

DESIGN AND FABRICATION OF SAFETY HELMET BY BANANA AND JUTE COMPONENTS

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in
MECHANICAL ENGINEERING

BY

Y. PREM CHAND (37150226)
S. VISHNU VARDHAN (37150708)



DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI-600119

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with “A” grade by NAAC I 12B Status by UGC I

Approved by AICTE

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Y.PREM CHAND(37150226)** and **S.VISHNU VARDHAN(37150708)** who carried out the project entitled “**DESIGN AND FABRICATION OF SAFETY HELMET BY BANANA AND JUTE COMPOSITES**” under my supervision from November 2020 to March 2021.

Internal Guide

(Asst Prof R.KUMARA SUBRAMANIAN, M.E)

Head of the Department

(Dr.G.ARUN KUMAR, M.E, Ph.D)

Submitted for Viva voice Examination held on_____

Internal Examiner

External Examiner

DECLARATION

We, **Y.PREM CHAND (37150226)** and **S.VISHNU VARDHAN (37150708)** here by declare that the Project Report entitled “**DESIGN AND FABRICATION OF SAFETY HELMET BY BANANA AND JUTE COMPOSITES**” done by us under the guidance of **Asst Prof R.KUMARA SUBRAMANIAN, M.E** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

1.

2.

DATE:

PLACE:CHENNAI

SIGNATURE OF THE CANDIDATE

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ABSTRACT

In this work plan and investigation is completed in the Composite Helmet by Using Jute Fibre and banana fibre. In this ongoing world the fibre fortified composite materials are orchestrated utilizing banana fiber and jute fiber as fortifications together with grid, which have pulled in the consideration of analysts because of their low thickness with high explicit mechanical qualities, accommodation, and in exhaustibility. The present work endeavours to make an advancement in the current existing protective helmet producing strategy and materials used to have better mechanical properties just as to upgrade the similarity among strands and the framework.

TABLE OF CONTENTS

CONTENTS	Page No
I. Table of contents	I
II. List of tables	ii
III. List of figures	ii
IV. List of plates	iv

CHAPTER No.	TITLE	PAGE No.
1.	INTRODUCTION	1
	1.1 Definition of Composite	2
	1.2 Classification of Composites	3
	1.2.1 According to the type of Reinforcing Material Composite can be classified	3
	1.2.2 According to the type of Matrix Material they are classified	3
2.	LITERATURE SURVEY	6
3.	PROBLEM IDENTIFICATION	11
	3.1 Merits in proposed system	12
4.	METHODOLOGY	13
	4.1 Spray Lay up Method	14
	4.2 Vacuum Bag Technique	15
	4.2.1 Advantages of using vacuum bagging	15
	4.3 Resin Transfer Moulding	16
	4.3.1. Procedure for Resin Transfer Moulding	16
	4.3.2. Benefits of Resin Transfer Moulding	17
	4.4 Hand Lay up Method	18
	4.4.1. Material Selection	19
	4.5 Chemical Treatments for Natural Fiber	22

CHAPTER No.	TITLE	PAGE No.
	4.5.1 Alkaline Treatment	23
	4.5.2 Permanganate treatment	23
4.6.	Computer Aided Design of Safety Helmet	26
	4.6.1. Solid Works	26
	4.6.2. 2D Drawing of Safety Helmet	27
	4.6.3. Solid Works Modeling	28
4.7.	Analysis of Safety Helmet in ANSYS	32
	4.7.1. Meshing	32
	4.7.2. Static Structural	34
	4.7.3. Total Deformation	34
	4.7.4. Stress and strain induced	35
4.8.	Procedure for Fabrication of the Composite	
	Using Hand lay up Method	36
	4.8.1. Preparation of Mould	36
	4.8.2 Applying the Gel-Coat	37
	4.8.3 Preparation of Resin	37
	4.8.4 Lay-up Skin Coat	37
	4.8.5 Laying Sisal Reinforcement	37
	4.8.6 Curing	37
	4.8.7 Remove Part From Mold	38
	4.8.8 Surface Finish	38
5.	RESULT AND DISCUSSION	40
6.	CONCLUSION & SCOPE OF FUTHER WORK	44
	REFERNCES	45

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
3.1	Deformation	11
4.1	Properties of Banana fiber	20
4.2	Properties of Jute fiber	21
4.3	Physical properties of Banana and Jute fiber	22
4.4	Mechanical properties of Banana and Jute fiber	22
4.5	Sizing	33
4.6	Result of Analysis	36

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
4.1	Work Flow	13
4.2	Spray Lay up Method	14
4.3	Vacuum Bag Technique	16
4.4	Resin Transfer Moulding	18
4.5	Hand Lay up Method	19
4.6	Banana Fiber	19
4.7	Jute Fiber	21
4.8	Epoxy Resin	24
4.9	Drafting of Helmet	27
4.10	Front cap	28
4.11	Shell in Front cap	28
4.12	Head part in Composite	29
4.13	Extruded Head	29
4.14	Front cap Fillet	30

4.15	Side Extrude cut	30
4.16	Bottom view	31
4.17	Front view	31
4.18	Meshing view	33
4.19	Force acting	34
4.20	Fixed support	34
4.21	Total Deformation	35
4.22	Elastic strain	35
4.23	Normal stress	36
4.24	Rectangular Piece of Mould sample 1	38
4.25	Rectangular Piece of Mould sample 2	38
4.26	Front view of Helmet	39
4.27	Side view of Helmet	39

CHAPTER 1

INTRODUCTION

All helmets endeavor to ensure the clients head by engrossing mechanical vitality and securing against infiltration. Their structure and defensive limit are modified in high-vitality impacts. Close to their vitality assimilation capacity, their volume and weight are likewise significant issues, as increased volume and weight raise the risk of injury to the client's head and neck. Consistently numerous employees are slaughtered or genuinely harmed in the development, assembling and force industry due to head wounds. Wearing a fitting well being protective helmet essentially diminishes the danger of injury or even demise. Defensive helmet could spare your life. At present quality of the helmet utilizing industry is less because of inappropriate determination and filling of materials. The aim of this project is to expand the quality of modern head protector by utilizing composite material. The security protective helmet chose ought to fulfill certain presentation necessities including stun ingestion, protection from entrance. To accomplish this an improvement in material by utilizing composite material will be concentrated in this project. The Sisal plant has a long term life-length and regularly produces 200-250 economically usable leaves. Each leaf normally contains around 1000 filaments. The fiber component represents just about 4% of the plant by weight, is extricated by a cycle known as Decor cation. The lattice material utilized in this examination was bio epoxy sap Evaluation D638 and Hard 3554D provided by Endeavors, Chennai. Sisal filaments have been utilized generally in high quality ropes in India particularly in South India locales.

1.1. DEFINITION OF COMPOSITE

A composite is made up of two components, one of which is called the reinforcing phase and is made up of fibres, papers, or particles, and the other is called the matrix phase. Metal, ceramic, or polymer may be used for the reinforcement and matrix materials. The main load-bearing members in composites are usually fibres or particles that are stiffer and stronger than the continuous matrix process. The matrix serves as a load transfer medium between fibres, and in less ideal cases where the loads are complex, the matrix may be expected to bear loads that run perpendicular to the fibre axis. Since the matrix is more ductile than the fibres, it offers composite durability. Before, during, and after composite processing, the matrix protects the fibres from environmental harm. When properly constructed, the new combined material has greater strength than the individual materials. Composites are used for a variety of uses, including structural, electrical, thermal, and environmental.

Composites are multifunctional material structures that have properties that no discrete material can match. They are cohesive structures created by physically integrating two or more compatible materials that differ in composition, characteristics, and shape. Composite materials are heterogeneous materials that are made up of two or more solid phases that are in near contact on a microscopic scale. On a microscopic scale, they can also be called homogeneous materials in the sense that any component of it would have the same physical property.

Some of the reasons why composites are chosen for particular applications are described below.

- High strength to weight ratio (low density high tensile strength).
- High creep resistance.
- High tensile strength at elevated temperatures.
- High toughness
- Low cost

1.2. CLASSIFICATION OF COMPOSITES

1.2.1. ACCORDING TO THE TYPE OF REINFORCING MATERIAL COMPOSITE CAN BE CLASSIFIED

- Fibrous Composite
- Particulate Composites

1.2.1.a. FIBROUS COMPOSITE

A fibre is distinguished by its length being substantially greater than its cross-sectional dimensions. The reinforcement's dimensions determine its ability to contribute properties to the composite. Fibers are very effective in improving the matrix's fracture resistance because a long-dimension reinforcement discourages the growth of incipient cracks parallel to the reinforcement, which could otherwise lead to failure, particularly in brittle matrices. Since large defects in the bulk material are reduced by the limited cross-sectional dimensions of the fibre, man-made filaments or fibres of non-polymeric materials have much higher strength along their length. The orientation of the molecular structure is responsible for the high strength and stiffness of polymeric materials.

1.2.1.b. PARTICULATE COMPOSITE

The reinforcement of particulate composites is particle-based. Spherical, cubic, tetra, platelet, or any other regular or irregular shape is possible. In general, particles are ineffective at enhancing fracture resistance, but they do increase composite stiffness to a small degree. Particle fillers are commonly used to adjust the thermal and electrical conductivity of matrix materials, improve performance at high temperatures, reduce friction, increase wear and abrasion resistance, improve machine ability, increase surface hardness, and reduce shrinkage.

1.2.2. ACCORDING TO THE TYPE OF MATRIX MATERIAL THEY ARE CLASSIFIED

- Metal Matrix Composites (MMC)
- Ceramic Matrix Composites (CMC)
- Polymer Matrix Composites (PMC)

1.2.2.a. METAL MATRIX COMPOSITES

Metal matrices have greater strength, fracture resilience, and stiffness. In corrosive environments, metal matrix composites can withstand higher temperatures than polymer composites. The popular matrix metals currently in vogue are titanium, aluminium, and magnesium, which are especially useful for aircraft applications. Metal matrix composites are being considered for a number of applications, including combustion chamber nozzles (in rockets and space shuttles), housings, tubing, wires, heat exchange, structural members, and more.

1.2.2.b. CERAMIC MATRIX COMPOSITES

Some ceramic fibres embedded in a ceramic matrix make up ceramic matrix composites. Increasing the hardness of ceramic matrix composites is one of the primary goals. Naturally, it is hoped, and indeed often discovered, that ceramic matrix composites would increase in strength and stiffness at the same time..

1.2.2.c. POLYMER MATRIX COMPOSITES

Polymeric matrix materials are the most widely used matrix materials. Polymers' mechanical properties are typically insufficient for many structural applications. In contrast to metals and ceramics, their strength and stiffness are especially poor. These problems are addressed by using polymers to strengthen other materials. Second, manufacturing polymer matrix composites does not necessitate the use of high pressure or high temperatures. In addition, the equipment required to make polymer matrix composites is less complex. As a result, polymer matrix composites rose in popularity and became widely used in structural applications.

Two types of polymer composites are

- Particle reinforced polymer (PRP)
- Fiber reinforced polymer (FRP)

1.2.2.c.i. PARTICLE REINFORCED POLYMER

Ceramics and glasses, such as small mineral particles, metal particles, such as aluminium, and amorphous materials, such as polymers and carbon black, are used as reinforcement particles. Particles are used to increase the matrix's modules while decreasing the matrix's ductility. They boost the material's properties.

Automobile brakes are made of particulate composites containing carbon or ceramic particles.

1.2.2.c.ii. FIBER REINFORCED POLYMER

Fibers and a matrix make up most fibre reinforced composites. Fibers provide reinforcement and are the primary source of strength, while matrix holds all of the fibres in place and passes stresses between reinforcing fibres. Filler is often used to smooth out the manufacturing process, give the composites special properties, or lower the product cost.

Low-weight, high strength and stiffness, and ease of installation are just a few of the benefits of fiber-reinforced polymer (FRP) composites, particularly for carbon FRPs (CFRP s). FRPs have become increasingly popular as a cost-effective alternative to conventional materials such as steel, aluminium, iron, copper, and other metals in recent years.

