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A RECENT TRENDS IN NATURAL FIBER REINFORCED COMPOSITES: CRITICAL REVIEW AND PREPARATION OF NOVEL COMPOSITE

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Abstract:

There has been a lot of activity to give ecologically economical and biodegradable materials for the up and coming age of composite items because of worldwide natural issues and expanded comprehension of sustainable green assets. Expanded utilization of common materials in composites has added to a lessening in ozone harming substance outflows and the carbon impression of composites. Notwithstanding the focal points picked up from green textures, there are troubles in working with them, for example, the low similarity between the fortification of regular fiber and lattice and the generally high retention of common filaments by dampness. Green composites are an adequate substitute for oil base material. Notwithstanding, before it should be possible, a scope for issues should be handled, including feeble interfacial bond between the lattice and common strands, dampness assimilation, helpless imperviousness to fire , low effect quality , and low toughness. A few scientists have explored properties of normal fibers composite. These examinations have added to the formation of numerous methods for the adjustment of common strands and tars. So as to satisfy the developing need for the utilization of eco-accommodating materials for various applications, correct investigation of common fibers and pitch type and source, change and preparing measures, physical with mechanical practices, applications, life cycle evaluations and other green composite properties are expected to give a superior comprehension of conduct of regular composite.

***Keywords:* Natural fiber reinforced composite, Sustainability, Green manufacturing.**

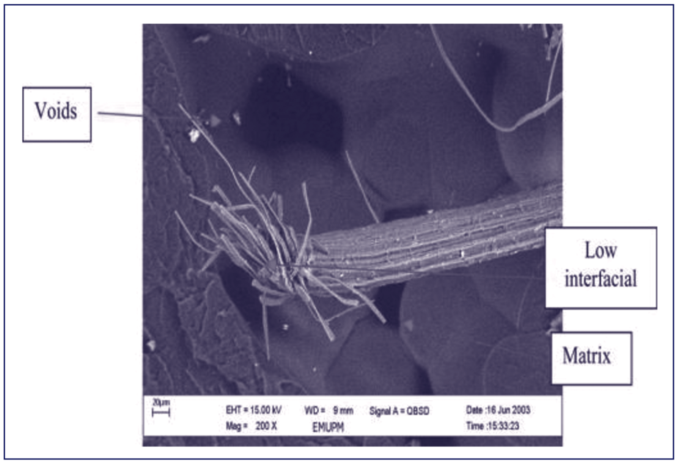
INTRODUCTION

Because of the expanding ecological mindfulness, characteristic fiber composites are getting more pervasive being used. Likewise, the materials' generally ease and low thickness, worthy explicit properties, ease of partition, upgraded energy recuperation, CO_2 lack of biodegradation, with recyclable properties, had concentrated on regular fiber use in composites. Materials which are vigorous, solid, low weight and have astounding mechanical properties that are significantly in a way that are good than those of conventional materials fuel the expanding interest for normal fiber in different businesses, for example, car and development. Ongoing examination appraises that in 2010, all out worldwide shipments of normal fiber composite materials expanded to 430 million pound, with an estimation of US $ 289 millions, the interest is required to ascend to US $ 531 millions of every 2016, with a compound yearly development rate (CAGR) of 11 percent throughout the following 5 years.1 The report additionally proposed that the expanded utilization of regular fiber composites in car applications is relied upon to increment. Surely, the car business is extended to remain the biggest market by 2016. A few car parts are currently delivered utilizing characteristic composites, by and large dependent on polypropylene (PP) pitch and filaments, for example, flaxes, hemps, kenaf or sisal. The vehicle models, firstly in Europe and later on in North America, included fortified common fibers thermocouple and thermoplastic in entryway boards, box plate, seat back and trunk liner. The utilization of regular fibers composite has expanded and picking up inclination over glass fibers and carbon fibers. Surface treatments for natural fiber is important topic for many scientists for utilizing the benefits of natural fiber in composites and for utilizing effectively it in many industrial usage. This research is very different and mentioned literature survey explains various methods like chemical, physical and biological ways [1].

