

MECHANICAL TESTING STUDIES ON EPOXY COMPOSITE REINFORCED WITH NANO EGGSHELL AND WALNUT SHELL POWDER

Submitted in partial fulfillment of the requirements for 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 MANOJ M (Reg. No. 38150905) and SURYA D (Reg. No. 38150906) who carried out the project entitled "MECHANICAL TESTING STUDIES ON EPOXY COMPOSITE REINFORCED WITH NANO EGGSHELL AND WALNUT SHELL POWDER" under our supervision from Nov. 2021 to April. 2022.

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DECLARATION

We MANOJ M (Reg.No 38150905) and SURYA D (Reg. No 38150906) hereby declare that the Project Report entitled **MECHANICAL TESTING STUDIES ON EPOXY COMPOSITE REINFORCED WITH NANO EGGSHELL AND WALNUT SHELL POWDER**” done by us under the guidance of **Dr. J. LILLY MERCY, M.E., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

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ABSTRACT

The combination of natural fiber takes part a very important role in space and the automotive industry. Because of the beauty of abundant availability and less in weight natural fibers such as pineapple, coir, banana, sisal, jute, luffa cylindrica, bagasse and more. Natural fibers are lightweight, regenerative, non-toxic, rotten, have some high tensile and flexural ability and low in cost etc.

In this report walnut shell nano powder and eggshell nanopowder are used to form composites and their mechanical properties are studied as the percentage of the powders are altered. Fiber surface reinforced resins are extensively used for many areas of application. The defense sector, aerospace sector, the automotive sector, the maritime transport sector and sports goods are the best examples where natural composite materials are used. Due to deforestation and declining yields, a shortage of wood fibers in recent years is being considered. Previous research has proven that chicken egg shell (ES) is an agricultural product registered all over the world as one of the common ecological headache especially in those countries where the egg production industry is well developed.

The walnut shell is another natural filling material that can be used in the formulation of polymer composites to improve mechanical properties. The main purpose of our work is to prepare the PMC using eggshell nanopowder and walnut shell nanopowder as a solvent and epoxy resin matrix material to discuss the mechanical properties for the chemical specimen. Another major goal is to reduce the use of plastic in industrial machinery leading to eco-friendly products and easy waste management.

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CHAPTER - 1

INTRODUCTION

Composite is a high-quality and unique material created by combining two different materials. It is also described as a merger of reinforcement and matrix, when combined provides a higher material than the material of each component. Van Schectman described a compound as two or more solid segments of different materials closely connected to a nanoscopic scale. The reinforcing fibers can be designed, ordered, arranged in distinct ways to effect the attributes of the produced compound. The composite matrix, usually a type of resin, keeps the alignment of matrix and reinforcement in insisted orientation. It safeguards the composite from synthetic and ecological attacks, and binds the composite in such a way that that the weights used cannot be easily transferred. In the past compounds have been used for civil engineering works, mud mixed with grass. The mud serves as a hardener while the grass can give it strength and texture. It is now using plastic and structural fibers.

1.1 TYPES OF COMPOSITE

Actually, three types of composites are available.

a) Ceramic matrix- Ceramic matrix compounds are a small group of natural fiber materials. They incorporate clay fibers added in a ceramic matrix, thus forming a ceramic fiber reinforced material. Matrices and fibers can contain any ceramic material. Ceramic matrix materials are engineered to control the main disadvantages such as low toughness.

b) Metal matrix - Metal matrix composites are composites those which have minimum two connecting components - metal and other material or a different type of metal. The matrix is reinforced with other materials to increase toughness and aging. When there are three or more components, it is called a metal matrix composite compound. In constructional applications, the composite is usually constructed of simple metal such as calcium, manganese, or aluminum. In humid temperature applications, cobalt and cobalt-nickel alloy matrices are commonly

used. Perfect metal matrix production is differentiated into three main categories: solids, liquids, and vapors. Continuous carbon, silicon carbide, or ceramic fibers are some of the materials that can be embedded in a metallic matrix material. Metal matrix is reluctant to fire, operates at a various temperatures ranges, does not take in moisture, and has a best air permeability and temperature. They too found that applications are resistant to radiation damage, and can get harm due to gas leaks. Many materials and alloys make good matrix for the durability of a composite application breakdown.

c) Polymer composite matrix - Polymer matrix compounds is differentiated into three subtypes, they are, thermoset, thermoplastic, and rubber. Polymer is a huge molecule made by repetitive constructure part linked by composite chemical bonds. PMCs contain polymer matrix composed of reinforced dispersion phase. Cheap simple production methods. PMCs are slightly heavier than steel or clay vessels and can withstand airspace and other means of corrosion, and show higher reluctance to electrical conductivity.

1.2 TYPES OF COMPOSITES (BASED ON THEIR SHAPES.)

The metal matrix composite is reinforced by different phases and planes such as three dimension, two dimension, one dimension. In 3D shapes we use particulate, for 2D we use laminar shapes and for one dimensional shapes we use fibrous matrix reinforcement. These classification have different mechanical strength and different fabrication methods.

a) Particle bolstered Composite: The debris used as a binder consist of clay and glass materials which include small mineral debris, metal particles along with aluminum and amorphous substances, which includes polymers and carbon black. Particles are used to growth the modulus of the matrix and to reduce the ductility of the matrix, devices related with the aid of covalent chemical bonds. This include a polymer matrix composed of a bolstered reinforcing dispersion segment, reasonably priced with easy production methods. They are barely thicker than metal or clay vessels, can withstand atmospheric and other styles of corrosion, and show off better resistance to electric conductivity.

b) Fiber bolstered Composite: In general, fiber reinforced specimens are developed of fibers and matrix. The fiber has a good strength, the matrix helps to clasp the strands and transmit pressure among the strands. The common fiber-bolstering agents include, carbon / graphite fibers, asbestos, beryllium and its carbide and oxide, molybdenum, aluminum oxide, glass fibers, polyamide, natural fibers etc. Matrix modulus and reducing matrix ductility. Likewise, the widely used matrix include epoxy resin, phenolic resin, polyesters, polyurethane, polyetheretherketone (PEEK), vinyl ester etc. They can be woven or twisted into a thread like a piece of fabric and they are changed to yields. They are the best for application in reinforced composites. Fibers are classified as natural fiber and manmade or synthetic fibers.

1.3 NATURAL FIBRES

Natural fibers are divided according to their source: animal, mineral and plant. Plant fibers are fibers that are widely accepted and are widely analyzed by the scientists. The main reason for the analyzation is less period of growth, regeneration and widespread accessibility. Vegetable fibers consists of lignin and cellulose, which are obtained from bast, leaves, seeds, fruits, wood, stem, grass / reed. Natural fibers are known to as have several benefits against manmade fibers such as accessibility, less in cost, less in density, range modulus-weight, increased sound damping, less production capacity, less carbon content and easily biodegradable. Some authors cite evidence of obvious advantages, such as, natural fibers are less expensive and they need lower amount of energy to make than the conventional reinforcing fibers like glass and carbon. Natural fibers have opposing characteristics because of their low structural stability and standards. Natural fibers have a wide range of corporal and mechanical properties, high vapor absorption, low durability, low power and low working temperatures.

The large variety of structures depends largely on the variety of plants, the growing conditions and the method of stripping. In addition, the structures to be conditional on the fiber shape of every cellulose and its extent of polymerization. We notice that direct cellulosic molecules are attached to hydrogen links and are related to hemicellulose and lignin that provide fiber stability. It holds

the fibers together and also the cellulose inside the fiber surface. The most common stages of the natural fiber extraction life cycle, rectifying, utilization, removal and recycling. There factors limiting the extraction and usage of fibers life cycle: huge variations in sand structure and phylogeny, hydrophilic natural fibers, depravity of micro-organisms, life sevice and sunlight. The physical and chemical properties of natural fibers are related to the source of the crop, the environment, the climate, the pesticides and the fertilizer.

1.3.1. Natural Fiber Materials

The natural fiber materials are classified as cellulose or lignocellulose, animal, mineral.

The cellulose fibers are further classified as bast, leaf, wood, stalk and grass. The examples of cellulose fibers are banana, coir, hardwood, wheat, bamboo, corn, etc. The animal fibers include wool, goat hair, cashmere, mulberry silk, etc. The major mineral fibers are asbestos, ceramics and metal fibers.



