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A Study on Mechanical and Tribological Properties of Al Alloy 7068 MMC's Reinforced with SiC and Tur-Husk

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ABSTRACT

There is a growing need for composites made of aluminum metal. The hybrid nature of the composite is due to the addition of the third element to the metal matrix. Aluminum 7068 was employed as the matrix, while Silicon Carbide and Alumina were used for reinforcing. To examine how the proportion of reinforcement affects the aluminum's properties, we experiment with different values. The first sample is Al7068 with 2% SiC and 8% Al2O3, the second sample is Al7068 with 4% SiC and 6% Al2O3, the third sample is Al7068 with 6% SiC and 4% Al2O3, and the fourth sample is Al7068 with 8% SiC and 2% Al2O3. Stir casting is used to get the necessary components. The composite specimens were machined to ASTM specifications after being cast. The purpose of this research is to examine the mechanical and tribological characteristics of Al-7068 alloy that has been reinforced with SiC and Al2O3 composite with varying weight fractions.

Keywords— Metal matrix composite, Reinforcement, Mechanical properties, Tribological properties

I. INTRODUCTION

1.1 OVERVIEW OF COMPOSITES

Composites, plastics, and ceramics have dominated the market as new materials for the last thirty years. Composite materials have expanded in both volume and variety of uses, continually invading and dominating new sectors. Composites have come a long way in the last several decades, and now they make up a sizable chunk of the engineered materials industry for anything from commonplace items to highly specialized ones. Despite composites' established value as lightweight materials, the present difficulty is to make them economically viable. In an attempt to create commercially viable composite parts, the composites sector has developed a number of cutting-edge production processes. It's clear that, in particular for composites, advances in manufacturing technology aren't adequate to overcome the price barrier by themselves. For composites to compete with metals, there must be a concerted effort across design, material, process, tooling, quality assurance, production, and even program management. Due to the massive scale of the transportation industry, the composites industry has come to realize that the commercial uses of composites promise to give considerably greater business potential than the aerospace sector.

As a result, in recent years composites' utilization has shifted away from airplanes and into other commercial applications. New polymer resin matrix materials and high performance reinforcing fibers of glass, carbon, and aramid have greatly facilitated the widespread use of these cutting-edge technologies. The anticipated cost savings are a direct outcome of the volume increase. Composite armoring built to withstand explosive hits, natural gas car fuel cylinders, windmill blades, industrial drive shafts, highway bridge support beams, and paper producing rollers are just some of the many modern uses for high performance FRP. When compared to metals, composites are lighter and may save costs when used in certain situations. Engine cascades, curved fairing and fillets, replacements for welded metal components, cylinders, tubes, ducts, bands to confine blades, etc. are all good examples. In addition, there is a strong focus on the adoption of innovative and sophisticated materials that not only reduce dead weight but also absorb the shock & vibration via designed microstructures to meet the need of composite for lighter building materials and more seismically resistant structures.

In order to make existing buildings more earthquake-proof or to repair damage brought on by earthquakes, composites are increasingly widely employed in the rehabilitation and strengthening processes. In contrast to more traditional materials like steel, composites may have their characteristics tailored to specific applications. The interface between two or more physically and/or chemically different, adequately organized or dispersed phases is what makes a material a composite. There are aspects to it that can't be captured by looking at the parts separately.

1.2 DEFINITION OF COMPOSITE

By far the most common definition is Jartiz's: "Composites are multifunctional material systems that give properties not obtained from any individual material." It's the process of physically joining together two or more materials that are cohesive yet have distinct composition, features, and even shape. The flaw in this description is that it permits any combination of elements to be categorized as a composite, without providing any indication of the distinctiveness of the mixture or the rules which should be given to it to separate it from other relatively boring, meaningless mixes.Kelly makes it very evident that the composites are not just a simple mix of two elements. The combination has unique characteristics in the wider sense. It's superior to both parts separately or quite different from both parts in terms of strength, heat resistance, or any other desired feature. Composites, as defined by Beghezan, are "compound materials" that "differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not their short comings," resulting in superior products. According to Van Suchetclan, composites are heterogeneous materials containing two or more solid phases that are in close contact with each other on a microscopic scale. On a microscopic scale, they may be thought of as homogenous materials since their properties are uniform throughout.

