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DESIGN AND ANALYSIS OF NATURAL FIBER INDUSTRIYAL SAFETY HELMET

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Abstract :In the construction Industries, though safety management improvements are continually being pursued According to the International Labour Organization, India has the highest accident rate among construction workers, with 165 of 1,000 injured on the job. Failure to wear safety helmets seems to be one of the major causes of the increase in accidents. The number of workers getting head injuries in the construction and industries because of not using the proper safety accessories are increasing every year. In the workplace, the workers lean towards taking out several of their safety accessories like the helmet, as the accessory may be too weighty, hot, or annoying to work with. Therefore, we need an appropriate safety helmet for the comfort ability of the worker to reduce the risk of head injuries. All the helmets attempt to protect the worker's head by absorbing the mechanical energy and protecting against penetration. Industry helmets are normally made up of polyethylene thermoplastic. Currently, the interest in using natural fibers has increased significantly. Natural fibers prove to have a wide area of research since they have low density, are lightweight, and have better mechanical properties. This project aims to help the workers by designing a safety helmet made of banana fiber reinforced with polyester which meets the IS2925 standards. Banana fiber is used as India and other tropical countries cultivate banana plants on a large scale. Banana fibers are super or too the natural fiber interims of properties. Cheaper goods in high-performing devices are possible with this technology. An industrial safety helmet is designed in CATIA V5 software. Random banana fiber helmet and random glass fiber helmet are going to be analyzed using ANSYS to meet the IS 2925 safety standards
Key words-safety helmets-natural fibers-IS2925standards-CATIA V5-ANSYS.

I. INTRODUCTIONON INDUSTRIAL SAFETY HELMET

Naturalfibersarebiodegradable,abundantlyavailable,possessgoodmechanical properties, have low density and are cost-efficient. Natural fibercomposites are gaining importance as they are cheaper, eco-friendly, stiffer andare non-carcinogenic. They have the potential to replace high-cost glass fiberwhichisusedforvariouspurposeslikepackaging,automobiles,andtheconstructionindustry.theincorporationofnaturalfiberswithglassfibersimproves themechanical propertiesof thecomposite.As banana fiber is an Agri-waste of banana cultivation, it reduces theadditional cost of these fibers. Industrial safety helmets are usedto protectworkers againstheadinjuries.

Forworkers,thehelmetshouldbecomfortableandlessenweight.Referenceshowsthatthemostcommonreasonfornotwearingahelmetistheweightofthehelmet,neckpain,feelingofsuffocation,andlimitationsinthemovementsofthehead andneck.The existing safety helmets are made of carcinogenic materials, materialsthathavethepotentialtocausecancerlikepolypropylene,polycarbonate,acrylonitrile butadiene styrene, and expanded polystyrene. Apart from beingcarcinogenicthey areheavy,on-biodegradable,and causeallergicreactions.Researchers have paved a path for using natural fibers for making safetyhelmets which can eliminate the cons of using the existing safety helmets whichhaveahazardousimpactontheworker.TheaimofourprojectistoDESIGNANDANALYZEasafetyhelmetmadeofBananafiberreinforcedwithpolyesterwhich meets the IS2925 standards.Safety helmet shave to comply with the IS2925 standards to make sure thatthey are fit for use. Industrial safety helmets are designed to give protectionagainstpenetrationandshockabsorption.Anindustrialsafetyhelmetisdesignedin CATIA V5 software. Helmets of fiber weight 10 to 50 wt.% of all the twovarieties such as random banana fiber helmet and random glass fiber helmet aregoing to be analyzed using ANSYS to check if they meet the IS2925 safetystandards.

ObjectiveOfOurProject:

The objective of this project is to show that natural fiber in forced polymersare capableto replacecarcinogenic industrialsafetyhelmets.

II. LITERATUREREVIEW

YusriHelmi Mohammad et al

III. Mechanical andthermal propertiesof glass fiber inforce diepoxycomposite withmatrixmodificationUsing quidepoxididentical rubber. Increase inglass fiberpercentageimproves theMechanicalproperties ofThe compositematerial.

SathishkumarT P et al

Ultimate tensilestrengthandflexural strengthof the fiberglasspolyestercompositeincreases withincrease in thefiberglass fiber weightfraction.

Jack J.Kenned et al

Need launchedBanana fiber safetyhelmetafter potential toreduce the glassfiber. Itshowsgreaterstrength than thecarcinogenicreinforced glassfiber. Laming on eco-friendly,greener environment.

