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Selection and Evaluation of Natural Fibers – A Literature Review

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Abstract
Natural fiber concentrates with control the environment effect, reduce the product weight and reduce cost of products. The natural fiber incorporation to the benefit of more automotive and strong construction materials like metals. Recently more researches are done made by natural fibers. Wide range applications are publish using these composite materials. Our research concentrates to find equal strength materials. Review aim is to view made best materials using natural fiber mix with ceramics and plastic used some applications. Therefore, suitable processing techniques and parameters must be carefully selected in order to yield the optimum composite products. This article aims to review the reported works on the effects of fiber made by machine moulding and analyze the chemical treatments, manufacturing techniques and process parameters on tensile properties of natural composites.
Keywords: *Ceramics, Composite materials, Machine Moulding Natural Fiber.*

1. Introduction

From centuries back, the early people began to use composite materials and it all started with natural fibers. Later on, the natural fiber lost much of its absorption to the advantage of more durable construction materials like metals. During the last period, since the importance of the environmental aspect, there has been a renewed interest in the natural fiber taking into account the ecological advantages of using renewable resources. Natural fiber composites have found applications as nonstructural materials, especially in the packaging, transportation and building industries.

The potential applications as a substitute for glass are under study to motivate by weight saving which results in a higher specific strength and stiffness, low cost material and 'recycling'. Example: cotton, hemp jute, flax, ramie, and sisal have replaced glass in a number of components in the automotive industries.

During last years, many of these issues have been addressed and partially solved, especially for what concerns the compatibility between polymers and natural fibers.

1.1. Composite clarification

The most widely used meaning is the following one, which has been stated by Jartiz "Composites are multifunctional material systems that provide characteristics not available from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form". The weakness of this definition resided in the fact that it allows one to classify among the composites any mixture of materials without indicating either its specificity or the laws which should give it which distinguishes it from other very banal, meaningless mixtures. Kelly very clearly stresses that the composites should not be regarded simple as a combination of two materials. In the broader significance; the combination has its own distinctive properties.

In terms of strength to resistance to heat or some other desirable quality, it is better than either of the components alone or radically different from either of them. Beghezan defines as "The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings", in order to obtain improved materials. Van Suchetclan explains composite materials as heterogeneous materials consisting of two or more solid phases, which are in intimate contact with each other on a microscopic scale.

They can be also considered as homogeneous materials on a microscopic scale in the sense that any portion of it will have the same physical property.

1.2. Advantages of composite materials

- Low density and high specific strength and stiffness
- Fibers are a renewable resource, for which production requires little energy, involves CO_2 absorption, whilst returning oxygen to the environment
- Fibers can be produced at lower cost than synthetic fiber
- Low hazard manufacturing Processes
- Low emission of toxic fumes when subjected to heat and during incineration at end of life
- Less abrasive damage to processing equipment compared with that for synthetic fiber composites

1.3 Composite Materials classification

1.3.1. Metal Matrix Composites (MMC)

MMC have lot of advantages over monolithic metals like higher specific modulus, higher specific strength, better properties at elevated temperatures, and lower coefficient of thermal expansion. Because of these attributes MMC are under consideration for wide range of applications viz. combustion chamber nozzle (in rocket, space shuttle), housings, tubing, cables, heat exchangers, structural members etc.

1.3.2. Ceramic matrix Composites (CMC)

One of the main objectives in producing CMC is increase toughness. Naturally it found that there is improvement in strength and stiffness of CMC.

1.3.3. Polymer Matrix Composites (PMC)

Commonly used matrix materials are polymeric. The reason for this is twofold. In general the mechanical properties of polymers are insufficient for structural purposes. In particular their strength and stiffness are low compared to metals and ceramics. These difficulties are overcome by reinforcing other materials with polymers. Secondly the processing of PMC need not involve high pressure and doesn't require high temperature. Also equipment required for manufacturing PMC are simpler. For this reason PMC developed quickly and soon became common for structural applications

1.4 Types of polymer composites

1.4.1 Fiber reinforced polymer (FRP)

FRP composed of fibers and a matrix. The main source of strength while matrix pastes all the fibers together in shape and transfers stresses between the reinforcing fibers. Fibers carry loads along their longitudinal directions. Sometimes, filler might be added to smooth the manufacturing process, impact special properties to the composites, and / or reduce the product cost. Common fiber reinforcing agents include asbestos, carbon / graphite fibers, beryllium, beryllium carbide, beryllium oxide, molybdenum, aluminum oxide, glass fibers, polyamide, natural fibers etc.