In general, FRP rods are used to replace steel bar as internal reinforcement in concrete beams and bridge decks. Sucker rods for lifting oil wells, submarine structures, subsea oil industry use, and as oceanographic as load-bearing bars or rods to replace steel materials are only a few of the latest applications for FRPs. Due to their low cost, Glass-Fiber-Reinforced Polymer (GFRP) composites are the most commonly used FRPs for different structures. When exposed to hydrothermal conditions, however, GFRPs have a low tensile strength and are prone to degradation due to hydrolysis, swelling of matrices, and bonding of Fiber/matrices. Carbon Fiber Reinforced Polymer (CFRP) composites, on the other hand, have excellent chemical and corrosion resistance, as well as higher modulus and strength, but less strain at break. The high cost of CFRPs, on the other hand, is a significant disadvantage that restricts its use in many engineering systems. Hybrid FRPs with glass and carbon fibres are widely used to balance their benefits. Glass and fibre reinforced polymers are expected to have the most benefits.

CHAPTER 2

LITERATURE REVIEW

1. **Title:** Fabrication And Characterization Of Natural Fiber Reinforced Polyester Composites

Journal: IOSR journal of mechanical and civil engineering

Author: Anuppatil, CkCheParge

Year: 2018

Description:

This paper proposed that uni-Directional arranged natural fibers possess less strength than the fibers arranged in the mat forms. It is a generally accepted fact that the toughness of the fiber reinforced composite mainly depends on the stress-strain behavior. The impact strength of the coconut fiber bio composites decreases with increase in filler content. Adding coconut shell upto 30% leads to increase in tensile strength. Therm set polymers showed a good result with a variety of natural fibers systems due to its good spreading efficiency and the resultant improved adhesion.

Conclusion:

On May 2018, Juan stated that epoxies can have a glass temperature of up to 220°C, meaning that they can be safely used up to these temperatures. Epoxy resins can be kept in an uncured state for a long duration. In the present study, both untreated and alkali treated short fibers were used as reinforcement in unsaturated polymer resin composites. The alkali treatment was found to be effective in improving the tensile and properties of fiber reinforced polymer resin.

2. Title: Extraction of pineapple fiber is done by using mechanical method.

Journal: International Research Journal of Engineering and Technology (IRJET)

Author: M.asim, khalina abdan, M.jawaid

Year: 2018

Description:

The pineapple fibers are of high mechanical properties when compared to other natural fibers. Epoxy possesses higher mechanical properties and more thermal and chemical resistance than other types of resin. Therefore, it has exclusive use in making aircraft components. Epoxy resin is also called poly peroxides. The reinforcing phase is the distribution phase in the composite. Many reinforcing materials were available such as the natural fiber, synthetic fiber, particle etc.

Conclusion:

The matrix phase is the continuous phase in the composite. It may be a polymer, metal or ceramic. Among these polymer is consider to be best by its mechanical and thermal properties. It is low cost and easy fabrication hence it is economical.

3. Title: Researches on the development of new composite material partially biodegradable using natural textile fiber.

Journal: Hindawi publishing corporation Journal of Materials

Author: Mp Todor, Bueli C

Year: 2017

Description:

The paper says that by including biodegradability, composites have been in which the filler fibers are bio reinforcement, most often vegetable fibers. It has been studied that, these composites in addition to waste, by reducing their deposited quantity we can maintain or improve the properties of polymer matrix and they can be recycled more favorably.

Conclusion:

For the composite development a compression molding is used. The pineapple

leaf fiber is used as reinforcing phase and epoxy resin LY556 as matrix phase is used. A hardener HY951 is used for the composite development.

- 4. Title:** Preparation and mechanical properties of jute fiber reinforced epoxy composites

Journal: Industrial Engineering and Management

Author: Asheesh kumar and Anushman srivastava

Year: 2017

Description:

The article says that Natural fiber bundle, straight configuration shows linear behavior up to some portion of the curve and the becomes non-linear at higher loads.

Conclusion:

The modes of failure in case of composites are,

- By Tension
 - a. Breaking of fibers
 - b. Di-lamination of lamina
 - c. Di-bonding of fiber from matrix
 - d. Fiber pull out
- By Compression
 - a. Buckling of fiber
 - b. Crushing of matrix

- 5. Title:** Tensile, flexural and impact properties of glass fiber reinforced polymer matrix composites

Journal: International Journal of Mechanical Engineering and Technology (IJMET)

Author: Bino Prince Raja D, Stanly Jones Retnam B, Mohini Shuka

Year: 2017

Description:

This proposed that Mechanical properties of fiber reinforced composites are

depending upon the properties of the constituent materials type, quantity, fiber distribution and orientation.

Conclusion:

Recently the efforts to reduce the weight of automobiles by the increased use of plastics and their composites.

6. Title: Mechanical Properties Evaluation Of Sisal Fiber Reinforced Polymer Composites.

Journal: In construction and building material from science direct

Author: Naheed Saba, Chandrasekar Muthukumar, Rajini N

Year: 2017

Description:

Sisal fibers are obtained from sisal plant. Natural fibers has a number of advantages such as low density, bio-degrade ability, non-abrasive, non-toxicity which enable them to use as filler or reinforcement in the polymer composites. Adding in therm sets, thermoplastics and bio polymer improves mechanical strength. Some of the factors influencing their mechanical properties are,

- Type of fiber used
- Type of matrix used
- Fiber-matrix adhesion
- Fiber dispersion
- Fiber orientation

Conclusion:

The composites consists of a bulk material and a reinforcement of some kind, added primarily to increase the strength and stiffness of matrix. Thermal setting polymers are resins which change its reversibility into an infusible and insoluble material by formation of covalent cross-linked bond. Epoxy resins has certain limitation they are, Low transverse strength, Low operational temperature limits.

7. Title: Study on pineapple leaves fiber and its polymer based composites

Journal: International Research Journal of Engineering and Technology (IRJET)

Author: Yogesh M, Hari Rao A N

Year: 2015

Description:

This Review says that Pineapple leaf fiber has a major problem related to adhesion with many polymer matrices. PALF contains waxy substance on surface causing low surface tension which negatively affects the bonding polymer matrix.

Conclusion:

Modification methods like alkali treatment are done to improve the surface properties.

8. Title: Natural Fiber Reinforced Polymer Composite Material

Journal: IOSR journal of mechanical and civil engineering

Author: Tushar Sona, Shirish Patil

Year: 2015

Description:

The therm setting polymers are cross linked polymers, formed by condensation polymerization. These polymers become permanently hard when heat is applied and do not softened upon subsequent heating.

Conclusion:

The mechanical and physical properties of natural fiber depends on the chemical composition and structural composition, fiber type and growth condition. The properties of natural fibers are comparable to glass fibers due to their low density, the specific properties, strength and stiffness.

CHAPTER 3

PROBLEM IDENTIFICATION

All employees working in regions where there is a potential risk of head injury from sway, or from falling or flying items, or from electrical stun, will be ensured by safety helmets. Safety helmets must be worn when performing most development works, works in the region of lifting gear (cranes, lifts, and so forth.) and suspended burdens, works in ranger service, works in storage, wells, shafts, burrows, and so on. In these circumstances the utilization of a well being safety helmet will help secure against wounds to the scalp, skull and cervical vertebrae.

The fundamental demerits of safety helmet which are used at present are

- The weight of the safety helmet which is utilized as well being gear.
- The safety helmet is made of plastic or polymeric material
- The deformation of the plastic is exceptionally low.

Materials choose for the analysis

- i. Polypropylene
- ii. Polycarbonate
- iii. CFC composite

DEFORMATION:

S.NO	Loads in N	Polypropylene	Polycarbonate	CFC
1	500	6.285	6.33	0.0191
2	2000	25.142	12.678	0.3659

Table 3.1 Deformation

3.1 MERITS IN PROPOSED SYSTEM :

- Glass fiber composite
- Less weight and ability to withstand more burden.
- Thermal resistivity of the composite is high

Chapter 4

METHODOLOGY

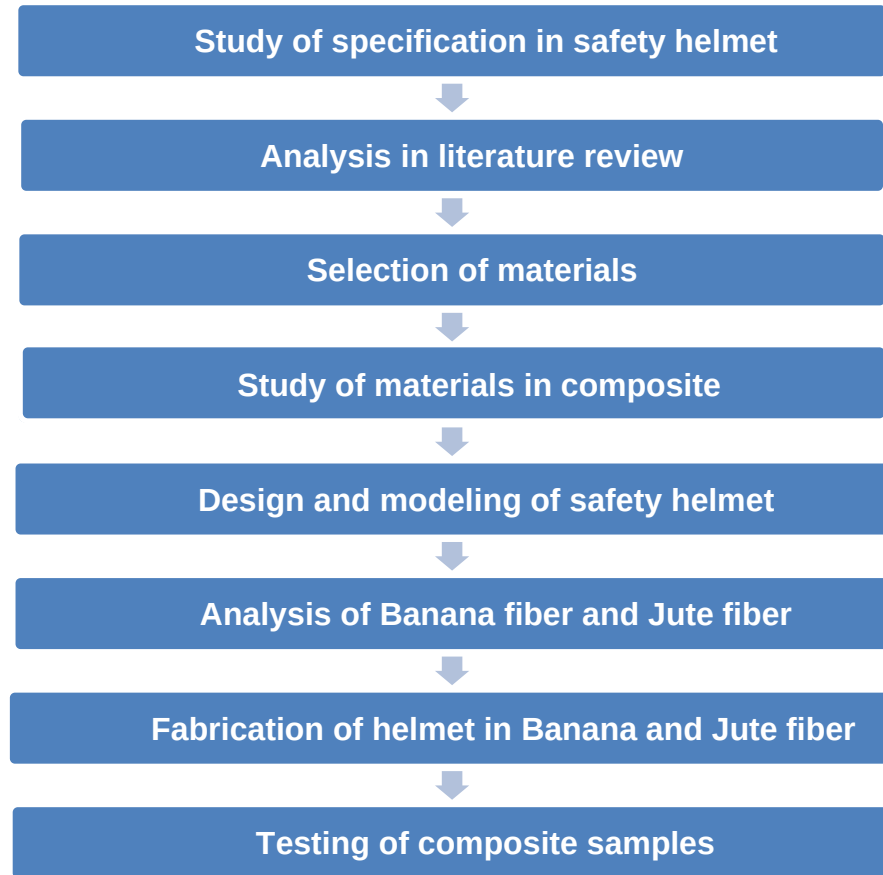


FIGURE 4.1: WORK FLOW

Fabricating composite parts can be done in a variety of ways. Many were produced in response to particular design or manufacturing challenges. The materials, the component nature, and the end-use or application will all influence the method chosen for a given part. They various techniques for fabricating composites are

- Spray Lay Up Method
- Vacuum Bag Technique
- Resin Transfer Moulding (RTM)
- Hand Lay UP Method

4.1. SPRAY LAY UP METHOD

The spray lay-up technique is an extension of the hand lay-up technique. A spray gun is used to spray pressurised resin and reinforcement in the form of chopped fibres in this technique. Glass roving is usually used as a reinforcement, passing through a spray gun before being chopped with a chopper gun. Matrix material and reinforcement may be sprayed at the same time or sequentially.

To make it easier to extract the part from the mould, a spray release gel is added to the mould surface. To extract air trapped in the lay-ups, a roller is rolled over the sprayed stuff. The commodity is cured at room temperature or at an elevated temperature after the fibre and resin have been sprayed to the desired thickness. The mould is opened after curing, and the formed composite component is removed and further processed.

The curing time is defined by the type of polymer used in composite manufacturing. Figure 2 depicts a diagram of the spray lay-up operation. Spray lay-up is used for lower-load-carrying sections such as small vessels, bath tubs, truck fairings, and so on. This method offers a high volume fraction of reinforcement in composites, and it has virtually no part size limitations. Lightly loaded structural panels, such as caravan bodies, truck fairings, bath tubes, small vessels, and so on, are examples.

