International
Journal
Of Advanced Research in Engineering & Management (IJAREM)

Studies of mechanical properties of glass/hemp fiber reinforced hybrid composites

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ABTRACT: Researchers worked on natural fiber reinforced composites to enhance the material performance. As these natural fibers offer a number of advantages over traditional synthetic fibers. The most attractive advantage is high strength to weight ratio. Glass fiber has been widely known as an engineering material that exhibits high specific performance to cost ratio which accounts for its current dominant role in serving as the major reinforcement material for the global composite market. While, hemp is a commonly used term for high-growing industrial varieties of the Cannabisplant and its products, which include fiber, oil, and seed. In this project the mechanical properties of glass and hemp fiber reinforced hybrid composites were studied. These composites were prepared by using Hand-layup technique while varying weight fractions from 0.4g, to 2g.The specimens are prepared according to the ASTM standards and experiments are carried out by using tensometer for tensile and flexural tests and charpy impact testing machine for impact test. From experimental results it is observed that glass and hemp fiber reinforced composites have higher tensile strength, flexural strength and impact strength compared to the matrix material.

INTRODUCTION:

Now a days, natural fiber reinforced composites exhibits the higher mechanical properties than the man made synthetic fiber reinforced composites .The mechanical properties such as tensile strength, flexural strength and impact strength. It is also observed that the significant increase in mechanical properties for hybrid composites. The hybrid composites are prepared by using glass fiber (synthetic fiber)and hemp (natural fiber).By using the hand layup process we will get the hybrid composites. We will prepare the 5 samples of glass fiber, hemp fiber and hybrid composites are prepared. And the experiments are carried out to evaluate the tensile strength, flexural strength and impact strength. By conducting the experiments we studied that the mechanical properties of glass/hemp reinforced composites is higher when compared to glass fiber and hemp fiber reinforced composites but there is slight reduction values in impact strength for hybrid composites.

Natural fiber reinforced composites are eco friendly to environment, mostly natural fiber are biodegradable, renewable. Weight of the natural fiber is less when compared to the man made fiber. One of the main factor is cost natural fiber is available at low cost when compared to the synthetic fiber. So hemp fiber is selected from the previous experiments conducted on hemp it is observed that toughness, flexural strength and specific gravity of the composite reduced by adding the hemp fiber to the composite. Hemp fiber adds tensile strength strong toughness to the composite. By using micro- braiding technique the hemp fiber can be used in the textile industry.

The synthetic fiber added to this composite is glass fiber the reason behind the selection of the glass fiber is cost, strength, less brittle nature .Due to climatic conditions there will be change in characteristics of natural and manmade fiber undergo the irregularities and loss in maximum load carrying capacity of the composite.

Bhoopathi [1] studied the mechanical properties of the banana-glass fiber composites and banana-hemp-glass fiber composites. After experiments conducted found that banana-glass fiber have higher mechanical properties when compared to the banana-hemp-glass fiber composites. Examinations are conducted to study the internal structures and fracture of specimen by using SEM analysis.

Misnon [2] have evaluated the characteristic of woven hemp fabrics with two different batches of fabrics with similar quality, physical properties and slight difference in thermal behavior . The mechanical properties slightly different but from the inferential statistics both fabrics have same tensile strength, modulus in this study it is concluded that fabric A and fabric B can be used for composite reinforcement.

Petrucci [3] studied the mechanical properties of hybrid composite laminate prepared using basalt fiber with glass, hemp, flax by vacuum infusion process. Three hybrid composite laminates with combination of glass, hemp, flax and basalt fiber. The experiments are conducted and it is observed that hemp and flax hybrid laminates performed well tensile strength, tensile modulus. The best performance was shown by

glass/flax/basalt hybrid composite than remaining two hybrid composite laminates. It is also seen that brittle nature for the entire three composite. Studied that that there is a problem identified matrix compatibility and complexity of hybrid composites.

Ramesh[4] have evaluated the mechanical properties of sisal/jute-glass fiber reinforced epoxy composites. Scanning electron microscope (SEM) analysis is carried out to find the fractured surface, failure of specimen. It is observed that sisal/GFRP composites have higher tensile strength than jute/GFRP composites and flexural strength is similar to both hybrid composites.