1.4.2 Particle Reinforced Polymer

Particles used for reinforcing include ceramics and glasses such as small mineral particles, metal particles such as aluminum and amorphous materials, including polymers and carbon black. It's used to increase the modules of matrix and decrease the ductility of the matrix. Also used to reduce the cost of the composites. Properties of ceramics and glasses high melting temp, low density, high strength, stiffness, wear resistance, and corrosion resistance. Many ceramics are good electrical and thermal insulators. Ceramics and glasses have one major drawback they are brittle.

1.5 Natural Fiber Reinforced Composites

It can be used as an element of CM. They can also be matted into sheets to make products such as paper or felt. Fibers are of two types: natural fiber and manmade or synthetic fiber.

1.5.1 Vegetable fibers

Vegetable fibers are made by cotton, jute, flax, ramie, sisal, and hemp. Cellulose fibers serve in the manufacture of paper and cloth.
Are shown in Fig 1
Categorize by

- Seed fiber: Made from seeds e.g. cotton and kapok.
- Leaf fiber: Collected from leaves. E.g. sisal and agave.

- Bast fiber or skin fiber: Collected from the skin or bast surrounding the stem of their respective plant. E.g. Flax, jute, kenaf, industrial hemp, ramie, rattan, soybean fiber, and even vine fibers and banana fibers.
- Fruit fiber: Made from the fruit of the plant, e.g. coconut (coir) fiber.
- Stalk fiber: Fibers are actually the stalks of the plant. E.g. straws of wheat, rice, barley, bamboo, grass and tree wood.

The most used natural fibers are cotton, flax and hemp, although sisal, jute, kenaf, and coconut are also widely used.

1.5.2 Animal fibers

Animal fibers are made from silk, wool, angora, mohair and alpaca are shown in Fig.2

- Animal hair: Fiber or wool taken from animals or hairy mammals. E.g. sheep's wool, goat hair (cashmere, mohair), alpaca hair, horse hair, etc.
- Silk fiber: Fiber collected from dried saliva of bugs or insects during the preparation of cocoons. E.g. silk from silk worms.
- Avian fiber: Fibers from birds, e.g. feathers and feather fiber.

1.5.3 Mineral fibers

Mineral fibers are naturally occurring fiber or slightly modified fiber procured from minerals. These can be categorized into the following categories are shown in Fig.3

- Asbestos: The only naturally occurring mineral fiber. Variations are serpentine (chrysotile) and amphiboles (amosite, crocidolite, tremolite, actinolite, and anthophyllite).
- Ceramic fibers: Glass fibers (Glass wool and Quartz), aluminum oxide, silicon carbide, and boron carbide.
- Metal fibers: Aluminum fibers.