II. LITERATURE SURVEY

[1] YOUHIZAMA ‘Evaluation Of Mechanical Properties Of Al6063 MMCs Reinforced With Nano Sic,Tur Husk And E-Glass Fiber’. According to the authors' research, composites have emerged as the material of choice for cutting-edge commercial projects. Heterogeneous systems consisting of matrix and reinforcement are metal matrix composites. You may modify their mechanical and physical features to suit your needs. They have widespread use in the automotive, aerospace, and maritime sectors. High tensile strength, toughness, hardness, low density, and superior wear resistance are only some of the ways in which metal composites outperform alloys and other metals.This research focuses on the mechanical characteristics of a hybrid metal matrix composite based on aluminum alloy (Al6063) and reinforced with Nano silicon carbide, glass fiber, and tur husk. Stir casting was used to create the sample specimens with varied percentages of reinforcement relative to aluminum alloy. Each of the three sets of reinforcements consists of three samples. Each set of specimens has a different composition, with 1% Nano SiC, 2% Nano SiC, and 3% Nano SiC, while the tur husk and glass fiber components vary by 1% and 2%, respectively. The composite castings were machined in accordance with ASTM specifications. Ultimate tensile strength, impact resistance, and wear behavior were some of the mechanical qualities tested for.

[2] MOHAMMED ZAFAR ALI , A Study on Mechanical and Tribological Properties of Aluminium 7075 MMCs Reinforced with Nano Silicon Carbide (SiC), Tur Husk and E-Glass Fiber. According to the authors' research, composites have emerged as the material of choice for cutting-edge commercial projects. The ability to tailor the qualities of aluminum alloys via design has made them the material of choice. Metal matrix composites (MMCs) made of aluminum alloy are gaining popularity in the automotive, industrial, and aerospace industries due to their lightweight, high strength, and excellent structural stiffness. The current work aims to produce and study the mechanical and tribological characteristics of Al-7075 Reinforced with Nano SiC, Tur Husk, and E-Glass fiber. We used the liquid metallurgy (stir cast) technique to make Al-7075 composites of varied compositions. In accordance with ASTM guidelines, the composite samples were machined for testing. Ultimate tensile strength, coupled with compressive strength and hardness qualities, are all greatly enhanced with the inclusion of Nano SiC, Tur Husk, and E-Glass fiber compared to the unreinforced matrix. Each of the three sets of reinforcements consists of three samples. Each set of specimens has a different composition, with 1% Nano SiC, 2% Nano SiC, and 3% Nano SiC, while the tur husk and glass fiber components vary by 1% and 2%, respectively. The composite castings were machined in accordance with ASTM specifications. Test specimens had their mechanical qualities examined, including their ultimate tensile strength, impact strength, and wear behavior.

3]JITHIN JOSE, research on the mechanical and wear aspects of hybrid metal matrix composites made from al7075, zircon, and flyash According to the authors' research, composites have emerged as the material of choice for cutting-edge commercial projects. Composites consist of a matrix phase and a reinforcing phase. The majority of research indicates that component-level materials should have enhanced mechanical and tribological qualities. We used stir casting to make four samples for this study. The first sample is pure Al7075, the second has 3% Zircon, the third contains 6% Fly Ash, and the fourth contains both 3% Zircon and 6% Fly Ash. The addition of Zircon and Fly Ash to Al7075 improved its tensile strength and hardness. Zircon and Fly Ash may reduce wear in Al7075. Scanning Electron Microscope researches microstructure to learn about wear.

[4] MADHUSUDHAN, research on the mechanical properties of metal matrix composites reinforced with Al7068-ZrO2 The proportion of Zirconium dioxide particles in composites led to a considerable increase in Hardness and Tensile strength. Predictably, as the proportion of reinforcement in the aluminum matrix grew in weight, the percentage of elongation decreased.

