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Experimental Investigation of Aluminium (Al6061) Alloy with Fly Ash Metal Matrix Composite Material

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ABSTRACT

Metal Matrix Composite (MMC) material performs the critical position in the area of automobile, civil and mechanical industries because of its stability and much less weight. In this, metal matrix composite is one in which the micro level analysis and the investigation has been carried out for the application based on the load-bearing structure with respect to wear, fatigue, etc. The metal-matrix improves strength, less weight, impact strength, stiffness and wear properties are analysed and replaced to the traditional building materials and other applications. In this paper, the effect of different reinforcements and concrete stability with the influence of chemicals of their metal-matrix bonding problems is analysed. The proposed material in the study is Aluminium (Al6061), Fly ash and Epoxy resin, which is more flexible and chemically bonded with their properties. Composite materials specimen fabricated with American Society for Testing and Materials (ASTM) standard, size with the varied ratio of 5%, 10%, 15%, 20%, and 25% resulted respectively. Through the experimental results the fatigue and wear test of every specimen for various parameters of load variation and ratio of mixing is found. The microstructure level analysis is done with a Scanning Electron Microscope (SEM). Finally, the optimization of the parameters is done with the grey fuzzy algorithm in MATLAB.

Keywords*: MMC (Al6061, fly ash and epoxy resin), fatigue and wear, SEM, MATLAB.*

1. INTRODUCTION

Metal matrix composites materials has been chosenmainly because of its strength. The experimental setup favoured inside the mixture of aluminum (A16061), fly ash and epoxy resin. It had been properly recognized and progressively improves the engineering properties along with wear rate, low density, specific strength and stiffness. The aluminum materials suffer from wear resistance, it can be overcome the difficult reinforcement levels along with particulars of reinforcement materials along with Zirconium, Alumina (Al_2O_3) and Silicon Carbide (SiC). New composite materials such as aluminum (Al6061) mixing with fly ash and epoxy resin composites materials are introduced. It will increase mechanical properties like strength, stiffness, wear resistance, corrosion resistance, fatigue resistance and elevated temperature resistance. Generally, Aluminium alloy is majorly used based on the lightweight applications. So new composite materials Aluminium (Al6061) mixing with fly ash and epoxy resin is created. The specimen in the ratio of 10%, 15%, 20% and 25% in ASTM standard size plate has been experimentally fabricated.

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2. LITERATURE REVIEW

Bieniass et al,[2003],[1].Tested that microstructure qualities of aluminum complex Ak12 composites containing fly ash particles, made by gravity and crush costing systems, setting erosion conduct and consumption energy are displayed and inspected. It has been found that gravity casting innovation is sensible in relation to casting, for obtaining a higher auxiliary uniformity with the at least conceivable porosity level, a large interface retention and a significantly uniform distribution of the composite material, the second The fly ash particles in the upgrade suggest the upgraded preparation of the consumed AK12 / 9% fly ash (75-100 micron split) and the non-reinforced structural analysis complex (AK12 amalgam) and the third ash particles are more expensive second The closeness of the cycle, casts the hole in the desert and the higher silicon content because of the responsiveness between the aluminum and silica in the AK12 combination and the aluminum fly ash composite determines the erosion behavior and the properties of the etched surface formed by the oxide film.

Rohatgi et al, [2006], [2]. Investigations into the Al356-Flying Pyrogen hollow microbead composites can be incorporated using a wide range of gas weight attack procedures in a variety of composite volumes of 20 to 65%. The density of the Al356-Fly-fired hollow microbead composites, carried out under different exploratory conditions, is between 1250 and 2180 kg/m3 and the volume fraction of the coal cells and the range is 20-65%. The scope. Used to increase the size of the particles, to connect the load and the volumetric expansion of the equivalent coal to the thickened melt temperature of the composite. This has an improvement with the reduction of the voids identified by all of the on-ear marks from the dissolution stream in the bed of hollow microbeads present in close proximity to the particles. Compressive mass smooth stress and modulus expansion and composite thickness of the composite.

Sedat Ozdenet et al, [2007], [3]. Exploring the effective behavior of Al and stimulating SiC molecules with AMC under various temperature conditions. The influencing behavior of composite materials is influenced by particles, molecular splitting, and weak matrix-enhanced holding groups. The effect of the test temperature on the behavior of all materials produced is not critical.

Karunamoorthy et al, [2008], [4]. A two-dimensional microstructure was investigated to establish a FEA simulation that was generated to examine the mechanical behavior of the MMC. The model has the effects of irregularities and clustering. The molecules that are grouped into stress-strain responses and disappointing behavior are considered from the model. The improvement in performance is done by inspection of the microstructure of the MMC, and the nature depends on the factor planned in the microstructure. The final target remains oriented to determine the FEA microstructure, the microstructure image is converted to a vector shape from the raster than it is converted to the IGES shown in ANSYS 7 and works in finite element analysis.

