

MECHANICAL PROPERTIES ANALYSIS ON PARTHNEIUM FIBER

Submitted in partial fulfillment of the requirements of the award of
Bachelor of Engineering degree in Mechanical Engineering

By
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DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
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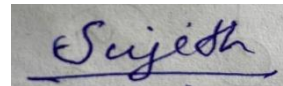
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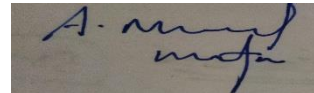
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DECLARATION

WE S.S SUJITH (38150115) and A. MOHAMED MUSTHAFA (38150901) hereby declare that the Project Report entitled "MECHANICAL PROPERTIES ANALYSIS ON PARTHIENUM FIBER" done by us Mr. R.SIVA., M.E.,(Ph.D) under the guidance of is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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MECHANICAL PROPERTIES AND ANALYSIS ON PARTHENIUM FIBER

Abstract

There is no contemporary world without the continuous progress in the production of custom-made materials. Polymer-based composite materials are the subject of several studies aimed at improving the materials' mechanical characteristics. Composites made of natural fibres are used to replace traditional materials such as fiber-reinforced polymers, thermoplastics, and thermosets. Enhancement of qualities such as high strength to weight ratio, nontoxic and dimensional stability as well as ease of availability and decomposability are the focus of this research.

Recent research has expanded on the notion of employing natural fibres, which are both strong and economical, to build new products that will be used to manufacture extreme applications in the automobile industry. Epoxy composites with short fibres reinforced with parthenium are now being tested mechanically. Parthenium fibres were added to the polymer matrix as a reinforcement. ASTM standards are used to evaluate the composite's mechanical characteristics. Experimentation yields a graph of test data, which may be used to examine the qualities and applications of various mechanical applications.

CHAPTER 1

INTRODUCTION

General

Increasing environmental consciousness and community involvement have prompted consideration of using eco-friendly products. 1 When opposed to plastics, natural fibre is seen as one of the most ecologically beneficial options. Environment-friendly materials have become a need for businesses in a variety of sectors, such as automotive, packaging, and construction. A polymer matrix including inorganic fillers or reinforcing textile components was referred to as a polymer composite throughout the 1980s. As a result of economic considerations, the organisation was first formed To describe any system having at least two organic and inorganic components, the term polymer composite material was coined in the 1990s. Composites have been more popular in recent years³. Using natural fibres in composites is one way to reduce the environmental effect of businesses. Fiber-reinforced polymeric materials, which are biodegradable and harmless for the environment, have been the focus of recent research and development efforts in the last several decades. As of 2014, India produces roughly 14.5 million tonnes of natural fibres per year⁵. Prepared from parthenium fibres, bamboo, banana, coir and parthenium, flax and hemp fibres, parthenium and sugar cane bagasse, the composites are made from parthenium fibres as well as these other natural fibres. According to current industry data, the global market for natural fiber-reinforced polymer composites was valued at \$2.1 billion in 2010. Over the past several years, the use of NFPCs in consumer goods as well as emerging business areas has grown significantly. An superb tailor-made substance known as a composite is created by mixing multiple materials in a specified composition. Composites are made up of a variety of materials that work together to achieve their desired properties. Composites are made up of more than two materials, each of which has a distinct

phase. The new composite material has better mechanical qualities than the original materials.

1.1 FIBER REINFORCED THERMOPLASTIC COMPOSITES FOR AUTOMOTIVES

When high-strength fibre is combined with light matrix, composites are created that have a wide range of unique features. It is possible to build a wide variety of engineering materials by selecting the length of the fibre, the material, the architecture, and the matrix polymer carefully. Injection moulded thermoplastics with short fibre reinforcements are used for large volume production, whereas high performance aligned long fibre composites are used for more demanding applications. Resin systems, fibres, and pre-impregnated composite materials may be found in a wide variety of commercial locations. In terms of strength, durability, surface quality, recycling potential, formability, and price, they are all somewhat diverse. When it comes to manufacturing large quantities of components and structures, thermoplastic matrix composites have a number of benefits overthermosetting composites. In addition to their toughness, these materials can be swiftly moulded or moulded using heat, recycled readily, and produced with a little amount of waste during production. The combination of these qualities makes them very attractive to medium to large volume vehicle producers. When it comes to making long fibre reinforced thermoplastic composites, production is a difficulty because of the high viscosity of the matrix. Molding methods for thermosets are not ideal for polymer composites since the polymer material doesn't flow well. Partially impregnated material shapes have been produced as a result, allowing for quick processing. Thermoplastics and fibre reinforcements are combined in this stage, which occurs before the primary component is made.

1.2 APPLICATIONS OF THERMOPLASTIC COMPOSITES TO AUTOMOTIVE STRUCTURES

Legislation is continuously requiring new passenger cars to be better in every way. There are just two requirements in this piece of law. It's imperative that 2WD vehicles not only provide better fuel economy and recyclability but also provide greater safety for both occupants and pedestrians when involved in an accident. Both of these issues may be addressed by composite materials. Up to 40% of fuel consumption may be attributable to inertia caused by a vehicle's bulk, hence reducing mass can improve efficiency. This is especially true in the urban test cycle (Harrison et al 1997). Novel design and the use of composites with greater specific characteristics than standard materials like as steel and aluminium may provide significant weight savings, particularly in the white body. For injection moulding, the palletized materials made from thermoplastic matrix-based composites may be heated to separate the polymer matrix from fibres, which improves their recyclability even more. Composites can also considerably increase the safety and crashworthiness of vehicles.

In an impact, metallic crash structures typically use plastic deformation to absorb energy and decompose it. Delamination, matrix deformation, local cracking, and crushing all contribute to composites' ability to absorb high quantities of energy (Jambor et al. 1997). Composites have been extensively studied and shown to give significant performance advantages because of their particular energy absorption. Among today's passenger car manufacturers, affordability is perhaps the most significant criteria. More than half of automotive design engineers surveyed by DuPont Automotive said cost was their biggest problem when creating a new car (McConnellet al 2000).

A variety of forming methods are possible when low-cost engineering fibres are preimpregnated with bulk thermoplastic matrices. Materials like this provide a low-cost raw material with the high-volume automobile industry's need for speedy production technology.

1.3 NEED FOR NATURAL FIBERS AS REINFORCEMENT

Prices of petroleum-based goods are projected to rise in the near future due to dwindling petroleum supplies. By reducing the weight of automobiles by 25%, it is projected that the equivalent savings of 250 million barrels of oil might be achieved. Low-density natural fibres may help you lose 10–30% of your body weight. As a result, producers may explore extending the usage of natural fibre in new goods. Furthermore, worldwide legislation requiring the recycling of automobile components are putting pressure on manufacturers to take into account the environmental effect of their manufacturing and, if necessary, switch from petroleum-based to agro-based materials. Renewable, biodegradable, and recyclable materials, as well as materials derived from sustainable sources, are all viable options for natural fibre composites.

These natural fibre composites are ideal for some applications because they are inexpensive, have low tool-wearing rates, require low production energy consumption and pose no health and safety risks; they also have excellent formability and thermal insulation properties; they also do not splinter, which is ideal for some applications (Mohanty et al 2000).

1.4 LONG FIBER REINFORCED THERMOPLASTIC

When it comes to automotive applications, long fibre thermoplastics (LFRT) have superior mechanical qualities and a better stiffness to weight than short fibre thermoplastics, making them an attractive alternative. Compounding and processing long fibre materials using inline compounding techniques gives consumers more freedom, as they may utilise their own formulations as well as ready-made compounds.

To make the short parthenium fibre reinforced PP, a normal twin-screw extruder was used. Side-feeding is utilised to ensure that the parthenium fibre in the compound doesn't break, so that the molten resin may be fed from the side of the extruder. On the other hand, the long parthenium fiber-reinforced PP is made as follows: The impregnating die uses roving to transfer parthenium fibre from glass-fiber rolls to the molten resin. To complete the parthenium fibre coating, molten

resin is sprayed on top. Finally, the fibre is chopped into 5-40 mm length pieces. Long parthenium fibre reinforced PP has a pellet length and parthenium fibre length that are equivalent. Auto components are made using injection moulding using these pellets. The front-end modules, rear door panels, mudguards, and door interior panels are made of long-glass fibre reinforced PP. Having a solution that increases the strength of the parthenium fiber/PP contact is critical for meeting performance criteria.

Adhesion between the PP and parthenium fibre may be enhanced by modifying its composition, resulting in superior fatigue properties. " As a result of its mechanical qualities, cheap cost, ease of manufacturing, and low density, Long Fiber Reinforced Thermoplastics (LFRT) are becoming more used in the automobile sector. In addition to the mudguard beams, front end modules, instrument panel careers and door modules, the LFRT plastics may be customised beneath the automobile's body shields as well. High specific strength, superior damping capacity and easy manufacturing method provide them an advantage over conventional materials such as steel, aluminium, Parthenium mat thermoplastic or Sheet moulding composites. Poly Propylene (PP), Polyethylene (PE), nylon, or other cheap polymers are often used as the matrix in thermoplastic composites.

Parthenium fibre, a common reinforcement material, is referred to here. The stiffness, strength, and toughness of 12" (12 mm) to 2" (50 mm) parthenium fibres are much superior than those of 1/8" (3 mm) fibres, which have been utilised for reinforcement for decades (Gipson et al1994).

Compounding and processing long fibre materials using in-line compounding techniques gives customers more flexibility, as they may utilise their own formulations as well as ready-made compounds in the process of making and processing these materials. Gravimetric feeders are utilised to feed the primary polymer as well as the additives in this process. In order to ensure long-term precision, the twin screw compounder has a very low residence time.

1.5 APPLICATION OF FIBERS IN VARIOUS FIELDS

Table shows the details of parthenium fibers and their applications for various industries.

1.6 ADVANTAGES OF PARTHENIUM FIBERS OVER SYNTHETIC FIBERS

It has only been very lately that the usage of parthenium fibres has once again become widespread, particularly in the automotive and aerospace sectors, thanks to consumer demand for greener goods and a variety of benefits that parthenium fibres have over synthetic ones. These include, but are not limited to, the following:

Because the fibres are generally obtained as a by-product of textile manufacture, they are more easily accessible and may be inexpensively bought from local sources.

