Experimental Investigation of HybridComposites with and without crabshell powder

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***Abstract*–Hybrid natural fiber polymer composites are gaining popularity day by day because of the renewability, sustainability, availability, and cost-effectiveness of natural fibers. Hybridization of fibers for different polymer matrices may be done in different ways like a combination of both natural fiber and synthetic fiber, and a combination of two different natural fibers. Theaimofpresentworkisto evaluatethemechanicalpropertiesofflaxfiberandkenaff iberreinforced withepoxy asmatrix and also evaluate the mechanical properties of hybrid composite with and without crab shell powder as filler material. The mechanicalpropertiessuchastensilestrength,flexuralstr engthofcompositesisexaminedbyvaryingtheweightofcr abshell powder by 5 grams, 10 grams, and 15 grams. Experiments are conducted to investigate the mechanical properties such as Tensile test, Flexural test. The hybrid composite with 5 gms of crab shell powder filler material has obtained high properties such as tensile strength up to 232.8 MPa. and flexural strength up to 100.2MPa.**

***Index Terms*: Kenaf fiber, Flax fiber, Crab powder, Reinforcement, Hybridization.**

I.INTRODUCTION

Materials are considered to be the backbone of any manufacturing industry. There are various materials used in the manufacturing industry, ranging from pure metals to alloys to composites. This transformation of materials from pure metals to composite stakes place due to the drawbacks of pure metals to satisfy the assumptions of modern products. In the modern era, composite materials are widely used in the manufacturing industry and replace the traditional materials to a great extent because of their good properties like high specific strength, strong damping capacity, and high specific modulus. Composite materials were firstly developed in the 1940s by using fiber as reinforcement [1]. Macroscopically composites are the combination of two or more chemically different materials processing special properties [2]. The constituents in the composite are reinforcement and matrix as shown in Fig.[1]

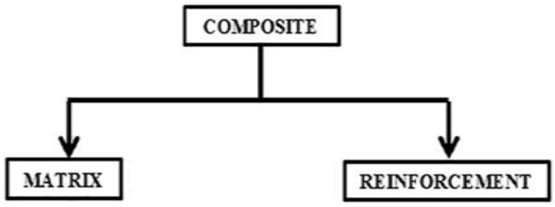

Fig.1: components of composite

The natural fibers actually used to substitute the synthetic materials for the manufacture of interestingeco-friendly energy absorbing devices, that are also lighter and cheaper [1].

The jute reinforced epoxy composite exhibited better mechanical properties than Jute-polyester composite [2]. The 0^0 and 90^0 (bidirectional) treated natural fiber reinforced composite have better tensile strength than 0^0 and $\pm45^0$ [3].

Utilizing kenaf as are enforcement parameter recycled with polypropylene resin, upon which an increase intensile strength upto 18%, flexural strength upto 28%, 27% of impact toughness was noticed which showed frightful increment in composite properties by reinforcing kenaf[4].

The stacking sequence had negligible effect on the tensile properties whereas the flexural and impact strength were largely affected by the stacking arrangement of the woven glass fiber and banana fiber [5].

The increase in the kenaf fiber layer in composite samples increases the storage modulus. this makes the composite of stacking sequence S3(KAKAK) an ideal choice for applications that demand high strength as well as high ductility like automobile parts and components[6].

II.MATERIAL PREPARATION

Kenaf fiber and Flax fiber are used as reinforcement materials in this work, where kenaf fiber and flax fiber both are natural fibers. In the hybrid composite, the matrix used is Epoxy Araldite (LY556) with a 10:1 Epoxy to Hardener ratio where the hardener is Aradur (HY951). Crab shell powder is used as a filler material with a composition of 5 grams, 10 grams, and 15 grams or 2.6%, 5.2%, 7.6% by weight.

Preparation of Crab Shell Powder:
Crab shells are initially cleaned in water and dipped in Sodium Hydroxide (NaOH) solution for 12 hours to remove impurities on the crab shell. Later the crab shells have been exposed to sunlight for 24 hours. These crab shells are ground to prepare a fine powder.

