International journal of advances in engineering and management (IJAEM)
Volume 3, issue 6 June 2021, pp: 2317-2326 www.ijaem.net ISSN: 2395-5252

Manu Facturing of Clutch Liner Using Epoxy Matrix Composite Filled With Aluminium Powder

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Submitted: 05-06-2021 Revised: 18-06-2021 Accepted: 20-06-2021

ABSTRACT
A composite is a material that is made by combining two or more substances that have deferent physical properties. also it is a combination of two phases called the reinforcing phase and matrix phase.Reinforcing phase is the form of fiber.Composite materials can successfully substituted the conventional materials composites are selected mainly due to their high strength to weight ratio, High tensile strength at elevated temperature, also thus have light weight and high strength. The composites are manufactured using the Hand lay technique. with 2% Aluminium and making clutch friction liner with attached to clutch plate the material is get in to same tests and the result are arranged and compared with conventional clutch liner.

Keywords: Epoxy, Glass fiber, Reinforcement, Matrix, Hand Lay-up,

I. INTRODUCTION

Glass fiber reinforced epoxy composites are very popular in composite industry for its increasing use in numerous engineering applications such as seals, gears, rollers, cams, wheel, clutches and bearings because of many advantages including improved mechanical properties, wide varieties of availability and design flexibility as compared to metal based counterparts. As a reinforcing material, glass fiber has a wide range of availability out of which bi-directional woven glass fiber reinforced polymer composites are getting acceptance in many industrial applications due to low weight, ease of processing and price.Composite materials are finding increased applications in many engineering fields. In the aerospace industry, the use of composite materials in commercial and military aircrafts has increased greatly over the last 20 years. For example, the usage of composites has evolved from less than 5 percent of the structural weight in the Boeing 737and747toabout50percentintheBoeing787Dreamliner.Bycontrast,Aluminium will comprise only 12 percent of the Boeing 787 aircraft. According to Chambers, while the use of composites is less than 10% of the structural weight in the F14 fighter it has increased to about 40% of the structural weight in the F22 fighter. In the ship building industry, thick-section glass and carbon fiber composites and sandwich composites are morewidelyincorporatedintoshipstructuresthanbeforetofulfillspecialdemands,such as light-weight, good insulation, low maintenance cost, and resistance to corrosion (Daniel and Ishai 2006). In civil structures, such as bridges, the use of carbon fiber-reinforced plastics (CFRP) has extended from only internal reinforcement in structures to both internal and external reinforcement. In addition to structures, wide applicationof composite materials can be found in automobile parts and frames, trucks, sports equipment's, etc. Among these composite materials, the laminated fiber-reinforced composite material is becoming common place in primary load bearing members of structuresandmachinesasahighperformancematerial. Comparedtometallicmaterials, laminated fiber-reinforced materials can provide not only the primary advantage of high strength to weight ratio, but also offer extra benefits of low coefficient of thermal expansion, good resistance to corrosion, low maintenance cost, and lowpollution.

II. LITERATURE SURVEY

"Effect of Various Fillers on Mechanical Properties of Glass Fiber Reinforced Polymer Composites", Prasad Galande& S. E. Zarekar, 2016,

Filler materials are the inert materials which are used in glass fiber reinforced polymer (GFRP) composites for modifying the chemical and physical properties of the matrix polymers to reduce material costs, to improve process ability, to improve product performance or to simply act as extenders or matrix diluents. Some of the commonly used fillers are carbon black, calcium carbonate, clay, alumina tri-hydrate, magnesium hydroxide, bone powder, coconut powder, hematite powder, TiO, SiO ZnS, graphite, etc.

"Mechanical Properties Evaluation of the Carbon Fibre Reinforced Aluminium Sandwich Composites", Uthirapathy Tamilarasan. LoganathanKar unamoorthy. Kayaroganam Palanikumar 2015

Sandwich laminates play an important role in industries and they are used in varieties of engineering applications. In the present investigation, carbon fiber reinforced aluminium sandwich laminates are fabricated and their properties such as tensile, flexural and impact are studied for their use in structural applications. All the tests are carried out as per ASTM standard Scanning Electron Microscope (SEM) analysis is carried out to investigate the structure of the sandwich laminates. The microstructures clearly indicate the fractured surface. The tested specimen clearly indicates the fracture surface of the sandwich composites.