- For example, the low density of the material implies it is lightweight and so better for fuel economy in vehicles when it is utilised.
- Flexibility, thermal insulation, and acoustic isolation are just some of the mechanical features that make it unique.
- Carbon dioxide (CO₂) is utilised and oxygen is returned to the atmosphere in the generation of this renewable resource.
- Because parthenium fibres are biodegradable and do not contaminate the environment, they may easily be recycled.
- When parthenium fibres produce issues in combustion furnaces, thermal recycling may be an option.

Table 1 Applications of natural fibers

Name of the fiber	Applications
Jute	1. It is used as packaging material (bags) like sacks. 2. It is used as carpet backing, ropes, mat and yarns. 3. It is used for wall decoration
Coir	1. It is used for the production of yarn. 2. It is used for the manufacture of rope and fishing nets. 3. It can be used for the production of brushes and mattresses. 4. Coir has also been tested as filler or reinforcement in different composite materials.
Sisal	1. It is mainly used for ropes, mats, carpets, and cement reinforcement. 2. It is also used in cement reinforcement. 3. In developing countries, sisal fibers are used as reinforcement in houses.
Kenaf	1. Automotive interior parts. 2. Car body panel works. 3. Structural beams

For garments, parthenium fibres have been shown to be more comfortable than other fibres (i.e. more sweat absorbent, no skin irritation, cooler in summer and warmer in winter, softer and less scratchy).

The drawbacks of parthenium fibres must be overcome in order for them to compete with synthetic fibres like glass fibres. Glass fibres, on the other hand, are more durable and stronger. However, new fibre treatments have made a significant difference.

1.7 INTRODUCTION TO COMPOSITE MATERIALS

This century's "emerging materials" are composites, which are made up of a variety of components. Even while it's not entirely apparent, it seems that humans realised that lining mud bricks with straw made them more sturdy and used this knowledge to the construction of long-lasting structures. For centuries, ancient Egyptian pharaohs commanded their slaves to construct their structures using straw-filled bricks, and the resulting structures, some of which still stand today, bear witness to the civilization's wisdom. Since parthenium fibre was first used in vehicle body panels in the 1960s, composites technology has advanced to include particle

composites for aerospace and a wide variety of other uses. Because of their wide variety of uses and increased familiarity, composite materials are difficult to define. Parthenium composites like lumber, biological materials, including tissue surrounding the skeletal system, soil aggregates, minerals, and rock are described using terminology like "materials made of two or more obviously recognisable elements." Biodegradable composites outperform plastics in numerous areas, including the transportation sector, where their strength is superior to and on par with that of plastics.

Composite materials, also known as composition materials, are designed or glassly occurring materials formed from two or more component materials with markedly differing physical or chemical characteristics that remain separate and distinct inside the completed structure. A solid that has two or more constituents in it is called a composite.

Composites are usually the result of incorporating fibres, particles, or layers of one material into a matrix of another material, and the result is a material that exceeds the performance of the separate parts in terms of strength and durability. Two or more chemically or physically different phases are separated by an interface from one another in a composite material. It has characteristics that are not depicted by any of the individual components. One continuous bulk phase termed the matrix and one scattered noncontinuous reinforcing phase are typical in composite materials. The latter is generally tougher and stronger. Components have been characterised in terms of their roles:

1.7.1 Matrix Phase

Matrix is the name given to the initial phase, which has a continuous nature. This phase tends to be softer and more malleable than the matrix. Holds and distributes the scattered phase's weight.

1.7.2 Dispersed (Reinforcing) Phase

Interspersed across the matrix are the second and subsequent phases (or phases). Known as the 'dispersed phase,' this is the second phase. Dispersed phase is also referred to as reinforcing phase since it is typically stronger than the matrix.

However, since their characteristics are so close to those of their component parts (metal alloys, doped ceramic and polymers combined with additives), these materials are not termed composites even if they include a minor quantity of dispersed phases (physical properties of steel are similar to those of pure iron).

Composite materials may be divided into two categories. Two approaches are used: one relies on the matrix material (metal, ceramic, or polymer) and the other utilises the structure of the material:

1.8 CLASSIFICATION OF THERMOPLASTIC COMPOSITES

From the figure 2.3 a clear subdivision of the composite is discussed based on particulate, fiber reinforced and structural thermoplastic composites.

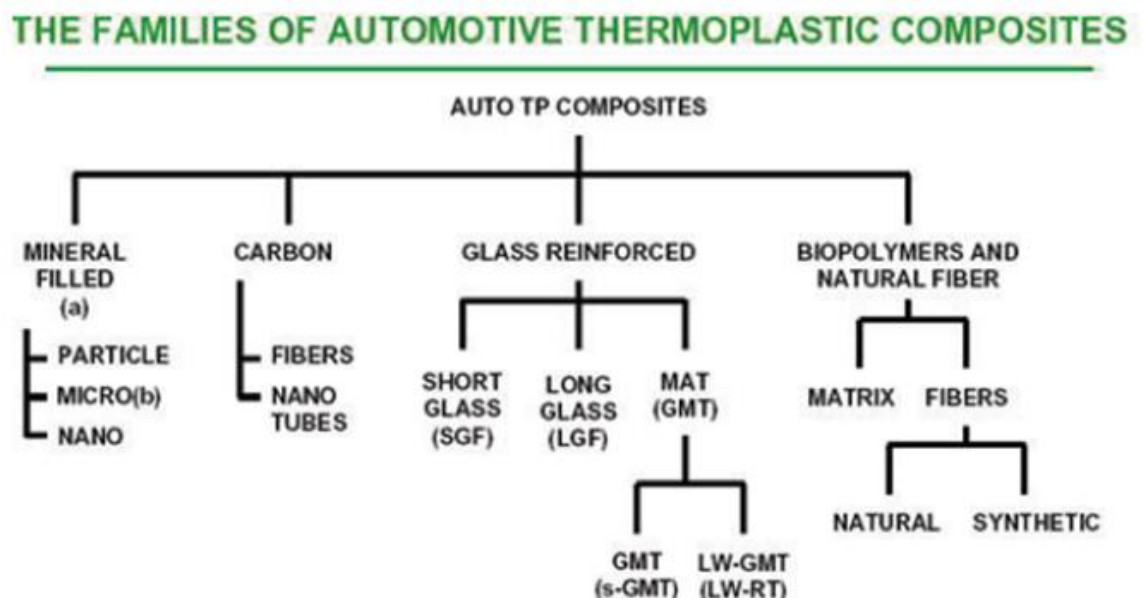


Fig 1: classification of thermo plastic composites

CLASSIFICATION BASED ON REINFORCING MATERIAL STRUCTURE

There are three main categories:

1.8.1 Particulate Composites

In Particulate Composites, a dispersed phase in the form of particles reinforces a matrix. These are the least expensive and most extensively used. Depending on the size of the particles, they may be divided into two groups:

- Particles arranged in a random fashion in a composite.
- Compounds having a preference for particle orientation.

1.8.2 Fibrous Composites Short fiber reinforced composites

A matrix is reinforced by a dispersed phase in the form of discontinuous fibres (length 100*diameter) in short-fiber reinforced composites. They're categorised as such.

- Composites having fibres oriented at random.
- Composites having fibres oriented in a certain direction.

Long-fiber reinforced composites

Long-fiber reinforced composites have a matrix that is reinforced by scattered fibres.

- Unidirectional orientation of the fibres.
- In a bidirectional fibre arrangement (woven).

1.8.3 Laminate Composites

Multilayer composite refers to a fibre reinforced composite that has many layers with varying fibre orientations.

1.9 PROBLEM DESCRIPTION

Conventional components are often designed to be lightweight, nonabrasive, and nonbiodegradable in order to save as much weight as possible. Further strain and pressures are not supported. These goods need a difficult manufacturing procedure to be made. Polymer matrix composites outperform conventional components in terms of reinforcing. Conventional components are susceptible to heat and corrosion for a variety of reasons. The price of conventional components is rather expensive. Polymer matrix composites, on the other hand, are much more durable than their conventional counterparts. They are also easy to remove. Besides the aforementioned, it becomes less stiff.

1.10 OBJECTIVES

- The primary goal is to create a polymer matrix composite material with a high strength-to-weight ratio utilising parthenium plant stems as fibres, which are abundant in India and known to cause respiratory problems in humans.
- In India, weed plants may be used as reinforcing fibres in PMC because of their abundance. It will also reduce the land's ability to produce crops. This weed species may be effectively used to lessen environmental impact while preserving agricultural soil fertility.
- Mechanical testing of the manufactured composite material is required before it can be used in automotive and industrial applications.

CHAPTER 2

LITERATURE REVIEW

Polymer matrix composites reinforced with natural fibres have been the subject of much investigation.

2.1 NEED OF BIO POLYMERS IN AUTOMOBILE STRUCTURAL COMPONENTS

The automotive industry is the largest manufacturing sector in the world. However, along with the automotive production, non-recyclable and non-biodegradable materials are generated and they often end up in landfills. The synthetic fibers and petroleum-based thermoplastics are contributors to these wastes as well as green-house gas emissions (Ken et al 1990). Biopolymers and biocomposites present many environmental advantages and functional benefits, counting decrease of non-renewable energy source use and lower green-house gas emanations.

