Study of Wear Characteristics of Banana-Basalt Fibre Composite

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Abstract— **Now-a-days, natural fibers have been receiving considerable attention as the substitute for synthetic fiber reinforcement such as glass in plastics. Among various fibers, coir is most widely used natural fiber due to its advantages like easy availability, low cost, low density, low production cost and satisfactory mechanical properties. The objective of the present research work is to study the wear behavior of banana-basalt fibre. Four different samples with constant filler content of 10 wt% were prepared by varying the length of the fiber (3 mm, 6 mm, 9 mm, 12 mm and 15 mm) and content of fibre using hand lay-up technique. The erosion wear of these composites have been evaluated at different impingement angle (135°, 45°) and at different impact velocities. The effect of fiber length and content on the wear properties of composites is also analyzed. Moreover, L18 orthogonal array have been formed for the load of 5N and 10N with the sliding velocity of 0.5m/s,1m/s and 1.5m/s along with sliding friction of 269m,359m and 449m. From the test results it was observed that wear rate increases by increasing the load. It is also noted that co-efficient of friction increases by increasing the load It has been**

observed that natural composites wear properties as compared to othercomposites.

The morphology of eroded surfaces is examined by using scanning electron

microscopy(SEM)

INTRODUCTION (*HEADING 1*)

Natural fibers have been produced for centuries, but the earliest patent was awarded to the Prussian inventor Hermann Hammesfahr (1845–1914) in theU.S. in 1880. Mass production of glass strands was accidentally discovered in 1932 when Games Slayter, a researcher at Owens-Illinois, directed a jet of compressed air at a stream of molten glass and produced fibers A patent for this method of producing glass wool was first applied for in 1933. Owens joined with the Corning company in 1935 and the method was adapted by Owens Corning to produce its patented "Fiberglass" in 1936. Originally, Fiberglas was a glass wool with fibers entrapping a great deal of gas, making it useful as an insulator, especially at high temperatures. A suitable resin for combining the fiberglass with a plastic to produce a composite material was developed in 1936 by du Pont. The first ancestor of modern polyester resins is Cyanamid's resin of 1942. Peroxide curing systems were used by then. With the combination of fiberglass and resin the gas content of the material was replaced by plastic. This reduced the insulation properties to values typical of the plastic, but now for the first time the composite showed great strength and promise as a structural and building material Filament winding is another very versatile technique in whichcontinuous tow or roving is passed through a resin impregnation bath and wound over a rotating or stationary mandrel. A roving consists of thousands ofindividual filaments.A schematic of this process, while a pressure vessel made by filament winding. The winding of roving can be polar (hoop) or helical. In polar winding, the fibre tows do not cross over, while in the helical they do. The fibres are, of course, laid on the mandrel in a helical fashion in both polar and helical windings; the helix angle depends on the shape of the object to be made. Successive layers are laid on at a constant or varying angle until the desired thickness is attained. Curing of the thermosetting resin is done at an elevated temperature and the mandrel is removed. Very large cylindrical (e.g., pipes) and spherical (e.g., for chemical storage) vessels are built by filament winding. Glass, carbon, and aramid fibres are routinely used with epoxy, polyester, and vinyl ester resins for producing filament wound shapes.

LITERATURE REVIEW

The purpose of this literature review is to provide background information on the issues to be considered in this thesis and to emphasize the relevance of the present study. This treatise embraces various aspects of polymer composites with a special reference to their erosion wear characteristics. This chapter includes reviews of available research reports:

Basalt fibre composites are widely used in construction and their hybrid composites are used in automotive industries. Amir Asadi et al studied the enhancement of basalt fibre as an alternative to the glass fibre performed in sheet moulding compounds to reduce the weight and cost of glass fibre on sheet moulding components by conducting single fibre fragmentation tests on Basalt Fiber (BF)/epoxy and Glass Fiber (GF) /Epoxy composites the result shows that BF/Epoxy shows improvement in impact properties. Bin Hao et al advanced basalt fibre by using Chemical Vapour Deposition (CVD) process in which a thin layer of pyrolytic carbon with a thickness of 15-30 nm was deposited on the fibre surface which makes the fibres conductive in nature. It was found that this fibre embedded into epoxy resin results in a piezo resistive effect of highest factor 38.6 under mechanical load with basalt fibre showed increased tensile strength and also structure failure. Mehmet Bulut examined the influence of graphene Nano-pellet (GnPs) inclusions on mechanical properties of basalt/epoxy composite laminates. The specimen was prepared with various weight ratios of GnPs (0.1, 0.2 and 0.3 %weight.). The test results showed that the mechanical property of 0.1%wt. specimen was high and a decreasing trend with 0.2 and 0.3 %wt. specimens. Marianne Inman et al [4] compared the mechanical performance of basalt fibre reinforced polymer rebar and steel rebar in concrete beams. They found that Basalt fibre Reinforced Polymers are stronger and alternative to steel reinforcement, but have lower elastic modulus than steel reinforcement concrete.

