INVESTIGATION OF MECHANICAL PROPERTIES OF ALUMINIUM ALLOY REINFORCED WITH SiC AND BAGASSE ASH

A Project report submitted in partial fulfilment of the requirements for the award of the

Degree of

BACHELOR OF TECHNOLOGY
IN

MECHANICAL ENGINEERING

Submitted by

V.LOHIT	**315126520225**
V.ADARSH	**315126520228**
T.V.S.K.MANOJ	**315126520219**
T.RAMARAJU	**315126520218**
SK.ANWAR ALI	**315126520276**

Under the esteemed guidance of

M.N.V.KRISHNAVENI, M.E., (PHD)

Assistant Professor

Department of Mechanical Engineering

PRAGNANAM BRAHMA

ANITS

DEPARTMENT OF MECHANICAL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES (A)

(Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC with 'A' Grade)

Sangivalasa, Visakhapatnam-531162

2018-19

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY OF SCIENCES

(Affiliated to Andhra University)

AUTONOMOUS

Sangivalasa, Bheemunipatnam (Mandal), Visakhapatnam (District)

PRAGNANAM BRAHMA

ANITS

CERTIFICATE

This is to certify that the Project Report entitled "**Investigation of mechanical properties of Aluminium alloy reinforced with SiC and Baggase ash**" has been carried out by V.Lohit (315126520225), V.Adarsh (315126520228), T.V.S.K.Manoj (315126520219), T.Ramaraj (315126520218), Sk. Anwar Ali (315126520276) under the guidance of M.N.V.Krishnaveni, in the partial fulfilment of requirements of Degree of Bachelor of Technology in Mechanical engineering, Andhra Pradesh, Visakhapatnam.

APPROVED BY

18.4.19

(Prof. B. Naga Raju)
Head of Mechanical Department
Dept. of Mechanical Engineering
ANITS, Sangivalasa
Visakhapatnam.

PROFESSOR & HEAD
Department of Mechanical Engineering
ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
Sangivalasa-531 162 VISAKHAPATNAM Dist. A.P.

PROJECT GUIDE

M.N.V.K.Veni

(M.N.V.Krishnaveni)
Assistant Professor
Dept. of Mechanical Engineering
ANITS, Sangivalasa
Visakhapatnam.

THIS PROJECT IS APPROVED BY THE BOARD OF EXAMINERS

INTERNAL EXAMINER

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

The gratification that results in a successful completion of a task would be incomplete without mentioning the key individuals who made it possible, who not only encouraged and boosted our morale but also got us through the snags in our work. We take in a great pleasure presenting a project, which is a result of research and knowledge.

We are extremely thankful to our honourable principal **Prof.T. SUBRAHMANYAM** for giving us the opportunity to carry out the project.

We would like to take the privilege to thank the Head of Department **Dr. B. NAGARAJU**, for permitting us to utilize the resources and providing the lab facilities, we would also like to thank the staff members of our department and lab technicians who directly or indirectly helped us in successful completion of the project.

We feel exceptionally grateful to **M.N.V.KRISHNAVENI**, our project guide who shared her expertise and made us understand the profundity of the topic all the while piquing our interest to work day and night for the project.

Last but not the least, we like to convey our thanks to all who have contributed either directly or indirectly for the completion of our work.

V.LOHIT (315126520225)
V.ADARSH (315126520228)
T.V.S.K.MANOJ (311126520219)
T.RAMARAJU (315126520218)
SK.ANWAR ALI (315126520276)

ABSTRACT

The world market for metal matrix based composites (MMCs) consumed 5.9 million kilograms of produce in 2014. It is expected to increase to 10 million in 2020 for a compounded annual growth rate of 7%. Various MMCs are found in many applications such as aerospace, space, electrical and automotive industries due to their good physical, mechanical and corrosion properties. But MMCs suffer from insufficient process stability, reliability and in-adequate economic efficiency. To overcome these problems, the hybrid metal matrix composites (HMMCs) were developed. The reinforcement materials in Aluminum alloy improve the mechanical properties.

In this work, the mechanical behaviour of Aluminum Hybrid Metal Matrix Composites (HMMCs) has been investigated. Al7075 alloy was selected as matrix alloy and Silicon Carbide (SiC) and Bagasse Ash were used as reinforcements with varying percentage for fabrication of HMMCs by liquid metallurgical technique (Stir Casting Technique). The mechanical properties such as yield strength, ultimate tensile strength, Brinell hardness and Impact strength were conducted for HMMCs specimen as per ASTM standard.

It was observed that the Tensile Strength and Compression Strength were the highest when 2%SiC and 0.5%BA were used as reinforcements. The hardness had no much significant change.

The results thus obtained are used for the analysis of vertical tail spar beam of an aircraft.

INDEX

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1COMPOSITE

A composite 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.

1.2 CHARACTERISTICS OF COMPOSITES

Composites are strongly heterogeneous materials. That is, the properties of a composite vary considerably from point to point in the material, depending on which material phase the point is located in.

The new materials may be preferred for many reasons common examples a include materials which are stronger, lighter, or less expensive when compared to traditional materials.

Composites are important materials which are now used widely, not only in the aerospace industry, but also in a large and increasing number of commercial mechanical engineering applications, such as internal combustion engines; machine components; thermal management and electronic packaging; automobile, train, and aircraft structures and mechanical components, such as brakes, drive shafts, flywheels, tanks, and pressure vessels; dimensionally stable components; process industries equipment requiring resistance to high-temperature corrosion, oxidation, and wear; offshore and onshore oil exploration and production; marine structures; sports and leisure equipment; ships and boats; and biomedical devices.

Composites are made up of individual materials referred to as constituent materials. There are two main categories of constituent materials: matrix (binder) and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and Physical properties to enhance the matrix properties.

1.3 REINFORCEMENT AND MATRIX

The roll of the reinforcement in a composite material is fundamentally increasing the mechanical properties of the neat resin system. All of the different fibers used in composites have different properties and so, Effect, the properties of the composite in different ways. For most of the application, the fibers need to be arranged into some form of sheet known as fabric, to make handling possible. Different ways for assembling fibers into sheets and the variety of fiber orientation's possible to achieve different characteristics.

Many materials when they are in fibrous form exhibit very good strength properties but to achieve the properties the fiber should be bonded by a suitable matrix. The matrix isolates the fibers from one another in order to prevent abrasion and formation of new surface flaws and acts as a bridge to hold the fibers in place. A good matrix should process ability to deform easily under applied load, transfer the load onto fibers and evenly distributive stress concentration.

1.4 CLASSIFICATION OF COMPOSITES

The two broad classes of composites are

- Particulate composites
- Fibrous composites

1.4.1 PARTICULATE COMPOSITES

As the name itself indicates, the reinforcement is of particle nature. It may be spherical, cubic, tetragonal, a platelet, or of other regular or irregular shape .In general particles are not very effective in improving fracture resistance but they enhance the stiffness of the composite to a limited extent. Particle fillers are widely used to improve performances at elevated temperatures reduce friction, increased wear and abrasion resistance, improve machinability, increase surface hardness and reduce shrinkage.

1.4.2 FIBROUS COMPOSITES

A fiber is characterized by its length being much greater compared to its cross-sectional dimensions. The dimensions of the reinforcement determine its capability of contributing properties to the composite. Fibers are very effective in improving the fracture resistance of the matrix since the reinforcement having a long dimensions discourages the growth of the incipient cracks normal to the reinforcement the might otherwise lead to failure. In the Case of polymeric material, orientation of the molecular structure is responsible for high strength and stiffness. Fibers , because of their small cross-sectional dimensions , are not directly usable in engineering applications .They are , therefore embedded in matrix materials to form fibrous composites .The matrix serves to bind the fibers together ,transfer loads o the fibers, and protect them against environmental attack and damage due to handling.

1.5 TYPES OF COMPOSITES

There are three main types of composite matrix materials:

Ceramic matrix - Ceramic matrix composites (CMCs) are a subgroup of composite materials. They consist of ceramic fibers embedded in a ceramic matrix, thus forming a ceramic fiber reinforced ceramic (CFRC) material. The matrix and fibers can consist of any ceramic material. CMC materials were designed to overcome the major disadvantages such as low fracture toughness, brittleness, and limited thermal shock resistance, faced by the traditional technical ceramics.

Polymer matrix - Polymer matrix composites (PMCs) can be divided into three sub-types, namely, thermoset, thermoplastic, and rubber. Polymer is a large molecule composed of repeating structural units connected by covalent chemical bonds. PMC's consist of a polymer matrix combined with a fibrous reinforcing dispersed phase. They are cheaper with easier fabrication methods. PMC's are less dense than metals or ceramics, can resist atmospheric and other forms of corrosion, and exhibit superior resistance to the abrasion.

Metal matrix - Metal matrix composites (MMCs) are composite materials that contain at least two constituent parts – a metal and another material or a different metal. The metal matrix is reinforced with the other material to improve strength and wear. Where three or more constituent parts are present, it is called a hybrid composite. In structural applications, the matrix is usually composed of a lighter metal such as magnesium, titanium, or aluminium. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common. Typical MMC's manufacturing is basically divided into three types: solid, liquid, and vapour. Continuous carbon, silicon carbide, or ceramic fibers are some of the materials that can be embedded in a metallic matrix material. MMCs are fire resistant, operate in a wide range of temperatures, do not absorb moisture, and possess better electrical and thermal conductivity. They have also found applications to be resistant to radiation damage, and to not suffer from out gassing. Most metals and alloys make good matrices for composite applications

1.6 METALLIC MATRIX COMPOSITES (MMCs)

The MMCs when reinforced with ceramic particles are very promising materials for structural applications due to excellent combination of properties. MMCs combine the properties of the metallic alloys (ductility and toughness) and the ceramic reinforcements (high strength and high modulus) leading to a superior profile of characteristics. The aluminium matrix composites (AMCs) represent a class of MMCs possessing properties like low density, high stiffness and strength, superior wear resistance, controlled coefficient of thermal expansion, higher fatigue resistance and better stability at elevated temperature. Due to this, these composites are used for the design of a wide range of components for advanced applications. It has been found that the use of AMCs in engine applications can reduce the overall weight, fuel consumption and pollution in the automobile sand aircrafts. AMCs reinforced with either silicon carbide (3.18 g/cm3) or alumina (3.9 g/cm3) particles are attractive materials for such applications. These reinforcements are denser than those of aluminium alloys (2.7 g/cm3) and increases the weight of the composites depending on the reinforcement's contents. Moreover, the addition of ceramic particles to the Al-alloy increases the hardness of composite and makes machining of developed composite more difficult .Such problems can be solved by the use of multiple reinforcements in the aluminium alloy. The ceramic reinforcements possess superior strength than any other type of reinforcement and because of the fact, these are used as a primary reinforcement primary reinforcement for development of hybrid composites. How-ever, the secondary reinforcements reduces the cost as these are readily available and weight as they have lower density of the hybrid composites. Moreover, the use of stir casting technique for fabrication of AMCs reduces the cost the composites, as it is economical, simple to perform and highly productive method use of stir casting technique for fabrication of AMCs reduces the cost of the composites, as it is economical, simple to perform and highly productive method used in industries.

Recent research investigations have revealed that agro/industrial waste materials such as fly ash, graphite, rice husk ash, etc., can be successfully used as a complementary reinforcement in AMCs.

1.7 COMPOSITES MANUFACTURING METHODS

There are various methods to manufacture composites. They are

1. Solid state methods
    - Powder Metallurgy
    - Foil Diffusion
2. Liquid state methods
    - Electro Plating and Electro Forming
    - Stir Casting
    - Pressure Infiltration
    - Squeeze Casting
    - Spray Deposition
    - Reactive Processing
3. Physical Vapors Deposition
4. In-situ Fabrication Technique

1.7.1 SOLID STATE METHODS

1.7.1.1 POWDER METALLURGY

Powder metallurgy (PM) is a metal working process for forming precision metal components from metal powders. The metal powder is first pressed into product shape at room temperature. This is followed by heating that causes the powder to fuse together without melting.

In the PM process the following three steps are followed in sequence: mixing, compacting, and sintering.

Mixing: A homogeneous mixture of elemental powders or alloy powders is prepared. Depending upon the need, powders of other alloy or lubricants may be added.

Compacting: A controlled amount of the mixed powder is introduced into a precision die and then it is pressed or compacted at pressure in the range 100 MPA to 1000 MPA. The Compacting pressure required depends on the characteristics and shape of the particles, the method of mixing and the lubricant used. This is generally done at room temperature. The model is generally called "green compact".

Sintering: During this step, the green compact is heated in a protective atmosphere furnace to a suitable temperature, which is below the melting point of the metal. Typical sintering atmosphere are endothermic gas, dissociated ammonia, hydrogen, and nitrogen. Sintering temperature varies from metal to metal.