"Mechanical Properties Of Carbon/Glass Fiber Reinforced Epoxy Hybrid Polymer Composites", TD Jagannatha and G Harish, 2015.

Hybrid composite materials are the great potential for engineering material in many applications Hybrid polymer composite material offers the designer to obtain the required properties in a controlled considerable extent by the choice of fibers and matrix. The properties are tailored in the material by selecting different kinds of fiber incorporated in the same resin matrix. In the present investigation, the mechanical properties of carbon and glass fibers reinforced epoxy hybrid composite were studied. The vacuum bagging technique was adopted for the fabrication of hybrid composite materials.

"Mechanical Characteristics of Aluminium Powder Filled Glass Epoxy Composites", Pujan Sarkar, Nipu Modak, PrasantaSahoo, 2017

Mechanical characteristics of glass epoxy and aluminium powder filled glass epoxy composites are experimentally investigated using INSTRON 8801 testing device as per ASTM standards. With a fixed wt% of fiber reinforcement, glass epoxy and 5-15 wt% aluminium powder filled glass epoxy composites are fabricated in conventional hand lay-up technique followed by light compression moulding process. Experimental results show that aluminium powder as a filler material influences the mechanical properties. Density and void fraction in composites increase whereas steady decrease of tensile strength is recorded with aluminium powder addition Micro hardness, flexural strength, inter laminar shear strength (ILSS) of 5 and 10 wt% aluminium content composites are improved compared to unfilled glass epoxy composite and with further addition aluminum up to 15 wt% decreasing trends are observed. Glass epoxy with 5 wt% aluminium concentration shows the highest improvement. Tensile modulus for aluminium addition of 5 wt% wridecreases whereas 10 wt% aluminium filled composite shows improvement in tensile modulus. These are explained on the basis of material properties, void fractions and bonding strength among the constituents.

Compared to a fixed binary options computer, SC offers many advantages, including hardware cuts and error-tolerant computers. Because of these advantages, SC has been considered as an appropriate alternative

to binary computing in different applications such as Image Processing, Neural Network, Digital Filter, and Low- Density Parity-Check Decoding (LDPD).

III. CONCEPT OF COMPOSITE MATERIAL

3.1COMPOSITE MATERIAL

A composite material is a combination of two materials with different physical and chemical properties. When they are combined they create a material which is specialised to do a certain job, for instance to become stronger, lighter or resistant to electricity. composite material (also called a composition material) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.

Basically, composites can be categorized into three groups on the basis of matrix material. They are Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC), Polymer Matrix Composites (PMC).

3.2.TYPE OF COMPOSITE MATERIAL

Basically composites can be categorized in to three

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groups on the basis of matrix material

3.2.1 Metal Matrix Composites:

A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal necessarily, the other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. An MMC is complementary to a cermet.

3.2.2 Ceramic Matrix Composites

Ceramic matrix composites (CMCs) are a subgroup of composite materials and a subgroup of ceramics. They consist of ceramic fibers embedded in a ceramic matrix. The fibers and the matrix both can consist of any ceramic material, whereby carbon and carbon fibers can also be regarded as a ceramic material.Ceramic matrix composites (CMCs) are widely used in aerospace sector (gas turbines, structural re-entry thermal protection) and energy sector (heat exchangers,fusion reactor walls). These applications require a joint either permanent or temporary between CMC components with surrounding materials.

3.2.3 Polymer Matrix Composites

A polymer matrix composite (PMC) is a composite material composed of a variety of short or continuous fibers bound together by an organic polymer matrix. PMCs are designed to transfer loads between fibers of a matrix. Some of the advantages with PMCs include their lightweight, high stiffness and their high strength along the direction of their reinforcements. Other advantages are good abrasion resistance and good corrosion resistance.Fiber-reinforced polymer matrix composites are used as materials of construction in structures, such as offshore oil platforms and components on such platforms, used for oil and gas exploration and production.