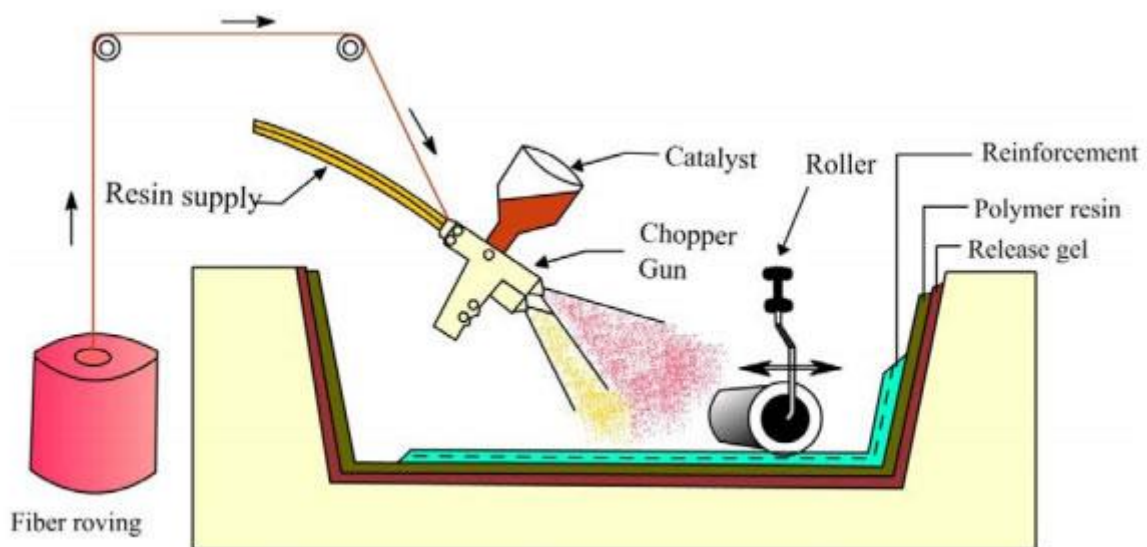


Fig 4.2. Spray Lay Up Method

4.2. VACUUM BAG TECHNIQUE

The vacuum-bag process was designed to manufacture a wide range of components, including large parts with complex shapes. Vacuum bagging does not have to be a difficult procedure. A simple vacuum bag construction would usually benefit a manufacturer who wants to increase a part's strength-to-weight ratio. The project may become more complicated as the process is refined or extended, or the procedure may become more advanced if larger parts are produced. Unfortunately, these intricate techniques seem to scare fabricators away from using this useful and efficient method of improving almost any hand laminate.

4.2.1. ADVANTAGES OF USING VACUUM BAGGING

Vacuum bagging is a method of applying mechanical pressure to a laminate during the curing process. This serves several purposes:

- Removes trapped air between laminate layers.
- Compacts the fibre layers for more efficient force-transmission among fibre bundles.
- Prevents shifting of fibre orientation throughout the curing process.
- Reduces humidity.
- Optimizes the fibre-to-resin ratio in the composite part(discussed in further detail later on).
- To compress layers with foam cores into complex and curved shapes, for example an aircraft wing profile.

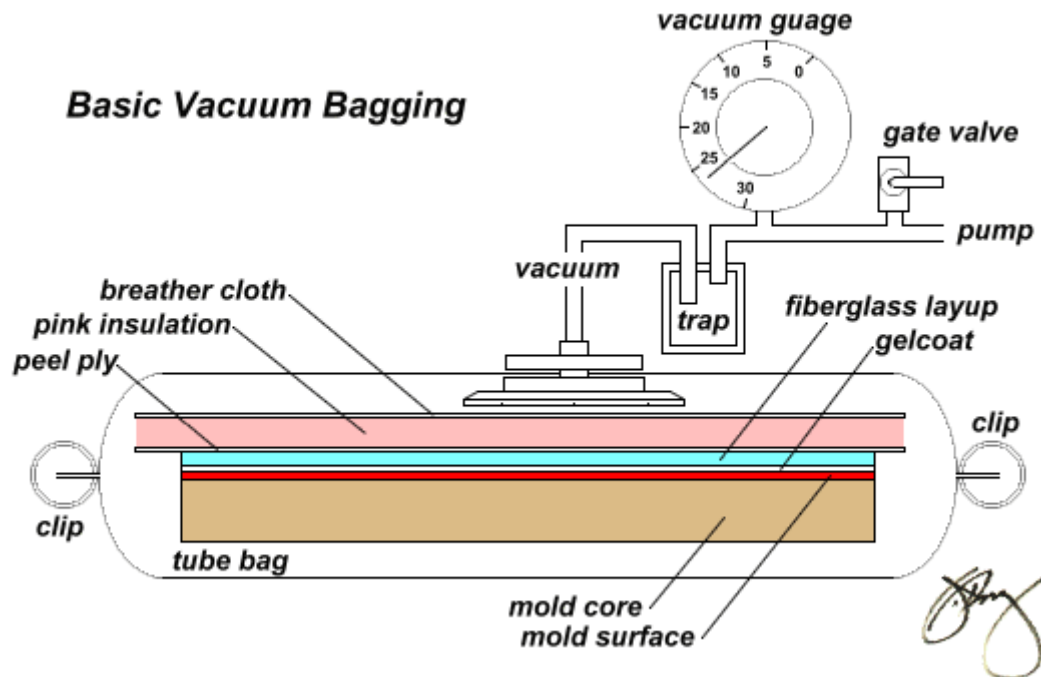


Fig 4.3. Vacuum Bag Technique

4.3. RESIN TRANSFER MOULDING

RTM is one of the most effective methods for producing composite parts in large quantities. It's also used to make parts with a lot of surface area, complicated forms, and smooth finishes. For these purposes, the resin transfer moulding process has been used in the automotive, industrial machinery, and agriculture industries for decades. Below is a step-by-step breakdown of the resin transfer moulding process and its benefits.

4.3.1. PROCEDURE FOR RESIN TRANSFER MOULDING

4.3.1.1. CREATING THE PERFORM

The perform, or contoured fibreglass reinforcement, is the matrix into which the resin will be injected. It is already in the shape of the finished product. The form of fibre must first be decided. RTM composites can be made from a range of fibre styles, ranging from random mats to two-dimensional woven.

4.3.1.2. PREFORM LAYUP

Once the preform or fiberglass reinforcement is created, it is packed into a mold cavity that has the shape of the desired part.

4.3.1.3. CLOSING MOLD

The mold cavity is then closed and clamped. The mold cavity allows for precise control over part thickness and allows for a smooth finish on both the A and B sides of the part. Gel coats may be used inside the mold to provide a high-quality, durable finish.

4.3.1.4. INJECTION PHASE

Catalyzed, low-viscosity resin is then pumped into the heated mold under pressure, displacing the air through vents , until the mold is filled. The injection phase must guarantee the complete impregnation of the preform. Bad impregnation of the fibers results in dry spot areas with missing adhesion between the layers.

4.3.1.5. CURING PHASE

After the injection phase, the curing cycle starts, and the resin polymerizes to become rigid plastic. Curing time varies and is dependent on the mold temperature and chemistry of the resin being used.

4.3.2. BENEFITS OF RESIN TRANSFER MOULDING

There are several benefits to using the resin transfer molding process over the alternative processes available. Some key benefits include:

- Good surface quality
- Wide range of reinforcements
- Large, complex shapes
- Dimensional tolerances
- Low capital investment
- Less material wastage
- Tooling flexibility
- Low environmental impact

- Labor savings
- Ability to add inserts and reinforcements at a point of infusion for greater strength
- Zero air entrapment within the product.

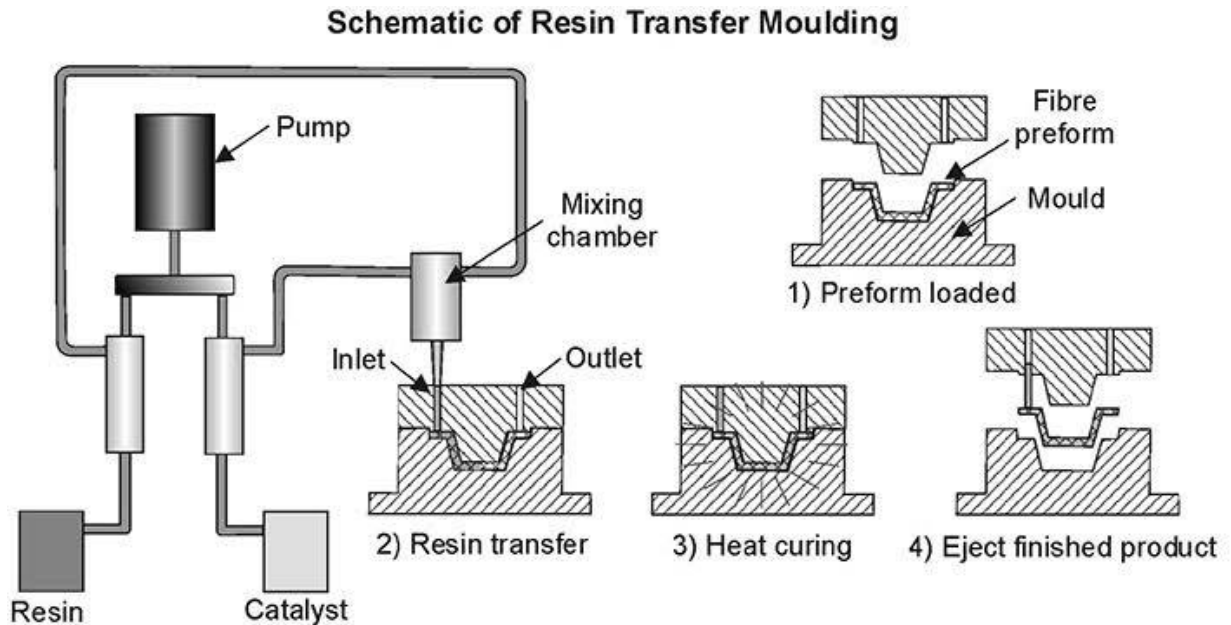


Fig 4.4. Resin Transfer Moulding

4.4. HAND LAY UP METHOD

In the reinforced fibre industry, hand lay-up is the most commonly used fabrication technique. It is usually used for limited runs, but it has also been successfully adapted for series production. It's a method of manufacturing that takes full advantage of two of resin's most significant properties: the ability to cure without heat and pressure. Since it needs the least amount of equipment, hand lay-up is the most popular and least costly process. Large and small objects, such as vessels, storage tanks, tubs, and showers, are made using this method.

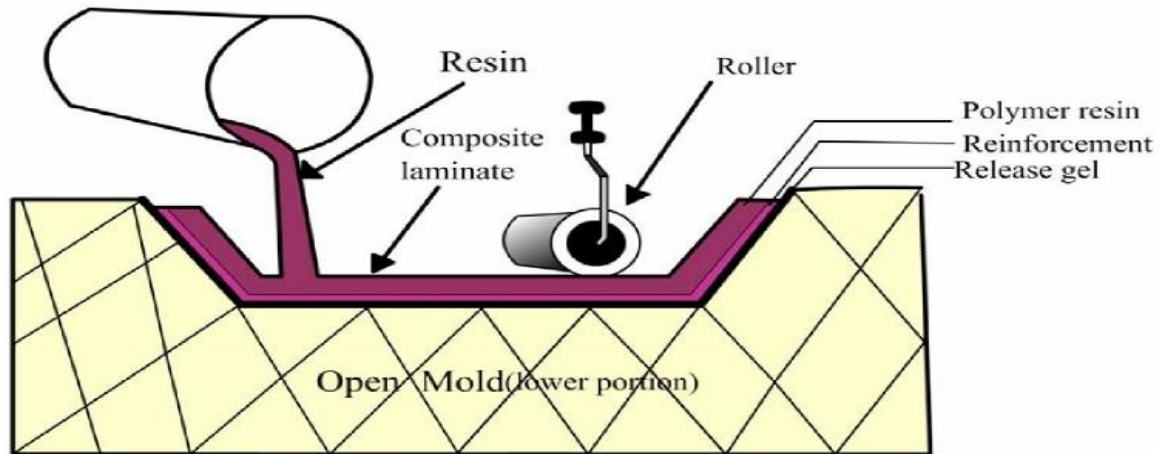


Fig. 4.5. Hand Lay Up Method

4.4.1. MATERIAL SELECTION

Reinforcement : Glass Fiber and Sisal Fiber

Matrix : Epoxy Resin LY556

Hardener : Methyl Ethyl Ketone Peroxide (MEKP)

BANANA FIBER

A banana is an edible fruit – botanically referred to as a berry – that is produced by a variety of large herbaceous flowering plants. Cooking bananas are often referred to as "plantains" in some countries, to differentiate them from dessert bananas.