Samper et al developed basalt fabric reinforced polymeric material with Epoxidized linseed Oil (ELO) and Epoxidized Soya Bean Oil (ESBO) as bio based matrix. The basalt fibre was modified with amino-silane and glycidyl-silane. The Scanning Electron Microscopy (SEM) analysis result shows that ELO resin has less defects such as blow holes, cracks which results in good mechanical characteristics in comparison with ESBO. Srinivasan et al investigated the mechanical and thermal behaviour of banana flax hybrid composite and found that hybrid composite have better mechanical behaviour than mono fiber. Nihat Kabay studied the effect of basalt fiber (BF) on physical and mechanical properties of concretes, they casted high strength and normal strength concretes by adjusting water to cement ratios as 0.45 and 0.60 where a total of ten mixtures were prepared by using different compositions and sizes of BF into those concretes. They found that flexural strength, fracture energy and abrasion resistance were high by using BF even at low contents. However, inclusion of BF in concrete results in a decrease in compressive strength. Zhongyu Lu et al for analyzed the effect on mechanical properties atelevated temperature between 120^0C-200 ^{0}C for 4 hours on the basalt fiber roving and pultruded basalt fiber-reinforced polymer (BFRP) plates. E-glass fiber roving and pultruded Glass Fiber-Reinforced Polymer (GFRP) plates were also tested under the same conditions. It was observed that as the temperatures increased the tensile strength and elastic modulus were reduced for BFRPs and BF rovings. John Branston et al [9] used the basalt fibre in chopped state as reinforcement with concrete to improve its mechanical properties. It has two types namely dispersion and minibar fibres. The experiment was carried out by three different fibres casted with concrete flexural and drop weight impact test was done. The results revealed that the dispersion had increased pre-cracking while the mini bars showed the post –cracking behaviour, due to protection from polymer. Lago et reinforced concrete with Steel-free pre-stressed to analyse increase in durability of structural elements. In their work, 10mm long steel is predated on reinforcement of concrete slab pre-stressed with basalt- fibre reinforced polymer (BFRP) bars and shear-reinforced with glass-fibre reinforced polymer bars. The above setup was experimented to study the flexural behaviour, Non-linear viscoelastic and elastic-plastic models. Preliminary test was employed on materials and 3-point test on slab element were analysed on its manufacturing process. Achievable limits of prediction were obtained.

MATERIALS SELECTION

In most part of India, these banana trunks are thrown as agricultural waste because most of the people are ignorant about the extraction of the fibre and its utilization except Kerala where this fibre is partly used for manufacturing house hold articles. This present portion of article gives an evaluation of yield, structure and properties of banana fibres gathered from a few commercially cultivated varieties. Results indicate that variation exists in both structure and properties of fibres from different regions along the length and across the thickness of the trunk. Banana fiber is a natural leaf fiber. It has its own physical and chemical characteristics and many other properties that make it a fine quality fiber.

Zink chloride &iodinereagent Golden yellow

Para – Nitro anilinereagent Bright orange

Potassium permanganate Pink

Meliorate green Green

Iodine and sulphuric acid reagent yellow

There are characteristics with high strength, small elongation, good luster, light, strong moisture absorption, fast moisture absorption and release, easy gradation as well as environmental protection etc. Banana fiber can be made into garment, curtain, towel, bed sheet etc due to it's characteristics with good luster and moisture absorption.

