinforcement material.

TABLE 2 Material used for the experiment

Sl.No	Reinforced Material	Matrix Material	Filler material
1	Glass Fibre	Epoxy Resin (Lapox L12)	Granite powder + fly ash

2.1 MATRIX MATERIAL

Lapox L12 is a liquid, unmodified epoxy of medium body which might be used with varied hardeners for creating fiber strengthened composites. The choice of the liquid hardener depends on the processing method to be used and on the properties required of the cured composite.

Fig.2 Epoxy resin with hardener

Fig 3.1 shows the mixing of both epoxy resin and the hardener so that the curing of the composite material takes a very less time and continuously stirred to avoid air inclusion and to get good mixture.
Hardener K6 is a liquid hardener of low viscousness activity at temperature. It's normally used for hand lay-up applications. Being rather sympathetic, it provides a brief operating life and fast cure at traditional encompassing atmosphere. Laminates can be complying with operating temperatures of about 100^0 C.

2.2 THE CHARACTERISTICS OF CURED RESIN WITHOUT REINFORCEMENT

Table 2.2 - Properties of epoxy

Parameters	**Value**
Tensile Strength	3445 N/mm^2
Compression strength	1080N/mm^2
Density	2.58 g/cm3
Flexural Strength	130-150N/mm^2
Impact Strength	17-20KJ/m^2

2.2.1 REINFORCING MATERIAL: PRODUCT- E-GLASS WOVEN ROVING 400GSM/1000M
GFRP is a form of strengthened plastic where the reinforcement fibre is specially a fiber. It's going to be at random organized however it's ordinarily a woven sort in mat kind. Fibre it's roughly comparable mechanical properties to alternative fibres like carbon fibre and polymers. Although it's not robust or as rigid as carbon fibre, it's cheaper and is and additional considerably less brittle once getting used in composites. Glass is being widely used because of the following reasons:

- It has Good corrosion resistance.
- Low cost technology of fabrication of continuous fibers from molten glass.
- Easily available and cost of glass fibre is also less.

Fig 2.2.1 - Fibre glasses are in different physical forms like microspheres, chopped or woven fiber.

Table 2.2.1 Properties of Glass Fibre-EWRH400

Parameters	**Accepted Standards**		**Test Results**
	Standard No.	Standard value	Average Value
Density	**ISO** 1889-1997	380-420	400.0g/m^2
Moisture Content	**ISO** 3344-1997	<=0.15	0.13%
Combustion Matter Content	**ISO** 1887-1995	0.60+_0.1	0.61

2.3 Granite Epoxy Composite

Granite epoxy is a particulate type composite, which comprises of epoxy resins, hardener and correctly graded granite aggregate as its ingredients. In this work, the following epoxy resin system is employed:

Epoxy resin : LAPOX 12
Hardener : Hardener K6
Filler : Graded
Black granite aggregates and Fly ash

2.4 Filler material

The filler materials used in the project are graded black granite aggregates and fly ash powder. These filler materials are very easily available and free of cost and the graded black granite powder it gives good strength to the composite materials and it gives good mechanical properties also, this granite powder is easily available in the granite quarry and also the fly ash powder is also easily available it is being used in the project as it is being a waste material obtained from the power plants. Fillers are added to a polymer

matrix for one or more of reasons are reduce weight and cost, Increase stiffness, thermal resistance, stability, strength, etc.

III. FABRICATION AND EXPERIMENTAL PROCEDURE

In Present work we have used materials such as granite powder, glass fibre, fly ash. The matrix material selected is Epoxy resin. The different compositions have been chosen by varying the content of glass and granite powder, using this, three different compositions has been prepared.

3.1 GRAIN SIZE

This test is performed to see the share of various grain sizes of Granite Powder. A sieve analysis (or gradation test) may be a procedure used (commonly employed in civil engineering) for the particle size distribution of a granular material. A sieve analysis is performed on any variety of organic or non-organic granular material as well as stands, stone, clays, granite, a large vary of manufacture powders, grain seeds, all the way down to a minimum size reckoning on the precise methodology.

3.2 CALUCATION

1) % of Granite Powder retained in each sieve, $R= (W_{sieve}/W_{total})x$ 100

% of Granite Powder retained in each sieve, R= (1.0/500) x 100

2) Total % of granite powder retained

$\sum R = 497.5$

3) Total Product $\sum R = 118$

Table3.2 - Grain size test for granite powder

Sl. No.	Sieve No µ	Weight of Granite powder (gms)	(%)granite powder retained in each sieve R	Multiplier (S)	Product (R*S)
1	850	7	1.4	5	7
2	600	2	0.4	10	4
3	425	92.5	18.5	15	277.5
4	212	187	37.4	20	748
5	150	51	10.2	25	255
6	Pan	158	31.6	30	948
			∑R=118		∑(R*S) 22395.5

Grain powder no. = $\sum(R*S)/\sum R$

Grain Powder No = 0.0052

3.3 FABRICATON

- The compacted material is being filled into the desired mould.
- The compacted material is allowed for curing at room temperature and for about 48 hours and taken out.
- The specimen is prepared of ASTM Standard. (For Tensile test ASTM E8).

