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"FABRICATION AND TESTING OF VARIOUS HYBRID MATERIALS KEVLAR BASALT AND CHOPPED MATE WITH HORN POWDER USING HAND LAY UP TECHNIQUE"

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ABSTRACT

A composite material can be defined as a combination of two or more constituent materials with different physical or chemical properties. And which remain separate and distinct on microscopic or macroscopic level within the finished structure. In other words, the constituents do not dissolve or merge into each other, although they act together to form a single material. Fiber materials have been widely used for several years and their market share is continuously growing. Composite fibers are lightweight and environmentally friendly as well as low cost compared to traditional engineering materials. The primary aim of this study was to using Basalt, chopped mate, kevlar, GOAT horn powder. By using the above mentioned three reinforcements with epoxy resin we will be provided with combinations of BASALT+10% GOAT HORN POWDER, CHOPPED MAT FIBER+10% GOAT HORN POWDER, KEVLAR FIBER+10% GOAT HORN POWDER, BASALT+ CHOPPED MAT FIBER+10% GOAT HORN POWDER, CHOPPED MAT FIBER + KEVLAR FIBER+10% GOAT HORN POWDER, KEVLAR FIBER+ BASALT FIBER+10% GOAT HORN POWDER, BASALT FIBER + CHOPPED MAT FIBER + KEVLAR FIBER + 10% GOAT HORN POWDER In all compositions commonly 10% of GOAT horn powder used. Testing such as tensile, flexural, impact, and hardness determine the properties of these composite was made the crossover material which are assessed tentatively as per ASTM norms. After which material is best consider the use real time application car bumper Create in Catia software and perform the static analysis in Ansys software finally find out the stress, strain, deformation, shear stress using best material and Gmat material.

INTRODUCTION OF FIBERS

HORN POWDER:

Figure 14 Horn powder

Horn powder	Values
Density(g/cm^3)	1.56
Tensile Strength(Mpa)	540
Young's Modulus (Gpa)	200
Melting Point	1566 °C
Possion's Ratio(u)	0.29

Table 2 Material properties of Horn powder

KEVLAR

Kevlar has numerous applications, going from bike tires and hustling sails to tactical armor carriers, all because of its high elasticity to-weight proportion; by this action it is multiple times more grounded than steel. It likewise is utilized to make present day walking drumheads that withstand high effect. Kevlar is a manufactured plastic, and it's made of a chemical compound called **poly-para-phenylene terephthalamide.** This chemical is made from creating a chemical reaction between an acid and a chemical solution containing nitrogen and hydrogen

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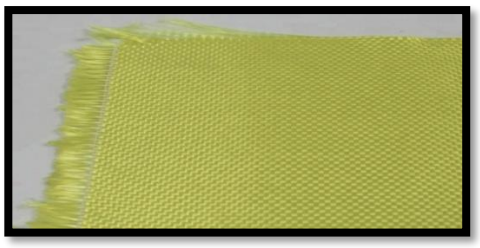

Figure 15 Kevlar

BASALT FIBER

The basalt is simply washed and then melted. The manufacture of basalt fiber requires the melting of the crushed and washed basalt rock at about 1,500 °C (2,730 °F). The molten rock is then extruded through small nozzles to produce continuous filaments of basalt fiber. A hard, dense volcanic rock that can be found in most countries across the globe, basalt is an igneous rock, which means it began in a molten state. For many years, basalt has been used in casting processes to make tiles and slabs for architectural applications. Additionally, cast basalt liners for steel tubing exhibit very high Abrasion resistance in industrial applications. In crushed form, basalt also finds useas aggregate in concrete.

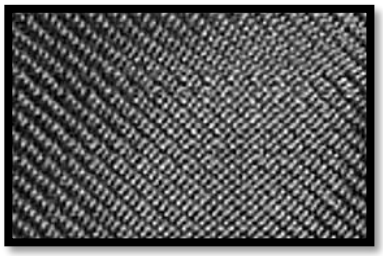

Figure 16 Basalt

CHOPPED MATT

Chopped strand mat is a non woven reinforcement fiber for the production of fiber-reinforced plastic.