[5] ARUN KUMAR M. B. AND R. P. SWAMY 'evaluation of mechanical properties of al6061,flyash and e-glass fiber reinforced hybrid metal matrix composites'. Composites comprising flyash, e-glass fiber, and Al6061 alloy were produced using the liquid metallurgy (stir cast) technique, with flyash content at 2%, 4%, 6%, and 8%. The composite test specimens that were cast were machined to specification. Ultrasonic flaw detector testing was performed on the samples to identify typical casting flaws. We have analyzed its mechanical characteristics and compared them to those of Al6061 alloy. As the flyash weight percentage rises, the material's tensile characteristics, compressive strength, and hardness all show substantial improvements. The composites' microstructures were analyzed to learn about the distribution of flyash and e-glass fiber inside the matrix. It has been shown that compared to an unreinforced matrix, adding flyash greatly increases ultimate tensile strength, as well as compressive strength and hardness qualities.

III. PROBLEM STATEMENT

No studies have been conducted on AL-7068 with sic and tur husk, despite the fact that there has been extensive work on composites involving AL-7075 with Nano Sic, AL-7075 with E-glass fiber, AL-7075 with Sic and red mud, AL-7075 with (Sic and rice husk), AL-7075 with (Sic and fly ash), and AL with coconut shell powder and E-glass fiber.

By adding Sic, turhusk powder—which modifies the tribological characteristics of an alloy to a certain extent—and examining these parameters in accordance with specified standards, it is possible to more thoroughly investigate the mechanical and tribological behavior of aluminum in hybrid metal matrix composites.

To create a novel composite material based on aluminum alloys. To be used in manufacturing settings like the car and aerospace sectors, it has to be lower in weight and more resistant to wear. Using tur husk in conjunction with metal alloys is an area that has seen very little research.

3.1 PROPOSED WORK

Studying the mechanical and tribological behavior of aluminium alloy 7068 reinforced with different % compositions of Silicon Carbide (SiC), Tur Husk using a stir casting process presents certain challenges. Changes in wear characteristics and mechanical behavior were considered. In order to expedite the manufacture of necessary MMCs, an experimental set up was constructed. The goal of this research is to determine how changes in the percentage composition affect mechanical and tribological qualities, such as tensile strength, impact test (V-notch) and wear resistance. Percentage-based samples were prepared and used to complete the task. Using a universal testing machine (UTM) for tensile testing, a charpy impact tester (CIT), and a computerized Pin on disc wear testing machine (PWT) for sliding wear testing in dry conditions.

3.2 OBJECTIVES

- With the goal of analyzing the model's strength and stiffness, we settled on the objective's 'cheap cost and deliver the best outcome' features.
- The purpose of this stir casting procedure is to make a high-quality hybrid composite.
- The purpose of this research is to examine how heat treatment affects the mechanical and tribological characteristics of hybrid composites.
- The primary goals of developing hybrid metal matrix composites (HMMC) are:
- Hybrid composites of Al7068 alloy with Silicon Carbide (SiC) and Tur Husk will be created using a stir casting technique.
- The goal of this research is to learn how the tensile strength, impact (V-notch), and wear rate of metal matrix composites change with varying percentages of reinforcement by weight.

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The tests performed on different types of specimens are as follows:

- Tensile Strength (Universal testing machine, UTM)
- Impact Test (V-notch Charpy Test Machine)
- Wear Test (Computerized Pin On Disc Machine).

IV. METHODOLOGY

For the composite to have excellent tribological characteristics, it must have strong interfacial bonding between the metal matrix. Using a stir casting technique, we're perfecting the casting of Al-7068 with varying amounts of (Sic, turhusk powder) as a reinforced material. Next, follow established procedures for creating composite specimens for testing. Because of the unique design of each testing instrument, a wide range of results is conceivable. After that, we make a composite out of the test material using a stir casting procedure to create an aluminum alloy matrix and (Sic) turhusk powder for reinforcement. The mechanical and tribological characteristics of the cast aluminum composite are next investigated.