G. B. Veeresh Kumar et al, [2010], [5]. The experimental density values have been agreed with the theoretical density values of the composites used in the acquisition of the total rule of thumb for composite materials. The dispersion of SiC and Al2O3 in the AL6061 alloy in the Al7075 alloy contributes to the improvement of the tensile strength of the composite. The upper disc wear tester obtained by the wear member used the computerized pin and the floor was an EN31 steel disc (HRC60), and the composite needle was used as a specimen to prove that the composite material has excellent wear resistance.

Sozhamanna et al, [2010], [6]. A strategy for examining flexible plastic finite components based on microstructure. This model is used for the failure of a two-dimensional microstructure model under the

conditions of ductile stacking. Next, investigations were carried out and arranged arbitrarily, and the microstructure of the grouped particles determines the quality and the effect of the faulty components. Finite element analysis simulation was established using the SEM image ANSYS. Significant faults and stresses - the level of strain response is mathematically expected for each microstructure. The composite materials here are aluminum alloy and SiC.

Venkat Prasat et al, [2011], [7]. The tribological behavior of the aluminum combination was examined with the stimulation of alumina and graphite produced during the mixing throw. Upper Test Wear Test - Friction assets of the wear and mixture metal grid composites were expected by using a dry down wear test using rods. The analysis was carried out by the Taguchi method production test. The AL27 symmetric cluster is selected as a check for information. The analysis, invented the impression of the wear rate of the sliding step connected to the load slip separation and the factors in the calculation of erosion. The results prove that the sliding separation has the load and sliding speed pursued by the most worthy impact. Finally, it is certain that the test has been completed, confirming that the results of the exploration and the filtering of the electronic micro-inspections are done on the worn surface.

Anilkumar et al, [2011], [8]. The mechanical asset composite material of the reinforced aluminum alloy ash body (AL6061) was examined by agitation casting. There are three arrays for composites that pass through a 45-50, 75-100 & 425 micron gray atom size. Each group has three types of examples with 10%, 15%, and 20% carrier weight combinations. The mechanical properties of the compression, rigidity, flexibility and hardness of the machine were considered. The non-enhanced AL6061 test also tried mechanical assets. This is proof that the composite of the aluminum compound has a reduced compression mass, and the elasticity and strength increase in the atomic size of the reinforcing fly slag. Enhances the ultimate elasticity of the particles in the fly powder, compresses the mass, stiffness and reduces the flexibility of the composite.

Madhu Kumar et al, [2012], [9]. Aluminum-based composites (AMCS) describe the elegance of a lightweight aluminum-centered structure with a light overall weight performance. The reinforcement in asset management companies may be continuous/discontinuous fibers, whiskers or granules, in the form of quantitative fractions. This work focused on the manufacture of aluminum (AL6061) composites with agitating casting directions of 75 μm, 88 μm, 105 μm of 3 to 12% by weight of glass particles and 250 μm of driving AMCS. The organization and mechanics of the asset management company produced were analysed.

Fatma Ayari et al, [2012], [10]. Finite element analysis is the maximum value of the mechanical properties of a large-scale spectrum of materials found using the technique. In the case of inner steel, the reinforcing debris of the base composite is represented by a preferred daily geometry, i.e., spherical, square, cylindrical and pyramidal shapes.

Rama Rao et al, [2012], [11]. Inspection of aluminum boron carbide composites was created by fluid metallurgical processes with various particle weight fractions (2.5, 5 7.5%). Elimination of proof of identification, using X-ray diffraction of boron carbide for the hardness and stress test description of metallographic examination and scanning electron microscopy composites. The results indicate measures to increase boron carbide. The thickening is reduced while the hardness of the composite material is enlarged. Despite the combined compression mass and the incremental expansion of boron carbide in the composite at the weight level.

Uvaraja et al, [2012], [12].Check the properties of this hybrid for regular advancement and the low cost utilization of conventional composite materials. The mixing of the metal matrix composite is made by scattering at least two reinforcing materials into a metal matrix. They have an impressive tradition of research and innovation in Toyota Motor Company in the early 1980s. Mixed MMC is a substantially new species of material represented by lighter weight, better quality, high wear resistance, large fatigue properties and dimensional solidity at temperatures above normal compound rise. Because such properties are attractive and capable of working at high temperatures, composite reinforcement with Al blends of SiC and B4C particles is made from a different choice of progressive materials. It has been found that the composite composite space in the industry and vehicle motor components resembles drive shafts, chambers, cylinders, and brake rotors, and thus the application of interest in detecting the wear behavior of the auxiliary components.

