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Structural improvement in industrial helmet by combining low and medium based elastic modulus value composite fibre

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***Abstract*---**In this project, the structural strength analysis of the joint helmet is carried out using coconut fibre and fibreglass. In recent years "fibre-reinforced alloys" have been integrated into reinforcements with matrix using glass fibre, which have attracted the attention of researchers due to their high specific mechanical strength, comfort and low density. Current work efforts to improve the existing helmet manufacturing process and compatibility between materials and fibre and matrix with superior mechanical properties. The composites are made of unreinforced "polyester matrix" and fibre, "reinforced composite materials" and fibreglass, which uses the hand lay-up method in the appropriate proportions to produce the helmet shell construction. The "fabricated helmet" is designed to be analysed by a "finite element method" to evaluate its mechanical properties such as decay and "compression failure".

***Keywords*---**structural improvement, industrial helmet, combining low, medium based elastic, modulus value composite fibre.

Introduction

All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protective capacity are altered in high-energy impacts. Beside their energy absorption capability, their volume and weight are also important issues, since higher volume and weight

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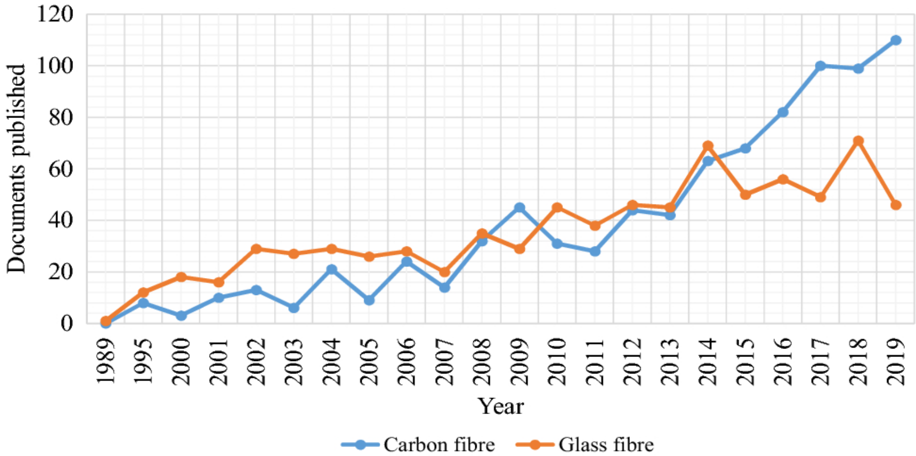
increase the injury risk for the user's head and neck. Every year many workers are killed or seriously injured in the construction, manufacturing and power industry because of head injuries. Wearing an appropriate safety helmet significantly reduces the risk of injury or even death. Protective headwear could save your life. At present strength of the helmet using industry is less due to improper selection and filling of material, uneven pressure distribution and blow holes. The aim of the project is to increase the strength of industrial helmet shell by using composite material. The safety helmet selected should satisfy certain performance requirements including shock absorption, resistance to penetration. To achieve this an improvement in shell material by using composite material will be studied in this project.



Literature survey

Veena Dinesh, H.K Shivanada, Arasu Kumar, Srinivasa Chari V, IJITEE March [2019], et allThe fibre like banana fibre, glass fibre and sisal fibres are effectively involved to make the new bio composite by changing the percentage of fibre. Produced new fibre with reinforcement of the natural fibres gives good mechanical properties as compared with the pure matrix. D Tamilvendan, G Mari Prabu, S Sivaraman, A. R. Ravikumar, IJRTE January [2020], et all Various hybrid composite test specimens as per ASTM were prepared with natural fillers such as sisal-pineapple-Kenaf fibres by using hand layup method. Vishal Shinde, Amit Desai, Subir Khan,IOSR-JMCE[2018], et all they compared the polycarbonate helmet with HDPE helmet in theoretical form using catia for design and ansys for analysis purpose. Max total deformation in polycarbonate composite is 0.059mm which is less than total deformation 0.207mm in HDPE. Murali, D.Chandramohan, S.K.Nagoor Vali, Mohan JMEAST May [2014] et all this project work natural fibre particle reinforced materials such as Sisal, Banana and jute reinforced polymer composite material with epoxy resin has been used for fabrication of industrial safety helmet.