Figure 4.6. Banana Fiber

PROPERTIES:

Properties	Banana fiber
Tenacity	28.58 g/denier
Fineness	18
Elongation(%)	6.54
Cellulose(%)	63-64
Micro febrile angle	11
Hemi cellulose(%)	6-19
Alco-ben Extractives(%)	2.50
Lignin(%)	5-10
Moisture content(%)	10-11
Density(Kg/m ³)	1350
Lumen Size (mm)	5
Tensile strength (MPa)	529-914
Young's modulus (Gpa)	27-32
Failure strain(%)	1-4

Table 4.1: Properties of Banana fiber

Advantages:

- Banana fiber possesses good specific strength properties comparable to those of conventional materials like glass fibers.
- Banana Material has lower density than glass fiber.
- Alkali treatments have been proven effective in removing impurities from the fiber, decreasing moisture sorption and enabling mechanical bonding and thereby improving matrix reinforcement interaction.

JUTE FIBER:

Jute is one of the most cost-effective natural fibres, second only to cotton in terms of volume and range of applications. Jute is a long, soft, lustrous vegetable fibre that can be spun into solid, coarse threads. Due to its durability, jute is the second most essential vegetable fibre after cotton. Advantages of jute include good

insulating and anti static properties, as well as having low thermal conductivity and a moderate moisture regain.



Figure 4.7. Jute Fiber

Properties:

Properties	Jute Fibre
Tenacity	3-5 gm/den
Elongation(%)	2.5
Cellulose(%)	64.4
Hemi-cellulose(%)	12
Lignin(%)	11.8
Pectin(%)	0.2
Specific Gravity	1.5
Waxes	0.5
Moisture content(%)	1.1
Fibers Length	5-12 ft
Density(g/cm ³)	1.46
Fibre length(mm)	0.8-6
Diameter of fibre	5-25
Tensile strength(Mpa)	393-773
Young's modulus	13-26.5
Micro-fibrillar angle	8.0
Price(EUR/kg)	0.3

Table 4.2: Properties of Jute fiber

Advantages:

- Unbreakable, maintenance free, durable
- Fire retardant and water resistant
- UV, acid and alkali resistant
- Less abrasive
- Less costly
- Low thermal conductivity

Fibre Type	Dia (μm)	Length(mm)	Aspect Ratio (i/d)	Bulk Density (kg/m³)	Moisture regain (%)	Source
Banana	-----	2-4	----	1300-1350	60	4
Jute	16-21	1.7-3	157	1300-1550	17	5

Table 4.3: Physical properties of Banana and Jute

Fiber Type	Tensile strength (Mpa)	Specific Tensile strength (Mpa)	Young's Modulus (Gpa)	Specific Young's Modulus (Gpa)	Failure Strain (%)	Source
Banana	529-914	390-675	25-30	20-25	1-4	3
Jute	200-450	140-320	20-55	15-39	2-4	7

Table 4.4: Mechanical properties of Banana and Jute

4.5. CHEMICAL TREATMENTS FOR NATURAL FIBER

Alkaline treatment, Silane treatment, Acetylation, Benzoylation, Acrylation & Acrylonitrile Grafting Coupling agents, Isocyanate treatment, Permanganate treatment, Peroxide treatment, Sodium Chlorite treatment, and so on are examples of chemical treatments/processing for natural fibre. Only two chemical

treatments on fibre were used in this analysis, namely:

- Alkaline Treatment
- Permanganate treatment

4.5.1 Alkaline Treatment

As natural fibres are used to strengthen thermoplastics and thermo sets, alkaline treatment, also known as mercerization, is one of the most effective chemical treatments. This procedure reveals the short length crystallites by removing a small amount of lignin, wax, and oil from the fibre cell wall's external surface. The disruption of hydrogen bonding in the network structure, which increases surface roughness, is the most significant modification caused by alkaline treatment. The treatment causes the highly packed crystalline cellulose order to amorphize, resulting in an amorphous area. Alkaline treatment has been shown to have two effects on fibre:

- a. It improves mechanical interlocking by increasing surface roughness.
- b. It increases the amount of cellulose exposed on the fibre surface, resulting in a greater number of potential combinations.

Fibers were cut to 260 mm in length and soaked in a 5 percent aqueous NaOH solution at room temperature for 12 hours, maintaining a liquor ratio of 15: 1 for proper cellulose depolymerisation, lignin elimination, and improved jute fibre strength. The fibres were then washed with fresh water several times to remove any NaOH that had adhered to the fibre surface. The treated fibres were carefully spread on the mat and then air-dried after being neutralised with dilute acetic acid and then washed again with distilled water.

4.5.2 Permanganate treatment

Permanganate is a compound containing the MnO_4 permanganate group. Via the formation of MnO_3 ions, permanganate treatment results in the formation of cellulose radical. The alkaline-treated jute fibres were dipped for minutes in a 50 percent permanganate acetone solution with a liquor ratio of 15:1 in this analysis. Fibers were spread on a mat and dried at 40 °C for 5 hours to eliminate excess solvent and moisture before being air-dried. The hydrophilic propensity of the jute fibre was reduced as a result of permanganate treatment, and thus the water content of the JFRP composite decreased.

EPOXY RESIN AND HARDNER

Epoxy resin refers to a type of reactive pre-polymer and polymer containing epoxied groups. These resins react either with themselves in the presence of catalysts, or with many co-reactants like amines, phenol, etc. The properties of the reinforcement are generally related to the mechanical performance of composite materials. The matrix materials are also important, as is the case with therm setting resin matrix composites, which can be customised for specific applications by changing the matrix polymer. By altering the manufacturing conditions as well as the form and amount of chemical hardener used, the mechanical, physical, and chemical properties of the polymer matrix can be customised. Epoxy's versatility and versatility made it ideal for a number of industrial applications, including laminated circuit boards, electronic part encapsulations, surface coatings, potting, fibre reinforcement, and adhesives. Epoxy's drawbacks can be solved by integrating and changing it before it is used in industry. Epoxy resin outperforms other types of resins in terms of shrinkage during cure and moisture and chemical resistance. It has a long shelf life and is impact resistant. It also has excellent electrical and insulating properties. The different epoxy resin and reinforcing combinations have a broader range of properties in molded parts. Epoxy resin is different from polyester resins with regard to curing. It is cured by a curing agent called "hardener" rather than a catalyst.



FIGURE 4.8. EPOXY RESIN

Because of their superior mechanical, thermal, and electrical properties, modified epoxy resins are now widely used in the manufacturing of natural fiber-reinforced composites and the manufacture of various industrial products. Epoxy

resin is used in a wide range of industrial applications. It outperforms other types of resin in terms of mechanical properties, as well as thermal and chemical resistance. As a consequence, it is only used in the manufacturing of aircraft parts. Poly-peroxides is another name for epoxy resin. Epoxy resin is a type of resin with tough mechanical properties, excellent chemical resistance, and high adhesive strength, making it ideal for a wide range of applications. Epoxy resin's uses are:

- Metal coatings
- Use in electronic and electrical components
- Electrical insulators
- Fiber-reinforced plastic materials
- Structural adhesives

4.6 COMPUTER AIDED DESIGN OF SAFETY HELMET

4.6.1 SOLID WORKS

Solid Works is a Parametric solid-based strong modeler, and uses a parametric element based way to deal with make models and congregations. Boundaries allude to limitations whose qualities decide the shape or math of the model or get together. Boundaries can be either numeric boundaries, for example, line lengths or circle distances across, or mathematical boundaries, for example, digression, equal, concentric, flat or vertical, and so on. Numeric boundaries can be related with one another using relations, which permits them to catch plan goal. Plan aim is the way the maker of the part needs it to react to changes and updates. For instance, you would need the gap at the head of a helmet can to remain at the top surface, paying little mind to the tallness or size of the can. Solid Works permits the client to indicate that the gap is an element on the top surface, and will at that point honor their plan goal regardless of what stature they later allocate to the can. Highlights allude to the structure squares of the part. They are the shapes and tasks that develop the part. Shape-based highlights regularly start with a 2D or 3D sketch of shapes, for example, managers, openings, spaces, and so forth. This shape is then expelled or sliced to include or eliminate material from the part. Activity based highlights are not sketch-based, and incorporate highlights, for example, fillets, chamfer, shells, applying draft to the essences of a section, and so forth. Building a model in Solid Works as a rule begins with a 2D sketch (in spite of the fact that 3D portrays are accessible for power clients). The sketch comprises of math, for example, focuses, lines, curves, conics (aside from the hyperbola), and splines. Measurements are added to the sketch to characterize the size and area of the calculation. Relations are utilized to characterize ascribes, for example, juncture, parallelism, opposite, and concentric section