Claudio scaponi[5] investigate the use natural fiber in the aeronautical industry, the main focus is on replacement of steel electronic rack mounted on the helicopter Eurocopter AS 350 with hemp/epoxy composite material. By using the hemp it is eco friendly weight of the structure is also reduced to 8kgs. The structure analysis carried out with FEM analysis and it is compared glass fiber composites the results similar. Due to advantage for environment we will chose natural fiber.

Caprino [6] studied the impact behavior of hemp/epoxy composite subjected to low velocity impact loading using falling weight impact equipment. This experiment is done for replacements of glass fiber. The experiment is conducted on hemp/epoxy composite. very limited delamination zone was found below the impact load. The no significance damage found below 75J .From the results about damage and absorbed energy the glass fiber can be replaced by hemp fiber in some applications.

Girisha [7] studied the mechanical properties jute/hemp reinforced polyester/epoxy hybrid composites .fibers are placed in different orientation 30%,45% and 90%.after experiments are performed it is observed that orientation 90% have higher mechanical properties when compared to remaining two orientations. The fiber incorporated with the polyester resin has higher mechanical properties than epoxy resin.

In this project studies about the mechanical properties of the glass/hemp fiber reinforced hybrid composites .This composite is fabricated by lay-up process .The mechanical properties such as tensile strength , flexural strength and impact strength is studied and observed that the mechanical properties is higher to glass/hemp reinforced hybrid composite.

2. Experimental work

2.1.Materials

The hybrid composites are prepared by using hemp and glass fiber. The raw hemp is available at shop. Glass fiber, polyster resin, catalyst, accelerator are brought from composite shop

PHYSICAL PROPERTIES	HAMP	GLASS
Density(g/cm^3)	1.48	2.6
Tensile strength(M Pa)	64.18	91.9
Flexural modulus(G Pa)	2080.1	2230.5

2.2. Preparation of hybrid composites

The mould is prepared on the smooth ceramic tile with rubber shoe sole to the required dimensions. Keep the ceramic tile clean. The gap between the rubber and the tile is filled with mansion hygienic wax. The thin coating of PAV (Poly vinyl alchol) is applied to the moulds. Using the hand lay-up process fill the mould with the general purpose resin (ECMALON 4411).The accelerator is mixed with the resin and catalyst is added to avoid explosion .The thin coating of resin is applied with fiber. The fibers are placed along the longitudinal direction of the specimen so that the fiber orientated 0^0 along the axial direction of the specimen .The specimens are removed and dirt particles cleaned .The same process is performed to different weight of the fiber they are 0.4,0.8,1.2,1.6,2.0 respectively for pure glass, pure hemp, hybid composites.

Figure 1 mould for preparing composites

Figure 2 obtained Specimens

2.3. Mechanical properties of composites

2.3.1. Tensile test

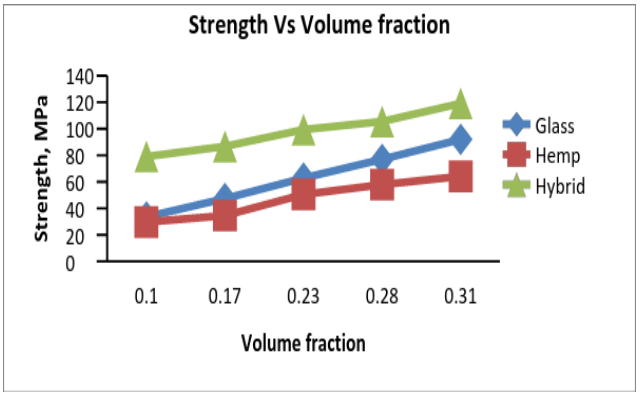
The tensile test specimen is prepared and testing is carried out as per ASTM D638 standards and procedures. The 15 specimens (5 pure glass, 5 pure hemp, 5 hybrid composites) are used know tensile behavior of the specimens. The test has been carried out on tensometer by applying the load on specimen until the failure occurs and results are noted and this procedure continued to remaining specimens. Tensile test specimen before and after facture is shown below