Anandh Kumar et.al, [2012], [13]. The observed work was done by adding reinforcing materials such as TiC, silicon carbide, alumina, titania, titanium nitride, etc., to an aluminum matrix to improve mechanical properties. The in-situ strategy supports the in-situ EX-technology above the ceramic-grade aluminum matrix like titanium carbide (TiC). In this inspection, an Al-Cu-based composite (arrangement of the 2014 aluminum compound) was used as a matrix and enhanced with TiC. In the MMC material, Al-5% of Cu, 10% of TiC, and Al-4.5% of the mixture of Cu show higher yield quality, extreme strength and hardness. The yield and extreme stiffness percentage increments are described as 5% and 24%, while the individual Vickers hardness extends from about 35%. The higher hardness of the proof proves that the TiC particles are added to the hardness of the matrix.

M.Dammak et al,[2013],[14].Experimental analysis of harm of new metallic-primarily based composites submitted to complicate loading has been investigated through SEM-EBSD for In-situ four-point bending checks and monotonic and opposite simple shear tests. The TiB_2 debris show sharp morphological and crystallographic texture. Each matrix grain sizes impact and particle reinforcement is noticeable on the general mechanical conduct.

M. Mahendra Boopathi et al, [2013], [15]. Tested for the development of hybrid metal complex composites takes turned into a critical region of research enthusiasm for materials science. From this point of view, this inspection has taken the sight of flying powder, silicon carbide and its mixture to evaluate the physical properties of Al2024. As a result, the attractive properties of aluminum and MMC are superior in the blending of the roughness of any single common material that is inaccessible. Hybrid throwing strategic aluminum MMC construction development.

B. SirahbizuYigezuet al, [2013], [16]. The SEM examples demonstrated uniform distributed of the ash atoms in the mixture with no voids. Research activities set up to determine these issues are for the most part directed towards choosing the correct decision of reinforced materials. This means the strengthening materials assume the important character in deciding the general implementation of the composites. Considering the quantity of distributed articles overviewed although setting up this audit, it was seen that three different methodologies have been received to enhance the implementation of DRAMCs. The principle approach includes discovering elective and less expensive defences in the improvement of DRAMCs. This is done for giving an answer to issues presented by surprising expense and restricted accessibility of regular clay reinforce.

Udhaya Prakash et al, [2013], [17]. The mechanical workability (Al413) of the ongoing aluminum compound was studied using a flying wire EDM ash B4C mixture composite. The purpose of this work is to examine parameters such as pulsation turn-off time, feed pulsation in timeline, full voltage and rate support in reactive MRR and also surface roughness processed aluminum alloy (Al413) fly ash B4C hybrid composite Utilize the influence line EDM. Experiments have been performed based on the L27 symmetry group of various mixtures of parameters. A poor check has been used to determine that the proposal parameters fundamentally affect the reaction. The response was assessed using a signal to noise ratio distribution survey. The experimental results suggest that it gives an ideal combination of maximum MRR and at least surface roughness parameters.

H. Izadii et al, [2013], [18]. Micro-hardness change composites of Al-SiC that have been explored by friction stir processing (FSP) and investigated have been delivered by conventional metallurgical powders and sintering techniques. The flow of material in the region of the mixture during the FSP is effective to continuously circulate the SiC particles. In any case, when a test having 16% SiC (by volume) was prepared, there was a combination of residual pores and absence. The treatment mixture was eroded after all of the examples showed an increase in hardness which was officially seen in the molecular distribution and porosity treatment changes.

R. Keshava Murthyet.al, [2013], [19]. Understanding the Al7075-TiB 2 in-situ composite, a combination of economically accessible Al-3% bromine and Al-10% Ti was prepared by casting. Both matrix compounds and composites were microscopically examined, microhardness tests, particle size studies and toughness tests. The microstructure represents a truly uniform transport of the TiB 2 element of the matrix compound. The normal size (particles) of the combination is smaller than the unreinforced mixture. Microhardness, yield quality and extreme stiffness of the Al7075-TiB 2 composite, compared to the unreinforced compound is impressively high.

C.J.Thomas Renald et al, [2014], [20]. Investigates Aluminum Metal Matrix composites are widely utilized in various applications like automobile, aerospace, marine and mineral processing and etc. In his project work, alumina and graphite materials are added as reinforcement particle into Al6061 alloy for preparing hybrid composite materials. The hybrid composite materials are produced byliquid metallurgy route approach. Finally, it is concluded that the combination of reinforcement alumina and graphite is to progress the wear resistance.

Ravichandran et al, [2014], [21]. Combined and considered the making performance of aluminum-based half and half powder metallurgic composites. MMC based on aluminum were integrated from Al-TiO_2-Gr powder mixtures utilizing the metallurgy process and their making qualities were considered amid cool annoying.

