SYNTHESIS & CHARACTERIZATION OF SHORT FIBER REINFORCED BIOCOMPOSITE

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Abstract

This proposal presents Fabrication and Characterization of Banana fiber strengthened biocomposite. Epoxy was utilized as a grid material. The creation of the biocomposite was finished by Hand-layup prepare. Biocomposites with different creation of fiber and grid were manufactured. The Banana strands utilized as a part of manufacture of composites were treated with NaOH and henceforth a relative review between Biocomposites fortified with treated and untreated filaments has been completed. Antacid treatment has demonstrated an extensive change in properties of biocomposite. The filaments treated with 0.5 % NaOH turned out to be better for fortification among different biocomposites. Biocomposite strengthened with 30% Banana strands has demonstrated a decrement in tractable, compressive, flexural, affect quality and Shore hardness. 20 % fortification was observed to be the ideal arrangement for biocomposite creation. The proposal work clears path for plentiful measure of research on creation of biocomposites strengthened with surface treated biocomposites and their application.

Keywords: *Biocomposites, Surface Treatment, Water Absorption.*

I. INTRODUCTION

A composite material is characterized as a mix of at least two materials that outcomes in better properties then the individual segments. Every constituent material holds its different synthetic, physical, and mechanical properties in composite material dissimilar to amalgams. Composite materials have comprised of at least one spasmodic stages installed in a persistent stage. The irregular stages are typically harder and more grounded than the nonstop stages. Intermittent stage are known as the "fortifications" or 'strengthening materials', though the persistent stage is named as the 'grid', which is more flexible and less hard. The fortifications serve to reinforce the composites and enhance general mechanical properties [1]. Properties of composites are firmly subject to the properties of their constituent materials, their appropriation, and cooperation among them. The composite properties might be the volume part aggregate of the properties of the constituents or the constituents may associate synergistically bringing about enhanced or better properties. Alongside the way of the constituent materials, the geometry of the fortification (shape, size, and size dispersion) impacts the properties of the composite all things considered. The focus conveyance and introduction of the fortification likewise influence the properties [2]. The interface has attributes that are not delineated by any of the part in segregation. The interface is a jumping surface or zone where the intermittence happens, regardless of whether physical, mechanical, concoction and so on. The framework material must "wet" the fiber. To get alluring properties in a composite, the connected load ought to be adequately exchanged from the framework to the filaments by means of the interface. This implies interface must be vast and show solid grip amongst strands and grid [3].

A. Types of Composites

Composites can be grouped on the premise of kind of network utilized in the composite for instance, polymer grid composites, metal framework composites, clay lattice composites, and carbon-carbon composites. The composite may likewise be arranged on the premise of the sort of fortification, for example, particulate strengthened composites and fiber fortified composites. The points of interest have been talked about:

Metal Matrix Composites (MMC)

A composite material comprising of metal as framework is called MMC. It have many favorable circumstances over solid metals like higher particular quality and modulus, bring down coefficient of warm extension and better properties at hoisted temperatures. Because of their above specify points of interest, MMCs are under thought for extensive variety of uses viz.

Ceramic matrix Composites (CMC)

On the off chance that the framework material is clay, then the composite is called CMC. One of the principle goals in delivering CMC is to expand the durability. CMC for the most part have high quality and firmness. The most generally utilized grid materials are SiC, Al2O3, ZrO2, Aluminum Nitride, Silicon Nitride, and so on.

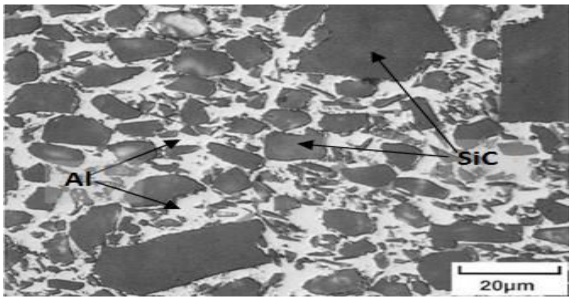


Figure1. 1 Al and sic particle in Metal Matrix [1]

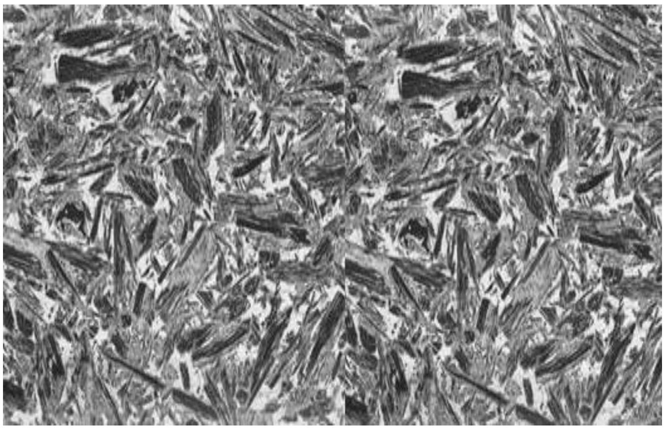


Figure1. 2 Ceramic Fiber reinforced in Sic matrix [2].