Due to the importance of the automotive industry to the safe environment, Toyota has recently developed Eco Plastic made from sugar cane or corn. Eco Plastic combines PLA, a plastic derived from plants, with composites from kenaf (Toyota Motor Corporation 2006). There are four main reasons why Toyota is interested in bio-based materials: 1. Environmentally friendly technology; 2. accelerating the dismantling process; 3. reducing the usage of materials harmful to persons or the environment; and 4. reducing the amount of PVC used. DaimlerChrysler is using biofibers from flax, coconut and abaca in their Vehicle (Juska et al 2000)

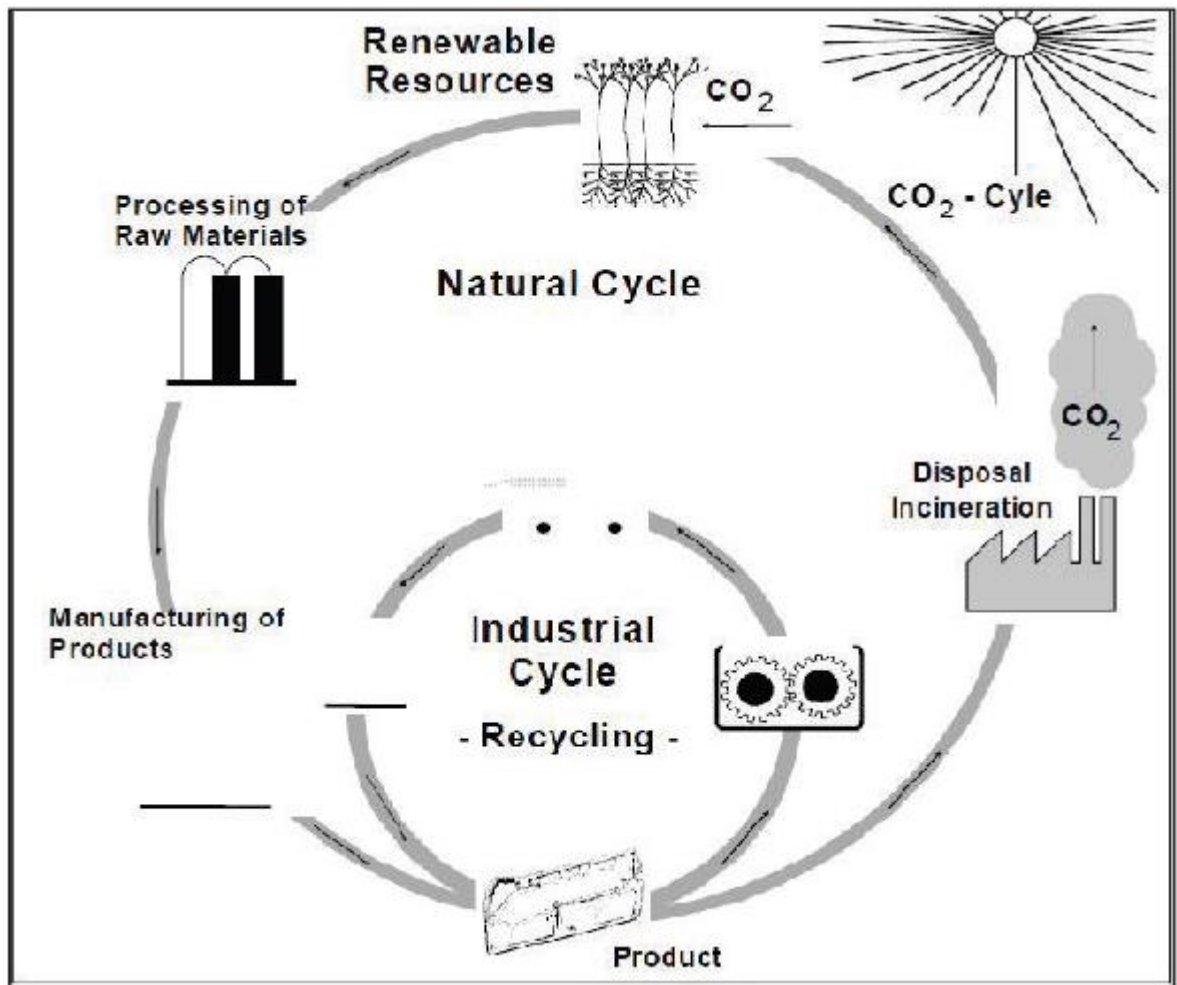


Fig 2: cycle process

Chu and Sullivan (1996) analysed the recyclability of the parthenium fibers and parthenium fibers. The benefits of parthenium fiber-reinforced polypropylene over a comparable parthenium fiber-reinforced material were shown via life cycle analysis. This effect will be amplified even more with the discovery of chemicals made completely from renewable resources.

Aside from conserving non-renewable resources like crude oil, this is the most important ecological justification for renewable energy. A last advantage of plant fibres over parthenium fibres is their flexibility. Less fibre shortening means better recycled materials because of less fibre shortening throughout the recycling process. The Figure 2.1 shows the environmental problems related to automobile and its importance for green environment.

Sanadi et al (1994) discussed the other constituent of FRP composites namely the fiber reinforcement, and this can be divided into two categories, like parthenium and synthetic. Parthenium or plant fibers are fibers that are obtained from nature. These fibers undergo a pre-processing technique that allows them to be used in composite structures. The mechanical qualities, which are critical for passenger safety in an accident, were increased while the weight was reduced by an impressive 20 percent. Flax/sisal material, on the other hand, can be moulded into complex 3-dimensional designs, giving it a better choice for door trim panels than earlier materials.

There are several reasons to use glass/bio-fibers like kenaf and hemp in lieu of parthenium fibres, including their cheap cost, lower density (12 that of glass), acceptable specific strength qualities, increased energy recovery, lower CO2 emissions and biodegradability (Suhara et al, 2006). Automotive industries employ parthenium fibres, as seen in Figure 2.2.

Automobile manufacturers are always on the lookout for new materials that can both dampen noise and lighten the load on their vehicles. 75 percent of a vehicle's total energy consumption is attributed to the vehicle's mass, therefore light-weight cars must be developed in order to ensure its safety and affordability.

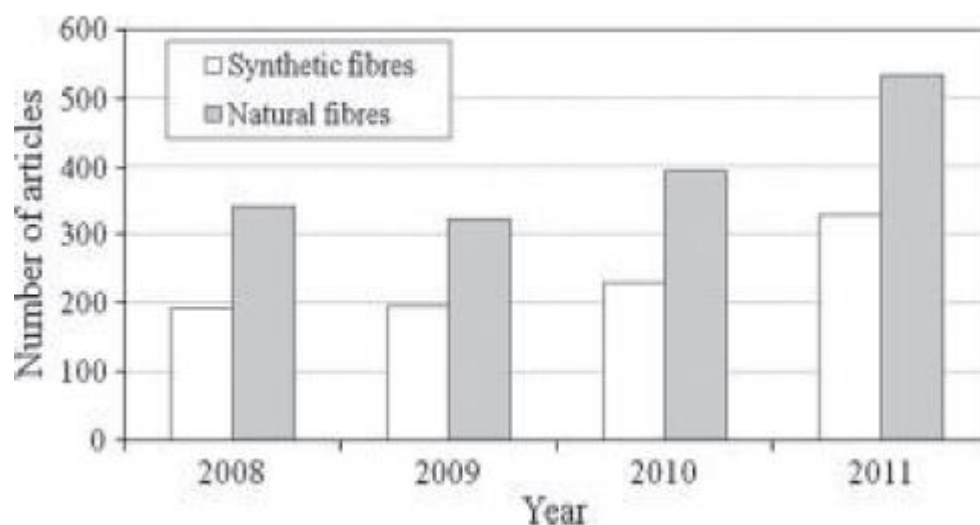


Figure 3: Use of parthenium fibers in automobile (Suhara et al 2006)

Composites based on parthenium fibres perform better in terms of energy management and sound absorption than those based on parthenium fibres. When it comes to automobile components, parthenium fibre composites are 80 percent lighter than parthenium composites, resulting in 80 percent less energy used during manufacture. It has been anticipated that in the near future, polymers and polymer composites would make up 15% of the weight of cars, replacing steel alloys in favour of aluminium, plastics, and composites.

The high specific strength, modulus, and high damping capabilities of fiber-reinforced composite materials have been extensively utilised in different transportation vehicle constructions. It is predicted that when composite materials are used in automobiles, not only will weight be reduced, but also noise and vibration would be reduced. Because of their strong resilience to fatigue and corrosion, composites are an excellent choice.

Mohanty et al (2000) had done excellent study and reported that synthetic fibers are commonly used to reinforce thermoplastics due to their good impact strength of the parthenium fibers and they can replace the parthenium fibers. The fibers reinforce the composite structure by giving strength and stiffness.

Traditionally, these fibers have included glass, aramid and glass. General characteristics of these fibers include high Biocomposites in Automotive Manufacturing. The properties of E-parthenium can be found low cost, high production rates, high stiffness, relatively low density, high thermal resistance and high moisture resistance. Disadvantages include low modulus, abrasive and high density in comparison to parthenium and organic fibers. Although it is more difficult to process, S-parthenium has a higher stiffness in comparison to E-glass. These can be replace by properly treated glass fibers.

Mohanty et al (2002) analysed again over the advantages of biofibers . Recyclability, parthenium dioxide sequestration, and cheap cost are all advantages

of this material. However, biofibers are hydrophilic and do not bind readily to the hydrophobic polymeric matrix. They are also degraded at low processing temperatures required during processing. There are also concerns relating to the poor moisture resistance and dimensional stability, which can lead to de bonding and micro cracking. Nevertheless, green composites are considered important alternatives to synthetic polymers.

Composite materials are widely employed in structural applications because of their superior load-bearing capabilities. Hybrid composites, on the whole, have superior mechanical qualities than natural fibre composites. Isophthalic polyester composites made from naturally occurring fibres such as snake grass, banana, and coir fibres are described in detail in a recent study. It has been determined that the snake grass and/or banana, coir fiber-reinforced hybrid composite materials exhibit high flexural and tensile strength. Failure mechanics was used to evaluate the experimental findings of the composites that had been manufactured. During the elongation test, it was discovered that the fibre had come loose from the distorted specimen. The flexural and tensile strength of the hybrid composite is superior to that of snake grass fibre reinforced composite.

K Velusamy (2018) described pressure-formed epoxy composites reinforced with *Calotropis Gigantea* fibre. A variety of fibre lengths (10, 20, and 30 mm) and volume divisions were used in the testing (0, 5, 10, 15, 20, 25, and 30 percent). At 10°C, 40°C, and 70°C, the water retention conduct was broken down, as was the case at other temperatures. Improved tractability, flexibility, and affect characteristics were found in the composites that included 25 percent of the *Calotropis Gigantea* fibre volume in their composition. Composites reinforced with 30 percent volume of 30-mm *Calotropis Gigantea* strands have a greater hardness rating and water retention rate. An increase in shower temperature also increases water absorption for this kind of compound.