Sometimes additional operations are carried out on sintered PM parts in order to further improve their properties or to impart special characteristics.

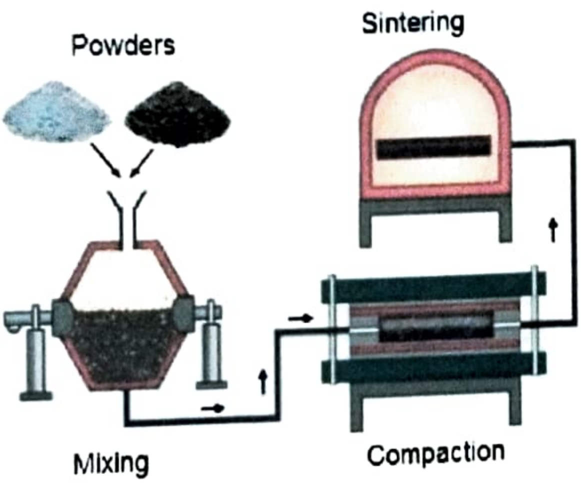


Fig 1.1 POWDER METTALURGY

1.7.1.2 FOIL DIFFUSION BONDING

Layers of metal foil are sandwiched with long fibers, and then pressed through to form matrix. This method is normally used to manufacture fiber reinforced MMC with sheets or foils of matrix material. Here primarily the metal or metal alloys in the form of sheets and the reinforcement material in the form of fiber are chemically surface treated for the effectiveness of inter diffusion. These fibers are placed on the metal foil in pre –determined orientation and bonding takes place by press forming directly. However sometimes the fibers are coated by plasma spraying or ion plating for enhancing the bonding strength before diffusion bonding ,the solid line show this. After bonding, secondary machining work is carried out. The applied pressure and temperature as well as their durations for diffusion bonding to develop, vary with the composite systems. However, this is the most expensive method of fabricating MMC materials.

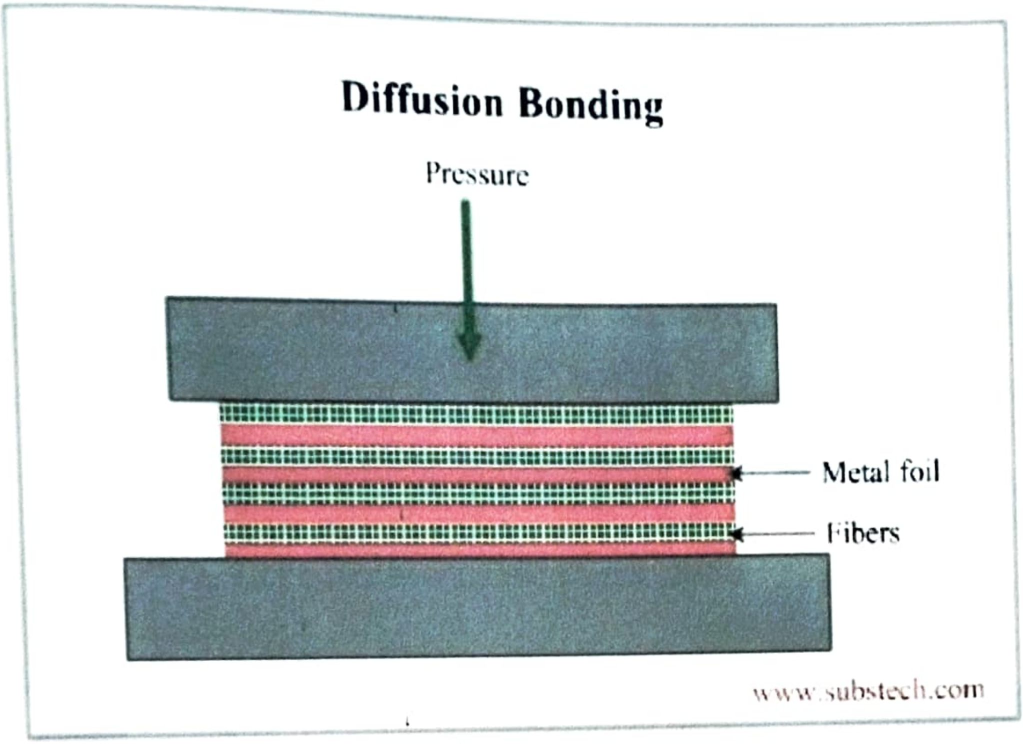


Fig 1.2 DIFFUSION BONDING

1.7.2 LIQUID STATE METHODS:

1.7.2.1 ELECTRO PLATING AND ELECTRO FORMING:

Electroplating is a process that uses electric current to reduce dissolved metal so that they form a thin coherent metal coating on an electrode. The term is also used for electrical oxidation of anions on to a solid substrate. Electroplating is primarily used to change the surface properties of an object (such as abrasion and wear resistance, corrosion protection, lubricity, aesthetic qualities), but may also be used to build up thickness on undersized parts or to form objects by electroforming. The process used in electroplating is called electro deposition. It is analogous to a concentration cell acting in reverse. The part to be plated is the cathode of the circuit. In one technique, the anode is made of the metal to be plated on the part. Both components are immersed in a solution called an electrolyte containing one or more dissolved metal salts as well as other ions that permit the flow of electricity. A power supply supplies a direct current to the anode, oxidizing the metal atoms that it comprises and allowing them to dissolve in the solution. At the cathode, the dissolved metal ions in the electrolyte solution are reduced at the interface between the solution and the cathode, such that they "plate out" onto the cathode. The rate at which the anode is dissolved is equal to the rate at which the cathode is plated, vis-à-vis the current through the circuit. In this manner, the ions in the electrolyte bath are continuously replenished by the anode.

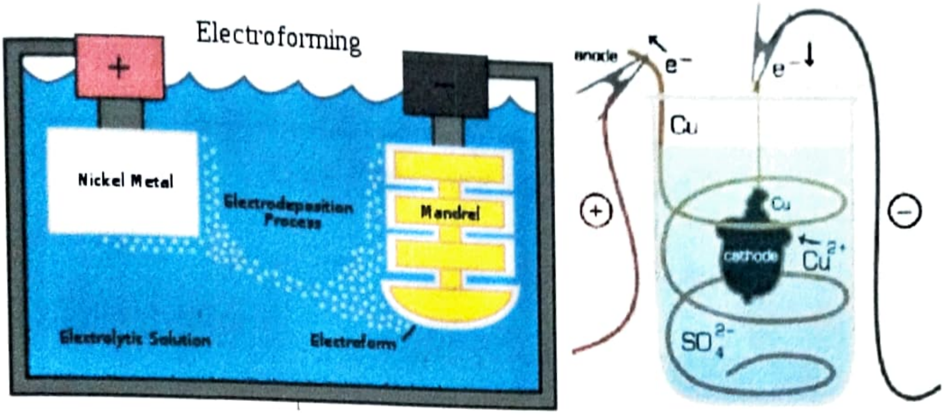


Fig 1.3 Electro forming and Electro plating

1.7.2.2 STIR CASTING:

Stir casting techniques are currently the simplest and most commercial method of production of MMCs. This approach involves mechanical mixing of the reinforcement particles into a molten metal bath and transferred the mixture directly to a shape mould prior to complex solidification. In the process, the crucial thing is to create good wetting between the particulate reinforcement and the molten metal. This process has major advantage that the production costs of MMCs are very low.

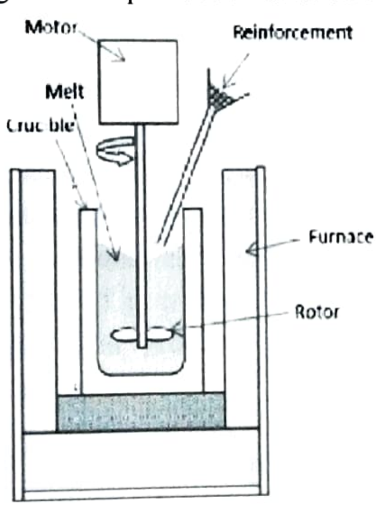


Fig 1.4 STIR CASTING

1.7.2.3 PRESSURE INFILTRATION:

Molten metal is infiltrated into the reinforcement through use a kind of pressure such as gas pressure. This process can also be called fiber – tow infiltration. Fiber tows can be infiltrated by passing through a bath of molten metal. Usually the fibers must be coated in line to promote wetting. Once the infiltrated wires produced, they must be assembled into to perform and gives a secondary consolidation process to produce a component. Secondary consolidation is accomplished through diffusion bonding or hot moulding in the two phase liquid and solid region. This method is desirable in producing relatively small size composite specimens having unidirectional properties.

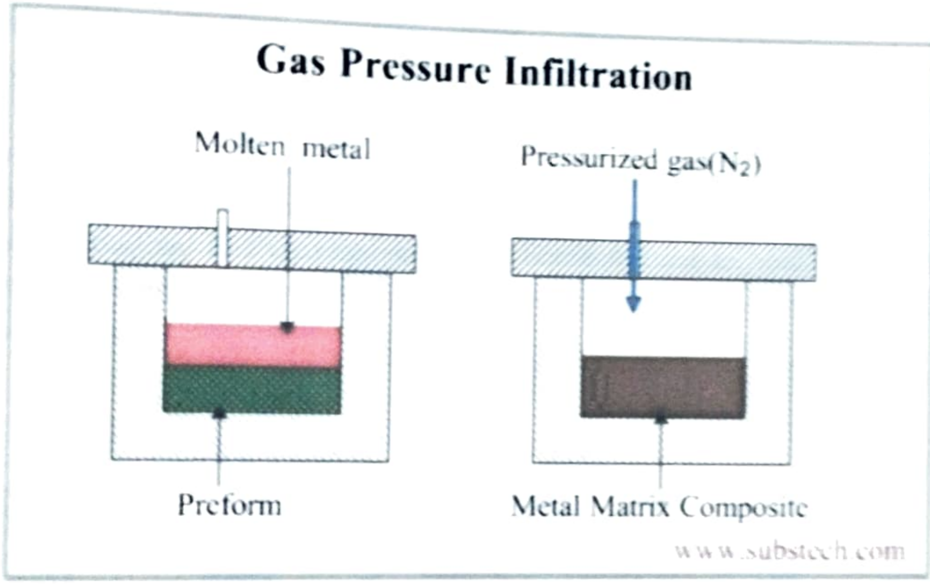


Fig 1.5 PRESSURE INFILTRATION

1.7.2.4 SQUEEZE CASTING:

Squeeze casting is a combination of casting and forging process can result in the Highest mechanical properties attainable in a cast product. The development of squeeze casting process, can usher in tremendous possibility for manufacturing of components of Aluminium alloys, which are not properly commercialized as yet. It can also be effective in import substitution of critical components. The process starts when the molten metal is poured into the bottom half of a preheated die. As soon as the metal starts solidifying, The Upper half of the die closes and starts applying pressure during the solidification process. The extent of pressure applied is significantly less than that in forging.

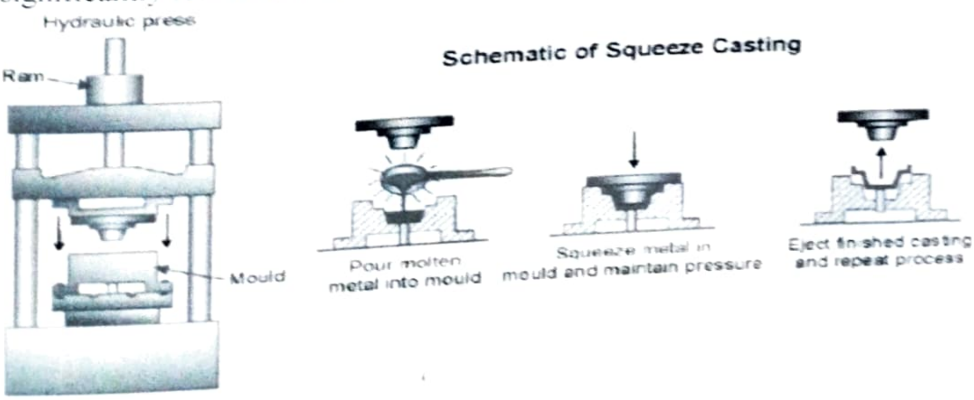


Fig 1.6 SQUEEZE CASTING

1.7.2.5 SPRAY DEPOSITION

Spray forming, also known as spray casting, spray deposition and in-situ compaction is a method of casting near net shape metal components with homogeneous microstructures via the deposition of semi-solid sprayed droplets onto a shaped substrate. In spray forming an alloy is melted, normally in an induction furnace, then the molten metal is slowly poured through a conical tundish into a small-bore ceramic nozzle. The molten metal exits the furnace as a thin freefalling stream and is broken up into droplets by an annular array of gas jets, and these droplets then proceed downwards, accelerated by the gas jets to impact onto a substrate. The process is arranged such that the droplets strike the substrate whilst in the semi-solid condition, this provides sufficient liquid fraction to 'stick' the solid fraction together. Deposition continues, gradually building up a spray formed billet of metal on the substrate.

