iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XII **Month of publication:** December 2017

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor :6.887
Volume 5 Issue XII December 2017- Available at www.ijraset.com

Natural Fibres and Resins for Sustainable Composites

K BalaMurali Krishna[1], Gopi Krishna Bese[2]
1, 2 Associate Professor, Rinivasa Institute of Engineering and Technology.

Abstract: The increasing environmental concerns and depletion of petroleum resources has forced the researchers around the globe to find new green and advanced materials. In present review, a particular interest was focused on composites, advantages of natural fibre over glass fibre and the effective use of lignocelluloses natural fibres as reinforcement in composites.The use of natural fibres is very interesting in this field, given their good mechanical properties, their low cost and the ecological aspect that they represent. The natural composite includes a reinforcement made of non-woven natural fibres (flax, hemp, kenaf, sisal, jute, ramie, bamboo or nettle), as simple component or as a mixture

I. INTRODUCTION

From many centuries mankind are using natural fibres for various applications to reach the basic requirement of food clothing and shelter. In many countries by using natural fibres people have been exploring fibres such as cotton stark, rice-straw, rice-husk, baggase, cereals-straw and kenaf for various domestic and industrial purpose. For particle boards many of these fibres are used primarily. Work on reinforcement composite with which barley stalk had been reported by the Bouhicha et al. [1].The main importance of these indigenous natural fibres are of preparation composite son synthetic fibres has been reported by the Paramasivam and Kalam[2]. Lee et al worked on novel short silk reinforced polybutylene succinate bio-composites by compression of moulding method and observed that are improvement in flexural and also tensile properties [3] Joseph et al. [4] These fabricated composites are reinforced with banana fibres and also with varying length of the fibre and loading. These analysis of composite textile, impact and flexural optimum length and type of banana fibre are different in phenol-formaldehyde resole material. Resins are much higher than glass and phenol formaldehyde resin between the interlocking of banana fibre and phenol formaldehyde.

Askargorta et al. [5] studied the wetting behaviour of fibre flax with possible replacement for polypropylene by flax fibre as reinforcement of the preparation to composites. Escamilla et al. [6] observed that grafting of polymethyl methacrylate or polybutylacrylate on these cellulosic fibre resulted on lower mechanical strength than those of un grafted cellulosic fibres their use into composites as reinforcing agent. Donnell et al. [7] made use of the vacuum infusion process to the preparation for composite panel out of plant oil based resin and the natural fibres. They used mats for flax and cheap source of recycled paper as cellulose fibre, cellulose pulp and hemp as reinforcement. For possessing mechanical strength these natural composites at low cost arte found and other various properties suitable for those applications for in house fabrication materials like furniture and parts of automotive. With variation in different lengths of jute fibre reinforced with paste cement and mortar are studied with flexural, direct tension, impact strength and axial compression. Low cost material construction particularly jute fibres can be used for development for roofing, wall panels and other building materials [8].Reinforcement of cement mortar with about 80%sisal pulp with mass provided 50-60 fold increase in toughness fracture over these neat matrix [9].

Thermoplastic and thermosetting resin are reinforcement by use of lignocellulose fibre for the development of light weight composites with low cost as reviewed by Mishra et al. [10]. Plant cell physico-chemico-mechanical properties as fibrous lignocelluloses composites are observed in relation to those shrinkage and water swelling behaviour [11]. Khanbashi et al. [12] studied that polymeric materials reinforced for potential using data palm fibres. For fibre reinforced concrete to get ultimate strength to predict an empirical formulas are given by shanmugam and swaddiwudhipong [13]. From natural sources feasibility of low cost for strong engineering materials are explored by Castiano et al. [14] natural fibres are reinforced with preparing laminates of urea formaldehyde. Satyanarayana et al. [15]there are new uses of polyester based composites reinforcement as natural fibres. After exposure to indoor and outdoor weathering performance of these composites are evaluated by both non-destructive and destructive testing methods. Dweib et al. [16]for housing facility they developed natural composites roof, structural panels and unit beams out of soya bean oil based resin using vacuum assisted resin transfer moulding technology. There are many advantages by introducing these composites as building, construction materials by having high strength and stiffness with weight, susceptibility to survive severe weather conditions, fatigue resistance, desired ductility and design flexibility. McMullen [17] Development of composites having starch and gelatin reinforced with cellulose fibres for use in aircraft structures.