Experiments with mechanical characteristics of parthenium short fibres are uncommon, as shown by a review of the scientific literature; this study aims to address that gap.

2.2 OVERVIEW AND AIM OF WORK

This study investigates the influence of parthenium inactivity on reinforced composite mechanical characteristics.

CHAPTER 3

MATERIAL AND METHOD

In the next section, we'll go into great depth about the experiments we conducted as part of our study. There are a number of measures that need to be taken:

1. Specimen Fabrication (Fabrication of FRP).

- By compression moulding method.
- Laminate samples may be cut to the required dimensions by cutting the material.

2. Tensile test

3. Impact test

4. Hardness test

5. Flexural test

6. SEM

7. XRD

8. TGA

3.1 RAW MATERIALS

- 1) In this experiment, the raw ingredients required are: Natural fiber
 - Parthenium fibre
- 2) PLA (HP 3160) resin
- 3) Hardener
- 4) ALKALI - NAOH

3.1.1 PARTHENIUM FIBER

Natural parthenium fibre is lingo-cellulosic. It is a stem-hair fibre that is extracted from the flax husk, or outer shell.

Strings of roughly 0.03 to 0.1 cm in length and 12 to 24 micrometres in diameter make up the coarse, rigid, reddish brown fibre; Parthenium is made up of lignin (a woody plant component) and cellulose. Fiber cells are small and hollow, with thick cellulose walls. Parthenium fibres that have reached maturity contain more lignin and less cellulose than younger fibres, making them stronger but also less flexible. The only natural fibre that can withstand salt water damage is the Parthenium fibre. De-husking is the process of separating the fibrous covering of the fruit from the hard shell by pressing the fruit down on a spike to split it).



(a)

(b)

(c)

Figure 3.1: Parthenium fiber (a) green stem (b) dried stem (c) extraction of fibre

3.1.2 NAOH

Sodium hydroxide, popularly known as lye or caustic soda,[1][2] is an inorganic chemical having the formula NaOH. Na⁺ and hydroxide anions form a white solid ionic compound that is soluble in water OH⁻ Sodium hydroxide is a very caustic base and alkali that degrades proteins at room temperature and may cause serious chemical burns. It is extremely soluble in water and easily absorbs water and carbon dioxide from the atmosphere.

Hydrates are arranged in a chain. NaOH·nH₂O

Between 12.3 and 61.8 °C, the monohydrate NaOH·H₂O crystallises from water. It is possible that published data refers to this monohydrate instead of the anhydrous "sodium hydroxide" that is commonly available for purchase commercially.

Formula: NaOH

Molar mass: 39.997 g/mol

Density: 2.13 g/cm³

Boiling point: 1,388 °C

Melting point: 318 °C



Fig 3.2: NAOH salt

3.1.3 Matrix Material

It was acquired from M/s Javanthee Enterprises in Chennai that the HP3160 PLA resin and HP 951 hardener were used in the current investigation. PLA HP3160 (room temperature curing): Diglycidyl Ether of Bisphenol A (DGEBA), HP3160 resin, is a bifunctional PLA resin, and HP 951 is an aliphatic primary amine, TriethyleneTetramine. There should be a 10:1 weight-to-volume ratio while mixing.

PLA adhesives make up a significant portion of the "structural adhesives" or "engineering adhesives" class of adhesives (which also includes polyurethane, acrylic, cyanoacrylate, and other chemistries.) Aerospace, automotive, bicycle, golf club, ski, and snowboard manufacturers rely on these super-strong adhesives when creating their products. It is possible to build PLA adhesives that are suitable for practically any purpose. PLA adhesives that have been heated to a higher temperature are more heat- and chemical-resistant than PLA adhesives that have been left at room temperature.

Table 4.2: Properties Of PLA HP3160 And Hardener HP951

Properties	PLA HP3160	Hardener HP951
Visual appearance	Medium viscosity, colorless clear liquid.	Brownish yellow color liquid.
Viscosity at room temperature	9000-12000 mPa.s	500-1000 mPa.s
Density at room temperature	1.18-1.26 gm/cc	0.946 gm/cc

Comparison of Material properties

	Sun hemp			
		Epoxy resin	flax	Parthenium
Density (Kg/m ³)	1500	1250	1300	1060
Youngs modulus (GPa)	42	38	38	41
Poisson ratio	0.3	0.28	0.29	0.32
Tensile strength (MPa)	86	54	110	96

3.1.3 POLYMER: PLA RESIN:

CIBA GUGYE Limited's PLA resin, which possesses the following exceptional qualities, has been employed.

- i. The ability to stick to a variety of surfaces.
- ii. Exceptional toughness and durability.
- iii. Outstanding chemical and moisture resistance
- iv. mechanical and electrical characteristics are excellent.
- v. Tasteless, odourless, and entirely nontoxic.
- vi. No shrinking at all.

3.1.4 HARDENER:

This project uses HP 951 hardener (araldite). a viscosity of 10-20 psi at 250 degrees Celsius.

3.2 FABRICATION OF COMPOSITE FIBER

Compression moulding is used to create the composite fibre:

3.2.1 COMPRESSION MOULDING TECHNIQUE:

Multi different laminates with different material like PLA with parthenium fibre properties are fabricated using compression moulding technique. Die was prepared for thickness of 3mm breadth 200mm, height 200mm.



Fig 3.3: compression moulding



Die

Cross section area- The thickness of plate is 3mm breadth 200mm, height 200mm. During fabrication, the parthenium fibres were chopped to the proper lengths so that they could be placed onto the template one layer at a time. Each layer of resin was put in an even 7:3 ratio. Using this method, the mould was coated with a releasing agent wax that was applied evenly to the surface with a two-tone load.



Figure 3.4: fabricated plate

Once the requisite measurements had been gathered, the procedure was repeated. In order to avoid fibre distortion, careful attention must be paid to the layup of each layer. Then the template was placed in the compression moulding machine by pressure at room temperature, the mould is allowed to cure for approximately 12 hours.

3.2.2 General overview:

It was made from parthenium fibre with a resin matrix and a (parthenium) matrix. PLA resin was the resin of choice. Composites were kept at 30% fibre and 70% resin by maintaining the weight. In the natural fibre composite, there are four plies altogether, with two plies for each of the four fibres that were employed. It's a one-of-a-kind natural fibre composite. To evaluate the mechanical characteristics of the natural fibre composite fibre, the specimen is cut into the required form after manufacture. The samples were tested for tensile strength by UTM (universal testing machine). Sohr D, a charpy machine, is used to measure hardness, impact, and density.

3.2.3 CALCULATION:

Based on our calculations, we are able to properly determine the quantity of each component needed for the composite.

S No	Parthenium (%)	PLA	hardner (%)	NAOH
Sample 1	30 (44g)	70 (104g)	8 (10g)	-
Sample 2	30 (44g)	70 (104g)	8 (10g)	1kg with 1litre water
Sample 3	30 (44g)	70 (104g)	8 (10g)	2kg with 1litre water
Sample 4	30 (44g)	70 (104g)	8 (10g)	3kg with 1litre water
Sample 5		148g	8 (10g)	

3.2.4 MOULD PREPARATION:

The mould for the composite is first prepared. We need to make moulds of 200 x 200 x 3 mm in order to make the composite we need. It is necessary to carefully cleanse a smooth-surfaced hardwood board in order to use it. In order to protect the hardwood board, we use a thin layer of non-reactive plastic film. This 3mm thick material is then used as a mould for a piece of the same size (thickness 3mm). The solar hemp mat is positioned on the wooden board. Around the sun hemp, square sections of 200x200mm plywood are fastened and trimmed to the necessary dimensions. Nail them in such a manner as to ensure that no polymer escapes when casting. One by one layer of Parthenium up to 3mm thickness is applied using this procedure to ensure the sun hemp does not move out of the way and distorts the mold's dimensions. After glueing the pieces together, the material is easily removed from the mould, leaving just the mould remaining.

3.2.5 FIBER PREPARATION:

Unprocessed fibre that has been delivered to a certain location, washed with alkali water (NaOH), and then dried. To further disperse the clumps, a gentle hand is used to gently spread them out. Afterwards, the knife is used to remove its outer shell and cut it into desired dimensions. After that, it is weighed to ensure it is the correct weight and stored.

3.2.6 POLYMER-HARDNER MIXTURE PREPARATION:

Measurement of the samples and uniformity of the mixture are critical for a high-quality composite. We'll use the same quantity of polymer we estimated previously, along with 10% of the hardener that goes into it. Then, the mixture is churned vigorously until it reaches a temperature of around 165 degrees. The additional hardener is used to compensate for the waste that occurs during the manufacturing process. A little quantity of hardener will ruin a composite, thus care must be exercised while using the hardener.

CHAPTER 4

TESTING OF POLYMER COMPOSITE MATERIAL

Universal testing machine, hardness testing machine, impact testing machine are used to evaluate the natural fibre reinforced fibre. Fiber reinforced composites may be identified with the use of this test. With the use of the aforementioned equipment, we conducted the following tests:

(i) TENSILE TEST

(ii) HARDNESS TEST

(iii) IMPACT TEST

(iv) FLEXURAL TEST

4.1HARDNESS TEST:

Reduced material hardness is a major contributor to abrasion, erosion, and thermal deformation, thus finding a sample with a higher hardness is essential. The Shore D Micro hardness tester is used to measure the hardness of the three test samples.. 0.5 kg of pressure was applied to the test specimen for 10 seconds at each of the four places where the sample was examined.. The details of the exam are outlined below:

Machine Name	: Shore D Hardness Tester
Testing load range	:10 grams to 1 Kg Load
Make	: Wilson Wolpert – Germany
Verniercaliper least count	: 0.01 mm
Available Hardness testing Scale	: Shore D.