Fig.1. crab shell powder

The relative weights of the fibers and resins:
Fiber and resin weight ratio for flax fiber is 1:3 and for kenaf fiber is 1:3.5.
Table 2: The composite fiber and matrix weight ratio.

S. No	Specimen name	Composition of composite by(wt%)
1	Hybrid composite	Flax (20.6%) +Kenaf (22.8%) + Epoxy (56.6%)
2	Hybrid composite with 5gms of filler material	Flax (19.25%) +Kenaf (20.2%) + Epoxy (58.4%) + Crab powder (2.67%)
3	Hybrid composite with 10gms of filler material	Flax (20.25%) +Kenaf (22.3%) + Epoxy (52.3%) + Crab powder (5.2%)
4	Hybrid composite with 15gms of filler material	Flax (21.4%) +Kenaf (23.8%) + Epoxy (48.1%) +Crab powder (7.6%)

III.MECHANICAL TESTING

On the fabricated hybrid composite material, the following tests are performed.
(a) Tensile test
(b) Flexural test
(c) Rockwell hardness test

Tensile, flexural tests are performed on the universal testing machine, Hardness test was conducted on the Rockwell Hardness test machine.
(a) Tensile test:
The dog-bone-shape tensile test specimens (250 × 25 × 3 mm^3) with ASTMD3039 standards are tested at a strain rate of 3mm/min using the universal testing machine. The results of the tensile test are presented in Table 3.

Fig.2. Universal testing machine

(b) Flexural test:
The Flexural test is conducted to get the modulus of rupture. Specimens of size 125 × 20 × $3mm^3$ with ASTM D709 standards are tested with a 3-point bending test machine (universal testing machine). The results of the flexural test are presented in Table 4.

(c) Rockwell hardness test:
Hardness of the test specimen is measured by Rockwell hardness test machine (under 60kgf).Specimen of size 35 × 20 × $3mm^3$ with ASTM D785 standards.

Fig.3. Rockwell hardness testing machine

IV.RESULTS AND DISCUSSION

The details of the tensile test conducted on the four composites as shown in the table 3.The hybrid composite with 5gm filler material have better tensile property (232.8) then the remaining three composites. The tensile test results plotted between tensile strength and specimen type as shown in Fig.5. It is noticed that hybrid composite with 5gm filler material shows higher strength than the rest of composites.

Table 3: Tensile test results

S. No	Specimen name	Maximum Load (Kn)	Tensile strength (σ)(N/mm^2)	Young's modulus (N/mm^2)
1	Hybrid composite	8.55	114.0	5700
2	Hybrid composite with 5gms of filler material	11.6	232.8	11600
3	Hybrid composite with 10gms of filler material	7.62	101.6	5080
4	Hybrid composite with 15gms of filler material	7.68	153.6	15360

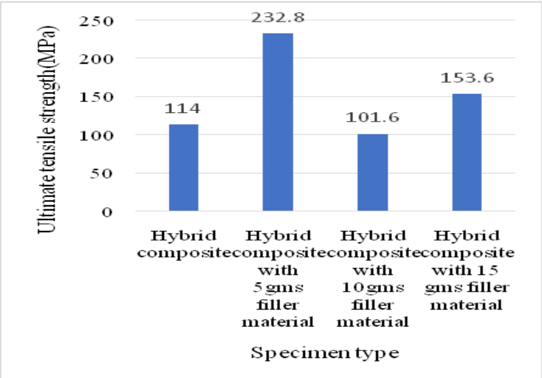

Fig.5.Graph between the specimen type and the tensile strength of the specimen.

(b) flexural test result:

The details of the flexural test conducted on the four composites as shown in the table 4. The hybrid composite with 5gm filler material have better flexural property (100.2) then the remaining three composites. The flexural test results plotted between flexural strength and strain as shown in Fig.6.It is noticed that hybrid composite with 5gm filler material shows higher strength than the rest of composites.