Methodology

Selection of matrix object

Epoxy LY-556 (di-glycidal ether of Bisphenol-A, DGEBA density 1.16gm / cm3) was extracted as an adhesive matrix belonging to the Epoxide family. HY 951 (tri-ethylene tetra-amine density 0.95 gm / cm3) was used as the hardener.

Selection of reinforcement and natural fibres

Natural fibres such as sisal and hemp were added as reinforcements to the polymer compound. Glass fibre (7ml, 200 ± 20 GSM) synthetic fibre.

Availability of Natural fibre (sisal & jute) each 0.7 mm thickness

Cecil is a natural fibre of the agave (agave) family (scientific name agave) Cecil is a fully biodegradable and highly renewable resource. Coconut fibre is exceptionally durable and has low maintenance and low wear.

Availability of Synthetic fibre (glass)

Strong and durable: The pound for fibreglass is stronger than fibreglass metal. Fibreglass has high resistance to corrosion; It does not rust. Design Freedom: There are very few restrictions on fibreglass design, which offers unlimited possibilities for the engineer. Appearance: The use of fibreglass for product covers and covers certainly enhances its aesthetics. Achieve any look and feel. The coating gives a high-tech look to the fibreglass components. Cost Performance: Since steel depends on the price of steel in China, you will get a fixed price with fibreglass. Low costs for maintenance and warranty work. Special properties: Fibreglass is non-conductive and radio frequency transparent. Protect employees from internal hazards without compromising performance in electronics housing.

Surface treatment of fibres

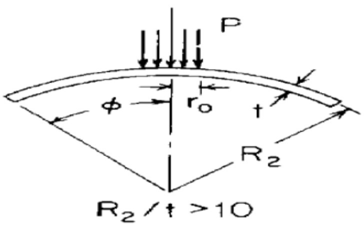
Newly drawn fibres generally contain numerous contaminants that can adversely affect the fibre matrix bond. As a result, the composite material made from such fibres does not have satisfactory mechanical properties. Therefore, it is desirable to remove the contaminant content of the fibres and improve the surface of the fibres to obtain a strong fibre-matrix bond. The fibres were treated with 5% NaOH for 3-4 h. They were then drawn and dried in the sun for 1-2 hours.

Wet Hand Lay-Up Technique

The Hand Lay-Up Technique is a simple combination method. The infrastructure requirement for this system is also very low. The processing steps are very simple. First, a release gel is sprayed on the mold surface to prevent it from sticking to the polymer surface. To get a good surface of the product, thin plastic sheets are used on the top and bottom of the printing plate. The reinforcement size is cut in the form of woven mats or chopped fibre mats and placed on the surface of the axis after the perspex sheet. The thermosetting polymer in liquid form is mixed well in the appropriate proportions with the recommended hardness (curing agent) and poured onto the surface of the mat already placed on the axis. Spread evenly with the help of a polymer brush. The second layer of foam is placed on the surface of the polymer and a cylinder is moved with moderate pressure on the foam-polymer layer to remove trapped air and excess polymer. The process is repeated until the required layers are applied to each layer of polymer and matte. After placing the plastic sheet, the release gel is sprayed on the inner surface of the top printing plate, then placed in stacked layers and pressed. After curing at room temperature or at a certain temperature, the mold is opened and the developed mixture part is taken out and further processed. The hand lay-up scheme is shown in Figure 1. The curing time depends on the type of polymer used for the composite processing. For example, for an epoxy-based system, the normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer-based compounds. Capital and infrastructure requirements are low compared to other methods. The production rate is low and it is difficult to achieve high levels of reinforcement in processed compounds. The hand lay-up method finds application in many areas such as aircraft parts, vehicle parts, boat tiles, dias board, deck.