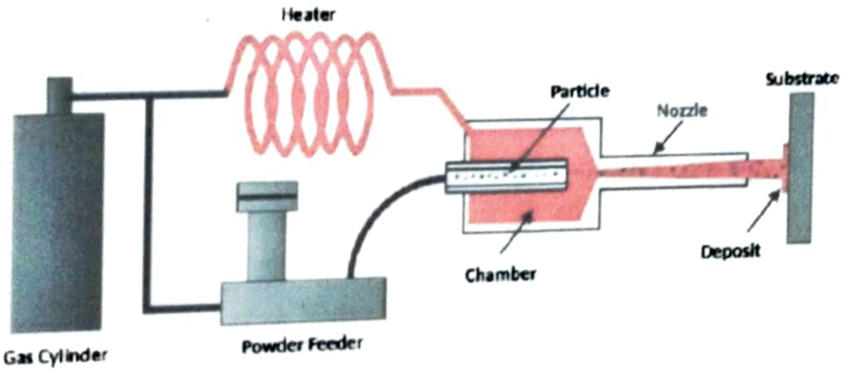


Fig 1.7 SPRAY DEPOSITION

1.7.3 PHYSICAL VAPOUR DEPOSITION:

Physical vapour deposition (PVD) describes a variety of vacuum deposition methods which can be used to produce thin films and coatings. PVD is characterized by a process in which the material goes from a condensed phase to a vapour phase and then back to a thin film Condensed phase. The most common PVD processes are sputtering and evaporation. PVD is used in the manufacture of items which require thin films for mechanical, optical, chemical or electronic functions. The source material is unavoidably also deposited on most other surfaces interior to the vacuum chamber, including the fixturing used to hold the parts.

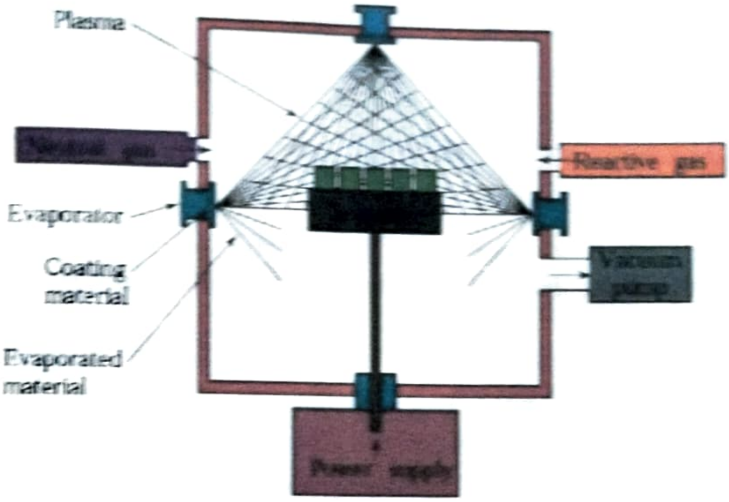


Fig 1.8 PHYSICAL VAPOUR DEPOSITION

1.7.4 IN-SITU FABRICATION TECHNIQUE:

In situ fabrication of Metal Matrix Composite is a process, in which dispersed phase formed in the matrix as result of precipitation from the melt during its cooling and solidification. Controlled unidirectional solidification of a eutectic alloy can result in a two phase microstructure with one of the phases, present in lamellar or fiber form, distributed in the matrix.

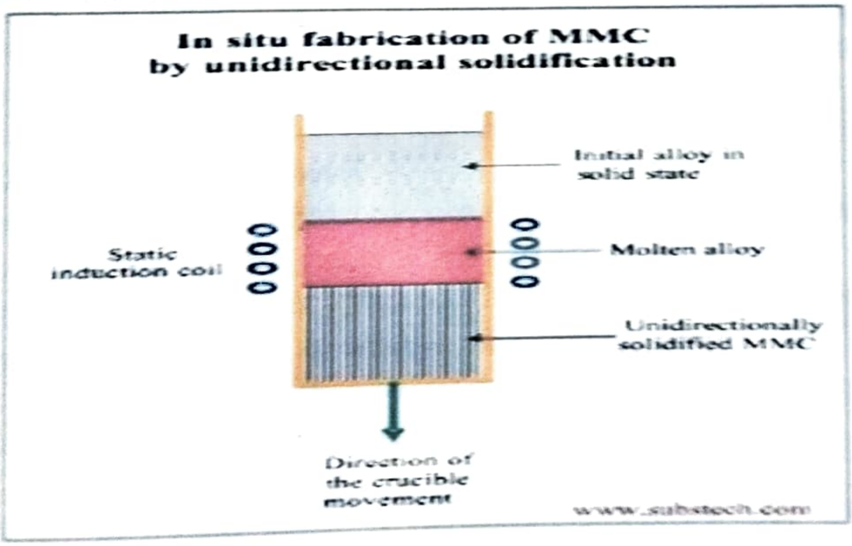


Fig 1.9 IN SITU FABRICATION

CHAPTER 2

LITERATURE REVIEW

B.Ravi, " Fabrication and Mechanical Properties of Al7075-SiC-TiC Hybrid Metal Matrix Composites"(International Journal of Engineering Science Invention).

From this literature B.Ravi concluded that from the liquid metallurgy techniques the hardness of cast Al7075- 5%TiC+5%SiC is increased by 39 % when compared with AL7075 base alloy. The ultimate tensile strength of as-cast Al7075 base alloy, Al7075- 5%TiC+5%SiC MMCs was 129 and 155 MPa respectively. This shows an improvement of 32% when compared with as-cast Al7075 base alloy. The yield strength of as-cast Al7075 base alloy, Al7075-5%TiC+5%SiC MMHCs were 104 and 116 MPa respectively this shows an improvement of 10.5% when compared with base alloy. From the investigation it was concluded that, composites containing 5wt% Titanium carbide and 5wt% Silicon Carbide reinforcements exhibited superior mechanical properties.

Necat Altınko¨k "Investigation of mechanical and machinability properties of Al2O3/Sic reinforced Al-based composite fabricated by stir cast technique".

In this study, tensile strength, hardness, and wear characteristics of A332 reinforced with 10 wt% of Al2O3/Sic was examined and effect of Al2O3/SiCp size on machinability has been evaluated.

From his study Necat Altinko concluded that with the increase in particle size, tensile strength, hardness and density of A332-Al2O3/Sic MMC material increased; but wear resistance decreased. Machinability of MMC is very different from traditional materials because of abrasive reinforcement element. This is due to abrasive element causes more wear on cutting tools. Flank wear of cutting tool are also increased with decrease in particle size.

Jaswinder Singh, Amit Chauhan, "Fabrication characteristics and tensile strength of novel Al2024/Sic/red mud composites processed via stir casting route".

It has been noted that density and porosity of the composites are reduced with the increase in the red mud content. The tensile strength of the hybrid composites is increased with the increase in red mud content (5%–20%) and the ageing time (0–24 h). As far as the tensile strength of the composites is concerned, the red mud content has been found to exhibit maximum influence followed by the ageing time. It has been noticed that the level of error for investigating the tensile strength of the composites remains within the acceptable limits (about 1.262%). The ANOVA analysis indicates that the contributions of red mud content and ageing time are 42.58% and 24.70%, respectively. The red mud particle size does not exhibit significant contribution as far as the UTS of hybrid composites is concerned. The morphological analysis of the fractured surfaces indicates that the failure of the hybrid composites takes place due to the combination of brittle and ductile mechanisms.

Overall, the addition of red mud reinforcement reduces the brittleness of the Al/Sic/red mud composites while improving the strength level. Further, the hybrid composite exhibits superior strength level (about 34% higher) than the pure alloy under optimized conditions.

Vinita, B.S. Motgi, "Evaluation of Mechanical Properties of Al 7075 Alloy, Fly ash, Sic and Red mud Reinforced Metal Matrix Composites".

Composite material 7075Al alloy reinforced with (Sic & Fly ash) and (Sic & Red mud) was successfully casted by stir casting method. The tensile strength in Al7075-SiC-Flyash samples, is found to increase by maintaining the constant percentage of Sic and Fly ash. In Al7075-SiC-redmud samples, increase in the red mud content increases the tensile strength. Higher tensile strength was observed in Al7075-SiC-Redmud composite than Al7075-SiC-Flyash. The impact strength increases in Al7075-SiC-Flyash and Al7075-SiC-Redmud, with increase in the Sic weight content while decreases with increase in Fly ash and red mud content respectively. Higher impact strength was observed in Red mud samples than Fly ash samples. The wear resistance of the composite Al7075-SiC- Fly ash, is found to be higher by maintaining the constant weight percentages of Sic and Fly ash while it decreases by increasing the weight percentage of Fly ash. In Al7075-SiC-Red mud, wear resistance increases with increase in Red mud content.

Mohammed Imran, A.R. Anwar Khan, Sadananda Megeri, Shoaib Sadik, "Study of hardness and tensile strength of Aluminium-7075 percentage varying reinforced with graphite and bagasse-ash composites".

Al7075–bagasse ash–Gr hybrid composite specimens are prepared using stir casting technique. Hardness of composites is gradually increased with increasing the reinforcement in the base alloy. The 95% confidence interval has shown BHN increased with increasing in reinforcement. Ductility of the composites decreases with increasing content of reinforcement in the matrix alloy. Resultant Al7075 bagasse ash–graphite hybrid composite possess ultimate tensile strength and yielding strength increased gradually with increasing in reinforcement.

S. Vinod Muchchandi, S. C. Pilli, "Design and Analysis of A Spar Beam For The Vertical Tail of A Transport Aircraft".

S. Vinod and S.C. Pilli based on the results of finite element predictions and by the calculations of the stress analysis approach concluded that the air drag load has more effect on the top and bottom flange. From the load cases the maximum stress is compared with yield stress and ultimate stress of 2024 T351 aluminium alloy. The obtained magnitudes of maximum stress are less than the yield stress and ultimate stress so we conclude that material in elastic limit and not yet started yielding.

CHAPTER 3
MATERIALS USED

3.1 ALUMINIUM 7075-T6 ALLOY

Colour Code – BLACK/WHITE

3.1.1 Chemical Composition of Al7075 T6

MATERIAL	PERCENTAGE
Aluminium	81.1 – 91.4
Zinc	5.1 – 6.1
Magnesium	2.1 - 2.9
Cu	1.2 – 2
Iron	0.5 max
Manganese	0.3 max
Chromium	0.18 – 0.28
Tin	0.2 max
Silicon	0.4 max
Other	0.15 max

3.1.2 MECHANICAL PROPERTIES OF AL7075 T6

Elongation at Break	11 %
Modulus of elasticity	71.7 GPa
Ultimate tensile strength	572 MPa
Tensile yield strength	503 MPa
Poisson's Ratio	0.33
Machinability	70%
Shear Modulus	26.9 GPa

3.1.3 APPLICATION:

The set of properties that 7075-T6 aluminium offers make it a solid choice for universal use in a variety of industries, while remaining a favorite for the industries of aerospace, marine, and transportation due to its excellent strength-to-weight ratio. Other very common uses include top-line bicycle components, tool-making, gliders, meter gears, fuse parts, missile parts, worm gears, keys, regulating valve parts, and many other different commercial aircraft, aircraft fittings, and aerospace and defense equipment and components. 7075-T6 is particularly used in many military applications like assault rifle upper and lower receivers, extension tubes, and precision rifles such as M-16s.

3.2 SILICON CARBIDE (Sic):

Silicon carbide behaves almost like a diamond. It is not only the lightest, but also the hardest ceramic material and has excellent thermal conductivity, low thermal expansion and is very resistant to acids and lyes.