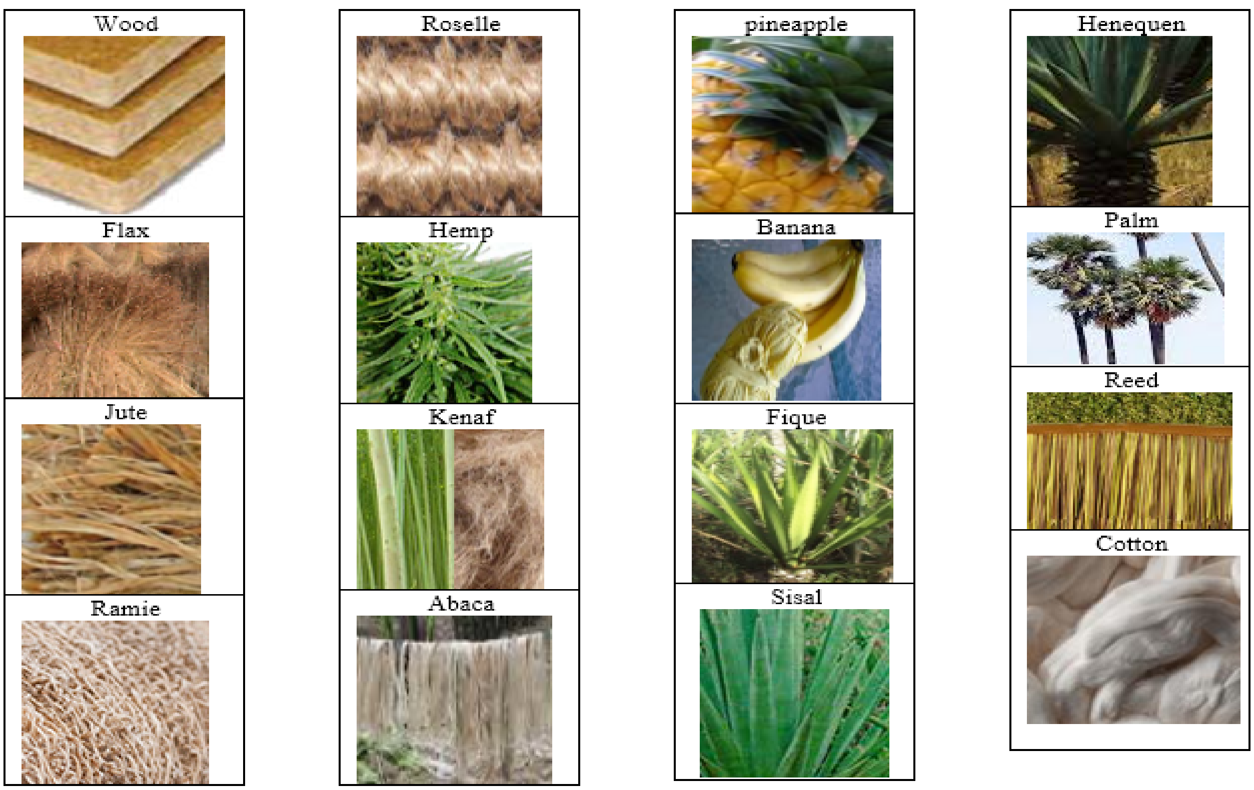

Fig 1. List of vegetable fibers

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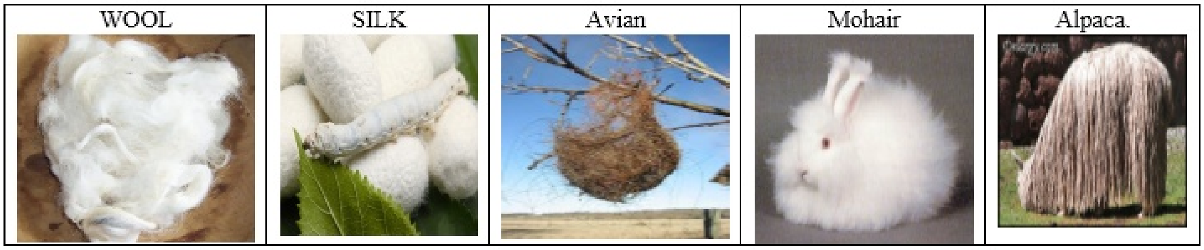