Calculation

The first component to check is the helmet's shell. The purpose of this verification was to compare the pressure and displacement values of a hemispherical shell under high load between the abacus simulation and the physical equations. This indicates that the shell of the abaqus helmet is correctly marked. Rox's Formula7, 8 and 9 are a small circle of concentrated block equations for a spherical shell. Factors A, B and C are given for the pressure and compression of the load concentrated on a small. Circle at the pole.



$$Deflection = \delta = -A\frac{PR_2\sqrt{1-\nu^2}}{Et^2}$$

$$Max\ membrane\ stress = \sigma_1 = \sigma_2 = -B\frac{P\sqrt{1-\nu^2}}{t^2}$$

$$Max\ bending\ stress = \sigma'_1 = \sigma'_2 = -C\frac{P(1+\nu)}{t^2}$$

$$\mu = r'_o\left[\frac{12(1-\nu^2)}{{R_2}^2t^2}\right]^{1/4}$$

Equations with Rock's formula for pressure and pressure denoting the variables required to complete the analysis with the image for the semicircle. Table of A, B and C values with respect to values of mu to calculate maximum deflection, membrane stress, and bending stress for a partial spherical shell under loading at one pole

μ	0	0.1	0.2	0.4	0.6	0.8	1.0	1.2	1.4
A	0.433	0.431	0.425	0.408	0.386	0.362	0.337	0.311	0.286
B	0.217	0.215	0.212	0.204	0.193	0.181	0.168	0.155	0.143
C	∞	1.394	1.064	0.739	0.554	0.429	0.337	0.266	0.211

The maximum displacement observed

Deflection=δ= (A*P*R (1- ν2)1/2)/ Et2

A =.386 P =100N R=15cm

Deflection=δ=100*.15*0.386(1-.222)1/2 /70x109 x0.012

Deflection=δ=8.096x10-6N/mm

Max membrane stress= σ1=σ2 == (B*P* (1- ν2)1/2)/ t2

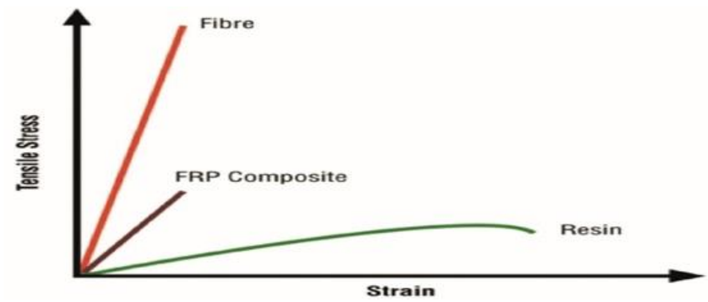
=0.196*100*(1-.222)1/2 / x0.012

Max membrane stress=0.19MPa.

Max bending stress= σ'1=σ'2= (C*P* (1+ν)/ t2

=0.554*100(1+22) /0.012

Max bending stress=.675MPa



Finite element solving on helmet

Introduction Of Finite Element Software

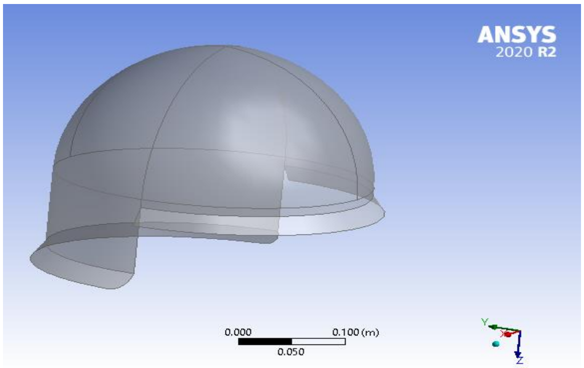
The basic premise of the FEA is that a body or structure can be broken down into smaller components of finite dimensions called "final elements". The original body or structure is then considered to be a set of these elements connected in a defined position Number of joints called "tips" or "nodal points". Simple functions are selected for approximate transfers for each finite element. Such hypothetical functions are called "form functions". It refers to the displacement within the element Terms for displacement at element nodes. Mathematically, the structure to be analysed is divided into loops of finite size finite components. Within each element, the variability of displacement is assumed to be determined by simplicity

Polynomial-shaped functions and node displacements. Equations for strains and stresses are developed based on unknown node displacements. From this, the equations of equilibrium are collected in easy matrix form. Planned and resolved in software. Nodal displacements are detected by solving the matrix stiffness equation after applying the appropriate boundary positions. Once nodal displacements are known, organ stresses and strains can be calculated.