The mechanical properties of fiber depend on type of fibre, originiage, volume fracton physical properties, structure, environmental conditions and processing methods. Different matrixsystems have different properties.Natural fibres have well prospective as reinforcements in polymer composites. Due to high specific properties and low density of natural fibres, I composites based on these fibres may have very good implications in industries

[2]. "Recycled paper was used as a cheap resource of cellulose fiber and found to work well with AESO resin in terms of flow, impregnation, and surface bonding, giving a modulus of over five times that of the neat resin. These lowcost natural composites were found to have mechanical strength and properties suitable for applications in housing construction materials, furniture and automot veiparts" [3]. "The results of the present study showed that useful composites with good strength could be successfully developed using pineapple fibre as a reinforcing agent for the polypropylene matrix. Tensile modulus and tensile strength of the composites increased significantly, compared with pure resin. The flexural modulus and flexural stress of the composites increased with the increase of volume fracton but the values are somewhat lower as comparing to the result of other researchers"[4].

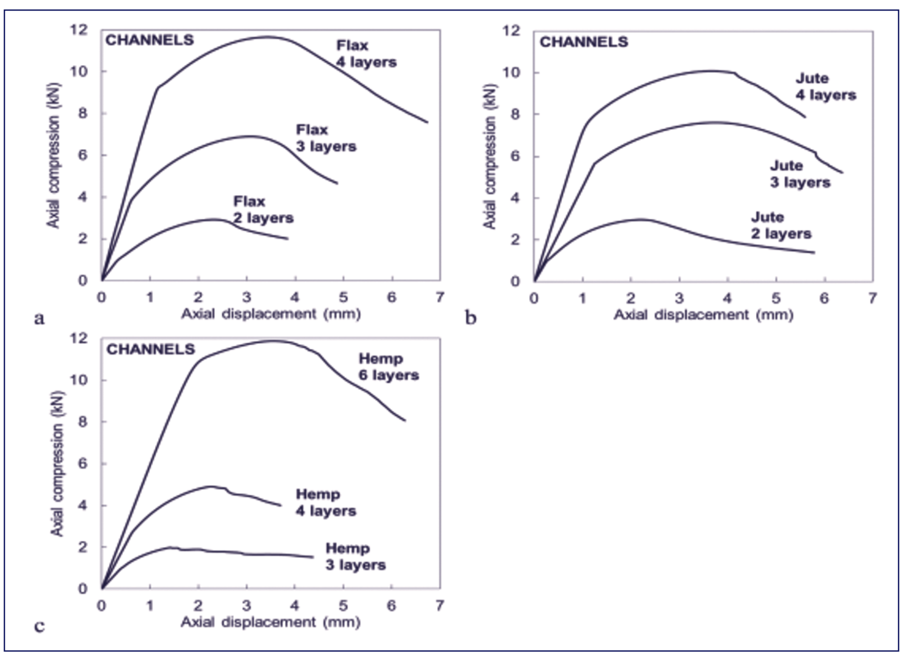
Fig. 1. SEM of tensile failure area of PALF – PP composite showing void with low interfacial between fiber and PP [4]



A material drugs of the constituents enhances I mechanical properties of filaments. The pure sweetener composite have the high estimations of effects and flexural quality than slashed glass filament composites; additionally, the extra drawn out fibers improves flexural and sway properties. Synthetic alteration of glass fibers surfaces are expected to raise appealing communication in the fiber polymer interfacing. This proves that the blending of strands able to conquer the short come of individual cleaved glass fibers having no interfacial holding between hacked glass fibers and polymeric grids [5]. A trial concentrate on advancement of polymers bio-composite. The powdered coconut shells, pecan shell and rice husk can be utilized as fortification with bio- epoxy sap to shape cross breed composites examples. The fiber pieces in every examples are 1:1 where the gum and hardener arrangement 10:1 individually. The created composites are tried according to ASTM norms to assess mechanical properties, like elasticity, flexural strength, shear strength and effect quality is being assessed both way with and without dampness. The result of tests showing half breed composite has obviously greater properties than single fiber glass fortified composite having mechanical burdens. It is discovered that the joining of pecan shells and coconut shells fibers will enhance the properties [6]. This paper audits different regular strands, their physical properties, fiber texture types, manufacture techniques, stacking arrangement and disappointment standards. Fiber Reinforced Plastics(FRPs) have high solidness, quality, exhaustion harm resistance, weakness solidarity with proportions of weight, less coefficient of warm extension , less consumption, higher inside damping means good vibration energy ingestion, harm as interior may be checked simply with non dangerous test and may be captured on utilization of defensive covering a superficial level [7].