Ashok Kumar. K et al

Natural fiberhelmets have agreater stresscapability thanpolypropylenehelme

IIIDESIGNINGINDUSTRIALSAFETYHELMET

Dimensions Of Industrial Safety Helmet According TOIS2925ST AND ARDS

Table1dimensionsofhelmetaccordingtoIS2925standard

Sl.no	Parts	Dimensions(inmm)
1	Width	220
2	Length	300
2	Peak	30to50
3	Wearingheight	150
4	Brim	Notmorethan6

DesigningOfIndustrialSafetyHelmetUsingCATIAV5

Software is used for surface and wire frame modelling of industrial safetyhelmet.**CATIA,**Computeraidedthree-dimensionalinteractiveapplication,usedfordesigning&manufacturingproductsinindustrieslikeaerospace,automotive,industrialtoolsetc.

Designing of industrial safety helmet according to IS2925 standards:

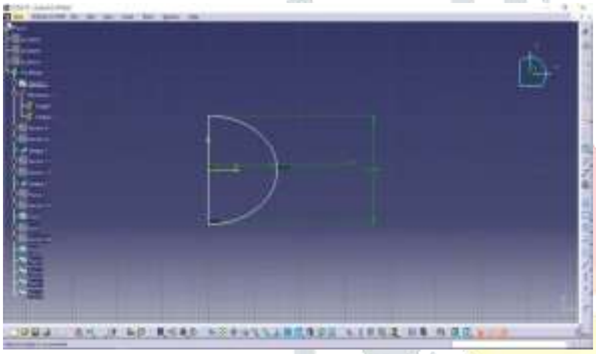


Figure 1 Constructionofellipse

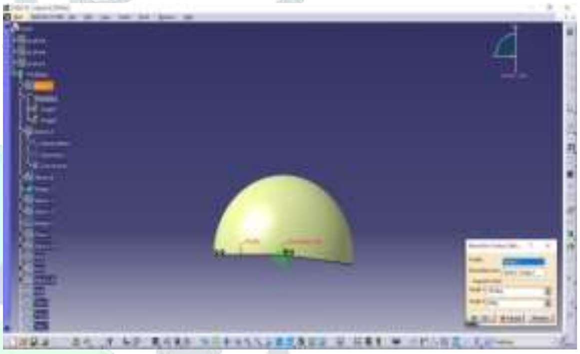


Figure 2 Constructionofshellofahelmet

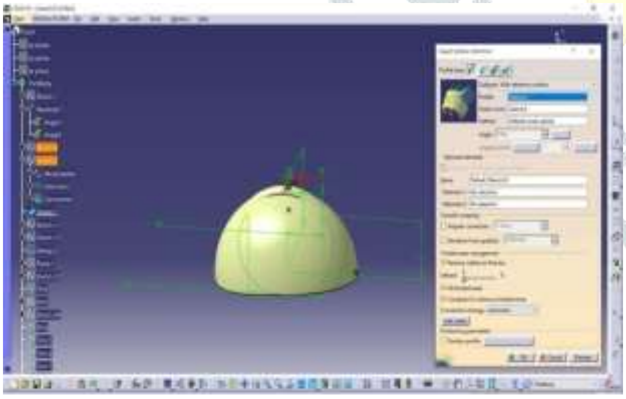


Figure. 3profileconstruction

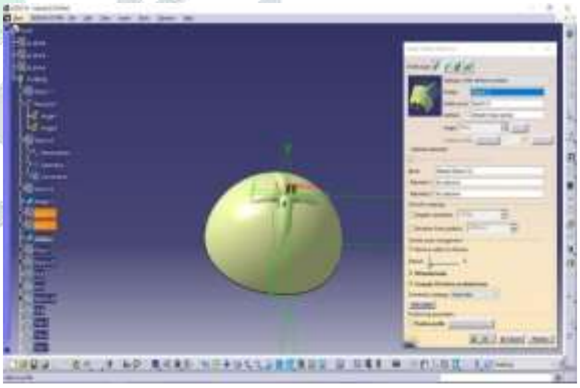


Figure. 4profileconstructiononbothsides

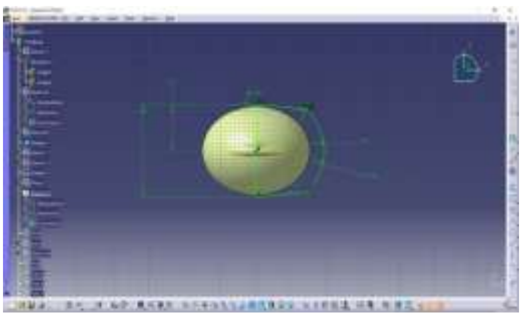


Figure. 5constructionofpeakofhelmet

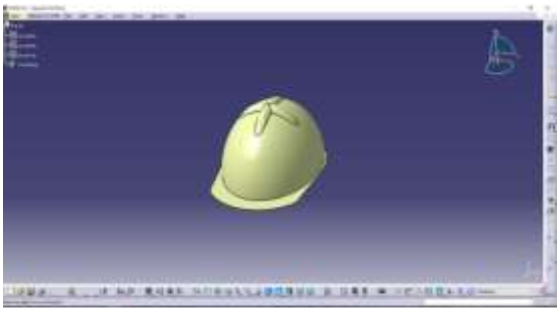


Figure.6 final imageofthehelmet

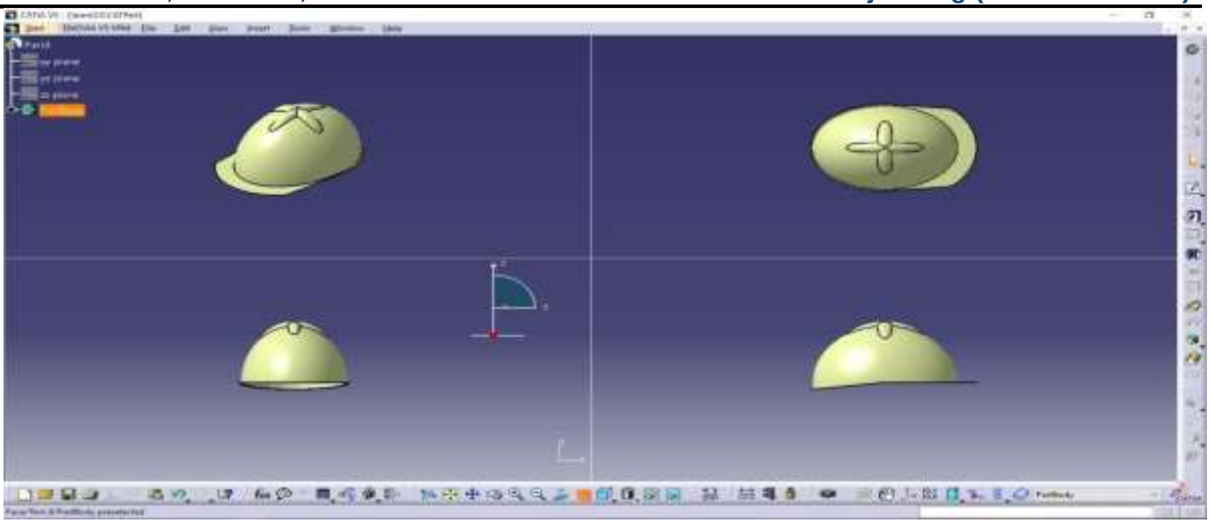


Figure.7 IsometricViewsOfTheHelmet

IV. THEORETICAL CALCULATIOS

Table 2PropertiesOfBananaFiber

S.no	Property	Value
1	Tensilestrength	560MPa
2	Density	1350kg/m³
3	Young'smodulus	43Gpa
4	Poistionratio	0.280