4.1 MACHINES USED TO TEST DIFFERENT PARAMETERS OF SAMPLES

Tensile Testing Machine

Using a UTM, we can measure the composite's tensile strength. Produced to the specifications of BS: 18: 1962. The parameters of the sample are 100mm in total length, 50mm in gauge length, 25mm in grip section length, and 12mm in grip diameter.The force applied and the specimen's lengthened extension are both measured in a tensile test. The modulus of elasticity, elastic limit, elongation, proportional limit, area reduction, yield strength, and yield point may all be calculated using a tensile test. The material's tensile characteristics determine its response to tensional pressures. A tensile test is a basic mechanical test in which a prepared specimen is subjected to a regulated load and the applied force and elongation of the specimen over some distance are measured. Maximum allowable engineering stress during a tensile test is known as the ultimate tensile strength (UTS) or simply the tensile strength. One measure of a material's strength is its resistance to breaking under stress. Here we see the universal testing machine and the tensile test specimen.

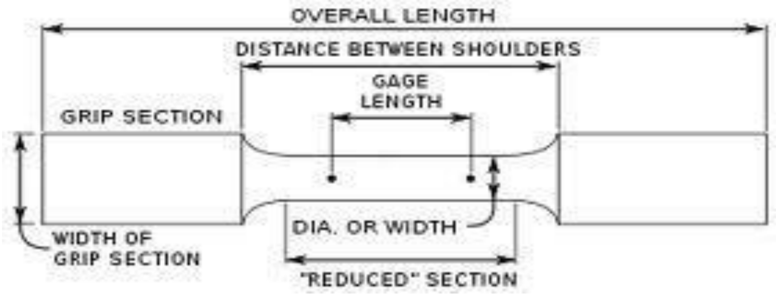

Fig. 1: Tensile test specimen

Dimensions of tensile specimen

Here the Overall length=160mm
Gauge length =50mm
Grip section length=25mm
Dia=12.5mm
Grip dia=20mm

Fig. 2: Tensile Testing Machine

Fig. 3: Tensile Testing Specimen

IMPACT TESTING MACHINE

Charpy testing may reveal a material's resistance to impact. While fracture mechanics calculations do not make use of impact characteristics, these tests are nonetheless employed as a quality control measure to evaluate notch sensitivity and to evaluate the relative toughness of engineered materials. The pendulum's impact on the specimen causes a single overload event that causes the specimen to fail. The pendulum is swinging at a 900 degree angle.You may keep track of how high the pendulum rebounds after breaking the specimen using a stop pointer. One way to evaluate the resilience of a metal under impact is to see how much force it can take before cracking. All you have to do is measure how high the pendulum swings when it hits the specimen and compare that to how high it was before you launched it. An ASTM (A370)-compliant sample is available for a small fee. The length, width, and height of the specimen are 55mm 10mm 10mm.a 45-degree V-cut out of the side, 2mm deep. Images below of impact testing machine and impact test specimen.

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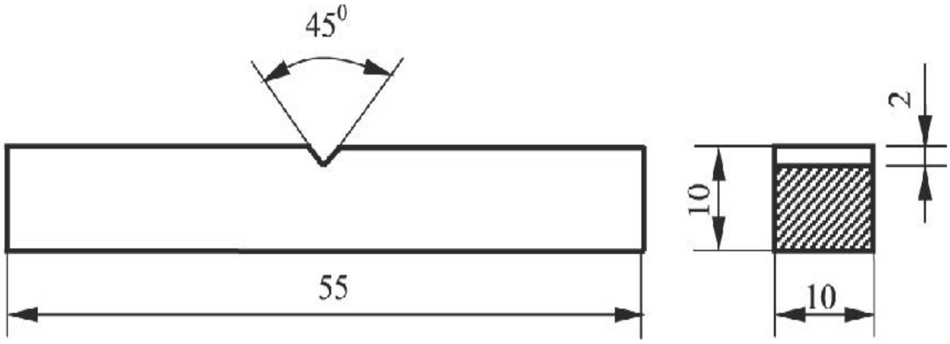

Fig. 4: Impact test specimen

Fig. 5:Impact Testing Machine

Fig. 6: Impact testing specimen

Wear Testing Machine

Dry sliding wear tests for different number of specimens was conducted by using a pin-on-disc machine (Model: Wear & Friction Monitor TR-201 CL DST- FIRST)

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Fig. : 7(a) Pin on disc wear testing machine, (b) Display unit

A disc with a 60-millimeter-wide worn track provided the counterforce needed to keep the pin in place while the disc rotated. A dead weight loading method pressed the pin into the disc. All of the materials were put through their paces using a 60 mm track diameter, a 2 kg weight, and a sliding speed of 600 rpm. Before each test, the pin samples' surfaces were cleaned using emery paper (80 grit size) to guarantee a clean, flat contact with the steel disc.