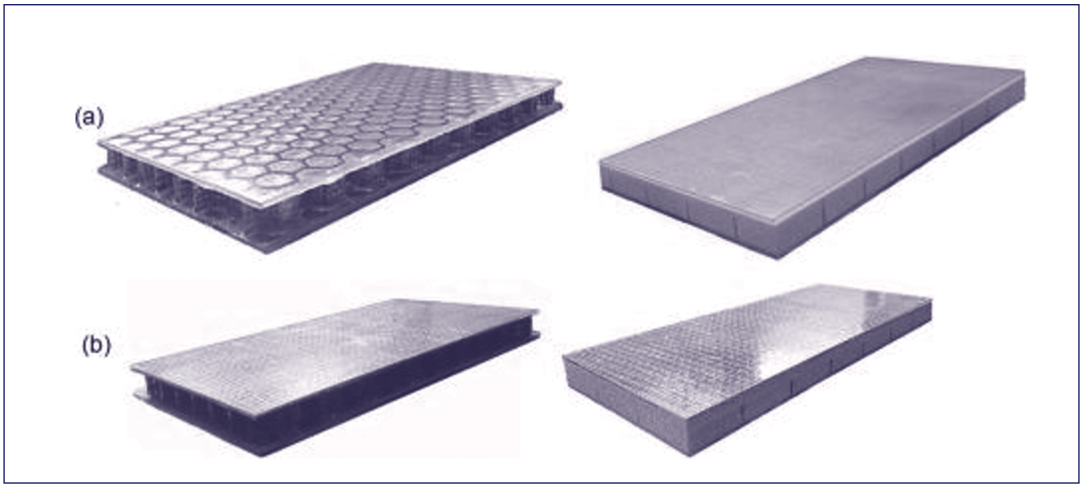
The current examination has exhibited the solid and unsurprising, but unassuming, mechanical conduct of regular fiber composite structure of flaxes, jutes and hemp in unadulterated pressure. With suitable regard for fiber and pitch plan and auxiliary calculation, characteristic fiber composites may demonstrate a feasible option in contrast to conventional structure materials later on [8].

Fig. 2 Exemplar composites channel test result; (a) flaxes, (b) jutes, (c) hemp [8]



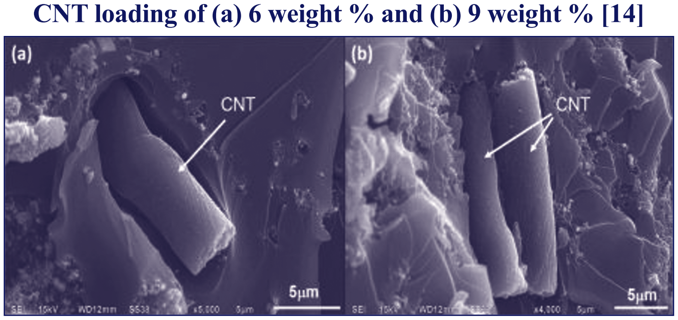
Impact of the different variables like the fiber's contents, fiber math, size, surface treatment method, coupling specialist on various properties as like mechanical, warm, conduct of water ingestion and others had been introduced. It very well may be surmised that its essential and extension for development of surface properties of regular fibers utilizing different strategies like physical and compound medicines, expansion of coupling specialists, and so forth for the assembly of the composites with required properties [9]. In the current work, mechanical properties and disappointment methods of normal and engineered fiber fortified composite sandwiched boards with three points twisting are considered. Expository models are created so as to anticipate mechanical reaction of apparent multitude of examples with various face sheet – center blends. The modes examined incorporate center shear, center squashing, face wrinkling, face yielding, and face sheet de-bonding. Regular fiber strengthened honeycomb and business PVC froth are utilized as centers. Jute strengthened polyesters and glass fibers fortified polyester are utilized as skin. Fiber fortified honeycomb centers are gotten by vacuum assisted resin transferring molding (VARTM) [10].