Figure 17 Chopped matt

FABRICATION OF COMPOSITE SPECIMENS (HAND LAYUP)

Hand lay-up procedure is the straightforward and least expensive strategy for composite handling.

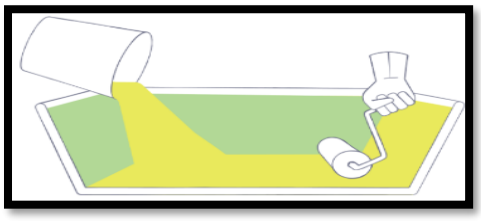

Figure 18 Fabrications of composite specimens

With the help of a brush, the polymer is evenly distributed. Then second layer of fiber is placed on the polymer surface and another layer of polymer is applied after this is closed with another thin plastic sheet after squeezer is moved with a gentle pressure on the thin plastic sheet to remove air .The consequential mold is cured for 24 hours at room temperature.

Figure 19 Complete sequential process for fabrication

Figure 20 Tensile test specimens

FLEXURAL TESTING OF COMPOSITES

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Three point bowing test are carried out as per ASTM-D790M-86 test procedure 1, system A to extract flexural properties, the specimens are 100 mm long , 25 mm wide and 4.5 mm thick . Two indistinguishable specimens are subjected for flexural testing. In three point bowing test, the external rollers are 70 mm separated and specimens are subjected at a strain rate of 0.2 mm/min. Flexural stress are determined by the following relations.

$$\text{Flexural stress } S = \frac{3PL}{2bt^2}$$

P= load in N

L= length between supports (70mm)

b= Width in mm

d= Thickness in mm

Figure 21 specimen's flexural test

IMPACT TESTING OF COMPOSITES

Impact test is also known as charpy v notch, Impact tester was sway analyzer supplied by M/S International Equipments, Mumbai, was used to test the impact properties of fiber Reinforced composite specimen. The Impact tester has four working abilities of effect quality i.e. 0-2.71 J.0-5.42 J,0-10.84 J and 0-21.68 J, with a base determination on every size of 0.02J, 0.05 J, 0.1 J and 0.2 J individually .Four scales and comparing mallets (R1,R2,R3,R4) are presented in equipment.

Standard test procedure, ASTM D256-97, for effect properties of fiber composites has been used to examine the unidirectional composite specimens. The specimens to be examined are of dimensions 63.5mm long, 12.36mm wide and 6mm in thick. A V-point is placed in impact tester record having an included point of 450 at the focal point of the specimen, and at 90¬¬0 to the specimen pivot. The profundity of the specimen to be examined under the indent is 2 mm.

Figure 22 Impact machine for impact testing

Impact strength was calculated by the following relation

$$\sigma = \frac{2P}{A}$$

P= Energy observed in J

A= Area in mm

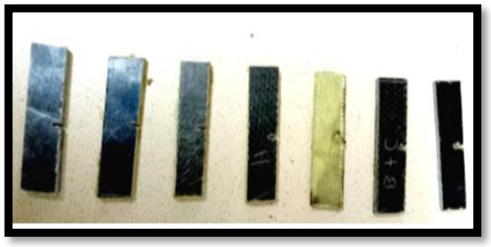

Figure 23 before testing impact testing

In this test, the configuration is limited to unidirectional and continuous fibers equal to the length of the specimen. The hardness properties of the composites are studied by applying indentation load normal to fibers diameter and normal to fiber length. The effect of fiber loading and post curing time on Rockwell hardness is illustrated in Figures 3 and 4. Generally, fibers that increase the module of composites increase the hardness of the composite. This is because hardness is a function of the relative fiber volume and modulus.