3.3.CLASSIFICATION OF POLYMER COMPOSITES

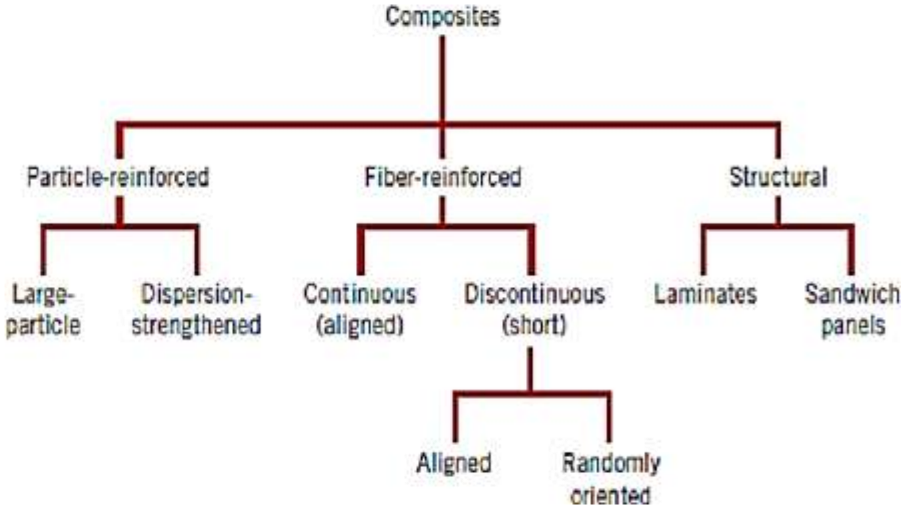

Fig.1.Classification of Polymer composites

3.3.1 Fibre Reinforced Polymer:

Fibre-reinforced polymer (FRP), also Fibre-reinforced plastic, is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, or aramid, although other fibres such as paper or wood or asbestos have been sometimes used. The polymer is usually an epoxy, vinylester or polyester thermosetting plastic, and phenol formaldehyde resins are still in use. FRPs are commonly used in the aerospace, automotive, marine, and construction industries. Most commonly used agents include asbestos, carbon/graphite fibers, beryllium, beryllium carbide, beryllium oxide, molybdenum, aluminum oxide, glass fibers, polyamide, natural fibers etc. Similarly common matrix materials include epoxy, phenolic resin, polyester, polyurethane, vinyl ester etc. Among these materials, resin and polyester are most widely used. Epoxy, which has higher adhesion and less shrinkage than polyesters, comes in second for its high cost.

3.3.2 Particle Reinforced Polymer:

Fiber and particle reinforced composite materials are finding increased applications in various areas of technology due to their mechanical and physical properties and good performance. Composite materials have been widely used in a variety of structures such as aircraft, robots, tennis

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rackets, bicycles, manufacturing machinery, etc. In fiber and particle reinforced composite materials, fibers/particles act as a load carrying medium and the matrix acts as a load transporting medium. The two or more phases are utilized to take advantage of the best properties of each, and minimize their weaknesses. Composite components are fabricated by various processes such as filament winding, hand lay-up, stir processing, etc. After fabrication, they may require machining to facilitate dimensional control for easy assembly and for functional aspects.

3.3.3 Structural Polymer Composite:

Structural polymer composite materials (PCMs) are used in various industries: aircraft, rocket, shipbuilding, automotive and electrical industry, construction, sports industry, chemical and special engineering, medicine, etc. This is due to a wide range of physicomechanical and operational properties of materials based on PCMs. For example, such materials combine low density, high modulus of elasticity and strength, durability, and other properties.Functional PCMs, as a rule, are understood as PCMs with special properties that are determined exclusively by their application areas. Moreover, such materials include both classical PCMs with macro- and microfillers and nanomodified (NM) PCMs (NM PCMs). In particular, the following materials belong to functional PCMs: thermal insulation, including foam and cellular, electrical insulation; corrosion resistant; conductive; arc resistant; friction; antifriction; hydrophobic; fire resistant; crack resistant; armoured, etc.At the same time, additional requirements are being made for aircraft industry and rocket production for such materials. In particular, this imparts structural properties such functional properties as electrical conductivity in the longitudinal and transverse directions.