Polymer Matrix Composites (PMC)

In PMC the lattice materials are polymeric. All in all the mechanical properties of polymers are inadequate for some basic purposes; their quality and firmness are low contrasted with metals and pottery. These challenges are overcome by fortifying different materials with polymers. The handling of PMC does not required high weight and high temperature. Additionally, hardware required for assembling PMC is easier. Consequently PMC grew quickly and soon wound up noticeably famous for basic applications.

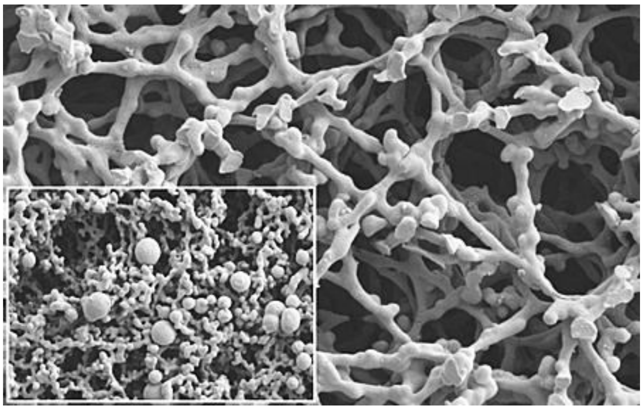


Figure1. 3 Nano structured PMC [3].

Carbon–Carbon Composites (CCC)

CCC utilizations carbon strands in a carbon lattice. CCC composites have been utilized as a part of high-temperature situations of up to 6000°F (3315°C). CCC is twenty times more grounded and 30% lighter than graphite strands. Carbon is weak and blemish delicate like pottery. Fortification of a carbon grid enables the composite to flop continuously and furthermore gives points of interest that are capacity to withstand high temperatures, low crawl at high temperatures, low thickness, great rigidity, compressive quality, high weakness resistance, high warm conductivity, and high coefficient of contact.

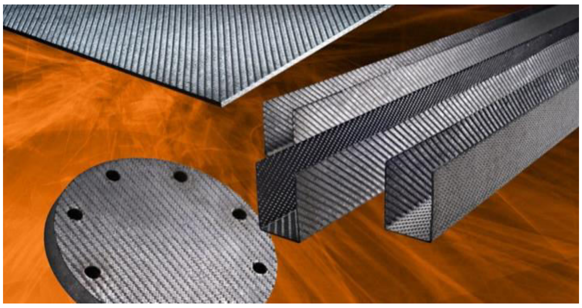


Figure1. 4 CCC [4].

II. RELATED WORKS

A. Constituents of composites

PMCs have created wide enthusiasm for different designing fields, especially in aviation applications. Research is in progress worldwide to create more current composites with changed mixes of filaments and fillers in order to make them usable under various operational conditions [8]. The composite fundamentally incorporates two constituents i) network and ii) fiber support.

Matrices

The part of network in a FRC is to exchange worry between the filaments, to give a boundary against an unfavourable situation and to shield the surface of the strands from mechanical scraped area. The network assumes a noteworthy part in the ductile load conveying limit of a composite structure. The coupling specialist or network in the composite is of basic significance. Four noteworthy sorts of lattices have been accounted for: Polymeric, Metallic, Ceramic, and Carbon. The greater part of the composites utilized as a part of the business today depends on polymer networks. Polymer pitches have been separated comprehensively into two classes: Thermosetting and Thermoplastics.

