

# Mechanical Characterisation of Sisal Fiber Reinforced Polymer Composite

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**Abstract**—Eco friendly natural composite is highly demanded in world. In this paper we have chosen Sisal fiber due to its better mechanical properties. We have chosen tamarind shell powder as filler material also we have chosen epoxy resin as matrix. Composite specimens were prepared at various compositions and mechanical tests such as tensile, compressive and flexural were carried out, the result showed that 30% fiber content showed maximum mechanical properties and then the value gets declined with addition of fiber further. This is due to accumulation of fiber at one place.

**Index Terms**—Sisal. Fiber Reinforced composites. flexural. Mechanical properties. Natural fiber.

## I. INTRODUCTION:

In the current quest for improved performance, which may be specified by Numerous criteria comprising less weight, more strength and lower cost, currently used materials frequently reach the limit of their utility. Thus, material researchers, engineers and scientists are always determined to produce either improved traditional materials or completely novel materials. Composites are an example of the second category. Over the last thirty years composite materials, plastics and ceramics have been the prevailing emerging materials. The volume and numbers of applications of composite materials have developed steadily, penetrating and conquering new markets persistently. Modern composite materials establish a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. Composites have already proven their worth as weight-saving materials; the current challenge is to make them cost effective. The hard work to produce economically attractive composite components has resulted in several innovative manufacturing techniques currently being used in the

composites industry. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. India endowed with an ample availability of natural fiber such as Bamboo, Ramie, Jute, Sisal, Pineapple, Coir, Sisal etc. has focused on the improvement of natural fiber composites mainly to explore value-added application avenues. Such natural fiber composites are well matched as wood substitutes in the housing and building sector. The development of natural fiber composites in India is based on two cleft strategies of preventing depletion of forest resources as well as ensuring good economic returns for the cultivation of natural fibers. The developments in composite material after meeting the challenges of aerospace industry have poured down for catering to domestic and industrial applications. Composites, the spectacle material with light-weight; high strength-to-weight ratio and stiffness properties have come a long way in replacing the conventional materials like wood, metals etc. The material experts all over the world focused their attention on natural composites to cut down the cost of raw materials.

## II. MATERIALS AND METHODS:

Raw materials used Sisal fiber, tamarind shell powder, Epoxy resin (LY556), Hardener (HY951)

### SISAL FIBER:

Sisal plant or plantain plant or not only gives the delicious fruit but it also provides textile fiber, the Sisal fiber. Sisal fiber is natural fiber. Natural fibers present important advantages such as low density, appropriate stiffness and mechanical properties and

high disposability and renewability. Moreover, they are recyclable and biodegradable. There has been lot of research on use of natural fibers in reinforcements. Sisal fiber, a lingo-cellulosic fiber, obtained from pseudostem of Sisal plant (*Musa sepientum*), is a bast fiber with relatively good mechanical properties. Sisal plant is a large perennial herb with leaf sheaths that form pseudo stem. Its height can be 10-40 feet surrounding with 8-12 large leaves. The leaves are up to 9 feet long and 2 feet wide. Sisal plant is available throughout Thailand and Southeast Asian, India, Bangladesh, Indonesia, Malaysia, Philippines, Hawaii, and some pacific islands.



#### TAMARIND SHELL POWDER:

Every year large quantity of agriculture wastes like coconut coir, tamarind shell, groundnut shell, peanut shell is disposed due to lack of uses for these materials. Here we explore the potential of tamarind shell particles as a fiber in epoxy composites. The mechanical properties such as tensile strength, bending strength, flexural and thermal hardness are evaluated.



#### EPOXY RESIN:

Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. The epoxide group is also sometimes referred to as a glycidyl or oxirane group. A wide range of epoxy resins are

produced industrially. The raw materials for epoxy resin production are today largely petroleum derived; although some plant derived sources are now becoming commercially available (e.g., plant derived glycerol used to make epichlorohydrin). Epoxy resins are polymeric or semi-polymeric materials, and as such rarely exist as pure substances, since variable chain length results from the polymerisation reaction used to produce them. High purity grades can be produced for certain applications, e.g., using a distillation purification process. One downside of high purity liquid grades is their tendency to form crystalline solids due to their highly regular structure, which require melting to enable processing.