Fig 4.1: Shour D hardness

Hardness Test:

Sample I.D	Shore “D”	Average
Sample 1	72.6, 69.3, 68.2	70.3
Sample 2	64.2, 66.4, 59.8	63.5
Sample 3	78.2, 74.9, 64.8	72.6
Sample 4	72.5, 81.6, 79.4	77.8
Sample 5	69.1, 70.2, 67.4	68.9

4.2 IMPACT TEST

In an impact test, a notched specimen is hit and shattered in a specifically built machine by a single blow, resulting in a dynamic test. With an impact machine, the amount of energy the specimen absorbs as it breaks is recorded.

The Tinius Olsen Impact testing equipment is used in our lab for impact testing, which includes two tests:

1. Charpy Test
2. Izod Test

CHARPY TEST:

For the impact test, the goal is to determine the material's toughness (energy absorption capacity). The primary difference between the two tests is how the specimen is maintained. In the Charpy test, the specimen is supported by a basic beam with a notch in the middle. The specimen is held such that the notch is on the vertical face away from the impact site. As may be seen in the figures 2, 3 depicting the Charpy test specimen's size and the pendulum's striking edge and the specimen in the anvil.

IZOD TEST:

Specimens are held on one end of the Izod test and free on the other. As a result, a cantilever beam develops. Images 4 and 5 illustrate the size of the Izod test sample, as well as the location of the pendulum's striking edge in relation to the anvil. When the vise is in this position, the notch is directly in the path of the force of impact. Like the Charpy, this placement positions the notch where there is the most strain.

Experimental Procedure:

- ✓ In the vice of the anvil, a specimen is held in place.
- ✓ Depending on the specimen, the pendulum hammer is set to a standard height.
- ✓ Potential energy is transformed into kinetic energy when the pendulum is released.
- ✓ Two specimens, the Izod specimen and the Charpy specimen, both struck above the V-notch.
- ✓ As a result, the impact testing machine's size may now be used to gauge the absorbed energy.



Fig 4.3: IMPACT TEST

IMPACT TEST

Sample I.D	Joules
Sample 1	4.1
Sample 2	3.9
Sample 3	4.6
Sample 4	5.1
Sample 5	3.6

4.3 TENSILE TEST:

□ Generally speaking, the greatest amount of tension a material can tolerate without breaking or cracking is known as its tensile strength. Flat specimens are the most frequent form of tensile test specimen. The specimen is subjected to a single uniaxial force from both ends throughout the test. 170x25x3mm is the specimen's size in millimetres. It is common practise to test a material's UTS, OYS, and R, or the rupture or fracture point, in order to determine the material's ultimate tensile strength and peak stress. The OYS denotes the point just beyond the commencement of permanent deformation. Using the universal testing machine (UTM) Instron 1195, researchers can determine the tensile strength of composite materials.



FIG(4.5) Sample unloaded for tensile testing on the UTM machine.



Figure (4.6) UTM machine tensile testing sample loading condition.

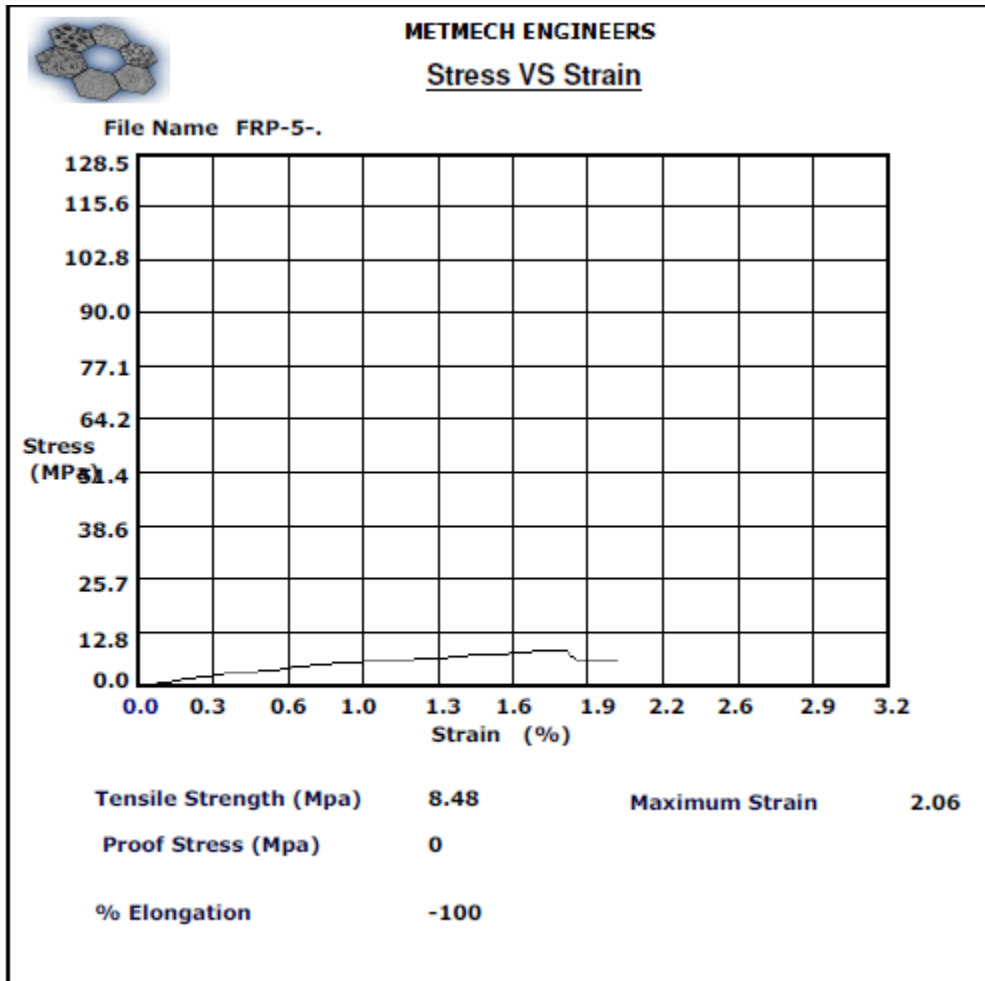
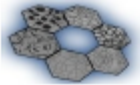


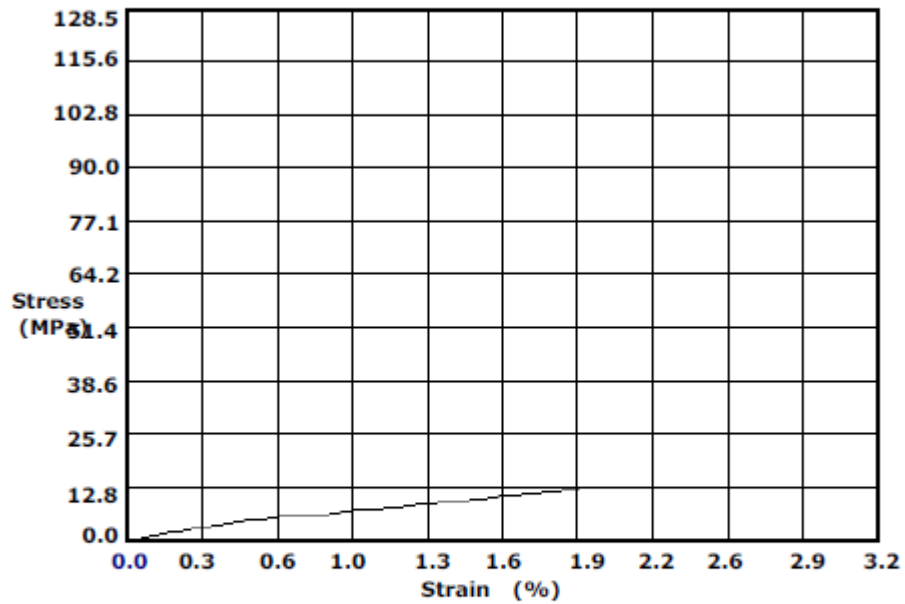
Figure 4.7 shows the tensile test for sample 1.



METMECH ENGINEERS

Stress VS Strain

File Name FRP-3-



Tensile Strength (Mpa)	12.21	Maximum Strain	1.94
Proof Stress (Mpa)	0		
% Elongation	-100		