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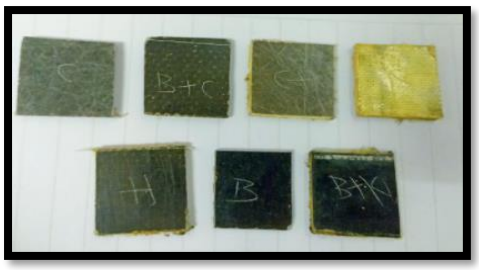

Figure 24 before Testings hardness test

TESTING IMAGES AT LABORATORY:

Figure 25 TESTING PROCESS OF SPECIMENS

AFTER TESTING:

Figure 26 AFTER TESTING FLEXURAL SPECIMENS

Figure 27 AFTER TESTING OF IMPACT SPECIMENS

Figure 28 AFTER TESTING OF HARDNESS SPECIMENS

RESULTS AND DISCUSSION

MECHANICAL CHARACTERISTICS OF COMPOSITES

The properties of the Kevlar, Basalt, chopped mate, Kevlar + basalt, basalt+chopped matt, Kevlar +chopped matt & Kevlar basalt+ chopped matt fibers and basalt reinforced epoxy hybrid composites with of fiber under this investigation are presented in below Table 4.1. I have taken each composite for each test. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The mechanical properties of Synthetic fiber reinforced composites are largely depends on the chemical, structural composition, fiber type and soil conditions and also on atmospheric conditions at the time of fabrication of the specimens.

S.NO	Composite	Tensile test		Flexural test		Impact test
		Load in N	Elongation n in mm	Load in N	Elongation n in mm	Strength in J
1	Basalt	6900	9.2	1960	8.5	3.7
2	Kevlar	9495	21.3	1450	7.0	5.45
3	Chopped matt	8920	17.1	1400	8.55	5.4
4	Basalt+ Kevlar	8620	10.6	1550	7.3	5.3
5	Basalt+ Chopped matt	7125	8.4	1810	8.0	3.9
6	Kevlar+ Chopped matt	9750	23.2	1070	8.6	5.7
7	Kevlar + Basalt+ Chopped matt	9525	22.1	1923	6.8	5.5

Table: 1 Specimen testing results

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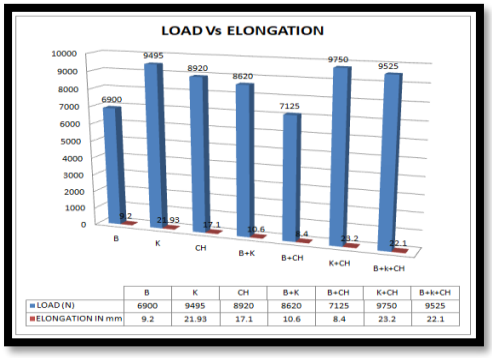
TENSILE STRENGTH

Fabrication and testing successfully completed in this project the tensile properties of Kevlar, Basalt, chopped mate, Basalt + chopped matt, Kevlar + Basalt, Kevlar+ Basalt+chopped matt, Kevlar+ chopped matt fabricated by using hand lay-up method. The tensile strength was calculated by the relation

S.NO	Composite	Load in N	Elongation In mm	Tensile strength N/mm²	% of elongation
1	Basalt	6900	9.2	9.50	5.60
2	Kevlar	9495	21.93	13.07	12.98
3	Chopped mate	8920	17.1	12.28	10.42
4	Basalt+ Kevlar	8620	10.6	11.87	6.46
5	Basalt+ Chopped mate	7125	8.4	9.81	5.12
6	Kevlar+ Chopped mate	9750	23.2	13.42	14.14
7	Basalt+ Kevlar+ Chopped mate	9525	22.1	13.11	13.47

Table: 2 tensile test results for 7 composites

After successful completion of the tensile strength we are getting maximum values for the Kevlar with chopped mate 9750 N.



Graph 1 tensile test result graph

FLEXURAL STRENGTH

Fabrication and testing successfully completed in this project the flexural strength of basalt, Kevlar, chopped mate and basalt chopped mate, basalt Kevlar, Kevlar chopped mate, basalt Kevlar chopped mate with Horn powder are fabricated by using hand lay-up method. The flexural strength was calculated based the following relation

Flexural strength $S = \frac{3PL}{2bt^2}$.