### III. FABRICATION METHODOLOGY OF SAMPLES:

#### Hand Lay Up Technique

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats are cut as per the mold size and placed at the surface of mold after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present.

The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mold is opened and the developed composite part is taken out and further processed. The time of curing depends on type of polymer used for composite processing. For example, for epoxy-based

system, normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer-based composites. Capital and infrastructural requirement is less as compared to other methods. Production rate is less and high-volume fraction of reinforcement is difficult to achieve in the processed composites. Hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, dais board, deck etc.



Prepared Composite sheet

#### FABRICATION OF COMPOSITES:

Composite plates were prepared using hand lay-up technique. First, a releasing agent (wax) was applied on the inner side of the mould to ensure easy removal of cured composite plates. The prepared reinforcing agent in a calculated amount were mixed with polyester resin and mixture was stirred by a mechanical stirred for few minutes. After that hardener were mixed with the resin mixture and stirred mechanically for few min. then, the mixture is poured into the mould and pressed using compression molding machine. Finally, the mould box containing the composite plate was allowed to cure at room temperature under load for few hours.

#### COMPOSITION OF COMPOSITE MATERIAL:

Specimen	Sisal fiber% + Tamarind shell powder %	Resin%
1	5+5	90
2	10+10	80
3	15+15	70
4	20+20	60

#### IV. TESTING

##### TENSILE TEST

Tensile Testing of Metals is a destructive test process that provides information about the tensile strength, yield strength and ductility of the material. It performs the tensile test in accordance with industry standards and specifications, including

ASTM tensile test methods. This process is also known as a tensile strength test or tension test. The most commonly used test specimen shape is dog bone shape. The dimension of the specimen is 200×50×3mm.

##### FLEXURAL TEST:

Flexural testing is used to determine the flex or bending properties of a material. Sometimes referred to as a transverse beam test, it involves placing a sample between two points or supports and initiating a load using a third point or with two points which are respectively call 3-Point Bend and 4-Point Bend testing. Maximum stress and strain are calculated on the incremental load applied.

Results are shown in a graphical format with tabular results including the flexural strength (for fractured samples) and the yield strength (samples that did not fracture). Typical materials tested are plastics, composites, metals, ceramics and wood.



Flexural testing Machine

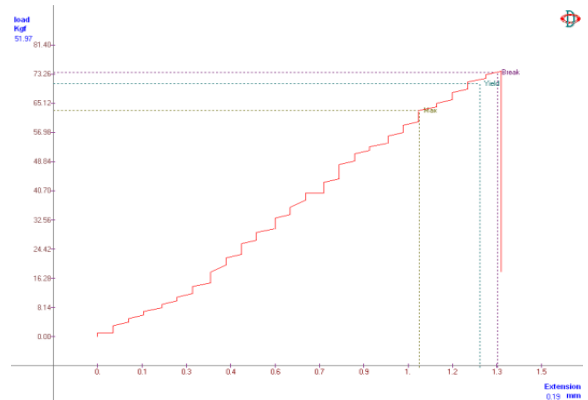
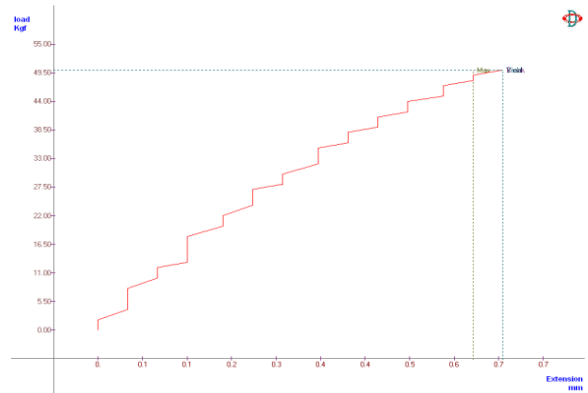
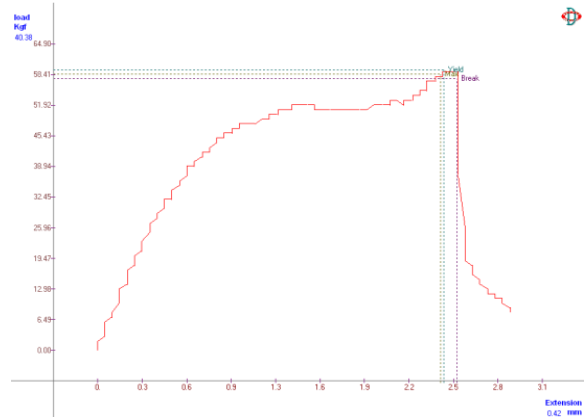
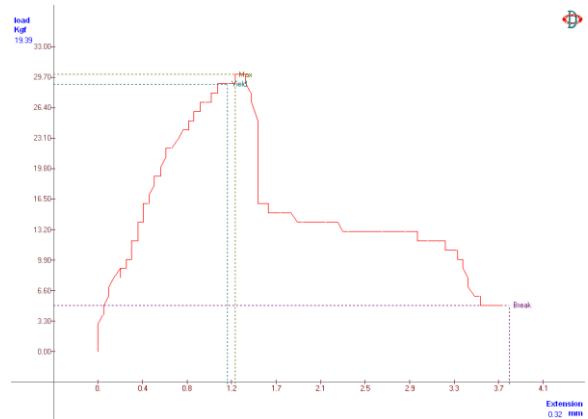
**COMPRESSION TEST:**

