Design and Analysis of Industrial Safety Helmet using Natural Fibers

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Abstract-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 increase the injury risk for the user's head and neck. Every year many workers are killed or seriously injured in the construction industry as a result of head injuries. Wearing an appropriate safety helmet significantly reduces the risk of injury or even death. Protective headwear could save your life. The aim of the project is to increase the strength of industrial helmet by making the modify material in existing one.Here natural fiber and epoxy resin are used as raw material to fabricate the helmet. In this project, the helmet model is analyzed using Creo simulate 2.0 software to test whether the helmet can withstand high impact load or not and compared the results of both the natural fiber helmet and polypropylene helmet.

Keywords- Natural fiber, Epoxy Resin, Creo Simulate2.0

I.INTRODUCTION

Natural fiber composites mostly consists fibres of jute, cotton, hemp and non-conventional fibers such as coir and many empty fruit bunches. Natural fiber thermoplastic composites are attractive as they are cheaper, stiffer, paintable, rot-resistant and also can be given the look of wood in addition to all this they have more life- cycle.. These composites are gaining importance due to their non-carcinogenic and bio-degradable nature. Natural fiber composites are very cost effective material especially in building and construction purpose packaging, automobile and railway coach interiors and storage devices. These can be potential candidates for replacement of high cost glass fiber for low load bearing applications. Coir is a natural fiber extracted from the husk of Coconut fruit. The husk consists of Coir fiber and a corky tissue called pith. It is a fiber abundantly available in India the second highest in the world after Philippines. It consists of water, fibers and small amounts of soluble solids. Because of the high lignin content coir is more durable when compared to other natural fibers. With increasing emphasis on fuel efficiency, natural fibers such as coir based composites enjoying wider applications in automobiles and railway coaches & buses for public transport system. There exist an excellent opportunity in fabricating coir based composites towards a wide array of applications in building and construction such boards and blocks as reconstituted wood, flooring tiles etc. Value added novel applications of natural fibers and coir based composites would not go in a long way in improving the quality of life of people engaged in coir cultivation, but would also ensure international market for cheaper substitution. Natural fibers have the advantages of low density, low cost and biodegradability.
However, the main disadvantages of natural fibers and matrix and the relative high moisture absorption. Therefore, chemical treatments are considered in modifying the fiber surface properties.

II.MATERIALS USED

Raw materials to be used in safety helmet are

a. Coconut Fiber
b. Banana Fiber
c. Epoxy Resin
A. Coconut Fiber:-
Coconut palms are mainly obtained from tropical regions of the world and the product form the coconut are applied in food and non-food products, which sustain the livelihood of people all over the world. The coconut palm comprises of a white meat which has a total percent by weight of 12 and 35 respectively . The husk from the coconut palm comprises 30% weight of fiber and 70% weight of pith material. The fiber are extracted from the husk by several methods such as retting, which is a traditional way, decorations, using bacteria and fungi, mechanical and chemical process, for the production pf building and packaging material, ropes and yarns, brushes and padding of mattresses and so on.

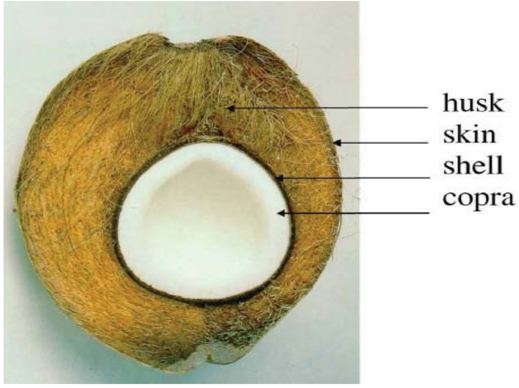

Figure 1.Coconut Fiber

Table 2.Chemical Composition of Coconut Fiber

Sr.No	Chemical composition	Percentage
1	Hemi-cellulose	31.1
2	Cellulose	33.2
3	Lignin	20.5

Table 2. Coconut Fiber properties

COCONUT FIBRE PROPERTIES	
Density (kg/m^3)	1288
Tensile strength (M pa)	3-13
Young’s modulus (G pa)	4-6
Poison ratio	0.3

B. Banana Fiber:-
Banana fiber, a lingo-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a best fiber with relatively good mechanical properties. The ‘‘pseudo-stem’’ is a clustered, cylindrical aggregation of leaf stalk bases. Banana fiber at present is a waste product of banana cultivation and either not properly utilized or partially done so. The extraction of fiber from the pseudo stem is not a common practice and much of the stem is not used for production of fibers. This is reflected from the relatively expensive price of banana fibers when compared to other natural fibres. The buyers for banana fibers are erratic and there is no systematic way to extract the fibres regularly. Useful applications of such fibers would regularize the demand which would be reflected in a fall of the prices.