Banana Luffa Cotton



Fig. 1.1: Natural Fibers

1.4 MAN-MADE FIBERS

Human-made fibers which might be produced by chemical synthesis are referred to as artificial fibers and further classified as organic or inorganic based on their content. usually, the power and stiffness of fiber substances are much higher than that of the matrix cloth, making them a load-bearing element in the composite structure. Glass fibers (GFs) are most broadly used among all the synthetic fibers as they provide fantastic strength and sturdiness, thermal stability, resistance to effect, chemical, friction, and wear properties. however, the machining of glass fiber-reinforced polymers (GFRPs) is relatively gradual, tough, and indicates reduced tool life even as running on traditional machining structures. GFs additionally deliver the downside of disposal at the give up of their carrier life.



Fig. 1.2: Synthetic Fibers

1.5 METHODS OF MANUFACTURING

Fiber-reinforced composite production demand the production of fiber preformance and reinforces the fibers with matrix material by different techniques. This include knitting, and sewing threads on lengthy mats or rugs. They are used to attain a high degree of self-action by help of of robots, providing command to the angle of the fiber and fiber quantity throughout the part of the component to be formed.

1.5.1 Traditional Process

It prepares a aggregate of fibers and pre-coated fiber, pre-lined with thermoplastic or thermoset resin fabric that handiest desires to be operational. these prepregs are perfect for use when thin layers are cut and placed on open skin. Dow automobile structures evolved VORAFUSE, a method that mixes epoxy resin and carbon fiber for pre-instruction to enhance cloth managing and cycle time inside the compression formation of composite structures

a) Hand lay-up process:

Hand-lay-up is the universally used method of producing composite mold. At first, fiber are shaped beforehand are applied to the skin in which a lean layer of sticky coating is given for proper removal. Resin materials are poured or applied using a brush for reinforcing materials. The roller is used to force the resin on the fabric to make sure stepped forward interaction among successive layers of reinforcement and matrix materials.

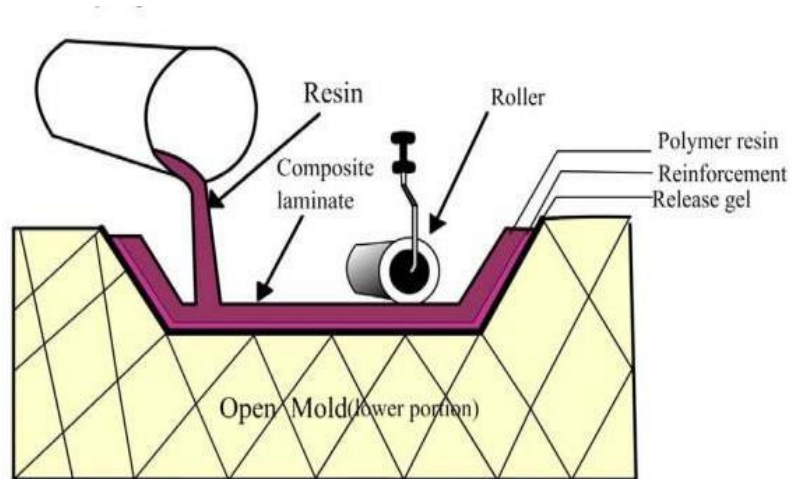


Fig. 1.3: Hand Lay-up technique

b) Spray up technique

This method of spraying is not unique from hand layup. However, he uses a spray gun that sprays amber and cut fibers on the skin. At the same time, a roller is used to attach these fibers to the material matrix. It is a type of open type of strategy, in which the carved threads provide good consistency and great speed.

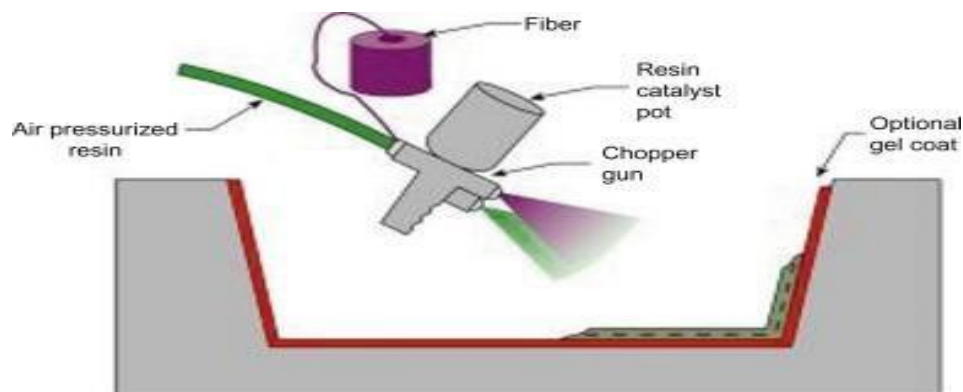


Fig. 1.4: Spray- Up process

c) vacuum bag molding

It uses a flexible film fabricated from substances inclusive of nylon polyethylene or polyvinyl alcohol (PVA) to seal and seal the component from the outside air. most of the time, the process of making a vacuum bag is finished with the assist of a handheld technique. The laminate is first made using a hand held method, after which located among the vacuum bag and the mould to ensure proper insertion of the fibers into the matrix object. The air among the mould and the vacuum bag is then pumped via a vacuum pump even as atmospheric strain presses part. Hierarchical compounds had been repaired with the aid of multiscale reinforcement of carbon fibers the usage of a vacuum bagging system, putting off the opportunity of porosity and incorrect insertion of double reinforcement, and an growth in flexural and interlaminar shear structures through 15% and 18% , respectively.

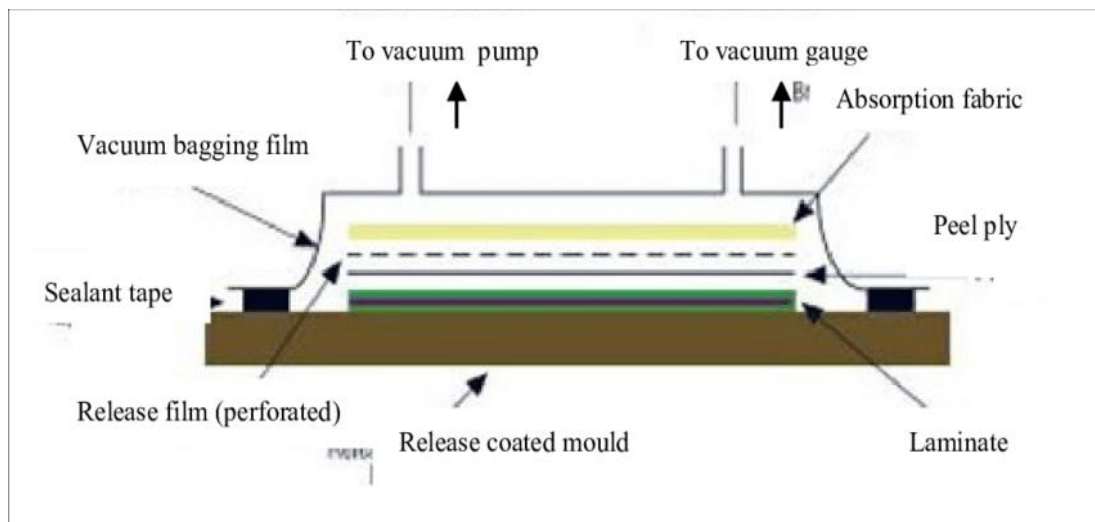


Fig. 1.5: Vacuum bag molding

d) Injection molding:

Injection molding can make composite elements with excessive accuracy and really low cycle instances. in the ordinary manner of injection formation, fiber compounds in the form of pellets are fed via a hopper, and then passed thru a warm tube, as proven. when the required quantity of molten material is inside the barrel, the screw injects the device into the mildew. where it cools and acquires the desired situations. Injection molding is determined to be very effective in thermoplastic

implantation of electrical merchandise required inside the clinical industry. The development of fiber-matrix coherence and similarity in the scattering of fibers in a matrix object is finished throughout nearby remedy.