IV. MANUFACTURING OF COMPOSITE MATERIALS

4.1 MATERIALS

4.1.1 Matrix material:

Epoxy LY 556 resin , chemically belonging to the “epoxide” family is used as the matrix material. Its common name is Bisphenol-A-Digilycidyl- Ether. The low temperature curing epoxy resin (Araldite LY 556) and the corresponding hardner (HY 951) are mixed in a ratio of 10:1 by weight as recommended.

Fig.2.Araldite

Fig.3.epoxy Resin

4.1.2 Reinforcement Material:

Glassfiber is used as the reinforcement material. The glass fiber is supplied by chemical companies.


Fig.4.Glassfiber

4.1.3 Filler material(Aluminium Powder):

It is a silvery white metal .Aluminum is remarkable for the metals low density and for its ability to resist corrosion. Its thermal conductivity and density values are 250 w/m.k and 2.7 g/cc. Structural components made from aluminium and

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its alloys are vital to the aerospace industry and very important in other areas of transportation and building. Its reactive nature makes it useful as a catalyst or addictive in chemical mixtures, including ammonium nitrate explosives, to enhance blast power.

Fig.5.Aluminium Powder

V. METHODES

The composites are generally manufactured using the hand lay-up technique. The other composite manufacturing techniques are vacuum bagging, compression molding. Filament winding & pultrusion. In this project we use the hand lay-up process for the fabrication of the composite material.

5.1 HAND LAY-UP PROCESS

Hand lay-up technique is the oldest method of composite manufacturing. The samples are prepared by respecting some steps. First of all, the mold surface is treated by release anti applied at the top and bottom of the mold plate to get a smooth surface of the product. The layers of woven reinforcement are cut to required shapes and placed on the surface of the mold. Thus, as previously mentioned, the mixed with other ingredients and infused onto the surface of reinforcement already positioned in the mold using a help brush to uniformly spread it. And then the other mats are placed on the preceding polymer layer and pressured using a roller to remove any trapped air bubbles and the excess of polymer as well. The mold is then closed and pressure is released to obtain a single mat. After curing at room temperature, the mold is opened and the composite is removed from the mold surface the schematic of hand lay-up is shown in Fig.

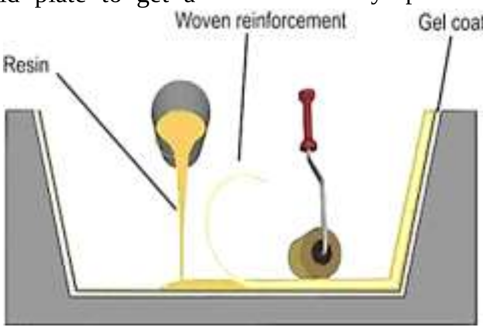

Fig.6.Hand Lay-Up Process

Hand Lay-up process was the method employed for the hybrid composite formation. It is the simplest method for the preparation of composites. The infrastructural requirement is also minimal for this method. The processing steps are quite simple and are follows.

- Initially, put thin plastic sheets as the base to get good surface finish of the product.
- Reinforcement in the woven mats or chopped strand mats form are cut as per the required size of 20 x 20 mm.
- Prepare the matrix by mixing resin and hardener in a proper ratio and spread it over plastic sheets provided as base by means of a brush.
- Now place the reinforcement above resin applied at the plastic sheet. The resin should spread properly bymeans of rollers to get a good base and also excess resin can be removed by the usage of rollers.
- Apply resin over the base layer and place layers in alternate order by placing resin in between them and roll it effectively.
- The top portion of the stacked composite is covered by means of a plastic sheet and finish it using rollers.

- The prepared specimen is kept at room temperature and proper loading is provided for one day.
- After a day, the loads are removed and the developed composite part is taken out.
- The curing time mainly depends upon the type of polymer used for composite formation.
- The prepared stacked composite specimen is cut into ASTM standard specimens by means of a cutter.