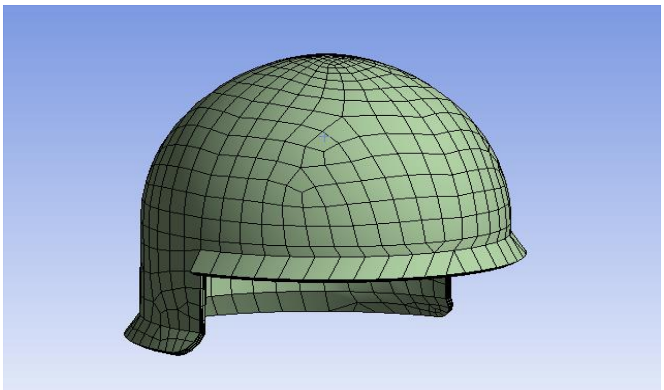
Ansys

General-purpose Limited Elemental Analysis (FEA) software package. Limited element analysis is a numerical method for reconstructing a complex system into very small pieces (user-specific size) called elements. The software implements the equations that manage the behaviour of these components and solves them all; Creates a detailed description of how the system works. These results can be presented in tabular or graphical formats. This type of analysis is commonly used for the design and upgrade of a more complex system for manual analysis. Systems that fit into this category are more complex due to their geometry, size or governing equations.

Importing External Geometry



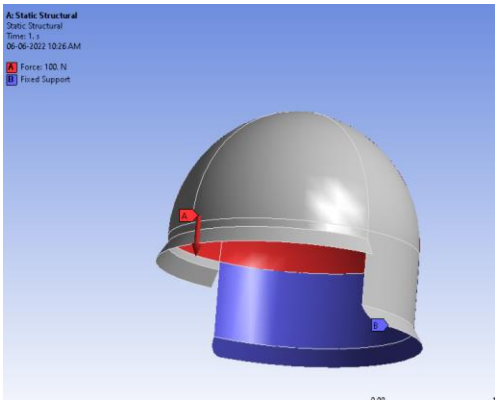
Generate Mesh

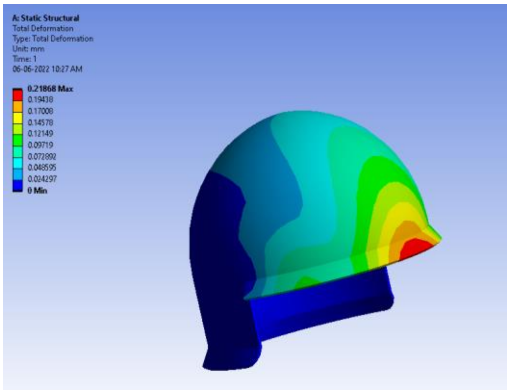


Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Medium
Initial Size Seed	Active Assembly
Smoothing	Medium
Span Angle Center	Coarse
Curvature Normal Angle	Default (30.0 °)
Min Size	Default (4.0980 mm)
Max Face Size	Default (20.490 mm)
Growth Rate	Default
Minimum Edge Length	10.0 mm
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	2
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Statistics	
Nodes	754
Elements	724

Object Name	*Fixed Support*	*Force*
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	2 Faces	4 Faces
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Components
Coordinate System		Global Coordinate System
X Component		0. N (ramped)
Y Component		0. N (ramped)
Z Component		100. N (ramped)