4.6.2 2D DRAWING OF SAFETY HELMET

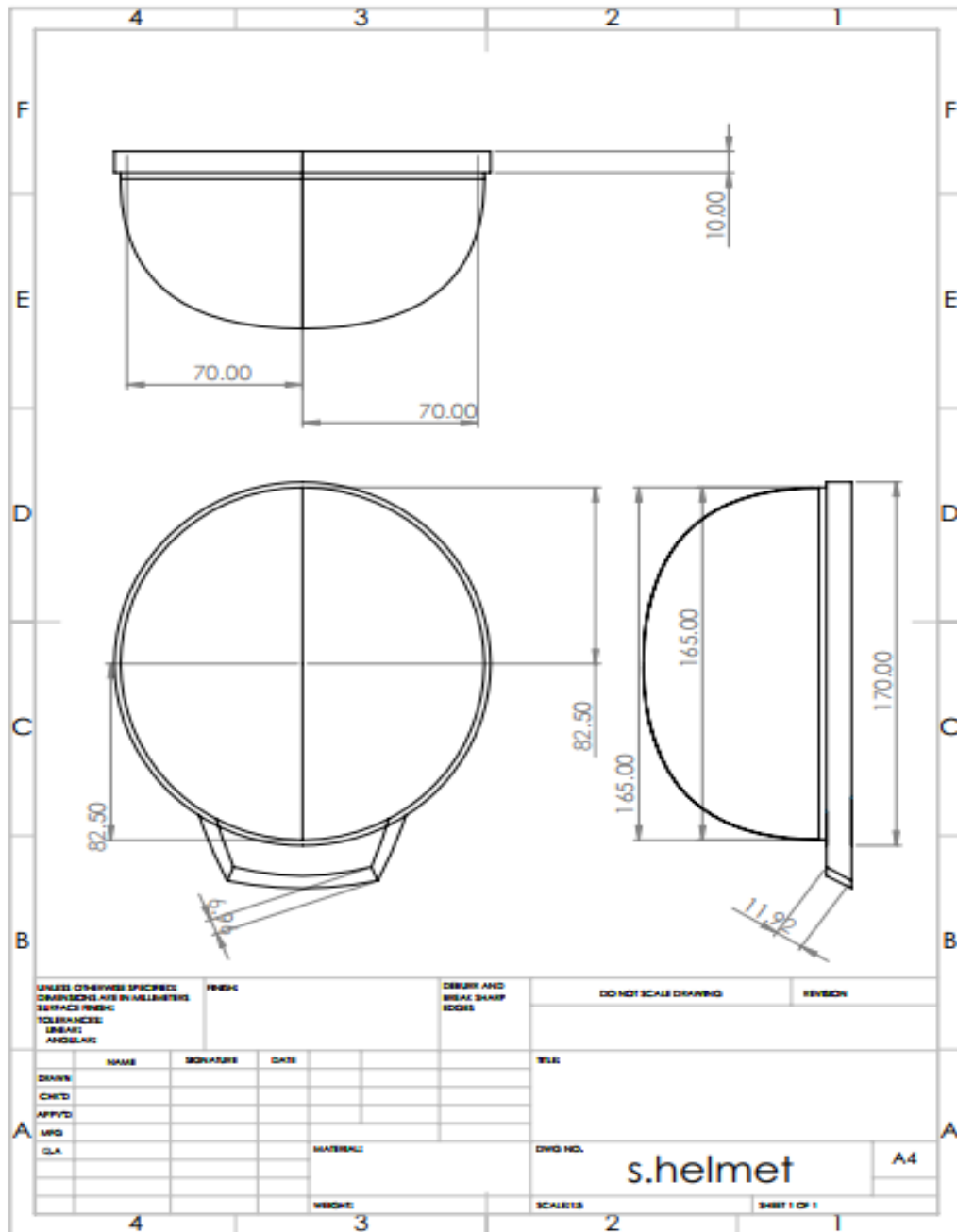


Figure 4.9: Drafting of helmet

4.6.3: SOLID WORKS MODELING

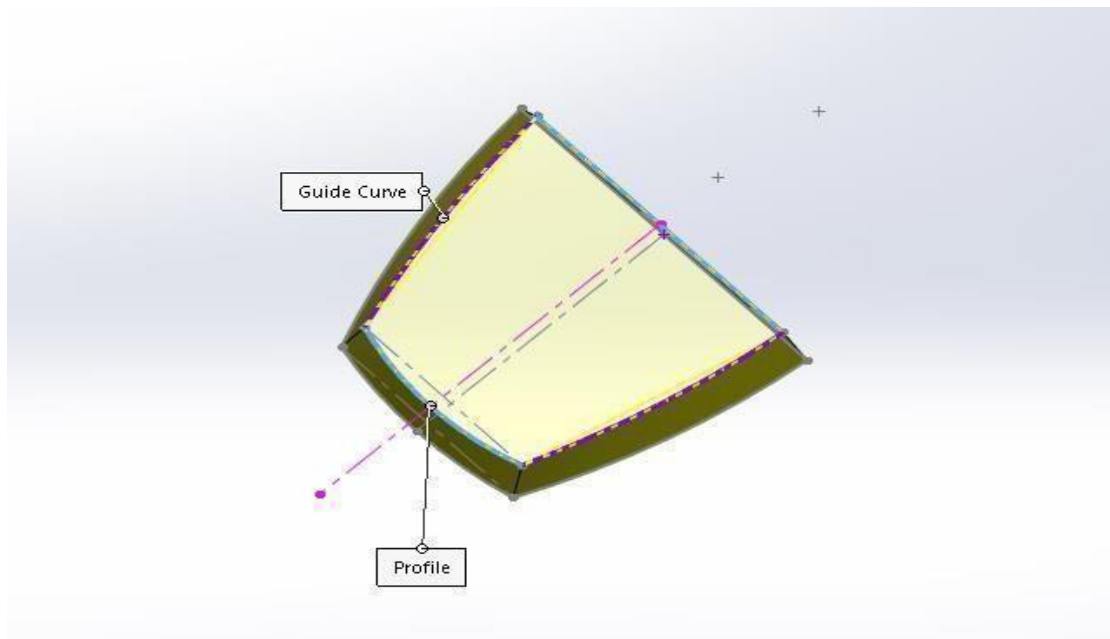


Figure 4.10: Front cap

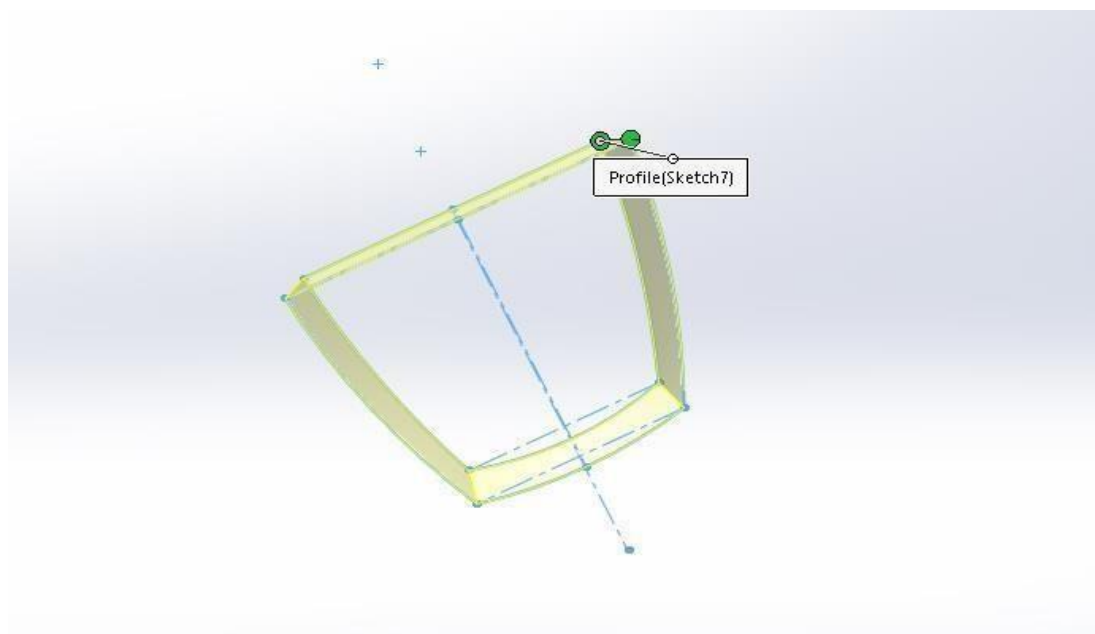


Figure 4.11 : Shell in front cap

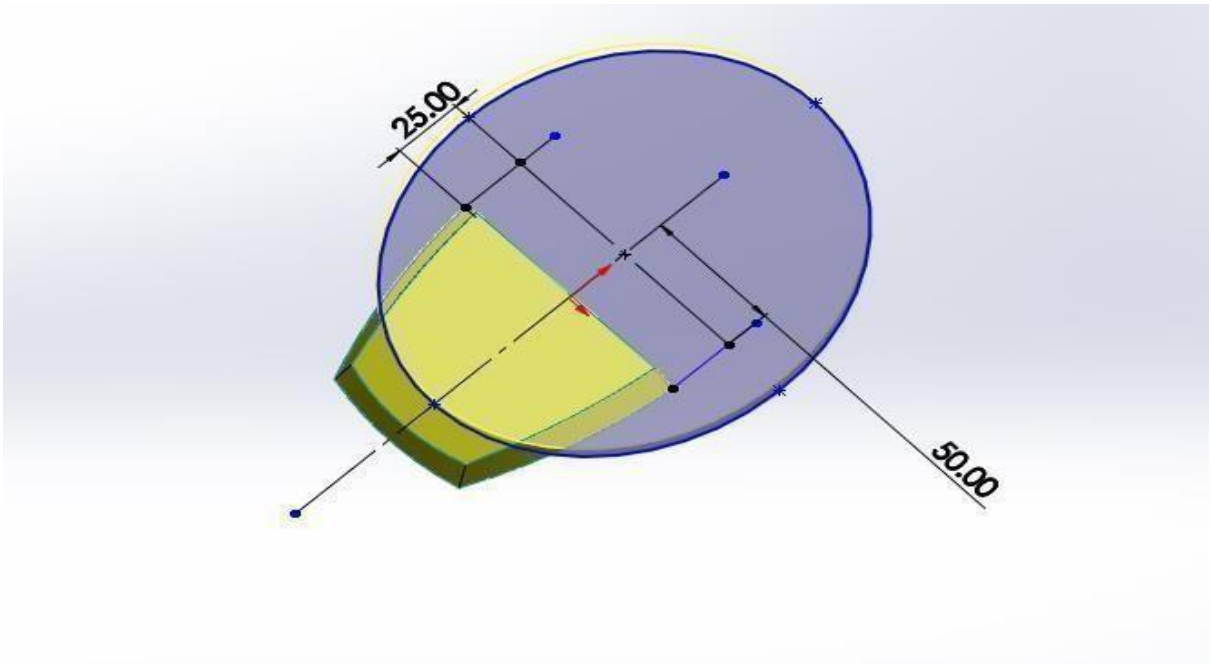


Figure 4.12: Head part in composite

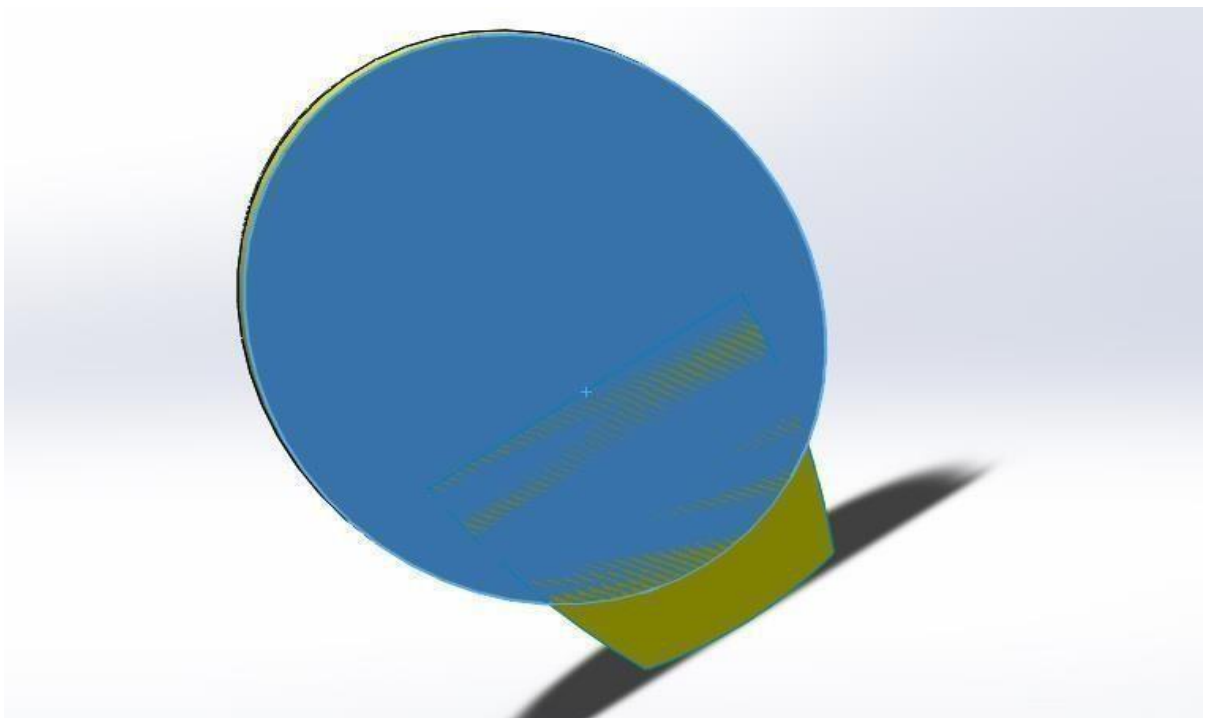


Figure 4.13 : Extruded head part

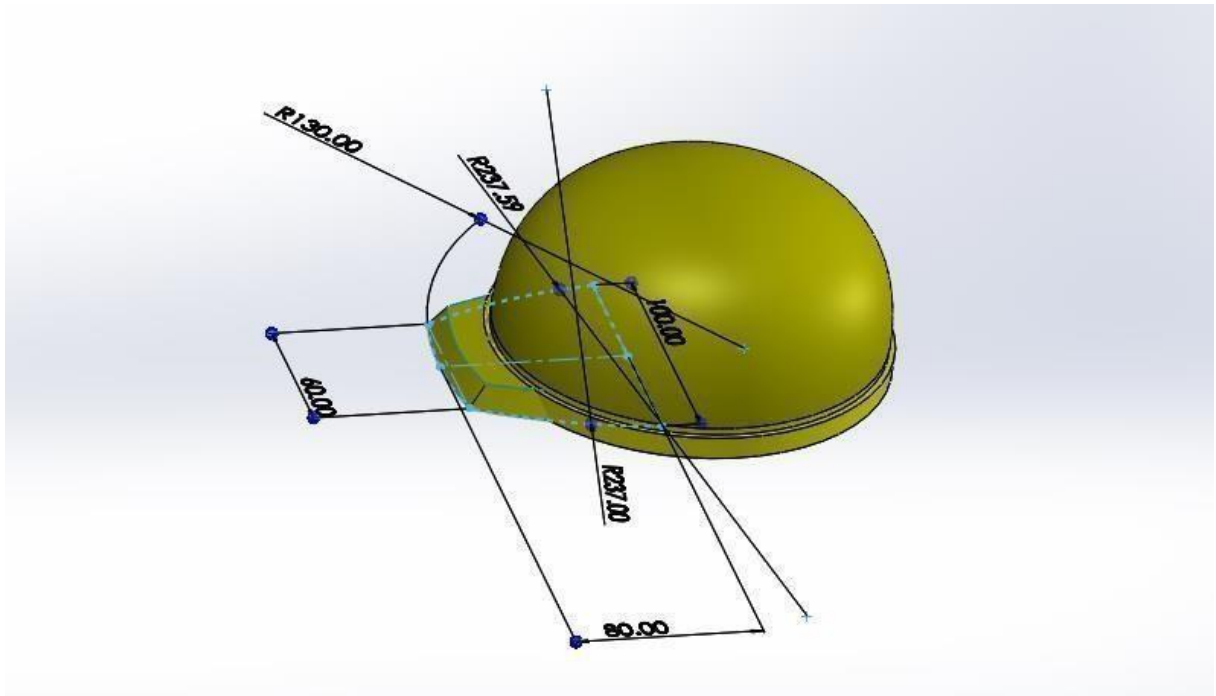


Figure 4.14: Front cap fillet

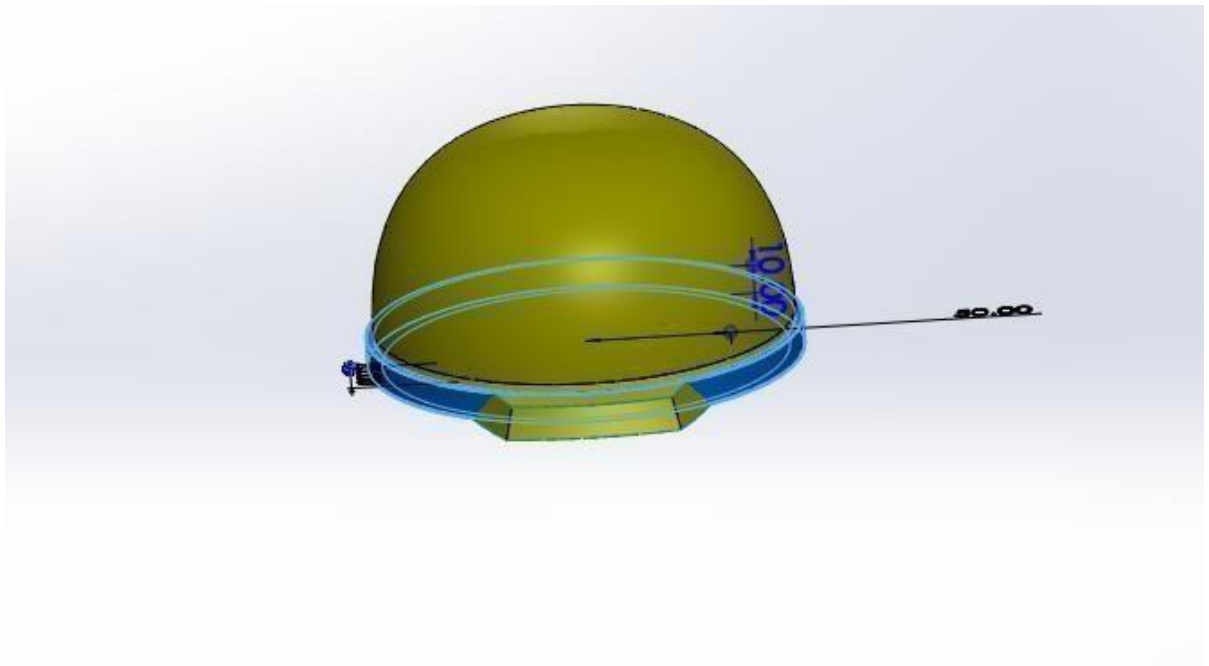


Figure 4.15: Side extrude cut

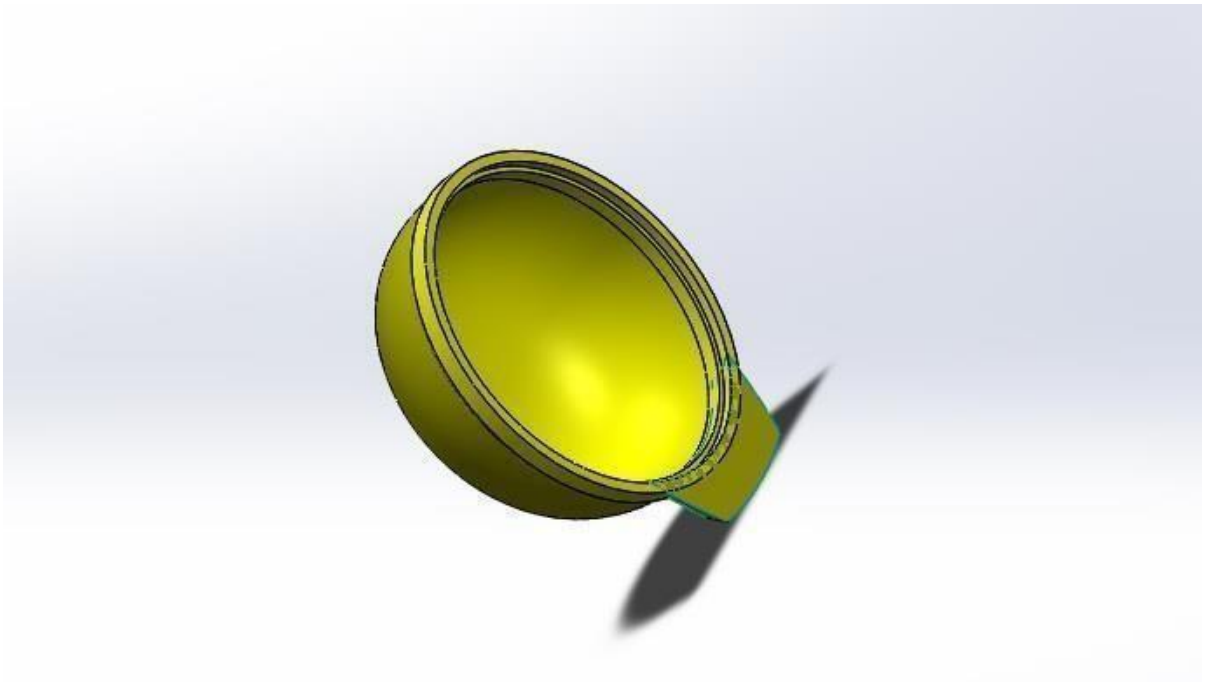


Figure 4.16: Bottom view

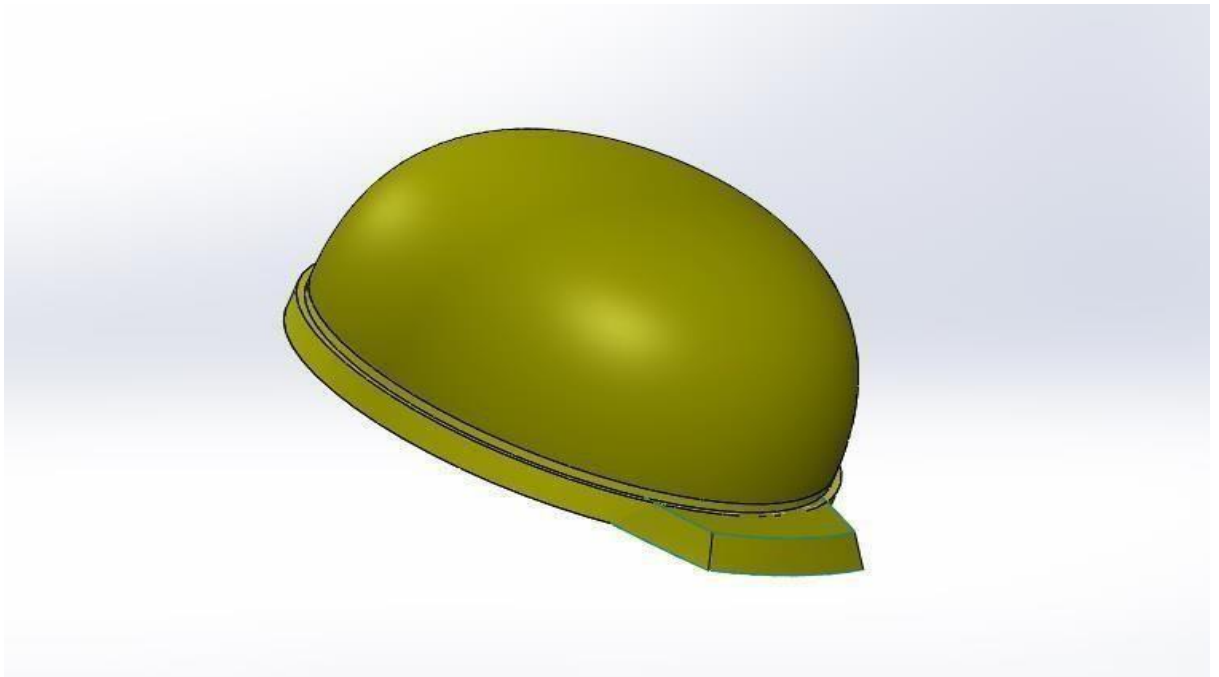


Figure 4.17: Front view

4.7. ANALYSIS OF SAFETY HELMET IN ANSYS

ANSYS creates and sells engineering modelling software that can be used during the product life cycle. For analysing resilience, durability, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes, ANSYS Mechanical finite element analysis software is used to simulate computer models of structures, electronics, or system components. ANSYS is used to assess how a product can perform under various conditions without the need to develop test products or conduct crash tests. For example, ANSYS software can be used to simulate how a bridge would hold up over time, how to better process salmon in a cannery to eliminate waste, or how to build a slide that uses less material. without sacrificing safety.

The ANSYS Workbench system, which is one of the company's main products, is used for the majority of ANSYS simulations. Larger structures are usually broken down into small components that are each modelled and evaluated separately using ANSYS. A user may begin by specifying an object's dimensions, then add weight, pressure, temperature, and other physical properties. Finally, over time, the ANSYS programme simulates and analyses movement, fatigue, fractures, fluid flow, temperature distribution, electromagnetic performance, and other effects.

4.7.1 MESHING

Complex geometries are decomposed into basic elements that can be used as discrete local approximations of the larger domain in simulation. The mesh has an effect on the simulation's precision, convergence, and pace.