Table3.3 Designation of Composites

Sl.No	Composite	Composition
1	C1	35% (Epoxy Resin) + 65% (40% GP +20%FA + 5% EG)
2	C2	35% (Epoxy Resin) + 65% (40% GP +15%FA + 10% EG)
3	C3	35% (Epoxy Resin) + 65% (40% GP +10%FA + 15% EG)

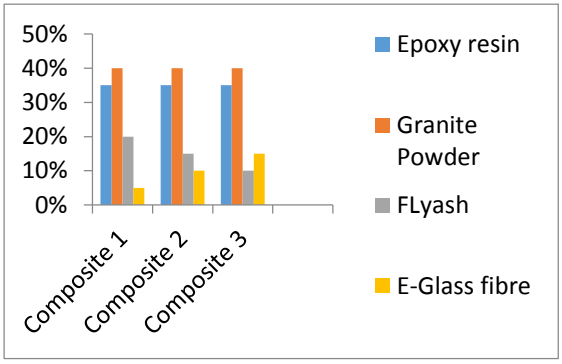

Fig 3.3 Percentage compositions of composites C1 C2 C3

3.4 TENSILE TEST

Tensile testing is one amongst the foremost elementary tests for engineering, and it provides valuable info regarding the fabric and its properties. The property obtained is used for the planning and for the analysis purpose of engineering structures, and for developing new material that higher suit a mere use. 3 completely different samples of various compositions of every material were tested within the universal testing machine and therefore the information is entered into the excel sheet. The info is employed for scheming the properties of every sample i.e., coefficient of elasticity, yield strength, final strength. The most purpose for conducting this take a look at is to seek out out the necessary mechanical properties.

Fig3.4 Test specimen after breakage

3.5 COMPRESSION TEST

The specimens are prepared with a minimum length of 50x18mm with three different compositions and each specimen are mounted in the UTM for compression testing and the load is applied until the specimen is fractured and the readings are noted down and the required compressive strength and other properties

were calculated. The specimens are prepared according to ASTM standard and the volumes of mixture are measured for preparing samples different compositions.

In this testing three different samples of different composition are selected. First for all the three composition the epoxy resin percentage is kept constant about 35% and also the Granite powder is constant of 40% and the fly ash is been decreased from 20% to 10% and the glass fibre is been increased from 5% to 15% and the samples were prepared. Once the samples are prepared these are tested in a Universal testing machine for compression test and the readings are being noted and from the data obtained calculations are made to obtain the compression strength of the composite material of glass fibre reinforced composite.

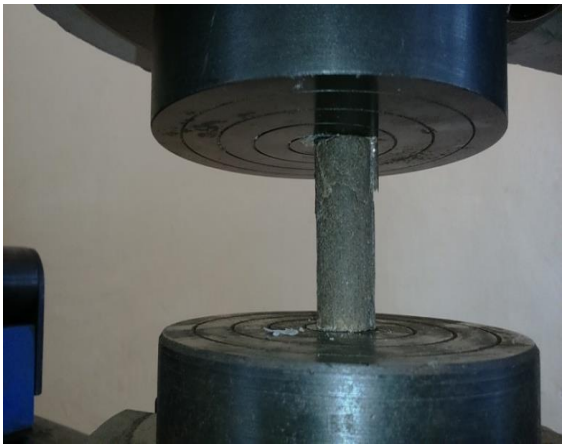

Fig 3.5 Compression test specimen under test in UTM

Fig 3.6 Compression specimens of 1st, 2nd, 3rd composition

IV. RESULTS AND DISCUSSION

The present study was aimed toward impact response of assorted materials particularly granite powder, fibre, fibre strengthened Plastic (GFRP) composites. Mechanical testing is one amongst the necessary role in evaluating elementary properties of engineering materials similarly as in developing new materials and in dominant the standard of materials to be used in style and construction. The compression and therefore the tensile tests were distributed and therefore the results were conferred during this section. With the assistance of Scanning microscope (SEM) the microscopic and fractographic examination were distributed to characterize the injury mechanisms in these composites.