Thermosetting

Thermoset is a hard and solid cross connected material that does not mollify or end up noticeably pliable when warmed. Thermosets are firm and don't extend the way that elastomers and thermoplastics do. A few sorts of polymers have been utilized as frameworks for common fiber composites. Most normally utilized thermoset polymers are epoxy saps and different pitches (Unsaturated polyester tars (as in fiber glass) Vinyl Ester, Phenolic Epoxy, Novolac and Polyamide). Unsaturated

Polyesters are to a great degree flexible in properties and applications. They are most well-known thermoset utilized as the polymer lattice in composites. They are generally created modernly as they have many points of interest contrasted with other thermosetting tars including room temperature cure capacity, great mechanical properties and straightforwardness. The fortification of polyesters with cellulosic filaments has been generally utilized. Polyester-jute, Polyester-sisal, Polyester-coir, Polyester-Banana-Cotton, Polyester-straw, Polyester-Pineapple leaf, and Polyester-Cotton-Kapok, are a portion of the great frameworks.

Carbon fibers

Carbon filaments are utilized as fortification in network materials to frame composites. Carbon filaments are unidirectional fortifications and can be orchestrated in such a route in the composite that it is more grounded toward the path, which must bear loads. The physical properties of carbon FRC materials depend extensively on the way of the grid, fiber arrangement, volume division of fiber and framework, and on the trim conditions. A few sorts of lattice materials, for example, glass, earthenware production, metal, and plastics have been utilized as frameworks for support in carbon fiber. Carbon Fiber Composites, especially those with polymer grids, have turned into the prevailing propelled composite materials for aviation, vehicle, donning merchandise and different applications because of their high quality, high modulus, low thickness, and sensible cost for application requiring high temperature resistance as on account of rocket.

Glass fibers

Glass is the most well-known of all fortifying filaments for PMCs. The foremost points of interest of glass fiber are minimal effort, high rigidity, high compound resistance and magnificent protecting properties. The two sorts of glass filaments regularly utilized as a part of the fiber strengthened plastics businesses are E-glass and S-glass. Another sort known as C-glass is utilized as a part of synthetic applications requiring more prominent erosion imperviousness to acids than is given by E-glass.

Kevlar fibers

Kevlar has a place with a gathering of exceptionally crystalline aramid (sweet-smelling amide) filaments that have the most reduced particular gravity and the most astounding elasticity to weight proportion among the current fortifying strands. They are being utilized as support in numerous marine and aviation applications.

Boron fibers

The most unmistakable element of boron fiber is their greatly high tractable modulus. Boron strands offer brilliant imperviousness to clasping, which thusly adds to high compressive quality for boron fiber fortified composites.

B. Literature Gap

Characteristic Fibers are utilized as fortifying materials in polymer lattices as a substitution for traditional carbon and glass filaments. Banana filaments are one of such strands gotten from stem of banana plant and utilized as fortifying material in composites. They have great rigidity and high modulus of flexibility. Above all else plant strands are hydrophilic in nature with a dampness substance of 8-13% because of the nearness of cellulose in cell structure. Notwithstanding cellulose, plant filaments contain diverse characteristic substances. The most imperative one is lignin. Because of low thickness, high elasticity, high tractable modulus, and low stretching at break of banana strands, composites in view of these filaments have great potential use in the different divisions like development, car, hardware, and so forth., As India is one of the biggest banana delivering nations on the planet the utilization of its fiber and its squanders for creating helpful segments would be extremely alluring for the economy. Banana fiber and its composites can be further alluring if an appropriate financially savvy outline technique for fiber detachment and its composite generation may expand its application to a more noteworthy degree. Along these lines we infer that the deliberate and constant research later on will expand the extension and better future for banana fiber and its composites.

Hydrophilic nature of banana strands is one of the essential inconveniences which keep its vast scale application in composite making. It prompts dampness assimilation at more noteworthy degree and subsequently rotting of composite in brief era happens. Substance treatment of fiber surface to enhance its grip with polymer network is an advantageous approach to enhance the mechanical properties and hygrothermal conduct of composite. Acetylation of filaments utilizing NaOH diminishes the vulnerability of strands to dampness retention and enhances mechanical properties also. Grouping of NaOH is likewise controlling element. Change in fiber properties by concoction treatment techniques needs an impressive work. The relative investigation of biocomposites with various weight division of fiber and network to that with biocomposite with various centralization of concoction treatment on filaments surface likewise requires a detail think about.

III. Materials and Methods

Manufacture of composites by hand lay-up process is ordinary strategy for composite preparing. This part depicts the points of interest of handling of the composites and the trial techniques taken after for their portrayal.

A. Epoxy resin AY105/Hardener HY951

The Araldite AY 105 IN/Hardener HY 951 are multipurpose, two segment, room temperature curing, stream capable cement of high quality and natural resistance. It is reasonable for holding a wide assortment of metals, earthenware production, glass, elastic, inflexible plastics and most different materials in like manner utilize. The modulus of flexibility and elasticity of Epoxy is 7000 MPa and 70 MPa separately [24].