Selection of Basalt Fibre

Basalt continuous fiber reinforced composite material strength, chemical stability, electrical insulation properties are superior to glass fiber reinforced materials, in large part to replace glass fiber, carbon fiber, widely used inaerospace, petrochemical, construction, automotive, etc.field; basalt melting process there is no discharge of boron and alkali metal oxides, the basalt fiber manufacturing process environmentally benign, non-industrial waste, no emissions of harmful gases into the atmosphere. The basalt fiber are the 21st century a new type of environmentally friendly fibers. Basalt fiber composite materials in civil engineering applications include chopped basalt fiber, basalt fiber sheet material, profiles, plates, ribs (rods) material, cable materials, as a new building material

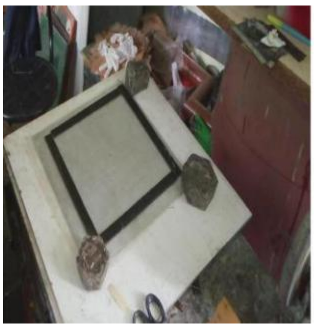
the application includesas modified concrete admixtures in the field of concrete enhanced. in the construction, repair, reinforce and update the field instead of the Restoration materials of carbon fiber reinforced beams, columns, plates, wall structure, bridges, tunnels, dams and other civil engineering can also be reinforced, especially for seismic reinforcement. in the field of road construction as a geogrid material. With a clear price advantage compared to carbon fiber, basalt fiber, and thus has broad prospects for development in the field of engineering applications.

FABRICATION OF LAMINATES

Laminates are fabricated in the various methods. These methods has different steps and they involve usage of additives and resins to involve uniform formation and even distribution of composite (PMMA and SIC). The method used in the process of laminates moulding is Hand Lay-up

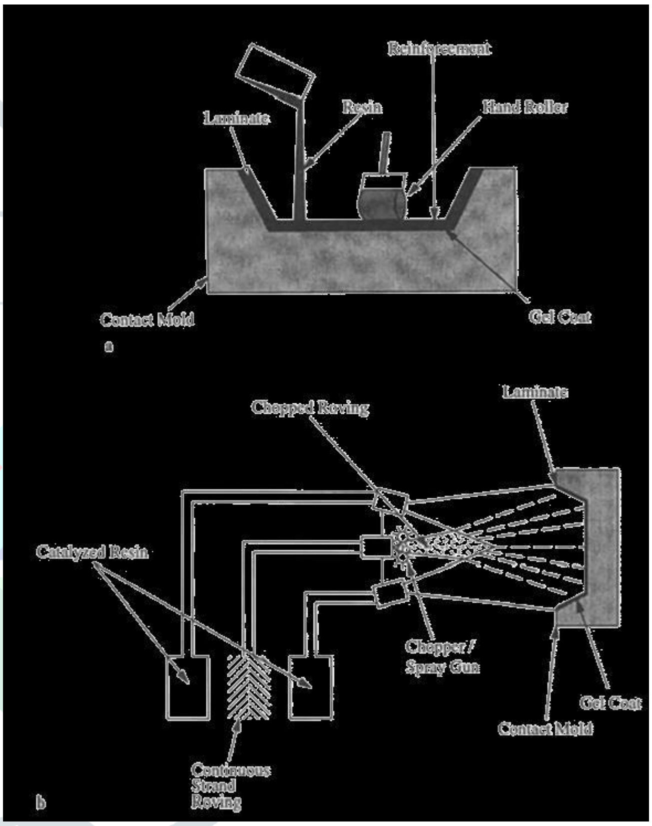
MOULD

The mould will have the shape of the product. In order to have a glossy or texture finish on the surface of the product, the mould surface also should have the respective finish. If the outer surface of the product to be smooth, the product is made inside a female mould. Likewise, if the inner side has to be smooth, the moulding is done over a male mould. The mould should be free from defects, since the imprint of any defect will be formed on the product



PREPARATION OF THE RESIN MIX.

The resin mix can be prepared at least one day ahead so that the entrapment of air bubbles escape before the lay-up begins. The mix consists of the resin, accelerator, fillers, and additives if any. The addition of accelerator to resin will not cause any cross linking until catalyst is added. The mixing can be done by either manually using a paddle or by using an air operated mixer. Vigorous stirring can cause entrapment of air bubbles therefore; mixing should be done at a very low rpm. The container in which resin mix is stored may be closed air tight to minimize the vaporization and loss of styrene.



The required number layers to obtain the thickness can be determined by taking into account the mat density and the glass-to-resin ratio by weight. The following points must be taken into account while preparing the matWherever joints are there, there should be a minimum overlap of 25 mm, in case of chopped strand and a 50 mm overlap is required in the case of wovenoving mat. Whenever, there is change in thickness the thickness must not abruptly change and instead it must gradually change. Tools for Lay-up: Weighing balance - to weigh the chemicals. Brushes - to apply resin for both gel coat application and for lamination. Rollers - to remove the air bubbles and also for applying resin. Long rollers are used to consolidate large areas but short rollers are used for corners and curved surfaces. Mugs and small bowls - for taking the resin mix for lay-up. Solvents: Solvents are required for cleaning the rollers and brushes during or after the lay-up sequence is over. Acetone or Nitrocellulose thinner can be used as solvents.

