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Experimental Investigation and Analysis of Mechanical Properties of Chopped Strand Mat-E Glass Fiber Polyster Resin & Silica Powder Composites

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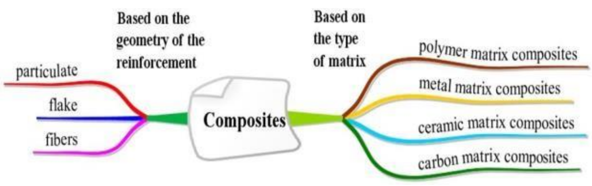
Classification:

Abstract - Composite materials play a vital role in many industrial applications. Researchers are working on fabrication of new composite materials worldwide to enhance the applicability of these materials. In view of this the mechanical performance of the composite material is essential. The objective of the present work is to analyze the effect of Silica powders content on the mechanical behavior of woolen E-glass 350gm-Glass fiber reinforced. Five different types of composites are fabricated using 0%,2%,4%,6%,8%wt of Silica powders with woolen-E glass fiber and polyester resin. The polyester resin, catalyst and accelerator are mixed in 50:1:1weight ratio in polyester matrix Silica. The aim of the project is to investigate the effect of Silica powders with woolen e-glass 350gm for making the composite material stronger and tougher. The investigation is carried out by mixing different weight percentages of the Silica powders with the polyester resin and preparing individual samples. After woolen- eglass preparation, the materials were properly mixed using the hand-lay techniques and different specimens were prepared with different compositions of the Silica powders. After all the samples were prepared, mechanical tests were carried out on the samples to ascertain the changesobserved due to the composition of Silica powders. The obtained results of various samples specimens were compared and graphically charted to characterize the new composites material.

Keywords: Chopped Strand Mat (CSM) 450 G M-Glass Fiber; Silica Powder; Polyester Resin;Hand-Lay;Catalyst;Accelerator.

1. INTRODUCTION

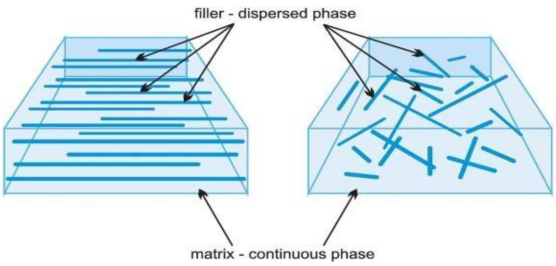
A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix. The reinforcingphase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally continuous. Examples of composite systems include concrete reinforced with steel and epoxy reinforced with silica fibers, etc.



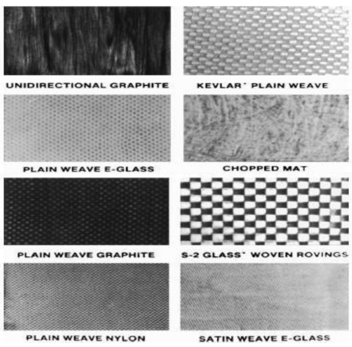
Classification of composite materials based on geometry and based on matrix.

1.1.Constituents in composites:

One constituent in composite is called the reinforcing phase and the one in which it is embedded is called the matrix. The reinforcing phase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally continuous.



Matrix phase: The primary phase, having a continuous character, is called matrix. Matrix is usuallymore ductile and less hard phase. It holds the dispersedphase and shares a load with it. **Dispersed (reinforcing) phase:** The second phase (or phases) is embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase.



Different Types of Mats

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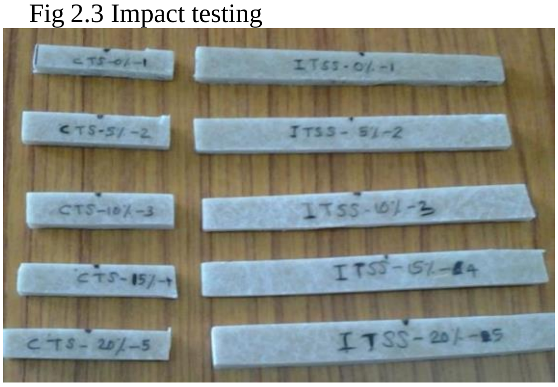
2. Methodology

2.1 Izod Impact test (ASTM D256):

Impact tests are used in studying the toughness of material. A material's toughness is a factor of its ability to absorb energy during plastic deformation. Brittle materials have low toughness as a result of the small amount of plastic deformation that they can endure. The impactvalue of a material can also change with temperature. The energy lost by the pendulum is equated withthe energy absorbed by the test specimen.