With silicon carbide ceramics the material properties remain constant up to temperature above 1400 c. the high young modulus > 400 GPa ensures excellent Dimensional stability. These material properties make silicon carbide predestined for use as a construction material silicon carbide masters corrosion, abrasion and erosion as skilfully as if stands up to frictional wear. Components are used in chemical plants, mills, expanders and extruders or as nozzles

Key Properties:

- It is a refractory material (high melting point)
- High Thermal conductivity
- Low thermal expansion
- Good thermal shock resistance

3.2.1 TYPICAL PROPERTIES OF SILICON CARBIDE:

PROPERTY	VALUE
Thermal Conductivity	120 W/m^{0}K
Coefficient of Thermal expansion	4.0 X 10^{-6}/^{0}C
Specific Heat	750 J/Kg^{0}K
Density	3.1 gm/cc

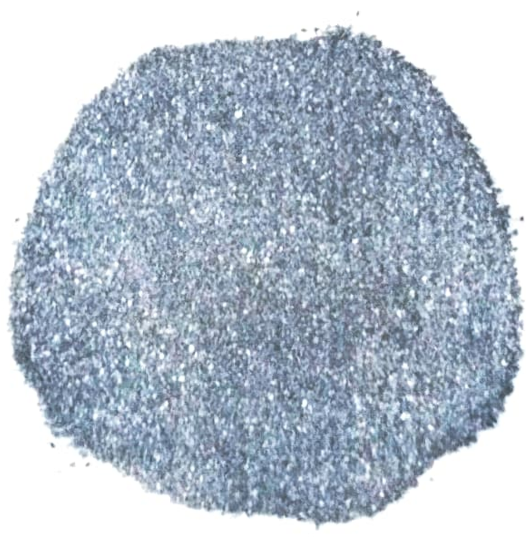


Fig 3.1 SILICON CARBIDE

3.2.2 APPLICATIONS OF Sic:

Automobile parts:

Silicon infiltrated carbon-carbon composite is used for high performance ceramic brakes, as they are able to withstand extreme temperature. The brake disks are used in sports cars, super cars like Bugatti Veyron, Bentley, Ferrari and other performance Audi cars. Silicon carbide is also used in sintered form for diesel particulate filters and also used as an oil additive to reduce friction, emissions and harmonics.

Abrasives and cutting tools:

Silicon carbide is a popular abrasive in modern lapidary due to durability and low cost of the material. In manufacturing, it is used for its hardness in abrasive machining processes such as grinding, honing, water-jet cutting and sand blasting. Particles of silicon carbide are laminated to paper to create sandpapers and grid tape on skateboards.

Astronomy:

The low thermal expansion coefficient, high hardness, rigidity and thermal conductivity makes silicon carbide a desirable mirror material for astronomical telescopes

Power electronic devices:

Silicon carbide was the first commercially important semiconductor material. as in the first commercially used LEDs based on Sic and it is mostly used in high temperature and high voltage devices

3.3 BAGASSE ASH:

Sugarcane ash is a byproduct of sugar factories found after burning sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this material is already causing environmental problems around the sugar factories. On the other hand, the boost in construction activities in the country created shortage in most of concrete making materials especially cement, resulting in an increase in price. Bagasse ash is mostly used as replacement material in cement.

Fig 3.2 BAGASSE ASH

3.3.1 APPLICATIONS OF BAGASSE ASH:

Nano cellulose:

Nano cellulose can be produced from bagasse through various conventional and noval processes this provides a path way to generate a higher value products from what can be considered a process waste steam.

Pulp, paper, board and feed:

Bagasse is commonly used as substitute for wood in many tropical and subtropical countries for production of pulp, paper and board. It produces pulp with Physical properties that are well suited for generic printing and writing papers as well as tissue products but it is also widely used for boxes and newspaper production. It can also be used for making boards resembling plywood or particle board, called bagasse board and Xanita board, and is considered a good substitute for plywood.

CHAPTER 4

FABRICATION OF COMPONENTS

4.1 STIR CASTING

Fabrications of composites were done by stir casting method. Silicon Carbide particles of 20μm size were used in this experiment to prepare AL-Sic at various composition Initially Aluminium 7075-t6 alloy ingots are kept in a graphite crucible and melt in electric resistance furnace at 700°c.Silicon carbide is preheated at 300°c in Muffle. The stirring setup is brought near the furnace, stirrer is dipped inside the crucible and stirred at 100rpm. As the impeller rotates it generates a vortex that draws the reinforcement particle into the melt from the surface. The stirring action was carried out about 45 minutes. Varying volume (1, 2, and 3%) of reinforcement Sic and bagasse ash (0.5) with melted aluminium 7075-t6.

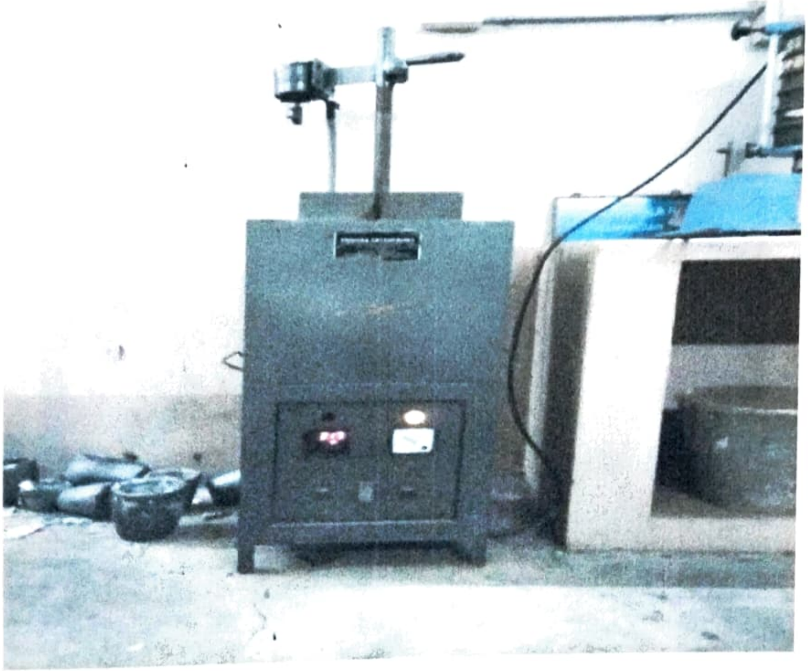


Fig 4.1 STIR CASTING EQUIPMENT

After by removing stirred setup, the mixed melt is poured into the required preheated metallic Die at 200°c.Composites were casted into a cylindrical rod in required dimensions. The molten metal is allowed to cool for solidification by air quenching

4.2 TABULAR FORM OF QUANTITY OF MATERIAL FOR STIR CASTING:

S.NO	Wt.% AL 7075-T6	Wt.% Sic	Wt.% Bagasse ash	wt(grams) AL 7075-T6	wt(grams) Sic	wt(grams) Bagasse ash
1	100	0	0	600	0	0
2	98.5	1	0.5	591	6	3
3	97.5	2	0.5	585	12	3
4	96.5	3	0.5	579	18	3

Fig 4.2 LIQUID METAL POURED IN METAL MOULD

MOLTEN METAL POURED IN DIE:

The casted composites were machined and made to prepare tensile testing, hardness and wear testing specimens as per standards.

CHAPTER 5
TESTS AND OBSERVATIONS

5.1 HARDNESS TEST:

5.1.1 OBJECT:

The hardness test is a mechanical test for material properties which are used in engineering design, analysis of structures, and materials development. The principal purpose of the hardness test is to determine the suitability of a material for a given application, or the particular treatment to which the material has been subjected. The ease with which the hardness test can be made has made it the most common method of inspection for metals and alloys.

5.1.2 INTRODUCTION:

Hardness is defined as the resistance of a material to permanent deformation such as indentation, wear, abrasion, scratch. Principally, the importance of hardness testing has to do with the relationship between hardness and other properties of material. For example, both the hardness test and the tensile test measure the resistance of a metal to plastic flow, and results of these tests may closely parallel each other. The hardness test is preferred because it is simple, easy, and relatively nondestructive.

There are many hardness tests currently in use. The necessity for all these different hardness tests is due to the need for categorizing the great range of hardness from soft rubber to hard ceramics.

5.1.3 THEORY:

Current practice divides hardness testing into two categories: macrohardness and micro hardness. Macro hardness refers to testing with applied loads on the indenter of more than 1 kg and covers, for example, the testing of tools, dies, and sheet material in the heavier gages. In micro hardness testing, applied loads are 1 kg and below, and material being tested is very thin (down to 0.0125 mm, or 0.0005 in.). Applications include extremely small parts, thin superficially hardened parts, plated surfaces, and individual constituents of materials.

5.1.4 TYPES OF TESTS:

1. Macro Hardness Testers Loads > 1 kg
   - Rockwell
   - Brinell
   - Vickers
2. Micro Hardness Testers < 1 kg
   - Knoop diamond
   - Vickers diamond pyramid

5.2 BRINELL HARDNESS TEST:

5.2.1 INTRODUCTION:

The Brinell hardness tester is a hand operated mechanical devices. A dash pot system restricts the rate of application of the load to avoid dynamic effects. A 10mm dia hardened steel ball is pressed into the specimen. The load is adjustable, applied load from 500kg to 3000kg are generated with different installed smaller masses. Smaller load are applied for soft material and larger loads for harder materials for very hard materials a 10mm diameter tungsten-carbide ball is installed

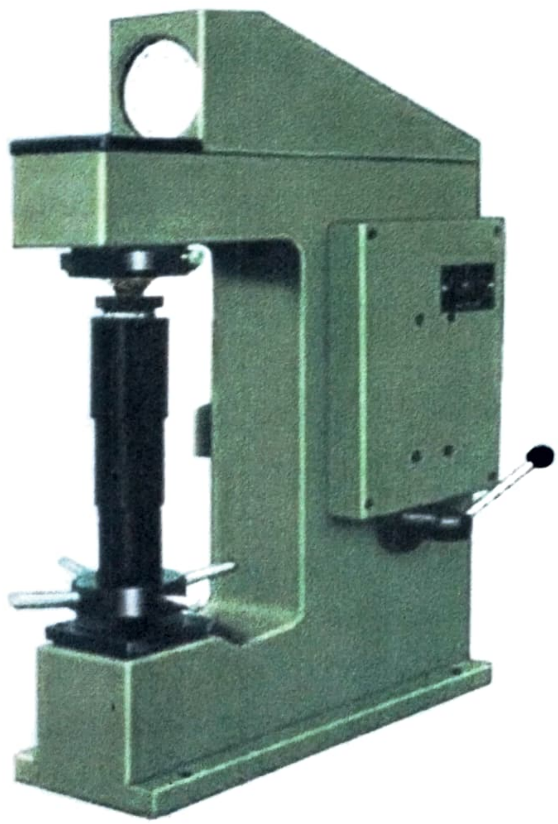


Fig 5.1 BRINELL HARDNESS TEST

5.2.2 TEST SPECIMEN:

The test specimen is prepared on the lathe using turning and facing process with D/L ratio of 1.875, as the diameter is 15mm and length is 8mm. a steel ball Indentation used for testing with a load of 250kg.

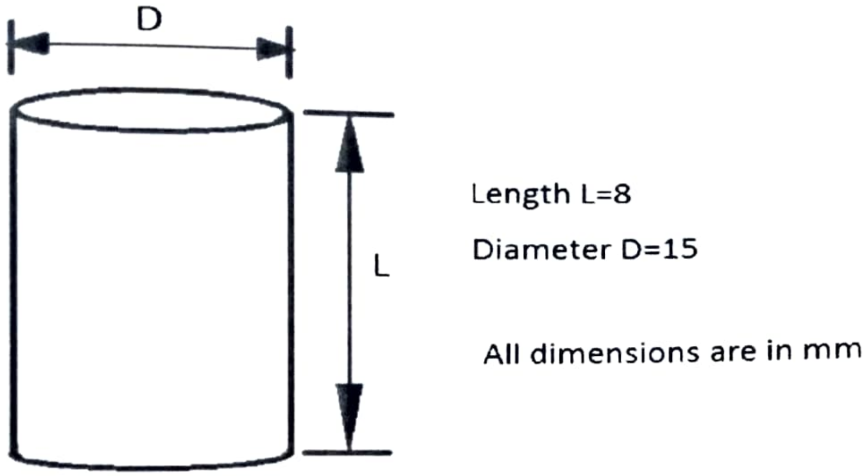


Fig 5.2 HARDNESS TEST SPECIMEN

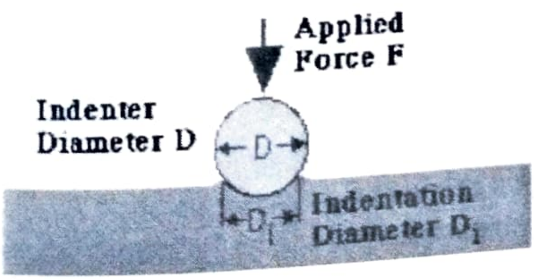
5.2.3PROCEDURE:

1) The indenter is pressed into the sample by an accurately controlled test force.

2) The force is maintained for a specific dwell time, normally 10 - 15 seconds after the dwell time is complete, the indenter is removed leaving a round indent in the sample.