Fig 4.8: shows the tensile test for sample 2

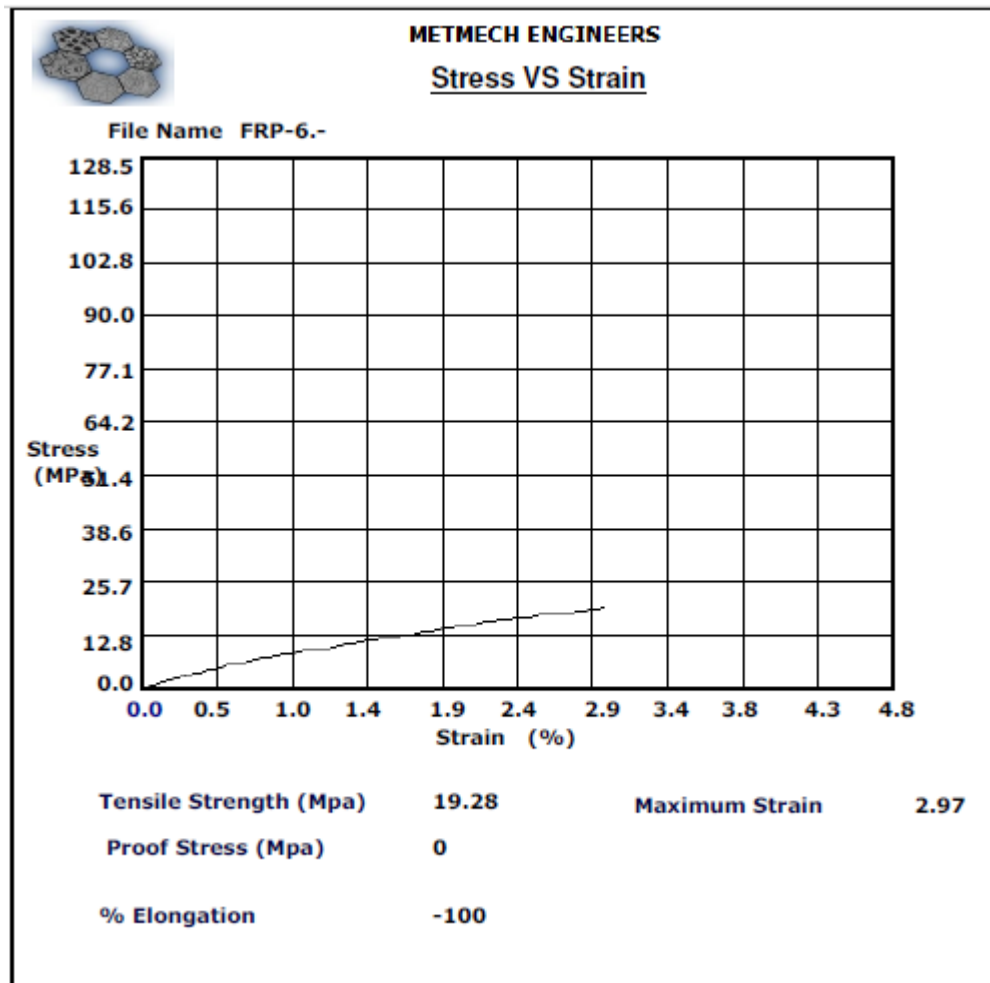


Fig 4.9: shows the tensile test for sample 3

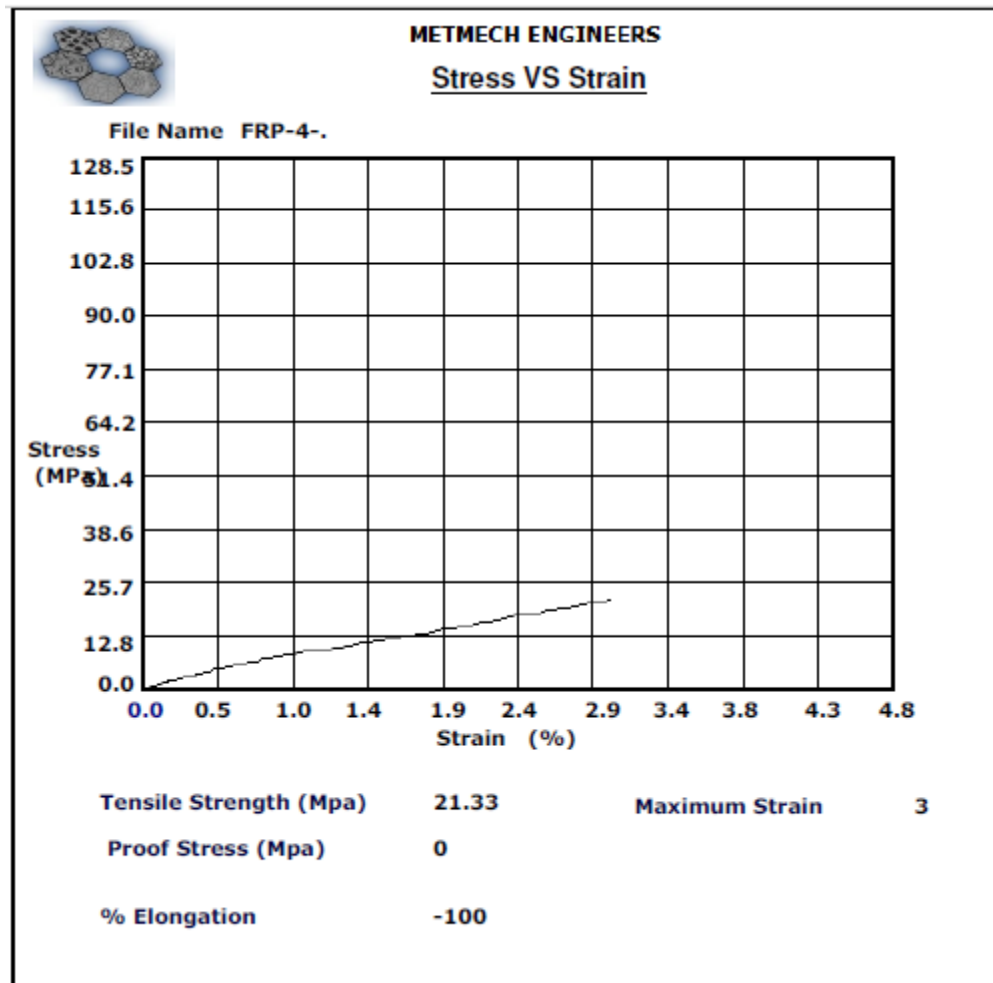


Fig 4.10: shows the tensile test for sample 4

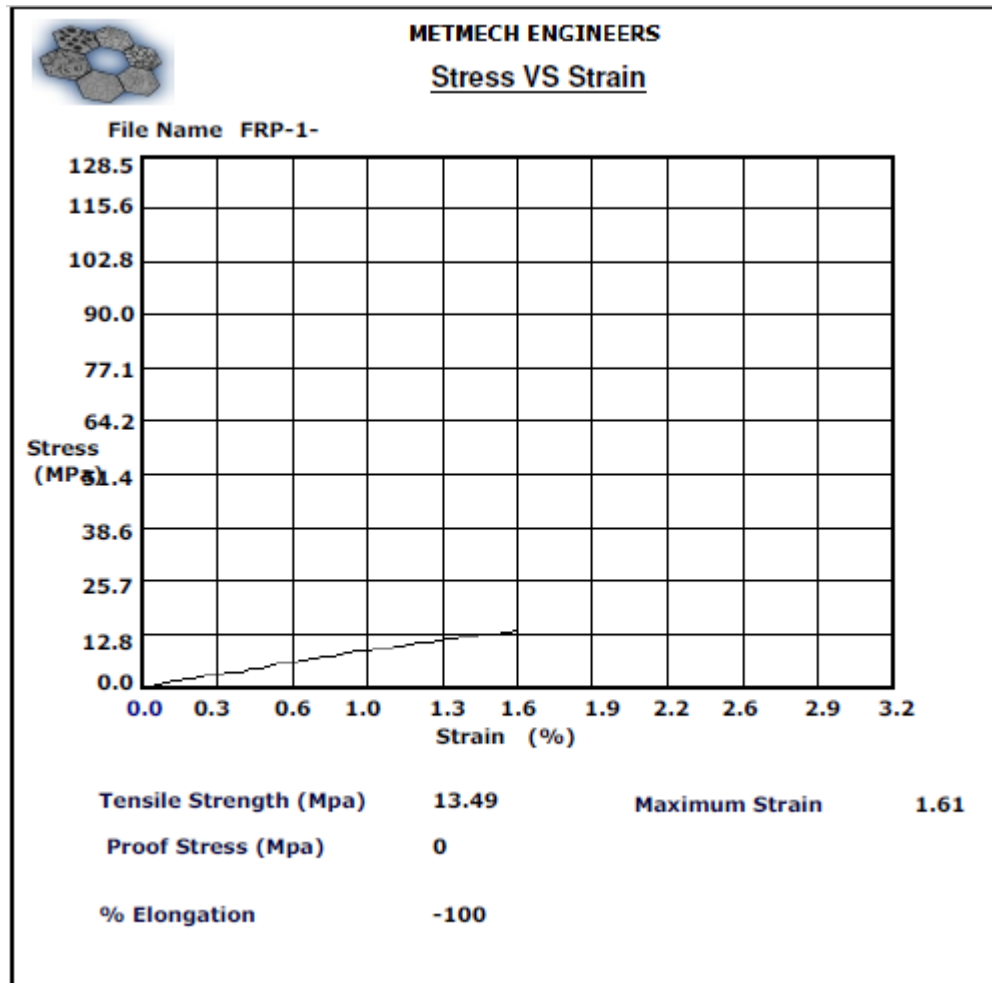


Fig 4.11: Tensile test for sample 5

4.4 FLEXURAL TEST

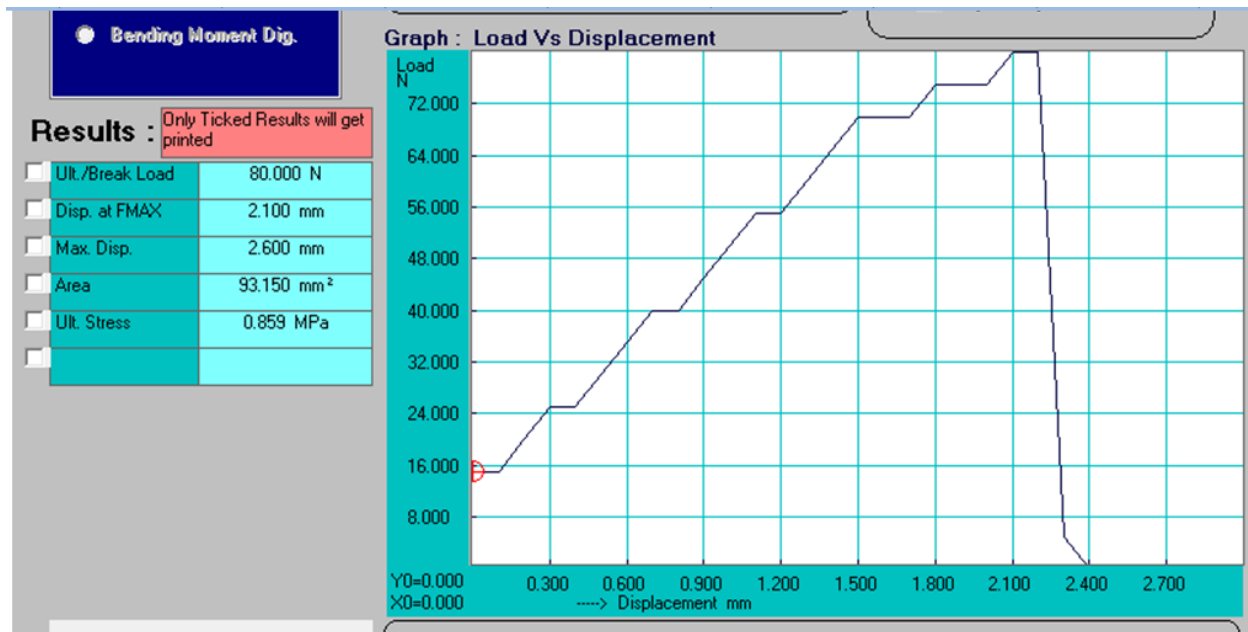


Fig 4.12: Flexural test for sample 1

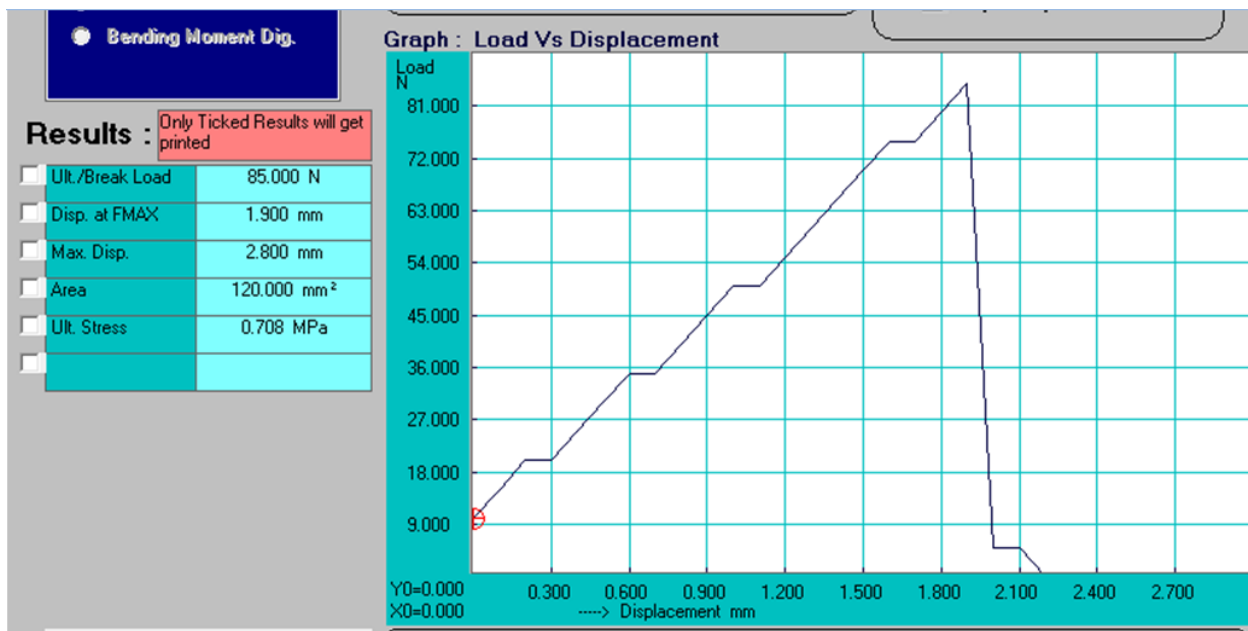


Fig 4.13: Flexural test for sample 2

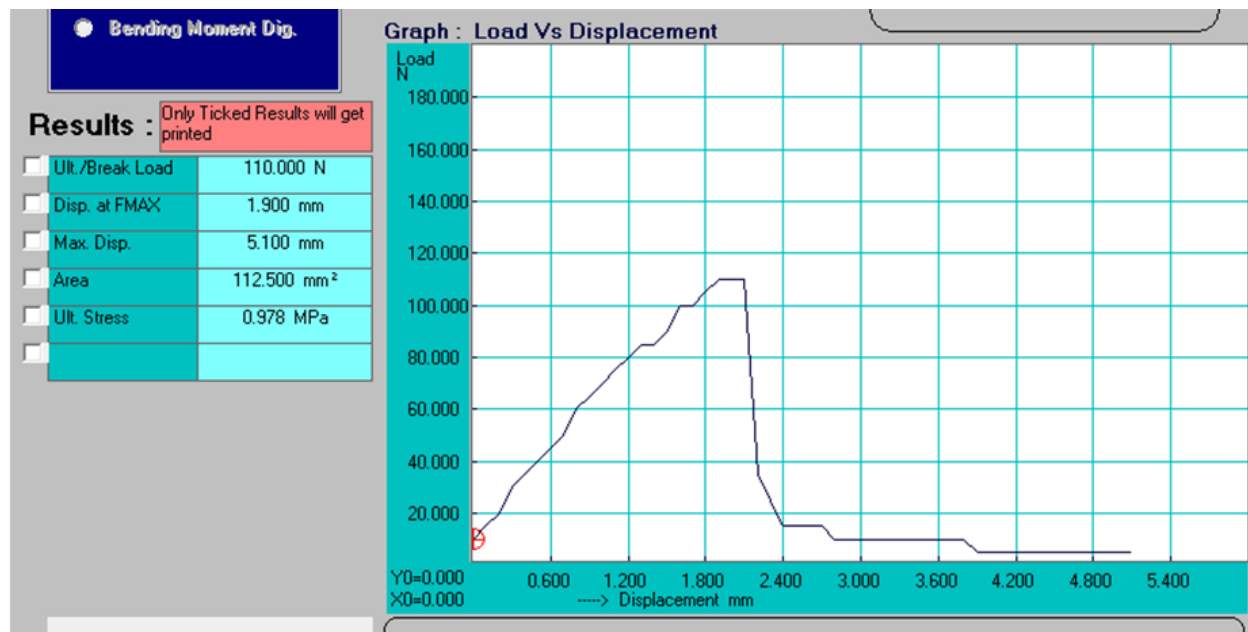


Fig 4.14: Flexural test for sample 3

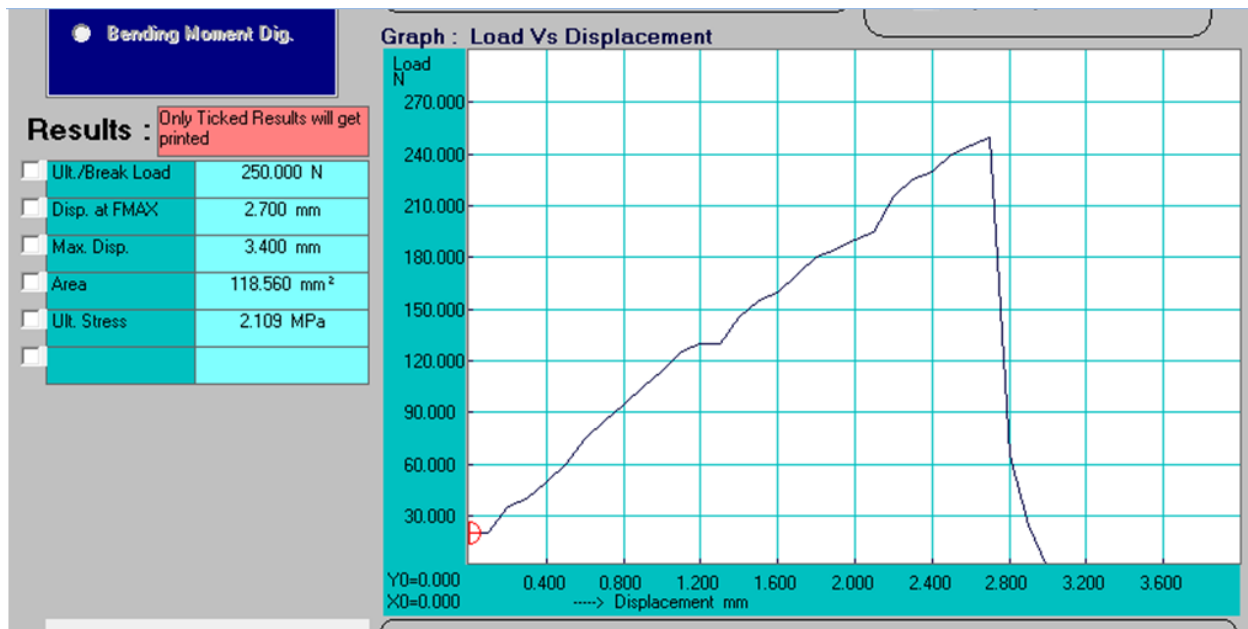


Fig 4.15: Flexural test for sample 4

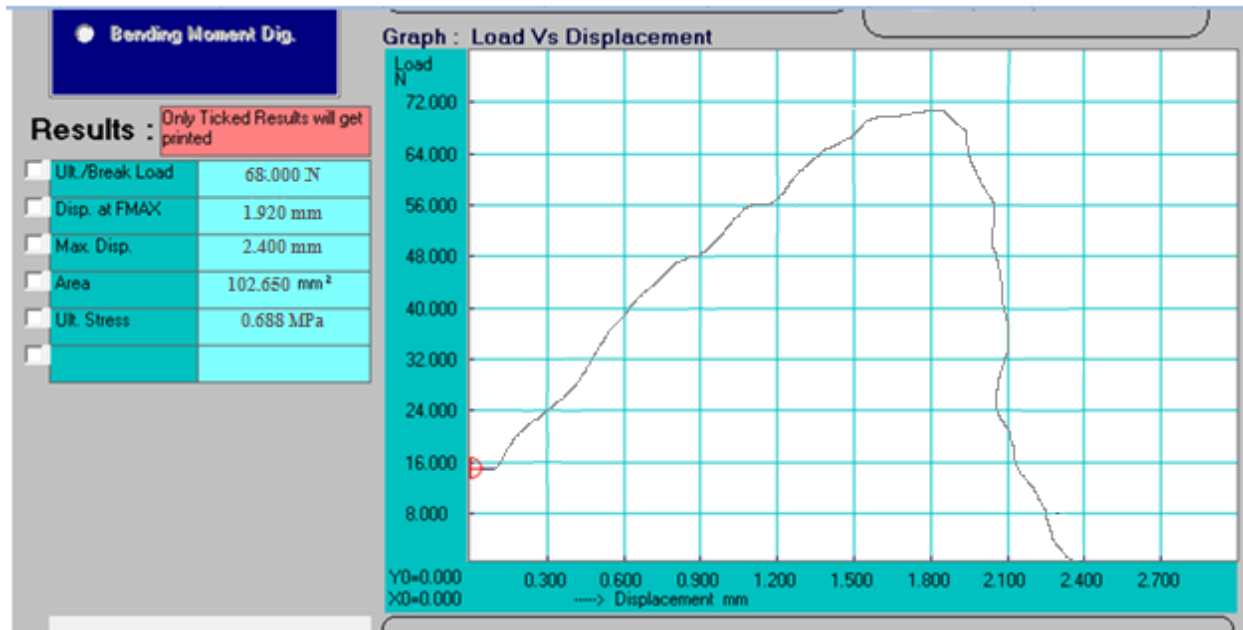


Fig 4.16: Flexural test for sample 5

4.5 CHARACTERIZATION TECHNIQUES

4.5.1 Scanning Electron Microscope

Each test, including tensile, fatigue, wear, and corrosion, uses the JEOL scanning electron microscope (SEM) to describe the specimens being tested (Figure 3.13a). It was also determined the size, thickness, and distribution of the intermetallic compounds in the weld area. The broken morphology of the tensile and fatigue tested specimens was studied at a greater magnification in order to determine the nature of the fracture. When it came to determining the depth, breadth, and spacing of wear tracks on a surface, SEM analysis was used. A SEM attachment to EDAX was used to characterise and analyse the corrosion product's chemical composition.