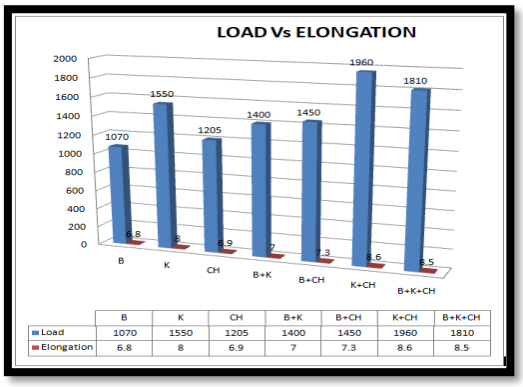
P= load in N; L= length between supports (70mm);b= Width in mm; d= Thickness in mm

After testing the Flexural strength and elongation are summarized in table. The percentages of elongations for all the composites are also calculated with the following formula.

$$\% \text{ elongation} = \frac{change\ in\ length}{original\ length} \times 100$$

- Basalt : % of elongation $= \frac{6.8}{70} \times 100 = 9.71\%$
- Kevlar: % of elongation $= \frac{8}{70} \times 100 = 11.42\%$
- Chopped matt: % of elongation $= \frac{6.9}{70} \times 100 = 9.85\%$
- Basalt+Kevlar: % of elongation $= \frac{7}{70} \times 100 = 10\%$
- Basalt+chopped matt: % of elongation $= \frac{7.3}{70} \times 100 = 10.42\%$
- Kevlar + Chopped matt: % of elongation $= \frac{8.6}{70} \times 100 = 12.28\%$
- Kevlar+ Basalt+Chopped matt : % of elongation $= \frac{8.5}{70} \times 100 = 12.14\%$

Based on the flexural strength finally concluded that Kevlar+ Chopped mate of Horn powder epoxy composite possess high flexural strength compared to remaining composite as shown in figure. And Basalt+ Kevlar+ Chopped mate having a second highest flexural strength compared to remaining composite



Graph 2 Flexural test result graph

IMPACT STRENGTH

Fabrication and testing successfully completed in this project I also focused on impact strength of basalt, Kevlar, chopped mate and basalt chopped mate, basalt Kevlar, Kevlar chopped mate, basalt Kevlar chopped mate with Horn powder fabricated by using hand lay-up method.And finally concluded the Kevlar+ Chopped mate material possess high impact strength compared to remaining compositions as shown figure

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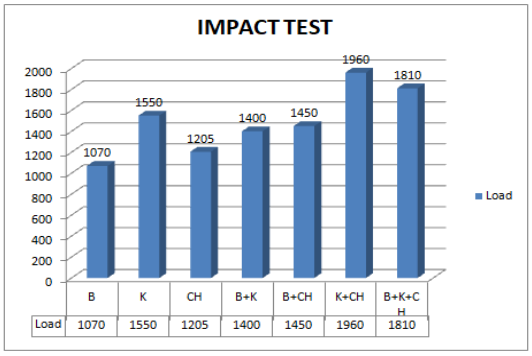
IMPACT TEST	JOULES
Basalt	3.7
Kevlar	5.45
Chopped mate	5.4
Basalt+ Kevlar	5.3
Basalt+ Chopped mate	3.9
Kevlar+ Chopped mate	5.7
Basalt+ Kevlar+ Chopped mate	5.5

Table: 3 Impact testing results for 7 composites



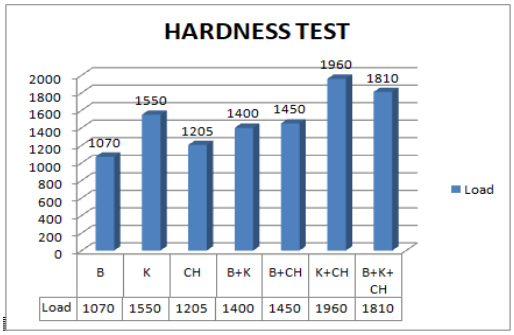
Graph 3 Impact strength result graph

HARDNESS NUMBER:

Brinell hardness values of these natural composites. Experiment gives the Kevlar with chopped mate having maximum Brinell hardness value 18.3 ,where Wt% ratio of resin & hardener: On the other hand, epoxy with basalt reveals the minimum hardness value 13.9.Brinell hardness vs. experiment number graph of the composite. Figure reveals the graph indicating Brinell hardness values corresponding to the experiment number. The graph shows, experiment with kevlar with chopped mate gives the higher value of Brinell hardness. On the other hand, experiment with basalt gives the lower Brinell hardness value.