3) The size of the indent is determined optically by measuring two diagonals of the round indent using either a portable microscope or one that is integrated with the load application device.

4) The Brinell hardness number is a function of the test force divided by the curved surface area of the indent. The indentation is considered to be spherical with a radius equal to half the diameter of the ball. The average of the two diagonals is used in the following formula to calculate the Brinell hardness number.



$$BHN = \frac{F}{\frac{\pi}{2} D \cdot (D - \sqrt{D^2 - D_i^2})}$$

Fig 5.3 BRINELL HARDNESS TEST AND FORMULA

5.3 TENSILE TESTING

5.3.1 INTRODUCTION

The mechanical properties of materials are determined by performing carefully designed laboratory experiments that replicate as nearly as possible the service conditions. In real life, there are many factors involved in the nature in which loads are applied on a material. The following are some common examples of modes in which loads might be applied: tensile, compressive, and shear. These properties are important in materials selections for mechanical design. Other factors that often complicate the design process include temperature and time factors.

Fig 5.4 UNIVERSAL TESTING MACHINE

5.3.2 TEST SPECIMEN

A tensile specimen is a standardized sample cross-section. It has two shoulders and a gage (section) in between. The shoulders are large so they can be readily gripped, whereas the gauge section has a smaller cross-section so that the deformation and failure can occur in this area.

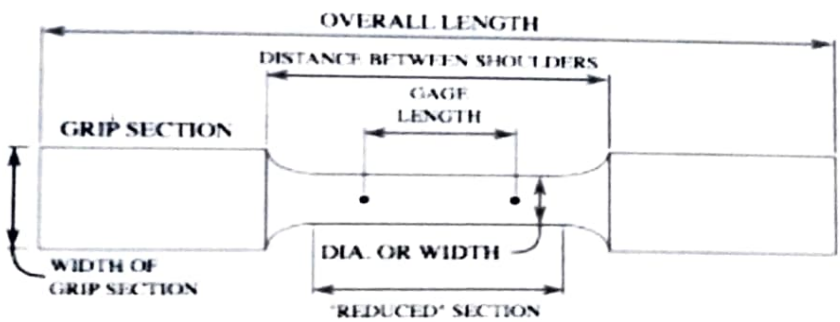


Fig 5.5 TENSILE TEST SPECIMEN

A standard specimen is prepared in a round or a square section along the gauge length, depending on the standard used. Both ends of the specimens should have sufficient length and a surface condition such that they are firmly gripped during testing.

5.3.3 SPECIMEN PREPARATION

1) The MMC specimens were machined into dog-bone shapes using lathe machine.

2) Their dimensions were determined according to the ASTM E8 standard mentioned earlier in the introduction. Measure the thickness, width and gauge length of MMC samples in mm. These dimensions should be approximately the same for each sample.

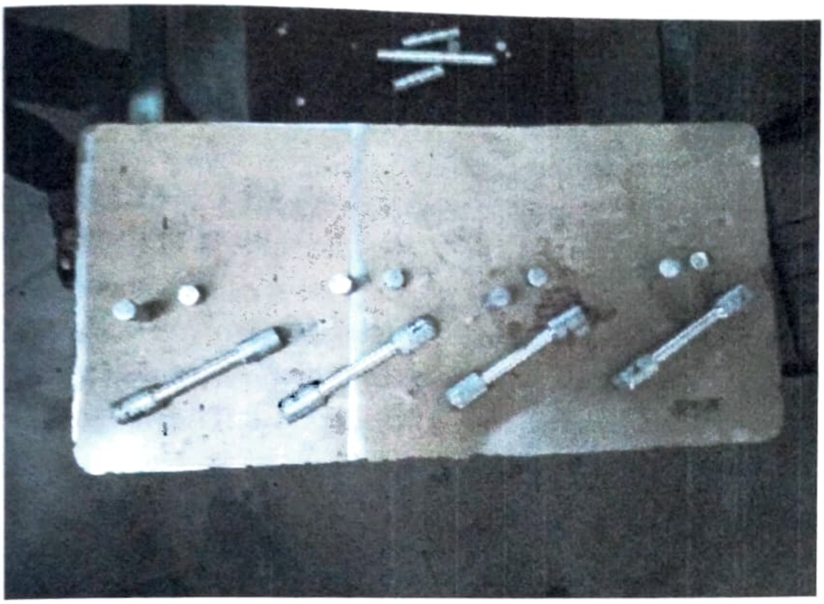


Fig 5.6 SPECIMENS

5.3.4 PROCEDUERE:

1. Make sure the proper load cell is installed, either 2 kN or 50 kN depending on the load range and sensitivity of the sample. To switch load cells, make sure the machine is off. Unscrew the bolts and remove using the handle. Make sure to plug the new load cell into the port behind the machine.
2. Calibrate the load cell by clicking on the button in the upper right hand corner. Make sure all loads are removed from the load cell and click calibrate.
3. Install the correct type of clamps for the testing. For tensile testing, 5kN or 50kN samples can be used. Install the clamps using the pins. Also install height brackets if needed. Zero the load once the clamps are installed.
4. Press the up and down arrows on the controller until the clamps are just touching. Press the reset gauge length button at the top of the screen to zero the position of the clamps.
5. Use the up and down arrows until the clamps are about 100 mm apart. This is a typical gauge length for the dog bone samples.
6. Place the MMC sample between the grips of both the tensile test machine. While holding the sample vertically with one hand, use another hand to turn the handle of the top grip in the closing direction as tightly as possible.
7. The specimen should be gripped such that the two ends of the specimen are covered by the grip, approximately 6 mm away from its gage-length. It is important that the specimens are tightly gripped onto the specimen grips to prevent slipping, which will otherwise result in experimental errors.
8. Make sure that the specimen is vertically aligned, if not a torsional force, rather than axial force, will result.
9. Turn the bottom handle in the "close" direction as tightly as possible. Visually verify that the sample is gripped symmetrically at its two ends.

10. Zero the extension by pushing zero extension button at the top of the screen. Also zero the load if needed. Wait for a few seconds to let the computer return its value to zero

5.4 COMPRESSION TEST:

5.4.1 INTRODUCTION:

A compression test is a method for determining the behaviour of materials under a compressive load. Compression tests are conducted by loading the test specimen between two plates, and then applying a force to the specimen by moving the crossheads together .The compression test is used to determine elastic limit, Proportional limit, yield point,yield strength and (for some material) compressive strength

TEST SPECIMEN:

The test specimen is prepared on the lathe using turning and facing process with D/L ratio of 1.875, as the diameter is 15mm and length is 8mm. a steel ball Indentation used for testing with a load of 250kg.

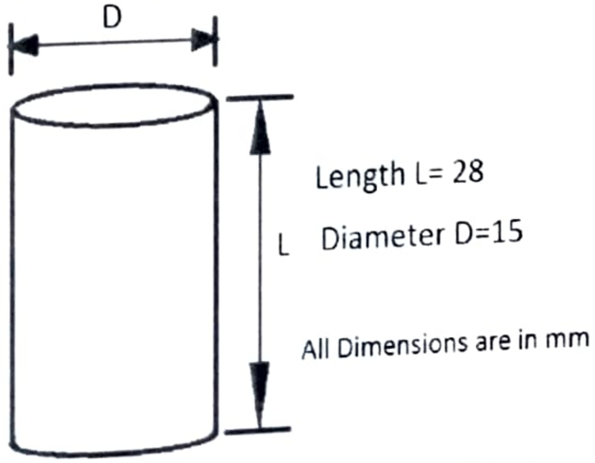


Fig 5.7 COMPRESSION TEST SPECIMEN

5.4.2 PROCEDURE

1. Dimension of test piece is measured at three different places along its height/length to determine the average cross-section.
2. Ends of the specimen should be plane. For that the ends are tested on a bearing plate.
3. The specimen is placed centrally between the two compression plates, such that the centre of moving head is vertically above the centre of specimen.
4. Load is applied on the specimen by moving the movable head.
5. The load and corresponding contraction are measured at different intervals the load interval may be as 500kg.
6. Load is applied until the specimen fails.

CHAPTER 6
TEST RESULTS AND DISCUSSIONS

6.1 TENSILE TEST

Tensile strength is stress and measured as force per unit area. In the SI system, the unit is Pascal (Pa) or Newton`s per square meter (N/m^2). For our testing, we utilize the UTM. The testing incorporated to take a sample with a fixed cross section area, and then pulling it with a controlled, gradually Above Table shows that the engineering maximum. Tension forces obtained from tensile stressvs. Sic bar chart for 0, 1, 2, 3Wt% Sic .increasing force until the sample changes shape or breaks. Increasing the amount of Sic particles leads to a decrease in the distance between them which cause an increase in the required stress for dislocations movement between the Sic particles. Tensile test was taken at room temperature by using Universal testing machine. In the experiment can be noted that addition of Sic particles improve the tensile strength of the composites. It showed that the 2 Wt% Sic got the higher tensile strength than the remaining. The fig Graph shows the effect of the increase in Sic% on the tensile strength test.

Fig: 6.1 Bar graph for Sic wt% vs. tensile strength

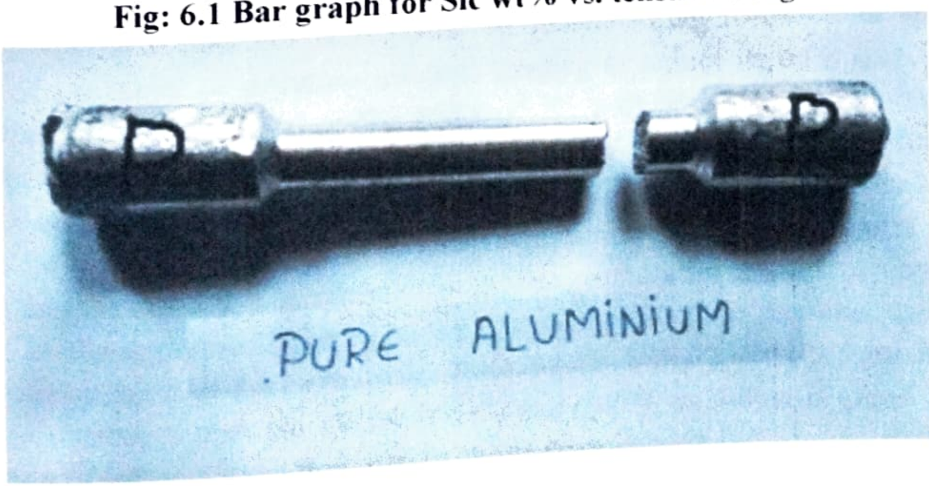


Fig 6.2 AL7075 T6

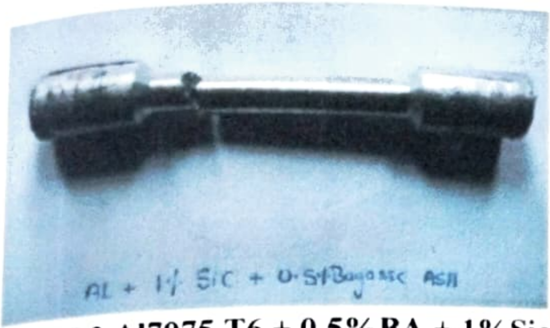


Fig 6.3 Al7075 T6 + 0.5%BA + 1%Sic

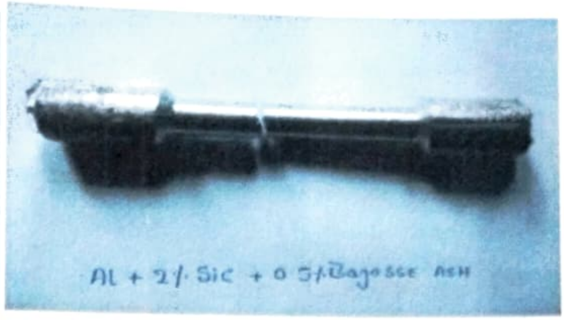


Fig 6.4 Al7075 T6 + 0.5% BA + 2%Sic

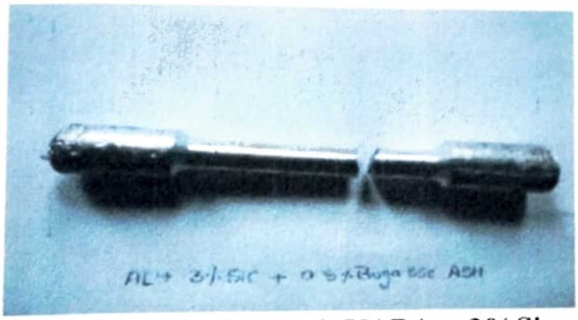


Fig 6.5 Al7075 T6 + 0.5%BA + 3%Sic

6.1.1 TENSILE STRENGTHS TABULAR FORM

S.NO	Composite	TENSILE STRENGTH(MPA)
1	Al7075 T6	505
2	Al7075 T6 + 0.5%BA + 1%Sic	529
3	Al7075 T6 + 0.5%BA + 2%Sic	545
4	Al7075 T6 + 0.5%BA + 3%Sic	464

6.2 COMPRESSIVE TEST:

Compressive strength is opposite to tensile strength which is defined as capacity of a material or structure which is tending to reduce its body size In the SI system, the unit is Pascal (Pa) or Newton's per square meter (N/m²) For our testing, we utilize the UTM. The testing incorporated to take a sample with a fixed cross section area, and then pushing it with a controlled load and the Breaking load obtained for 0, 1, 2,3Wt% Sic increasing force until the sample changes shape or breaks. Compressive test was taken at room temperature by using Universal testing machine. In the experiment can be noted that addition of Sic particles improve the compressive strength of the composites. It showed that the 2 Wt% Sic got the higher compressive strength than the 1Wt%, 3Wt% and 0Wt% as shown in (fig-6 2 6). The deformation of test specimen is shown in above figures.