Fig 2.3 Impact testing



ROCKWELL'S HARDNESS TEST:

Rockwell hardness determines the penetration under plastic state of the material, which is important for deciding the scratching, abrasion or penetration properties of the material. Intension of hardness test is to calibrate machines to force a hard steel ball under specified conditions of load and time, into the surface of the material under test and to measure the diameter of the resulting impression after release of the load. This test consists of indenting the surface of the metal by a hardened steel ball of specified diameter D mm under a given load F in Newtons and measuring the average diameter d in mm of

the impression by a Rockwell microscope used in separate.

Hardness test done specimens

BENDING STRENGTH (ASTM D-790):

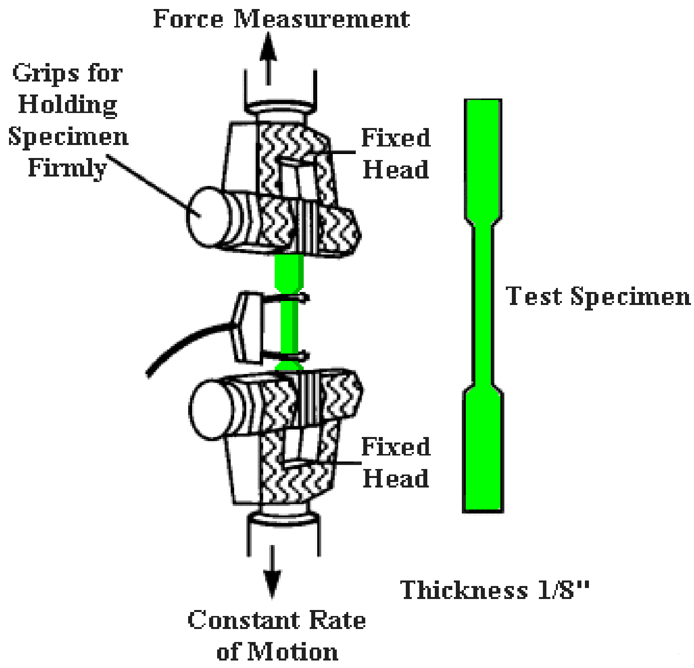
Bending strength determines the ability of the composite under vertical loading. A bending test is performed on actual beam cross section by using the three points loading systems The bending fixture is supported on the platform. The loading is held in the middle of the specimen when specimen under test is supported with knife edge points. At a particular load the deflection at the centre of the beam is determined by using a dial gauge. The deflection at the beam centre is given by: δ=Wl3/48EI.Knowing W, l, δ and I, can determine the modulus of elasticity E of the beam material. It is more advisable to plot the load deflectioncurve and determine the value of w/ δ from the linear part of the curve, which should be used to determineE and stiffness. The failure of beam may take place due to yielding, buckling. Excessive local high stress due to concentrated loads and the distribution of progressive bending stresses in a beam material have linear stress strain curve. Bending test gives modulus of elasticity ofthe composite material.

Fig2.4Bendingtest.

3.1 TENSILE TEST (ASTM D-638):

Tensile test confirms the ability to resist deformation under tensile load. This test consists in straining a test piece by tensile stress, generally to fracture, in order to determine one or more of the mechanical properties. The cross-section of the test pieces may be circular, square, and rectangular or any other form in special cases. But for polymer matrix composite test pieces of rectangular section are used. Plain ends are used for holding the specimen during testing.The test piece is fitted to the testing machine in such a manner that the pull is applied axially. The accuracy and sensitivity of the testing machine shall be within 5% of the maximum load applied to the specimen. The extensometer is used to correct to 0.005% of the gauge length and the instrument shall possess a sensitivity of 0.001mm. The rate of loading, when approaching the yield stress, should not be more than 7.5 MPa per second. The arrangement of test specimen and its details are done

Fig -2.5: Tensile Testing Machine



3. Results and Graphs

Results :

Tensile Testing of Chopped Strand Mat -350 Composite

Tensile test was conducted using universal testing machine of 400KN on specimen with different percentages of Silica powder and the values of the tensile load and elongation are shown in table 3.1

Table 3.1 Tensile test performance on different percentages of Silica powder

S.No.	Specimen	Elongation in mm(ΔL)	Tensile load(P)KN	Tensile Stress KN/mm^2	Strain (e) (mm)	Young's Modulus(KN/m m^2
1	TSS-0%	8	9.5	0.1496	0.0333	4.4881
2	TSS-5%	6	5.5	0.0721	0.0251	2.8871
3	TSS-10%	7	7	0.0918	0.0291	3.1496
4	TSS-15%	7	6.25	0.0984	0.0291	3.3745
5	TSS-20%	7	8	0.1049	0.0291	3.5995

The relation between the Modulus of Elasticity in MPa and CSM-350 Specimens with different percentages of Silica powder is shown in Graph 4.