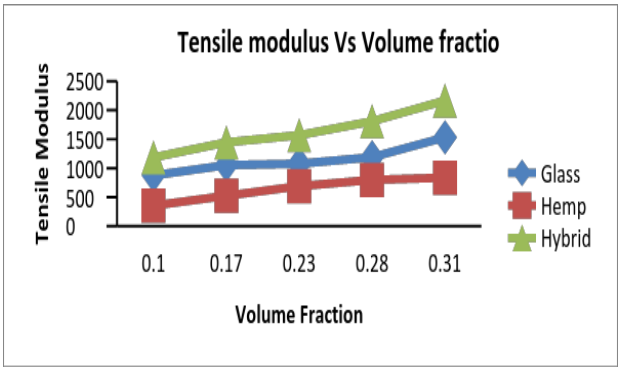
Figure 3 Tensometer

Figure 4. Tensile specimen before test

Figure 5.After Facture

Sl no	Fibre	Volume fraction	Tensile strength (Mpa)	Tensile modulus (Mpa)
1	Glass	0.1	33.6	876.52
2		0.17	47.4	1053.3
3		0.23	62.86	1077.6
4		0.28	77	1189.6
5		0.31	92	1531.66
1	Hemp	0.1	29.66	355.92
2		0.17	34.6	525.64
3		0.23	50.53	690.36
4		0.28	57.9	799.14
5		0.31	64.18	837.13
1	hybrid	0.1	79.06	1185.9
2		0.17	86.73	1445.5
3		0.23	99.37	1569
4		0.28	105.5	1808.57
5		0.31	119.1	2165.45





2.3.2. Flexural test

The flexural test specimens are prepared as per standards of ASTM D790. The 15 specimens (5 pure glass, 5 pure hemp, 5 hybrid composites) are used know flexural strength of the specimens. The experiments on carried on tensometer. The results of flexural strength and elongation are noted and the same procedure is carried out for remaining specimens. Flexural test specimen before and after facture is given below.

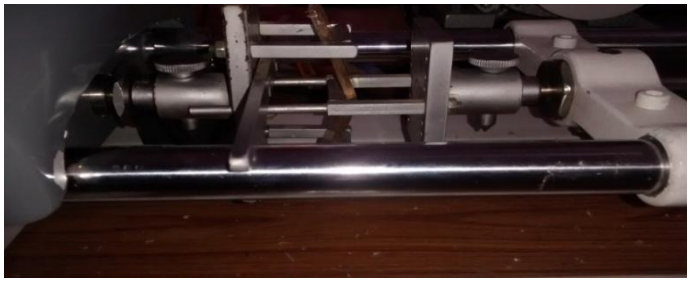
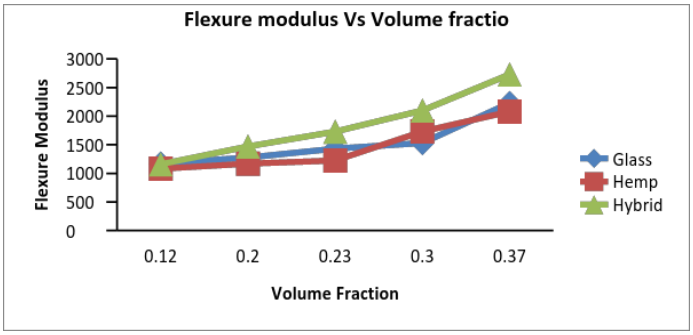