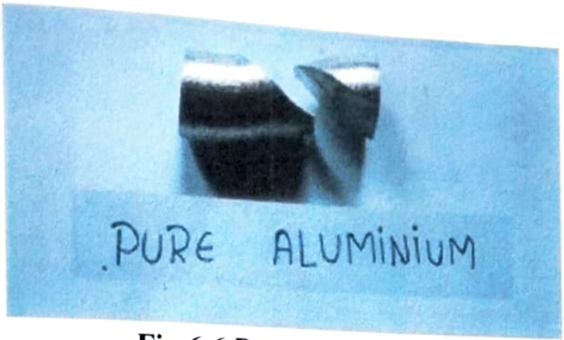


Fig 6.6 Pure Aluminium

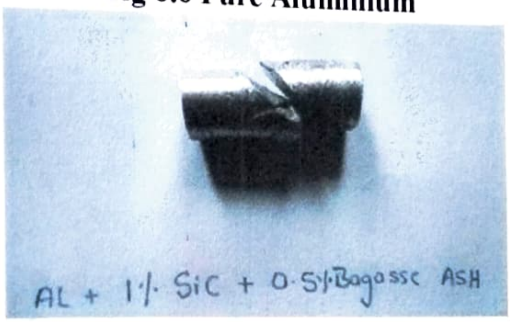


Fig 6.7 Al7075 T6 + 0.5%BA + 1%Sic

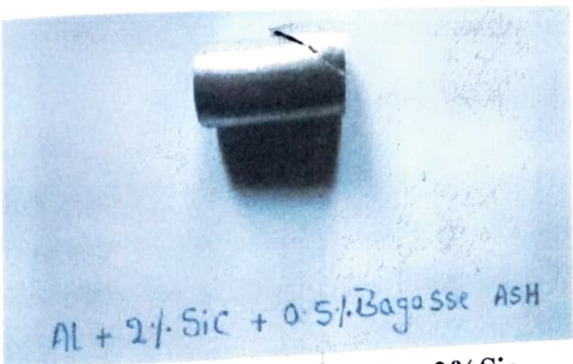


Fig 6.8 Al7075 T6 + 0.5%BA + 2%Sic

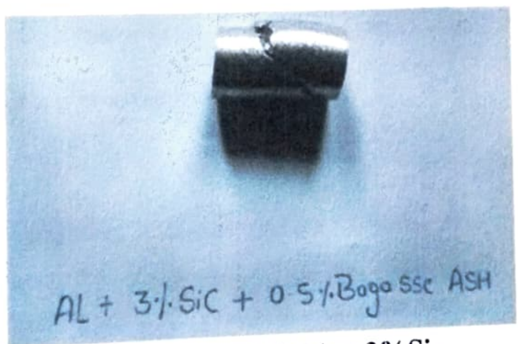


Fig 6.9 Al7075 T6 + 0.5%BA + 3%Sic

6.2.1 TABULAR FORM FOR COMPRESSION TEST

S NO	Composite	Breaking Strength(MPA)
1	Al7075 T6	873.14429
2	Al7075 T6 + 0.5%BA + 1%Sic	618.9377
3	Al7075 T6 + 0.5%BA + 2%Sic	702.9364
4	Al7075 T6 + 0.5%BA + 3%Sic	685.25248

GRAPHICAL REPRESENTATION:

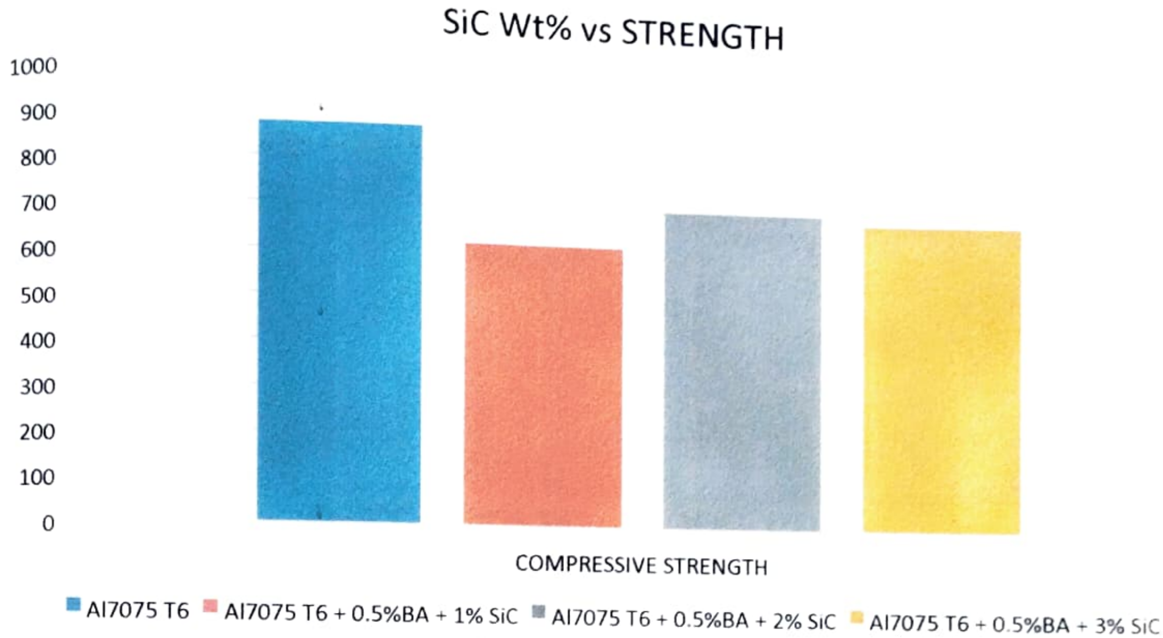


Fig: 6.10 Bar graph for Sic Wt.% vs. Compression strength

6.3 BRINELL HARDNESS TEST

Hardness number (BHN) has units of kg/mm^2, but the units are usually omitted in expressing the number. For harder materials (above 500 BHN), the cemented carbide ball is used because the steel ball experiences elastic deformation that compromises the accuracy of the reading. Also, higher loads (1500 and 3000 kg) are usually used for harder materials. Because of differences in BHN results under different loads, it is considered a good practice to indicate the load used in the test when reporting BHN readings.