Table 4: Flexural test results

S. No	Specimen name	Maximum Load(N)	Flexural strength(σ)(N/mm^2)	Flexural modulus (N/mm^2)
1	Hybrid composite	62.5	67.7	14717.39
2	Hybrid composite with 5gms of filler material	92.5	100.2	19608.6
3	Hybrid composite with 10gms of filler material	70	75.8	13541.07
4	Hybrid composite with 15gms of filler material	75	81.2	19817.07

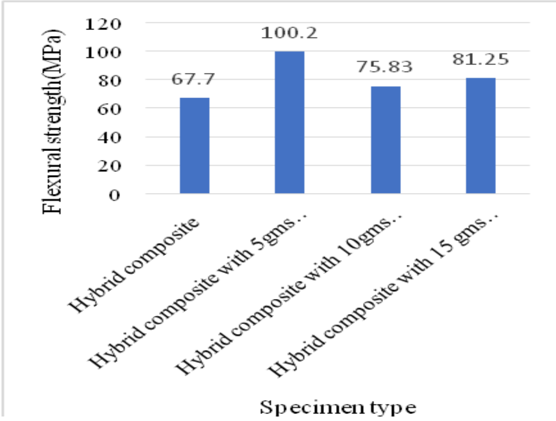

Fig.6. Plot between specimen type and flexural strength

(c) Hardness test results:

Fig.9 shows the details of the hardness test conducted on the four composites. The hybrid composite with 5gm filler material have better hardness 69 then the remaining five composites.

Table 5: Hardness test results

S. No	Specimen label	Rockwell hardness number
1	Hybrid composite	69HRB
2	Hybrid composite with 5gms of filler material	57HRB
3	Hybrid composite with 10gms of filler material	58HRB
4	Hybrid composite with 15gms of filler material	67HRB

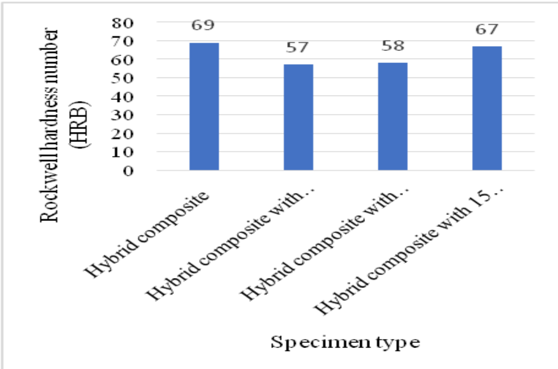

Fig.7. Plot between specimen type and Rockwell hardness number

V.CONCLUSION

By studying the results obtained from different tests conducted on specimens with different percentage composition of crab shell powder as filler material, the following conclusions are presented.

It is observed that the hybrid composite with 5 grams (2.67% by weight) crab shell powder filler material has obtained superior properties over the other specimen with a different percentage of crab shell powder.

The tensile strength is increased up to 232.8 MPa, flexural stress up to 100.2 MPa for the composite with 2.67% by weight of crab shell powder.

Hardness is also increased up to 67 kg/mm^2 with an increase of the percentage of filler material.

Results show that the mechanical properties of the composite material are improved due to the addition of cab shell powder.

The properties of hybrid composite material are increased by having a 2.67 percentage of crab shell powder.

Though the properties of the composite with the 2.67% of filler material are lower than the composite without filler material, the tests show a trendline of a gradual and significant increase in the mechanical properties with the increase in the percentage composition of the crab-shell powder.

This may imply that the composite with filler material displays superior properties over the composite without filler material with further increase in the weight percentage of crab shell powder, with a significant advantage of cost reduction and eco-friendliness.

VI.FUTURE SCOPE

The filler material percentage may also be further increased to find the optimum amount of weight percentage for achieving maximum property values.

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