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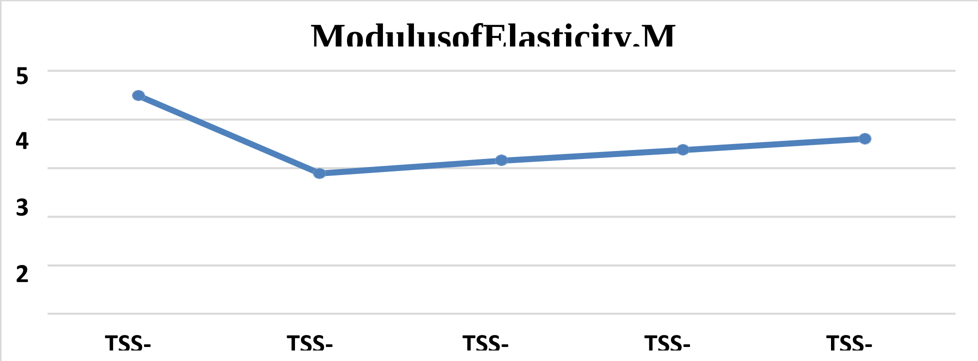


Graph 3.1 Modulus of Elasticity Variations at different weight percentages of Silica under Tensile Test.

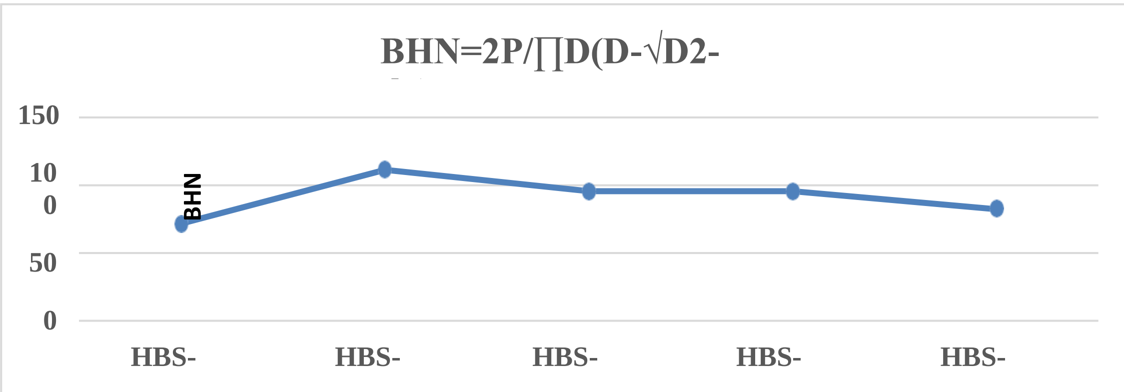
3.2Hardness Testing of Chopped Strand Mat -350 Composite.

Hardness test was conducted using Brinell hardness testing machine of 187.5Kg on specimen with different percentages of Silica powder and the values of the load and Dia of impression.

Table 3.2 Brinell hardness test performance on different percentages of Silica powder.