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures.

**V. RESULT AND DISCUSSION:**

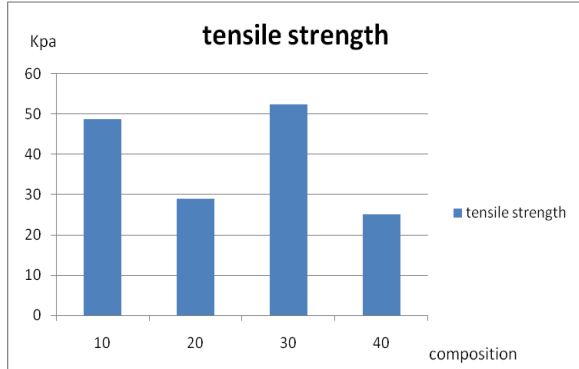
**Tensile test result:**

The tensile test is done at the speed of 2mm/min the specimen will break that point is called tensile strength at break. The below 1,2,3,4 graph shows the tensile strength at break, tensile strength at yield, breaking point.



Tensile Strength for Various Compositions:

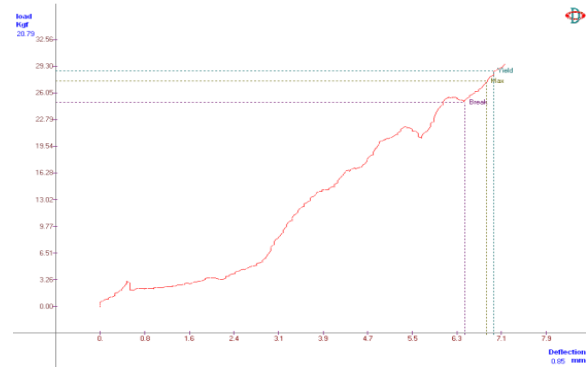
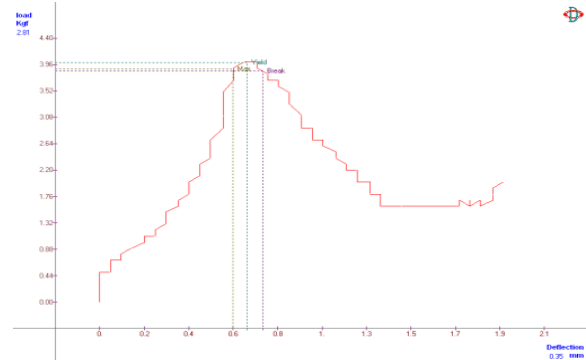
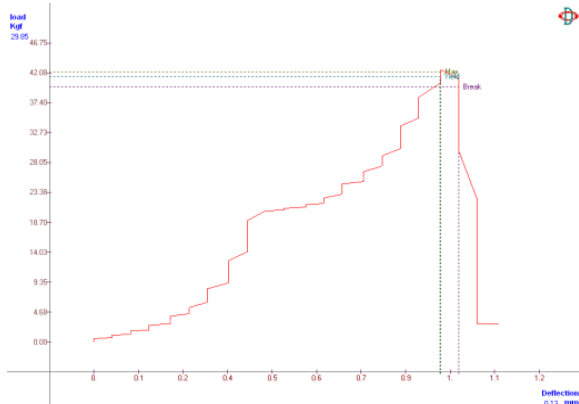
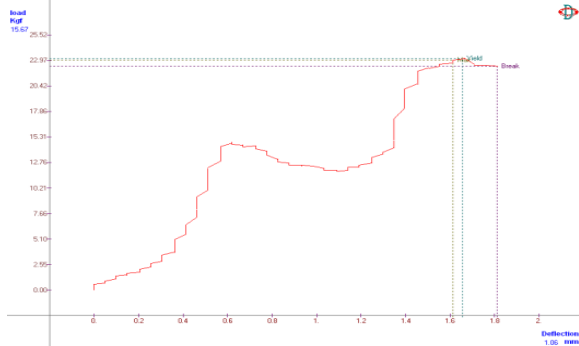
Composition (%)	10	20	30	40
tensile strength	48.8	29	52.5	25