Composites consisting of short wheat structure fibres with better resin penetration and fibre wetting have been found to depict high strength. The flexural strength increased by 40% on butyrate lignin adhesion [18]. In case of flax fibre loaded with approximately8 to 10% by mass, flexural strength increased that was comparable to Pinusradiata fibre reinforced cement mortars. These facture toughness values are approximately half to that of pinusradiata composites. So flax fibres are not as effective for asbestos fibre replacement as they are pinusradiata fibre [19]. Rousion et al. [20]manufactured hemp/kenaffibre-unsaturated polyester composites using resin transfer moulding process. Their tensile and flexural strength were analysed. Cement mortar reinforcement of bamboo mesh imparted considerable ductility, tensile as well as its toughness impact strength and flexural [21]. Maffezzoli et al. [22] formulated cardanolmatrix based bio-composites reinforced with natural fibre. Bledzki etal. [23] improved the properties of epoxy resins and polypropylene composites through reinforcement with mercerized flax and hemp fibres. Mechanical properties of the fibre were monitored by focusing on mercerization parameters. Triglyceride oils derived from plants were used in the preparation of polymers with a wide range of physical properties and their reinforcement with 20% hemp fibres displayed a tensile strength of 35 MPa. In case of reinforcement with flax fibre, tensile and flexural strengths were found to be in the range between20-30 and 45-65 MPa, respectively. However, hybrid composites like rein for cement with both glass and natural fibres showed properties in between the two [24].

Aggarwal [25] improved physic-mechanical and bagasse-cement composites testing report showed that these composites satisfying most of the requirements of various standards on cement-bonded particle boards with high performance even in moist conditions. Coutts and Ni [26] reported bamboo fibres as a potential reinforcement for autoclaved cement building material. By loading 14% of mass on fibre the composite results shows that flexural strength greater than 18Mpa and 1.3 gcm-1 densities but the facture toughness is less than of 0.5KJ m-2. Zhuet al. [27] reported the fabrication of banana fibre reinforced cement composites and fibre loading of 8-16% by mass resulted in increase in flexural strength by 20 MPa for use as commercially viable building materials.

The successful applications of natural fibre reinforced composite is one of the key problems, the compatibility issues and adhesion between these fibre and polymer matrix. For solving problems researches started modifying the fibre surface properties as well as using compatibility to increase the adhesion between matrix and reinforcement. Cellulosic fibres are considered as potential reinforcement due to their easy renewability, availability, biodegradability, low cost, high toughness, low specific gravity, acceptable specific strength and enhanced recover energy etc. price and compulsory demand of ecologic awareness are primarily driven from the applications of cellulosic fibres varieties of cellulosic fibres are commercially available, as hibiscus sabdariffa, grewiaoptiva, sisal, jute, flax and pine needles etc. in these fibres hibiscus sabdariffa and grewiaoptiva are now being assessed as potential reinforcement in polymer composites. Due to industrial utility hibiscus sabdariffa are now being cultivated almost throughout the world to mature it takes about six months. Mature plant serves as sources of bast fibres. In existing literature scanty information is available on effective utilization of these fibre as reinforcement material. Chauhan and kaith had made several attempts to utilize te fibre and explore their viability as backbone for fopolymerization graft and as well as reinforcement to phenol formaldehyde matrix base composites[28-35].

II. CLASSIFICATION

A. Natural Fibres

For substitution Natural fibres are good candidates as reinforcement for composite products in place of customary synthetic fibres like E glass. There are some 2.3million tonnes of glass fibres devoted for various applications around the globe opportunities for natural fibres are a number of use in place of existing glass fibres. The advantages of Natural fibres over glass fibre: low cost, low density, high toughness, acceptable specific strength properties, good thermal properties, low embodied energy, reduced tool wear, increases irritation for skin and respiratory system, processing have a low energy requirement. In addition to their biodegradable or recyclable depends on the selected matrix. For vegetable fibres are often referred to natural fibres, plants are characterised into three types, depending on extraction from plants part.