10006

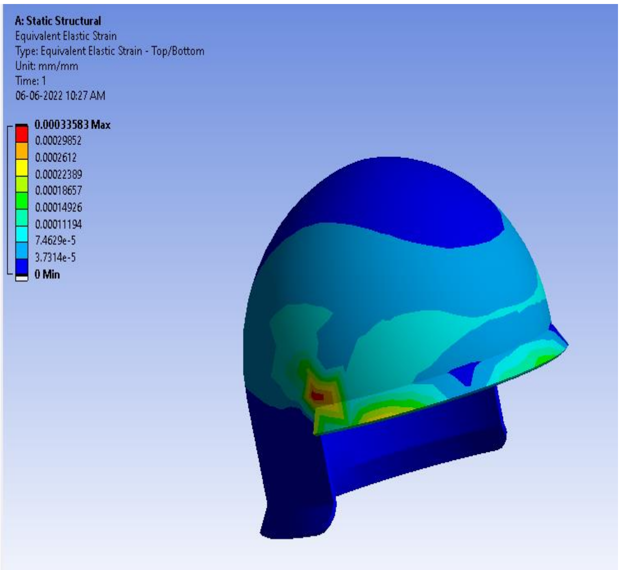




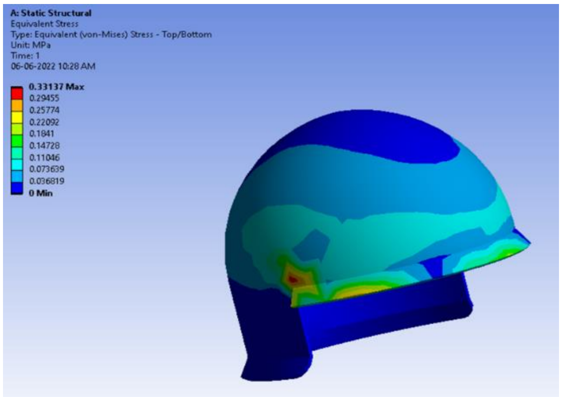
Polyethylene > Constants

Density	9.5e-007 kg mm^-3		
Coefficient of Thermal Expansion	2.3e-004 C^-1		
Specific Heat	2.96e+005 mJ kg^-1 C^-1		
Thermal Conductivity	2.8e-004 W mm^-1 C^-1		
Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
1100	0.42	2291.7	387.32

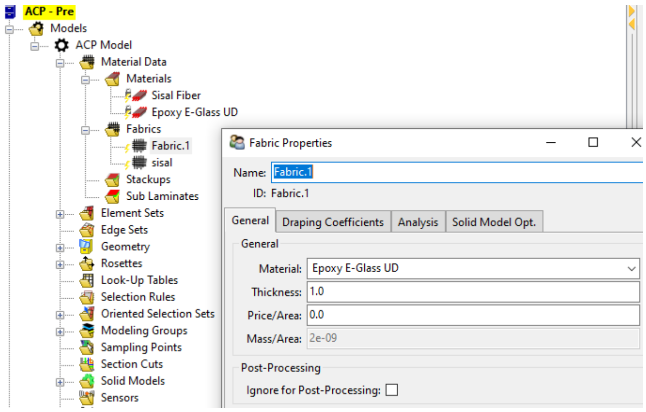
Elastic strain



Maximum stress of in plastic helmet



Composite Material Analysis in Ansys



Sisal Fibre > Constants

Density	1.45e-006 kg mm^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Specific Heat	4.34e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05e-002 W mm^-1 C^-1
Resistivity	1.7e-004-ohm mm

10008

Sisal Fibre > Compressive Ultimate Strength

Compressive Ultimate Strength MPa
0

Sisal Fibre > Compressive Yield Strength

Compressive Yield Strength MPa
250

Sisal Fibre > Tensile Yield Strength

Tensile Yield Strength MPa
250

Sisal Fibre > Tensile Ultimate Strength

Tensile Ultimate Strength MPa
460

Sisal Fibre > Isotropic Secant

Reference Temperature C
22

Coefficient of Thermal Expansion

Relative Permeability	Density
10000	2.e-006 kg mm^-3

Sisal Fibre > Alternating Stress Mean Stress

Alternating Stress MPa	Cycles	Mean Stress MPa
3999	10	0
2827	20	0
1896	50	0
1413	100	0
1069	200	0
441	2000	0
262	10000	0
214	20000	0
138	1.e+005	0
114	2.e+005	0
86.2	1.e+006	0

Sisal Fibre > Strain-Life Parameters

Strength Coefficient MPa	Strength Exponent	Ductility Coefficient	Ductility Exponent	Cyclic Strength Coefficient MPa	Cyclic Strain Hardening Exponent
920	-0.106	0.213	-0.47	1000	0.2

Sisal Fibre > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	3770	0.32	3490.7	1428