4.1 COMPRESSION TEST

Table 4.1.1 Compression Test Report of Specimen 1

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with e-glass fiber and fly ash
Specimen Diameter	18 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm
Specimen Cross Section Area	254.47 mm^2
OUTPUT DATA	
Load At Peak	15.030 N
Elongation at Peak	2.790 mm
Compression Strength	59.064 N/mm^2

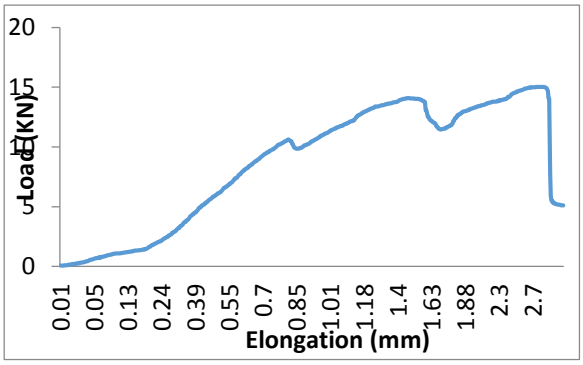

Fig 4.1.1 Load v/s Elongation graph of specimen C1

Table 4.1.2 Compression Test Report of Specimen C2

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with e-glass fiber and fly ash
Specimen Diameter	18 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm

Specimen Cross Section Area	254.47 mm^2
OUTPUT DATA	
Load At Peak	13.260 KN
Elongation at Peak	1.800 mm
Compression Strength	52.109 N/mm^2

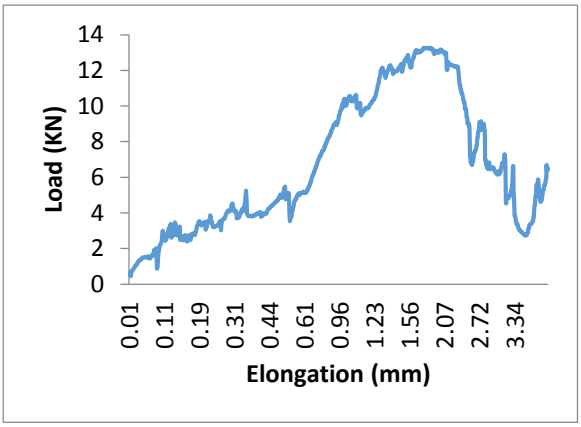

Fig 4.1.2 Load v/s Elongation graph of specimen C

Table 4.1.3 Compression Test Report of Specimen C3

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with e-glass fiber and fly ash
Specimen Diameter	18 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm
Specimen Cross Section Area	254.47 mm^2
OUTPUT DATA	
Load At Peak	15.390 KN
Elongation at Peak	2.790 mm
Compression Strength	60.479 N/mm^2

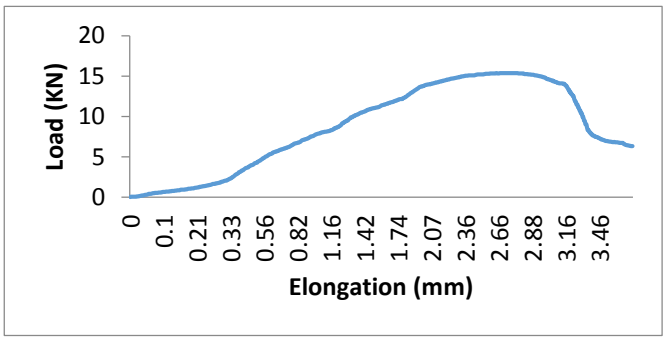

Fig 4.1.4 Load v/s Elongation graph of specimen C3

4.2 TENSILE TEST

The tensile check is that the most typically used for measurement the mechanical properties of a fabric. it's wide being used to give basic style info on the strength of the fabric and is an acceptance check for the specification of the materials. The key parameters that describe the stress- strain curve obtained throughout the stress check are, strength (UTS), yield strength or yield purpose (σ y), modulus of elasticity (E), proportion elongation (ΔL %) and also the reduction in size (RA %). Toughness, Resilience, Poisson's magnitude relation also can be found by the employment of this check. During this check, the specimen is ready appropriate for absorbing into the jaws of the testing machine kind which will be used.

Stress = P/A0 (Load/ initial cross-sectional area)

Strain = e = l/l0 (Elongation/initial gauge length)

Engineering stress and strain area unit freelance of the pure mathematics of the specimen.