B.Banana and Banana Fibers

Banana strands gotten from the stem of banana plant (Musa sapientum) have been portrayed for their mechanical properties. The way of delegate stress strain bends and crack at various strain rates have been examined. Banana fiber at present is a waste result of banana development and either not appropriately used or halfway done as such. The extraction of fiber from the pseudo stem is not a typical practice and a great part of the stem is not utilized for creation of filaments. This is reflected from the generally costly cost of banana filaments (Table 3.1) when contrasted with other normal strands. The purchasers for banana strands are inconsistent and there is no precise approach to separate the filaments routinely. Valuable utilizations of such filaments would regularize the request which would be reflected in a fall of the costs [25].

Table 3. 1 Price of different natural fibers [2].

Natural Fiber	Price ($/kg)
Flax	0.15- 0.21
Hemp	0.15-0.30
Kenaf	0.15-0.60
Banana	0.43-0.81

Bast strands, similar to banana, are mind boggling in structure. They are for the most part lignocellulose, comprising of helically twisted cellulose miniaturized scale fibrils in indistinct framework of lignin and hemicellulose. The cellulose content fills in as a central component for mechanical properties alongside smaller scale fibril edge. A high cellulose substance and low small scale fibril point grant alluring mechanical properties for bast strands. Lignin is made out of nine carbon units gotten from substituted cinnamyl liquor; that is, Coumaryl, Coniferyl, and Syringyl alcohols. Lignins are related with the hemicelluloses and assume an essential part in the characteristic rot resistance of the lignocellulosic material. The piece of banana pseudostem acquired by natural investigation, as dictated by Bilba et.al is as given in Table 3.1

C. Fabrication of Bio composites

Banana filaments are strengthened in epoxy gum to set up the composite. The composite pieces are made by traditional hand-lay-up method. Banana Fiber (Figure?) is utilized as fortifying material in this composite since banana trees are richly accessible in India. The low temperature curing epoxy gum (AY 105) and comparing hardener (HY951) are blended in a proportion of 4:1 by weight as suggested. Epoxy AY 105 pitch is artificially having a place with the "epoxide" family and its basic name is Bisphenol A Diglycidyl Ether. The epoxy gum and the hardener are provided by Universal Enterprises, Kanpur. Composites of four unique organizations are made. The castings are put under load for around 24 hours for legitimate curing at room temperature. The thrown of every composite is cured under a heap of around 50 kg for 24 hours before it expelled from the shape. At that point this cast is post cured noticeable all around for another 24-25 hours subsequent to expelling out of the form. Examples of appropriate measurement are cut utilizing a precious stone cutter for mechanical testing.

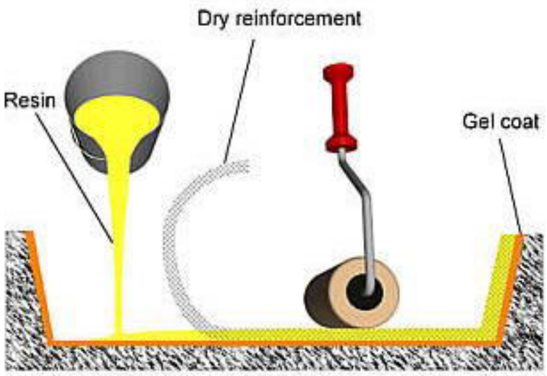


Fig. 3. 1Hand Lay Up Process

IV. CHARACTERIZATION OF COMPOSITES

A. Tensile testing machine

Biocomposites tensile testing has been carried out on Hounsfield tensometer (Figure 4.1). The machine is manufactured at Tensometer Limited, Croydon, Surrey, England. The available load scales of the machine are- 0-31 kgf, 0-62 kgf, 0-125 kgf, 0-250 kgf, 0-500 kgf, 0-1000 kgf and 0-2000 kgf. Tinius Olsen Tensometer can also be used for compression testing, and bending test of biocomposites as well.

Fig. 4. 1Hounsfield Tensometer

B. Specimen Specification

Shore hardness test allows for hardness measurement on plastic specimen using a specified standard indenter. ASTM D2240-00 refers several rubber hardness measurement scales (A, B, C, D etc.). The thickness of the specimen should be at least 6.0 mm. The specimen for Shore hardness test is as shown in Fig. 4.2 The two most common scales, using slightly different measurement systems, are the ASTM D 2240 type A and type D scales. The A scale is for softer plastics, while the D scale is for harder ones. Each scale results in a value between 0 and 100, with higher values indicating a harder material.