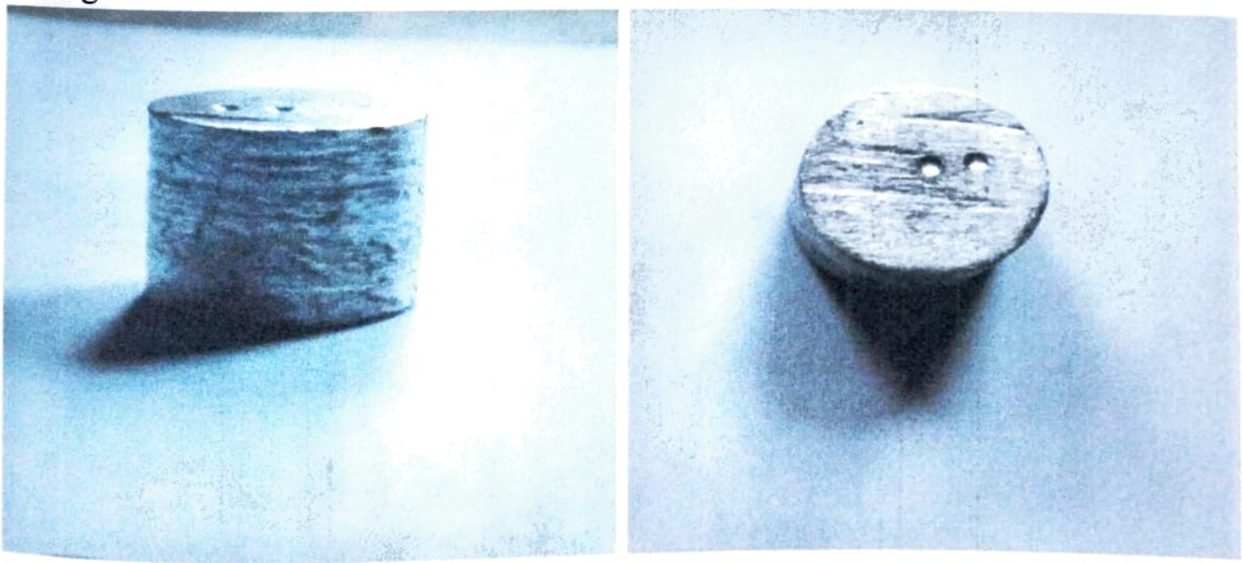


Fig – 6.11 PURE ALUMINIUM

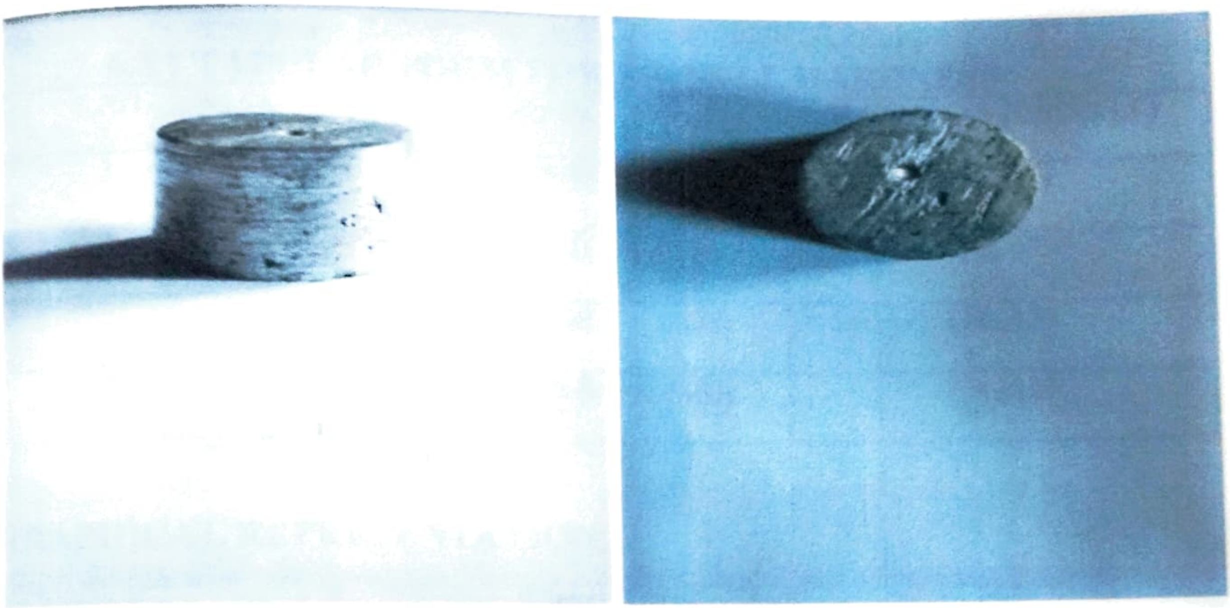


Fig 6.12 Al7075 T6+ 0.5% BA + 1%Sic

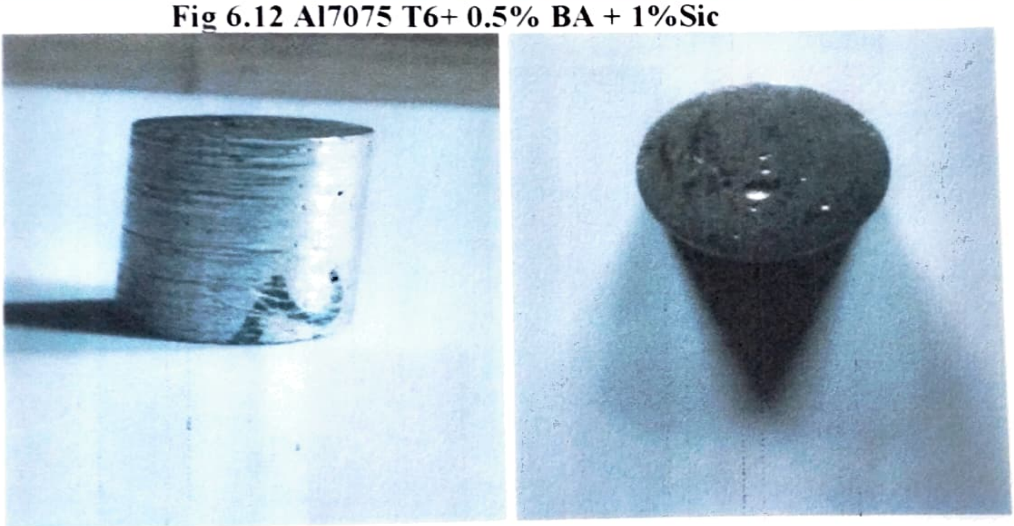


Fig 6.13 Al7075 T6 + 0.5%BA + 2%Sic

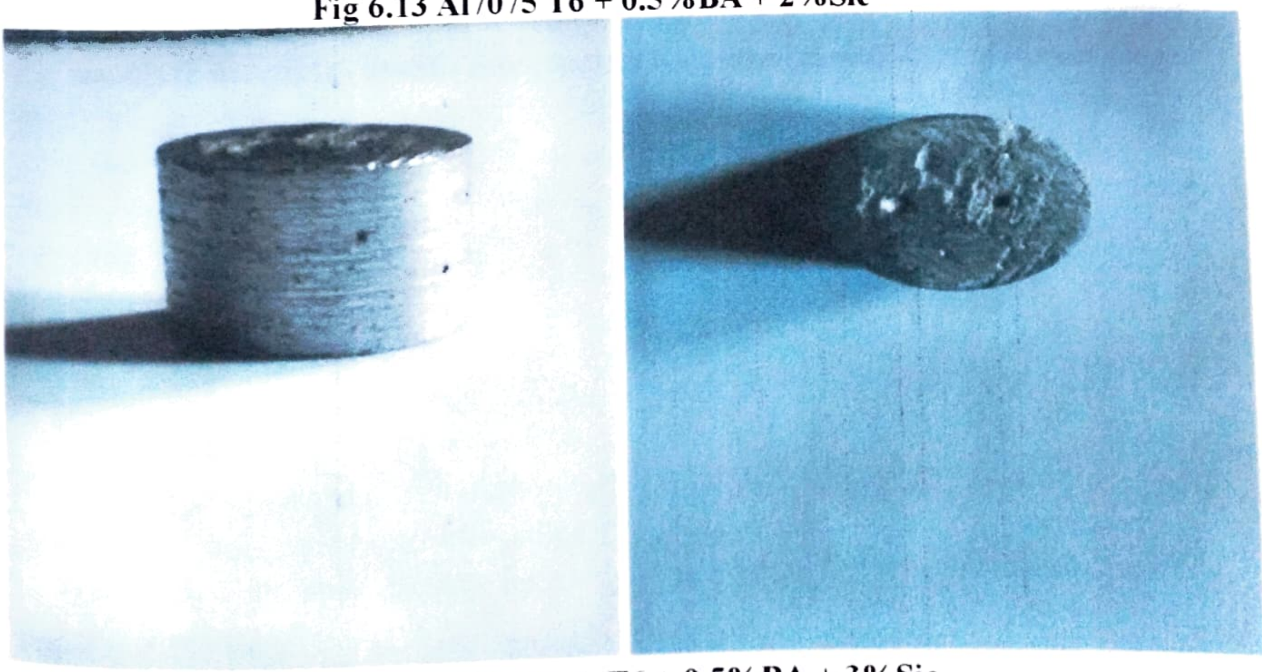
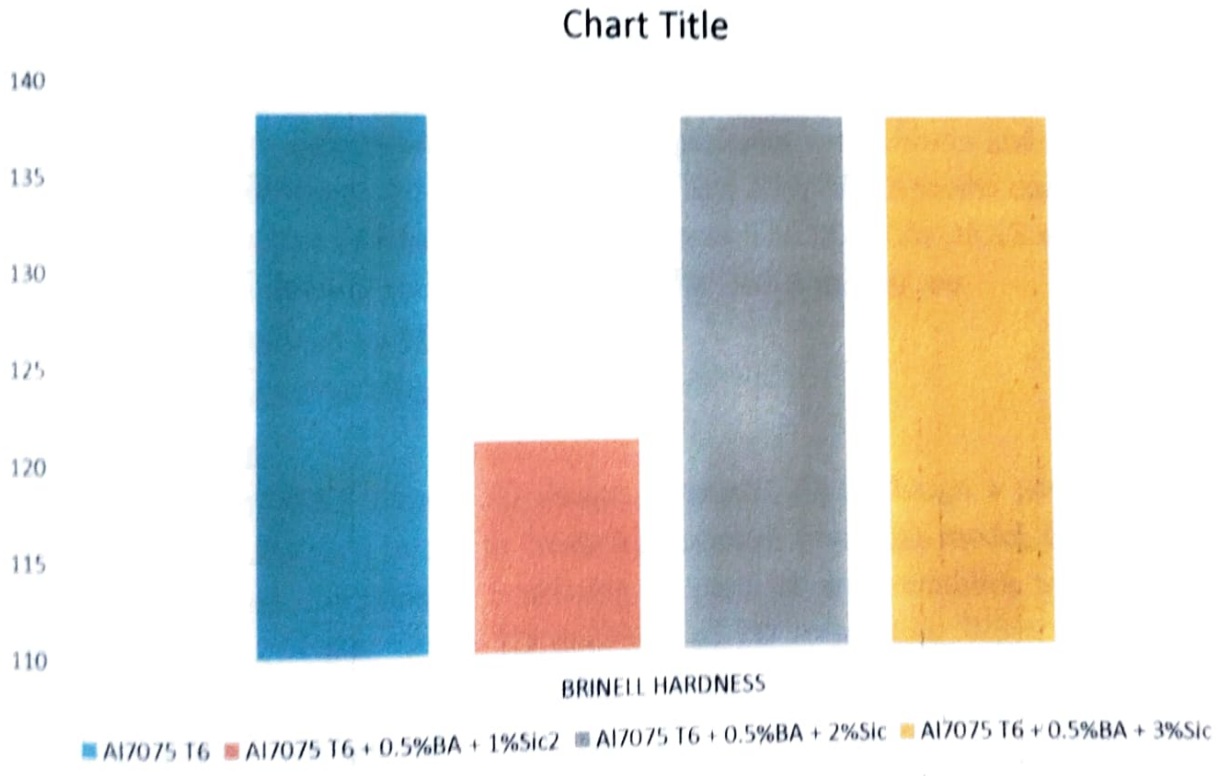


Fig 6.14 Al7075 T6 + 0.5%BA + 3%Sic

6.3.1 TABULAR FORM FOR BRINELL HARDNESS

S.NO	Composite	HARDNESS (BRINELL)
1	Al7075 T6	138.2129
2	Al7075 T6 + 0.5%BA + 1%Sic	121.07
3	Al7075 T6 + 0.5%BA + 2%Sic	138.2129
4	Al7075 T6 + 0.5%BA + 3%Sic	138.2129

GRAPHICAL REPRESENTATION:



CHAPTER 7

DESIGNING

7.1 Introduction to Solid works

Solid Works is a solid modelling computer-aided design (CAD) and computer aided engineering (CAE) computer program that runs on Microsoft Windows. Solid Works is published by Dassault Systems. Solid works Corporation was founded in December 1993 by Massachusetts Institute of Technology graduate Jon Hirschtick. Solid Works released its first product Solid works 95 in November 1995. In 1997 Dassault, best known for its CATIA CAD software, acquired Solid Works for $310 million in stock.

Solid Works currently markets several versions of the Solid Works CAD software in addition to eDrawings, a collaboration tool, and Draft Sight, a 2D CAD product.

The SOLIDWORKS CAD software is a mechanical design automation application that lets designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings. A SOLIDWORKS model consists of 3D geometry that defines its edges, faces, and surfaces. The SOLIDWORKS software lets to design models quickly and precisely. SOLIDWORKS models are:

- Defined by 3D design
- Based on components

7.2 3D Design

SOLIDWORKS uses a 3D design approach. As to design a part, from the initial sketch to the final result, to create a 3D model. From this model, to create 2D drawings or mate components consisting of parts or subassemblies to create 3D assemblies. We can also create 2D drawings of 3D assemblies. When designing a model using SOLIDWORKS, to visualize it in three dimensions, the way the model exists once it is manufactured. This document discusses concepts and terminology used throughout the SOLIDWORKS application. It familiarizes with the commonly used functions of SOLIDWORKS. Parts are the basic building blocks in the SOLIDWORKS software. Assemblies contain parts or other assemblies, called subassemblies.

7.3 Terminology:

These terms appear throughout the SOLIDWORKS software and documentation.

Origin: Appears as two blue arrows and represents the (0,0,0) coordinate of the model. When a sketch is active, a sketch origin appears in red and represents the (0,0,0) coordinate of the sketch. To can add dimensions and relations to a model origin, but not to a sketch origin.

Plane: Flat construction geometry. To use planes for adding a 2D sketch, section view of a model, or a neutral plane in a draft feature, for example.

Axis: Straight line used to create model geometry, features or patterns.
To create an axis in different ways, including intersecting two planes. The SOLIDWORKS application creates temporary axes implicit for every conical or cylindrical face in a model.

Face: boundaries that help define the shape of a model or a surface. A face is a selectable area of a model or surface. For example, a rectangular solid has six faces.

Edge: Location where two or more faces intersect and are joined together. To select edges for sketching and dimensioning, for example.

Vertex: Point at which two or more lines or edges intersect. To select vertices for sketching and dimensioning, for example.

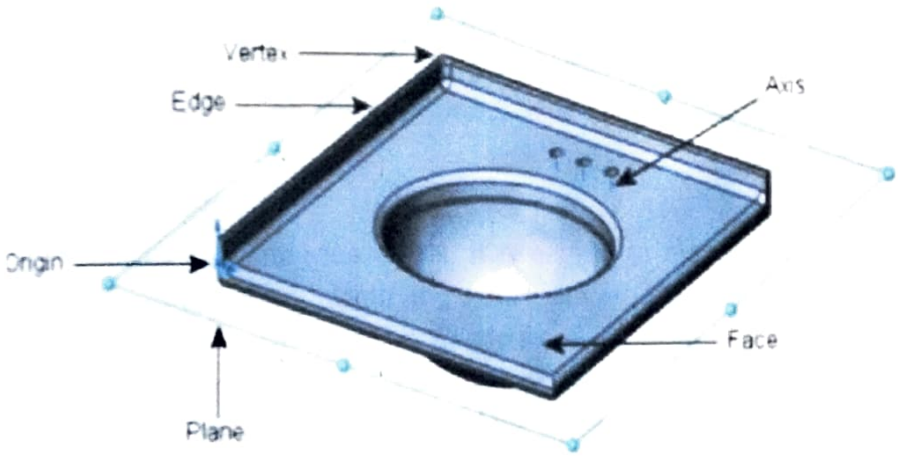


Fig 7.1 TERMINOLOGY

7.4 Design Process:

The design process usually involves the following steps:

- Identify the model requirements.
- Conceptualize the model based on the identified needs.
- Develop the model based on the concepts.
- Analyse the model.
- Prototype the model.
- Construct the model.
- Edit the model, if needed.

7.5 Design Intent

Design intent determines how you want your model to react as a result of the changes you need to make to the model. For example, if you make a boss with a hole in it, the hole should move when the boss moves:

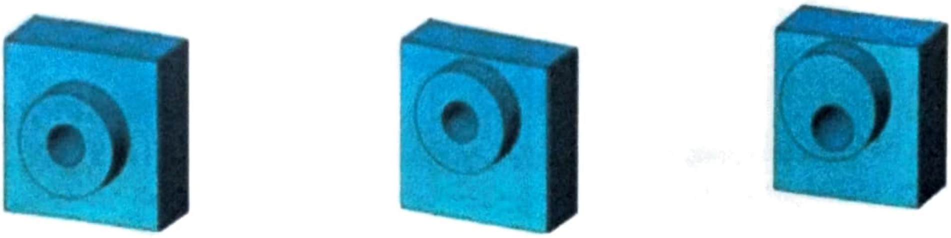


Fig 7.2 DESIGN INTENT WHEN BOSS MOVES

Design intent is primarily about planning. How to create the model determines how changes affect it. The closer the design implementation is to design intent, the greater the integrity of the model. Various factors contribute to the design process, including: Current needs: Understand the purpose of the model to design it efficiently. Future considerations: Anticipate potential requirements to minimize redesign efforts.