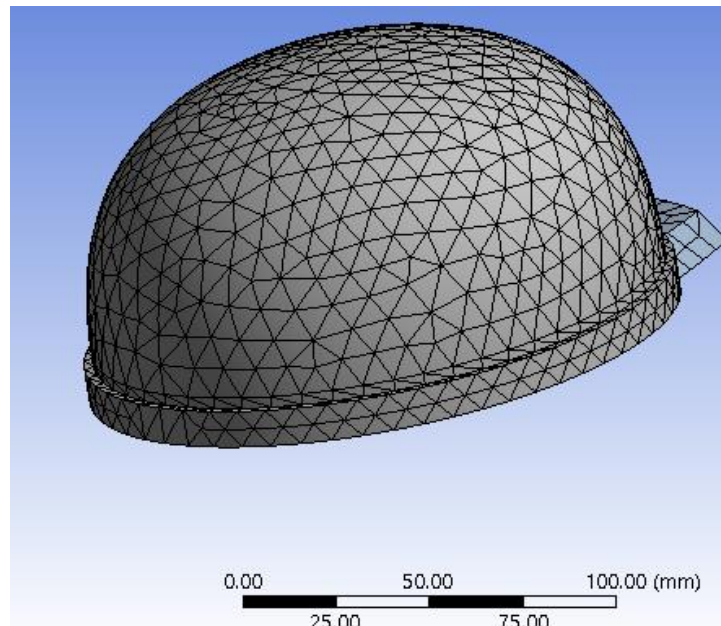


Figure 4.18: Meshing view

Object Name	Mesh
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	Mechanical
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Use Fixed Size Function For Sheets	No
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Fast
Span Angle Center	Coarse
Curvature Normal Angle	Default (30.0)
Min Size	Default (1.70040 mm)
Max Face Size	Default (8.50190 mm)
Max Size	Default (8.50190 mm)
Growth Rate	Default

Table 4.5: Sizing

4.7.2 STATIC STRUCTURAL

The determination of the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects

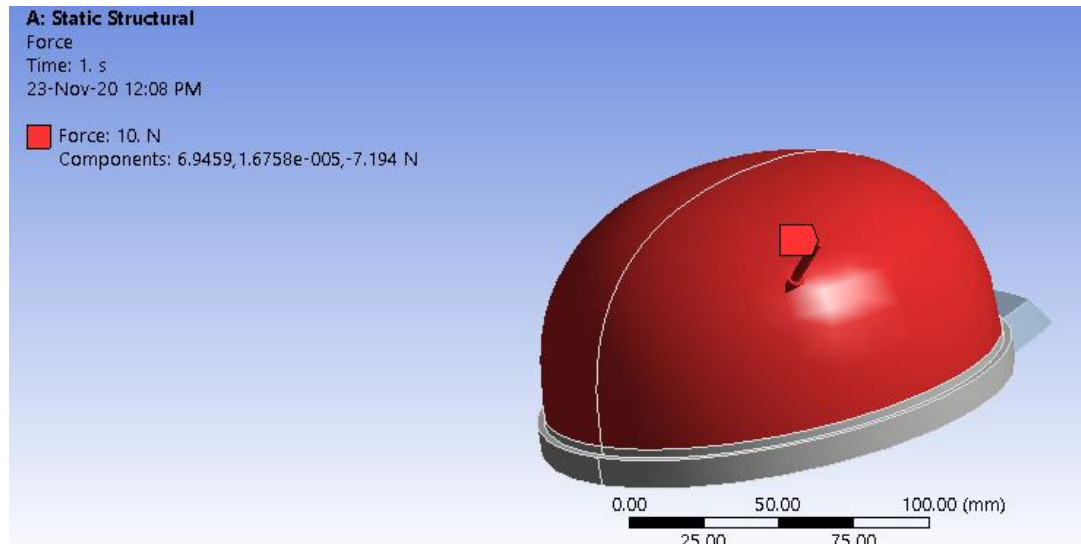


Figure 4.19: Force acting

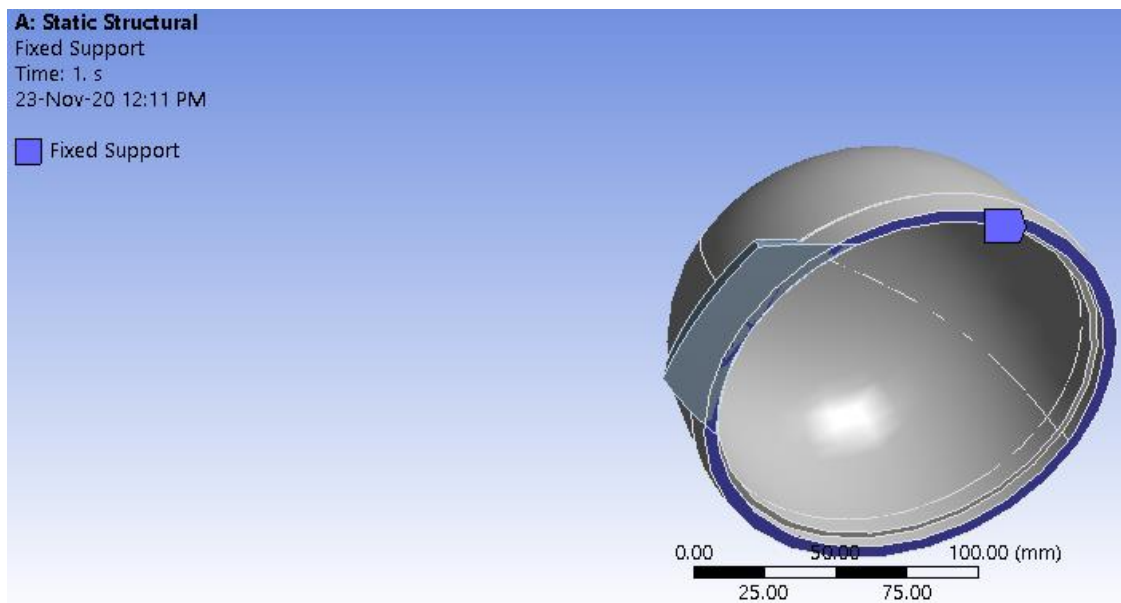


Figure 4.20: Fixed support

4.7.3 Total deformation

Directional deformation can be put as the displacement of the system in a particular axis or user defined direction. Total deformation is the vector sum all directional displacements of the systems.

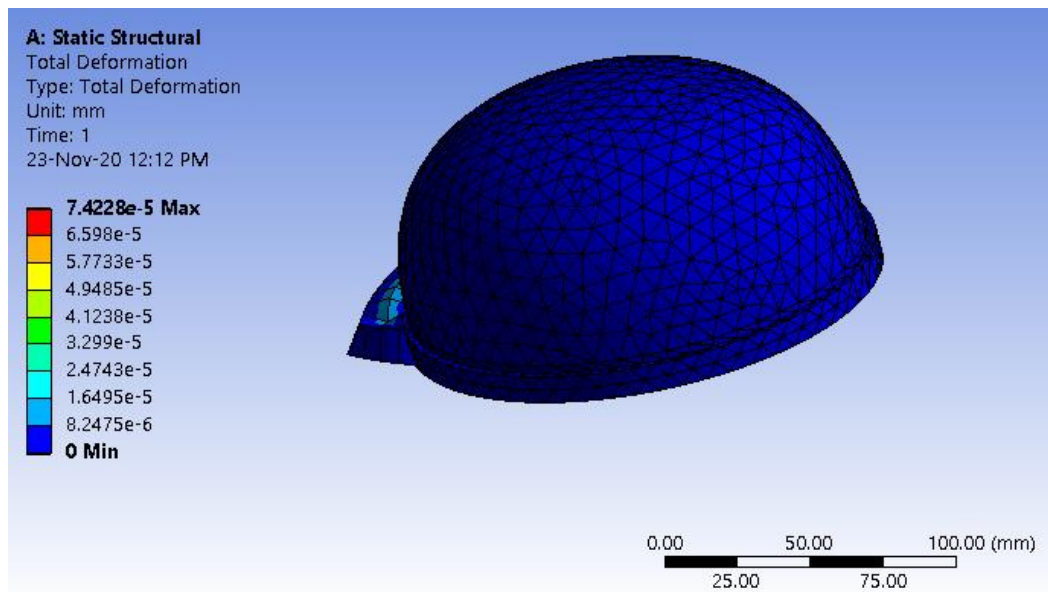


Figure 4.21: Total deformation

4.7.4 Stress and strain induced

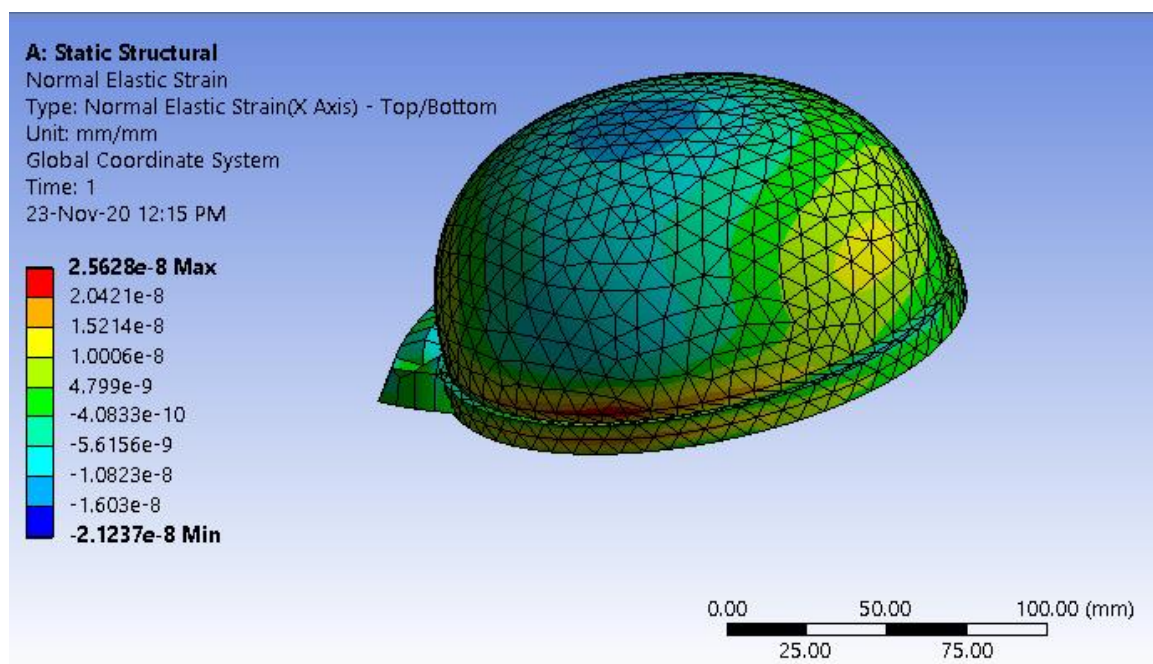


Figure 4.22: Elastic Strain

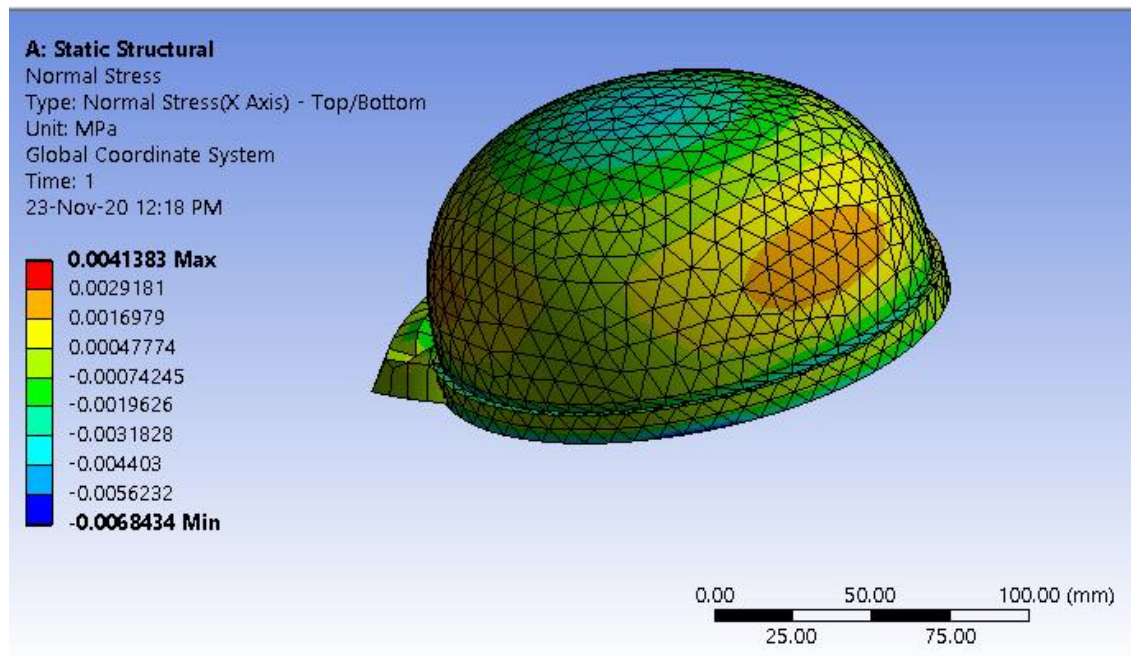


Figure 4.23: Normal Stress

Results:

Minimum	0. mm	-2.1237e-009 mm/mm	-6.8434e- 004MPa
Maximum	7.4228e-006 mm	2.5628e-009 mm/mm	4.1383e- 004MPa

Table 4.6-Result of analysis

4.8 PROCEDURE FOR FABRICATION OF THE COMPOSITE USING HAND LAY UP METHOD

4.8.1. PREPARATION OF MOULD

Remove any dust and dirt from mold. If mold is of plaster, wood, or new fiberglass, apply soft wax and buff with soft towel. Spray or brush with Poly Vinyl Alcohol(PVA) solution, parting compound and allow to dry. If mold material is glass, metal, ceramic, or well-cured fiberglass, apply three coats of hard wax, buffing between each coat.