Wear occurs when one or both of two solid surfaces in solid-state contact lose material. Surface modification of already existing alloys is preferable to utilizing wear resistant alloys since wear is a surface removal event that happens mostly on exterior surfaces.

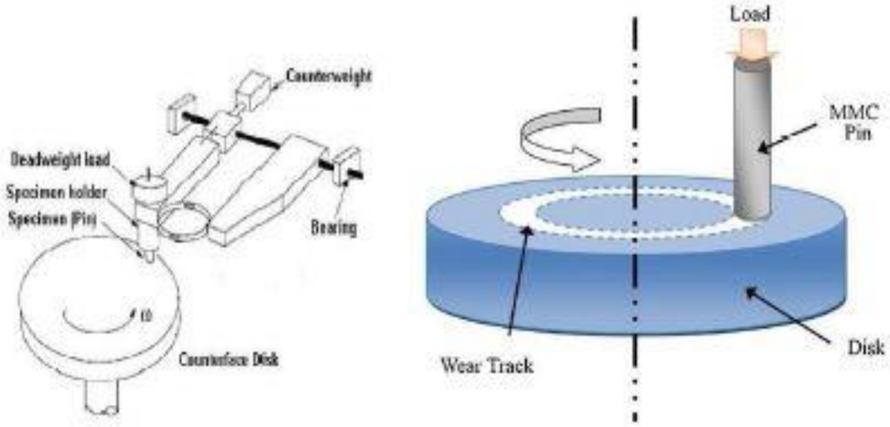


Figure 8 Schematic Views of Pin-On-Disk Apparatus

Figure 9: Experimental set up of wear test

Fig 10. Wear testing specimen

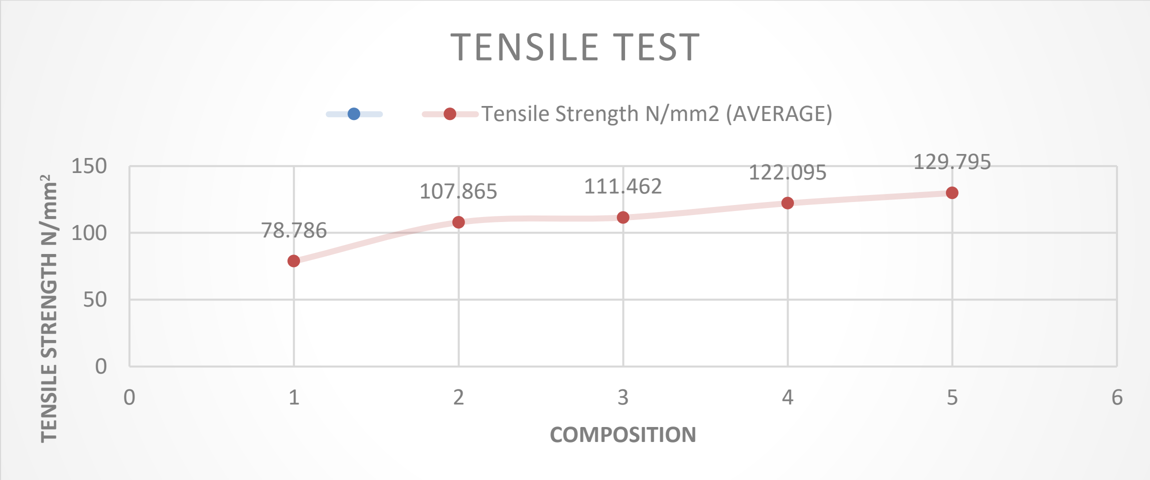
V. RESULTS AND DISCUSSION

5.1 TENSILE TEST

A tensile test, often known as a tension test, is one of the simplest Mechanical tests you may do on a sample of material. A tensile testing specimen machined to ASTM E8 standards. We used a Universal Testing Machine to perform tensile testing on these materials at ambient temperature. The repeatability of this specimen is 1 in 160, the overall length is 160mm, the gauge length is 50mm, the grip section length is 25mm, and the grip diameter is 12.5mm. Specimens of composites with varying amounts of reinforcement were tested. Tests in tension provide the following data table. Specimen S4, made up of AL-7068, 8% SiC, and 2% Tur husk, had the highest ultimate tensile strength (129.795N/mm2) of all the samples evaluated.