7.6 Design Method

Before actually designing the model, it is helpful to plan out a method of how to create the model. After identifying needs and isolating the appropriate concepts, model can be developed: Sketches: Create the sketches and decide how to dimension and where to apply relations. Features: Select the appropriate features, such as extrudes and fillets, determine the best features to apply, and decide in what order to apply those features. Assemblies: Select the components to mate and types of mate to apply .

CHAPTER 8

ANALYSIS AND RESULTS

8.1Introduction:

Vertical tail and the rudder are important structural components of an aircraft. Movement of the rudder controls the yawing of an aircraft. Structurally speaking vertical tail is a typical mini-wing construction. A major difference could be absence of ribs and multiple spars (more than 2) in the vertical tail construction. Vertical tails have symmetrical air foil cross sections. Therefore in the absence of rudder deflection there is no aerodynamic load acting on the fuselage. However significant side loads develop due to rudder deflection and this is the major design load for the vertical tail. For transport aircraft side gust load is also important from a design point of view. In this project a typical spar of a vertical tail of a transport aircraft will be analysed. Loads representative of a small transport aircraft will be considered in this study.

8.2 Problem Definition of Spar Beam:

Cantilever beam having length of 3250 mm and loads (62-620 Kg) as shown in Table and Fig. Cantilever beam with the loads at each station (1-10) shown in Fig.

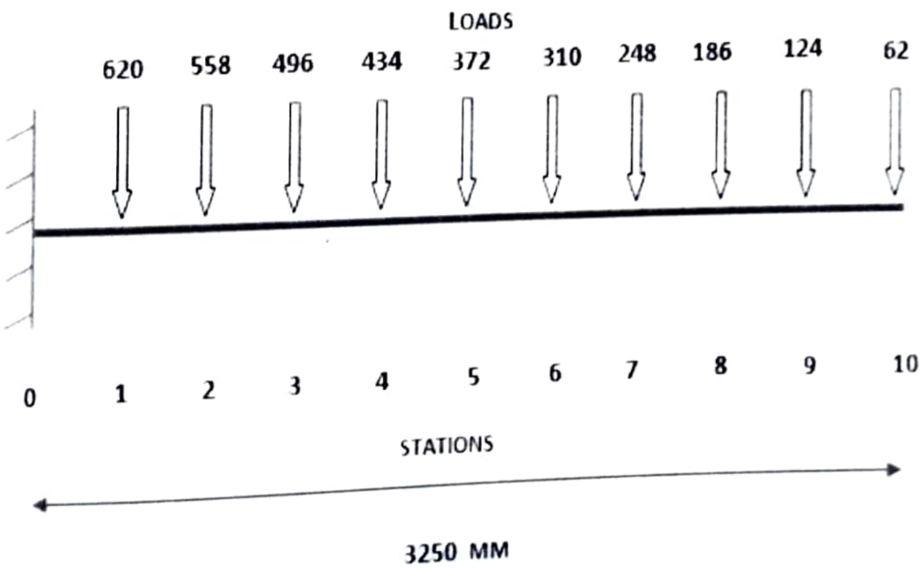


Fig8.1LOADS ON TAIL SPAR

8.3 LOADS AND DISTANCE OF LOADS FROM ROOT:

STATION	DISTANCE FROM ROOT	LOADS IN KG
0	0	0
1	325	620
2	650	558
3	975	496
4	1300	434
5	1625	372
6	1950	310
7	2275	248
8	2600	186
9	2925	124
10	3250	62

The cross section of the beam is I-section with varying cross section throughout ITS length.

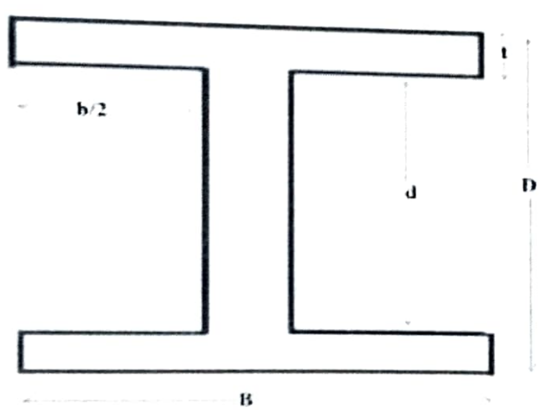


Fig 8.2 SECTION FOR TAIL SPAR

8.4 ANALYSIS RESULTS:

Solid works software is used to design the vertical tail spar which is an Isection beam of varying cross section. The loads are applied according to the design data provided

The cantilever beam with loads indicated the bending moments and corresponding dimensions of I section at differe stations are shown in Table 5.3

Station	Bending moments N-m	D(mm)	B(mm)	t(mm)	b(mm)	d(mm)
0	43487.7	164.106	82.053	8.2053	73.847	147.695
1	32615.7	149.1	74.55	7.455	67.095	134.19
2	23720.5	134.084	67.042	6.7042	60.338	120.676
3	16604.4	119.054	59.527	5.9527	53.574	107.148
4	1106.9	104.003	52.001	5.2001	46.801	93.603
5	6918.5	88.921	44.46	4.446	40.014	80.029
6	3953.4	73.789	36.894	3.6894	33.205	66.41
7	1976.7	58.566	29.283	2.9283	26.355	52.71
8	790.6	43.152	21.576	2.1576	19.418	38.837
9	197.6	27.184	13.592	1.3592	12.232	24.465
10	0	13.592	6.6795	0.6795	6.116	12.2325

I section is shown in Fig 5.2. B=0.5D, t=0.05D, b=0.45D, d=0.9D (From Westermann table) and analysed using the same software. The results obtained are applied for the material data for analysis.

Fig 8.3 Analysis on vertical tail spar material of Al7075 T6

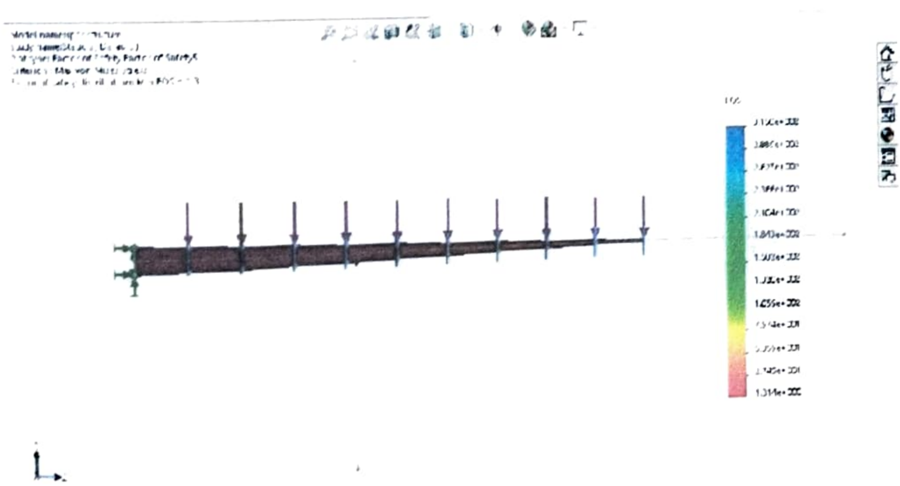


Fig 8.4 Analysis for Al7075 t6 + 0.5%BA + 1%Sic

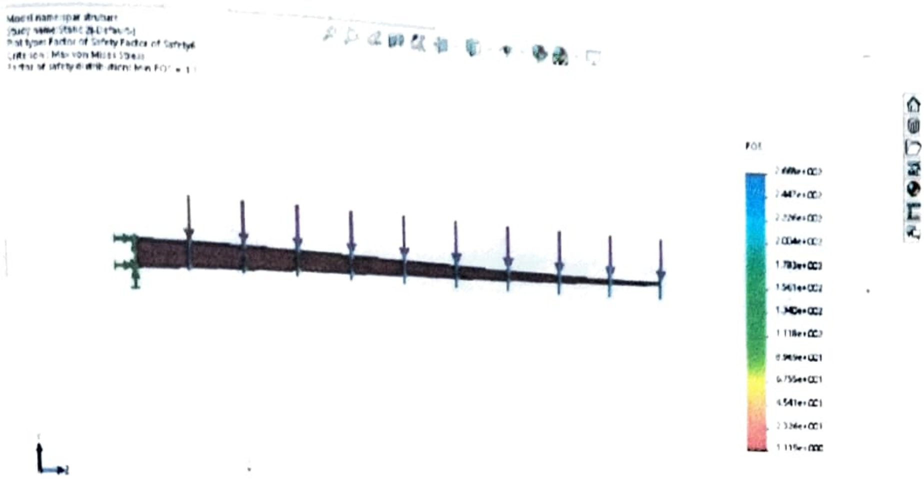


Fig 8.5 Analysis for Al7075 T6 + 0.5%BA + 2%Sic

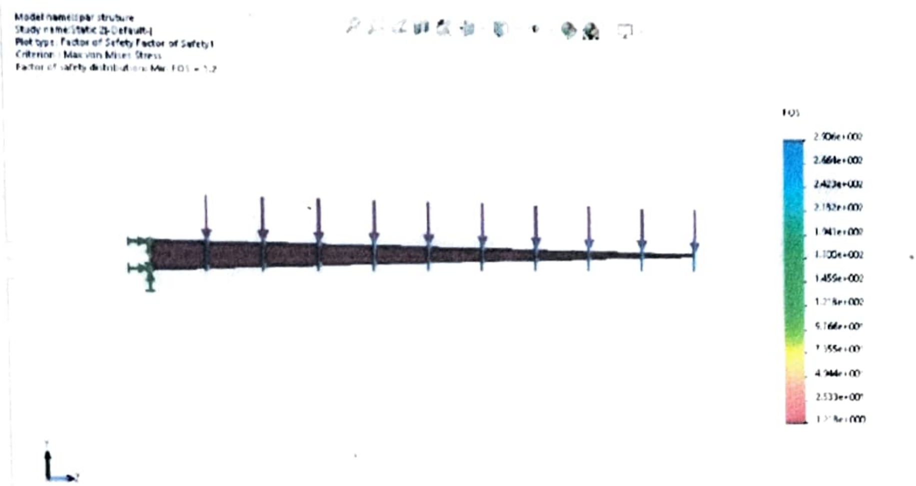


Fig 8.6 Analysis for Al7075 T6 + 0.5%BA + 3%Sic

CHAPTER 9

CONCLUSION

Pure Al ,Al-SiC, Al-Bagasse-ash-SiC, with various compositions were successfully fabricated by stir casting process. Wetting of reinforcements with the aluminium matrix was further improved by the addition of magnesium. Based on the experimental observations the following conclusions have been drawn:

➢ It has been seen that the different mechanical properties of metal matrix in a composite is greatly influenced with the addition of reinforcements.

➢ In tensile test, presence of 2% SiC + 0.5% Bagasse ash particle increases the tensile strength of Al7075 to a greater value comparing to the pure Al7075.

➢ In hardness testing, the value for the composite having Al7075+2% SiC+0.5% BA has no change compared to the pure Al. This shows that the presence of Sic particles the hardness has no much effect. Hence keeping the hardness same the other mechanical properties of the material can be changed.

➢ The stress analysis shows that magnitudes of maximum stress are less than the yield stress so we conclude that material is in elastic limit and not yet started yielding.

➢ The factor of safety of the tail spar increased from 1.2 (for pure Al7075) to 1.3 (for Al7075 with 2%SiC and 0.5%BA).

CHAPTER 10

REFERENCES

[1] B. Ravi, "Fabrication and Mechanical Properties of Al7075-Sic-TiC Hybrid Metal Matrix Composites" (International Journal of Engineering Science Invention).

[2] Vinita, B.S. Motgi, "Evaluation of Mechanical Properties of Al 7075 Alloy, Fly ash, Sic and Red mud Reinforced Metal Matrix Composites".

[3] NecatAltınko "Investigation of mechanical and machinability properties of Al2O3/Sic reinforced Al-based composite fabricated by stir cast technique".

[4] Jaswinder Singh, Amit Chauhan, "Fabrication characteristics and tensile strength of novel Al2024/Sic/red mud composites processed via stir casting route".

[5] S. VinodMuchchandi, S. C. Pilli, "Design and Analysis of a Spar Beam for the Vertical Tail of a Transport Aircraft".