Fig. 3. Laboratory made Sandwiched panels with (a) glass fibers skin (b) jute skin [10]



Surviving examination contrasting life cycle ecological execution of normal fiber composite with glass fiber fortified composite locate the regular fiber composite are earth unrivaled in the particular applications contemplated [11]. A few minimal effort half breed composites made out of polyurethane and sustainable characteristic strands were created and investigated for its mechanical and physical properties. Composites are manufactured by supplanting up to 20% w/w of polyethylene glycol in customary polyurethane froths with the combination of three characteristic filaments: sugarcane bagasse, sisal and rice husk [12]. Normal filaments (sisals, kenaf, hemp, jutes and coir) strengthened polypropylene composites are handled by pressure shaping utilizing a film stacking technique. Mechanical properties of diverse characteristic fiber composites are tried and analyzed [13]. Creators built up another strategy for integrating CNTs and CNPs using synergist thermolysis of regular cotton strands. Longer CNTs, which can be 20 lm or more, can be created from normal cotton filaments with hydrogen climate at a thermolysis temperature about 1200 degree Celsius. Microstructure examination of integrated CNTs shows development system of L CNTs by synergist thermolysis for cotton strands can be unique in relation to those of utilizing CVD and different strategies. The structure of delivered nano materials (CNTs or CNPs) likewise rely upon the morphology of the cotton filaments after pretreatment measure [14].

Fig 4 SEM photos of CNT epoxy composites sample having CNT loading of (a) 6 weight % and (b) 9 weight % [14]



A pineapple leaf fiber (PALF) which is wealthy in cellulose, generally economical, and bounteously accessible has the potential for polymer support. The current examination researched the elastic, flexural, and sways conduct of PALF-strengthened polyesters composite as a component of fiber stacking, fiber length, surface adjustment [15]. This paper assumed that the half and half composites made by normal fibers with glass fibers shows better mechanical properties over characteristic fibers composite [16].Diverse normal filaments like jute, banana and sisal have been utilized as fortification and epoxy as network to make the regular fiber strengthened polymer unidirectional composite with the assistance of hand layup and pressure shaping. Mechanical properties like elasticity, flexural strength and effect quality for treated and non treated regular fiber strengthened polymer unidirectional composites have been researched and looked at [17]. Creators introduced a factual investigation of flexible modulus, quality, disappointment strain for far reaching set of composite LNF frameworks. It found that the changeability of LNF cover property like carbon fiber covers. It gave proposals to apply the measurable boundaries decided here to the plan of characteristic fiber composite structures. Our discoveries give a more profound comprehension of LNF composites unwavering quality and are significant for the further acknowledgment of these materials by the business [18].The exhibition of curaua fibers fortified polyester s composite exposed to ballistic effect with high energy 7.62 mm ammo. Composite fortified by 0, 10, 20 and 30 volume % of curaua strands are created and independent tried as covering objective to assess the assimilated energy [19]. The current investigation plans to decide the mechanical properties to be specific, Tensile strength , Flexural strength , and Impact strength of green coconut's fibers fortified HDPE polymer composite materials [20].This work is to assess the effect opposition of epoxy framework composites strengthened till 30 volume % of constant and adjusted jutes strands. This assessment is performed by estimating the Charpy retained effect energy of standard ASTM indented examples [21]. Utilizing normal fiber mat, aluminum sheet and epoxy gum, crossover composites are created through vacuum helped sap move forming (VARTM) measure. With tale sandwich structures, these cross breed composites contain characteristic fiber-based shells and super meager aluminum sheet center. The half and half composites offered phenomenal electromagnetic obstruction (EMI) protecting execution with great mechanical properties acquired from aluminum sheets and normal fiber based composite, separately. The shell material (characteristic fiber-based composites) gives insurance of the aluminum sheets from presenting to environment straightforwardly to forestall being consumed [22]. The reason for this examination is to explore the mechanical plausibility of a crossover Glass, Flax, Epoxy composite materials for bone crack obsession, for example, break plates. These half and half composite plates have a sandwiched structures in which external layers are made of Glass, Epoxy and the center from Flax, Epoxy. This arrangement brought about a one of a kind structure contrasted with earlier composites recommended for comparative hospital usage. To assess the mechanical properties of this cross breed composites, uniaxial strains, pressure, 3 point bowing and Rockwell Hardness tests are directed [23]. Creators dealt with composite made up from rice husks in Indonesia and the malleable and flexural strength of composite expanded while fiber weight part expanded [24].