Table 1: Results of Tensile Test

SL.NO	Sample Name	Composition	Tensile Strength N/mm^2 (Trial 1)	Tensile Strength N/mm^2 (Trial 2)	Tensile Strength N/mm^2 (AVERAGE)
1	S	AL-7068 Pure	77.052	80.520	78.786
2	S1	AL-7068+2%SiC+8%Tur Husk	107.004	108.726	107.865
3	S2	AL-7068+4%SiC+6%Tur Husk	76.639	146.286	111.462
4	S3	AL-7068+6%SiC+4%Tur Husk	122.026	122.165	122.095
5	S4	AL-7068+8%SiC+2%Tur Husk	123.016	136.575	129.795



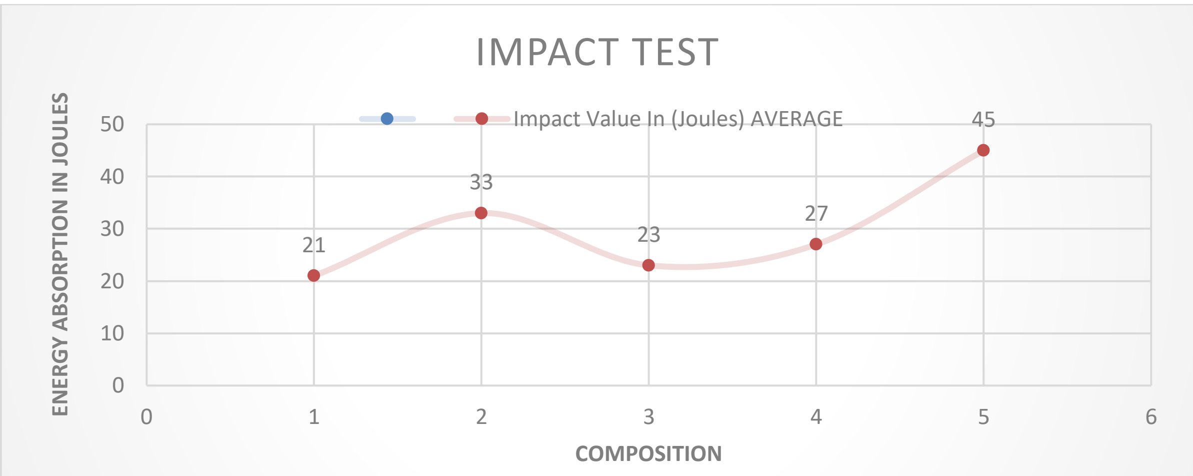
Graph 1: Tensile Test

5.2 IMPACT TESTING

Charpy testing, which measures the energy absorbed by a material during fracture, is another name for impact testing. Machined impact test/Charpy V-notch test is an ASTM A370-compliant standard high strain-rate test. At room temperature, we performed impact experiments by smashing a specimen with a pendulum and recording the resulting data. The table presents the results of the impact test. Specimen S4, composed of 8% SiC +2%Tur husk, had the highest Impact strength (45 joules) of all the samples examined.

Table 2: Results of Impact Test

SL.NO	Sample Name	Composition	Impact Value In (Joules) Trial 1	Impact Value In (Joules) Trial 2	Impact Value In (Joules) AVERAGE
1	S	AL-7068 Pure	22	20	21
2	S1	AL-7068+2%SiC+8%Tur Husk	32	34	33
3	S2	AL-7068+4%SiC+6%Tur Husk	22	24	23
4	S3	AL-7068+6%SiC+4%Tur Husk	26	28	27
5	S4	AL-7068+8%SiC+2%Tur Husk	44	46	45