Table3propertiesofglassfiber

S.no	Property	Value
1	Tensilestrength	184.4MPa
2	Density	2.54kg/m^3
3	Young'smodulus	76GPa
4	Poisson'sratio	0.21

Steps for calculating tensile modulus, Shear modulus and poisson's ratio for a given material:
CalculateEandGforthecompositeusing thevaluesofE_{11} and E_{22}

$$E = E_{random} = \frac{3}{8}E_{11} + \frac{5}{8}E_{22} \quad GPa \qquad (a)$$

$$G = G_{random} = \frac{1}{8}E_{11} + \frac{1}{4}E_{22} \quad GPa \qquad (b)$$

$$E_{22} = \frac{1+2\eta V_{f}}{1-\eta V_{f}} E_{m} \qquad (3)$$

$$\eta_{T} = \frac{\frac{E_f}{E_m}-1}{\frac{E_f}{E_m}+2} \qquad (4)$$

$$E_{11} = \frac{1+2(\frac{l}{d})\eta V_f}{1-\eta V_f} E_m \qquad (1)$$

$$\eta = \frac{\frac{E_f}{E_m}-1}{\frac{E_f}{E_m}+2(\frac{l}{d})} \qquad (2)$$

Were
E_{22}=transversemodulus
η_T=HalpinTsaiconstant
CalculationofPoisson'sratio(ν)forthematerial
$\nu = \nu_{random} = \frac{E}{2G} - 1$

Table 4.propertiesofglassfiberat10weightpercentage

S.no	wt%ofglass fiber	EGlass fiber	Matrix
1	Massfraction w_f	0.1	1-0.1=0.9
2	Density(g/cm^3)	2.54	General purposepol yesterresin=1.14
3	volume(cm^3)	$\frac{0.1}{2.54}$=0.0393	$\frac{0.9}{1.14}$=0.78947

Table.5PropertiesofrandomGlassfiberatvariousweightpercentages

Fiberwt%	**Erandom(GPa)**	**νrandom**	**Grandom**	**Prandom(g/cm3)**
10	4.72	0.388	1.7459	1.489
20	5.255	0.3940	2.1545	1.478
30	7.1685	0.37855	2.6225	1.467
40	8.825	0.3789	3.2125	1.456
50	11.017	0.412	3.9975	1.445