Epoxy E-Glass UD > Orthotropic Elasticity

Temperature C	Young's Modulus X direction MPa	Young's Modulus Y direction MPa	Young's Modulus Z direction MPa	Poisson's Ratio XY	Poisson's Ratio YZ	Poisson's Ratio XZ	Shear Modulus XY MPa	Shear Modulus YZ MPa	Shear Modulus XZ MPa
	45000	10000	10000	0.3	0.4	0.3	5000	3846.1	5000

Epoxy E-Glass UD > Orthotropic Strain Limits

Temperature C	Tensile X direction	Tensile Y direction	Tensile Z direction	Compressive X direction	Compressive Y direction	Compressive Z direction	Shear XY	Shear YZ	Shear XZ
	2.44e-002	3.5e-003	3.5e-003	-1.5e-002	-1.2e-002	-1.2e-002	1.6e-002	1.2e-002	1.6e-002

Epoxy E-Glass UD > Orthotropic Stress Limits

Temperature C	Tensile X direction MPa	Tensile Y direction MPa	Tensile Z direction MPa	Compressive X direction MPa	Compressive Y direction MPa	Compressive Z direction MPa	Shear XY MPa	Shear YZ MPa	Shear XZ MPa
	1100	35	35	-675	-120	-120	80	46.154	80

Epoxy E-Glass UD > Puck Constants

Temperature C	Compressive Inclination XZ	Compressive Inclination YZ	Tensile Inclination XZ	Tensile Inclination YZ
	0.25	0.2	0.3	0.2

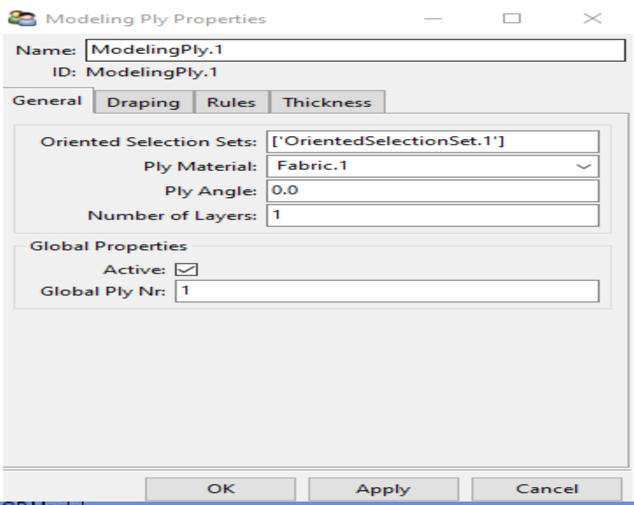
Epoxy E-Glass UD > Additional Puck Constants

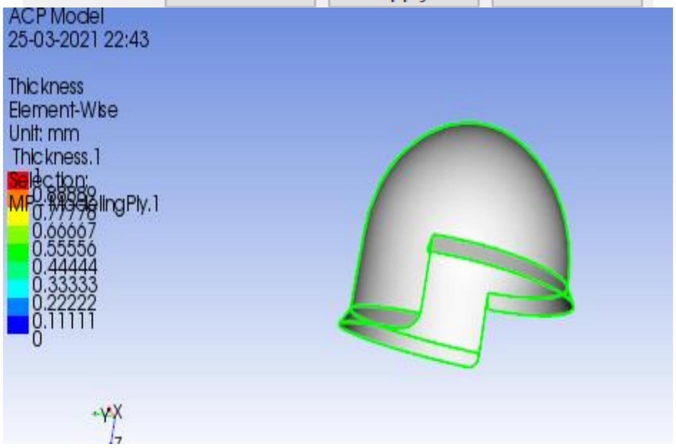
Interface Weakening Factor	Degradation Parameter s	Degradation Parameter M
0.8	0.5	0.5

