Experimental Investigations on Egg Shell and Coconut Shell Bio Composites

R.Girimurugan\textsuperscript{1} S.Sabarish\textsuperscript{2} S.Sathish\textsuperscript{3} N.Sathish Kumar\textsuperscript{4} M.Vijaya Sankar\textsuperscript{5}

\textsuperscript{1}Assistant Professor \textsuperscript{2,3,4,5}UG Students \textsuperscript{1,2,3,4,5}Department of Mechanical Engineering
\textsuperscript{1}Nandha College of Technology, Erode-638052, Tamilnadu, India

Abstract— Bio-composite is a composite material formed by a matrix and a reinforcement of natural fibers. These kinds of materials often mimic the structure of the living materials involved in the process keeping the strengthening properties of the matrix that was used, but always providing biocompatibility. In this investigation resin, coconut shell powder and egg shell powder reinforced composites were fabricated by reinforcing egg shell powder and coconut shell powder with a grain size between 200-800\textmu m. In this investigation five samples were prepared by varying the weight percentage of resin, coconut shell powder and egg shell powder in the range of 33\% coconut shell powder + 2\% egg shell powder + 65\% epoxy resin, 31\% coconut shell powder + 4\% egg shell powder + 65\% epoxy resin, 29\% coconut shell powder + 6\% egg shell powder + 65\% epoxy resin, 27\% coconut shell powder + 8\% egg shell powder + 65\% epoxy resin, 25\% coconut shell powder + 10\% egg shell powder + 65\% epoxy resin respectively. The above five samples were made with a dimensions of 290 mm × 290 mm × 3 mm in an open mould. Different mechanical behavior tests were carried out on the above five samples. The water absorption characteristics were evaluated through the water absorption test. These experimental results shows that the mechanical behavior and water absorption behavior of these composites are depends upon the increasing weight percentage of coconut shell and also decreasing weight percentage of egg shell.

Key words: Coconut shell powder, egg shell powder, epoxy resin, bio composites, mechanical behavior

I. INTRODUCTION

In the latest years, composites fulfill optimal requirement criteria for several designers’ materials. In the last 50 years, there have been major developments in the design and fabrication of light-weight, high strength materials, primarily due to the increase of polymer composite materials\textsuperscript{1}. Several researchers have aimed at their work towards defining abundant combinations of biodegradable matrix/natural fillers in order to promote new classes of biodegradable composites with enhanced mechanical properties, as well as to attain products with lower cost. Among several investigated natural fibers in this area, different fillers have the significant importance. For example, the development of wood flour composites has been actively pursued with the increasing consumption of wood-based raw materials. In their substitutions were inevitably needed. The Natural Fillers (NF) reinforced materials offer several environmental advantages, such as decrease dependence on non-renewable material sources, lower pollution and green house emission. Natural lignocelluloses fillers (flax, jute, hemp, etc.) represent an environmentally friendly alternative to conventional reinforcing fibers (glass, carbon). The Advantages of natural fillers over traditional ones are their low cost, high toughness, corrosion resistance, low density, good specific strength properties and reduced tool wear. However, there are several disadvantages in natural fillers, like low tensile strength, low melting point, not suitable for high temperature application, poor surface adhesion to hydrophobic polymers, non-uniform filler sizes, degradation by moisture. Therefore, chemical treatments are done so as to modify the fiber surface properties.

Balaji.A, et al. the authors threw light on the uses of natural fibres used in the fibre reinforced composites. They also emphasize on the use of these composites in the automotive industries. In this work they suggested the suitable matrices for the natural fibres in the broad categories like thermosetting thermoplastics rubber and natural polymers. They gave an idea about the composition of bagasse, its mechanical and the thermal properties and its analysis. Their review paper, —Bagasse Fiber – The Future Biocomposite Material: A Reviewl, have clarified the use and recent development of bagasse fibers reinforced polymer composites, types of matrix, processing methods, and modification of the fiber and its applications. This paper shows the opportunity for development of the composites using bagasse fibers. Also creates possibility of use of the bagasse particles in composites. Balraj Bhaskar, et al., the author has studied the hardness and water absorption of the coconut husk, he gave sieve analysis water absorption test ans the testing of compressive strength of the blocks of size of 10 x 6 x 4 cm\textsuperscript{3} made from the concrete reinforced with the coconut shell particles coated with oil. He found that if the coconut shell particles are coated, compressive strength of the blocks is enhanced and the composite can effectively be employed in the construction industries. Bhaskar J, et al., these authors formed the resin composites using the coconut shell particles in the sizes of 200 t0 800 micrometer by wt\% of 20, 25, 30 and 35. They investigated that the compressive strength and water absorption property depends upon the size of the coconut particles. Though the strengths are increased but the elongation decreases. Thus there is possibility of improvement of these qualities by adding the other particulates in combination of the coconut shell powder. Husseinsyah, S, et al., the Authors have studied the effect of natural lignocelluloses on the mechanical properties of polymers. In their work they found that the tensile strength of the polymer composites, Young’s modulus and the water absorption is increased with increase in the percentage of coconut shell particles in the composite. Michael P. Wolcott Karl, et al., they did the work on Wood Plastic Composites and their production technologies. They made sure that such composite can be prepared tested and advantageously utilized in the different areas of industries. They suggested the
technologies to produce the wood plastic composites such as the extrusion and compounding and also their impact on the mechanical properties. They wrote that —When synthetic and mineral fibers are used, machine wear and damage of processing equipment is much higher than with wood filler. Fiber damage during processing is greatly reduced when wood is utilized, which allows for recycling production waste without compromising quality. Similarly there is possibility of enhancing the quality of the material by using the particulate fillers in the matrix. Mohammad Dahmardeh Ghalehno, et al., experimental particleboard from bagasse and industrial wood particles have studied and estimated the modulus of elasticity and modulus of rupture of a composite developed by using the bagasse with varying proportions. They carried out the manufacturing and tests as per the standard DIN 68763. This study was made with 40% bagasse 11% resin in the surface layers. Different experiments were designed for the different percentages of shelling ratio, resin content and press time. It is concluded that with increase in the percentage of bagasse the modulus of elasticity increases. This also shows the effect of shelling ratio, resin content and pressing time on the mechanical strengths. Olumuyiwa Agunsoye.J, et al., the coconut shell particles were used as the reinforcement in the polymer matrix and composite were formed by compacting low density polyethylene matrix with 5% -25% volume fraction coconut shell particles. The mechanical properties such as the tensile strength, hardness was tested and found satisfactory. Their study explains the potential of agro-based waste fiber in Nigeria as an alternative particulate material for the development of a new composite. This literature also shows that there is possibility of combining the different particulates in the composites.

II. PROBLEM FORMULATION

Engineering materials are exhibiting different behavior during processing. The past literature shows that the products which are made from polymers and other materials exhibits a non-eco-friendly effects due to its nature. These type of materials consists of higher production considered also it has normal mechanical behavior under different operating conditions. So this project concentrates an invention of new material to the engineering society with eco-friendly nature.

III. METHODOLOGY

In this project we are talk about how to change bio-composite material to useful one. Initially we follow some steps.

A. Egg shell

An eggshell is the outer covering of a hard-shelled egg and of some forms of eggs with soft outer coats. Bird eggshells contain calcium carbonate and dissolve in various acids, including the vinegar used in cooking. While dissolving, the calcium carbonate in an eggshell reacts with the acid to form carbon dioxide.

B. Coconut shell

Coconut shell is the strongest part covered in coconut fruit. Coconut shell is located in between the coconut flesh and coconut husk. This shell is naturally created to protect the inner part of coconut. This is shell is use to produce various handicraft applies and other applications. Most of handmade decorative are created by using coconut shell due to their strength. Coconut shells are also used to made charcoal which is use as fuel and this coconut charcoals are far better than other charcoals. Coconut shell charcoal is widely used to produce active carbon. Normally active carbon is known as the charcoal which has treated with oxygen’s. Active carbon is use widely for removing impurities. This coconut shell charcoals are widely used in

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purification industry and other industries which active carbon are used. Most of South Asian and Pacific countries where coconut grows create various handicrafts out of coconut shells. The strong form of this shell is ideal to create handicrafts and these handicrafts keep for longer time period due to the strength of coconut shell. There is a huge demand for these types of natural handicraft in all over the world. There is various method uses to produce active carbon and coconut shell produce the top grade active carbon charcoal which got great performances. There are lots of coconut shells need to produce 1 kg of active carbon but the charcoal created from coconut shell are much clean and good in quality compare to other charcoals productions. Coconut shell based active carbon production got great demand due to its high quality and there are various plants produce this active carbon from coconut shell in Sri Lanka, India and other Pacific countries where the coconut trees are available.