From the above graph show the tensile strength of (composition 30%) specimen have good tensile strength. Because the specimen has 70% of epoxy resin and 30% of fiber so the reinforcement is good. So, we select 30% fiber is used specimen.

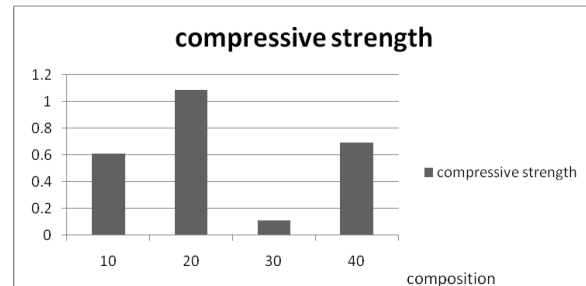
Compression test result:

The compression test is done with the speed of 2mm/min. the graph 1,2,3,4, show the compressive strength, compressive yield strength.



Compressive Strength for Various Compositions:

Composition (%)	10	20	30	40
Compressive strength	0.6099	1.09	0.105	0.69

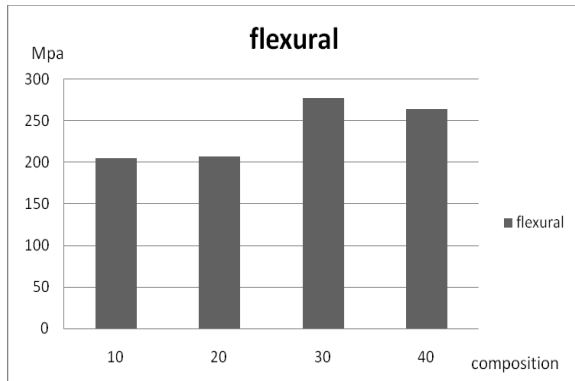


The above graph show specimen (80%-20%) have good compressive strength. it has better to choose 20% fiber composition have better compressive strength.

Flexural test result:

Flexural Strength for Various Compositions:

Composition (%)	10	20	30	40
Flexural Modulus (Mpa)	205.0	207.1	277.2	264.0
	5	5	4	9



The above graph shows the specimen (70%-30%) composition have good flexural modulus .so it is better to choose 30% fiber composition.

## VI. CONCLUSIONS:

From the results obtained that the hybrid natural Sisal fiber and tamarind shell powder reinforced polymer composite material can be used as an alternate material in today's world. In tensile test the composition 30% fiber have good strength. The result obtained from the compression test also conclude that composition 30% fiber have good compressive strength. when the amount of fiber is approximately equal to the resin ratio it gives greater compressive strength it better to choose 30% composition. In the flexural test the result shows that when the amount of fiber too about same to the resin ratio the flexural strength decreases the 30% fiber composition ratio shows better flexural strength. This paper is a detailed report on the natural fiber reinforced composite and how it can modify the mechanical properties.

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