Fig 2.List of animal fibers

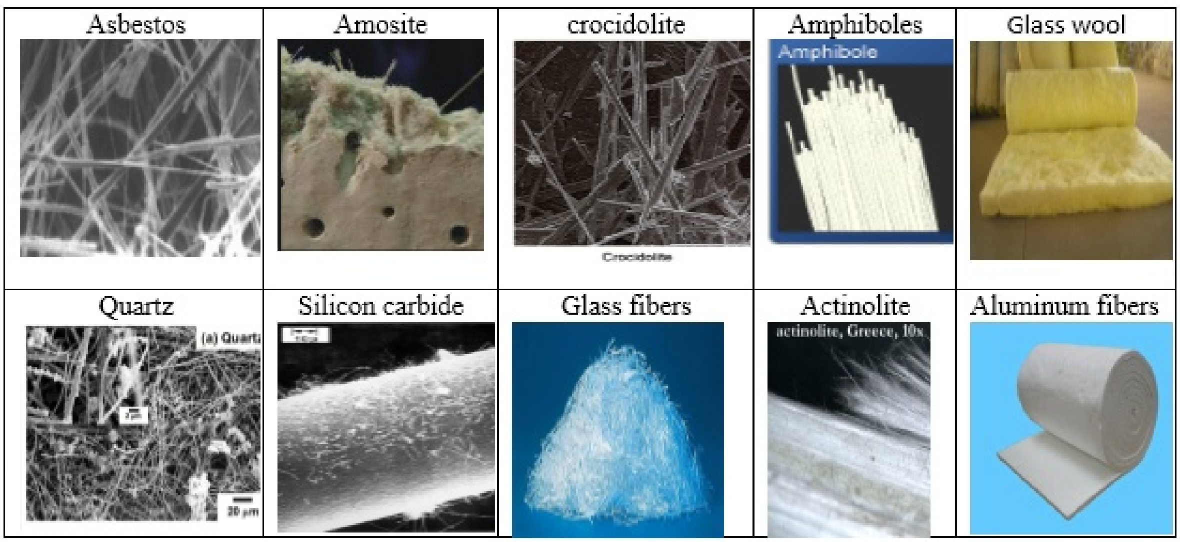

Fig 3 List of mineral fibers

1.6. Hemp Fiber

Hemp fiber is a kind of natural fiber, which possesses high specific strength and modulus, low price, recyclability, easy availability. Using hemp fiber as reinforcement to make hemp fiber reinforced polymer composites has aroused great interest of materials scientists and engineers all over the world. Many researchers have been done in recent years, which include the study of mechanical properties of the composites, finding an efficient way to improve the interfacial bonding properties between hemp fiber and polymeric matrices and fiber surface treatment on the mechanical performance of the composites.

1.6.1. Uses of Hemp

Hemp is valued for cordage use because of its strength, durability, ability to stretch, affinity for certain and resistance to worsening in saltwater. Hemp is used by industry in three grades. Products made from hemp are being developed rapidly, such as furniture and wall tiles made of resonated hemp. A recent development expanded the range even to car parts for cabin interiors. Other products developed from hemp fiber include spa products, cat scratching posts, lumbar support belts, rugs, slippers, cloths and disc buffers.

Hemp wall covering meets the abrasion and tearing resistance standards of the American Society for Testing and Materials and of the National Fire Protection Association. Apart from ropes, twines and general cordage hemp is used in low- cost and specialty paper, dartboards, buffing cloth, filters, geotextiles, mattresses, carpets, handicrafts, wire rope cores and macrame.

In recent years hemp has been utilized as a strengthening agent to replace asbestos and fiberglass as well as an environmentally friendly component in the automobile industry. Products made from hemp fiber are purchased throughout the world and for use by the aerospace, leisure, construction, sport, packaging and automotive industries.

1.7. Roselle

The seeds are considered excellent feed for chickens. The residue after oil extraction is valued as cattle feed when available in quantity.

1.8 Banana Fiber

Banana fiber, a ligno-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bast 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 pseudostem is not a common practice and much of the stem is not used for production of fibers. The buyers for banana fibers are erratic and there is no systematic way to extract the fibres regularly. Useful applications of such fibres would regularize the demand which would be reflected in a fall of the prices.

The Roselle (Hibiscus sabdariffa) is a class of hibiscus subject to the Old World tropics. It is an annual or returning herb or woody-based sub shrub, rising to 2–2.5 m tall. The leaves are extremely three- to five-lobed, 8–15cm long, set alternately on the stems. The flowers are 8–10 cm in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1.5–2 cm wide, enlarging to 3–3.5 cm, fleshy and bright red as the fruit matures. It is an annual plant, and takes about six months to mature. Roselle is native from India to Malaysia, where it is commonly cultivated, and must have been carried at an early date to Africa. It has been widely distributed in the Tropics and Subtropics of both hemispheres, and in many.

1.8.1. Uses of Banana&Plantain

Culinary Uses: Banana leaves, pseudostems, fruit stalks and peels can all be used for various culinary purposes. Bananas are primarily eaten as a fruit, either on its own or as a part of a salad. All parts of the banana have medicinal applications as well.