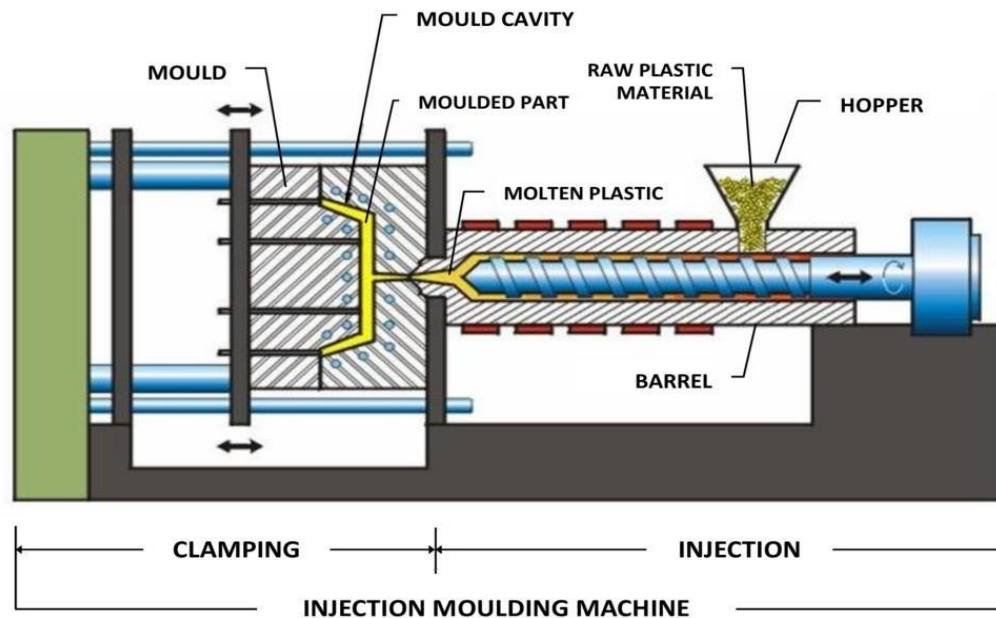


Fig. 1.6: Injection molding

e) Pultrusion process:

The process of pultrusion can be described as a thread that continues to be pulled by a resin bath, which is also covered with a hot mold. Pultrusion is a uninterrupted process, convenient in making compounds with fixed cross that has a relatively long length; performs manufacturing with a excessive degree of automation and occasional manufacturing expenses.

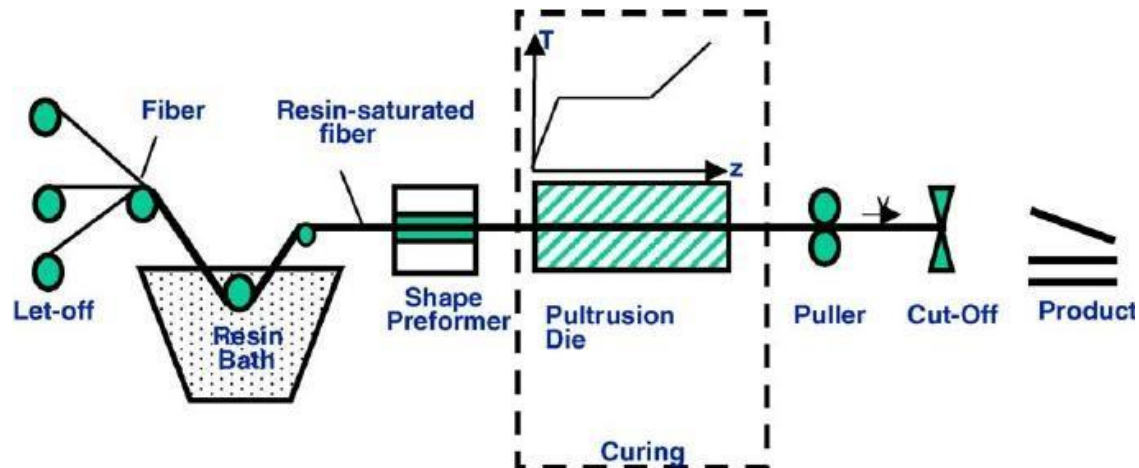


Fig. 1.7: Pultrusion process

1.5.2 Modern Manufacturing Process

Rising nanotechnology has prompted researchers to be searching for new methods to supply nanoscale fiber for composite production. The system of making electrostatic fiber referred to as electrospinning makes use of electric strength to supply continuous fibers of nanometers to three micrometers. The spinneret-extracted polymer answer forms a continuous fiber, gathered in the collector. gives superior bodily and mechanical residences, flexibility over technique parameters, excessive vicinity to scale capability, and high porosity; consequently, it reveals strength in numerous fields of biomedical applications including wound recuperation, tissue engineering scaffolds, drug shipping, as a membrane for biosensors, enzyme disorder, cosmetics, and so on

a) Additive Fabrication:

Additive Production (AM) provides an extraordinary geometric sophistication for entirely customizable products as it benefits from computer-assisted design and eliminates the need for design, which is economic for the production method. It is one of the improving automation in production of composites as they offer a extensive choice of fiber and fiber alignment. It is capable to transform design ideas into a fast-paced product without squandering any time and space, making it good for modelling and personalization.

1.5.3 Automatic Manufacturing Techniques

Automated manufacturing is an ongoing method that offers automation, which ends up in free financial savings. Filament winding enables to create axisymmetric, as well as other non-axisymmetric, composite additives, including pipe bends. driven by way of numerous pulleys, continuous prepreg sheets, rotating, and monofilament are made to pass the resin bath and are collected over a rotating mandrel. Then, after applying sufficient layers, the mandrel, which has the favored form of the product, is ready to remedy at room temperature. The newly evolved robotic filament winding (RFW) machine is provided with an business robot feed feed and garage gadget. It brings benefits beyond process manage, repetition, and manufacturing time through changing a human consumer.

a) Automated tape layup (ATL)

ATL process is an established process for manufacturing of composites nowadays. This technique is easy and have many benefits. In this method we use wide unidirectional tapes which are laid onto a mould part by a loaded rolling system with varying extent of articulation. It is based on the complexity of the part which is going to be machined or manufactured.

1.6 MECHANICAL TESTING METHODS

The mechanical homes of materials are determined by means of appearing carefully designed laboratory experiments that mirror as almost as possible the service conditions. within the real life, there are many elements concerned in the nature wherein loads are implemented on a cloth. the following are a few common examples of how those masses might be carried out: tensile, compressive and shear, and many others. these properties are vital in materials choices for mechanical design. different factors that regularly complicate the design method encompass temperature and time factors.

1.6.1 Tensile test

Tensile test is a type of detrimental process, in which the standard and size template (configured according to ASTM D 638 :) is under transverse load. As

shown in Figure 1.8, during a rigorous test, a bone-shaped sample is held from the ends and pulled to extend at a fixed point where it separates, highly ductile polymers may not reach the point where it separates. For analytical purposes, a pressure frame (σ) against stress (ϵ) was developed during the tensile test, which can be mechanically done on software program furnished with the aid of the tool manufacturer.

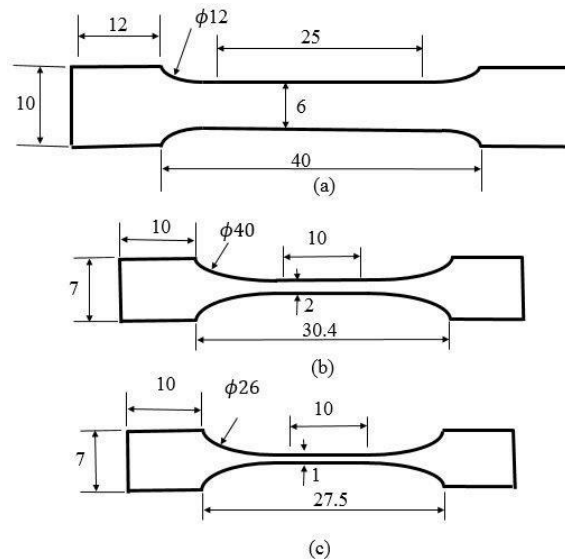


Fig.1.8: Tensile specimen

1.6.2 Flexural test

The sum of the variable test to decide the ability of the item by means of measuring the pressure required to bend the beam below the required loading condition. generally, a 3-point bending position is used consistent with the ASTM D790. The technique of making ready a three-point bending test sample is tremendously easy, as the standard sample is a easy rectangular log with unique dimensions according to ASTM D790 and ISO 178. The period of the template should exceed the space among the bases and the energy. used in the center of the template. but, one-point bend exams and 4-factor bend tests are also available. The 3-point flexural bend check uses a simple aid set, in which a square bar is positioned over bases and broken by a single imperative load.

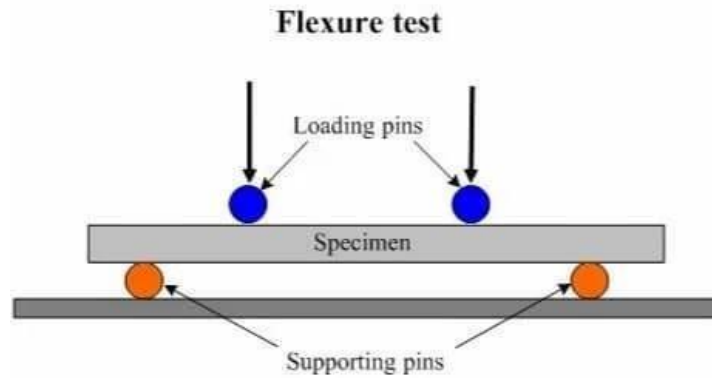


Fig. 1.9: Flexural test

1.6.3 Impact test

The impact test is used to look for metals that will be exposed to something when it detects shocks that cause the template to wear out, break or crack fully. For this test the specimen is holded in a geometric holder and its shape is found by the class of test used and then the commonly known but not constant weight of the pendulum is removed from the known height to collide with the template with sudden force. This conflict between weight and template often leads to damage to the template but the transfer of power between the two is used to determine the fracture of the object.

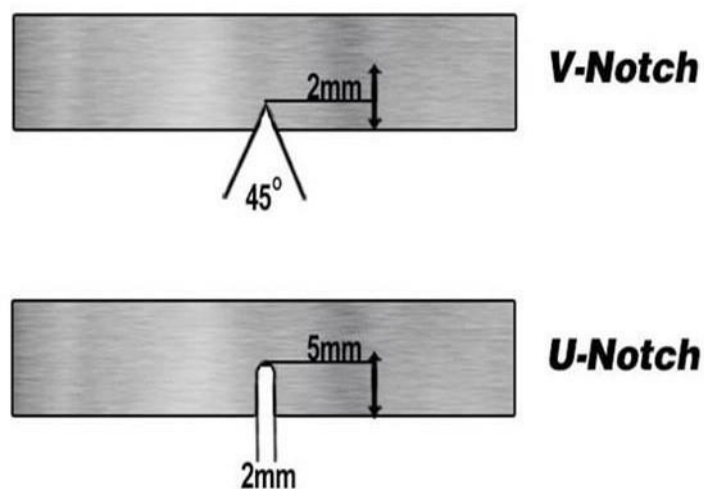


Fig. 1.10: Impact test specimen

1.6.4 Hardness test

Hardness check is a non-damaging test approach that involves using a constant load with a round or sharp object, underneath controlled situations, to create an indent inside the metallic floor. that is then measured to determine the durability of the asset. The several ways to test the complexity available, each with its own standards and advantages. The mission department is focused on testing the strengths of Rockwell, Brinell, and Vickers. The department is metallurgical and also provides minimally invasive tests, which include the Knoop test and the Vickers test.

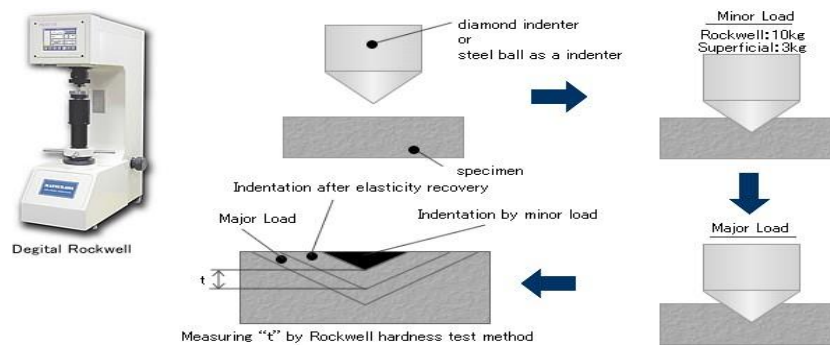


Fig. 1.11: Hardness test

CHAPTER 2

LITERATURE SURVEY

2.1 EPOXY REINFORCED COMPOSITES

Cemal Kochan et al (2020) studied the mechanical properties of waste mussel shell particles reinforced epoxy composites.

This study examines the mechanical properties of the new particles to fill the bio-filler reinforced with shellfish shells. It was found that the compound has a minimum hardness of 170 HV, 24 MPa high durability, 112.8 MPa low compression strength and 75 MPa flexible power.

IO Oladele (2020) examined the mechanical properties of peeled chicken shell / sisal fiber hybrid reinforced with epoxy compounds.

This study investigates the impact of calculated and non-calculated egg shell particles (ESP) and sisal fiber (SF) on materials and caps of egg shell particles / sisal fiber reinforced compounds in epoxy. The egg shell was processed to obtain a calculated net 43 micrometer shell and the sisal fibers were extracted by retrieval and treated with NaOH. The combination was developed using the laying on of hands by combining selected items with pre-determined measurements. However, weight 3% appeared as a weight component with higher values.

IG Akande (2021) investigated the potential of bio waste in the development of compounds for production use.

The result shows that bio-wastes have great potential for the development of compounds with significant improvements in mechanical properties and chemical composition of the material as confirmed by the large number of books discussed for the purpose of this review.

P Dwivedi (2020) reported the use of peanut shell as an enhanced aluminum-based compound to reduce environmental pollution.

The nut shell is a waste that produces a lot of soil pollution. By using short ground ash as reinforcing materials with aluminum, mechanical properties can be improved. In addition, congestion and compound costs can be reduced. The purpose of this review article is to study the impact of different types of reinforcement on the manufacture of composites with advanced mechanical properties.

R Boopathi (2020) studied the impact of eggshell nanoparticles and the impact of alkalization on the expression of industrial hemp fiber reinforced epoxy composite.

The results of the project clearly showed that the incorporation of eggshell nanoparticles has a significant impact on the thermal and morphological properties of alkali-treated hemp fiber composite.

YG Thyavihalli Girijappa (2020) reported the effect of natural fillers on reinforced fiber polymer composites.

These books highlight the impact of natural fillers on fiber-reinforced polymer matrix compounds and discuss physical, chemical, thermal, and mechanical properties according to XRD, FTIR and SEM. The main purpose of this article is to discuss the different types of building materials and natural fillers and to evaluate their suitability for potential engineering applications.

SP Dwivedi (2021) is researching the egg shell and the use of ash ash husk as a catalyst for the development of compounds.

By using Rice husk ash and egg shell as an aluminum reinforcement, mechanical properties can be improved. In addition, the strength and durability of the compound can be increased by a different percentage of weight reinforcement. In this study, various possibilities for the combination of RHA and Eggshell and aluminum alloy have been discussed.

MA Khan (2016) investigated the use of a blend of natural fiber blend with filler and externally as a stabilizer.

The effects of the cutting parameters are assessed in relation to the inclination of the kerf wall, the degree of removal of the material, and the rigidity of the area. Surface morphology was also studied to consider the basic mechanisms involved in compound mechanical engineering. The hybrid fiber composite with filler has proven to be able to produce a good engineering component without delamination and fiber pullouts during the machine.

S Saravanel (2020) reported an investigation into the hardness of the dirty plastic and eggshell powder reinforced polymer composite by a moving line.

This research project is designed to determine the feasibility of refining contaminated products into a polymer matrix in order to improve mechanical properties. A combination of 30 weights% includes discarded plastics and 15we%% inclusion of egg shells producing high hardness.

Dash (2016) pronounced an research into the mechanical residences of coconut shell dust, Epoxy and fly-ash compounds.

The homes of composite laminate equipment prepared for random distribution of reinforcement had been investigated which include microstructure, solid strength, sturdiness, water absorption with the aid of requirements. From the tensile check it's far cited that as the share of coconut shell dirt increases the grip energy of the samples increases to fifteen% and then decreases via 20%. The Vickers strength check yielded values along with 15.884VHN, sixteen. 098VHN and sixteen. 88VHN with 10%, 15% and 20% of CSP reinforcement respectively. From water absorption tests because the gain in weight is less than 2% consequently moisture absorption is negligible.

Mateusz Barczewski (2017) Evaluation of highly filled epoxy composites modified with walnut shell waste filler.

The results obtained from DMTA assessments confirmed a boom inside the composites stiffness at elevated temperatures as a feature of the growing natural filler content. The cloth characterization became supplemented by using thermal stability evaluation realized via thermogravimetric evaluation (TGA). It changed into discovered that the incorporation of ground walnut shell brought about an stepped forward thermal balance of composite materials.

2.2 EGG SHELL AND WALNUT SHELL REINFORCEMENT

Gaurav Gupta (2016) studied about walnut shell reinforced composite. By this overview walnut shell powder is used to make a polymer composite and its mechanical strength is mentioned when the composition of the walnut powder is modified. Fiber and textile surface bolstered composite. materials are extensively used in a broad range of utilization fields. Protection industry, area enterprise, automotive enterprise, sea delivery industry and game materials are exemplary fields where composite materials are extensively used.

T.T. Hawal (2015) investigated about the making and enactment of epoxy composite bolstered with walnut shell micropowder.

Addition of Walnut shell powder to the epoxy brought about an increase inside the tensile, flexural and compression strength by using 10.4%, 17.6% and forty two% respectively. Scanning electron microscope check was conducted to study the morphology of composite.

Anil Pol (2017) studied the I testing methods for walnut shell and polymer resin with fiber reinforced composites.

Walnut shell is dealt with as waste however because of its desirable mechanical power, chemical property and abrasive nature so it is helpful for enhancing belongings and it used as reinforcement. Fabricate the specimens by using varying % of weight of 0%, five%, 10%, 20%, 30% and 40% walnut shell flour utilized in polyester resin and making use of resin with E-Glass fiber with the aid of the usage of hand lay-up approach. The take a look at is achieved to determine compression test, Charpy check, tensile test and put on test is carried out.

A Asha(2014) investigated on the Mechanical Properties of Egg Shell Powder Reinforced Polymeric Composite. In this work polymer black eggshell specimns are made by using an compression molding process. The samples were prepared in accordance with ASTM standards, where polyamide and nylon black is used as matrix substance, the eggshell particles are used as bolstering material to make the specimens . The properties such as tensile stabilty, impactness, and flexural strengths are valuated for both the specimen and the composite.

CHAPTER 3

MATERIALS AND EXPERIMENTAL METHODS

3.1 METHODOLOGY

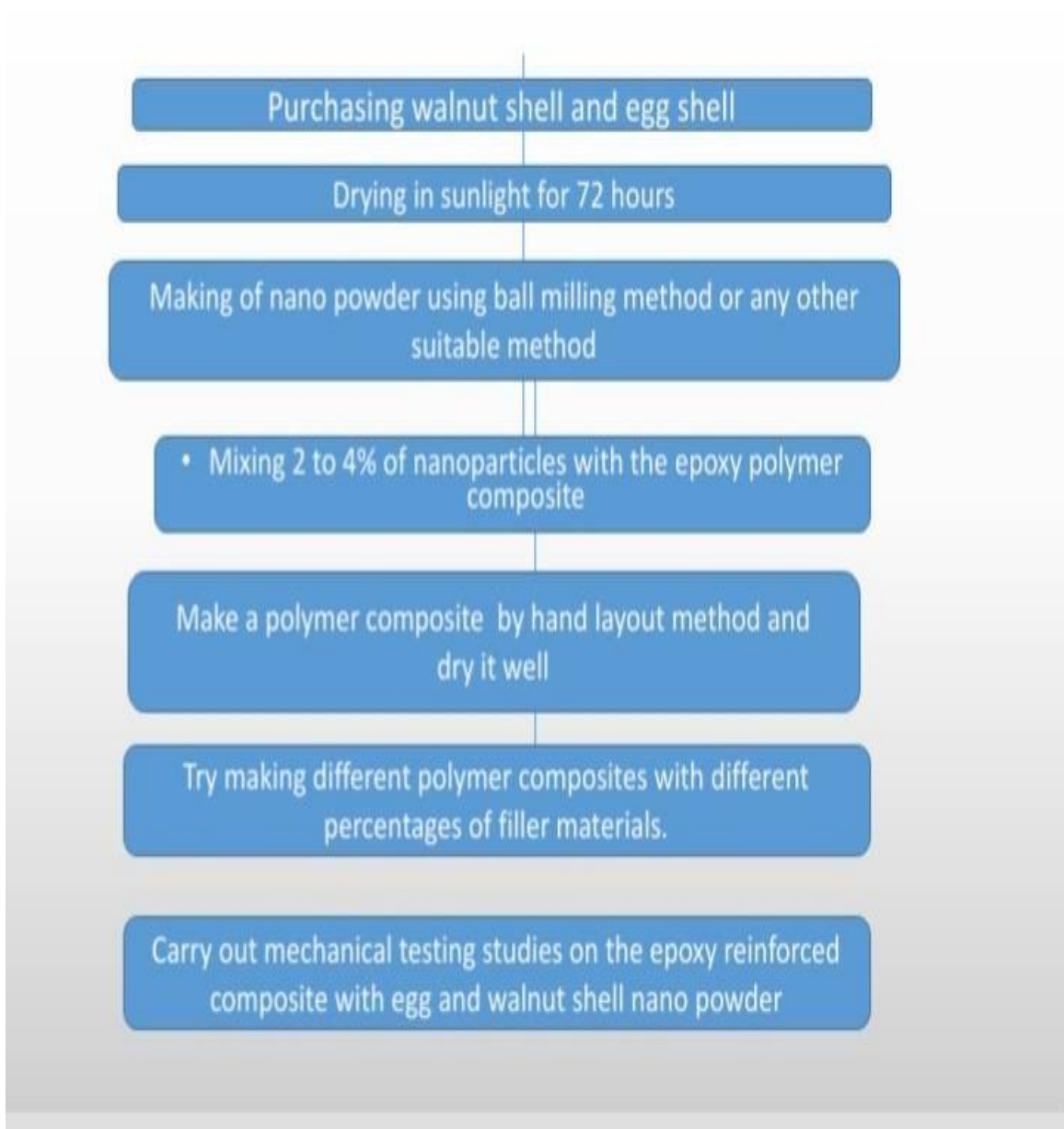


Fig. 3.1: Methodology flow chart

3.2 MATERIALS

The main materials used for the process was Epoxy LY556, Hardener HY951, Eggshell nano powder, walnut shell nano powder. The other substituent materials used are plastic tray, mylar sheet, beaker set, stirrer, hand gloves, etc.

3.2.1 Epoxy LY551 & Hardener HY951

Araldite LY 556 is a medium-viscosity, unmodified epoxy resin based on bisphenol-A. It Possesses superb mechanical homes and resistance to chemical compounds, which may be changed inside wide limits using special hardeners in addition to fillers. It has a low tendency to crystallize.

Aradur HY951 is a low viscosity, unfilled epoxy casting resin device, curing at room temperature. high filler addition opportunity. the important thing properties are precise mechanical energy, proper resistance to atmospheric and chemical degradation.

We bought Epoxy LY556 and Hardener HY951 from Sakthi Fibres, Saidapet.



Fig. 3.2: Epoxy resin and hardener

3.2.2 Egg shell and Walnut shell powder

The eggshell and walnut shell are agricultural by-product's which are considered as waste materials. But they contribute to be a excellent filler material in polymer composite preparation. The eggshell mainly consists of calcium carbonate crystals and protein coating. The walnut shell fibres include ash(3.4%), lignin(50.3%), hemicellulose(22.4) and cellulose(23.9%).



Fig. 3.3: Egg shell and walnut shell

3.3 EXPERIMENTAL METHOD

The method of preparation of composites are as follows:

3.3.1 Preparation of eggshell walnut shell nano powder by Ball milling method

The eggshell was collected from the hotels near Aarani and were cleaned using clean water to remove dust and yolk residue. Walnut shell was bought in Kalpakkam, and both were dried in sunlight for 72 to 96 hours. After proper drying of both shells, they were taken to Dr. VB Ceramics in OMR Kottivaakam. Ball milling was done for 6 hours for eggshell and 9 hours for walnut shell. We got a fine powder of eggshell and walnut shell. Planetary ball milling machine was used to reduce the size of particles using different size of balls.



Fig. 3.4: Ball milling machine and nano powders

3.3.2 Fabrication of Polymer Composite Material

The fabrication process of Epoxy polymer composite material was done by hand lay up method. The mould box was prepared using a plastic tray of length 200 mm, width 150 mm and height 50 mm. The plastic tray was fully covered and pasted using mylar sheet of desired dimension. Mylar sheet was used because of its high strength and chemical stability. It also acts as separating agent from the mould box.



Fig. 3.5: Mould preparation

Then 100 ml Epoxy resin was poured in beaker and mixed with 10 ml hardener in the ratio 10:1. Different ratio of eggshell and walnut shell powder was added to resin solution. The mixture of resin, hardener and powder was mixed

thoroughly for 3 minutes using a wooden stirrer. Then the mixed solution was poured in the plastic tray having mylar sheet and allowed to settle. The tray was adjusted such that the resin mixture flows equally in all directions. 16 specimens of different powder percentage combinations were made and allowed to dry and cure for 4 days. The specimens were kept at room temperature for curing. The powder percentage added to the 100 ml resin mixture is shown in the below table.

Table 3.1: Filler percentage table

S.NO	WALNUT POWDER (%)	EGG POWDER (%)
1	1	0
2	2	0
3	4	0
4	0	1
5	0	2
6	0	4
7	1	1
8	1	2
9	1	4
10	2	1
11	2	2
12	2	4
13	4	1
14	4	2
15	4	4



Fig. 3.6: Experimental procedure

After few days the specimen cured well and it was taken out from the plastic tray easily with help of mylar sheet. The specimens were dried in sunlight for 2 days for reducing stickyness from the specimen . Next the specimens were ready for testing.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

After the completion of fabrication process, the specimens were made ready for mechanical testing. In the results section we are going through the SEM images and the different testing values of the specimen.

4.2 SCANNING ELECTRON MICROSCOPE (SEM) ANALYSIS

The eggshell and walnut shell nano powders were subjected to SEM analysis. The analysis was done at SRM University, and the test was done using FEI Quanta FEG 200- High-Resolution Scanning Electron Microscope (HRSEM).

The walnut shell powder specimen images have been given below.

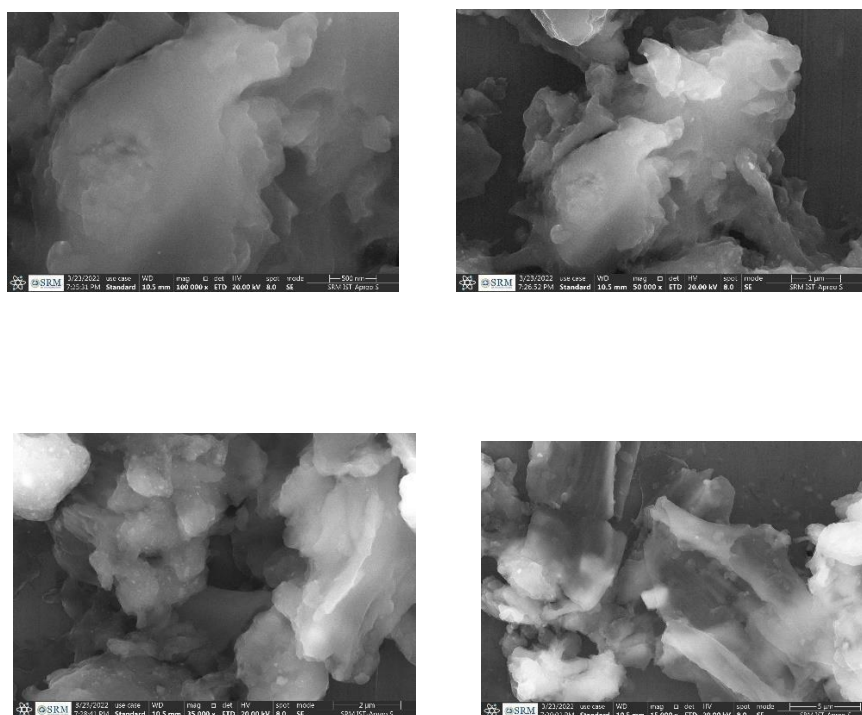


Fig. 4.1: Walnut specimen images

The eggshell powder specimen images have been listed below.

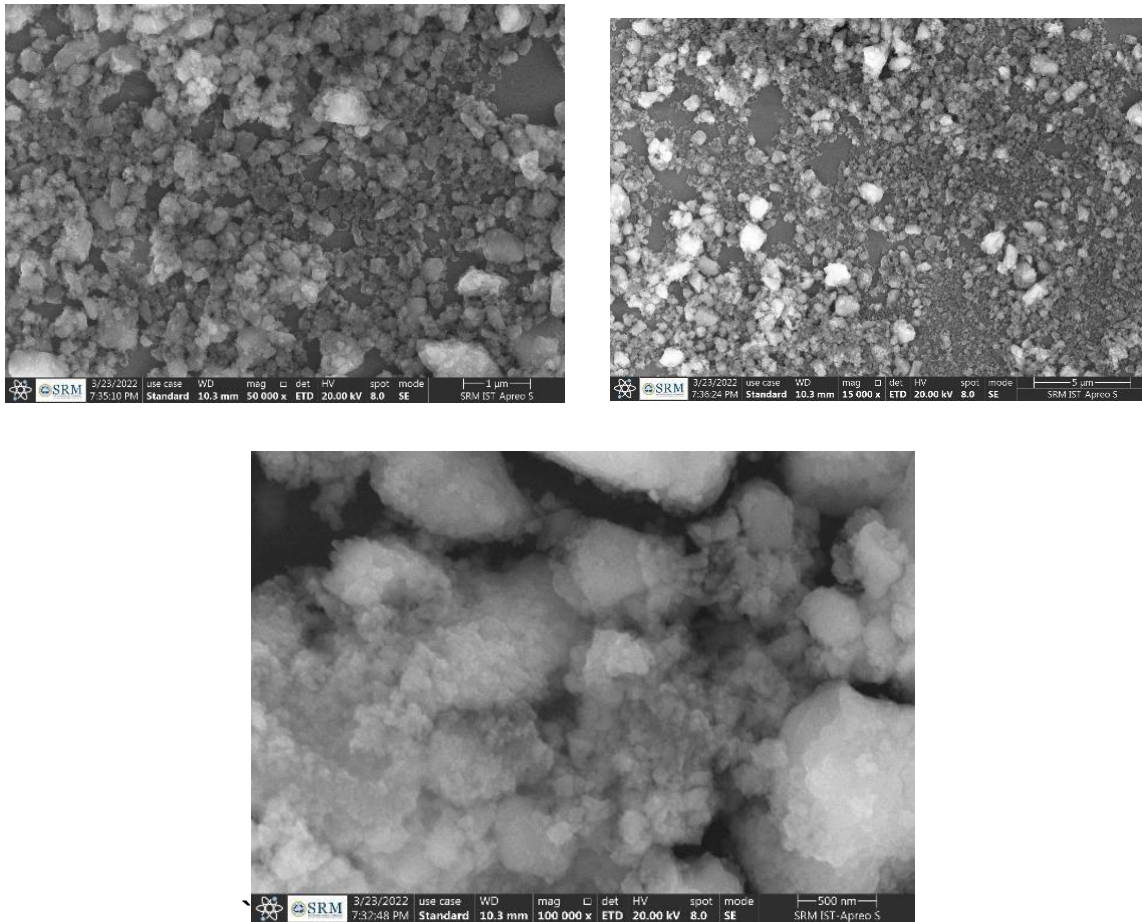


Fig. 4.2: Eggshell specimen images

4.3 MECHANICAL TESTING STUDIES

The tensile and flexural test reports are as follows.

The tensile and flexural values for different percentages of powder combination is given in a table.

Table 4.1: Testing values

S. NO	WALNUT SHELL POWDER (IN %)	EGGSHELL POWDER (IN %)	FLEXURAL STRENGTH (IN MPA)	TENSILE STRENGTH (IN MPA)
1	1	0	0.118	1.82
2	2	0	0.326	2.42
3	4	0	0.707	4.24
4	0	1	0.098	0.60
5	0	2	0.134	0.98
6	0	4	0.331	1.28
7	1	1	0.136	1.84
8	1	2	0.162	2.60
9	1	4	0.428	1.92
10	2	1	0.316	2.68
11	2	2	0.412	3.20
12	2	4	0.469	3.70
13	4	1	0.718	4.40
14	4	2	0.762	5.32
15	4	4	0.798	6.40

FLEXURAL CHART

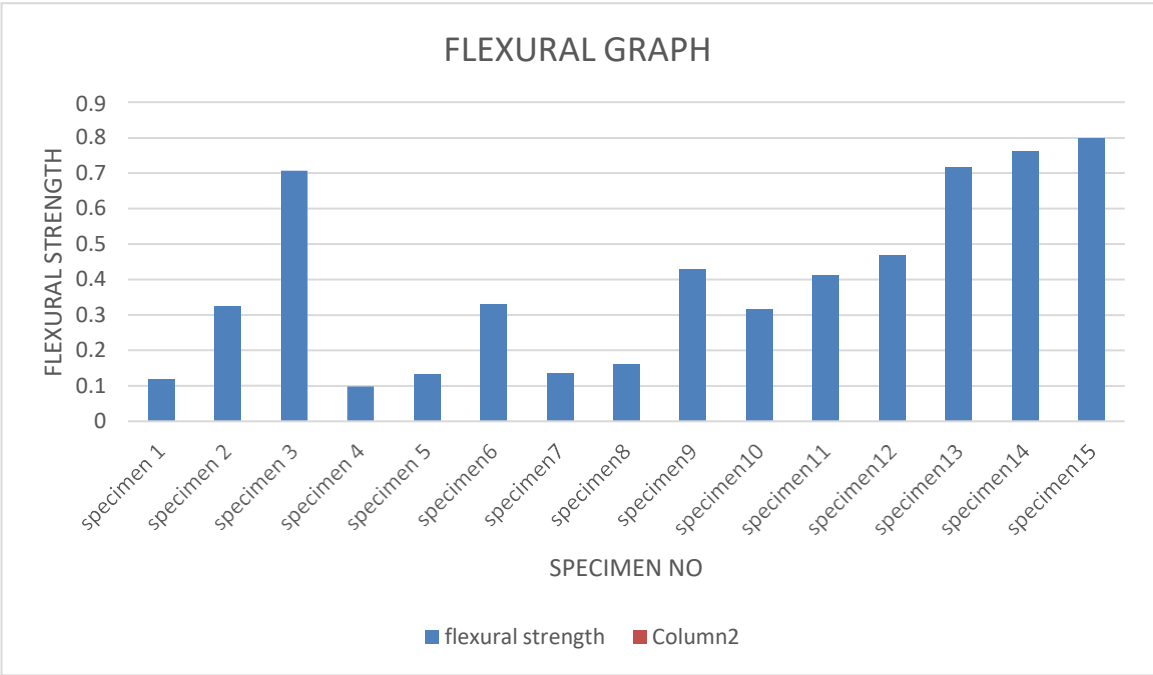


Fig. 4.3: Flexural chart

TENSILE CHART

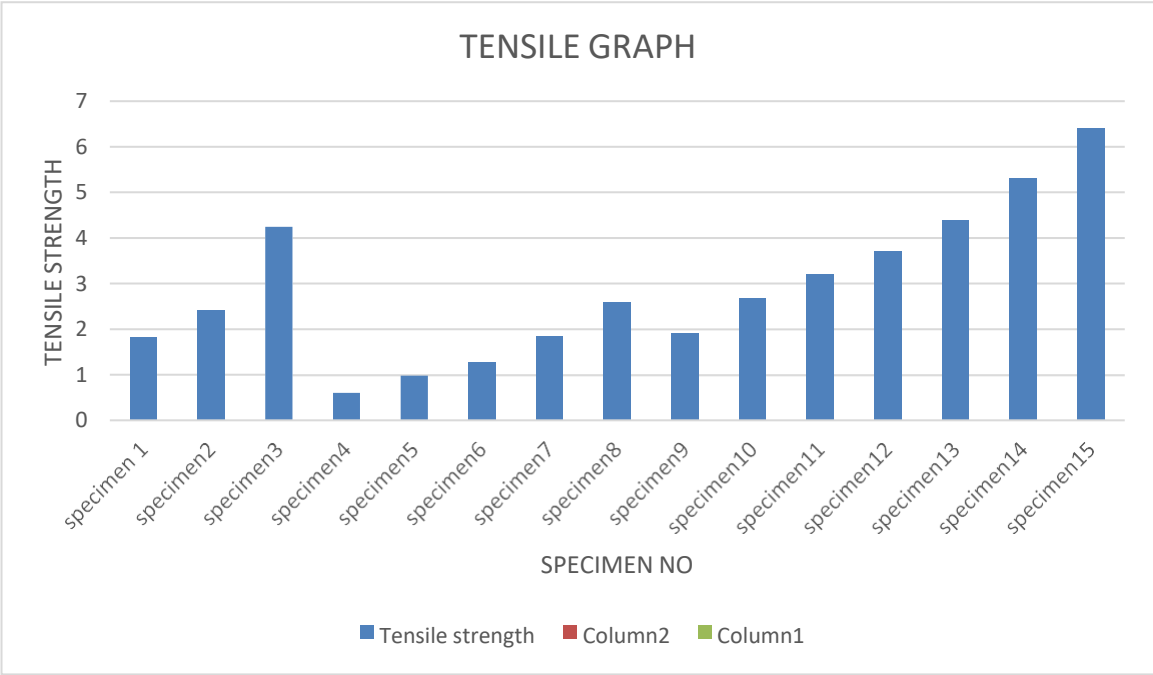
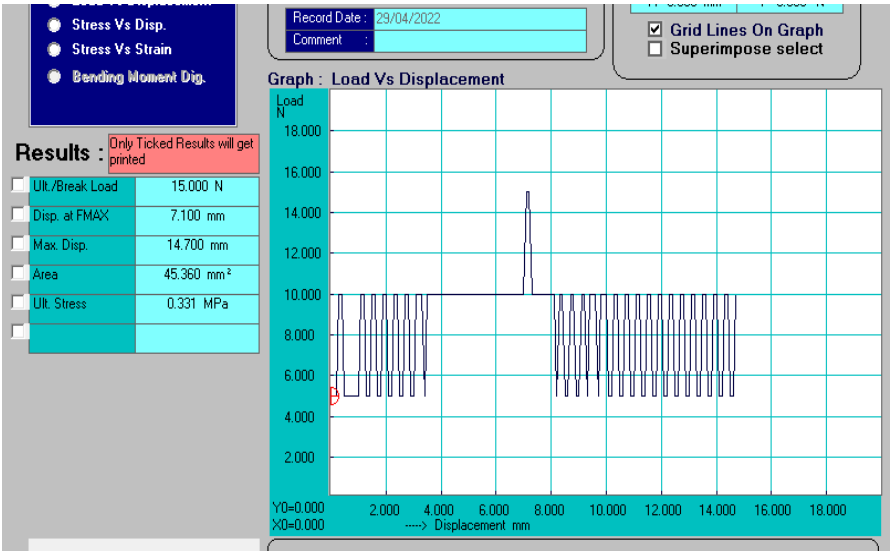