Fig. 4. 2 Shore Hardness Specimen

C. Shore Hardness Test of Banana Fiber-Reinforced-Epoxy Biocomposites

We apply the durometer on composite and note down the hardness from show of Durometer. The last estimation of the hardness relies on upon the profundity of the indenter after it has been connected for 15 sec on the material. On the off chance that the indenter infiltrates 2.54 mm or more into the material, the durometer is 0 for that scale. In the event that it doesn't enter by any stretch of the imagination, then the durometer is 100 for that scale. It is consequently that various scales exist. Durometer is a dimensionless amount, and there is no straightforward connection between a material's durometer in one scale, and its durometer in whatever other scale, or by some other hardness test.

V. RESULT AND DISCUSSION

In this chapter, the properties obtained through various experiments on natural fiber reinforced bio composite are discussed.

A. Force Elongation Curves of different biocomposites in Tension

Comparison of tensile test For 1 mm short fiber Bio composite.

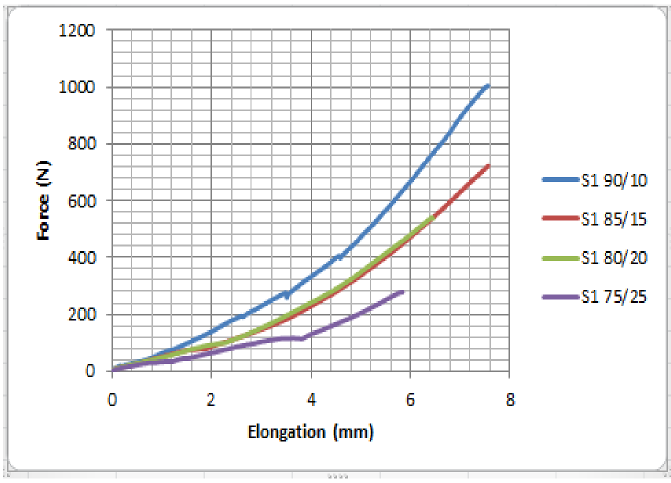


Fig. 5. 1Comparison among Force- elongation curves for various composition of 1mm short fiber bio composites during tension

It can be seen from the bend acquired through tests that as the proportion of fiber increments in the composite, its elasticity diminishes. The bend indicates nonlinear conduct from start of the test till the crack point. All the creation tried are demonstrating practically same conduct in the middle of 0 N to 200 N estimation of the constrain, after that the bend is changing its conduct. 90% epoxy and 10% fiber structure is indicating most astounding quality as its break point is 1000 N. 85% epoxy 15% fiber structure and 80 % epoxy 20% fiber creation is demonstrating practically same conduct yet the later one is having lesser quality as its break is happening at 520 N and the previous one is broken at 720 N. 75% epoxy and 25% fiber sythesis is having littlest quality as its crack point is 280 N as it were.

Comparison of tensile test For 4 mm short fiber Bio composite

This bend gotten through test demonstrates that on expanding the fiber length quality of composite have been diminished. Like the 1 mm fiber composite here additionally quality of composite declines with increment in the proportion of fiber. The bend indicates nonlinear conduct from start of the test till the break point. All the arrangement tried are demonstrating practically same conduct in the middle of 0 N to 100 N estimation of the drive, after that the bend is changing its conduct. 90% epoxy and 10% fiber organization is indicating most astounding quality as its break point is 700 N. 75% epoxy and 25% fiber arrangement is having littlest quality as its crack point is 140 N as it were.

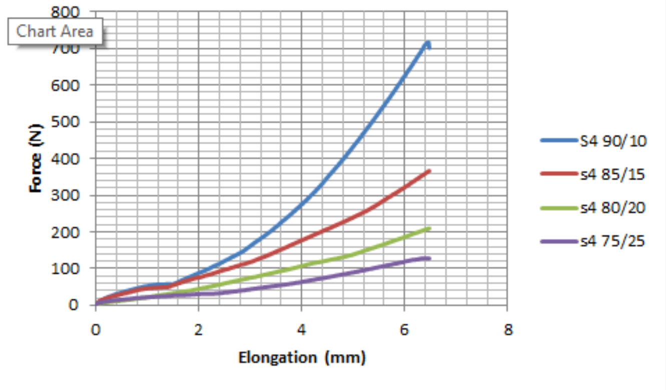


Fig. 5. 2 Comparison among Force- elongation curves for various compositions of 4mm short fiber bio composites during tension