Edible leaf: The tender leaf with the stem in an emergency.

Stem: The tender core is sometimes eaten or extracted for starch.

Flower: Parts of the flower are eaten as an artichoke.

Immature fruit: Boiled or fried as a starchy staple. Can be extracted as Starch or dried as flour.

Mature fruit: The soft pulp can be eaten raw or cooked, or can be incorporated into baked products and fermented beverage.

1.9. Mechanical Properties of Natural and Synthetic Fiber

Fiber	Density (g/cm3)	Length (mm)	Failure strain (%)	Tensile strength (MPa)	Stiffness/Young's modulus (GA)	Specific tensile strength (MPa/gcm^{-3})	Specific Young's modulus (GA/gcm^{-3})
Ramie	1.5	900–1200	2.0–3.8	400–938	44–128	270–620	29–85
Flax	1.5	5–900	1.2–3.2	345–1830	27–80	230–1220	18–53
Hemp	1.5	5–55	1.6	550–1110	58–70	370–740	39–47
Jute	1.3–1.5	1.5–120	1.5–1.8	393–800	10–55	300–610	7.1–39
Harakeke	1.3	4–5	4.2–5.8	440–990	14–33	338–761	11–25
Sisal	1.3–1.5	900	2.0–2.5	507–855	9.4–28	362–610	6.7–20
Alfa	1.4	350	1.5–2.4	188–308	18–25	134–220	13–18
Cotton	1.5–1.6	10–60	3.0–10	287–800	5.5–13	190–530	3.7–8.4
Coir	1.2	20–150	15–30	131–220	4–6	110–180	3.3–5
Silk-	1.3	Continuous	15–60	100–1500	5–25	100–1500	4–20
Feather	0.9	10–30	6.9	100–203	3–10	112–226	3.3–11
Wool	1.3	38–152	13.2–35	50–315	2.3–5	38–242	1.8–3.8
E-glass	2.5	Continuous	2.5	2000–3000	70	800–1400	29

Table 1. Properties of natural and synthetic fiber

TABLE 1. shows properties of some natural fibers and the main type of glass fiber (E-glass). It can be seen that flax, hemp and ramie fiber are amongst the cellulose-based natural fibers having the highest specific Young's moduli and tensile strengths although it should be stated that much variability is seen within the literature. Commonly, geography relating to fiber availability plays a major role in fiber selection [17]. The focus, for example in Europe has been on flax fiber, whereas hemp, jute, ramie, kenaf and sisal have been of greater interest in Asia. Harakeke fiber, (Phormiumtenax commonly known as New Zealand flax) is also being considered to be used in structural applications in New Zealand due to its good mechanical properties and its local availability there.

Generally, higher performance is achieved with varieties having higher cellulose content and with cellulose microfibrils aligned more in the fiber direction which tends to occur in bast fibers (e.g. flax, hemp, kenaf, jute and ramie) that have higher structural requirements in providing support for the stalk of the plant. The properties of natural fibers vary considerably depending on chemical composition and structure, which relate to fiber type as well as growing conditions, harvesting time, extraction method, treatment and storage procedures. Strength has been seen to reduce by 15% over 5 days after optimum harvest time [20] and manually extracted flax fibers have been found to have strength 20% higher than those extracted mechanically [18]. Strength and stiffness of natural fibers are generally lower than glass fiber, although
stiffnesses can be achieved with natural fibers comparable to those achieved with glass fiber. However, the specific properties compare more favourably; specific Young's

Modulus can be higher for natural fibers and specific tensile strength can compare well with lower strength E-glass fibers.