Dora Siva Prasadh et al, [2014], [22]. It has been observed that the use of a double metal casting process can be made effortlessly using a composite metal mixture of up to 8% rice hull ash and silicon carbide particles. Uniform transport of rice hull ash and SiC is seen in the matrix. The increase in the level of porosity with the increase in porosity and hardness through the thickness of the hybrid composite is reduced. Yield quality and extreme stiffness increase with increased RHA and SiC content. It is exposed to differences in the base aluminum combination, and the precipitated active is accelerated by including support. This impact is obtained by a curing heat treatment in which the hardness of the most extreme time is additionally reduced.

Smith et al, [2014], [23]. The measurement of this measurement and the residual stress are estimated from four thick section steel pieces, which are welded by electronic bar (EB). All segments are estimated in the welded state, with a ferrite section that is subjected to PWHT at that point. In the two ferrite components, the residual stress of the apex, for their joint state, was found to be approximately equivalent to the yield quality of the parent material. The EB welding residual compressive stress was found in the passage of the ferritic steel and the place where the vacation occurred. This is because the stiffness of the different hardened steel EB welds, located in the weld expression is estimated. After the PWHT of the ferrite EBW segment, the peak stress considered is reduced from about 600 MPa to 90 MPa. The numerical simulation of the EBW process in the general profile of the residual stress is expected to be a coordinated estimate, but the FE survey predicts a solid peak. It has been found that the distribution of residual stress measured in the ferritic steel section is substantially the same thickness of the individual segments and is combined to a separation of about 40% of the product thickness. Interestingly, in tempered steel components, the load is substantially more fully conveyed about the weld centerline.

Weglewski et al, [2014], [24]. The results of the particle size measures for the thermal stress and damage of the mixture of sintered chromium and alumina were investigated. The post-test estimates the effect of the molecular size on the numerical simulation of the effect of the agitation on the residual thermal stress generated by the sintered metal structure composite at the manufacturing temperature. In the case of different Cr(Re), the Al2O3 composite is prepared by (i) starting plasma sintering and (ii) thermally compressing. Residual thermal stress is estimated by neutron diffraction and is controlled by a FEM model of the micro-scan of the material microstructure in the view. At this point, the numerical model of the miniature size breaks the effective Young's modulus that is actuated by residual stress to connect to the damaged composite. A check of the numerical results of the information with the measurement of the residual stress and the elastic modulus is introduced and a really large agreement is noted.

R. Pradeep et.al, [2014], [25]. Surveyed the investigation of mechanical good properties of Aluminium Red Mire and Silicon Carbide MMC of Aluminium combination of g- 7075 with adding of varying weight ratio configuration, for example SiC6%+Red mire 2%+ Al7075, SiC8%+Al7075, SiC2%+Red mire 6%+Al7075, SiC4%+Red mire 4%+Al7075, Red mire 8%+Al7075 Red mire and Silicon Carbide elements by casting method. The test result exposes that the mix of a composite material with reinforced, for example SiC and Red mud particles, enhances mechanical properties like elasticity, compressive quality, hardness and yield quality.

M. Ravichandran et al, [2014], [26]. Completed the inspection work by manufacturing Al MMC through fluid powder metallurgy course. The aluminum mixture composite containing TiO_2 reinforce molecule was delivered to think about the mechanical properties, for example rigidity and hardness. The description are additionally done to clear the stage presence in the composite and the results discuss about the reinforce development with the mechanical properties. Outcomes demonstrate that the development of 5 weight level of $TiO_2$to the complete aluminium increases the mechanical properties.

Vigneshkumar et al, [2015], [27]. Studied metal matrix composite materials are highly important in automotive industries. It works under Al6061/SiCp reinforced metals matrix composite materials to be fabricated in the weight variation of 5%, 10% and 15% SiCp materials. Wear test were conducted in pin-on-disk apparatus. This study gives varies load parameters and prepare Taguchi L27 orthogonal array of experimental design in this test used to analyse the performances such as wear loss and frictional force. It is concluded that in this case reinforcement increases with increase in wear resistance.

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Sharanya Nair et al, [2015], [28]. The growth of producing industries has someplace brought about the growth within the use of composite materials. Metallic Matrix Composites (MMC) are the advanced and new age materials that locate application in sectors like automotive, aerospace, rail additives, protection, etc. due to their mild weight, high power, correct corrosion etc.

P. Subramanian Reddy et al, [2016], [29]. In the current situation, there is high demand to increase the overall performance due to materials in the automotive and aerospace industries. In various composite materials, aluminum matrix composites (AMMC) are mainly used to complement industry expectations. It can be concluded that AMMC material casting techniques resulting from agitation, and also the mechanical properties of many compositions of boron carbide and silicon carbide reinforced aluminum alloy 6061 have also been investigated.