1) From fruits plants fruit fibres are extracted, they are hairy, light, and allow the wind to carry the seeds.
2) In the stems of the plant providing the plant its strength and they are Best fibres. In tropical plant fibres, such as kenaf, or ramie, it is possible to find the fact that the fibre bundles making the outer stem structure are continuous for the height of the stem in the manufacture of long fibre composites.
3) Extracting fibres from leaves are rough, sturdy and also form parts of plants transportation system, they are called as leaf fibres.

Determining the properties of natural fibres, while dealing with natural products one has to keep in mind that with properties are strongly influenced by their growing environment Temperature, humidity, the composition of the soil and all air affect the height of the plant, strength of its fibres, density, etc. The way of harvesting the plants and processed can result in a variation of properties

B. Fruit fibres

1) *Cotton:* With other natural fibres comparison, Cotton is rather weak. Due to its dry weight it can absorb moist up to 20%, without wet feeling and is also a good conductor of heat. Cotton is applied for the manufacturing of clothes, blankets, carpets, mobs and medical cotton. It is uses as great amount of water when growing and intensive fertilisation is requires. These attributes can have an adverse environmental impact, for example: the Aral Sea evaporation.
2) *Coir (Coconut fibre):* Coconut fibre is obtained by the husk of the coconut palm fruit. The fruits are dehusked with a spike and after retting, subtraction of fibres is from the husk with washing and beating. The fibres are strong, light and can easily withstand heat and salt water. After growth of nine months, the nuts are still green and contain white fibre, in production of yarn can be used, rope and fishing nets. After growth of twelve months, they become brown and can be used for mattresses and brushes.

C. Stem fibres

1) *Jute:* The extraction from the ribbon of the stem. When the help of sickle shaped knife harvested the plants are cut near the ground. The small fibres, 5 mm, were obtained by successively retting in water beating, stripping the fibre from the core and drying. Due to short fibre length, weakest stem fibre is the jute, although it’s rotting very easily. It issued as packaging material (bags), carpet backing, ropes, yarns and also wall decoration.
2) *Flax:* With an increase Flax is a strong fibre strength of 20% in wet conditions and without feeling wet it can absorb 20% moist. Due to sunlight and burns the elastic fibre degrades when ignited. Flax has good heat conducting properties, and is hard wearing durable. However, in the same place constant creasing in sharp folds tends to break the fibres. The production of linen and canvas, ropes and sacks Flax is used.
3) *Ramie:* Ramie is an expensive and durable fibre that can be dyed very easily, and it is therefore more often used in construction material for decorative fabrics. Applications are curtains, sewing wallpaper, thread and furniture covers.
4) *Hemp:* The hemp yarn has of all natural fibres. Against water is highest resistance, but it must not be creased mostly to avoid breakage. For rope, fishing nets, paper, sacks, fire houses and textile fibre production.
5) *Kenaf:* In tropical regions Kenaf is a strong fibre plant grown now. It is river retted but is capable of continuous cropping. For making rope, cordage, canvas, sacking, carpet backing, nets, table cloths etc...The fibre strands which are 1.5 - 3 metres long are used.

D. Leaf fibres

1) *Sisal:* These products strong and sturdy fibres are highly stable against heat and moist. They are used for mats, ropes, cement reinforcement and carpets mainly

E. Long fibres in thermosetting composites

A wide range of long natural fibres (flax, hemp, jute, coir, sisal, kenaf, bagasse, pineapple leaf fibre etc.) have been used in thermosetting matrices such as epoxy, polyester, polyurethane and phenolicresins. Here several different fibre lay ups are possible, with non-woven mats combining low cost and ease of handling. The directions of the principle stresses fibre can be used unidirectional from tow or in woven textiles for higher performance and greater precision in aligning fibres. The production cost is Hand layup,in terms of performance are greater however high end applications the benefits. Using of natural fibre in both epoxy resin and thermoplastic resins environmental benefit (polypropylene and ABS)review of several studies was made in 2004 has been reviewed by Life Cycle Assessment and a. It concluded that natural fibre reinforced composites had four principle benefits over glass fibre reinforced systems:

1) Lower environmental impact of Natural fibres has in production than glass fibre.
2) NFCs have a higher fibre loading than GFCs thus reducing the proportion on non-renewable resin or polymer required for production.
3) Less energy is used in service Lighter weight of NFCs means that, for example, as a vehicle component than would be needed for heavier GFC material.

4) The end of life can recover energy at Incineration.
5) Pyrolysis to produce syn-gas would also be option.

III. BIO BASED RESINS

The market of rapidly developed bio derived polymer has led to wide ranging research on natural fibres in many matrices. Some of the main thermoplastics are starch and starch caprolactone blends; polyesters such as polyalkenesuccinates, polyester amides, poly hydroxyalkanoates such as polyvinyl butyrate and polyvinylvalerate and poly α-hydroxy acids such as polylactic acid and polyglycolic acid. In these only some are biodegradable, including the starch polymers, polyhydroxyalkanoates and polyesteramides. With natural fibre reinforcement could lead to a new generation of biodegradable products suited to packaging and disposable applications in use of these polymers. In many urban areas the provision of compositing increased facilities is anticipated over the coming decade as many countries seek to reduce the quantity of material going to landfill. In these poly-lactic acid has received much attention, these widely available biodegradable polymer and has a relatively high melting point 160°C allowing processing conditions similar to those employed for polypropylene. Relatively PLLA also has high mechanical properties. In tests with 70%kenaf fibre in at failure was three times higher than in PLLA strength. This showed a strong anisotropic effect, however further tests using a laminate with fibre oriented in four principal directions(0°, 45°, 90° and 135°) showed a great improvement.

A. Starch

It is a complex polymer comprising a mixture of amy lose and amylo-pectin polysaccharides, yet uncharacterized is the exact structure. The starch properties will vary according to the ratio of amylose/amylo-pectin and according to the plant source. Corn is the major source of starch but it canalso be extracted from potato, rice and wheat. The polymer is crystalline due to the component presence are amylo-pectin. The two main disadvantages of starch are its water-solubility and poor mechanical properties. Hence, this polymer is suited to applications where long term durability is not needed and where rapid degradation is advantageous. In the manufacture of food trays it is often processed as foam where it providesan alternative to polystyrene for use, moulded shaped parts or as loose

B. Packing filler.

1) Polyesters: This group includes polyhydroxyalkanoates and poly (alkalinedicarboxylates) and are produced synthetically by condensation reactions between dicarboxylic acids and diols. Poly (alpha-hydroxy acid)examples include PGA (poly glycolic acid) and PLA (poly lactic acid). PLA in particular shows potentialas a structural material since it can be polymerized to a high molecular weight and is hydrophobic, yet vapour permeable. To maintain mechanical competence the properties latter render the polymer sufficient lifetime without rapid hydrolysis, whilst maintaining good composting capability provided always that industrial not domestic composting techniques are employed. The uses for this polymer group centre on medical applications such as sutures, implants, drug delivery systems and grafts.
2) *Cellulose acetate:* A modified polysaccharide Cellulose acetate is which can be prepared from a reaction between acid anhydride and cellulosic products derived from cotton linters, wood pulp, recycled paper or sugar cane. Biodegradation occurs through microbial attack. The manufacturing process for cellulose acetate was first patented at the end of the nineteenth century and the polymer found use in filaments, films and lacquers since that time. This biodegradable polymer exhibits good toughness and a high degree of transparency.
3) *Polyurethanes:* Generic polymer type are not generally biodegradable unless chemically modified as a Polyurethanes. These modified biodegradable polyurethanes are present being synthesised for use in regenerative medicine.
4) *Furfural alcohol and furan resins:* A compound which is extracted from naturally occurring agricultural residues are pre-cursor to furfural alcohol and furan-based resins is furfural. Residues may derive from sugar cane bar Grasse as well as corn cobs, cereal by-products or wood products.
5) *Bio based thermosetting resins:* A large number of bio based thermosetting resins can be formed from vegetable oils – by grafting hydroxyl, acrylate and maleate moieties or combinations of these onto the fatty acid triglyceride. Vegetable oils can also be epoxidase to form a reactive component for bio-based epoxy resins, the epoxidase oil also further reacted to produce polyols and used with isocyanides in polyurethane resin formulations. Thermosetting polyester resins can be produced using many combinations of diols and diacids to form the polyester resin base, the base then cross links on addition of carboxylic acid curing agents. Other naturally derived resins can be formed from cashew nut shell liquid (CNSL) which is extracted from the shell of cashew nuts as a by-product of the nut industry. The CNSL is rich in anarcardic acid, which is converted to cardanol during the heated extraction process. Cardanol can be polymerised by free radical polymerisation, and condensation