When comparing data from different sources, it should be considered that a number of variables that are not always reported have an influence on fiber properties. These include testing speed, gauge length, moisture content and temperature. Generally strength increases with increasing Moisture content and decreases as temperature increases; the Young's modulus decreases with moisture content [21]. Sometimes it is also unclear in the literature as to whether the tests have been conducted on single fibers (single cells) or on fiber bundles (sometimes referred to as technicalfibers). Calculation of properties is generally based on the total cross-section of a fiber or fiber bundle, however, single fibers havea central hollow lumen which takes up a significant proportion of the cross-sectional area. The fraction of cross-sectional area takenup by the lumen has been found to be, for example, 27.2%, 6.8% and 34.0% for sisal, flax and jute respectively [22] and so it could beconsidered that measurements of

strength and stiffness obtained not taking this into account are underestimations to the samedegree.
The lumen area fraction for harakeke has been found to be 41% which based on an apparent strength of 778 MPa obtainedfor the fiber neglecting the lumen, suggests a true fiber strength of 1308 MPa [19]. It should also be kept in mind when predicting composite properties that fiber properties vary with direction relative to the fiber axis, although not surprisingly given the experimentalchallenge, there is only limited information on transverse data available. The longitudinal Young's modulus for jute has beenestimated to be seven times that for the transverse Young's modulus [23].

As would be expected given that the fibers are normally stronger and stiffer than the matrix, strength and stiffness of the composite are generally seen to increase with increased fiber content. However, this relies on having reasonable fiber/matrix interfacial strength, and strength can reduce with strongly hydrophobic matrices such as polypropylene (PP) with increasing fiber content unless coupling agents or some other interfacial engineering method is used; regardless, Young's modulus still generally increases with fiber content but more modestly than when the interface is not optimised [25].

When reasonable interfacial strength is established, composite strength commonly peaks with fiber contents of 40–55 m% for injection moulded thermoplastic matrix composites with reduction at higher contents explained as being due to poor wetting leading to reduced stress transfer across the fiber–matrix interface and increasing porosity (see section on porosity below). Stiffness has been found to increase up to higher fiber contents of around 55–65 m% with similar materials, possibly due to less dependency on interfacial strength than composite strength [19, 24–26]. Furtherinsight has been provided by work investigating the influence of fiber content in terms of weight fraction on porosity and volume fraction of fiber. This has shown that maximum volume fractions of fiber occur around fiber contents of 50–60 m% with further additionof fiber resulting in higher porosity rather than increased fiber volume fraction, the influence of which has been incorporated intorule of mixtures models and shown to improve accuracy of prediction for stiffness and strength [23,26,27].

As well as being an issue for short term composite properties, high fiber volume fractions are also of concern due to the potential for increased water uptake leading to degradation of longer term properties. It has been reported that hemp fiber reinforced PP composites with a fiber volume fraction of 0.7 absorbed almost 53 m% water and had not reached saturation after 19 days, whereas only 7 m% water uptake was observed in composites with a fiber volume fraction of 0.3 and saturation had been achieved in the same time period [28].

For composites containing fibers with failure strains lower than that of the matrix (commonly the case for NFCs), basic compositetheory suggests that there should be a volume fraction of fiber below which composite strength will be lower than that of thematrix known as the critical volume fraction (Vcrit). From a fracture mechanics perspective, below Vcrit, when the fibers fail, the matrixcan cope with load transferred from the failed fibers and the fibers are acting merely as holes within the matrix. Critical volume fractions of fiber have been found to be 8.1% and 9.3% for jute and flax respectively in unsaturated polyester (UP), much higher than values obtained for synthetic fiber composites, although lower than fiber contents commonly studied in the literature and so this effect is not observed often [29].

Fiber length, which can be incorporated into the aspect ratio for a fiber (length/diameter), is an important factor influencing the mechanical properties of composites. In a short fiber composite, tensile load is transferred into a fiber from the matrix through shear at the fiber/matrix interface. At the ends of the fiber, the tensile stress are zero and increase along the fiber length; therefore, a fiber needs to have a length of greater than a critical length (Lc) in order for the fiber to be able to be broken during tensile loading of a composite [30]. At the critical length, just prior to fracture, the fiber would theoretically only have been carrying half of the load compared to that of a continuous fiber at the same compositestrain. Ideally, fiber length would be much greater than the critical fiber length to allow for efficient reinforcement of a composite such that the majority of the fiber could be loaded as if it were a continuous fiber.