The impact of strengthening regular fiber as meshed yarn woven texture on mechanical properties of polymer composite was researched. The aftereffects of interlaced yarn texture composites were contrasted and the regular yarn texture composite and arbitrary arranged personally blended short fiber composites for a similar level of fiber weight [25]. This examination embraced a thermodynamically reliable Continuum Damage Mechanics (CDM) way to deal with build up a prescient model for ductile reaction in normal fiber fortified composites (NFC). By virtue of fiber-explicit harm systems remarkable to various leveled stringy structures like plant strands, NFCs will in general display extensive nonlinearity in their fiber-course reaction (dissimilar to customary Glass or Carbon fiber composite) e which is represented in the harm model created in this investigation as nonlinear advancements of firmness and in versatility [26]. Concise outline for improving mechanical properties like ductile or flexural quality or relating modulus flexibility) for common fiber strengthened polymerized materials. Mechanical quality of the regular fibers fortified polymer composite-NFRPC being contrasted and of glass fiber strengthened polymerized composite and discovered for accomplishing comparable mechanical quality of material, volume part of common fiber ought to be a lot more than glass fiber [27]. Regular fiber composites (NFCs), as the name suggests, Made of normal assets, hence, has a biological character Characteristics, for example, biodegradability. The properties of NFC are principally controlled by the kind of fiber, the ecological condition where the plant strands are produced and the sort of fiber medicines. In any case, with their unordinary and wide scope of fluctuation, characteristic fiber composites could develop as a cutting edge elective designing material that could supplant the utilization of engineered fiber composites [28]. This paper gives a basic investigation of the writing on the different parts of common filaments and bio-composites, with specific respect to substance adjustments it is examined in this article. The extremity of normal strands is a significant disadvantage, which makes it incongruent with the hydrophobic framework. This contradiction brings about a frail between facial connection between the filaments and the framework. This, indeed, adds to hindered mechanical properties. This insufficiency can be helped by the compound modification of the filaments to make them less hydrophilic. This paper investigates the current improvements in substance adjustments and portrayals of common strands. The structure and properties of characteristic filaments is examined [29].

Type of natural composites

Composite	**Properties**	**Reference**
Polyamide 6 -PA6 and natural fibers like flaxes, kenaf , FR.	Strength, thermal stability	[30]
Expandable Graphite (EG)	Tensile strength, fire resistivity	[31]
Flax fiber composite	Tensile strength, mechanical properties (water ageing)	[32], [33]
Flax fiber reinforcement	Fatigue strength	[34]
Sisal polymer composite	Tensile strength, hardness, toughness	[35]
Sugar cane polymer composite	Mechanical properties	[36]
flax, basalt and hybrid flax & basalt	Impact behavior	[37]
lactic acids, thermoset resins, flax and flax-basalts fibers	Impact strength	[38]
Polylactic acids –PLA, reinforced composites with unidirectional flaxes and flax with papers layer.	Mechanical Properties	[39]