VI. COMPOSITE FABRICATION

The low temperature curing epoxy resin (LY 556) and corresponding hardener (HY 951) are mixed in a ratio of 10:1 by weight as recommended. aluminium powder with average size 100-200 µm are reinforced in epoxy resin to prepare the composites . The dough is then slowly decanted into glass tubes, coated beforehand with wax and uniform thin film of silicon –releasing agent. the composites are cast by conventional hand-Lay- up process in glass tube so as to get cylindrical specimen. (dia 9 mm, length 120mm).composites of four different compositions (with 0.2% of al) are made. The castings are left to cure at room temperature for about 24 hours for solidification. For easy removal of the specimen Mylar sheets are used. Specimens of suitable dimension are cut using a laser cutter for further physical characterization.

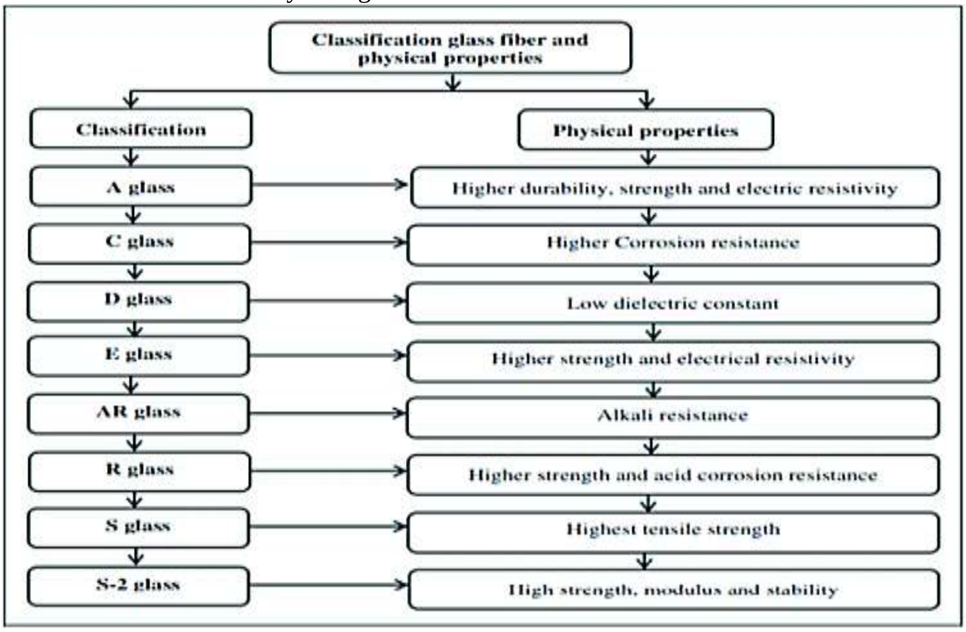

Fig.7.Physica Property of Various Classes of Gl;ass Fiber

Table.1. Comparison of New composite with conventional materials

Properties	**Conventional**	**New composite**
Poisson's ration	0.3	0.35 – 0.4
Weight	More	Less
Electrical Resistance	Decrease	Increase
Thermal conductivity	Increase	Decrease
Yield Point	78 X 103 MPa	90 X 103 MPa
Breaking Point	81 X 103 MPa	94 X 103 MPa
Tensile Strength	1.8 X 103 MPa	2.1 X 103 MPa
Impact Load - Izode	132 J	152 J
Impact Load Charpy	235 J	282 J
% of elongation	3.5 %	4.2 %
Brinell Hardness No:	298	386

VII. EXPERIMENTAL TESTS

7.1 TENSILE TESTING

Tensile Testing is a form of tension testing and is a destructive engineering and materials science test whereby controlled tension is applied to a sample until it fully fails. This is one of the most common mechanical testing techniques. Tensile testing utilizes the classical coupon test

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geometry as shown below and consists of two regions: a central region called the gauge length, within which failure is expected to occur, and the two end regions which are clamped into a grip mechanism connected to a test machine. These ends are usually tabbed with aluminum, to protect the specimen from being crushed by the grips. This test specimen can be used for longitudinal, transverse, cross-ply & angle-ply testing. It is good idea to polish the specimen sides to remove surface flaws, especially for transverse tests. The specimen geometry is based on the ASTM standard 3039. The composite is cut into the desired geometry after manufacturing. Two specimens are required for the tensile testing, one with 0.2% Al & the other specimen without Aluminum.