polymerisation between phenolic units can occur in the presence of aldehydes. These two component resin systems are suited to the same resin transfer moulding, vacuum bagging, sheet moulding and bulk moulding systems used in traditional thermo set composite manufacture.

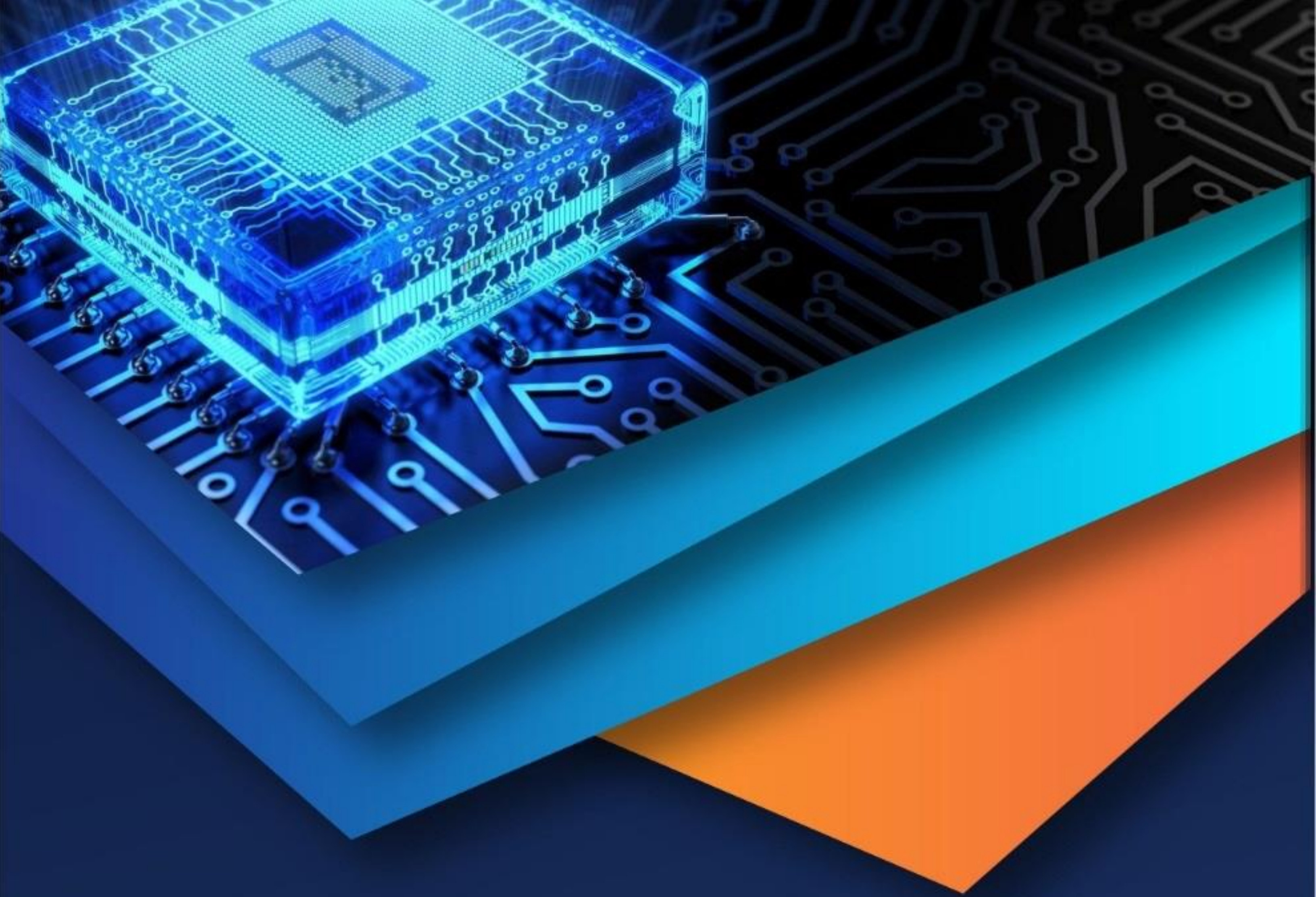
IV. CONCLUSION

Natural fibres and resigns are a gift to humans, using these renewable recourses wisely is very important, there is a huge demand and scope for research and study on these naturally available materials these kind of materials will surely replace metals and synthetic materials one day more over they also helps us in keeping our environment clean and free from pollution. In this journal, all the naturally available fibres and resigns are discussed with their occurrence, applications