banana–flax based natural fiber composite	Mechanical & Thermal properties	[40]
Mat, roving, fabric, yarn and nanofilament	Biodegradable and mechanical properties	[41]
carbon, basalt and flax fiber	Strength, impact performance	[42]
Flax/glass composite	fracture toughness and interlinear shear strength	[43], [44]
Natural fiber-polymeric composite	Mechanical enhancement	[45]
Flax/PLA biodegradable composites	Absorb more energy and to normalize residual stresses	[46]
Flax-fibre nonwoven reinforcements	Mechanical and the formability behaviors	[47]
Flaxifibreireinforcedicompositesiwithianiinter-leavedinaturaliviscoelasticilayer	Vibrational behavior	[48]
Shortiflaxifiber imats, unidirectionali(UD)I layers iofiflaxi	Mechanical properties	[49]
Twilliflaxiandiglassifiberilaminateipliesi	Tensile Strength	[50]
Carbonifiberiandiflaxifiberireinforcedipolymeri (CFRPiandiFFRP)	Vibration suspension and damping	[51]
Hemp-flax composite	Absorption of water, mechanical strengths, thermal conductivity ,shrinkages.	[52]
Flax, flax – carbon, carbon fibre matrix	Strength	[53]
Flax fiber Flax fiber	Strong design	[54]
Poly-(propylene) (PP)/plant fibers composites, Flax fibers (Marylin variety	Mechanical properties and performance	[55]
Automated fiber placement (AFP)	Biomedical properties	[56]
Carbon and Flax fiber	Mechanical properties and controlling vibration damping	[57]
Plant fibers, woven	Mechanical properties	[58]
TiO2 grafted flax fibers	Mechanical and physical properties	[59]
Flax fiber	Residual Stresses	[60]
Flax-epoxy composites	Impact strength	[61]
flax/epoxy and flax/polypropylene	Mechanical properties and environmental friendly	[62]
Cellulose fibers	Mechanical property	[63]
Bamboo fibers	Wear property	[64]
Sisalifiberi	Tensile,iweariandiwateriabsorptioni characteristicsi	[65]
Hempifiber	Impactiandiflexuraliproperties	[66]
Piassavaifiber	MechanicaliCharacteristics	[67]
Celluloseifiber	ToughnessiandiImpactistrength	[68]
Recycleicellulose	fiberiFlexural,ifractureitoughnessi7,wateriabsorption	[69]
Coirifiber	Tensileiproperties	[70]
Juteifiber	Flexuraliandiinter-laminarishearistrengthi	[71]
Flaxifiberi	DatairelatediwithiRoseniModel	[72]
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Kenafifiber	Tensileiandiflexuralistrength	[75]
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Kenafifiberi	Validateitheitensileistrengthibetweeniexperimenti andi theoreticali-usingi(RuleiofiMixture)	[77]
Celluloseifiber	Thermaliproperties	[78]
Sugaripalmifiberi	Fickianidiffusivity	[79]
Weaveiflaxifiber	Wateridiffusivity	[80]
Flaxifiberi	Fractureianditoughnessi	[81]
Palmitreeifiber	Dielectriciproperties	[82]
Hempiyarnifiberi	Studyibetweeniexperimentaliandinumericali results	[83]
Silki	Energyiandifailureiresponse,iCrash worthinessicharacteristics	[84], [85]
HempifiberiFatigueibehavior	Lateral crushing	[86]
Flaxifiber	Dampingibehavior	[87]
Flaxifiberi	Fatigueibehavior	[88]
FlaxifiberiCrash worthinessicharacteristics	Fire reaction	[89]
Flaxifiberi	Interfacialicharacteristics	[90]
Hempifiber	Fatigueibehavior	[91]
Flaxifiber	Fireireactionicharacteristics	[92]
Naturalisilki	Absorptionienergy	[93]
Flaxifiberi	Crushingiproperty	[94]
Hempifiberi	Rheologicalianditthermalianalysis	[95]
Bananaifiber	Tensileiandiflexuralistrength	[96]
Tenaxileafifiberi	Mechanicaliandithermalicharacteristics	[97]
Bambooifiberi	Weariandifrictionalicharacteristics	[98]
Flaxifiber	Fatigueiproperties	[99]
Juteifiber	Tensileicharacteristics	[100]

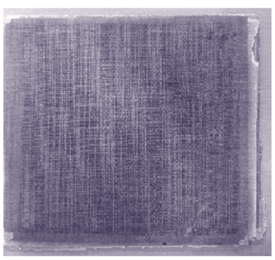
Literature Gap and preparation of novel composite: Tremendous work was carried out with natural composites and glass composites. Mechanical and thermal properties can effectively enhance with hybrid composites (jute + flax, flax+ glass). The synthetic and natural fiber hybrid composite produced by VARTM process gives a chance of supplanting existing materials with a higher strength, minimal effort elective that is earth benevolent.