![Egg shell and crushed egg shell](image1)

**Fig. 2:** (A) Egg shell (B) Crushed egg shell (C) Egg shell powder

![Coconut shell and coconut shell powder](image2)

**Fig. 3:** (A) & (B) Coconut shell (C) Coconut shell powder

### C. Epoxy resin

Epoxy is either any of the basic components or the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as polylepoxides, are a class of reactive prepolymer and polymers which contain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols. These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing. Reaction of polylepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with high mechanical properties, temperature and chemical resistance. Epoxy has a wide range of applications, including metal coatings, use in electronics / electrical components/LED, high tension electrical insulators, paint brushes manufacturing, fiber-reinforced plastic materials and structural adhesives. Structure of cured epoxy glue. The triamine hardener is shown in red, the resin in black. The resin's epoxide groups have reacted with the hardener and are not present anymore. The material is highly cross linked and contains many OH groups, which confer adhesive properties.

![Epoxy resin](image3)

**Fig. 1:** Epoxy resin
D. Sample preparation

Fig. 2: (A) Sample -1 (33%CSP+2%ESP+65% Epoxy resin) (B) Sample -2 (31%CSP+4%ESP+65% Epoxy resin) (C) Sample -3 (29%CSP+6%ESP+65% Epoxy resin) (D) Sample -4 (27%CSP+8%ESP+65% Epoxy resin) (E) Sample -5 (25%CSP+10%ESP+65% Epoxy resin)

One the first hand we take coconut shell and egg shell convert it into powder form and now epoxy resin is been added on to the some mixture and then its passed to the moulding machine, Now the measurement was been taken by various loads, and sizes and hence process various test was also conducted on the sample.

V. RESULTS AND DISCUSSIONS

A. Top and bottom surface Hardness

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material. Indentation hardness value is obtained by measuring the depth or the area of the indentation using one of over 12 different test methods. Click here to learn more about hardness testing basics.

Fig. 3: Top surface hardness for different samples
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The graph plotted between different ratio samples and Hardness strength. Coconut shell powder increased Hardness strength increased. But, egg shell powder increased Hardness strength is decreased. so the sample 1 is more % of coconut shell (33% coconut shell powder + 2% egg shell powder + 65% epoxy resin)

B. Compression testing

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time.
The graph plotted between different ratio samples and compression strength. Coconut shell powder increased compression strength increased. But, egg shell powder increased compression strength is decreased. So the sample 1 is more % of coconut shell (33% coconut shell powder + 2% egg shell powder + 65% epoxy resin).

![Graph](image1)

**Fig. 7: % of area reduction**

**C. Tensile testing**

A tensile test, also known as tension test, is probably the most fundamental type of mechanical test you can perform on material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, you will very quickly determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its strength along with how much it will elongate. The graph plotted between different ratio samples and tensile strength. Coconut shell powder increased tensile strength increased. But, egg shell powder increased tensile strength is decreased. So the sample 1 is more % of coconut shell (33% coconut shell powder + 2% egg shell powder + 65% epoxy resin).

**D. Flexural testing**

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. The graph plotted between different ratio samples and flexural strength. Coconut shell powder increased flexural strength increased. But, egg shell powder increased flexural strength is gradually decreased. So the sample 2 is more % of coconut shell (31% coconut shell powder + 4% egg shell powder + 65% epoxy resin).

**E. Water-absorption testing**

Water-absorption testing tests a test to determine the moisture content of soil as a percentage of its dry weight (British Standard 1377, 1967). The sample is weighed, dried in an oven, then reweighed under standard conditions. It is calculated as the moisture content, which is equal to: (weight of the container with wet soil minus the weight of the container with dry soil) divided by (weight of the container with dry soil minus the weight of the container), then multiplied by 100 to express it as a percentage.

![Graph](image2)

**Fig. 8: Tensile strength for different samples**
Fig. 9: Flexural strength for different samples

Fig. 10: Water absorption result for different samples (24 Hrs)

Fig. 11: Water absorption result for different samples (48 Hrs)
VI. CONCLUSIONS

The experimental investigation on mechanical properties tensile strength and flexural strength of CSP, ESP and epoxy composite material is greatly influenced by the CSP and ESP filled volume fraction. The maximum tensile strength is obtained for the composite prepared with 33% CSP+2%ESP+65%Epoxy Resin volume fraction. The tensile strength increase of filler volume the tensile strength goes on decreasing. The maximum flexural strength is obtained for the composite prepared with 31% CSP+4% ESP+65%Epoxy Resin, filled while; the flexural strength is minimum for the composite prepared with 31% CSP+4% ESP+65%Epoxy Resin filled. The less water absorption is obtained for the composite prepared with 25%CSP+10% ESP+65%Epoxy Resin volume fraction (Fig. 8). An increase of reinforcing volume the water absorption goes on increasing. Consequently, the composite prepared with filled 33% CSP+2%ESP+65%Epoxy Resin volume fraction is suitable for the application in the interior part of an aircraft, motor car and automobile where materials with good tensile strength, low density and low hydrophilic characteristic are required.

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