TENSILE TEST VALUES

Table 4.2.1 Tensile Test Report of Specimen T1

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with E-glass fiber and fly ash
Specimen Diameter	25 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm
Specimen Cross Section Area	490.87 mm^2
OUTPUT DATA	
Load At Peak	12.00 KN
Elongation at Peak	1.090 mm
Tensile Strength	24.446 N/mm^2

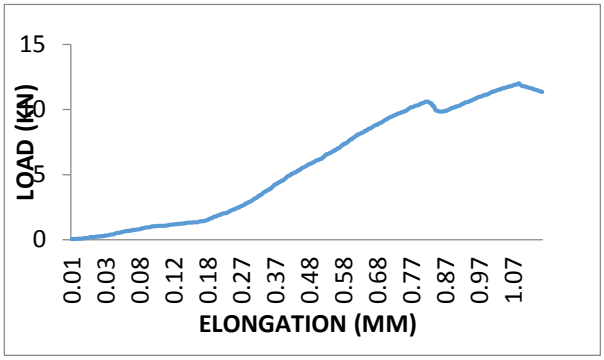

Fig 4.2.1 Load v/s Elongation graph of specimen T1

Table 4.2.2 Tensile Test Report of Specimen T2

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with e-glass fiber and fly ash
Specimen Diameter	25 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm
Specimen Cross Section Area	490.87 mm^2
OUTPUT DATA	
Load At Peak	13.380 KN
Elongation at Peak	1.270 mm
Tensile Strength	27.2577 N/mm^2

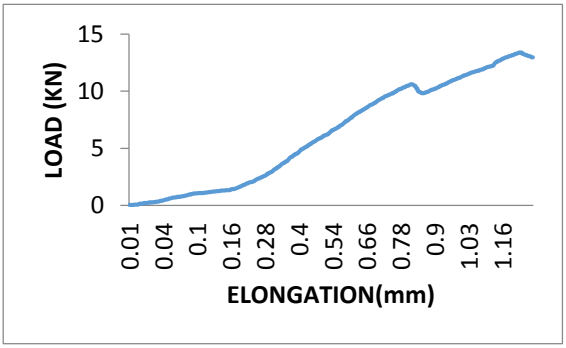

Fig 4.2.2 Load v/s Elongation graph of specimen T2

Table 4.2.3 Tensile Test Report of Specimen T3

INPUT DATA	
Specimen Shape	Solid Round
Material Type	Composite Material
Specimen Description	Granite powder with e-glass fiber and fly ash
Specimen Diameter	25 mm
Pre Load Value	0 KN
Max. Load	600 KN
Max. Elongation	250 mm
Specimen Cross Section Area	490.87 mm^2
OUTPUT DATA	
Load At Peak	14.070 KN
Elongation at Peak	1.330 mm
Tensile Strength	28.663 N/mm^2

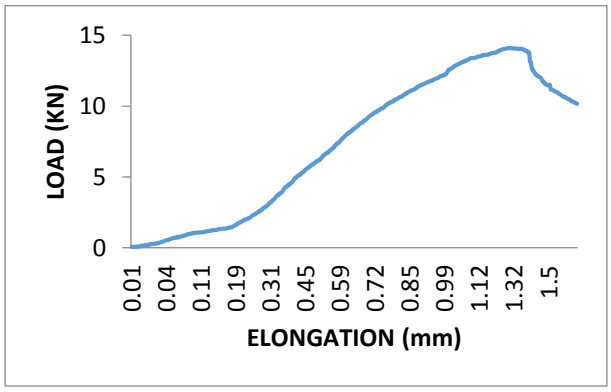

Fig 4.2.3 Load v/s Elongation graph of specimen T3

V. DISCUSSIONS

The test carried out from the compression test and the tensile test it is found that by increasing the E-glass fibre content in preparation of specimen and by decreasing the fly ash powder and after testing in an universal testing machine from the above tables and the graphs it is shown that increase in fibre material shows a greater strength and MOE. During the compression test and as well as the tensile test carried at initial stage the load is gradually increased from 0.06KN of load and this load is increased step by step

until the specimen sustained a greater value of load and until the specimen failed to sustain a certain amount of load and till the peak load is achieved.

VI. CONCLUSIONS

Compression tests and the tensile tests were conducted on three different compositions of GFRP on three different specimens by gradually increasing the load. Based on the experimental data fractographic study, following conclusions was made.

- Load versus deformation plots of GFRP composites showed a variation in the failure behaviour by the peak load formation.
- In the compositions of the compression test the granite powder is kept constant and the glass fibre volume is increased from 5% to 15% for all the three compositions and tests are carried out.
- During the compression test of the 1st composition it is observed that it exhibited a very less compressive strength and by tests conducted for the second and third composition it showed a high compressive strength and the tensile strength by increasing the glass fibre.
- The project work shows that successful fabrication of a granite powder filled epoxy resin, glass fibre composites with different compositions using hand layoup method.
- Compression and tensile tests were conducted successfully.
- In compression test compared to specimen C1, C2, C3, C3 gave more strength which contains 15% glass fibre..

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