LAMINATION PROCEDURE

In the process of lamination a thin layer of resin is applied on the gel coat layer. Then, a chopped strand mat is placed over it. The resin is again applied over the mat by using brush to wet the mat. By using the roller the air bubbles are removed. After the first layer is laid up, subsequent layers are laid in a similar manner. More than 4 layers of resin and glass mat should not be applied without allowing the resin to cure at a time. When WRM is laid up, CSM is used in between in order to increase the inter-laminar shear strength. The lay-up procedure for WRM and CSM are identical except that the resin used for WRM is half the quantity of that is needed for CSM.

WATER JET CUTTING

The above ASME STANDARD specimen is created using water jet cutting machining using CNC operated water jet machine. Water Jet Machining (WJM) also called as water jet cutting is a non-traditional machining process in which high velocity jet of water is used to remove materials from the surface of the work piece. WJM can be used to cut softer materials like plastic, rubber or wood. In order to cut harder materials like metals or granite, an abrasive material is mixed in the water.

OPERATION

All water jets follow the same principle of using high pressure water focused into a beam by a nozzle. Most machines accomplish this by first running the water through a high pressure pump. There are two types of pumps used to create this high pressure; an intensifier pump and a direct drive or crankshaft pump. A direct drive pump works much like a car engine, forcing water through high pressure tubing using plungers attached to a crankshaft.

An intensifier pump creates pressure by using hydraulic oil to move a piston forcing the water through a tiny hole. The water then travels along the high pressure tubing to the nozzle of the water jet. In the nozzle, the water is focused into a thin beam by a jewel orifice. This beam of water is ejected from the nozzle, cutting through the material by spraying it with the jet of high-speed water. The process is the same for abrasive water jets until the water reaches the nozzle. Here abrasives such as garnet and aluminium oxide are fed into the nozzle via an abrasive inlet. The abrasive then mixes with the water in a mixing tube and is forced out the end at high pressure. **WEAR TEST**

Wear is the damaging, gradual removal or deformation of material at solid surfaces. Causes of wear can be mechanical (e.g., erosion) or chemical (e.g., corrosion). The study of wear and related processes is referred to as tribology. The abrasive wear tester is a versatile equipment for abrasive wear testing of materials in reciprocating sliding. It consists of a table that holds the specimen and presses it against an steel disc. This machine has several advantages such as high reproducibility, short test time, simple flat test geometry, easy evaluation, simple operation. This machine has some disadvantages. The friction cannot be measured by this machine; some parameters such as humidity and temperature cannot be controlled.

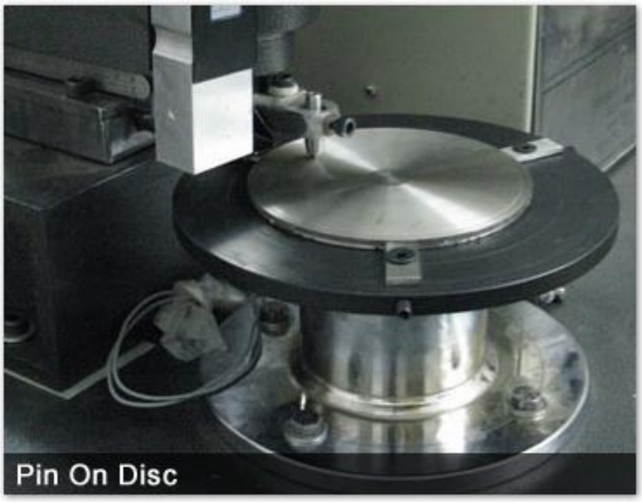
WEAR ANALYSIS

While most, if not all oil analysis programs include at least some means of detecting active machine wear, all too often problems can be missed or misdiagnosed due to a basic lack of understanding of the strengths and weakness of the test method used. Let's look at some of the more common test methods used for monitoring and analyzing wear. Monitoring and controlling problems that lead to active machine wear are critical to an effective oil analysis strategy. For this reason, educated oil analysis users focus their attention on contamination monitoring and control, and onensuring that the physical and chemical properties of the oil are in good condition. Nevertheless, no matter how effective a proactive lubrication management program might be, at some time or another, a component will start to show signs of wear. This is where wear analysis comes into play.