Not surprisingly, Lc has been found to vary with fiber, matrix, fiber treatment and fiber content. Lc values for hemp/PP composites with maleated polypropylene (MAPP) coupling agent were found using composite properties and the Kelly–Tyson model to be 0.49, 0.67, 0.67 and 0.62 mm for fiber contents of 20, 30, 40, and 50 m% respectively (si = 14.5 MPa) [31]. A higher value of 0.83 mm obtained for similar materials was obtained using the fragmentation test (si = 15.4 MPa) with alkali treated fibers [25] with an almost identical value of 0.82 mm (si = 12 MPa) obtained for flax with the same matrix based on the Kelly–Tyson model [32]. Much larger values were obtained from other work using fragmentation for Hemp, flax and cotton with PP and MAPP of 3.2, 3.2 and 5.0 mm (si = 14.3, 12.0, 0.7 MPa) respectively and 2.3 mm (si = 22.0 MPa) for sisal [34,35].

Relatively poor bonding between cotton and PP with MAPP was suggested to be influenced by lack of lignin which could potentially bond with PP containing MAPP, which also explains the best interfacial strength being found for hemp with more accessible lignin at the interface than flax. The adhesion between polylactic acid (PLA) and the hemp, flax and cotton was found to be insufficient for fragmentation testing analysis[34]. Lc for flax/thermoset matrix composites has been found to be generally at the lower end of the range. Values of 0.9, 0.5 and0.4 mm (and si = 13, 28 and 33 MPa) for UP, vinyl ester (VE) and epoxy resins respectively have been obtained using fiber fragmentation
supporting their use in NFCs [35]. However, a large Lc of 3mm (si = 0.9 MPa) has been observed for jute fiber with UP, although this was noted as being an upper bound value [36].

Although increasing fiber length generally increases fiber load bearing efficiency, if fiber length is too long the fibers may get tangled during mixing resulting in poor fiber dispersion which can reduce the overall reinforcement efficiency [37-39].

2. Applications of NFC

The natural fiber composites can be very cost effective material for following applications:

- Building and construction industry: panels for partition and false ceiling, partition boards, wall, floor, window and door frames, roof tiles, mobile or pre-fabricated buildings which can be used in times of natural calamities such as floods, cyclones, earthquakes, etc.
- Storage devices: post-boxes, grain storage silos, bio-gas containers, etc.
- Furniture: chair, table, shower, bath units, etc.
- Electric devices: electrical appliances, pipes, etc.
- Everyday applications: lampshades, suitcases, helmets, etc.
- Transportation: automobile and railway coach interior, boat, etc.
- The reasons for the application of natural fibers in the automotive industry include:
- Favorable Eco balance during vehicle operation due to weight savings.

3. Advantages of NFC

- Low specific weight, resulting in a higher specific strength and stiffness than glass fiber.
- It is a renewable source, the production requires little energy.
- CO_2 is used while oxygen is given back to the environment.
- Producible with low investment at low cost, which makes the material an interesting product for low wage countries.
- Reduced wear of tooling, healthier working condition, and no skin irritation.
- Thermal recycling is possible while glass causes problem in combustion furnaces.
- Good thermal and acoustic insulating properties.

4. Materials Testing

Materials made by as per required composition ratio. Materials are treating chemical reaction in required time. The following machineries are used to find out the mechanical properties for

- Tensile testing.
- Compression testing.
- Flexural testing.
- Impact testing.
- Hardness testing.
- Moisture absorption testing.

5. Literature Survey

V. K. Srivastava, et al. [1] Analysis of particles loaded fiber composites for the evaluation of effective material properties with the variation of shape and size.

Noorunnisa Khanam, et al. [2] studied the tensile, flexural and compressive strength of hybrid composites with different fiber lengths of coir/silk in unsaturated polyester matrix.

Coir/silk fibers taken ratio of 1:1 and incorporated with unsaturated polyester resin with different lengths such as 1, 2 and 3 cm. Finally observed that 2 cm fiber length produced higher, flexural and compressive strength than others.

Mylsamy and Rajendran, et al. [3] reinforced raw and alkali treated chopped agave fibers in epoxy matrix. Its prepared 3 mm, 5 mm and 7 mm length raw and alkali treated fibers. It found alkali treated fiber withstood more fracture strain than the other one. Out of the three different fiber length reinforcements, alkali treated 3 mm agave fiber reinforcement superior better mechanical properties.
Frederico, et al. [4] investigated the dynamic-mechanical behavior of epoxy matrix composites reinforced with ramie fibers. The temperature variation of the dynamic-mechanical parameters of epoxy matrix composites

incorporated with up to 30% in volume of ramie fiber was investigated by DMA tests. Parameters storage modulus, loss modulus and tangent delta are investigate temperature from 20 to 200°C in equipment operating in its flexural mode at 1 Hz under nitrogen. It show result that incorporation of ramie fiber tends to increase the visco.

Abdullah, et al. [5] analysis different materials for pallet design using Ansys.

A pallet designed and analyzed by compare various materials on Pro-E and ANSYS respectively, analysis considering uniformly distributed static force on pallet. ANSYS show result, PVC made pallets excellent compares other pallets because less deformation in shape as compared to other material.

J. Arputhabalan, et al. [6] reviewed improve the tensile using chemical modification, increase in fiber content that time increase tensile strength and Young's modulus of reinforced composites .

Sukhdeep Singh, et al. make 50% fresh & 50% recycled reinforcement hemp fibers in HDPE matrix reduces the tensile strength with increase in hemp content. Composite with 20% hemp fibers observed high tensile strength compared 50-50 mixture of fresh and recycled HDPE.

C. Scarponi, et.al. [7] demonstrate hemp/epoxy used to replace glass/epoxy at Naca cowlings ultra-light aircrafts. Suggested more conservative approach regards the number plies to be used.

Sylvie Pretot, et.al. [8] appears that hemp-lime coating has a greater impact than sand-lime coating as it embeds more binder.

P. Tronet et.al. [9] deals with processing lime hemp composite blocks by compaction. Rigid compression die developed reach moderately high compression pressure. Fitted with force and strain transducers to measure stress state during compaction. To understand effect mix design and stress level on the compressibility and homogeneity of hardened composites. Also increases moisture both friction and packing compressibility.

Giedrius Balciunas, Et.al [10] investigates thermal conductivity and microstructure on hemp hurds with cement, clay & starch. Compressive strength dependence on density of various compositions.

M.M. Kabir, et.al [11] discussed tensile properties with treatment effect in various fiber diameters. It found tensile strength of chemically-treated fibers lower than untreated fiber.

K.L. Pickering, et.al [12] addressed to improve properties for strength, stiffness and impact strength including the moisture effect long and short term performance. NFCs compare with GFRPs in stiffness and cost; values of tensile and impact strength are approaching those GFRFs. NFC Applications extended theatrically including load bearing and outdoor applications automotive exterior under floor paneling, sports equipment and marine structures. Ask required extend application range including improvement of moisture resistance and fire retardance.

Shadrach Jeya Sekaran, et.al [13] researched banana fiber epoxy with glass composites preparing hand-lay method. Varying flexural load to show average 5.6 mm displacement. SEM used test external surface layer. Need good strength on that time further research required to replace suitable natural fibers of synthetic fibers.

V.P. Arthanarieswaran [14] Scanning Electron Microscope used to analyze banana (B), sisal (S) fibers were chopped and woven E-glass (G). Nine different laminates prepared sequence of B, S, BS, G/B/G, G/S/G, G/BS/G, G/B/G/B/G, G/S/G/S/G and G/BS/G/BS/G then find tensile, flexural and impact strength evaluated and compared that addition of two and three layer of glass fiber can improve the tensile strength factor of 2.34 and 4.13 respectively. Flexural properties enhanced on banana–sisal fiber with two layers of glass fibers rather than three layers and laminate with sisal and three glass ply offers better impact strength.

6. Conclusion

A lot of research has been done on natural fiber reinforced fiber composites but research on Hemp, Sisal, Banana and Roselle are not so familiar. Polymer composites are very rare. Against this background, the present research work has been undertaken, with an objective to explore the potential of the above said fiber polymer composites and to study the mechanical and material characterization of different composites. In future, the final composite material coated by calcium phosphate and hydroxyapatite (hybrid) composite can be used for both internal and external fixation on the human body for fractured bone.

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