Table3.Composition of Banana fiber

Sr. No	Constituents	Percentage
1.	Cellulose	31.27
2.	Lignin	15.07
3.	Moisture	9.74
4.	Ashes	8.65

Table 4. Banana fiber properties

BANANA FIBRE PROPERTIES	
Density (kg/m^3)	1101
Tensile strength (M pa)	22-26
Young's modulus (G pa)	7.7-20
Poison ratio	0.3

C. Epoxy Resin:-

The Epoxy resin acts as a binder for the reinforcement while controlling the physical shape and dimensions of the part. Its primary purpose however is to transfer the load, or stress, applied to the part to the reinforcement. The matrix also protects the reinforcement from adverse environmental effects. The reinforcement's function is to enhance the mechanical properties of the composite and is typically the main load bearing element. Reinforcements are usually in the form of either fibers or particles. Matrix and reinforcement materials can be polymers, metals, ceramics, or carbon.

III.DESIGN OF INDUSTRIAL SAFETY HELMET

A. Dimensions of the Helmet according to BS EN 397:1995:-

Table 5.Dimensions of the helmet according to BS EN 397:1995

Sr.No	Parts	Dimensions
1	External vertical distance	not more than 80 mm.
2	Internal vertical distance	not more than 50 mm
3	Horizontal distance	not less than 5 mm.
4	Wearing height	80 mm for helmets mounted on head form
5	Cradle	width shall be not less than 15 mm
6	Chin strap	not less than 10 mm

B. Pro-E model of the Industrial safety helmet:-

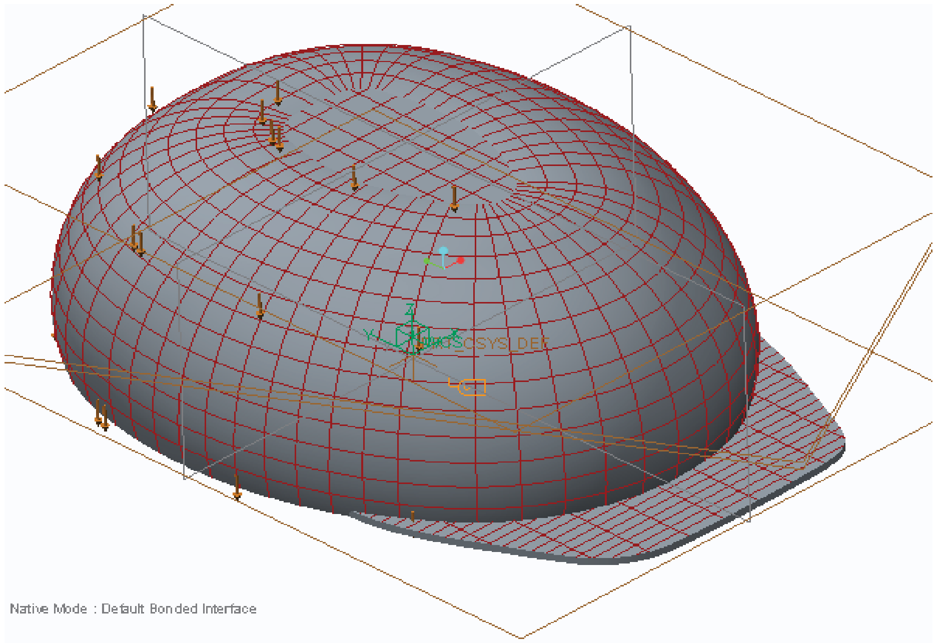

Figure 2.Pro-E model of the Industrial safety helmet

C. *Detailed diagram of the Industrial safety helmet:-*

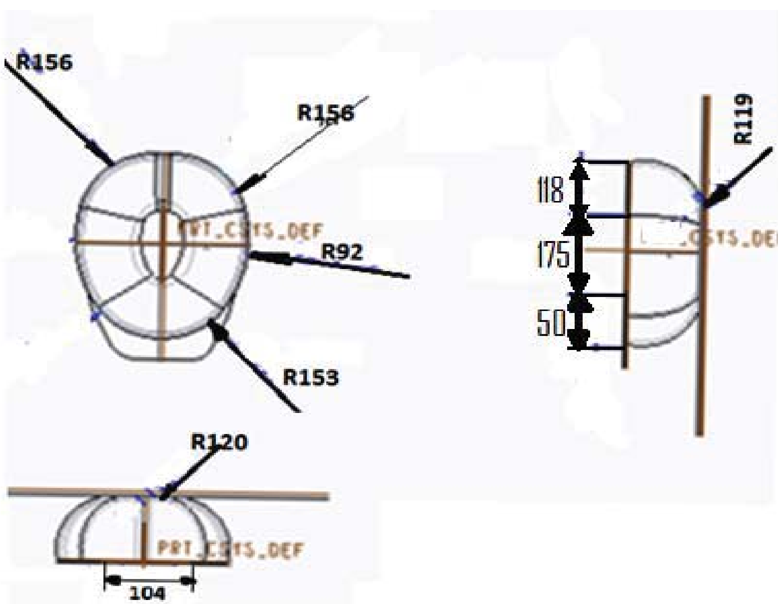

Figure 3.Detailed diagram of the industrial safety helmet

IV.ANALYZING THE INDUSTRIAL SAFETY HELMET

A. Properties of material:-

Table 6.Properties of material

MATERIALS	PROPERTIES			
	Density (kg/m^3)	Tensile strength (M pa)	Young's modulus (G pa)	Poison ratio
Polypropylene	1140	55-83	1.2-2.9	0.4
Coconut fiber	1288	3-13	4.0-6.0	0.3
Banana fiber	1101	22-26	7.7-20.0	0.3

B. VON-MISSES Stress Analysis and Displacement analysis for the Industrial Safety Helmet made of Polypropylene:-

The properties of the polypropylene are given as input to Analyze the designed model of the helmet. The output of the model is obtained. Von-misses stress and displacement of the designed model is obtained.

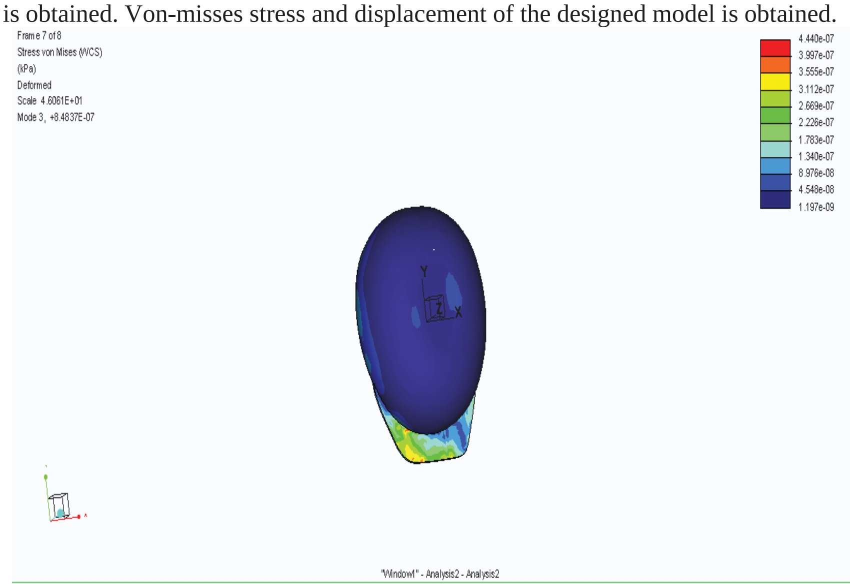

Figure 4. VON-MISSES Stress Analysis of Polypropylene Helmet

Maximum von-misses stress =4.4 e^{-7}kPa

Minimum von-misses stress =1.197e^{-9}kPa

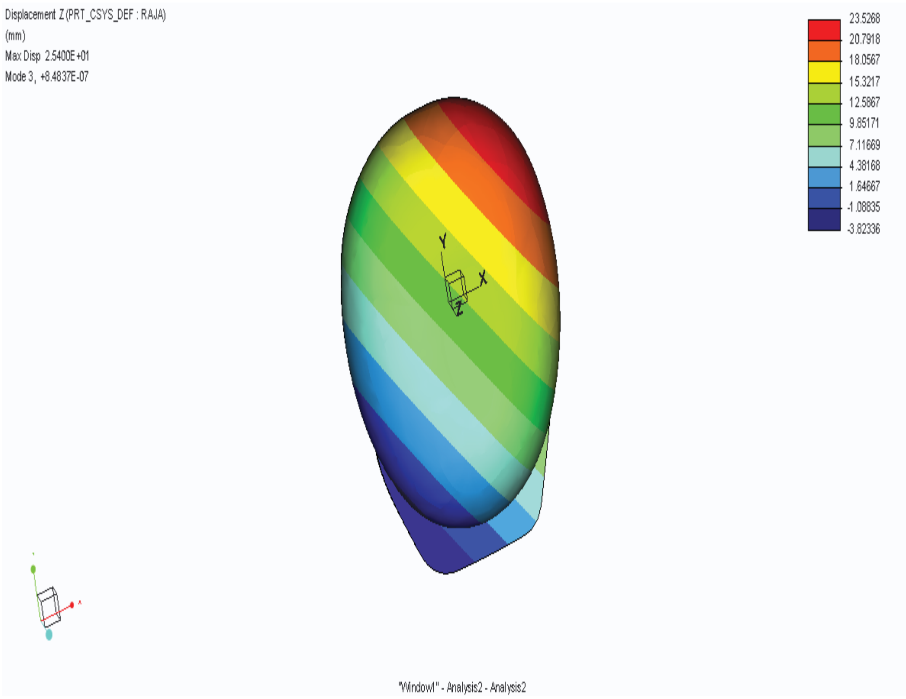

Figure 5. Displacement Analysis of Polypropylene Helmet

Maximum Displacement =23.5268mm
Minimum Displacement =1.64667mm

C. VON-MISSES Stress Analysis for the Industrial Safety Helmet made of Natural Fiber:-
The properties of the banana and coconut fiber are given as input to Analyze the designed model of the helmet. The output of the model is obtained