R.S. Ravendra et al [2016], [30]. Scanning Electron Microscope (SEM) analysis is used to take a look at the distribution and homogeneity of the α-Al_2O_3 particles inside the Al6061 matrix. Effects display that addition of α-Al_2O_3 nanoceramic powder as reinforcement has a drastic impact on the mechanical homes like hardness, compression power and ultimate tensile strength of the MMCs when compared with that of the Al6061 matrix. Similarly, the improved % of α-Al_2O_3 nanoceramic powder contributed in increased hardness, compression electricity and final tensile power the MMCs.

Magibalan et al [2017], [31].Various processing technologies for the manufacture of aluminum matrix Composite materials, their mechanical properties test is available.

Pankaj et al [2018],[32].Emphasis is placed on the preparation of metal-based composites of aluminum and its alloys on different typical ceramic powder materials.

Pulkit et al [2019],[33].presents aluminum matrix composite material is widely used in engineering applications. Aluminum matrix composites provide such superior performance that cannot be achieved by any existing monolithic material. The properties of the aluminum matrix composite are highly enhanced by the nature of the matrix, which can be in the form of continuous or discontinuous fibers. It also depends on the processing technology used to produce the aluminum matrix composite, which depends on many factors, including the choice of the patient's type matrix and reinforcement material, the degree of microstructural integrity required and their structure, mechanical, electrical Chemical and thermal properties.

3.SCOPE AND OBJECTIVE

The purpose of this research work is to understand the complex patterns of almost all frictional strengths, which may occur in fly ash metal matrix composites subjected to wear tests and use this knowledge to design new materials with sufficient longevity for various applications. Automobile industry. The following specific goals will be addressed in order to achieve this goal:In order to prove the choice and manufacture of materials.

- Understand and determine the various mechanical properties of fly ash metal matrix composites.
- High performance, high strength, light weight and matrix selection.
- Fabrication of composite sheets under controlled conditions.
- For wear and composite samples, SEM tests were performed in accordance with ASTM standards.
- In order to study the orientation effect of the layer in the SEM and the wear of the metal matrix composite.

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- To understand the effect of thickness on the mechanical properties of the substrate.
- The performance to different samples was compared to the composition.
- Carry out real MATLAB to verify the experimental results.

4. PROPOSED MATERIAL TEST & MODEL

From the above literature survey studies it is concluded that the AMMC material made by casting process, mostly using powder metallurgy (SiC, TiC and TiO_2) and also check the material strength. In this paper the AMMCmaterial fabricate with reinforcing fly ash as composite material (Al6061+resin) and checks the material properties. Through the analysis, results like fatigue, wear and SEM are carried out for the prediction of stability, durability and bonding of the materials. By making specimen sizeas 150x150x150 mm cube with different ratio of mixing the mixture with the following material:

Fly Ash = 10 - 25%

Al6061 = 60 - 90%

Epoxy Resin = 0 - 15%

4.1. MATERIAL DETAILS

- Al6061
- Fly ash
- Epoxy resin

Al6061

Aluminium alloy 6061 in this material most broadly used of the 6000 series aluminium alloys. It is an adaptable heat treatable extruded alloy with average to high strength capabilities.

Physical Properties

- Density: 2700kg/mm^3
- Melting Point: Approx. 620ºC
- Modulus of Elasticity: 70-80 GPa
- Poisson’s Ratio: 0.33

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Table 1 Composition of Al6061 Alloy

S. No.	Components	Amount (Wt. in %)
1	Aluminium	Balance
2	Magnesium	0.8 - 1.2
3	Silicon	0.4 - 0.8
4	Iron	Max. 0.7
5	Copper	0.15 - 0.40
6	Zinc	Max.0.25
7	Titanium	Max. 0.15
8	Manganese	Max. 0.15
9	Chromium	0.04 - 0.35
10	Others	0.05

Key Properties

- Good toughness.
- Good surface finish.
- Good workability.

Applications

- Aerospace industries.
- Marine industries.
- Automobile industries.

Fly Ash

Fly ash is determined from the burning of power plants to pulverized coal. In order to burn, the mineral impurities of the coal last and go with the exhaust gas out of the chamber. As the molten material rises, it cools and solidifies into round glass pieces called fly ash.

Key Properties

- Slower strength gain.
- Seasonal limitation.
- Increase in air entraining mixtures.

Applications

- Blocks.
- Paving or bricks.

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Epoxy Resin

Epoxy resins represent some of the highest performance resins available at this time. The expression of an epoxy resin refers to a chemical structure in which the oxygen atoms bonded to two carbon atoms have been bonded in the same manner.

Key Properties

- Excellent mechanical strength.
- Low curing contraction.
- Excellent resistance to heat.
- Excellent adhesive strength.

Applications

- Industrial tooling.
- Wind turbine.

5. EXPERIMENTAL SETUP AND PROCEDURE

Specimen Preparation

In this experimental setup the combination of aluminium 6061, fly ash and epoxy resin are used. In this metal matrix composite material mixing ratio is given in Table 2. This matrix composition was selected as it provides an excellent combination of stability and elevated temperature.

Table 2 Composition of Matrix and Reinforcement in % Weight (wt)

Samples	Al6061 (wt in %)	Fly ash (wt in %)	Epoxy resin (wt in %)
1	60	25	15
2	70	20	10
3	80	15	5
4	90	10	0

Table 2 provides the details of Al6061, fly ash and epoxy resin, which are used as matrix and reinforcements. This matrix composite material is manufactured in United Manufacture India (UMI), at Sangakiri, India.

In this experimental setup metal matrix composites materials in stir casting method is manufactured. This process is easy and inexpensive method for manufacturing of reinforced metal matrix composite material. The MMC is used to achieve the optimal properties.

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Fig 1 Stir Casting Method

Al6061, Fly ash and Epoxy resin were fabricated by stir casting method. These casted composite specimens have been machined as per test standards. After machining the specimen with different ratio mixing of metal matrix composite materials and testing wear resistance test, fatigue test are checked.

Table 3Properties of Matrix and Reinforcement

Material	Density kg/m^3	Melting Temperature ^0C
Al6061	2700	620
Fly ash	994	1400
Epoxy resin	1.1-1.4	177

6. TESTING OF COMPOSITE

The following tests were conducted to determine the properties of composite materials.

6.1. Wear Test

Wear test were conducted on pin on disc machine. Specimens were machined as per standard test size. The working contact surface is cleaned by acetone. Wear test experiment is conducted at atmospheric room temperature. The wear tests were conducted for four samples of material with different ratio. The different ratio composite material is shown in Table 2.

Wear rate = Wear Volume/(Normal Load x Sliding Distance).

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Wear rate = V_i/F x Smm^3/Nm

V_i = Wear volumein mm^3

F = Load in N

S = Sliding distance in mm

Fig 2 Pin On Disc Tester

DESIGN OF EXPERIMENT

Table 4 First Sample, DifferentMixing Ratio of Al6061 60%, Fly Ash 25% and Epoxy Resin 15%

Sliding velocity in mm/s	Normal load in N	Sliding distance in mm	Wear rate in mm^3/Nm
1.5	10	100	0.00287
3	20	150	0.00285
4.5	30	200	0.00282

Table 5 Second Sample, Different MixingRatio of Al6061 70%, Fly Ash 20% and Epoxy Resin 10%

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Sliding velocity in mm/s	Normal load in N	Sliding distance in mm	Wear ratein mm^3/Nm
1.5	10	100	0.00308
3	20	150	0.00305
4.5	30	200	0.00301

Table6 Third Sample, Different Mixing Ratio of Al6061 80%, Fly Ash 15% and Epoxy Resin 5%.

Sliding velocity in mm/s	Normal load in N	Sliding distance in mm	Wear rate in mm^3/Nm
1.5	10	100	0.00325
3	20	150	0.00328
4.5	30	200	0.00323

Table 7 Fourth Sample, Different Mixing Ratio of Al6061 90%, Fly Ash 10% and Epoxy Resin 0%.

Sliding velocity in mm/s	Normal load in N	Sliding distance in mm	Wear rate in mm^3/Nm
1.5	10	100	0.0034
3	20	150	0.00338
4.5	30	200	0.00335

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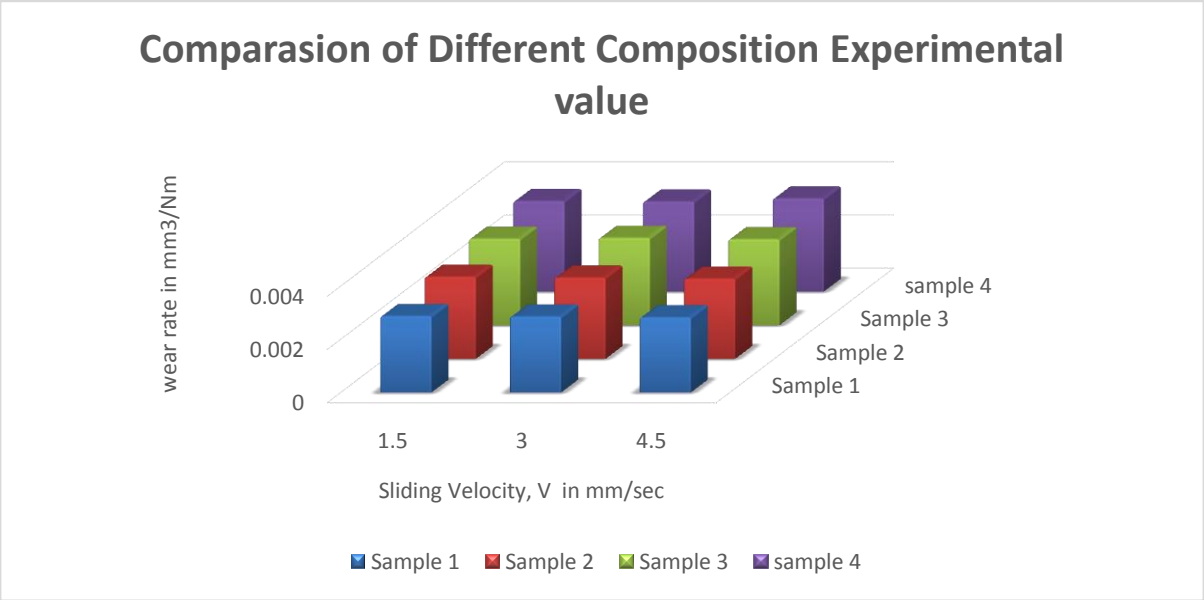

Fig 3 Comparison of Different Composition Material Experimental Value

6.2. Fatigue Test

Fatigue approach tiredness, as human beings do equal task again and again. Equal as for structural or mechanical when a load acts in repeated or cyclic way it ends in cyclic variation in stress and pressure

Within the component, i.e., the issue subjected to anxiety and compression repeatedly. Fatigue is premature failure of the aspect. Any variable loading is fatigue. Loading means load changes with respect to time.

Test Procedure: The standard specimens are machined according to ASTM standards. The specimens are refined in order to reduce the surface roughness and geometrical irregularities. The specimens are examined in INSTRON fatigue testing machine on the frequency of 15Hz. The specimens are subjected to stress above the endurance limit like 300 MPa, 270 MPa, 220 MPaand 180 MPa.

Table 8 Fatigue Test Results of Al6061, Fly Ash and Epoxy Resin Composite Specimens

Samples	Max Load (N)	Strength (N/mm^2)
1	3712500	165
2	3037500	135
3	2362500	105
4	1912500	85

$$\text{Strength} = \frac{Load}{Area}$$

$$= \frac{3712500}{150\ X\ 150}$$

$= 165\ N/mm^2$

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6.3. Microstructure Analysis

A scanning electron microscope (SEM) was used to analyze the distribution of the fly ash and epoxy particles in the base material 6061 aluminum SEM by scanning the image with the focused electron beam to produce a sample. The interaction with the electrons on the atoms in the sample produces a variety of signals containing information about the composition of the surface of the sample. Electron beam scanning typically combines the position of a raster scan pattern with a beam of light with a detected signal to produce an image. The non-uniform distribution of uniform and enhanced particles was confirmed by using SEM analysis.

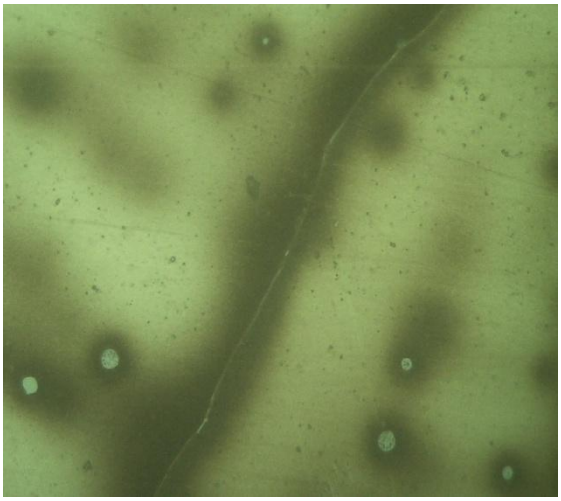

Fig 4 shows first sample, thefly ash traces observed and enablethe crack to initiate and also to propagate. To eliminate this problem, the epoxy resin of reinforcementshould be maintained constant before mixingwith the matrix.

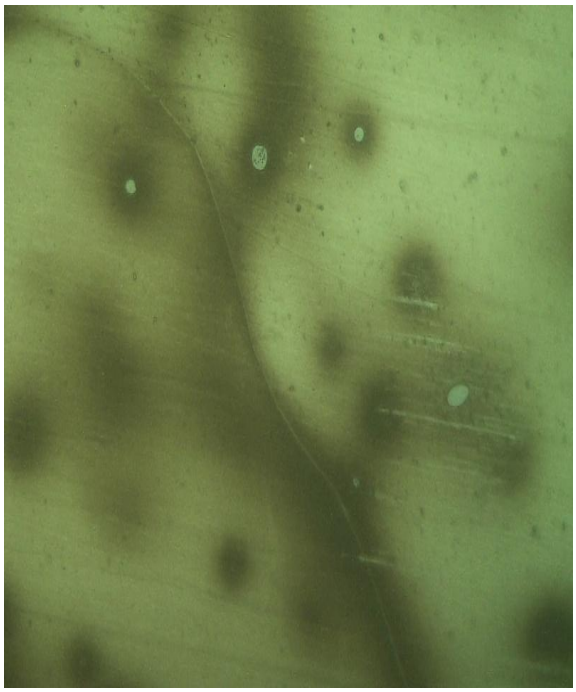

Fig 5 shows second sample, the accumulation of the aluminium matrix due toimproper stirring.

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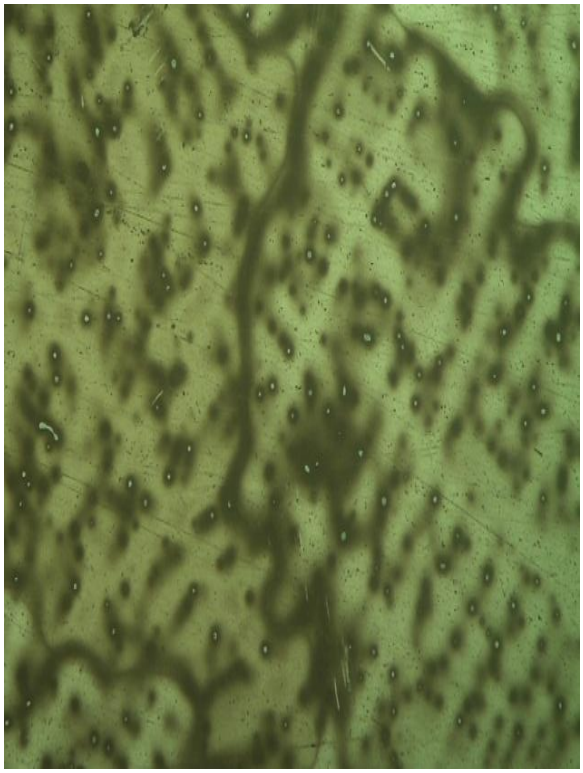

Fig 6 third sample, in this SEM analysis shows how the plate will fractured the combination of different mixing ratio of Al6061 80%, Fly ash 15% and Epoxy resin 5%.

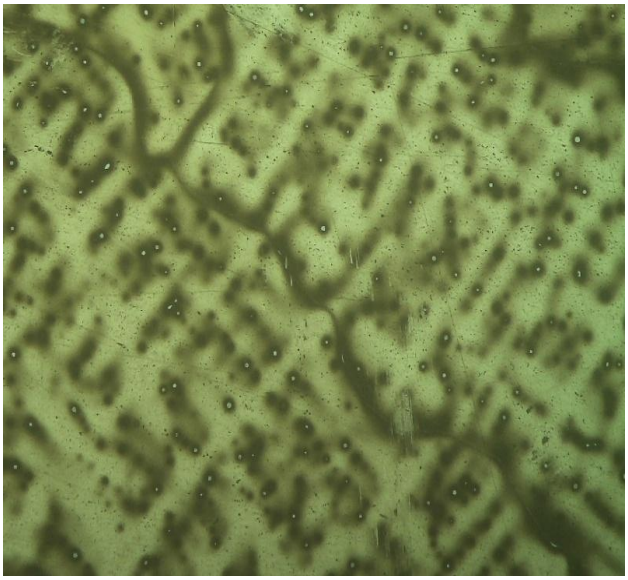

Fig 7 showsfourth sample, the distribution of aluminiummolecules and reinforcements are visible in thisimage. This image shows the crack involved in the sample

CONCLUSION

- Al6061 metal matrix composite materials have been successfully fabricated by stir casting method with the composition of fly ash and epoxy resin.
- In this work, the stir casting technique is used for the fabrication of aluminum metal matrix composites with different compositions of Al6061, Fly ash and Epoxy resin. Of the different samples tested, sample

1 (60 % Al6061, 25 % Fly ash and 15 % Epoxy Resin) has less wear rate (Shown in Table 4) and increased strength in fatigue test (Shown in Table 8 and Fig 4) compared to other samples.

- Due to the presence of epoxy resin and the high amount of aluminum contained in the fly ash, more energy complex sample 1 was absorbed.
- This work can be further extended by comparing composites made with different casting methods and comparing the mechanical properties of the composites.
- In the combination of Al6061, Fly ash and epoxy resin ratio will increase the time of wear and fatigue strength.
- In experimental setup using Scanning Electron Microscope (SEM) analysis, among all four combinations it is arrivedthat the sample 1 microstructure level is good condition.

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