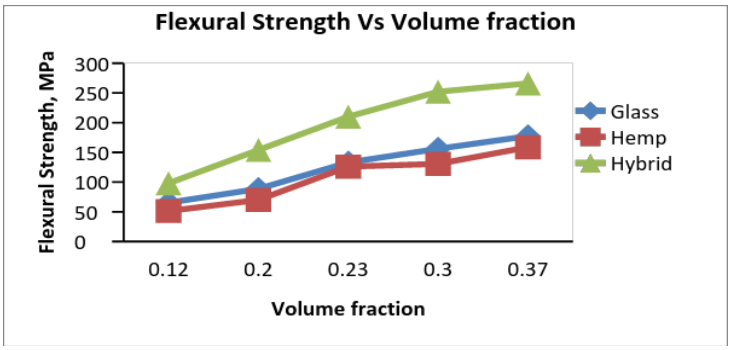
Figure 6 . 3 point bending test

Figure 7 .Before test

Figure 8 After facture

Sl no	Fibre	Volume fraction	Flexural strength (Mpa)	Flexural modulus (Mpa)
1	Glass	0.12	65.3	1172.6
2		0.2	88.6	1276.5
3		0.23	133	1432.4
4		0.3	156	1531.6
5		0.37	177.3	2230.5
1	Hemp	0.12	51.3	1082.51
2		0.2	70	1170
3		0.23	126	1225
4		0.3	130.6	1731.9
5		0.37	158.6	2080.81
1	hybrid	0.12	98	1160.2
2		0.2	154	1470.72
3		0.23	210	1730.6
4		0.3	252	2100.5
5		0.37	266	2730.6





2.3.3. Impact test

The test specimens are prepared as per standard ASTM A370. The 15 specimens (5 pure glass, 5 pure hemp, 5 hybrid composites) are used know flexural strength of the specimens. The specimen should provide 'v' notch with the help of hack saw blade. During the test maximum energy that is used to break the specimen is noted and same procedure is carried out for remaining specimen. Impact test specimen before and after facture are given below.

Figure 9 charpy impact testing machine

Table 3 IMPACT TESTING RESULTS

Sl no	Fibre	Volume fraction	Flexural strength (Mpa)
1	Glass	0.12	120.2
2		0.19	176.76
3		0.24	237.5
4		0.3	282.65
5		0.35	340.5
1	Hemp	0.12	101.6
2		0.19	130
3		0.24	251.7
4		0.3	255.6
5		0.35	300.21
1	hybrid	0.12	98.3
2		0.19	124.6
3		0.24	262.2
4		0.3	272.4
5		0.35	302.9

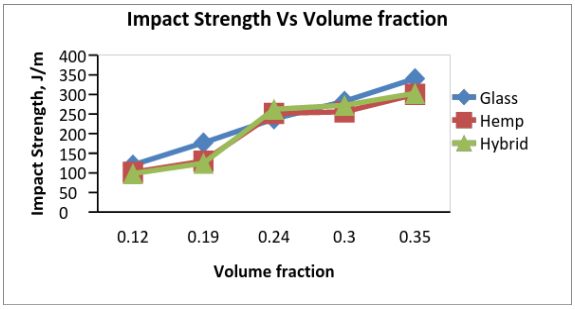


Figure 10 .Before test

Figure 11. After facture

3. Results and discussions

The use of natural fiber and manmade fiber is increased because of many characteristics like eco-friendly, renewable, weight. Many scientists are working on hybrid Composites to replace the alloys and alluminium, steel. In this project we study about the glass/hemp fiber reinforced hybrid composite is used without affecting load carrying capacity the specimens are prepared as per ASTM standards and tensile, flexural, impact tests are performed .The experiment results are presented in tables below

3.1. Tensile test analysis

The specimens are experimented on tensometer and by using the formulae we will calculate tensile strength, tensile modulus and volume fraction. Graphs are plotted between volume fraction and tensile strength, volume fraction and tensile modulus are drawn below

Table 6 .Summary of tensile properties(hybrid)

3.2. Flexural test analysis

The specimens are tested and experiment values are noted and by using formulae we will get flexural strength, flexural modulus and volume fraction. Graphs are plotted between volume fraction and flexural strength, volume fraction and flexural modulus are drawn below.

3.3. Impact test analysis

For this test we will use charpy impact testing machine. This experiment is carried out for evaluating the impact load for different specimens. Using the formulae we will calculate the impact strength and volume fraction and graph is plotted between impact strength and volume fraction is given below.

5. Conclusions

The glass/ hemp fiber reinforced composite samples are fabricated by the hand layup method. Tests have been conducted on the specimens at different volume fractions to find out mechanical properties such as tensile, flexural and impact strength and from the results obtained the following conclusions are drawn.

It is observed that tensile strength, tensile modulus, flexural strength, flexural modulus, impact strength of hybrid composite is greater than the pure glass fiber composite and pure hemp composite

From the above results it observed that hybrid composite have greater mechanical properties than pure glass composite and pure hemp composite.

6. References

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