B. Force Elongation Curves of different bio composites in Compression

Comparison of compression test For 1 mm short fiber Bio composite

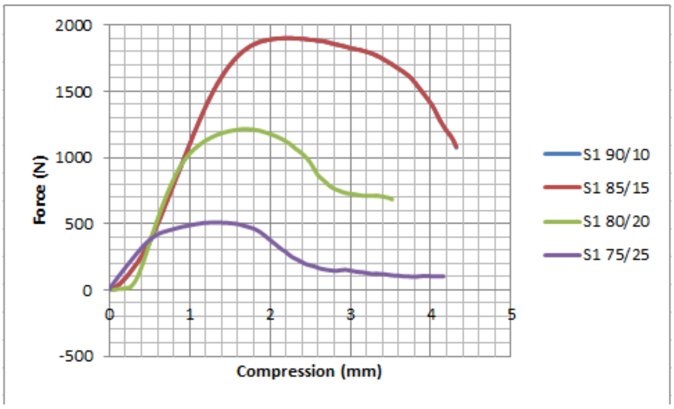


Fig. 5. 3 Comparison among Force- elongation curves for various compositions of 1 mm short fiber bio composites during compression.

It can be seen from the bend that in pressure test composite is indicating totally unique conduct than in strain. At first it is demonstrating direct conduct after that it is nonlinear. In pressure test 85% epoxy 15% fiber creation is indicating most astounding quality while 75% epoxy 25% fiber is demonstrating least quality.

C. Force Elongation Curves of different bio composites in Bending

In bowing test composite is demonstrating lesser quality when contrasted with pressure and strain test. The bend indicates nonlinear conduct from start of the test till the break point. All the creation tried are indicating practically same conduct in the middle of 0 N to 20 N estimation of the compel, after that the bend is changing its conduct. 90% epoxy and 10% fiber synthesis is demonstrating most noteworthy quality as its crack point is 160 N. 75% epoxy and 25% fiber organization is having littlest quality as its crack point is 40 N as it were. Comparison of bending test For 1 mm short fiber Bio composite.

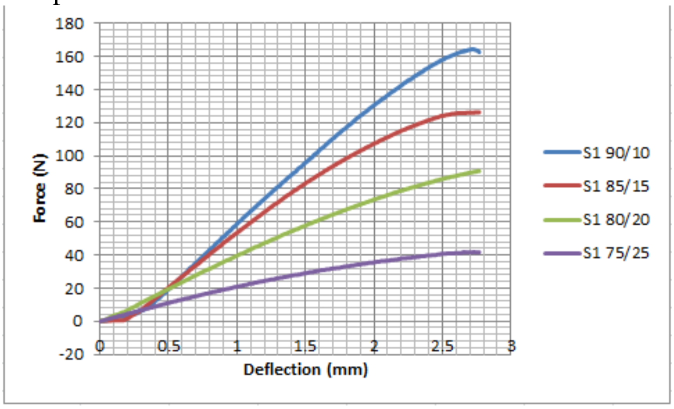
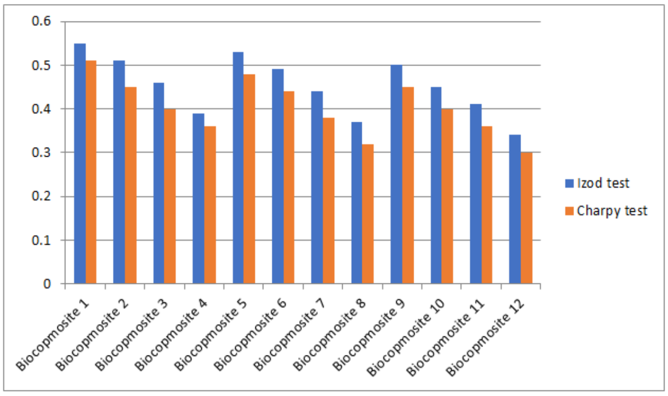


Fig. 5. 7 Comparison among Force- elongation curves for various compositions of 1 mm short fiber bio composites during bending

D. Impact Testing of Banana fiber-reinforced-Epoxy biocomposites

Results obtain under Charpy and Izod tests are shown and bar chart of results obtained in both tests is shown.



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His main research interests include Mechanical Engineering, and CAD. He is currently doing his project in Fiber Reinforced Biocomposite.