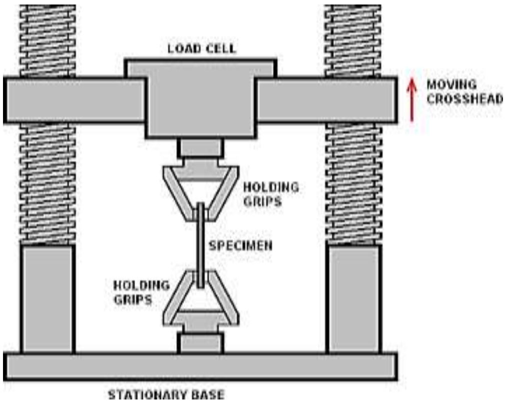

Fig.8.Tensile Test

7.2 INTERLAMINAR FRACTURE TOUGHNESS TESTING

interlaminar fracture toughness measures the critical value of delamination growth as a result of an opening load. It is used to establish the design allowables used in damage analyses of composite structures.

7.3 IZODE TEST

Note the reading .A test specimen having a V-shaped notch is fixed vertically, and the specimen is broken by striking it from the same side as that of the notch by the use of the hammer. The fracture energy is determined from the swing-up angle of the hammer and its swing-down angle. The Izod impact value (J/m, kJ/m2) is calculated by dividing the fracture energy by the width of the specimen.

IZODE = 152J

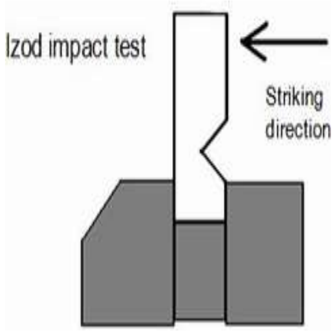

Fig.9.Izode Test

7.4 CHARPY IMPACT TEST

A test specimen having a V-shaped notch is placed on the holder in such position that the notched section is in the center of the holder, and the specimen is broken by striking the back of the notched section with the hammer. The fracture energy is determined from the swing-up angle of the hammer and its swing-down angle. The Charpy impact value (kJ/m2) is calculated by dividing the fracture energy by the cross-section area of the specimen.

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CHARPY = 282 J

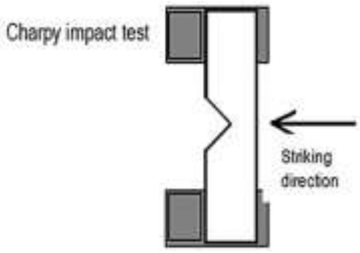

Fig.10.Charpy Impact Test

7.5 BRINELL HARDNESS TEST

Brinell hardness testing is typically used in testing aluminum and copper alloys (at lower forces) and steels and cast irons at the higher force ranges. As the Brinell test uses relatively high loads, and therefore relatively large indent, it is frequently used to determine the hardness in circumstances where the overall material properties are being ascertained and local variations in hardness or surface conditions make other methods un- suitable, such as forgings or castings of large parts. Highly hardened steel or other materials are usually not tested by the Brinell method. As such, Brinell hardness testing machines.

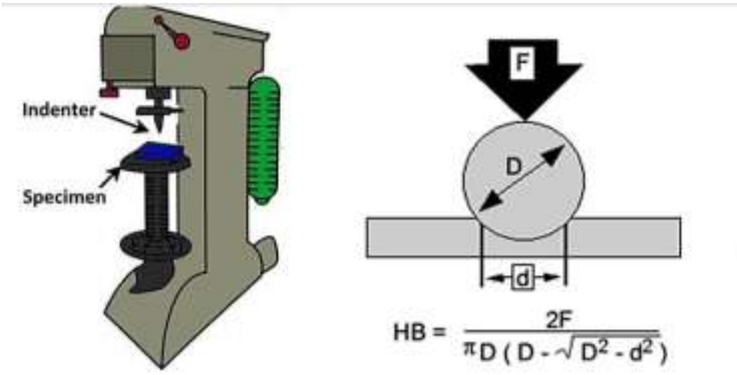

Fig.11.Brinell Hardness Test

P = 3000 Kg
D = 10 mm
d 1 =d 2 = 3.1 mm
B.H.N = 386

Test Methode Illustration;
D = Ball diameter
d 1 = d 2 = Impression diameter
F = Load
H.B = Brinell Result