BIBLIOGRAPHY

[1] Bouhicha M, Aouissi F, Kenai S (2005) Performance of Composite soil reinforced with barley straw. Cement and Concrete Composites 27: 617-621.
[2] Paramasivam T, Abdul Kalam APJ (1974) On the study of Indigenous Natural Fiber Composites. Fiber Science and Technology 7: 85-88.
[3] Lee SM, Cho D, Park WH, Lee SG, Han SOK, et al. (2005) Mechanical properties of Phenolic Composites. Compos SciTechnol 65: 647-654.
[4] Joseph S, Sreekala MS, Oommen Z, Koshy P, Thomas S (2002) A comparison of the mechanical properties of phenol formaldehyde composites reinforced with banana fibres and glass fibres. Compos SciTechnol 62: 1857-1868.
[5] Aranberri-Askargorta I, Lampke T, Bismark A (2003) Wetting behavior of flax fibres as reinforcement for polypropylene. Journal of Colloid and Interface Science 263: 580-585.
[6] Canche-Escamilla G, Cauich-Cupul JI, Mendizabal E, Puig JE, Vazquez-Torres H, et al. (1999) Mechanical properties of acrylate-grafted henequen cellulose fibres and their application in composites. Composites Part A: Applied Science and Manufacturing 30: 349-353.
[7] Donnell AO, Dweib MA, Wool RP (2004) Natural Fiber Composites with plant oil based resin. Compos SciTechnol 64: 1135-1140.
[8] Mansur MA, Aziz MA (1982) A study of jute fibre reinforced cement composite. International Journal of Cement and Concrete Composites and Lightweight Concrete 4: 75-82.
[9] Monties B (1991) Plant cell walls as fibrous lignocellulosic composites: relations with lignin structure and function. Animal Feed Science Technology 32: 159-175.
[10] Mishra S, Mohanty AK, Drzal LT, Misra M, Hinirichsen G (2004) A review on Pineapple leaf fibres, Sisal fibres and their biocomposites. Macromolecular Materials Engineering 289: 955-974.
[11] Coutts RSP, Warden PG (1992) Sisal pulp reinforced cement motar. CementConcrete Composites 14: 17-21.
[12] Al-Khanbasi A, Al-Kaabi K, Hammami A (2005) Date palm fibres as polymericmatrix reinforcement: Fiber Characterization. Polymer Composites 26: 486-97.
[13] Shanmugam NE, Swaddiwudhipong S (1988) Strength of Fiber ReinforcedConcrete deep beams containing openings. International Journal of CementComposites and Light weight Concrete 10: 53-80.
[14] Castano VM, Martinez L, Sanchez H, Arita L (1992) Preparation andcharacterization of Natural fibre-polymer resin composite. Materials Letters 15:108-112.
[15] Satyanarayana KG, Sukumaran K, Kulkarni AG, Pillai SG, Rohatgi PK (1986)Fabrication and Properties of natural fibre-reinforced polyester composites.Composites 17: 329-333.
[16] Dweib MA, Hu B, Donnell AO, Shenton HW, Wool RP (2004) All NaturalComposite sandwich beams for structural applications. Compos Struct 63:147-157.
[17] Mc Mullen P (1984) Fiber reinforced composites for aircraft primary structure: ashort history 1936-1984. Composites 15: 222-230.