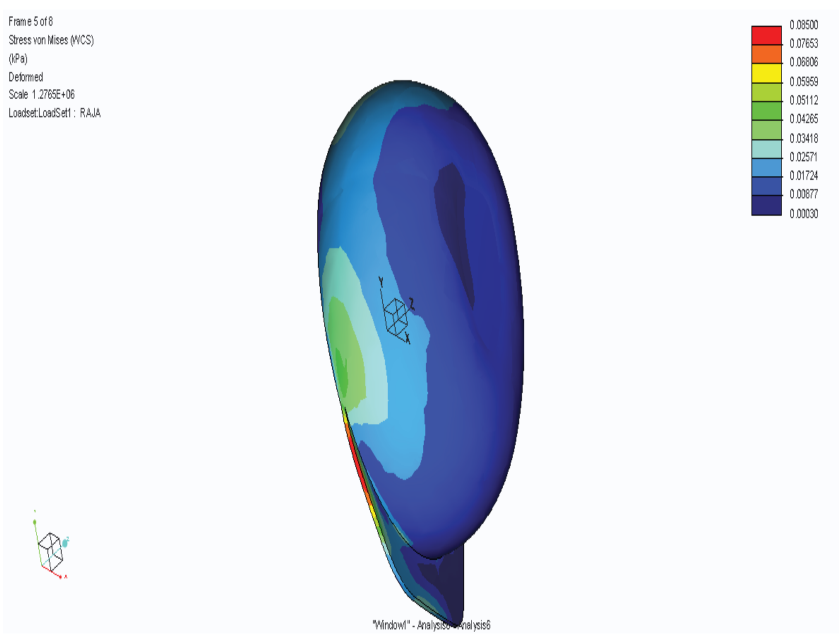

Figure 6. VON-MISSES Stress Analysis of Natural Fiber Industrial safety Helmet

Maximum von-misses stress =0.085kPa
Minimum von-misses stress =0.00030kPa

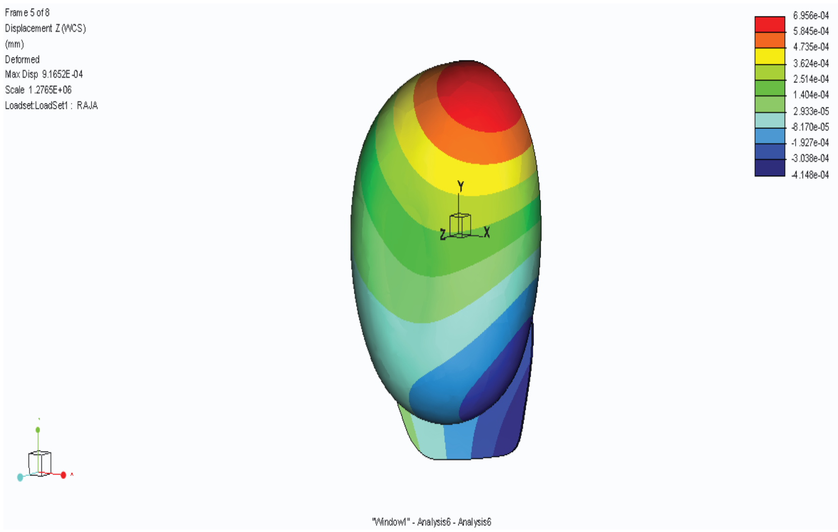

Figure 7. Displacement analysis of Natural Fiber

Maximum Displacement =6.89 e^{-2}mm
Minimum Displacement =4.148e^{-2}mm

D. Comparing the Analysed results of Natural Fiber Helmet and Polypropylene Helmet :-

Table 7. Comparison of two results

Helmet materials	Properties	
	Von misses stress (k Pa)	Displacement (mm)
Polypropylene (existed material)	4.4e^{-7}	23.42
Natural fiber	0.08248	6.89 e^{-2}

V. CONCLUSION

The Results of the natural fiber helmet and polypropylene helmet are determined using the Pro-E software.

- Displacement in the polypropylene helmet shows less displacement and natural fiber shows greater displacement.
- Natural Fiber Helmet has greater Stress capability than the Polypropylene Helmet.

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