WEAR ANALYSIS STARTEGY

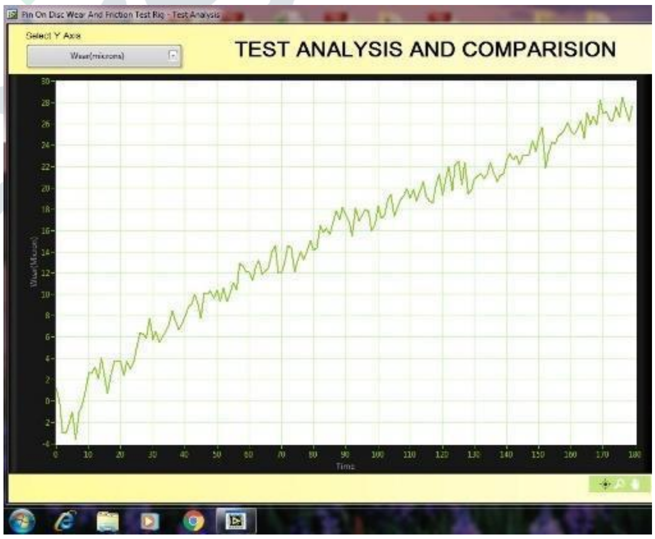
In the present research work, an attempt has been made to identify an eco friendly natural fiber to be used as reinforcement in the manufacture of brake friction material. There is an increase in the environmental awareness in the world which has aroused an interest in the research and the development of biodegradable and high performance materials. The first generation of modern brake materials was asbestos fiber reinforced composites. Due to the environmental problem the natural fibers were introduced instead of asbestos fiber in this research work. The thermal, mechanical and tribological properties of various natural fibers were studied and analyzed. Specimens for study were prepared by hand layup technique to study the wear properties. The worn specimens were then put under a Scanning Electron Microscope for detailed analysis of the severity of wear.Brake pads are primarily used to slow

down a vehicle by converting kinetic energy into heat through friction that takes place at the interface between brake pad and a rotor disc. The brake pad is almost always the reason for brake failures. This is because, the brake pad is the component that is at the receiving end when a brake is applied and is subjected to wear and tear depending upon pedal pressure, vehicle speed, disc temperature, and environmental conditions. The problems created areunwanted vibrations due to rotor warping (judder), decreased brake effectiveness
(fade) and some noise . A stable friction coefficient at any condition, irrespectiveof temperature, humidity, age, amount of wear and corrosion, dirt and water must be maintained by the brake pad material. Added to this, it must also meet all safety requirements, have a long life, and provide high comfort, with absence of vibration and noise. The variation in friction coefficients are influenced by the ingredients of brake pad materials and braking conditions. About 10-15% of the rubbing surface of a rotor disc is covered by brake pads. The pad is pressed against the disc with an estimated force of about 5 kN, when the brake is applied slightly (assuming typical pad size of 80mmx50mm) producing a nominal contact pressure of about 1.2MPa at the pad surface. However, when the brake is applied hard, the surface pressure could touch 10MPa. Also, a high surface temperature approximately 200°C to 400°C is produced while braking along with pressure. This pressure and temperature have to be taken into account while choosing frictional material for brake pads. While rotor discs are commonly made from cast iron, metallic fibers or asbestos is used with appropriate binder resin for brake pads. Usually, Phenolic resin is used as a binder for fabricating brake pad materials and further added with mineral fibers, fillers, friction modifiers, abrasives and metallic particles that modify characteristics of heat flow. The type and amount of ingredients are determined on the basis of empirical observations. Although binder resins are commonly blamed for shortcomings in braking and subsequent problems, right fiber reinforcements are the solution for improving physical strength and friction performance. The specimens were subjected to wear test under a pin-on-disc machine that simulates the wear on material, returns the wear and coefficient of friction for each sample. We have used a TR-20PHM-M1 pin-on-disc wear testing machine available