COMPOSITE	HARDNESS NUMBER
Basalt	13.9
Kevlar	16.5
Chopped mate	15.3
Basalt+ Kevlar	14.3
Basalt+ Chopped mate	14.1
Kevlar+ Chopped mate	18.3
Basalt+ Kevlar+ Chopped mate	16.5

Table: 4 Hardness testing results for 7 composites



Graph 4 Hardness number result graph

INTRODUCTION TO CATIA

Welcome to **CATIA (Computer Aided Three Dimensional Interactive Application)**. As a new user of this software package, you will join hands with thousands of users of this high-end CAD/CAM/CAE tool worldwide. If you are already familiar with the previous releases, you can upgrade your designing skills with the tremendous improvement in this latest release.

.DESIGN PROCEDURE IN CATIA:

Design process of maruthi suzuki a lot car bumper Go to the sketcher workbench create the 1200x300 c shape using profile and thickness is 8mm after apply pad using part design workbench again go to the front view xy plane create the front part gill area and light area apply pocket as per dimensions .

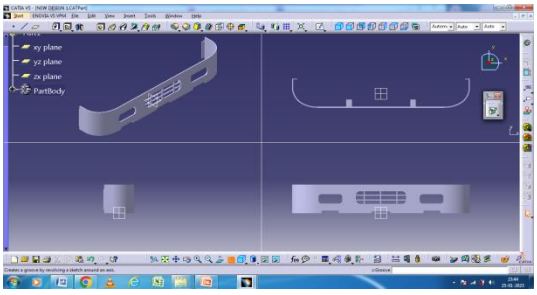


Figure 29 Multiple view of car bumper

INTRODUCTION TO ANSYS

ANSYS is a large-scale multipurpose finite element program developed and maintained by ANSYS Inc. to analyze a wide spectrum of problems encountered in engineering mechanics**.**

PROGRAM ORGANIZATION:

The ANSYS program is organized into two basic levels:

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- Begin level
- Processor (or Routine) level

The Begin level acts as a gateway into and out of the ANSYS program. It is also used for certain global program controls such as changing the job name, clearing (zeroing out) the database, and copying binary files. When you first enter the program, you are at the Begin level.

FINITE ELEMENT METHOD:

The Basic concept in FEA is that the body or structure may be divided into smaller elements of finite dimensions called "Finite Elements". The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called "Nodes" or "Nodal Points". Simple functions are chosen to approximate the displacements over each finite element. Such assumed functions are called "shape functions". This will represent the displacement with in the element in terms of the displacement at the nodes of the element.

Basic Steps in FEA

- Discretization of the domain
- Application of Boundary conditions
- Assembling the system equations
- Solution for system equations
- Post processing the results.

. **MATERIAL PROPERTIES:**

MATERIALS PROPERTIES	KEVLAR	KEVLAR+CHOPPEDMATE +10grms horn powder
Density(kg/m^3)	1380	1423
Poisson's ratio	0.35	0.32
Young's Modulus(GPa)	76	84
Tensile Strength(N/m^2)	29*10^6	31.5*10^6

MESH AND BOUNDARY CONDITIONS:

The meshed model of bullet proof jacket of nodes =10129 and elements is 4845 Using Material as finalized material from above mentioned Kevlar with chopped matt call it as a hybrid and existing material for car bumper of alto Maruthi car