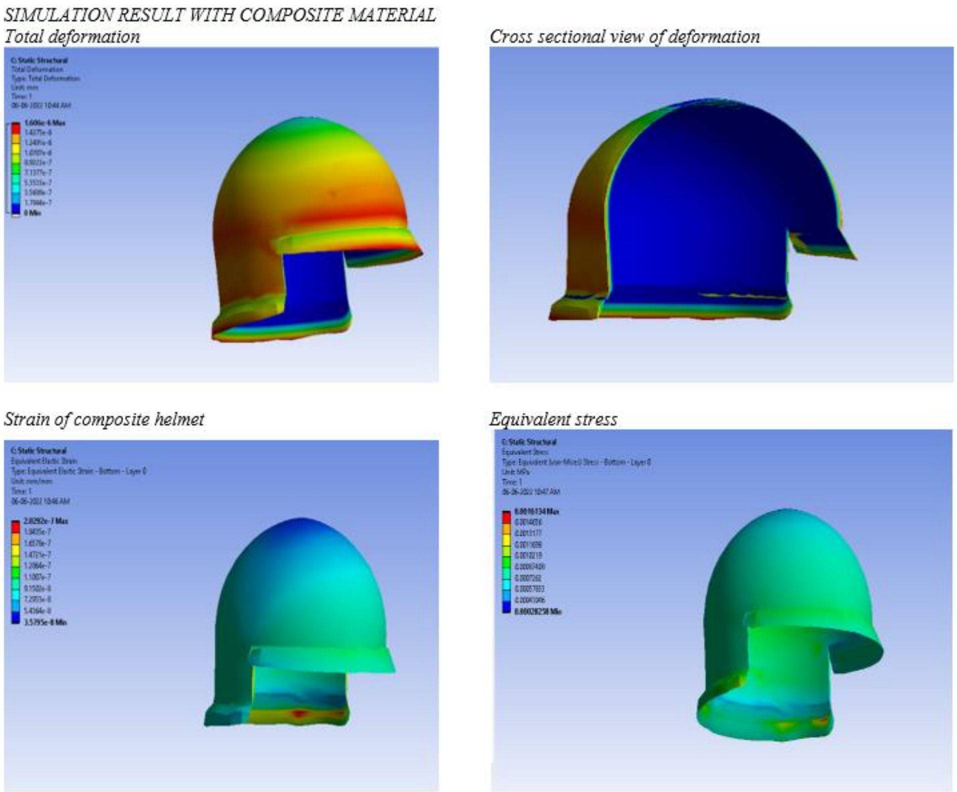
Epoxy E-Glass UD > Tsai-Wu Constants

Temperature C	Coupling Coefficient XY	Coupling Coefficient YZ	Coupling Coefficient XZ
	-1	-1	-1

Fibre arranged to make laminate







Scope of the project

Analysis of the affected natural fibre and glass reinforced polymer is carried out using finite element method (FEM). FEM is verified compared to plastic and fibre products. The standard configuration defined element code strength test is used approximately. First, the study of fibreglass composite is one of enormous complexity. An attack event can generate several different damage modes at once. Fibreglass damage is rarely diagnosed, so it is important to identify the contributing factor to the damage. This is especially dangerous in some applications such as automobiles. Due to all these factors, the attack response test will be carried out. Instead of stopping the use of plastics that affect the earth, the plastics industry needs to find an alternative. Must stand with strength properties comparable to plastic materials.

Advantages of natural fibres

Comparing to conventional reinforcing fibres like glass, carbon and Kevlar, natural fibres have the following advantages: Environmentally friendly, fully biodegradable, Non-toxic, Easy to handle, Non-abrasive during processing and use, Low density/light weight, Source of income for rural/agricultural community, Renewable, abundant and continuous supply of raw materials, Low cost, Free from health hazard (cause no skin irritations) High toughness, Good thermal properties.

Conclusion

S.no	Material	Total deformation	Strain	Stress (MPa)
1	Polyethylene	0.22	0.00033	0.33
2	Natural fibre	1.606×10^{-6}	2.029×10^{-7}	0.0016

The same load is applied because the two geometries are identical; The equal pressure distribution is the same in both cases. But the equivalent maximum strain in the polycarbonate compound is 0.0000002 mm / mm, which is less than the maximum strain of 0.0003 mm / mm in polyethylene. The maximum total decomposition in the natural compound is 0.011 mm, which is less than the total decomposition of 0.0000016 mm in polyethylene. Comparing these results, it is clear that the use of e-las coated natural cis fibre supports greater strength.

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