Table.6 Propertiesofrandombananafiberatvariousweightpercentages

Fiberwt%	**Erandom(GPa)**	**νrandom**	**Grandom**	**ρrandom(g/cm3)**
10	4.86	0.3315	1.825	1.16132
20	6.11	0.3517	2.26	1.18394
30	7.6	0.360	2.793	1.2070
40	9.305	0.354	3.435	1.2314
50	11.117	0.436	3.875	1.256

IV. SIMULATIONS

TRAILOFANSYSMODULE

WeareusingANSYSworkbench2019R3forthisproject. TheExplicitdynamicsmoduleisusedforthisproject. Afterimportingtheexplicitdynamicsmodelintoprojectsschematics,theengineeringdata istaken. Forthisexperimentedanalysismodel,wehavegivenstructuralsteelonly. TheStructuralsteelisreadilyavailableintheengineeringdatalibraryofANSYSWorkbench. ThentheCATIAmoduleofthehelmetwithablockisimportedinigsextension. Themodelconsistsofahelmetandablockontoprofit. Thismodelhasaconnectingnonwheretheblockmusthitthehelmet. So,therewillbecamegeneratedonboth thebodies. Wemakeafixedsupportandgiveavelocitytoit(asitisatrailrandomvelocitywas taken) Thentherequiredsolutionsliketotaldeformationanddirectionaldeformationaregiven andtestedfor10,20,30,40,50weight percentages.

DIRECTIONAL DEFORMATION AND TOTAL DEFORMATION OF HELMETS A TINCREMENTAL ORDER OF THEIR WEIGHT PERCENTAGES OF BANANA FIBER

The total deformation and Directional deformation for 10% random banana fiber:

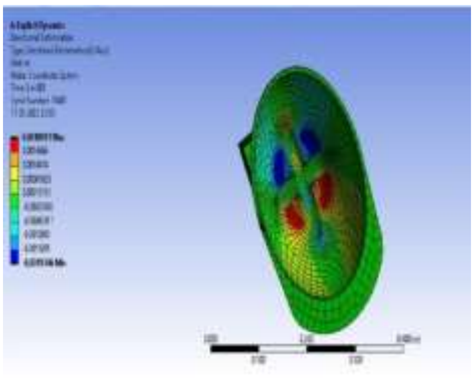


Figure 8directionaldeformationfor10%RBF

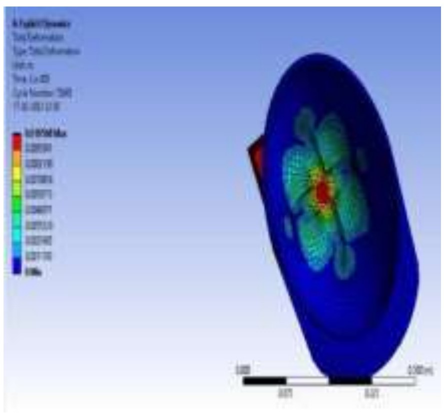
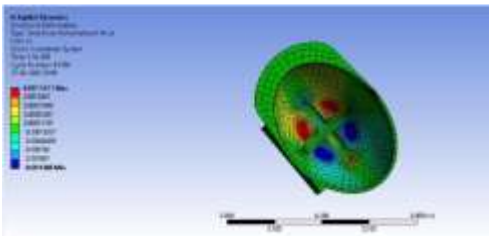


Figure 9totaldeformationfor10%RBF

ThetotaldeformationandDirectionaldeformationfor20%bananafiber:



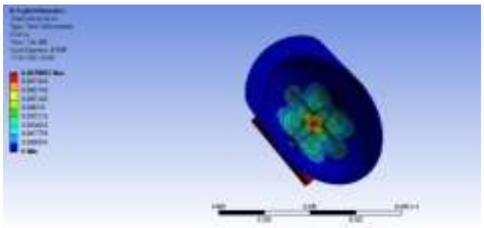
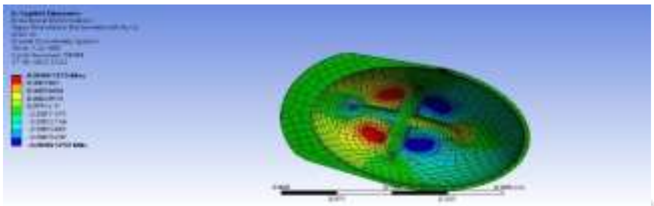


Figure 10 directionaldeformationat20%RBF Figure.11 totaldeformationat20%RBF

ThetotaldeformationandDirectionaldeformationfor30%bananafiber:



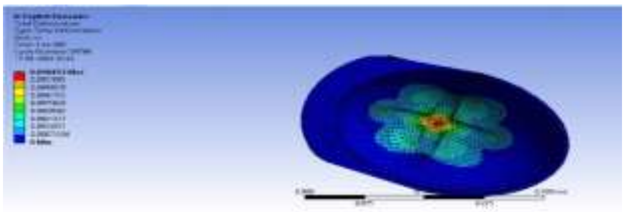
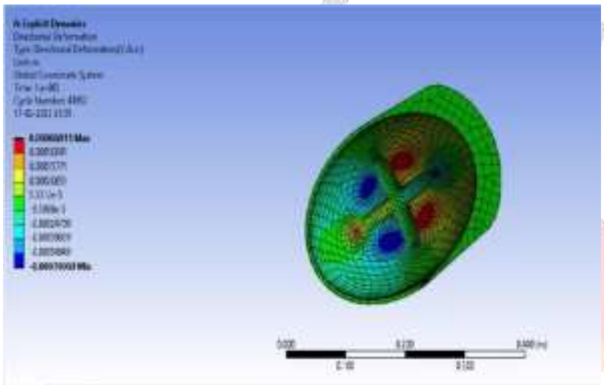


Figure.12 directionaldeformationat30%RBFFigure.13 totaldeformationat30%RBF

ThetotaldeformationandDirectionaldeformationfor40%bananafiber:



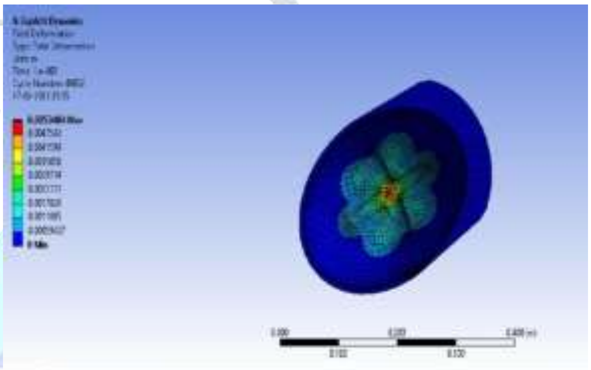
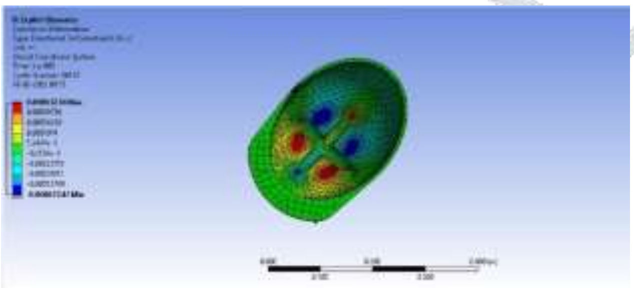


Figure.14 directional deformationat40%RBFFigure.15 totaldeformationat40%RBF

ThetotaldeformationandDirectionaldeformationfor50%bananafiber:



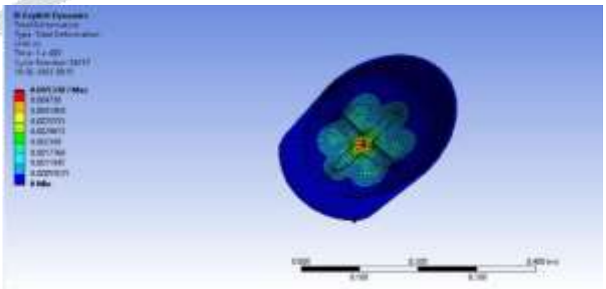


Figure.16 directionaldeformationat50%RBFFigure 17 totaldeformationat50%RBF

Directional Deformation And Total Deformation Of Helmets at incremental Order Of Their Weight Percentages Of glass fiber

ThetotaldeformationandDirectionaldeformationfor10%glassfiber:

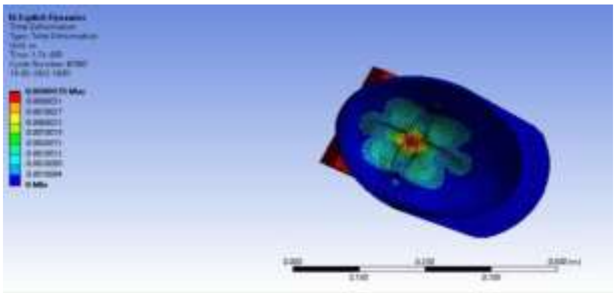


Figure.18 totaldeformationfor10%GF

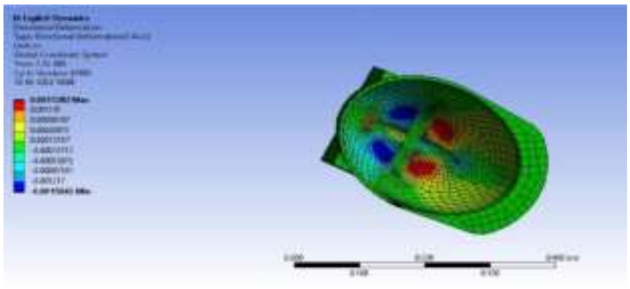


Figure 19 directionaldeformationat10%GF

ThetotaldeformationandDirectionaldeformationfor20%Glassfiber:

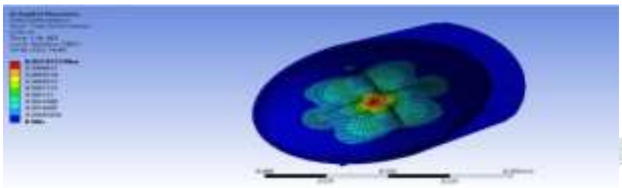


Figure.20 totaldeformation at20%GF

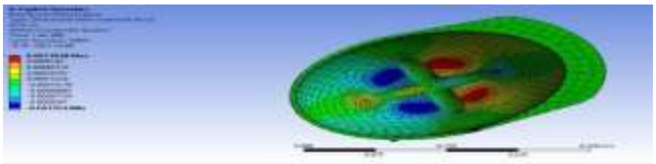


Figure. 21 directionaldeformationat20%GF

ThetotaldeformationandDirectionaldeformationfor30%Glassfiber:

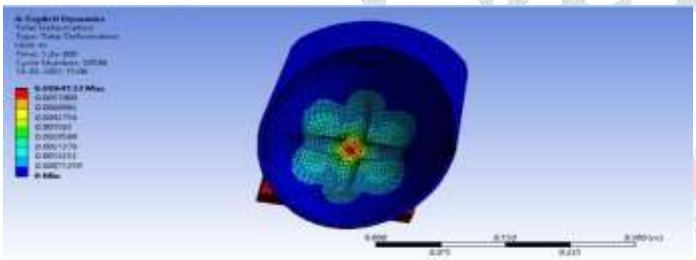


Figure.22 totaldeformation at30%GF

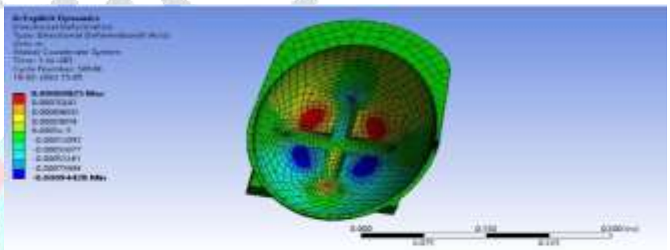


Figure.23 directionaldeformationat30%GF

ThetotaldeformationandDirectionaldeformationfor40%Glassfiber:

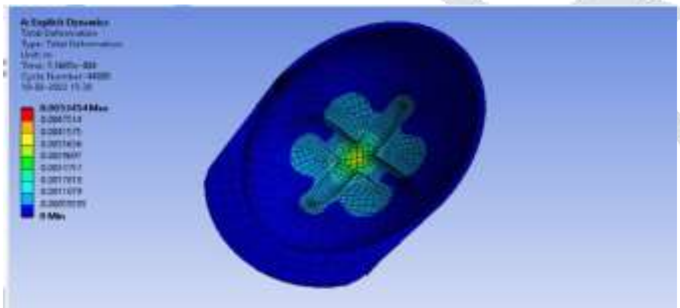


Figure.24totaldeformation at40%G

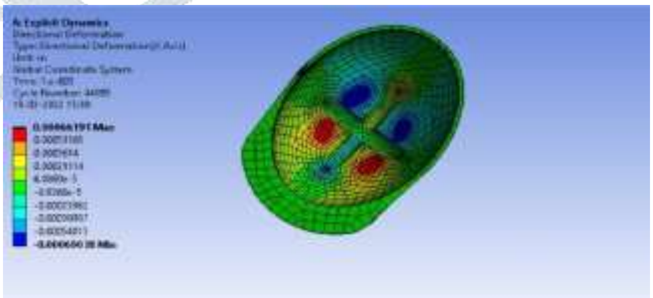


Figure. 25directionaldeformationat40%GF

ThetotaldeformationandDirectionaldeformationfor50%Glassfiber:

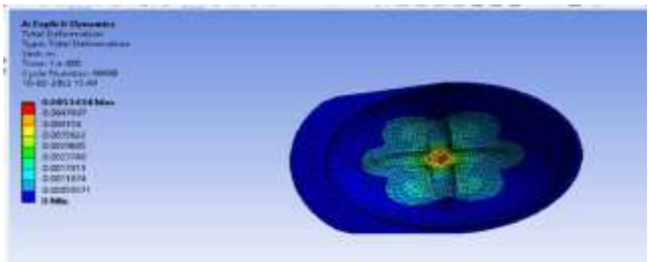


Figure.26totaldeformation at50%GF

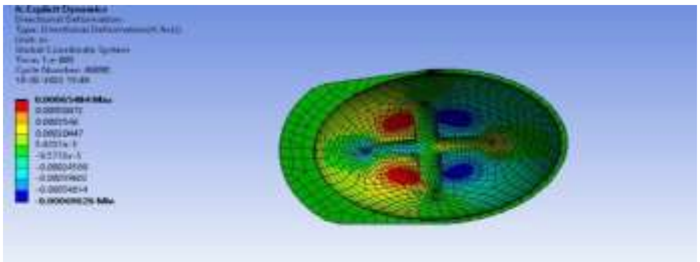


Figure.27directionaldeformationat50%GF

V. RESULTS AND DISCUSSION

Energy Absorption curves for glass fiber and banana fiber at differentwt.percentages