7.6 UTM (Universal Testing Machine)

- Make Specimen 10 X 3 mm.
- Mark the gauge length of specimen.
- Fix the specimen on UTM
- Open the left valve gradually.
- Note the Yield Point from dial gauge.
- Open the valve slightly and break the specimen and note the reading.

Gauge Length = 5.65 X √A0 = 30.94 mm
Percentage of elongation. = 4.2 %
Yield Point= 90 X 103 MPa
Breaking Point = 94 X 103 MPa
Tensile Strength = 2.1 X 103 MPa

Fig.12.Universal Testing Machine

VIII. PROJECT WORK

Clutch is a mechanism which enables the rotary motion of one shaft to be transmitted, when desired, to a second shaft the axis of which is coincident with that of the first.

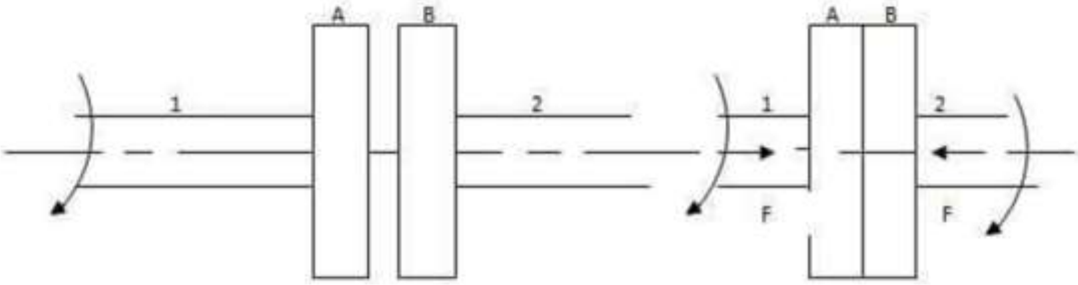

Fig.13.Principle of Friction Clutch

Let W=Axial load applied μ =Coefficient of friction T=Torque transmitted
R= effective mean radius of friction surface. The expressions for the same for different types of clutches have been derived at appropriate places in this chapter.

Then $T = \mu WR$
Thus, we see that the torque transmitted by a friction clutch depends upon three factors ie., μ, W and R. This means that increasing any or all of the above factors would increase the amount of torque which a clutch can transmit. However, there are upper limits in each of these cases.

IX. COST ESTIMATION

METERIALS	**COST**
Fiber glass	1000
Epoxy	300
Hardner	200
Aluminium powder	800
Materials for work	1300
Fabrication	400
Travelling charge	500
Total	**4000**

X. RESULT & DISCUSSION

- FromtheTensileloadtestresults,itwasfoundthat maximum peak load was obtained for glass fibre composite.
- UTM was also found maximum for glass fibre composite compared toasbestos.
- Yield load was higher for glass fibre alone composite, but glass fibre with aluminium almost came close to thatvalue.
- Strain was found higher for glass fibrecomposite.

XI. CONCLUSION

ThisexperimentalinvestigationonAluminiumfilled epoxy composites have led to the following specific conclusions. Successful design of epoxy based composites filled with micro-sized Al by hand-lay-up technique is possible. Determined the making and testing of fiber glass composite with aluminium powder. Fiber glass composite with Aluminium powder like sandwich composites which has less weight and good strength. These new class of Al filledepoxycompositescanbeusedforapplicationssuchas electronic packages, encapsulations, die (chip) attach, thermal grease, thermal interface material and electrical cable insulation. New created Clutch liner with epoxy compositematerialiscomparedwithasbestos,astheresult Mechanical Properties and Thermal Properties are better than conventionally usedmaterial.

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