4.8.2. APPLYING THE GEL-COAT

Enable the first coat of gel-coat to cure before applying the second coat to ensure there are no light spots. Spray up to a thickness of .015" to .020" with a gel-coat gun if using a gel-coat gun. Proceed to the next stage after the gel-coat has cured long enough that your fingernail cannot easily scratch it free (test at edge of mould where damage will not appear on part).

4.8.3. PREPARATION OF RESIN

The epoxy resin is taken in a beaker. The hardener is added to the resin at 10:1 ratio and it is stirred with mechanical stirrer for 15mins in order to remove the entrapped air in the resin.

4.8.4. LAY-UP SKIN COAT

Apply the glass fibre mat after brushing catalysed resin over the gel-coat. Working with the roller, apply more resin as needed until all white areas in the mat fibres have vanished and all air bubbles have been expelled. Resin-rich areas deteriorate the component. Brushes must be used where rollers cannot reach. Clean all tools in acetone once this step is done. Allow the skin coat to cure before moving on to the next stage.

4.8.5. LAYING SISAL REINFORCEMENT

After first layer of glass fiber mat apply the sisal fiber. Add resin to this layer and use roller to remove air bubbles. Further continue this process with alternate layers of sisal fiber. This process must be continued for five layers of fiber. Apply each layer as in step 3, but it will not be necessary to wait for curing between these layers. Finally a layer of glass fiber placed and resin is applied over them.

4.8.6. CURING

Depending on the temperature and nature of the component, curing can take anywhere from 24 to 48 hours. Longer cure time in a female mould affects shrinkage and makes parting easier. The portion comes off more quickly in the male mould until it shrinks significantly. A longer cure can be needed if the part is prone to warping. In any case, the component should be supported in its ideal

shape until it is completely healed when it is removed.

4.8.7. REMOVE PART FROM MOLD

To begin, inspect the trim edge all the way around the mould to ensure there is no resin bridging the mold-to-part line. If required, sand this side. Then, to begin the separation, wooden wedges, such as "tongue sticks," can be forced into the edges. Pull and flex to keep the separation going. In certain situations, a small hole in the mould must be drilled and air or water pressure applied.

4.8.8. SURFACE FINISH

Trim edges and back of part may need to be fine-sanded and coated with surfacing resin.

FABRICATION:



Figure 4.24: RECTANGULAR PIECE OF
MOULD SAMPLE 1



Figure 4.25: RECTANGULAR PIECE OF
MOULD SAMPLE 2



Figure 4.26: FRONT VIEW OF HELMET



Figure 4.27: SIDE VIEW OF HELMET

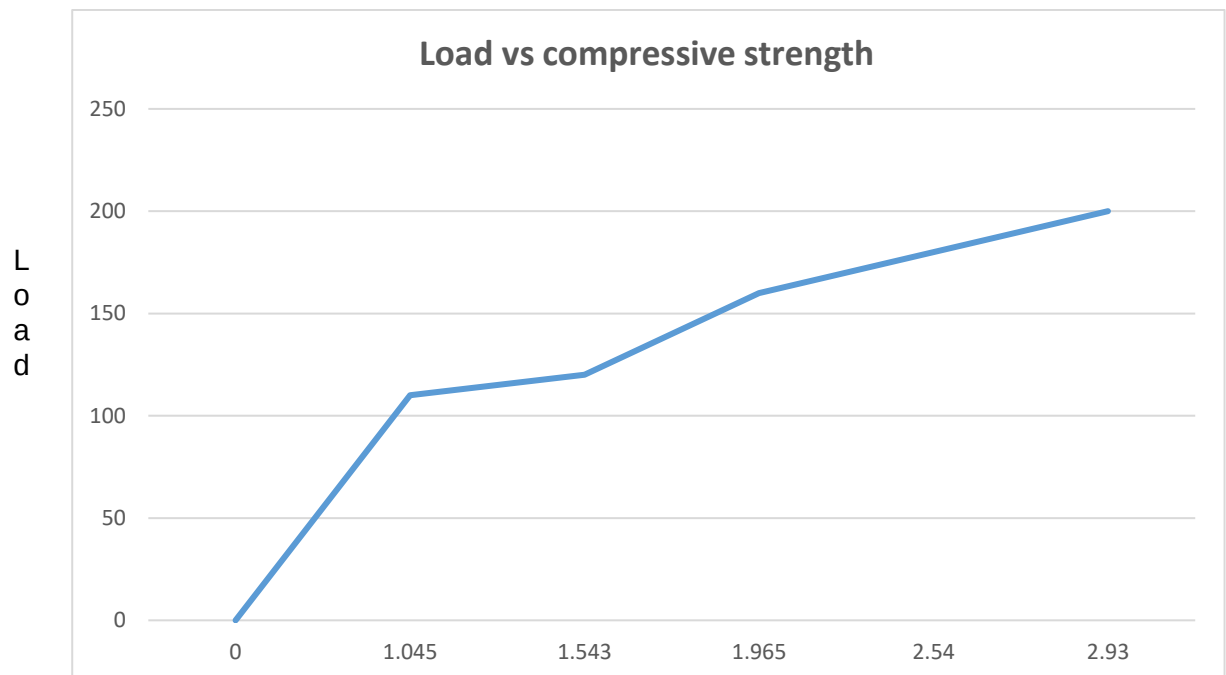
CHAPTER 5

RESULT AND DISCUSSION

Sample 1- 80%banana 20%jute

Compression test

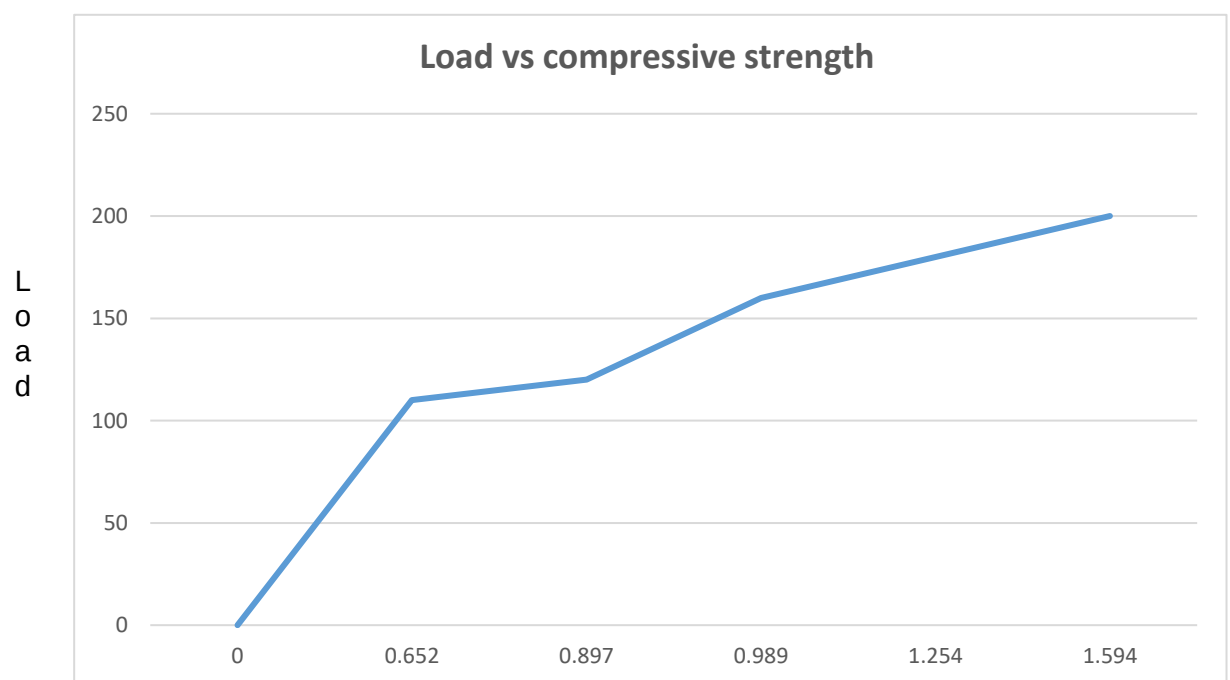
S.no	Peak Load (N)	Compressive Strength(N/mm ²)
1	0	0
2	110	1.045
3	120	1.543
4	160	1.965
5	180	2.54
6	200	2.93



Sample 2-90% banana 10% jute

Compression test

S.no	Peak Load (N)	Compressive Strength(N/mm2)
1	0	0
2	110	0.652
3	120	0.897
4	160	0.989
5	180	1.254
6	200	1.594



Tensile test

Sample 1

Sample no	Peak Load (N)	Tensile Strength(N/mm ²)
1	250	1.65

Sample 2

Sample no	Peak Load (N)	Tensile Strength(N/mm ²)
1	250	1.24

TEST REPORT:



धातुकर्मीय प्रयोग शाला / METALLURGICAL LABORATORY
आयुधनिर्माणी, मेदक / ORDNANCE FACTORY MEDAK
एदुमैलारम-502 205 / YEDDUMAILARAM - 502 205



ISO:9001-2000
ISO:14001-2004

NO: OFMK/ML-11/20-21

DATE: 08.03.2021

Report No: 389

ULR-TC546721000000133F

TEST REPORT

Test requisition No. : 21, Dtd: 06.03.2021

Description/ Size : Bio composite laminated samples, Size: 80(L) x 50(W) x 4.15(T) mm

Specification/ Grade : Bio composite fiber material

Test method: ASTM D790

Mode of test: Impact test.

Sample type: Flat

Test Results:

Batch No	Impact Energy (KJ/m)
Sample-I	14.7
Sample -II	13.5
Sample-III	15.2

Remarks:

1. Above results relate to samples received at lab
2. Samples will be retained for a period of six months from the date of issue of this report unless demanded back by the client.
3. This report shall not be re produced without written approval from the laboratory except in full.
4. Date of test is between the date of receipt of indent & report.

Authorized Signatory

D. CHANDRA RAO
Jr. Works Manager
Govt of India Ministry of Defence
Ordnance Factory Medak
Yeddumailaram - 502 205

CHAPTER 6

CONCLUSION & SCOPE OF FURTHER WORK

This experimental investigation of mechanical properties of hybrid composite in safety helmet utilizing glass and sisal fiber, also epoxy composites uses in lightweight applications of automobile industries and aerodynamic industries. The work shows that successful creation of a hybrid composites is conceivable by basic hand lay-up method. It has been seen that the mechanical properties of the composites, for example, tensile strength, flexural strength, impact strength and shear strength of the composites show great outcomes. Contrasted with the previous works our hybrid composites gives the more noteworthy shear stress applications. It's likewise represents that great effect quality. Furthermore, it is less brittle contrasted with the other kind of composites. Our project shows the combination of hybrid fiber gives the best mechanical properties compared to either of these lone composites.

A significant test in manufacturing Composite material is the absence of fiber-grid portrayal discernment. For the utilization of FRPC s in assortment of fields, understanding their constituent's critical material properties is important, with the fundamental builds and the accessibility of assembling innovation. For instance, for the creation of nano composites, one ought to secure nanotechnology, including all the necessary devices and hardware. Likewise, the decision of assembling measure in the long run influences the last properties of material. Creation volume impacts the expense—the higher the volume of creation, the less would be the expense of materials. Expanding creation volume, on account of the car business, prompts more serious danger of putting resources into crude materials while setting up assembling set-up as per the creation rate and process duration. Additionally the plan multifaceted nature of the item expands the process duration, hindering the creation rate. Developing interest of superior composites for aviation and basic applications glorified the utilization of oil based materials, leaving issue of composite garbage removal. Nonetheless, these days, various specialists are creating different bio composites utilizing normal strands and bio-based polymers,yet not these are totally bio degradable.

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