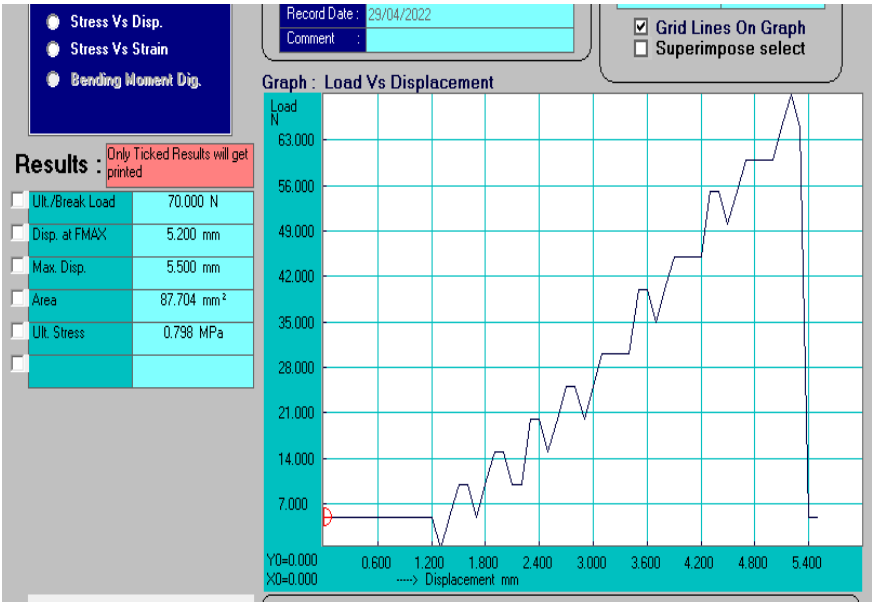
Fig. 4.4: Tensile chart

4.3.1 Flexural Test:

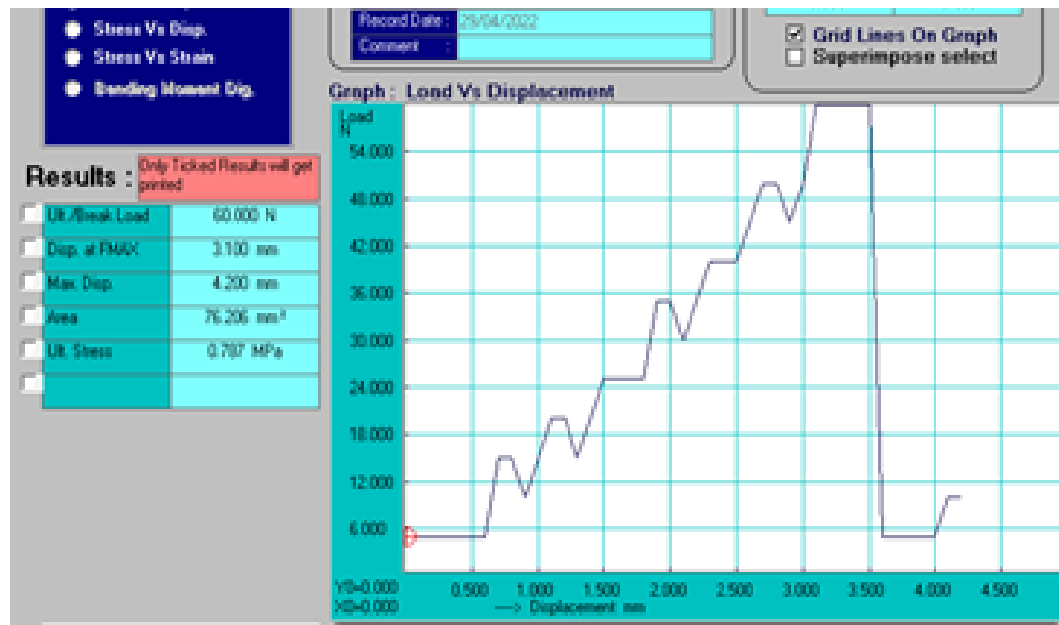
Sample I.D: Egg Shell Matrix



Sample I.D: Egg Shell with walnut Matrix

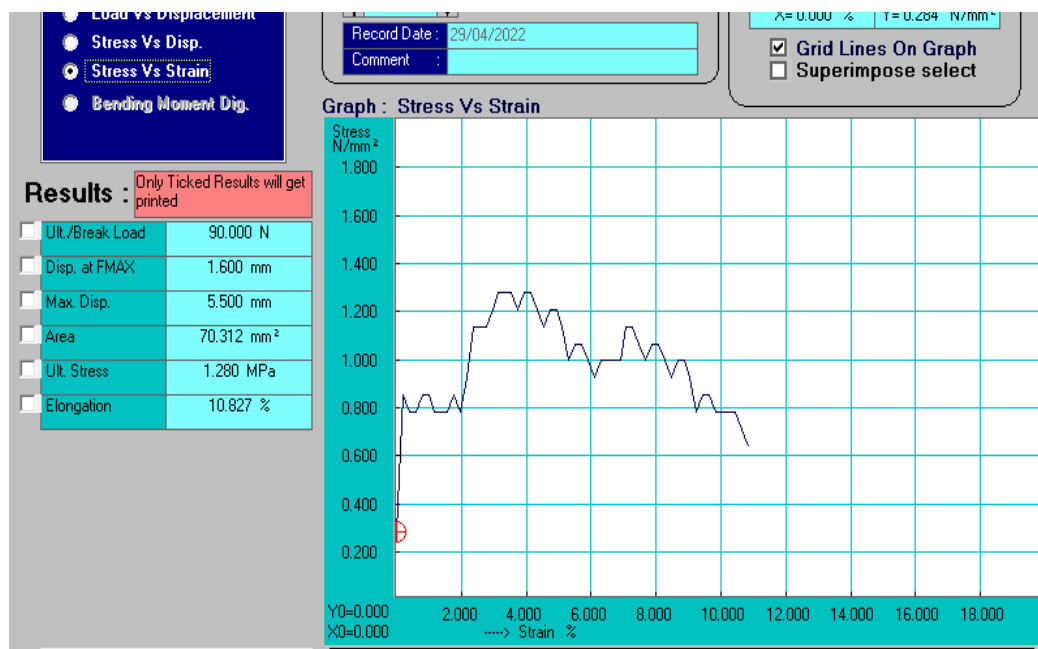


Sample I.D: walnut Matrix

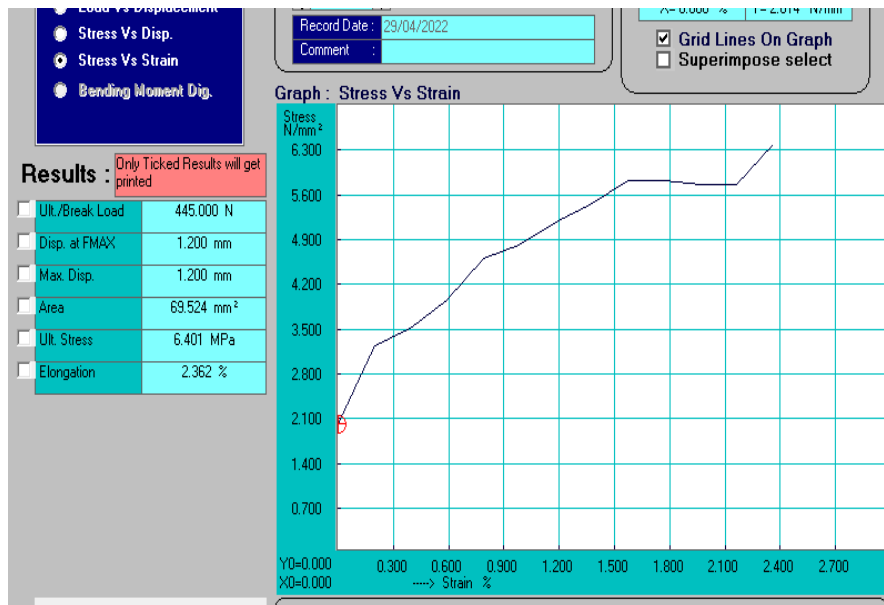


4.3.2 Tensile Test

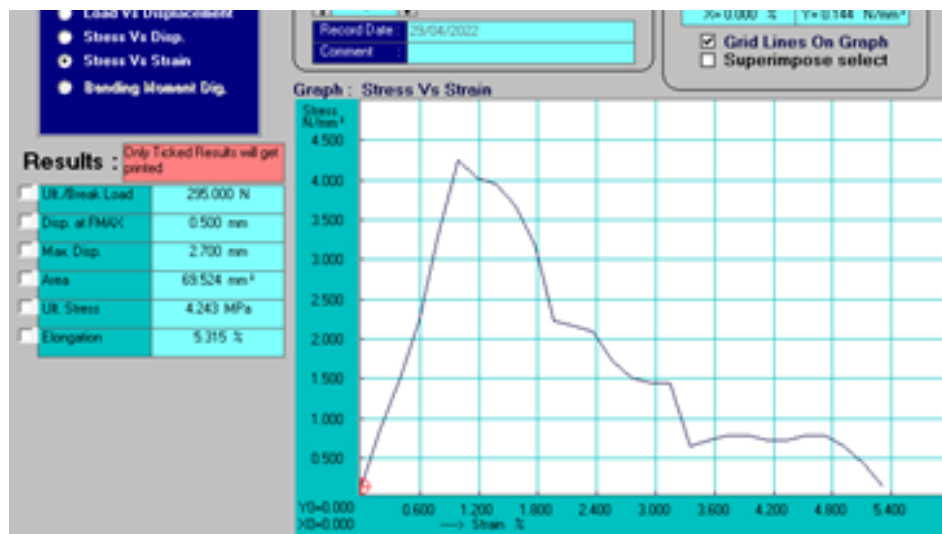
Sample I.D: Egg Shell Matrix



Sample I.D: Egg Shell with walnut Matrix



Sample I.D: walnut Matrix



From the above sample graphs, we infer the results of the flexural and tensile strengths of the specimen. It has been found that the flexural strength of the specimen containing 4 % eggshell content is 0.331MPa. When we add 4% walnut shell powder the flexural strength of the composite is increased more than twice, and it is 0.707 MPa. While combining the powders, that is 4% eggshell and 4%

walnut shell, due to the synergistic effect the flexural strength is increased to 0.799 MPa. From this, we can say that when we add both powders together the flexural strength has become maximum.

Similarly, when we use 4% eggshell in the epoxy composite the tensile strength is 1.28 MPa. While we add 4% walnut shell powder the tensile strength increases nearly four times and is 4.24 MPa. When we combine the powders the tensile strength of the composite is maximum due to the synergistic effect and the tensile strength value is 6.40 MPa.

CHAPTER 5

SUMMARY AND CONCLUSION

The objective of the study was to find the effect of nano eggshell powder and nano walnut powder reinforcement on the epoxy resin. 15 samples of epoxy resin reinforced with eggshell and walnut nano powders were fabricated through the hand lay-up process. 1%, 2%, and 4% of the nano powders were added to the resin along with the hardener. After the completion of fabrication process, the specimens were dried in normal room temperature from 48 to 72 hours. Then the specimens were removed from the mold and subjected to mechanical testing such as flexural and tensile test. The results of the test were tabulated and explained in chapter 4. From the results we infer that when we add both eggshell and walnut-shell nano powders to the epoxy composite the mechanical properties were best and maximum. The composite having walnut shell powder as reinforcement has better tensile and flexural strength than the composite having eggshell powder. But due to synergistic effect, the composite having combined percentages of nanopowders have maximum flexural strength of 0.798 MPa and tensile strength of 6.40MPa.

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