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PINEAPPLE LEAF FIBER REINFORCED POLYMER COMPOSITE AS A REPLACEMENT FOR ABS PLASTICS IN INDUSTRIAL SAFETY HELMET SHELL - A REVIEW

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ABSTRACT:

Industrial safety helmet provides head protection to industrial workers. Workers have a lot of problems by using industrial safety helmet there are thermal discomfort, heavy weight, and plastic material. Now a day's plastic is the major problem for global warming. In industrial safety helmet majorly acrylonitrile-butadiene-styrene plastic is used. Composite materials have recently becomes attractive to scientists, researchers and engineers. In composite materials there are two types of fiber are used for reinforcement. There are synthetic and natural fibers. In this paper we reviewed 30 papers published between 2000 to 2014 in this journals categorized according to types of natural fibers, properties of natural fibers, utilization of pineapple leaf fiber, design and analysis of industrial safety helmet, methodology and fabrication method of industrial safety helmet by using pineapple leaf fiber by hand layup method and to analysis the mechanical testing procedure.

KEY WORDS: *HELMET, GLOBAL WARMING, COMPOSITE MATERIAL, NATURAL FIBER, MECHANICAL TEST.*

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1. INTRODUCTION:

1.1 Overview of composite material:

A composite material is defined as a material system which consists of a mixture or a combination of two or more distinctly differing materials which are insoluble in each other and differ in form or chemical composition. The constituents are combined in such a way that they keep their individual physical phases and are not soluble in each other or not to form a new chemical compound. Many combinations of materials are known as composite materials. In another words a combination of two or more materials (reinforcement, filler, resin, etc..,) differing in form or composition on a macro scale. The constituents retain their identities, i.e., they act in concert. Normally the components can be physically identified and exhibit an interface between each other. The different type of fiber is natural (plant, animal, mineral) and manmade fiber for different application.

EXAMPLE: concrete, mortar, reinforced rubbers, concrete reinforced with steel rebar, granite consisting of quartz, mica and feldspar, conventional multi-phase alloys, mud wall with bamboo shoots, wood.

The composite materials are usually classified by type of reinforcement such as polymer, composites, cements and metal-matrix composite. Polymer matrix composite are mostly commercially produced composites in which resin is used as matrix with different reinforcing materials. [1],[2].

1.2 Overview of natural fiber:

Natural fibers are mainly price driven commodity composites. That provides usable structural properties at a relatively low cost. By using of natural fiber have many advantages such as being desired from the renewable resource they required low energy input in their manufacturer. Now a day's natural fibers as reinforcement in technical applications it mainly used in automobile and packing industries. The natural fiber composites offer many benefits such as corrosion resistance, high strength, light weight, water resistance, high durability, electrical resistance, chemical resistance, fire resistance. If the natural fibers have some difficulties there are high moisture absorption, low thermal resistance and highly anisotropic properties. [3],[4].

1.3 Over view of industrial safety helmet:

Personal protective equipment (PPE) work regulations 1992 place responsibilities on employers to implement certain basic health and safety. PPE can be defined as all equipment which is intended to be worn or held by a person at work and which protects against one or more risks to their health or safety.

As per the Indian standard industrial safety helmet have a major role to provide head protection against small falling objects striking the top of the shell in industrial environments. All helmets attempt to protect the users head by absorbing impact or other mechanical energy and protecting against penetration. Most of the helmets are made from abs plastic or resin which may be reinforced with fiber aramids.

The major issues in this helmet are energy absorption capacity, volume, weight, thermal discomfort, itching and material (plastic). [5], [6]

2. LITERATURE REVIEW

(A) Natural fibers:

Ticoalu et al (2010) focused on current development in natural fiber composite. In this paper natural fiber is classified in to following types there are sisal, hemp, bamboo, coconut, flax, kenaf, jute and ramie. The source of the fiber is bast, leaf, seed, core, grass and reed. They will analysis natural fiber composite could emerge as a new alternative engineering material which can substitute the use of synthetic fiber composite. All natural composites are which are composites made of natural fiber and biodegradable resins are an important development that shows feasibility not only for non load bearing construction elements but also structural element. In this paper conclude that the natural fiber composite offer good environmental benefits.

Akil et al (2011) analysed the natural fiber and its types. In this paper have the some common type of natural fiber is vegetable (cellulose or lingnocelluiose), animal (protein), mineral fibers.

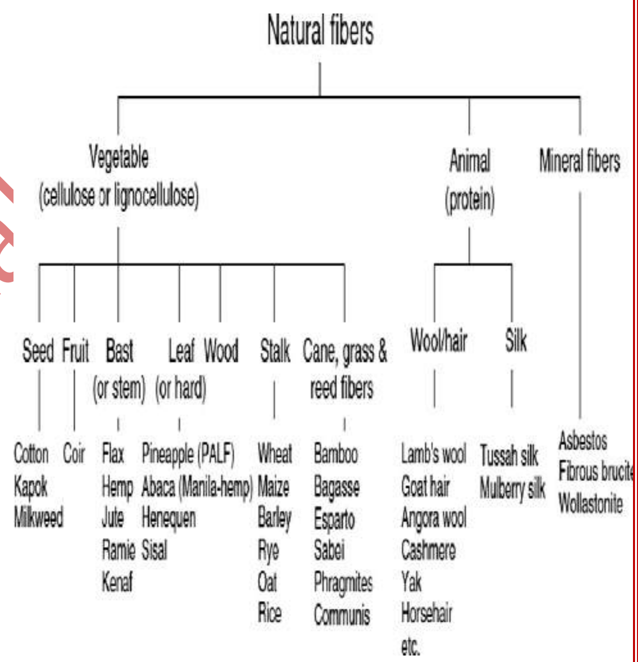

Figure 1: Types of natural fiber [8]

The source of the fibers is seed, fruit, bast, leaf, wood, stalk, and wool/hair. The most available fiber is vegetable and animal fiber.

Abilash et al (2013) has reviewed about different type of eco friendly fibers and analysis their mechanical properties, physical performance, and also the appearance, bonding, and physical properties of fiber composites. In this paper natural fiber is classified in to following types there are plant fiber, animal fiber, mineral fiber, manmade fiber. The conclusion of this paper is the eco friendly natural fiber reinforced polymer composites product and its manufacturing process is good fit the environment and economy and to protect it.

(B) Properties of natural fiber:

Ryszard kozlaowski et al (2008) analysed the flammability and fire resistance of reinforced natural fiber. First they will analysis the properties of natural fiber and the matrix material and also consider the density, young's modulus, tensile strength, specific modulus, elongation to break and moisture absorption. Then to analysis the properties of following matrix polymers there are polyethylene(PE), polypropylene(PP), polyvinyl plastic, polyvinyl chloride(PVC), polystyrene(PS), and acrylonitrile-butadiene-styrene(ABS). Then find the rate of flame spread, heat release rate (HRR), mass loss, and carbonization rates. Then they conclude that the flame retardants was determined in polypropylene, poly urethane and starch thermoplastic, fully degradable biopolymer can be flame retarded efficiently by the introduction of as low as 10% of ammonium polyphosphate and LOI value of 60 can be achieved with 30% of flame-retardant additive.

Chapple et al (2010) examined the important aspects of the flammability of natural fiber reinforced composites and to outline some of the more strategies used to improve the fire performance. First they will analysis the flammable properties of polymer, natural fiber and composites. Then to study the strategies for fire retardancy of natural fiber reinforced composites, ammonium polyphosphate, aluminium trihydrade, resin blends, nano composites and tin flame retardants. Finally they showed that the fire resistance of natural fiber reinforced composites can be improved.

Akil et al (2011) focused on the properties of the natural fiber reinforced composites. They will analysis the chemical properties of jute, flax, hemp, kenaf, sisal, cotton and mechanical properties of flax, hemp, jute, sisal, PALF, Kevlar, carbon.

Table 1: Chemical properties of some natural fiber [8]

Fiber	Cellulose (%)	Lignin (%)	Extractive (%)	Pectin (%)	Wax (%)	Moisture content (%)
Jute	61-71	12-13	-	0.2	0.5	12.6
Flax	71-78	2.2	2.3	2.2	1.7	10.0
Hemp	70.2-74.4	3.7-5.7	3.6	0.9	0.8	10.8
Kenaf	53-57	5.9-9.3	3.2	-	-	-
Sisal	67-78	8-11	-	10	2.0	11.
Cotton	82.7	-	-	-	0.6	-

Table 2: Mechanical properties of some natural fiber [8]

Fiber	Density (gcm^{3})	Diameter (μm)	Tensile strength (MPa)	Young's modulus (GPa)	Elongation of break (%)
Flax	1.5	40-600	345-1500	27.6	2.7-3.2
Hemp	1.47	25-500	690	70	1.6
Jute	1.3-1.49	25-200	393-800	13-26.5	1.16-1.5
Sisal	1.45	50-200	468-700	9.4-22	3-7
Palf	-	20-80	413-1627	34.5-82.5	1.6
Kevlar	1.44	-	3000	60	2.5-3.7
Carbon	1.78	5-7	3400-4800	240-425	1.4-1.8

(C)Utilisation of natural fibers:

Chandramohan et al (2011) utilized the natural fiber like Sisal, Banana, Roselle, and hybrid composition of sisal and banana, Roselle and banana, Roselle and sisal are fabricated with bio epoxy resin using moulding method and to analysis the flexural rigidity and hardness of single and combined fibers. Hardness test contacted by using Brinell hardness testing machine and microstructure specimens are scanned by scanning electron microscope finally they conclude that the sisal and Roselle is one of the best material for using both internal fixation and external fixation for fracture bone on human body compared to other Material.

Navdeep malhotra et al (2012) has focused on mechanical characterization of natural fiber reinforced polymer composites. The author fully focused on the following type of natural fibers there are jute, straw, flax, hemp, wood, sugarcane, bamboo, grass, kenaf, sisal, coir, wheat, banana fiber and pineapple leaf fiber. The matrix material used for reinforcing the fiber is classified as thermoset, thermo plastics and elastomers. The following parameters are affecting fiber properties there are fiber properties and configuration, resin/matrix, additives and modifier properties, fiber volume content and process parameters. Finally the author will carry the mechanical test, fiber length, fiber volume, thermal condition, failure rate and surface treatment. Due to the high specific properties and low density of natural fiber composites based on these fibers may have very good implications in industrial use.

Sakthivel et al (2013) analysed the mechanical properties of natural fiber reinforced polymer composites. The agricultural waste can be used to prepare fiber reinforced polymer composites for commercial use. They will analysis the mechanical properties of coir, banana, and sisal fiber. To make a desired shape by the help of various structures of pattern and measure the mechanical test. In this test banana reinforced natural composites is the best natural composites among the various combination. The banana fiber is used for manufacturing of automotive seat shell among the other natural fiber combination.

(D)Suitable chemical treatment:

Sherely annie paul et al (2008) analysed the thermal diffusivity, thermal conductivity and specific heat of polypropylene/banana fiber composite at room temperature. In this research they use a lot of chemical treatment and test thermal conductivity and thermal diffusivity of banana fiber by using practical and theoretical method. To chopped the banana fiber in to 6mm length and the surface treatment. In this treatment they used as the following chemicals Alkali, benzoyl chloride, KMNO4 and triethyoxy octyl Silone (TEOS). Alkali treatment will soak in stainless steel vessel at 2% and 10% for 1 hour and fiber was dried in an air oven at 70°c for 3 hour. Chopped fiber is soaked 2% NaOH solution for half an hour. Soaked fiber will agitated with benzoyl chloride for 30 min and dried in an air oven at 70°c for 3 hours. Silone and $KMNO_4$ treatment is same as above benzoyl chloride treatment method. Then to analysis the properties of treated fiber by use scanning electron microscope, and analysis thermal conductivity and thermal diffusivity. In the research conclude that the increase of the thermal conductivity is observed only for benzoylated and 10% NaOH treated fiber composite.

Ahmad alawar et al (2009) has found out the effect of different treatment process on the natural fiber. The fiber underwent different surface modification method such as alkali treatment and acid treatment. The treatment was performed at 100°c for 1 hour and analysed the mechanical properties, chemical properties and Fourier infrared spectroscopy. First the fiber will form a mat shape product. The sample were washed with fresh water and dried at room temperature and cut to the desired length. First step the fiber will be treated with sodium hydroxide (NaOH) with various concentrations like 5%, 2.5%, 1.5%, 1%, and 0.5% at 100°c for 1 hour. Then the next sample will treated with hydrochloric acid (HCL) with 0.3, 0.9 or 1.6N at 100°c for 1 hour. Then to examine the treated fiber in scanning electron microscope, and also test thermal characterization, tensile strength and other mechanical properties. Finally treatment of 1% NaOH for 1 hour at 100°c sample is withstand the maximum tensile strength and surface morphology HCL is rejected as the fiber treatment.

Kabir et al (2012) analysed a comprehensive overview on different surface treatment applied to natural fiber for advanced composite applications.

The major drawbacks of using natural fiber are their high degree of moisture absorption and poor dimensional stability. The chemical source for the treatments include alkaline, Silone, acetylation, acrylation and acrylonitrile grafting, maleated coupling agent, permanganate, peroxide, benzoylation, isocyanate, stearic acid, sodium chlorite, fatty acid derivate (oleoyl chloride) and fungal. Finally the chemical treatment is an essential processing parameter to reduce hydrophilic nature of the fiber and thus improves adhesion with the matrix.

(E)Selection of pineapple leaf fibers:

Ravindra mangal et al (2001) analysed to measurement of effective thermal conductivity (I) and effective thermal diffusivity (K) of pineapple leaf fiber reinforced phenol formaldehyde (PF) composites have been studied by transient plane source (TPS) technique. Phenol formaldehyde is kind of matrix. Then to separate the sample in different weight like that (15, 20, 30, 40, 50%) have been taken. Then to analysis the thermal properties compared the results of thermal conductivity of composites with two models (Rayleigh/Maxwell and Meredith/Tobias model) in this research the author will conclude that the decrease the thermal conductivity and diffusivity of pineapple leaf fiber reinforced by using phenol formaldehyde (PF) composite.

Vinod et al (2013) is said that the pineapple leaf fiber (PALF) is one of the natural which have a good potential, high mechanical properties as reinforced composite. Author will investigate the effect of fiber length on the tensile properties of PALF reinforced bisphenol composite. To extract the fiber then to treat with NaOH solution, then to prepared the laminated composite by use polypropylene. The mould was first cleaned with wax so that the laminated easily comes out of the die after hardening. Then around 15 to20 ml of promoter and acceleration are added to bisphenol and the colour of the resin change from pale yellow to dark yellow with the addition of these two agents. Then laminated three different fiber orientation mats of prepared by hand layup method, and cut the fiber in 3mm, 6mm, 9mm, 12mm length and analysis the tensile strength. Finally 9mm length laminated fiber shows better tensile strength compare then the fiber length of 3mm, 6mm and 12mm respectively.

In this pineapple leaf fiber is most attractive fiber many research will going about PALF. Following table is considered as properties of pineapple leaf fiber in various author researches.

Table 3: Chemical properties of PALF

Chemical composition	**DIFFERENT AUTHORS**				
	Bhoduri et al (1983)	**Mohanty et al (200)**	**Abdul kabil (2006)**	**Saha et al (1990)**	**Siregar et al (2008)**
Cellulose (%)	69.5	70-82	73.4	68.5	67.12-69.34
Hemicelluloses (%)	-	-	-	18.80	-
Lignin (%)	4.4	5-12.5	10.5	6.04	14.5-15.4
Pectin (%)	1.2	-	-	1.10	-
Fat and wax (%)	4.2	-	-	3.2	-
Ash (%)	2.7	-	2	0.9	1.21
Extractive (%)	-	-	5.5	-	3.83-0.97

Table 4: mechanical properties of PALF

Properties	**DIFFERENT AUTHORS**				
	Mohanty et al (2001)	**George et al (1993)**	**Luo et al (1995)**	**Arib et al (2006)**	**Mohamed et al (2009)**
Tensile strength (MPa)	413-1,627	170	445	126.6	293.08

Young's modulus (GPa)	34.5-82.5	6.26	13.21	4-4.5	18.934
Elongation at break (%)	1.6	0.8-1.6	3.37	2.2	1.41
Diameter (μm)	20-80	5-30	-	-	105-300
Density ($g\ cm^3$)	-	1.44	1.36	1.07	-
Moisture content (%)	11.8	-	-	-	-

(F) Types of pineapple leaf fiber:

Supriya mishra et al (2004) analysed the hybrid natural composites of pineapple leaf fiber and sisal as reinforcement in thermoplastic and thermosetting resin for developing low cost and light weight. In this paper concerned with the structures, properties and composition of PALF and sisal, and its chemical modification of thermoset, thermoplastics, rubber, cement, hybrids and bio composites are analysis. They used two chemical modification methods there are chemical treatment of fiber and chemical coupling. Alkali, cyanoethylene and acetylation are used to treat the PALF/sisal composite fiber. Chemical coupling method which improves the interfacial adhesion the fiber surface is treated with a compound that forms a bridge of chemical bonds between fiber and matrix. In this research they conclude that the PALF/sisal reinforced composites generally have poor interface and moisture resistance. So various surface treatment method of fibers have been developed in order to alter the adhersion properties, moisture resistance, biodegradation and mechanical properties are improved by these pre-treatment's of fibers.

Nanthaya kengkhetkit et al (2012) analysed about utilization of the pineapple leaf fiber waste. Pineapple leaf is a source of high quality natural fiber but it is left underutilized. The conventional methods for PALF extraction such as scraping, retting and decorticating with a decortications start from long fresh leaf and use mechanical force to remove soft covering material to provide long fiber. Then the PALF was separated by using scraping (S), retting (R), ball-milling (BM), and milling (M) method. The fiber yield will calculated by using following equation

Weight of dry PALF (g) (%) = Fiber yield *100
Weight of fresh PALF (g)

Then to prepare the PALF-PP (polypropylene) composite to form a sheet of 1mm thickness and analysis the morphology, thermal analysis and mechanical test. The author will provide the test result in graph method and to conclude that the 6 kind of fiber will grinding by using ball mill and disc mill. The M-PALF is found very suitable and could be used directly plastic reinforcement. M-PALF is believed would increase the utilization of pine apple leaf waste especially in the plastic industries.

Alfredo R.Senaneto (2013) analysed the six cultivars of fiber of different pineapple varieties were characterized by tensile test, thermo gravimetric, x-ray diffraction, scanning electron microscopy. This paper aims to add information value to the literature regarding to pineapple leaf fiber and its characteristics for technical and engineering applications. It was demonstrated that within the pineapple leaf fiber family, there are intrinsic variability for natural materials, indicating different potential uses for each variety. Author will carry the test in six potential varieties of the bromeliaceae family there are bromeliad sp, ananas comosus var.comosus, bilbergis sp, Ananas comosus var. bracteatus, Ananas comosus var. erectifolius, Ananas macrodontes x Primavera. In this 6 type of pineapple leaf fiber will test the following methodology there are Fourier transform infrared spectroscopy, morphological analysis, tensile test, thermo gravimetric analysis, x-ray diffraction test. Finally conclusion of this research is natural fibrous materials of smaller dimensions and higher crystallinity index when higher mechanical strength and modulus are desired.

(G) *Industrial safety helmet and its problems*:

Patrick kirk et al (2000) determined the impact of outdoor weathering, in particular ultraviolet light (UV) and solar radiation on the effective life of three models of plastic safety helmets. A sample of each helmet colour and model were destructively tested in accordance with the appropriate helmet standard at three monthly intervals. The effective life of helmet exposed to outdoor weathering ranged from 13.5 to 36 months. In this test involved two separate testing procedures and using 3 kinds of helmet A, B, C for testing. The first test procedure is cold shock absorption test. In this test will carrying three month intervals for each samples and models. The purpose of this test was to locate the time at which the helmets experienced consistent failure rates. The second test procedure is more comprehensive test based NZS 5806 involved the testing of nine helmets under a range of condition cold, hot, and wet, also have the shock absorption test, cold penetration test and lateral rigidity test. The authors conclude that the helmet failures occurred to all model of A, B, C coloured helmet.

Davis et al (2002) analysed the environmental conditions in the helmet dome space were evaluated. Three different helmets are used in this study there are standard helmet, passively ventilated helmet and actively ventilated helmet. It was found that none of the tested helmets burdened the body significantly for the physiological variables that were examined. The evaluation of the dome space environment conditions showed that both the dry-bulb temperature and wet-bulb temperature varied significantly among the helmets tested. The psychophysical results showed that ventilation contributes to greater helmet comfort, and that weight and fit are important factors in helmet design. In this research author conclude that the actively ventilated helmet maintained a significantly lower dome space dry-bulb temperature. Then either the standard helmet or the passively ventilated helmet, but despite having the lowest dome space dry bulb and wet bulb temperature, was not preferred due to its excessive weight and uncomfortable fit.

Tan et al (2006) to design of a helmet cooling system using phase change material (PCM) to absorb and to store the heat produced by the wearer head. The PCM is packed in a pouch and placed between the helmet and the wearer head. The heat from the wearer head is transferred to the PCM by conduction through a heat collector which is spread over the wearer head. The temperature on the wearer head is maintained just above the PCM temperature, thus the wearer would not suffer from an uncomfortable and dangerous hot environment on the head. The cooling unit is able to provide comfort cooling up to 2 hours When the PCM is completely melted. Since the head skin temperature of the wearer is designed to maintain at around 30°c, the PCM, climselc28, which has the melting temperature of 28°c is chosen. It has relatively high storage capacity per unit volume and it is not flammable. It is also relatively inexpensive and widely available in the market. The sealed pouch stores the PCM in both solid and liquid state. The authors conclude that the limitation of the PCM needs to be discharged before it can use again. The usage of the PCM-cooled helmet can be increased with the use of PCM with higher heat storage.

(H) Design and analysis of industrial safety helmet:

Borsellino et al (2004) analysed the problem and evaluation of sandwich composite structure. The main problem for sandwich composite is intrinsic anisotropy and non-homogeneity. Then to extend the knowledge of mechanical properties both on single components and on complete structures focusing on the effects induced by different kind of skin arrangements (Kevlar, glass, carbon fiber). Then the authors will analysis the following test with the sandwich structure in order to acquire important comparison parameters. They are compressive test, flexural test, and shear test. The flat wise compression test, three point bending test by using mechanical testing machine. The finite element analysis will carry by using ANSYS software. The author concludes in flexural test the failure of the top skin starts by local wrinkling on the compressed side of the panel. For carbon fibre sandwich the fracture stress is higher than the glass or Kevlar one. The addiction of higher modulus carbon fibre does not induce evident effects on flexural strength or modulus. The deformation to break of the Kevlar fibre sandwich is lower than other structures one.

Ting Chin Chen et al (2009) analysed to improve the thermal properties of industrial safety helmet. In this paper author will redesign the industrial safety helmet shell to improve its thermal properties. According to these design suggestions a new design prototype was developed, tested and further modification. In this design following concepts are used there are ventilation holes on the front and back as well as both sides of the helmet shell, wind channels were designed on the top of the shell and on both side of the shell, the beak of the helmet has an arched front tip and a wind channel that integrated smoothly in to the front end of the helmet shell, the arched flanges on both sides and the back end of the helmet shell to allow more air flow between the helmet shell and the head from different direction, and flanges around the ventilation holes to prevent water from leaking into the helmet on a rainy day. The author conclude that the improve the thermal properties of helmet in two ways there are to provide better insulation against radiant heat, which is the major heat source when wearing a helmet, and to provide better ventilation to intensity convection.

Anil kumar.k et al (2012) analysed to increase the strength of industrial helmet by making the modify material in existing one. The work is carried out in three stages first to design the 2D diagram by using AutoCAD software. Then to develops the 2D diagram to 3D diagram by using pro-E software. After designing the helmet, mould flow analysis is used for finding material filling, pressure distribution, air traps and weld lines during the injection moulding process at constant pressure and different ranges. Also analysis the flow front temperature, pressure drop, cooling time, shear rate, and shear stress. They will use three different materials in this research there are ABS, impact ABS and nylon 4-6 (polyamide). Next to analysis impact test is done on industrial safety helmet by using COSMOS software. The author conclude that the nylon 4-6 plastic is good instead of ABS plastic and impact ABS plastic helmet by using based on the various result.

(I) Method to fabricate industrial safety helmet by composite materials:

Gujja sunil kumar et al (2004) has been made to fabricate a fiber glass reinforced plastic helmet using an industrial helmet as the mould. The industrial helmet is essentially made up of polyethylene thermoplastic. The construction of the fiber glass helmet is done using the fiber glass hand lay-up operation. The author analyze the replacement of polyethylene high- density is a polyethylene thermoplastic made from petroleum known for its large strength to density ratio. The fabrication of helmet is step by step process first select the shape and size of the helmet. Then to cut the fiber glass in no. of pieces then to apply the wax on the sample helmet, Wax is act as the releasing agent. Mix epoxy and hardener in the ratio of 2:1 and stir it thoroughly. Applying mixture above the sample helmet then to apply the fiber glass cut piece then kept to drying. This process will continue with 4 coating. Allow the layer to dry for 12 hours, then to remove the unwanted materials. Four layered glass specimens were tested for tensile strength, hardness and flexural strength have been compared alongside the standard mechanical properties of a high density polyethylene industrial safety helmet. The authors conclude that the properties of the glass fiber are better than high-density polyethylene helmet.

Yuhazri.M.Y et al (2007) analysed and fabricate the industrial safety helmet shell by using natural fiber. They will select the following composite materials there are epoxy resins from thermoset polymer were used as the matrix materials and natural fiber as the reinforcement and for the purpose of this research coconut fiber, as natural fiber, have been selected. First the coconut fiber will carry chemical treatment for this project, 90% of the weight is for the epoxy with hardener and 10% of weight is for the coconut fibers is in the form of mould. The plaster of Paris (POP) is used to support the plastic mould and this POP mould fabricates in to two parts. First part of the mould is positive mould and the second part of the mould is negative mould. To mixing ratio of the epoxy resin and hardener is 3:1. Then to injecting the composite material in to the POP pattern. Then the sample is kept in room temperature for 24 hours. Then to carry the mechanical test of hardness test, impact test, young's modulus and also analysis the quasi-static penetration test. Finally authors conclude a mechanical property of the coir helmet is suitable for use. But the mixing ratio of the fiber and resin will maintain at 20:80 in this ratio will meet the high mechanical properties.

Murali et al (2014) analysed the natural fiber particle reinforced materials such as banana, sisal and jute reinforced polymer composite material with epoxy resin has been used for fabrication of industrial safety helmet. Then they will identify the impact strength and compression strength values. The helmet manufacturing aspects are reviewed both the thermoplastic and the natural fiber composite shell manufacturing techniques are presented with specific mentioning of the advantage and disadvantage to each type from the manufacturing point of view. The fabrication of industrial safety helmet is done with hand lay-up method that is engraved to the shape of the industrial safety helmet. The epoxy resin with hardener was thoroughly mixed with required fibers in the ratio of 60:40. The mould was placed in room temperature for 24 hours then to carry the mechanical test of impact and flexural test. In this result will compare to ABS plastic. Then the hybrid composite result is better than plastic material.

3. CONCLUSION:

Finally in this review conclude from the previous researches. Natural fiber composites as the name implies is made of natural resources thus possesses environmentally beneficial properties such as biodegradability. The natural fiber is one of the best composite materials by developed new engineering materials. In this natural fiber the pineapple leaf fiber is one of a source of high quality natural fiber but is left underutilized. The major issues in industrial safety helmet are energy absorption capacity, large volume, heavy weight, thermal discomfort, itching and material (plastic). In this review analysis the types of natural fibers, properties of natural fibers, utilization of pineapple leaf fiber, design and analysis of industrial safety helmet, methodology and fabrication method of industrial safety helmet by using pineapple leaf fiber by hand layup method and also analysis the procedures to check mechanical properties of industrial safety helmet. From the literature review Final conclusion is.

- The natural fiber is a main resource to replace the plastic.
- Plaster of Paris is better to use hand layup method.
- NaOH is used to treat the pineapple leaf fiber.
- To provide the ventilation holes to reduce the thermal discomfort.
- To provide the light colour paintings (white, sky blue, yellow) is used to reduce the heat absorption.
- The pineapple leaf fiber properties are more or less equal to abs plastic properties.

Thus the pineapple leaf fiber composite is suggested as replacement for plastic in helmet shell manufacturing. Further research is needed on improving the comfort and effectiveness of ventilating safety helmets without compromising the safety of the wearer and utilisation of pineapple leaf fiber. A helmet needs to be developed with acceptable weight, comfortable fit.

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