[18] Thielemans T, Wool RP (2004) Bio-based carbon fibres and high performancethermosetting. Composites Part A: Applied Science and Manufacturing 35:327-338.
[19] Coutts RSP (1983) Flax fibres as reinforcement in cement mortars. InternationalJournal of Cement Composites and Lightweight Concrete 5: 257-262.
[20] Rouison D, Sain M, Counturier M (2004) Compos Science Technology 64: 629-634.
[21] Mansur MA, Aziz MA (1983) Study of bamboo-mesh reinforced cementcomposite. International Journal of Cement Composites and LightweightConcrete 5: 165-171.
[22] Maffezzoli A, Calio A, Zurlo S, Mele G, Tarzia A, Stifani C (2004) Cardanolbased Matrix bio-composite reinforced with natural fibres. Compos SciTechnol64: 839-845.
[23] Bledzki AK, Fink HP, Specht K (2004) Unidirectional Hemp and Flax EP-andPP-Composites: Influence of Defined fibre treatment. J ApplPolymSci 93:2150-2156.
[24] Khot SN, Lascala JJ, Can E, Morye SS, Williams GI, et al. (2001) Developmentand application of triglyceride based polymers. J ApplPolymSci 82: 703-723.
[25] Aggarwal LK (1995) Bagasse- reinforced cement composite. Cement ConcreteComposites 17: 107-112.
[26] Coutts RSP, Ni Y (1995) Autoclaved bamboo pulp fibre reinforced cement.Cement Concrete Composites 17: 99-106.
[27] Zhu WH, Tobias BC, Coutts RSP, Langfors G (1994) Air-cured banana-Fiberreinforced cement composites. Cement Concrete Composites 16: 3-8.
[28] Kaith BS, Chauhan A (2008) Synthesis, Characterization and MechanicalEvaluation of Phenol-formaldehyde composites. E-Journal of Chemistry 5:S1015-S1020.
[29] Kaith BS, Chauhan A, Singha AS, Pathania D (2009) Induction of themorphological changes in Hibiscus sabdariffa fibre on graft copolymerizationwith Binary vinyl monomer mixtures. Inter Jour Polym Anal Characterization14: 246-258.
[30] Chauhan A, Kaith BS, Singha AS, Pathania D (2010) Induction of themorphological changes in Hibiscus sabdariffa on graft copolymerization withacrylonitrile and co-vinyl monomer in binary mixtures. Malaysian PolymerJournal 5: 140-150.
[31] Chauhan A, Kaith B (2011) Evaluation of Morphological Transition in AdvancedMaterials. Der ChemicaSinica 2: 20-29.
[32] Chauhan A, Kaith B (2011) Evaluation of Dynamic Materials procured fromwaste Biomass. ISRN Material Science 7.
[33] Chauhan A, Kaith B (2011) Recycling the Cellulosic Biomass to CompetentMaterial. J Textile Science Engineering 1: 1-5.

[34] Chauhan A, Kaith B (2012) Physical, chemical, thermal, and mechanicalassessments of Roselle-reinforced composites. Journal of Polymer Engineering32: 127-133.
[35] Chauhan A, Kaith B (2013) Evaluation of Serenifibre reinforced composite. JEngFiberFabr 8: 36-43.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY