Fabrication and Mechanical Testing of Sheep & Camel Fiber with Duck Egg Shell Powder Using Hand Lay Up Technique

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ABSTRACT

Fiber reinforced polymer composites is an important class of structural material due to their numerous advantages. As of now there is an increment in interest toward Natural composites which are made by reinforcement of characteristic fiber. Camel wool, sheep wool with duck eggshell powder has good malleable properties; thus, it could be utilized as a fiber reinforcement material. It gives desired property at easier expense of generation. To this end, an attempt has been made to study the potential application of Animal fibers and they are economically and effortlessly found in India for making value added products. Animal Fiber reinforced polymer composites are being used in almost every type of applications in our daily life and its usage continues to grow at an impressive rate.

Composites are the most advanced and adoptable materials among all the engineering materials. The natural composites have advantages like low cost, biodegradable nature, recyclable etc. Sheep wool is regarded as one of the most performative insulating natural materials due to its thermo-hygrometric and acoustic properties, Camel wool offers a unique combination of warmth, breathability, hypoallergenic properties, and durability that make it an exceptional choice for clothing and textiles.

Objective of the present work is to evaluate and compare the mechanical properties of composites made from animal fibers like camel fiber, sheep fiber with duck egg shell powder using hand lay-up technique using Epoxy and Hardener. After conducting different tests like tensile, flexural, impact strengths and hardness on the specimens obtained after fabrication, it can be concluded that the sheep fiber & camel fiber (hybrid) with 10% duck egg shell powder has better mechanical properties when compared to the other results.

CHAPTER 1 INTRODUCTION

INTRODUCTION TO COMPOSITES

A composite material is a material that consists of one or more discontinuous components (particles/fibers/reinforcement) that are placed in a continuous medium (matrix). In a fiber composite the matrix binds together the fibers, transfers loads between the fibers and protectsthem from the environment and external damage. Composite materials, or shortened to composites, are microscopic or macroscopic combinations of two or more distinct engineered materials (those with different physical and/or chemical properties) with a recognizable interface between them in the finished product. For structural applications, the definition can be restricted to include those materials that consist of a reinforcing phase such as fibers or particles supported by a binder or matrix phase.

Classification of Composites:

- **Matrices:**

- Organic Matrix Composites (OMCs)
- Polymer Matrix Composites (PMCs)
- carbon-carbon composites
- Metal Matrix Composites (MMCs)
- Ceramic Matrix Composites (CMCs)

- **Reinforcements:**

- Fibers reinforced composites
- Laminar composites
- Particulate composites

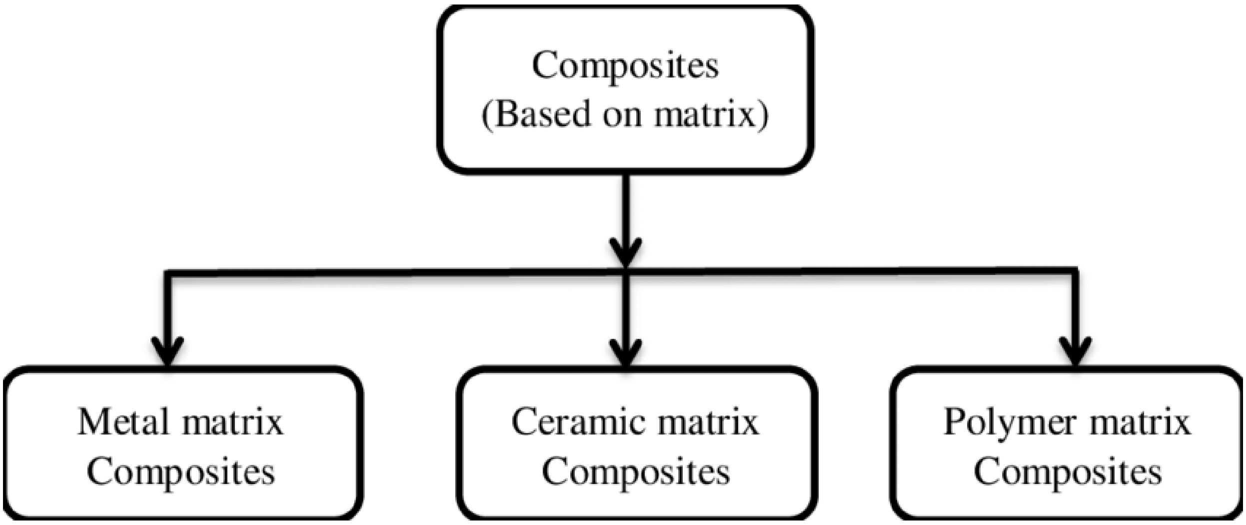


Figure 1.1: Classification of Composites Based on the type of matrix material

POLYMER MATRIX COMPOSITES

Resin systems such have limited use for the manufacture of structures on their own, since their mechanical properties are not very high when compared to most metals. However, they have desirable properties, most notably their ability to be easily formed into complex shapes. Materials such as glass, aramid and boron have extremely high tensile and compressive strength but in 'solid form' these properties are not readily apparent. This is because when stressed, random surface flaws will cause each material to crack and fail well below its theoretical 'breaking point'. To overcome this problem, the material is produced in fiber form, so that, although the same number of random flaws will occur, they will be restricted toa small number of fibers with the remainder exhibiting the material's theoretical strength. Therefore, a bundle of fibers will reflect more accurately the optimum performance of the material. However, fibers alone can only exhibit tensile properties along the fiber's length, in the same way as fibers in a rope. It is when the resin systems are combined with reinforcing fibers such as glass, carbon and aramid, those exceptional properties can be obtained. The resin matrix spreads the load applied to the composite between each of the individual fibers and protects the fibers from damage caused by abrasion and impact. High strengths and stiffnesses, ease of moulding complex shapes, high environmental resistance all coupled withlow densities, make the resultant composite superior to metals for many applications.

Overall, the properties of the composite are determined by:

i) The properties of the fiber

ii) The properties of the resin

iii) The ratio of fiber to resin in the composite (Fiber Volume Fraction)

iv) The geometry and orientation of the fibers in the composite.

TYPES OF FIBERS

Fibers are thread-like structures that are long, thin, and flexible. These may be spun into yarns and then made into fabrics. There can be different types of fibers. Based on their origin, fibers are classified as natural fibers and synthetic fibers. Synthetic fibers can be produced in laboratory and can be cheaper compared to natural fibers but natural fibers are much more comfortable.

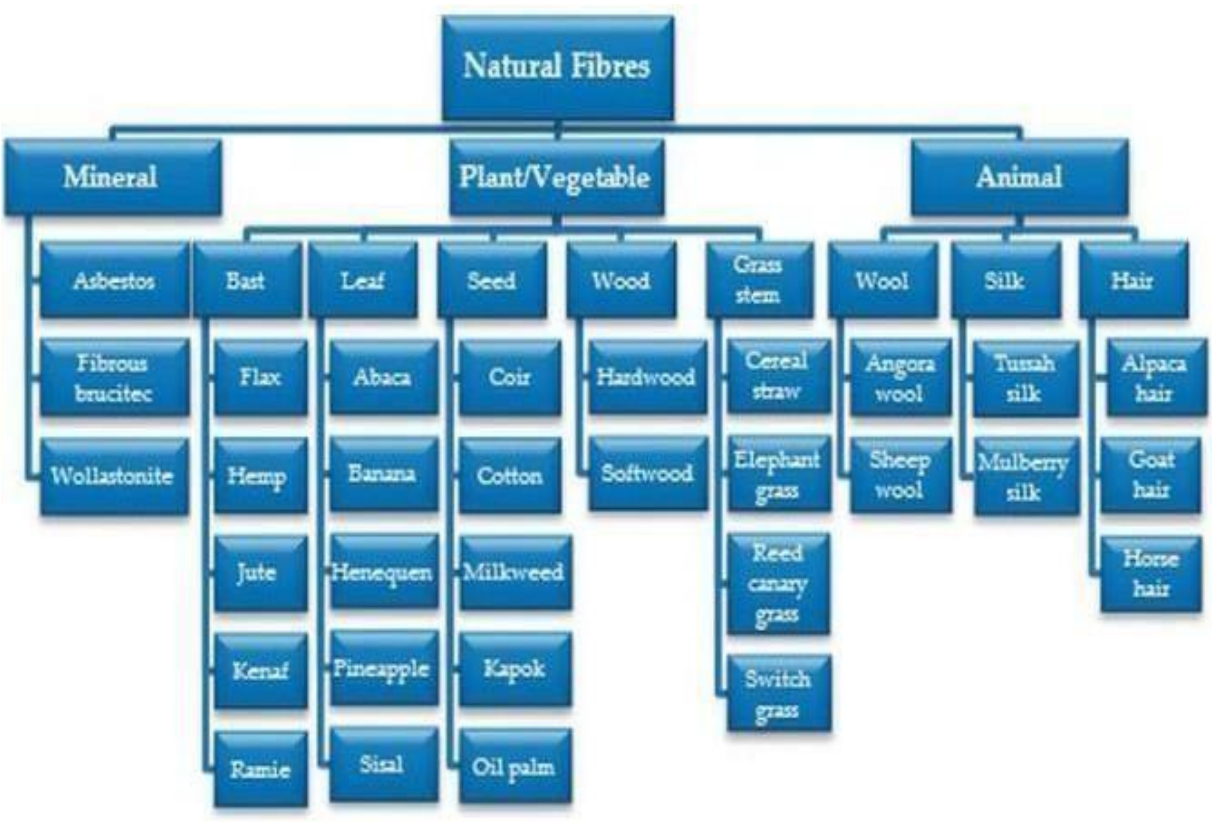


Figure 1.2: Classification of Fibers

NATURAL FIBERS

Natural fibers are the fibers that are obtained from plants, animals, or mineral sources. Some examples are cotton, silk, wool etc. Natural fibers can again be divided into two types based on their source i.e. plants and animals.

Figure 1.3: Natural Fibers

ANIMAL FIBERS

Animal fibers are protein based, the complex material which most of animal body is madeof. Animal fibers are fibers obtained from the hair or fur of animals, and are used in textile production to create a wide range of products such as clothing, carpets, and upholstery. The most common animal fibers used in textile production is wool, alpaca, mohair, cashmere, camel hair, llama, angora, yak, qiviut, and vicuna.

Animal fibers are in the form of hair (wool) or filament (silk). Human hair also falls underthis category.

TYPES OF ANIMAL FIBERS

There are several types of animal fibers. They are described below:

1. **Wool fiber:** Wool is obtained from the hair of sheep, goats, and other animals. It is knownfor its warmth, elasticity, and durability. It is a natural insulator, meaning it helps to keep the body warm and is also naturally flame resistant. Wool fibers have a natural crimp, which makes them springy and resilient, and allows them to be spun into yarns that are strong and elastic.

Figure 1.4: Wool

2. Alpaca: Alpaca fiber is obtained from the hair of the alpaca, a mammal native to South America. It is known for its softness, warmth, and hypoallergenic properties. Alpaca fibers are finer and stronger than sheep's wool and have less lanolin, which makes them hypoallergenic. Alpaca fibers are naturally water-repellent and insulating, making them a great choice for outdoor clothing and accessories.

3. Mohair: Mohair is obtained from the hair of the Angora goat. It is known for its silky texture and sheen. Mohair fibers are naturally strong, resilient, and moisture-wicking, makingthem a great choice for clothing and home decor.

4. Cashmere: Cashmere is obtained from the undercoat of the Cashmere goat. It is known for its softness, warmth, and durability. Cashmere fibers are finer, stronger, and lighter than sheep's wool, making them a luxurious choice for clothing and accessories.

5. Camel Hair: Camel Hair is obtained from the hair of camels. It is known for its warmth, softness, and water-resistance. Camel hair fibers are naturally insulating and have a unique ability to wick away moisture, making them a great choice for outdoor clothing and accessories.

6. Yak fiber: Yak fibers are obtained from the hair of yaks. It is known for its warmth, strength, and water-resistance. Yak fibers are naturally insulating and have a unique ability to wick away moisture, making them a great choice for outdoor clothing and accessories.

7. Llama fiber: Llama fibers are obtained from the hair of llamas. It is known for its warmth, strength, and durability. Llama fibers are naturally insulating and have a unique ability to wick away moisture, making them a great choice for outdoor clothing and accessories.

8. Vicuna fiber: Vicuna fibers are obtained from the hair of the vicuna. It is known for its warmth, softness, and rarity. Vicuna fibers are considered one of the finest and softest naturalfibers in the world.

PROPERTIES

Animal fibers have a variety of properties that make them useful in textile production and other industries. Some of the main properties of animal fibers include:

- **Warmth:** Many animal fibers, such as wool and cashmere, are excellent insulators and provide warmth even when wet. This makes them ideal for use in clothing and other textiles that will be worn in cold weather.
- **Softness:** Some animal fibers, such as cashmere and alpaca, are known for their softness, which makes them ideal for use in clothing and other textiles that will be worn next to the skin.
- **Moisture-wicking:** Some animal fibers, such as alpaca and mohair, have moisture- wicking properties, which means they can absorb and release moisture away from the skin, keeping the wearer dry and comfortable.
- **Durability:** Many animal fibers, such as wool and cashmere, are known for their durability, which makes them ideal for use in textiles that will be subjected to frequent wear and tear.
- **Elasticity:** Many animal fibers, such as wool, have a natural elasticity, which means they can stretch and recover their shape, making them ideal for use in textiles that require a certain amount of give, such as knitwear.
- **Flame-Retardant:** Some animal fibers, such as wool, are naturally flame-retardant, which means they can resist catching fire. This makes them ideal for use in textiles that will be used in high-risk environments.
- **Dyeability:** Many animal fibers take dye easily and hold color well, which makes them ideal for use in textiles that require a specific color or pattern.
- **Hypoallergenic:** Some animal fibers like Alpaca and cashmere are hypoallergenic, which means they do not irritate the skin or cause allergic reactions, making them ideal for use in clothing and other textiles that will be worn next to the skin.

ADVANTAGES

Animal fibers have a wide variety of uses in textile production and other industries. Someof the most common uses of animal fibers are given below:

a) **Clothing:** Wool, cashmere, alpaca, mohair, and other fibers are used to make a wide range of clothing items such as sweaters, coats, pants, dresses, and suits. Wool is a natural insulator, making it ideal for use in winter clothing. Cashmere is known for its softness and warmth, making it ideal for use in sweaters and other types of clothing. Alpaca and mohair fibers are known for their softness, warmth, and moisture-wicking properties, making them ideal for use in outdoor clothing.

b) **Home decor:** Animal fibers are used in the production of home decor items such as carpets, rugs, blankets, and upholstery. Wool fibers are known for their durability and resilience, making them ideal for use in carpets and rugs. Cashmere fibers are known for their softness and warmth, making them ideal for use in blankets and other types of home decor.

c) **Footwear:** Animal fibers such as wool and alpaca are used in the production of footwear such as woolen socks, slippers, boots, and other types of shoes.

d) **Accessories:** Animal fibers are also used in the production of accessories such as scarves, hats, gloves, and other types of accessories. Wool and cashmere fibers are known for their warmth and softness, making them ideal for use in accessories.

e) **Technical Textiles:** Animal fibers like wool and cashmere are used in the production of technical textiles such as flame-retardant and moisture-wicking clothing. Wool fibers are naturally flame-retardant, while cashmere fibers are naturally moisture-wicking, making them ideal for use in technical textiles.

f) Industrial uses: Animal fibers are also used in the production of industrial products such as rope, twine, and insulation. Wool fibers are known for their strength and elasticity, making them ideal for use in rope and twine. Wool fibers are also used as insulation in buildings and other types of structures.

APPLICATIONS

- **AUTOMOBILE/TRANSPORTATION:**

Fibers play crucial roles in various aspects of automobile and transportation industries, contributing to enhanced performance, safety, and efficiency. Here are some key areas wherefibers are utilized:

Fibers such as carbon fiber, glass fiber, and aramid fiber are commonly used in composite materials for automobile components. These materials offer high strength-to-weight ratios, improving fuel efficiency and reducing overall vehicle weight. Composite materials are utilized in body panels, chassis components, and interior parts, leading to lighter vehicles with improved performance.

Figure 1.5: Fibers in Transportation

- **SPORTS:**

Fibers play a crucial role in various aspects of sports, contributing to performance, safety, and comfort. Here's how fibers are utilized in sports:

High-performance sportswear often utilizes advanced fiber technologies to enhance comfort and performance. Fabrics made from synthetic fibers like polyester, nylon, and elastane offer moisture-wicking properties, breathability, and stretchability, keeping athletes dry and comfortable during intense physical activity. Specialized fibers like carbon fiber may also be incorporated into shoe designs to provide lightweight stiffness and energy return, enhancing performance in activities such as running and cycling.

- **MEDICAL:**

Medical fibers are often used in the manufacturing of surgical sutures. These fibers needto be biocompatible, flexible, and possess sufficient tensile strength to hold tissues together during the healing process. Fibers are also utilized in the fabrication of implantable medical devices such as vascular grafts, stents, and artificial ligaments. These fibers must have high biocompatibility, durability, and mechanical strength to withstand the physiological conditions within the body. Materials such as polypropylene, polyethylene, and silk are commonly used for this purpose.

- **CIVIL /INFRA STRUCTURE:**

High-strength, lightweight fibers with excellent tensile strength and stiffness. They are often used in structural reinforcement applications where weight reduction and high strength-to-weight ratio are critical, such as in bridge components, seismic retrofitting, and high- performance composites for aerospace and automotive industries. Synthetic fibers with high tensile strength and energy absorption capabilities. They are used in applications requiring high impact resistance and blast protection, such as blast-resistant structures, protective barriers, and seismic retrofitting.

- **MARINE:**

Buoyant materials such as closed-cell foam or hollow fibers are incorporated into marine equipment like life rafts, buoys, and floating barriers to provide buoyancy and flotation capabilities. Shipbuilders explore the use of natural fibers like hemp, flax, or jute as reinforcement materials in composite structures. While not as strong as synthetic fibers, natural fibers offer environmental benefits and can be used in non-structural components or as core materials in sandwich structures.

Figure 1.6: Fibers in Marine applications

LIMITATIONS

1. High cost of raw materials and fabrication.
2. Composites are brittle and thus are more easily damageable.
3. Transverse properties may be weak.
4. Matrix is weak, therefore, low toughness.
5. Reuse and disposal may be difficult.
6. Health hazards during manufacturing, during and after use.
7. Joining two parts is difficult.

CHAPTER 2 LITERATURE REVIEW

[1] Xueliang Xiao, Jinlian Hu, David Hui et.al A review of structural models for α-keratin hair shows a parallel composite structure for the alignment of fibrils in matrix. The models with parallel fibrils consistent along a fiber axis indicate repeat tensile behavior in elastic phase (such as 1% tensile strain), even the fiber being processed by lithium bromide (LB) solution or sodium bisulfite (SB) solution. However, in our experimental cyclic stretching to camel hair fiber, 20% of unrecoverable strain is noted after the first stretching

[2] Xueliang Xiao and Jinlian Hu et.al As a kind of specialty fiber, fine camel hair shows good warmth, softness, and luxurious texture. Its scarcity drives investigation of such hair based on its structure, mechanics, and processing. Referring to slenderization process of wool fibers, this paper studies the effects of water, aqueous lithium bromide, and sodium bisulfite solutions on camel hair properties, respectively, for slenderization potential of camel guard hair. After hair fiber soaked in the three solutions, it is found that the largest stretching elongation is from the processing of aqueous sodium bisulfite solution (1.2 M) and the diameter of hair can be half reduced after stretching to 90% of strain. The porous modulated and cortex fibrils topographies of hair show high advantage of such hair fiber in slenderization for hollow structure under high fixed stretched status.

[3] J. Tusnim, N.S. Jenifar and M. Hasan et.al Development of new composite products from the easily renewable natural materials has a strong potential to deliver novel biodegradable and recyclable materials suitable for the automotive, packaging industry andall other applications. Polypropylene is soft as compared to jute and wool fiber. In present research, jute fiber and sheep wool fiber reinforced hybrid polypropylene composites were prepared by varying fiber loading and fiber ratio. Prepared composites were subsequently characterized. Mechanical properties increased with an increase in fiber loading. Best set of properties were obtained from 15% fiber loading with jute and wool fiber ratio of 3:1. These tests could help further to unveil other properties besides mechanical ones and help in comparison of raw fibers with chemically treated fibers in future.

[4] Anup Kumar, Gagan Bansal, Vinay Kumar Singh et.al Livestock waste is been used currently in various applications like textiles, crafting, decorations and even in bio- composite manufacturing. The reason for it is the abundance availability and compatible characteristics of the Livestock waste. In the current research work, the hybrid bio composite is fabricated using epoxy resin (CY-230) as matrix with hardener (HY-951) as curing agent, reinforced with varying weight percentages (wt%) of chicken feather fiber (CFF) and residuepowder extracted from Rohu Fish Scale (ERP) to enhance the mechanical and physical properties of developed composite. Composite materials with their high strength to weight ratio and their diverse functionalities have attracted most of the researchers towards the advance study of the hybrid composites. The efforts are made to focus on advanced technology and uplift the use of chicken feather fiber as a Natural Biomaterial which is at present serve as a waste of poultry industry and fisheries industry to enhance the use of livestock waste in a sustainable growth of the earth and healthy environment.

[5] Bonke Mncwango and Dhiren Allopi et.al Farming practices generate various types of waste. Lowering environmental problems that are because of reckless clearance of waste depends on the sufficient utilization of agricultural waste. When considering the magnitude of the scale of waste that is generated globally, the management of agricultural wastes is an essential consideration for keeping the environment clean. It has been found during the review process that chicken eggshells for use in concrete remain the most viable type of eggshells even though there are minor advantages of other eggshells such as duck eggshells and ostrich eggshells. The main reasons for this are that chicken eggshells have higher levels of $CaCO_3$ than those tested such as ostrich and duck eggshells. The other reason is that chicken eggshells have higher levels of magnesium than other eggshells such as both ostrich and duck eggshells. It was also found from the review that the neglect of the use of the eggshell membrane is a further potential avenue for research for use in concrete production

[6] Wanitcha Unjan and Nuchnapa Tangboriboon et.al Duck eggshell is a potential material for use as the calcium carbonate (CaCO3) source to react with sulfuric acid to prepare the calcium sulfate dihydrate or gypsum (CaSO4.2H2O), calcium sulfate hemihydrate or plaster of Paris (CaSO4.0.5H2O), and stable anhydrite (CaSO4) in terms of CaSO4.xH2O (x = 0.0-2.0) by thermal process. Calcium sulfate can form hydration and dehydration process due to water adsorption-desorption ability within the layered microstructure. Calcium sulfates have a potential candidate function as a binder, filler, absorbent, catalyst, and coagulant in a variety of buildings, ceramics, petroleum and petrochemical, dental and mechanical industries. Calcium sulfate dihydrate or gypsum is one of the important materials suitable for building, mold making, etc., whereas anhydrite or anhydrous calcium sulfate is suitable for function as a filler in various industries such as the paint, plastic, rubber, coating, cement, etc. [34-36]. There are many advantages of the chemical precipitation method used in this study for calcium sulfate compounds preparation i.e., easy, and convenient forming, low price, and high purity calcium sulfate including wasteeggshell reduction. The obtained calcium sulfate dihydrate or gypsum can form at room temperature. When the calcium sulfate dihydrate (CaSO4.2H2O) is dried at 110ºC, they can change to calcium sulfate hemihydrate or plaster of Paris (CaSO4.0.5H2O) and transform to anhydrite or anhydrous calcium sulfate (CaSO4) in terms of type III, type II, and type I at a temperature from300ºC to 1000ºC. The XRD phase formation of calciumsulfates will change from rhombohedral (gypsum) to hexagonal (anhydrite) crystal structure. The SEM micrograph will change from needle-like shape (hemihydrate or plaster of Paris) to plate- or disk-like shape, and to rod-like shape (anhydrite). The true density, color, odor, specific surface area, average pore diameter, and average particle size of the best anhydrite or anhydrous calcium sulfate obtained in this study calcined at 900ºC are equal to 2.95 g/cm3, white powder, odorless, 3.57m2 /g, 96.98 Å, and 3.983 µm, respectively.

[7] Sabith Ahamed Manegar, Chennakeshava R, Amruth M Acharya, Jevil Clement Mendonca, Shashank B C et.al After vegetable or plant fibers, animal fibers are the most used natural fibers. Proteins make up the most of them, and they may act as insulation in composites. Wool fiber from horses, goats, lamas, rabbits, musk oxen, and other animals is an example of this fiber. Silk, feathers, and hair are also derived from a variety of sources. Wool fibers have different properties than each other. Alpaca fiber is lighter and colder than sheep fiber and is almost white in color, while angora fiber is thin and fluffy and comes from the Angora rabbit. Cashmere fiber is a luxury soft wool fiber obtained from the cashmere goat, while qiviut wool obtained from the musk ox is a more costly smooth fiber. Even though the above fibers have different properties, sheep fiber is the most used fiber due to its broader availability and lower cost. Silk is another essential natural protein fiber that can be woven into textiles and can be obtained from a variety of sources. The fabrics come from a variety of insects, with most of the silk coming from butterfly larvae. Feathers from chickens can be found in vertebrates. They have a complex integumentary structure, are produced in small follicles on the chicken's outer skin layer, and contain keratin proteins. Chicken feathers have certain special properties, such as low density and superb thermal and acoustic insulation. They are composed of 91% keratin (protein), 1% lipids, and 8% water, and can be used as reinforcement materials in composites.

[8] K.W. Corscadden (2014) The results indicate that although wool is competitive with other insulation products in terms of thermal properties and offers other potential natural and economic development benefits in its use.

[9] Xin et al investigated the flexural properties of the composites which were prepared by combining wool fiber and polyester resin. It was reported that uneven distribution of fibers led to fiber pull-out from the matrix, permanent deformation, and breakage of fibers as well as appearance of dendrite-like structure. Fourier transform-infrared spectroscopy (FTIR) spectra of the Sansevieria cylindrica fibers reinforced polymer composites have been reported [25].

CHAPTER 3 OBJECTIVE OF PROJECT

OBJECTIVE OF PROJECT

Following are the objectives that have been outlined:

1. Fabrication of a new class of epoxy-based hybrid composite reinforced with sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder.
2. Evaluation of mechanical properties such as tensile strength, flexural strength, impact, and hardness.
3. To study the potential utilization of Sheep fiber, camel with duck egg shell powder as reinforcement material in epoxy-based composites for various applications.
4. To assess whether the fabricated hybrid composite can be used as an animal fiber based alternate material for synthetic fiber reinforced composites.

3. 2 MATERIALS SCOPE OF MATERIALS

This part manages the materials that are chosen to set up the mixture composite material dependent on the Properties.

The materials chose are

1. Hardener
2. Epoxy
3. Camel fiber and Sheep wool fiber
4. duck egg shell powder

The duck egg shell powder is treated with NaOH arrangement, dried and is ready for manufacture measure.

EPOXY RESIN

In present work epoxy LY556 is utilized as network material to create mixture fiber epoxycomposites. Epoxy LY556 is picked on the grounds that it is a one such network which is broadly utilized on the grounds that it shows low shrinkage, higher mechanical properties, simple creation, incredible compound and dampness opposition, great wet capacity. Epoxy saps are the most regularly utilized thermoset plastic in polymer framework composites. Epoxy saps are a group of thermoset plastic materials which do not emit response items whenthey fix thus have low fix shrinkage. They additionally have great attachment to different materials, great compound and natural opposition and great protecting properties.

HARDENER

Hardener utilized for present examination for starting gel arrangement is hardener HY951 which is displayed. The mix of epoxy LY556 and hardener which fixes at room temperature, astounding glue strength, great mechanical and electrical properties. The proportion of the epoxy and hardener are taken 10:1 that is 10 grams of epoxy and 1 gram of hardener.

Figure 3.1: Epoxy Resin LY556 and Hardener HY-951

Properties of hardener HY-951:

It is a multipurpose two segments, room temperature relieving, straightforward fluid glue of high strength. It is reasonable for holding wide assortment of metals, pottery, glass, rubbers, unbending plastics, and most different materials in like manner use.

Thickness: 0.95gm/cm^3.

CAMEL WOOL FIBER

Camel wool is a type of fabric derived from the coats of camels. This type of fabric is more commonly known as camel hair, and it is usually derived from a camel subspecies known as the Bactrian camel. These types of camels are common in the Mongol Steppes region, and they can be found across a wide area stretching from Turkey to China and Siberia. Unlike most camels, which are short-haired, Bactrian camels are known for their long, lustrous hair and large twin humps. The camel hair derived from the Bactrian camel consists of two separate portions: The guard hair and the undercoat. The guard hair is hard and coarse, and it doesn't make very good fabric unless it is mixed with another substance like sheep wool. This part of a Bactrian camel's coat protects it from the brutal winters on the Steppes, and in the middle of winter, it gives Bactrian camels a thick and fuzzy appearance.

Figure 3.2: Application of Camel Wool Fiber

The undercoat is quite soft, and it is used by Bactrian camels much in the same way that fiberglass insulation is used between the inner and outer walls of houses. While the guard coat may be used to make certain types of textiles, the undercoat is the portion of the Bactrian camel's hair that is most used to make apparel.

Figure 3.3: Camel Wool Fiber

The use of camel hair as a textile fabric is a practice that is most associated with the waning days of the British Empire, but the use of this type of hair to make garments has experienced a recent renaissance among the sustainably-minded or population. While most types of wool can only be derived by shearing hairs off animals, Bactrian camels naturally shed their winter coats every spring, which means that harvesting this type of hair is usually asustainable and cruelty-free enterprise. Camel wool is generally separated into three grades: High-grade fibers are usually derived from the undercoat, and only the best undercoat fibers can be truly high-grade. It is high-grade camel wool fibers that are most used to make consumer textiles.

Undercoat fibers that are not considered to be high-grade are usually referred to as medium-grade, and while these fibers may also be used to make apparel, the garments thatare made with medium-grade fibers are rougher to the touch. Lastly, low-grade camel hair fibers are usually derived from the guard coat, and these rough and inflexible fibers are only suited for carpets and similarly rigid textiles.

Property	Value
Density (kg/m^3)	~ 1,310
Poisson's Ratio	~ 0.35 - 0.45
Young's Modulus (GPa)	~ 1 - 3
Ultimate Tensile Strength	~ 200 - 400 MPa

Table 3(a): Camel Wool Fiber Properties

SHEEP WOOL FIBER

Sheep wool fiber, sourced from the fleece of sheep, stands as a timeless textile revered for its warmth, durability, and adaptability. Its natural insulating properties offer unparalleled comfort in cold climates, all while ensuring breathability for wearers. Resilient and robust, wool fibers withstand bending and stretching without losing shape, offering longevity to garments and textiles. Remarkably elastic, wool can stretch up to 30% of its length before bouncing back to its original form, ensuring comfort and flexibility. Additionally, its moisture-wicking capabilities make it ideal for regulating body temperature by absorbing sweat, keeping individuals dry and comfortable. Wool's inherent fire resistance, biodegradability, and diverse softness levels, ranging from coarse to luxurious, further underscore its appeal. Commonly utilized in various applications such as apparel, textiles, insulation, bedding, and industrial uses, sheep wool fiber continues to be cherished for its natural qualities and versatility across diverse sectors.

Figure 3.4: Sheep Wool Fiber

Property	Value
Density	1.31 g/cm³
Poisson's Ratio	~0.3
Young's Modulus	200 - 350 MPa
Ultimate Tensile Strength	40 - 100 MPa

Table 3(b): Sheep Wool Fiber Properties

DUCK EGG SHELL POWDER

Duck egg shell powder is a finely ground form of duck eggshells. It is created bythoroughly cleaning and drying duck eggshells, then grinding them into a fine powder. This powder is commonly used for various purposes due to its potential health benefits andpractical applications.

Uses and Benefits:

1. **Calcium Supplement:** Duck egg shell powder is rich in calcium carbonate, making it a natural source of calcium. It can be consumed as a dietary supplement to support bone health and prevent calcium deficiency.

2. **Gardening:** The calcium-rich composition of duck egg shell powder makes it beneficial for gardening. It can be added to soil to enrich it with calcium, improving plant growth and preventing calcium deficiency in plants.

3. Poultry Feed: Ground duck eggshells can be added to poultry feed as a source of calcium for laying hens. Calcium is essential for eggshell formation, so supplementing their diet with eggshell powder can result in stronger eggshells and overall better health for the birds.

4. Household Uses: The abrasive nature of eggshell powder makes it effective as a gentle abrasive cleaner. It can be used to scrub and polish surfaces without scratching them, makingit ideal for cleaning delicate items like glassware and ceramics.

5. Beauty Products: Some cosmetic and skincare products incorporate eggshell powder due to its exfoliating properties. It can help remove dead skin cells, leaving the skin smoother andbrighter.

Figure 3.5: Duck Egg Shell Powder Processing

CHAPTER 4 HAND LAY-UP PROCESS

Resins are impregnated by hand into fibers which are in the form of woven, knitted,

stitched, or bonded fabrics. This is usually accomplished by rollers or brushes, with an increasing use of roller type impregnators for forcing resin into the fabrics by means of rotating rollers and a bath of resin. Laminates are left to cure under standard atmospheric conditions.

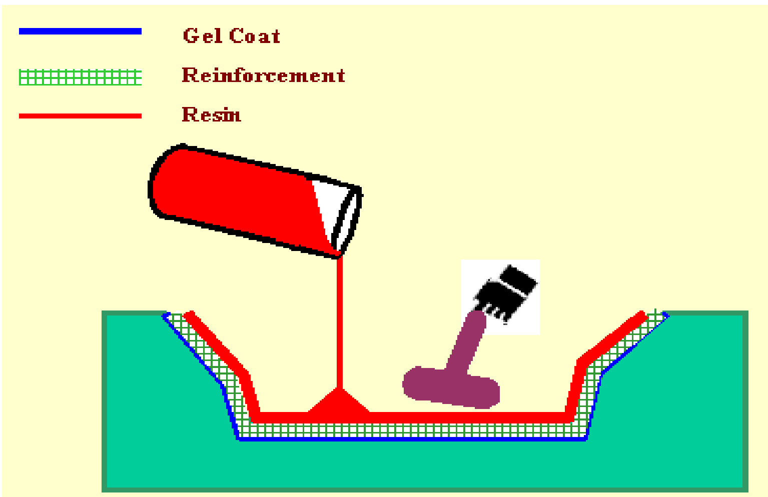


Figure 4.1: Schematic Hand Layup Process

MATERIALS

MOLD

Generally, a mold must be used for making parts using the lay-up process to place the layer in or on to obtain the desired shape. However, in this lab, we will not use a mold, but instead a tabletop to hold the flat shape of the layup. (A 'mold' is also called a 'tool' in industry when referring to composites processes).

- Different mold shapes are accomplished by machining material, casting material or molding material.
- Different materials may also be used as molds (metal, composites, wood, plaster, rubber etc.)

RELEASE AGENT

Prevents resin from sticking to the mold. In this experiment the tabletop will be covered with plastic sheeting to act as the release agent. Some other release agents used in industry are:

- Waxes
- spray releases
- release films
- Internal releases (added to gel coat or resin system)

Release agents are usually applied to the composite molds or tooling in a separate designated area as they can act as a contaminate if accidentally integrated into the composite layup.

RESINS

The resin acts as the matrix of the composite to 'bind' the composite materials together and transfer the component stresses that may act on the part to the fibers in the composite. The fibers are designed and selected to handle the designed stresses imposed. In this experiment a two-part epoxy and hardener resin system will be used. Various speed (set up time) hardeners can be used depending on the requirements of the job.

Figure 4.2: Resin Applying with brush

REINFORCING FIBERS

There are many different fibers that can be used to make up a composite and each materialcan be obtained in different formats. Both variables are design options that are available according to the design constraints of the final product and make up a significant part of the material selection process. In this experiment a standard weave fiberglass cloth will be used.

EXPERIMENTAL PROCEDURE:

WORK STATION PREPARATION

An initial preparation of all the materials and tools that are going to be used is a fundamental standard procedure when working with composites. This is mainly because oncethe resin and the hardener are mixed, the working time (prior to the resin mix gelling) is limited by the speed of the hardener chemically reacting with the epoxy producing an exothermic reaction. Each group of students must prepare all materials and supplies available and set up before proceeding. Also, as part of the initial preparation, the woven cloth must becut according to the shape of the part. In this experiment the student needs to have two pieces of fiberglass material cut into one-foot squares.

MOLD PREPARATION

Before starting with the layup process an adequate mold preparation must be done. Mainly, this preparation consists of cleaning the mold and applying a release agent in the surface of it to avoid the resin to stick. In this experiment the mold preparation is simply taping the plastic sheeting to the tabletop. If this was an actual mold the student would do thefollowing:

- Clean the mold with a clean cloth
- Apply and spread release agent in the surface of the mold
- Wait certain to set up the release agent
- Buff with clean cloth

LAY-UP PROCESS

Once all the materials are prepared, the workstation is ready and the mold preparation done; the students can start with the layup process. The first step is to mix the resin and the hardener. The proportions are usually given by the supplier and can be found on the containers of the hardener or resin. The portions can be either measured by weight for by volume but it is important to follow these proportions exactly as this is a complete chemical reaction and all components must react completely for maximum strength of the matrix. It is easiest to measure proportions using the volume method and a screw in pump that inserts intothe cans of resin and hardener.

Figure 4.3: Hand Layup Process

These pumps can be purchased along with the containers of 6 resin and hardener. Make sure to keep the resin pump and container top separate from the pump and container top ofthe hardener because any contamination will initiate the chemical reaction and cause the resulting blend to harden. The mixing is performed in the mixing containers with the mixing stick and should be done slowly to not entrain any excess air bubbles in the resin. Be careful to mix completely and deliberately for a full two minutes before applying. It is best to use a "flat" stick-such as tongue depressor; a round stick does not work well as it does not 'paddle' the mixture to blend it properly. Note: Plastic mixing containers may melt during the exothermic reaction, so it is best to use containers that are specifically made for the purpose of mixing epoxy resin. These are typically available from the resin vendor. Next an adequate quantity of mixed resin & hardener is deposited in the mold and a brush or roller is used to spread it around all surface. It is important not to add too much resin, which willcause too thick of a layer, nor to add less than the necessary amount, which will cause holesin the surface of the part when it is cured. An estimate of the amount of resin needed can be based on weight of glass fiber cloth. One can assume 50 volumes% resin/50% volume% fiberand then use the density of the reinforcement to arrive at the weight of the resin. It is good to then add a small safety factor so that enough resin is mixed for the layup. The first layer of fiber reinforcement is then laid. This layer must be wetted with resin and then softly pressing using a brush or a roller make the resin that was added in the previous step wick up through the fiberglass cloth. If the fiber is not completely wet, more resin can be added over the top and spread around. At this stage a second layer of glass fiber is added and special care must be taken to eliminate all air bubbles possible. This can be accomplished by either rolling any air bubbles out with a small hand rolling tool or brushing out the air bubbles with a paintbrush. This step is repeated until the desired thickness is obtained. As the glass fiber layers are added to build laminates and total part thickness the individual layers may be oriented at varying angles to accomplish specific strength in the direction of the reinforcement weave- this is called 'clocking'. Sometimes during the buildup of successive layers of reinforcement a cover sheet of plastic can be temporarily put over the layup and rolled together with the layers underneath to reduce the mess and squeeze out excess resin. It is important when the proper amount of resin has been used for the layup that any excess resin in the cup is placed on and in an area that does not have any flammable material, such as a concrete sink or slab. The students should watch the exothermic reaction that is taking place as the resin gels. Typically, the cup gets hotter than the composite panel, because of the heat of reaction that is being transferred to the cup.

CURING

The part can be cured at elevated temperatures using an oven (usually somewhere around 160 degrees F) or at room temperature. Generally, the proper curing time of each type of resin-hardener, as well as the working time, is given by the supplier on the back of the containers. If the part is left on plastic sheeting be sure to use proper 7 plastic sheet that will survive the elevated temperature. Most plastic sheet available from hardware stores (polyethylene) may melt. If planning the layup part is going to be moved to a curing oven, then layup should be done on a caul plate- generally a sheet of aluminum or steel >1/8" thick. For the purposes of this experiment and using an epoxy resin system, room temperature curing is adequate.

CLEANING

Once that part is ready to be cured, it must be moved to an adequate location. In this caseit can be moved to a curing oven or simply left to cure in place until the next day. Then a cleanup must be done before leaving the class. All the materials used (brushes, rollers, mixing tools, scissor), including the table, must be cleaned using acetone and cloth. Also, the rest of the fiberglass woven reinforcement must be collected from the table and floor. How todispose of acetone: Soap and water can be used on skin if exposed. Some shop hand cleaners (Go Jo) work well also. Any excess acetone should be properly disposed of, it is a good idea to put it in a proper disposal can with lid and disposed of correctly.

COMPOSITIONS TAKEN:

1. Sheep fiber
2. Camel fiber
3. Sheep fiber + Camel fiber
4. Sheep fiber + Camel fiber + 10% Duck egg shell powder

STEPS INVOLVED IN THE FABRICATION OF SPECIMEN:

The Sheep fiber, Camel fiber, Sheep fiber + Camel fiber, Sheep fiber + Camel fiber +10% Duck egg shell powder, 10 grams of hardener (HY951) is mixed with 100 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen is
mm for tensile test and flexural test.

- **CAMEL FIBER** reinforced Epoxy Composite specimen was fabricated by hand layup technique. In these process 4 sheets of 260 grams of camel fiber (260/300mm), 20 grams of hardener (HY951) is mixed with 200 grams of Epoxy (LY556) which is used as matrix in the composite. Thickness of the specimen that obtained by 2 sheets of camel fiber is around 1mm. The thickness of the specimen for tensile test, impact, hardness, and flexural test is 4.5 mm.

Figure 4.4: Camel Fiber

- **SHEEP FIBER** reinforced Epoxy Composite specimen was fabricated by using hand layup technique. In this process 4 sheets of 317 grams of Sheep fiber (317/300 mm) the 4.5 mm thickness and 20 grams of hardener (HY951) is mixed with 200 grams of Epoxy (LY556) which is used as matrix in the composite. The thickness of the specimen for tensile test, impact, hardness, and flexural test is 4.5 mm.

Figure 4.5: Sheep Fiber

- **SHEEP FIBER+CAMEL FIBER** For this hybrid composite 2 sheets of camel fiber, 2 sheets of sheep fiber, epoxy, and hardener are used. In this process 4 sheets of 330 grams of camel fiber and sheep fiber are (330/300mm) used to obtain the 4.5 mm thickness. And 20 grams of hardener (HY951) is mixed with 200 grams of Epoxy (LY556). The thickness of the specimen for tensile test, impact, hardness, and flexuraltest is 4.5 mm.

Figure 4.6: Camel + Sheep Fiber (Hybrid)

- **CAMEL FIBER + SHEEP FIBER WITH 10% DUCK EGG SHELL POWDER**

Fiber reinforced Epoxy Composite specimen is fabricated. In this process 4 sheets of

376 grams of camel fiber, sheep fiber (376/300mm) used to obtain the 4.5 mm thickness. For this camel fiber + Sheep fiber composite is added to 200 grams of epoxy and 20 grams hardener and 10% Duck egg shell powder in all compositions. The thickness of the specimen for tensile test, impact, hardness and flexural test is 4.5 mm.

Figure 4.7: Sheep+ Camel Fiber with 10 grams of Duck Egg Shell Powder

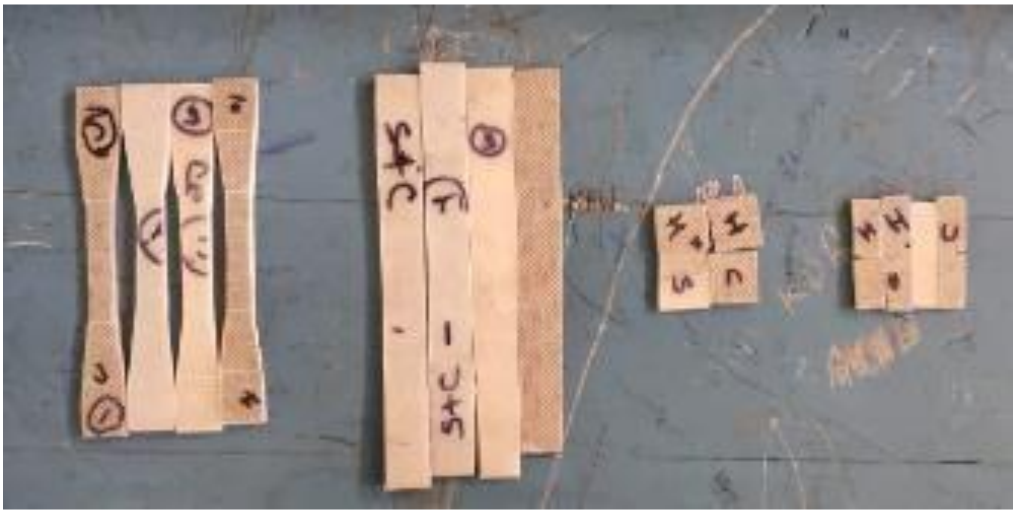


Figure 4.8: Specimens Before Testing's

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 09 | Sept - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

CHAPTER 5 RESULTS AND DISCUSSION

TENSILE TEST CALCULATIONS

Fabrication and testing successfully completed in this project the tensile properties of sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder in all composition's fibers fabricated by using hand lay-up method.

Figure 5.1: Tensile Testing Machine

The tensile strength was calculated by the relation

Tensile stress σ_t = $\dfrac{\text{tensile load}}{\text{area of cross-section}}$

$= \frac{P}{A}$ N/mm²

Where, P=Load

A=Area of cross section As per results peak load (N) values of tensile specimens,

- Sheep fiber:

$\sigma t = \frac{2250}{165 \times 44} = 0.309$ N/mm²

- Camel fiber:

$\sigma t = \frac{1205}{165 \times 44} = 0.165$ N/mm²

- Sheep fiber/Camel fiber:

$\sigma t = \frac{2650}{165 \times 44} = 0.365$ N/mm²

- Sheep fiber/Camel fiber+10grams duck egg shell powder:

$\sigma t = \frac{3250}{165 \times 44}$

$= 0.447$ N/mm²

The percentage of elongation is calculated by the follow equation

$$\textbf{\% elongation} = \frac{\textit{change in length}}{\textit{original length}} \times \mathbf{100}$$

As per results displacements (mm) values of tensile specimens,

- Sheep fiber

% of elongation $= \frac{8.5}{164} \times 100 = 5.18\%$

- Camel fiber

% of elongation $= \frac{7.6}{164} \times 100 = 4.63\%$

- Sheep fiber/Camel fiber

% of elongation $= \frac{6.5}{} \times 100 = 3.96\%$

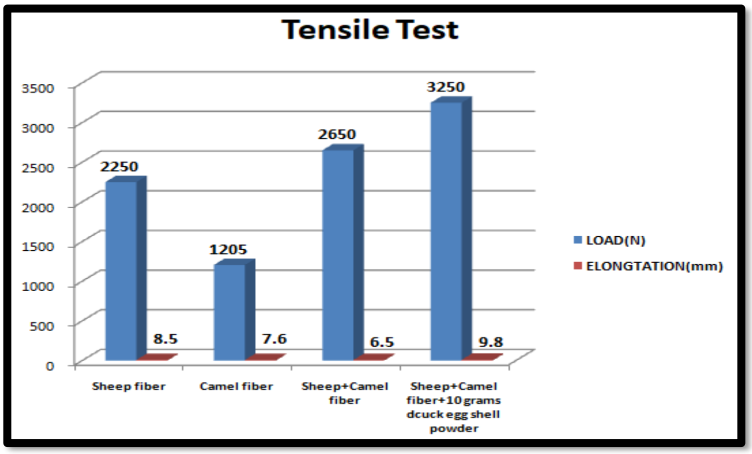
164

- Sheep fiber/Camel fiber+10grams duck egg shell powder:

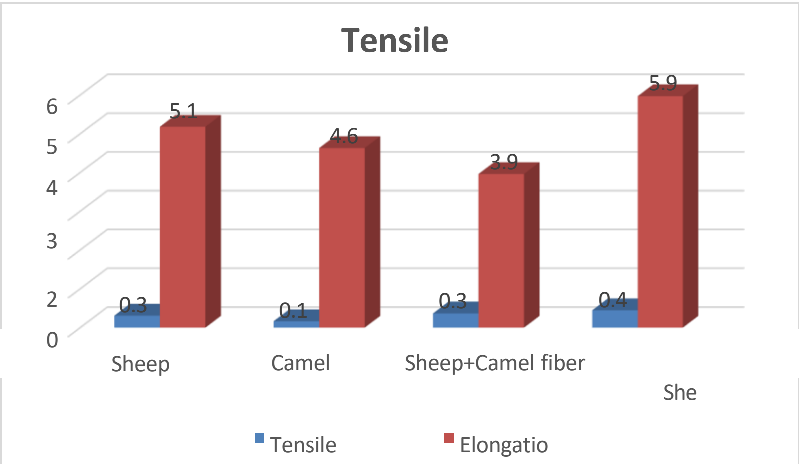
% of elongation = $\frac{9.8}{164}$ ×100= 5.97%

S.NO	COMPOSITE		TENSILE TEST		
		LOAD(N)	ELONGTATION(mm)	TENSILE STRESS(N/mm2)	ELONGTATION(%)
1	Sheep fiber	2250	8.5	0.309	5.18
2	Camel fiber	1205	7.6	0.165	4.63
3	Sheep+Camel fiber	2650	6.5	0.365	3.96
4	Sheep+Camel fiber+10 grams dcuck egg shell powder	3250	9.8	0.447	5.97

Table 5(a): Tensile Test Results



Tensile Test Graph



Tensile Test Graph

Based on the tensile strength finally concluded that sheep fiber/camel fiber with 10 grams duck egg shell powder possess high tensile strength compared to remaining composite.

FLEXURAL TEST CALCULATIONS

Fabrication and testing successfully completed in this project the flexural strength of sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder are fabricated by using hand lay-up method.

The flexural strength was calculated based the following relation

Flexural strength S = **3 P L** ______

2 b t^2

Where, P= load in N

L= length between supports (70mm)b= Width in mm
d= Thickness in mm

Figure 5.4: Flexural Testing Machine

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 09 | Sept - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Figure 5.5: Flexural Test Specimens After Testing

As per results peak load (N) values of flexural specimens,

- Sheep fiber:

$$S1=\frac{3\times172\times70}{2\times25\times4\times4}=45.15\ N/mm^2$$

- Camel fiber:

$$S1=\frac{3\times128\times70}{2\times25\times4\times4}=33.60\ N/mm^2$$

- Sheep fiber/Camel fiber:

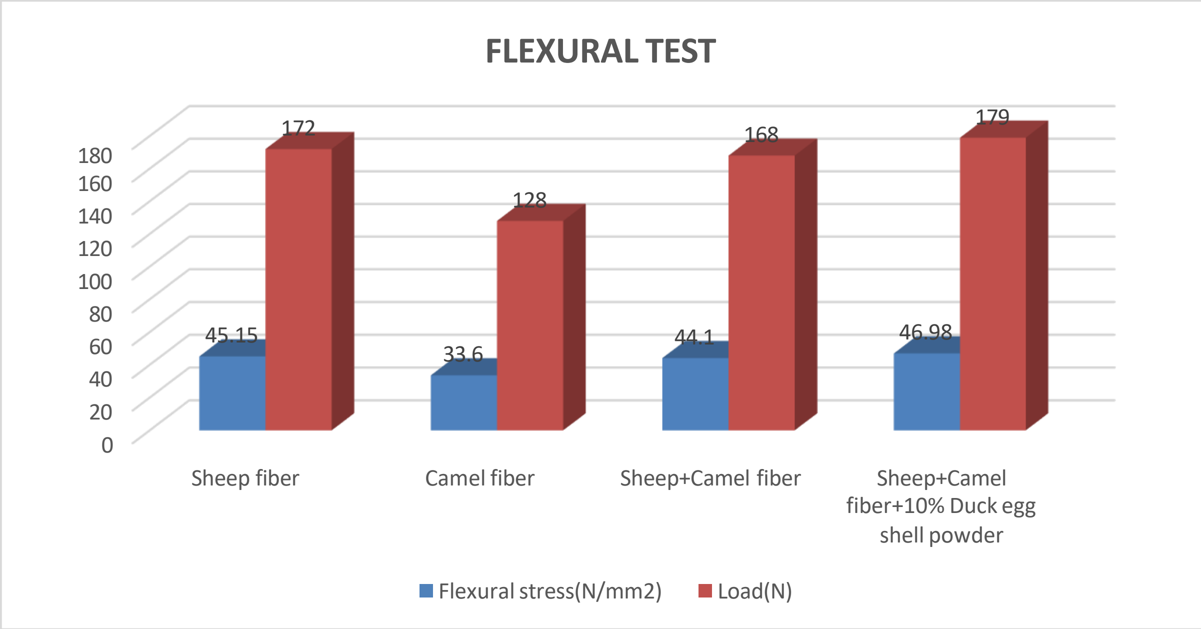
$$S1=\frac{3\times168\times70}{2\times25\times4\times4}=44.10\ N/mm^2$$

- Sheep fiber/Camel fiber +10grams duck egg shell powder:

$$S1=\frac{3\times179\times70}{2\times25\times4\times4}=46.98\ N/mm^2$$

S.NO	COMPOSITE	LOAD(N)	FLEXURAL STRESS(N/mm2)
1	Sheep fiber	172	45.15
2	Camel fiber	128	33.6
3	Sheep+ Camel fiber	168	44.1
4	Sheep+ Camel fiber+ 10% Duck egg shell powder	179	46.98

Table 5(b): Flexural test results



5.6 Flexural Test Graph

Based on the flexural strength finally concluded that sheep fiber/camel fiber with 10 grams duck egg shell powder possess high flexural strength compared to remaining composite.

IMPACT TEST CALCULATIONS

Fabrication and testing successfully completed in this project I also focused on impact strength of sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder 7 combinations in all compositions fabricated byusing hand lay-up method.

Figure 5.7: Impact Test Specimens After Testing

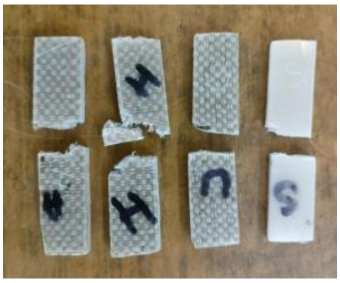


Figure 5.8: Impact Tester

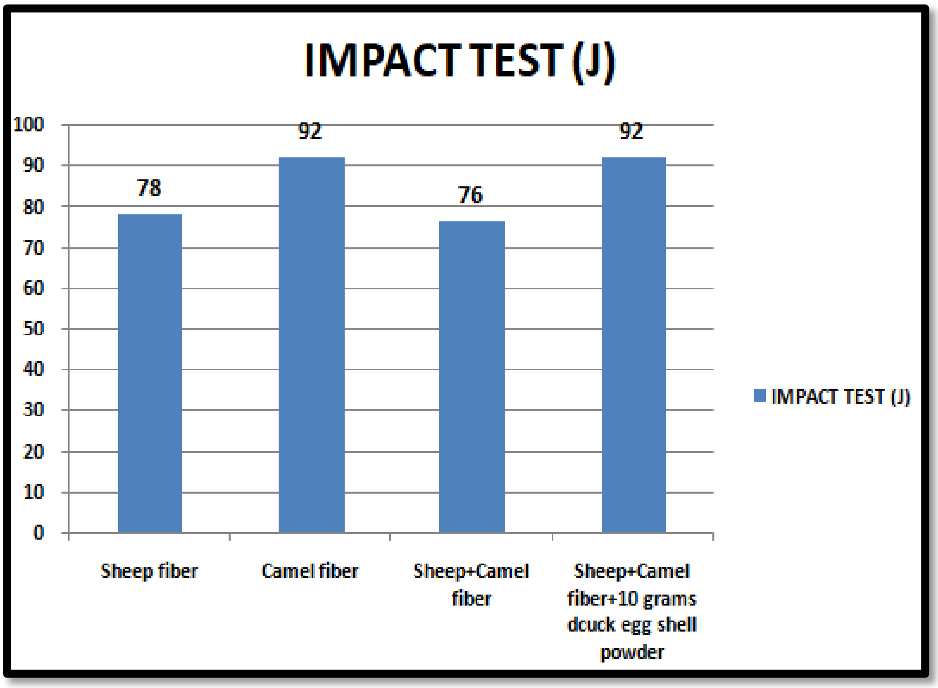
Impact strength was calculated by the following relation

$$\sigma = \frac{2P}{A}$$

Where, P= Energy observed in JA= Area in mm

S.NO	COMPOSITE	IMPACT TEST (J)
1	Sheep fiber	78
2	Camel fiber	92
3	Sheep+Camel fiber	76
4	Sheep+Camel fiber+10 grams dcuck egg shell powder	92

Table 5(c): Impact Test Results



5.9 Impact Test Graph

Based on the impact strength finally concluded that sheep fiber/camel fiber with 10 grams duck egg shell powder possess high impact strength compared to remaining composite.

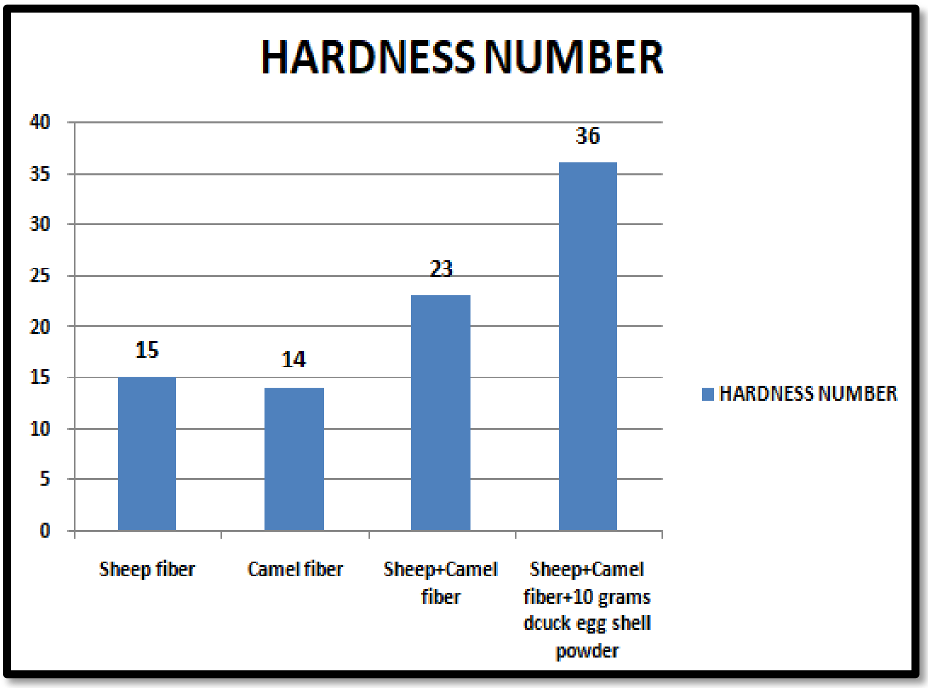
HARDNESS TEST CALCULATIONS

Brinell hardness values of sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder are used fabricated by using hand lay-up method natural composites.

Figure 5.10: Hardness Tester

S.NO	COMPOSITE	HARDNESS NUMBER
1	Sheep fiber	15
2	Camel fiber	14
3	Sheep+Camel fiber	23
4	Sheep+Camel fiber+10 grams dcuck egg shell powder	36

Table 5(d): Hardness Test Results



5.11 Hardness Test Graph

Based on the hardness number finally concluded that sheep fiber/camel fiber with 10 grams duck egg shell powder possess high hardness compared to remaining composite.

MECHANICAL CHARACTERISTICS OF COMPOSITES

The properties of the sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder, reinforced epoxy hybrid composites with of fiber under this investigation are presented in below Table. I have taken each composite for each test. Details of processing of these composites and the tests conducted on them have been described in the previous chapter. The mechanical properties of Synthetic fiber reinforced composites are largely depending on the chemical, structural composition, fiber type and soil conditions and on atmospheric conditions at the time of fabrication of the specimens.

S.NO	COMPOSITE	TENSILE	TEST	FLEXURAL	TEST	IMPACT TEST	HARDNESS
		LOAD(N)	ELONGTATION(mm)	LOAD(N)	ELONGTATION(mm)	IMPACT TEST (J)	NUMBER
1	Sheep fiber	2250	8.5	1720	8	78	15
2	Camel fiber	1205	7.6	1280	7.5	92	14
3	Sheep+Camel fiber	2650	6.5	1685	10.5	76	23
4	Sheep+Camel fiber+10 grams dcuck egg shell powder	3250	9.8	1790	10.9	92	36

Table 5(e): Testing Results

The results of various characterization tests are reported here. This includes evaluation of tensile strength, flexural strength, and impact strength and hardness test. Has been studied and discussed. Based on the tabulated results, various graphs are plotted and presented in figures for composites.

CHAPTER 6 CONCLUSION

- The present work has been done with an objective to explore the use of sheep fiber, camel fiber, sheep fiber+ camel fiber and sheep fiber+ camel fiber+10 grams of duck egg shell powder are manufactured using hand lay-up method. Epoxy is used as matrixin the reinforced composite and investigated the mechanical properties like tensile, flexure, impact, and hardness tests of composites. This work is focused to find the best composite among the four combinations.
- After conducting a comprehensive series of mechanical tests including tensile, impact, hardness, and flexural tests on the specimens manufactured with different combinations of sheep fiber, camel fiber, and duck egg shell powder, it is evident that the composite comprising sheep fiber and camel fiber with 10% duck egg shell powder demonstrates superior performance across all parameters.
- The results obtained from the tests consistently indicate that the addition of duck egg shell powder enhances the mechanical properties of the composite material. This improvement can be attributed to various factors such as the reinforcing effect of the natural fibers and the filler effect of the duck egg shell powder, which collectively contribute to increased strength, toughness, and hardness of the composite.
- Specifically, the composite of sheep fiber, camel fiber, and 10% duck egg shell powder exhibits higher tensile strength, improved impact resistance, greater hardness, and enhanced flexural properties compared to other compositions tested in this study. These findings highlight the efficacy of this particular combination in enhancing the overall mechanical performance of the composite material.
- Therefore, based on the results obtained from the conducted tests, it can be concluded that the composite formulation involving sheep fiber, camel fiber, and 10% duck egg shell powder holds promise as a viable and advantageous material for various applications requiring robust mechanical properties. Further research and development efforts can focus on optimizing this composition for specific industrial or commercial uses, thereby harnessing its potential for broader adoption and utilization in the field of composite materials.

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