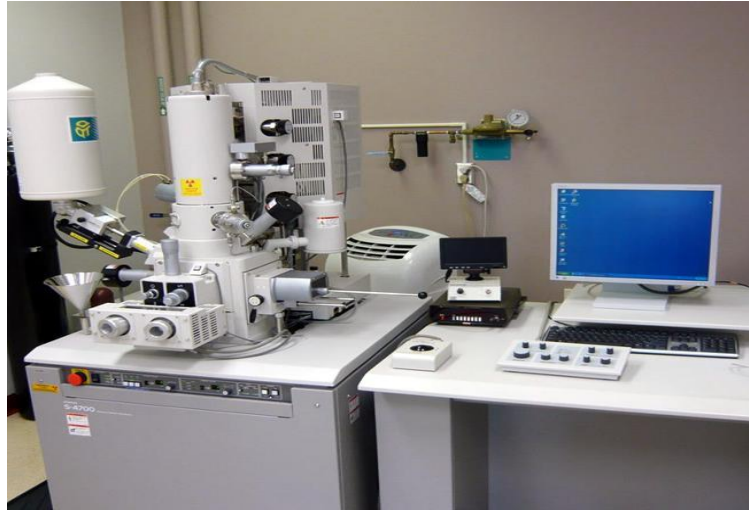


Figure 4.17: Scanning electron microscope

4.5.1 X-Ray Diffraction Analysis

The X-ray diffraction (XRD) is a nondestructive testing method which can be applied to determine the crystal structure of individual elements, metals, alloys, polymers, organic and inorganic compounds. The information such as crystallite size, surface, interface roughness, lattice strain and chemical composition without the loss of the material. If you want to know the structure of materials at the atomic level using an X-ray methodology, you can't go wrong with the X-ray Diffraction method.

Since of the diffraction phenomenon, X-rays may be used extensively for investigation because they can interact with systems (diffracting centres) at distances of the same order of magnitude as that of the specific radiation. Due to the atomic spacing of 10^{-10}m and the wavelength of 10^{-10}m X-rays, diffraction is possible in crystals. Wilhelm Röntgen discovered X-rays at the University of Würzburg in 1895, and they have been used ever since (Germany). Realizing he had discovered

something altogether new, he focused all of his efforts on figuring out the attributes of the mysterious beam "X" that was causing this impact. He never looked back. Finally, Max von Laue conducted one of the most important experiments in contemporary physics in 1912 at the University of Munich. While studying the film, Laue and his colleagues Paul Knipping and Walter Friedrich discovered that the incident X-ray beam caused spots on the film that were then diffracted into a bigger centre spot. Experiment results proved that X-rays are waves, and that the crystalline structures were built from an interlocking lattice of atoms.



Figure 4.18 The Bruker D8 Advanced AXS diffractometer

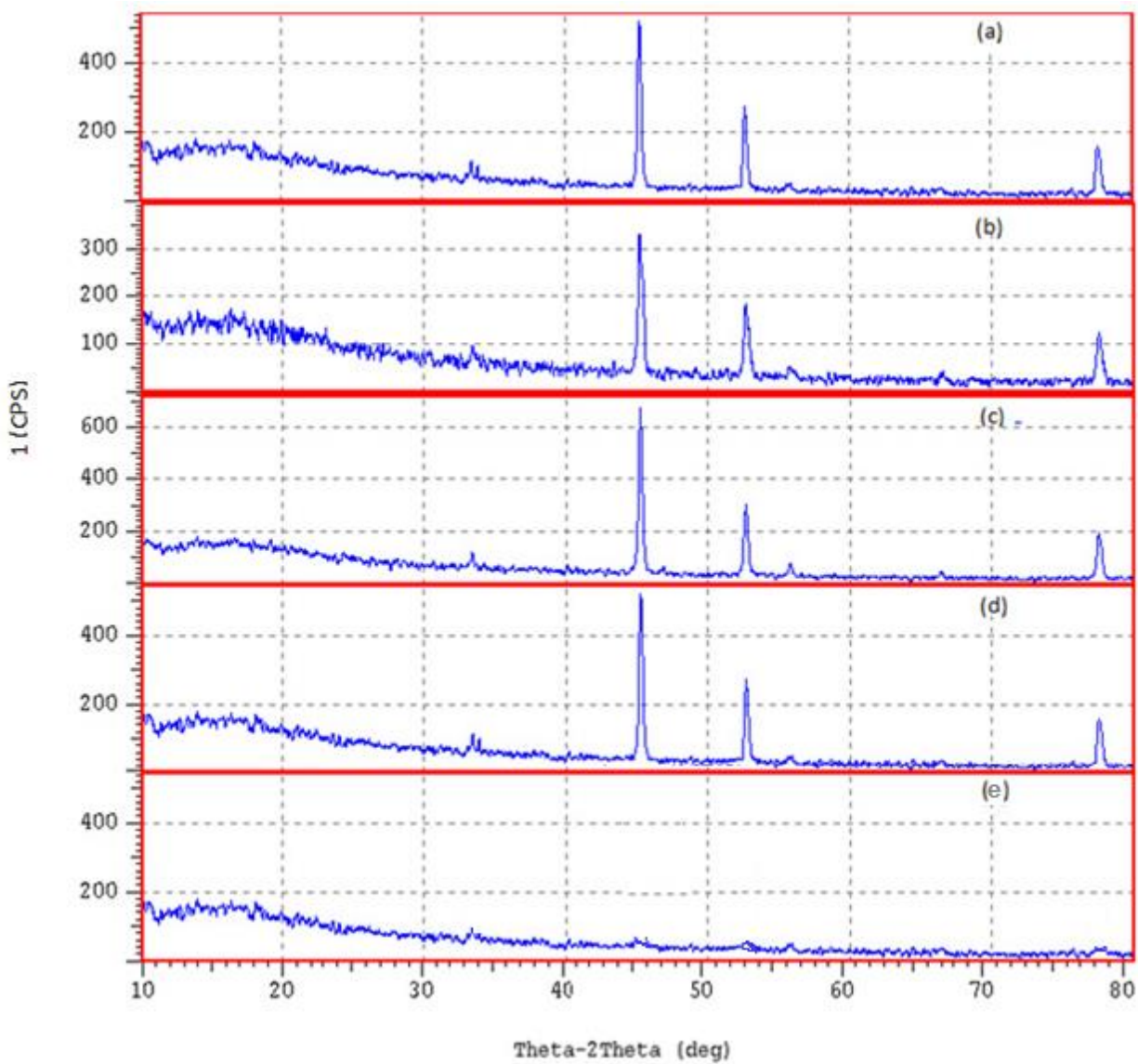


Figure 4.19: XRD pattern for different sample (a) Sample 1 (b) sample 2 (c) sample 3 and (d) sample 4 (e) sample 5

CHAPTER 5

5.1 APPLICATION

- Home appliance like(door)
- Automobile light casing
- Harsbetsheet
- Panel making
- Lathe bet
- Wheel hub etc....

5.2 ADVANTAGES

- A few of the NFCs' potential benefits include the followings:
- In addition, natural fibres may be replenished.
- Reduce the amount of pollutants that is released into the atmosphere during manufacturing.
- It takes less energy to produce fibres than it does to grow bamboo.
- fibre plant CO₂ neutrality: the amount of CO₂ that is neutralised
- Amounts released during processing are equivalent to the amount of growth that occurs.
- There is a lower price.
- low cost
- Ease of decomposability.
- It is replace natural plastic
- Strong bonding strength
- 3D-combination
- High flexural strength

- High tensile strength
- High hardness strength and impact strength
- The processing equipment will be less damaged by using this product.
- NFC's low density is a major factor in its appeal to the car industry.
- With the use of biodegradable polymers, we can create recyclable materials that are completely biodegradable.

5.3 DISADVANTAGES

But it also has the following disadvantages.

- Large scatter of all the parameters.
- Properties depend on growing and processing conditions.
- Degradation of properties (heat, flame).
- Fibers are short; that means lower performance of their composites.
- Structure is highly inhomogeneous.

5.4 APPLICATION OF NATURAL FIBER COMPOSITES

For the time being, biocomposites are most often used in the construction and automotive industries. Opportunities and uses will certainly emerge when future advances and improvements in performance take place. " The built environment has a lot of potential since it generates a lot of trash at a time when companies are being held accountable for their environmental effect. Modern furniture and housewares are being replaced with "greener" alternatives.

CHAPTER 6

CONCLUSION

Resin and fibres have been successfully combined to create the Polymer composite. The mechanical qualities of the newly created Fiber reinforced PMC material were evaluated to ASTM specifications. The findings showed that the concentrated Fiber reinforced PMC with alkali treated samples performed better than the PMC specimens in terms of performance. Alkali-treated natural fibres in the polymer matrix composite display improved mechanical capabilities, according to the study. Fibre volume fraction has a major impact on mechanical qualities, in particular on the rise in flexural strength. The newly created material has improved tailor-made qualities and will be an option for automotive applications.

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