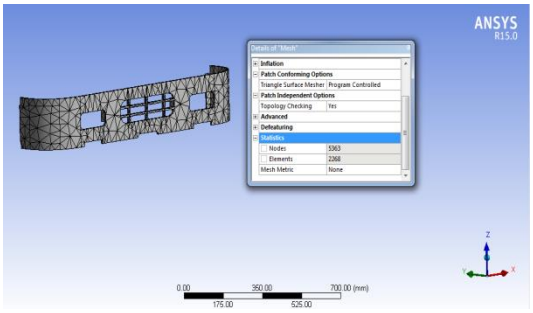


Figure 30 MESHING: NODES: 5363 ELEMENTS: 2268

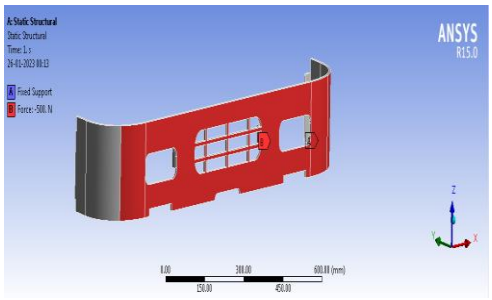


Figure 31 BOUNDARY CONDITIONS FORCE: 500N

ANALYSIS ON ANSYS

STRUCTURAL STATIC ANALYSIS:

A static analysis calculates the effects of study loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis can however include steady inertia loads and time varying loads that can be approximated as static equivalent loads. Static analysis is used to determine the displacements, stresses, strains and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed, i.e. the loads and the structure's responses are assumed to vary slowly with respect to time. The kinds of loading that can be applied in static analysis include:

- Externally applied forces and pressures.
- Steady state inertial forces
- Imposed displacement
- Temperatures

Static Analysis of Kevlar fiber + 10grms Horn powder Material:

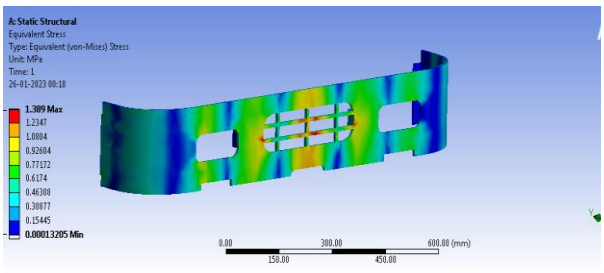


Figure 32 Von-misses stress of Kevlar fiber + 10grms Horn Material.

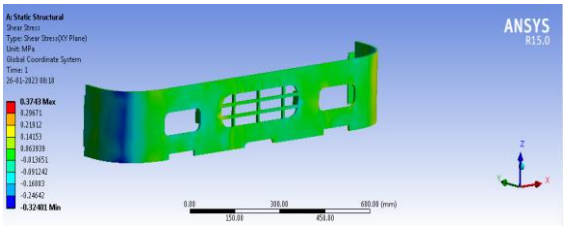


Figure 33 shear stress of Kevlar fiber + 10grms Horn powder Material

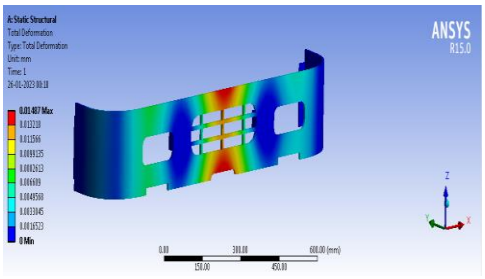


Figure 34 Total deformations of Kevlar fiber + 10grms Horn powder Material

STATIC ANALYSIS OF ALB390 MATERIAL:

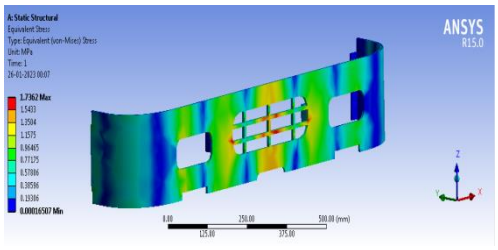


Figure 35 Von-misses stress of ALB390 Material

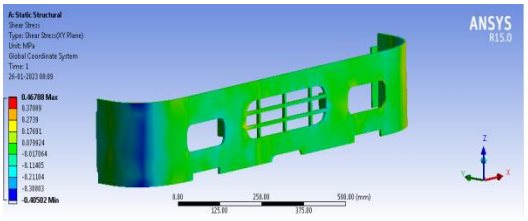


Figure 36 Shear stress of ALB390 Material

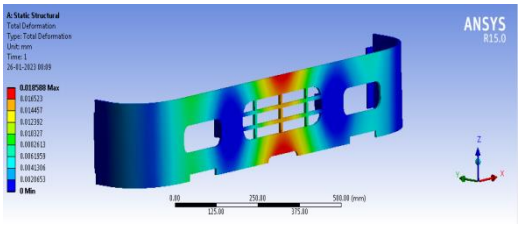
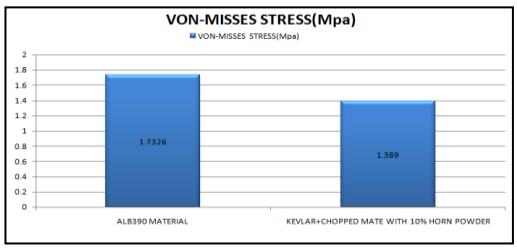


Figure 37 Total deformations of ALB390 Material

GRAPHS:

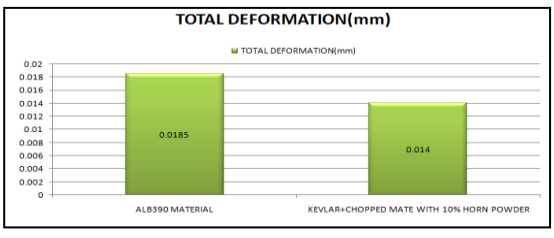
VON-MISSES STRESS GRAPH:

The below graph von-misses stresses of two different materials like KEVLAR+CHOPPED MATE WITH 10% HORN POWDER and ALB360 MATERIAL. Finally observed KEVLAR+CHOPPED MATE WITH 10% HORN POWDER Have low von-misses stress 1.389Mpa compared to ALB360



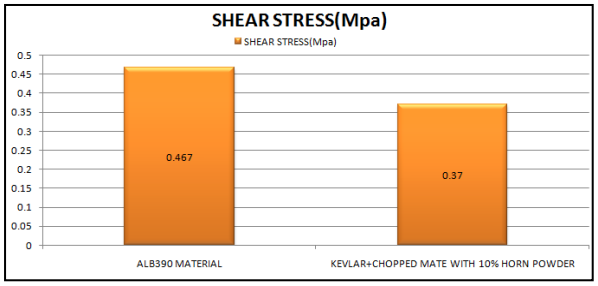
Graph 6 Von misses stresses of existing and proposed material

TOTAL DEFORMATION GRAPH:



Graph 7 Total deformation for existing and proposed material

SHEAR STRESS GRAPH:



Graph 8 Strain for existing and proposed material.

CONCLUSION

1) The tensile stress has substantially increase in sample of hybrid composite epoxy reinforced with chopped mate with Horn powder resin and Kevlar fibers than sample of composite epoxy reinforced with basalt fibers and remaining hybrids. Because Kevlar fiber with chopped matt was continuous fibers which have high tensile strength and tensile modulus than chopped and basalt fibers which have random arranged.

2) Flexural strength results show that the hybrid composite (epoxy reinforced with chopped mate and Kevlar fibers) have a higher value than the sample of epoxy chopped Horn powder fiber composite as Kevlar fibers have a good adhesion (bonding) with epoxy than basalt fibers

3) Results of hardness test show that hybrid composite have a lower value of Brinell number composite (epoxy chopped Kevlar fibers composite). In generally the hardness decreases with increases of materials elasticity.

4) The sample of hybrid composite reinforced with Horn powder Kevlar fibers with chopped mate have a higher value of impact strength than sample of composite reinforced with basalt and chopped mate fibers because of existence of Kevlar fibers in hybrid composite which have a higher strength and impact resistance.

5) As modeling and static analysis also shows better stress, strain and deformation values for chopped matt with Kevlar among the existing Kevlar fiber. Among all these testing's and static analysis considerations we are finally concluded that Kevlar with Chopped matt with Horn powder combination is better than reaming six compositions

6) Car bumper Design process done in catia software and Analysis done in ansys software with two materials KEVLAR+CHOPPED MATE WITH 10% HORN POWDER and ALB360 MATERIAL Finally KEVLAR+CHOPPED MATE WITH 10% HORN POWDER is the best material because of Low von-misses stress, deformation, Shear stress.

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