Material: In this experiment for fabricating the composites specimen Jute, Flax, coir, hair and Glass fabrics are used. The raw jute and flax fabrics are collected from Go Green Products Chennai, Tamil Nadu India. The coir and hair collected from local market. The epoxy resin (Biresin CR-82) and Hardner (CH-80) are provided by Axson Sika pvt. ltd. Germany. The Glass- fabric 7781 available in Nano composite lab BVUCOE Pune.

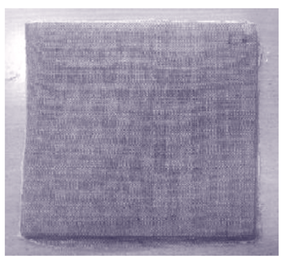
Preparation of composite specimen: Following are the steps of preparation of final composite samples which is according to ASTM standards.

Laminate Preparation: In this work, samples of laminates of jute, Flax, Glass having each six layers of fabrics and for combination of fabric having three layers of each fabric. For coir and hair fibers consider the average weight of six layer flax fabric 100 gm. All laminates were made by using VARTM process as shown in figure 5. This method used in this study was employed due to its simplicity and availability of the items. Also maintain high fiber volume low void in the composite laminate. First, the vacuum pump is turned on to expel air from the perform assembly. After the system has been equilibrated and all air leaks have been eliminated, the resin is allowed to flow into the perform. A pressure of 1 atm. provides both the driving force for the resin to impregnate the reinforcement and the compression force to compact the perform to the desired fiber volume fraction. The vacuum is left on until the resin has completely gelled. The part may then be cured at room temperature or in an oven. Due to the low injection pressure (1 atm), a resin distribution medium with high permeability is often incorporated into the vacuum bag lay-up to facilitate the resin flow in the perform.

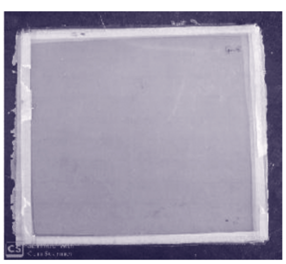
Fig: 5 VARTM setup



Jute Fiber composite



Flax Fiber composite



Glass Fiber composite

Fig. 6 prepared Laminate sheets of Natural and Synthetic fiber composite.

Cutting of coupons: After manufacturing sheets of all natural fiber composites cutting according to ASTM: D638 standards by Water Jet Machining (WJM), OMAX 60120 Jet Machining Center at Kakade Laser, Narhe Pune as shown in Figure 6 and 7. is used to cut the coupons as per the ASTM standards. In WJM, mechanical energy of water i.e high pressure about 3800 bar is used to achieve material removal or machining. As the process does not produce any heat, there is less damage to the component.

Figure 7 : Water Jet Machine

CONCLUSION

Regular filaments stuffed with epoxy composites have enormous potential for designing applications because of their natural appropriateness, mechanical plausibility and financial feasibility. Much exertion has been made toward this path to deliver these generally new composites, but numerous mechanical and financial issues presently can't seem to be settled before the effective commercialization of characteristic fiber-based epoxy composites. Different analysts utilized different medicines (counting soluble, saline, ultrasonic and so forth) and restricting specialists (zinc oxide, alumina, nano-earth and tourmaline) to upgrade the proficiency of regular fiber – epoxy composites notwithstanding, basic treatment is the most ordinarily utilized method for improving mechanical, warm and water assimilation properties of characteristic strands because of economy and high effectiveness. Regular fiber strengthened epoxy composites with ground-breaking mechanical properties and high toughness have been created in the course of the most recent decade. The critical difficulties for the not so distant future are to additional lift solidness and maintainability. Mechanical proficiency of these composites by lessening creation costs while executing an eco-accommodating methodology. Mixing of fiber is additionally a superior decision for upgrading the mechanical and warm presentation of normal fiber support epoxy composites. In the presented work, the critical review to know the recent trends of natural fiber reinforced composite has been studied critically. On the basic of literature gap, a novel composite has been prepared. The details process is presented in the present work.

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