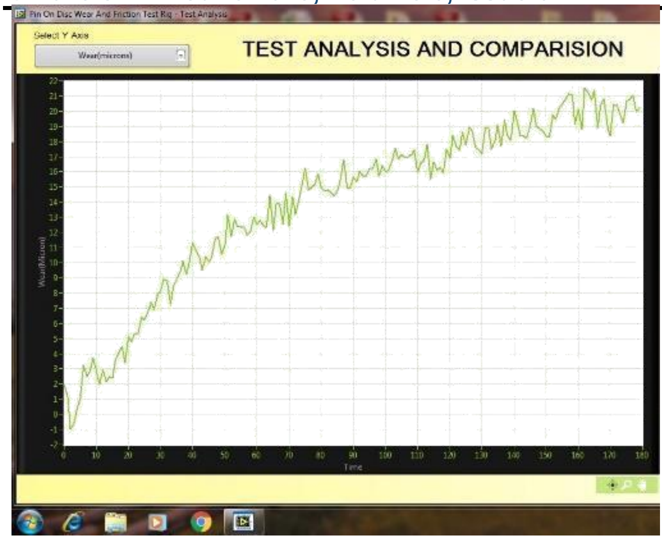


with the Department of Manufacturing Engineering, Annamalai University. The specimen pin was inserted to collet placed inside specimen holder, and clamped by top. Three different sliding distances(269,359 and 449m), Sliding velocities (0.5, 1.0 and 1.5m/s) and loads (5 and 10N) were selected for wear tests under ASTM G 99 Standard. The specimen pin was inserted to collet placed inside specimen holder, and clamped by top. Friction is produced when the specimen pin is loaded against a rotating disc. The machine operation was controlled by an electronics controller. The software in the machine has two screens, one for acquiring and displaying data and other for displaying post-processed graph showing individual test parameters such as wear and frictional force

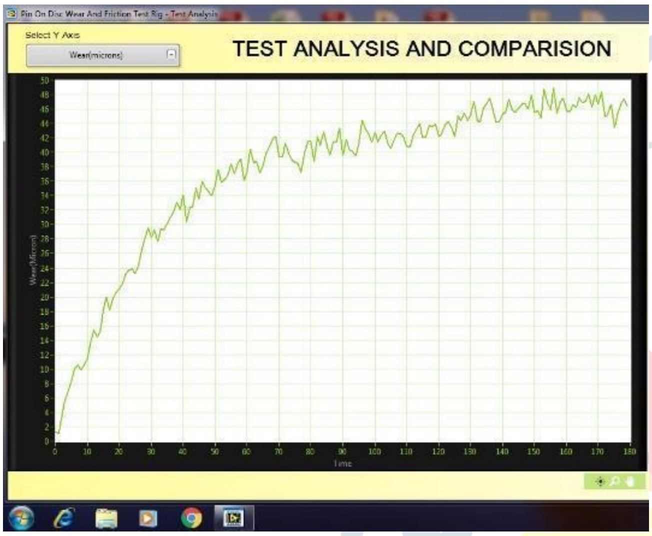
WEAR TEST RESULTS



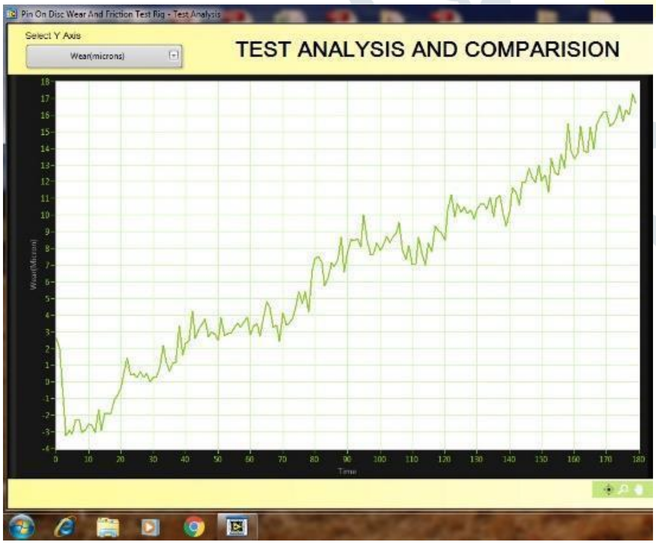
LOAD- 500gm ,Test speed-159



LOAD- 500gm ,Test speed-318



LOAD-500gm ,Test speed-478



LOAD-1Kg ,Test speed-159

CONCLUSION

In this project basalt banana based hybrid composite was fabricated by Hand lay-up process also pin on disc wear test was performed in order to study and analyze the wear behavior of fabricated composite. Moreover, L18 orthogonal array have been formed for the load of 5N and 10N with the sliding velocity of 0.5m/s,1m/s and1.5m/salong with sliding friction of 269m,359m and 449m. From the test results it was observed that wear rate increases by increasing the load. It is also noted that co-efficient of friction increases by increasing the load.

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