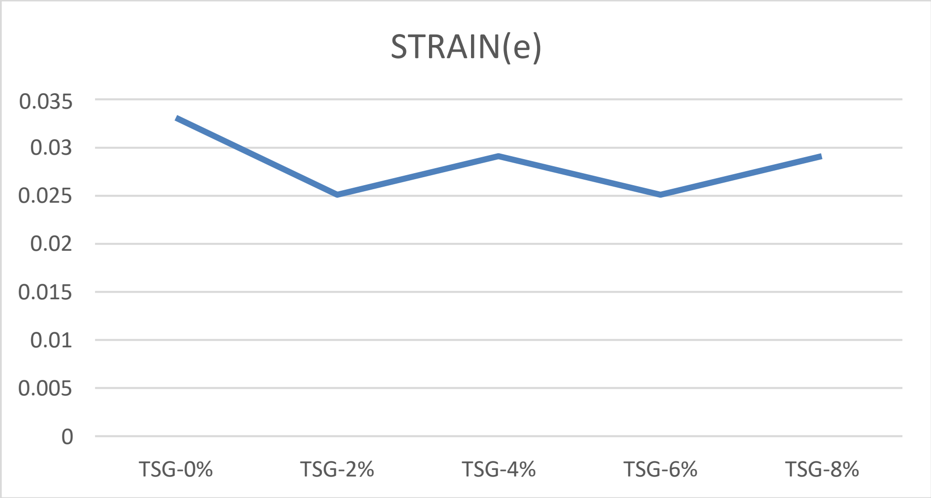
Brinell Hardness Number Test					
S.No	**SpcNo.**	**Diaof indenter(D)**	**Diaof impression(d)**	**Load(P)**	**BHN=2P/∏D(D-√D2-d2)**
1	HBS-0%	2.5	1.7	187.5	71.58929342
2	HBS-5%	2.5	1.4	187.5	111.3605433
3	HBS-10%	2.5	1.5	187.5	95.49578227
4	HBS-15%	2.5	1.5	187.5	95.49578227
5	HBS-20%	2.5	1.6	187.5	82.45719982

The relation between the Brinell Hardness number and CSM-350 Specimens with differentpercentages of Silica powder is

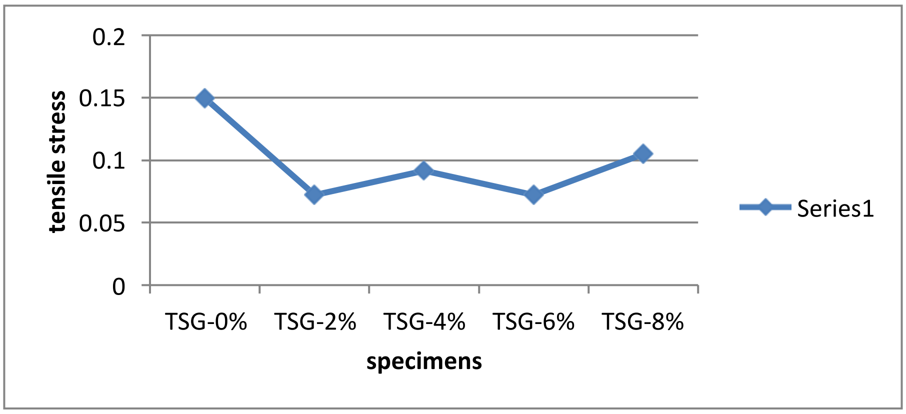


shown in Graph 3.2

Graph 3.2 Brinell Hardness Number Variations at different weight percentages of Silica under BrinellHardness NumberTest.



Graph 3.3 Strain Variations at different weight percentages of Silica under Tensile Test.

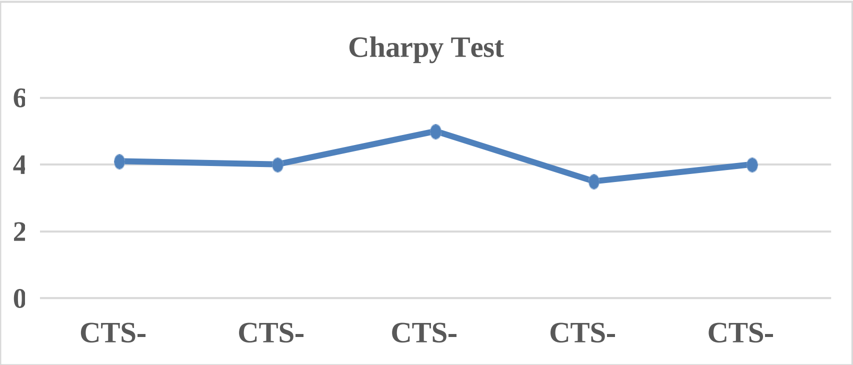


Graph 3.4 Tensile Stress Variations at different weight percentages of Silica under Tensile Test.Table 3.3 Charphy Test performance