10% GLASS FIBER

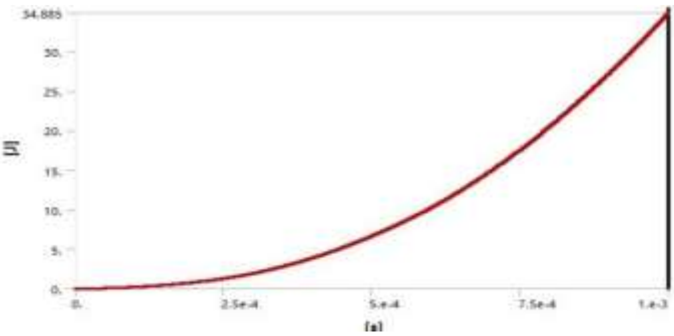


Figure 28energyabsorptioncurvefor10%GF

10% BANANAFIBER

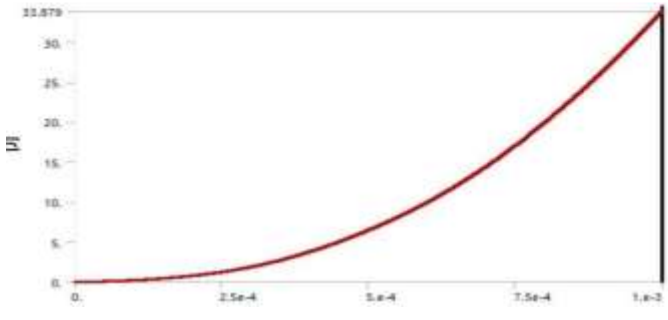


Figure. 29energyabsorptioncurvefor10%RBF

20%GLASS FIBER

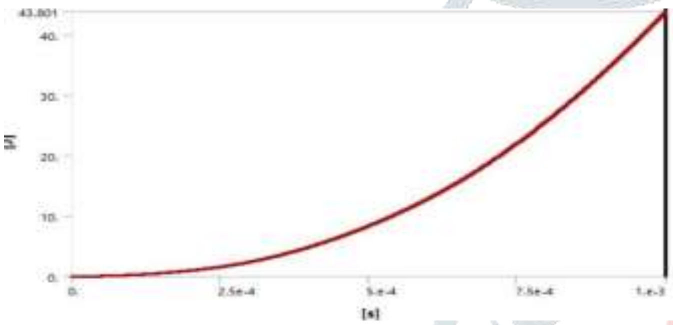


Figure30energyabsorptioncurvefor20%GF

20% BANANA FIBER

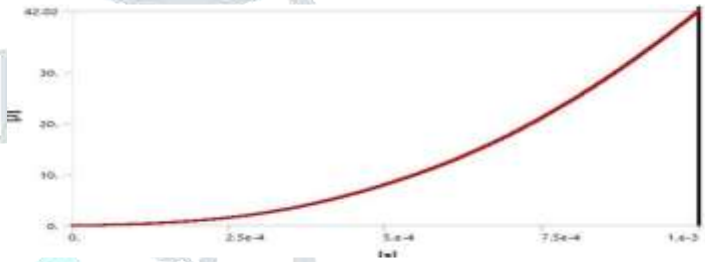


Figure.31energyabsorptioncurvefor20%RBF

30%GLASS FIBER

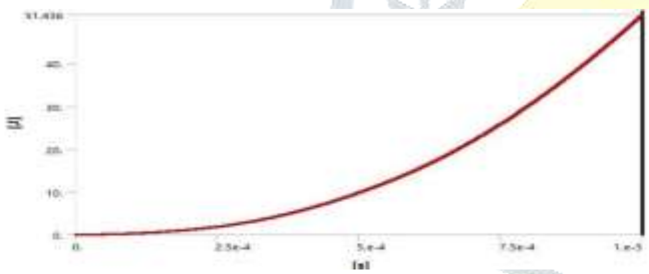


Figure 32energyabsorptioncurvefor30%GF

30% BANANA FIBER

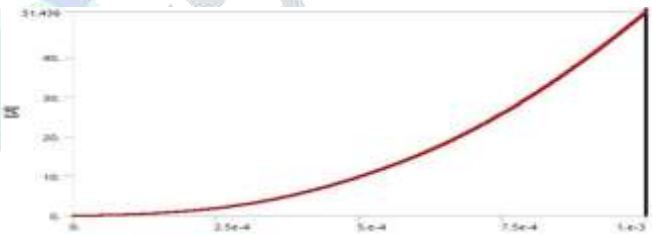


Figure.33energyabsorptioncurvefor30%RBF

40%GLASS FIBER

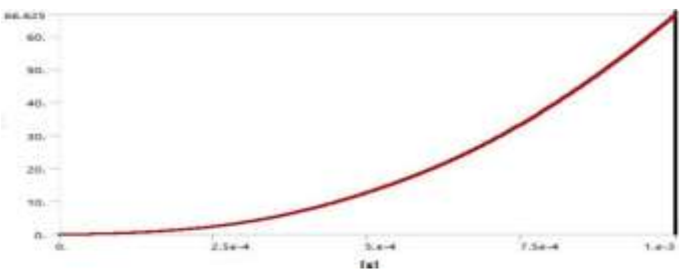


Figure 34energyabsorptioncurvefor40%GF

40% BANANA FIBER

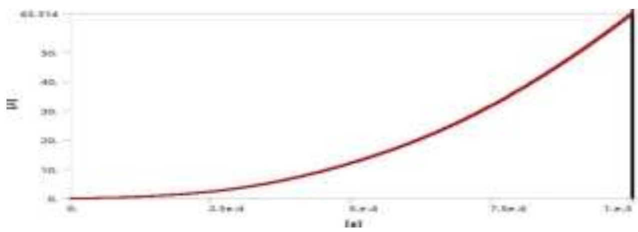


Figure.35energyabsorptioncurvefor40%RBF

50%GLASS FIBER

50% BANANA FIBER

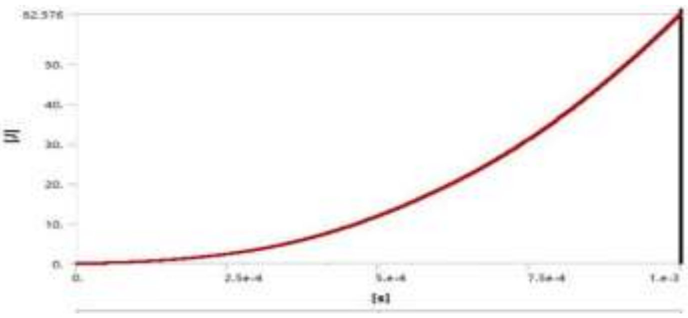


Figure 36energyabsorptioncurvefor50%GF

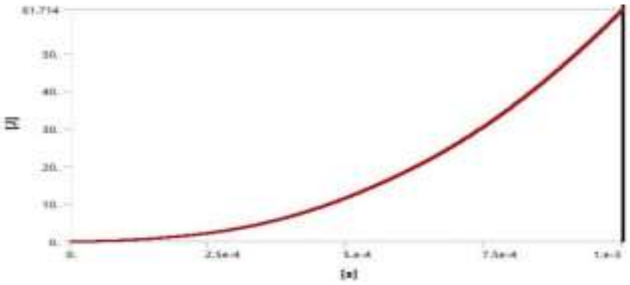


Figure 37energy absorptioncurvefor50%RBF

Table 7 shockabsorptionvaluesfordifferentfiberandfiberpercentage:

Fiberpercentage	Bananafiber	Glassfiber
10%	34.885J	33.789J
20%	43.801J	42.020J
30%	54.461J	53.436J
40%	66.625J	63.313J
50%	62.576J	61.745J

IV. CONCLUSION

Fromthisproject,weconcludethatindustrialsafetyhelmetsmadeofpolymer can be replaced by industrial safety helmets made of natural fiber. In thisproject, we have designed an Industrial safety helmet according to the IS 2925standards using CATIA V5 software and conducted numerical analysis on variousnatural fibers using ANSYS software. We have obtained deformation and energyabsorption values from the numerical analysis.The obtained deformation andenergy absorption values for glass fiber in forced polyester helmet (40 wt.%) are0.0052410mmand63.313J.Similarlyforbananafiberreinforcedpolyesterhelmet(40 wt.%) the values are 0.0053485mm and 66.625 J. As we all know that for ahelmet,theenergyabsorptionvaluemustbehightoavoiddamage.Fromourstudy,weconcludedthatat40wt.%thehelmetshowstheh ighestenergyabsorptionvalueamongallotherwt%.Beyond40wt%fiberloading,asudden.fallinenergyabsorption was noticed due to the agglomeration factor in which fiber-to-fibercontactbecamemoredominantduetoinadequateresin.Thisphenomenonresultedin poor interfacial bonding and stress transfer among the composite constituents.Beyond 40 wt.% the deformation increases in the case of GFRP and slightlyreducesforBFRP..

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