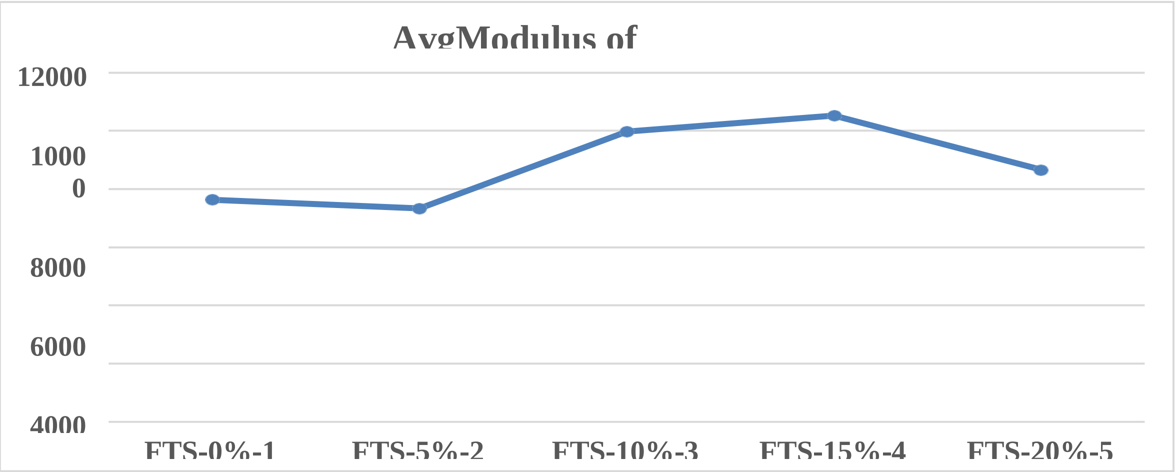
on different percentages of Silica powder

CharphyTest		
S.No.	**SpecNo.**	**ImpactStrength(J)**
1	CTS-0%	4.1
2	CTS-5%	4
3	CTS-10%	5
4	CTS-15%	3.5
5	CTS-20%	4

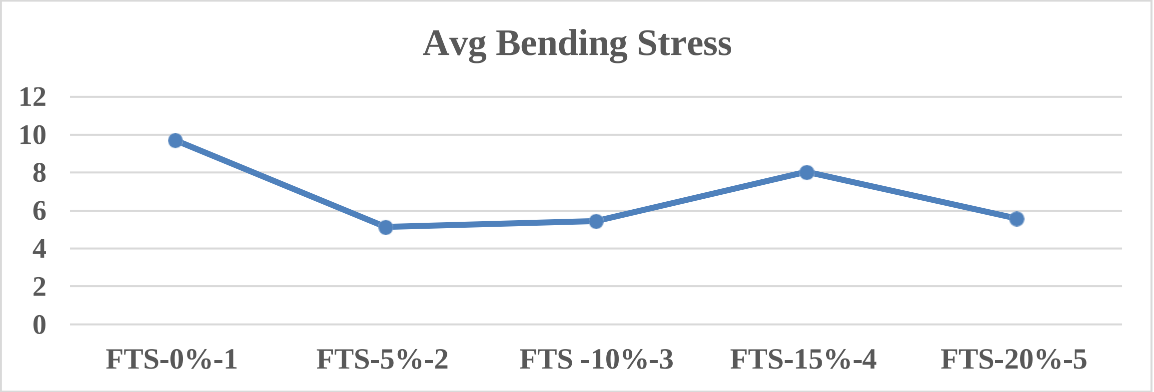
The relation between the charphy and CSM-350 Specimens with different percentages of Silica powder is shown in Graph 3.4



Graph 3.4 Charphy Variations at different weight percentages of Silica under Charphy Test.



Graph 3.5 Avg Modulus of Elasticity Variations at different weight percentages of Silica under BendingTest.



Graph 3.6 Avg Bending Stress Variations at different weight percentages of Silica under Bending Test.

4. Conclusion & Future Scope

Conclusion

- Chopped Strand Mat 450 polyester composite with silica powder was successfullyprepared as a composite material with five different wt.%, viz 0%wt, 5%wt, 10%wt,15%wtand20%wt.
- The tensile strength and flexural strength with 0wt% silica powder composite ismaximum compared with 5wt%, 10wt%, 15wt%, and 20wt%. The hardness at 5wt%silica composite is maximum compared with 0wt%, 10wt%, 15wt%, and 20wt%silica composite.
- The increase of silica powder lead to the increase of the Izod impact strength of thecomposite.

Scope for Future work :

Image analysis can also be performedto observe the changes in the microstructure ofcomposite, which will be the future scope of thework.

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