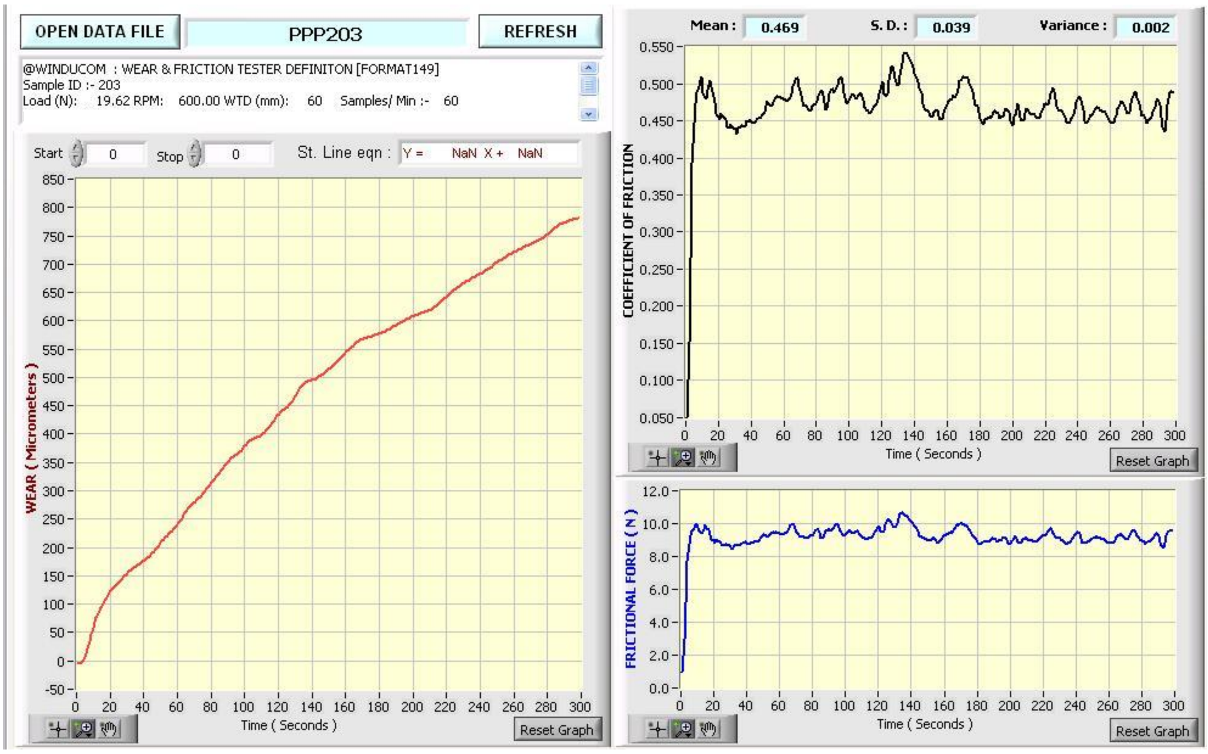
Graph 2: Impact Test

5.3 WEAR TESTING

Wear is a phenomenon involving the progressive loss of material. Friction causes a gradual wearing away of both touching surfaces while they are moving in opposite directions. We used a dry sliding wear testing system to submit the specimens to wear against a revolving EN-32 pin on disc. For 300 seconds, we ran the tests dry at ambient temperature.The variables in this test are 60mm track diameter and 300 seconds. Comparison of the alloys with varied amounts of SiC in addition to aluminum reveals the properties. The data demonstrates that an Al-7068+2%Sic+8% specimen spun at 600 rpm while weighing 2 kilogramTur Hus is less worn than the Al-7068+4%Sic+6% specimen.Highest wear on a tur husk is at 1010 m.The table below details the wear test findings.

Table 3: Results of wear Test

SL NO	Load (N)	Sliding Speed (RPM)	Sliding Time (sec)	Wear Rate (µm)
Al7068 Pure	20	600	300	785
Al7068+ 2% SiC+8%Tur Husk	20	600	300	490
Al7068+ 4% SiC+6%Tur Husk	20	600	300	1010
Al7068+ 6%SiC+4%Tur Husk	20	600	300	885
Al7068+ 8%SiC+2%Tur Husk	20	600	300	700



Graph 3: Specimen S (Pure)

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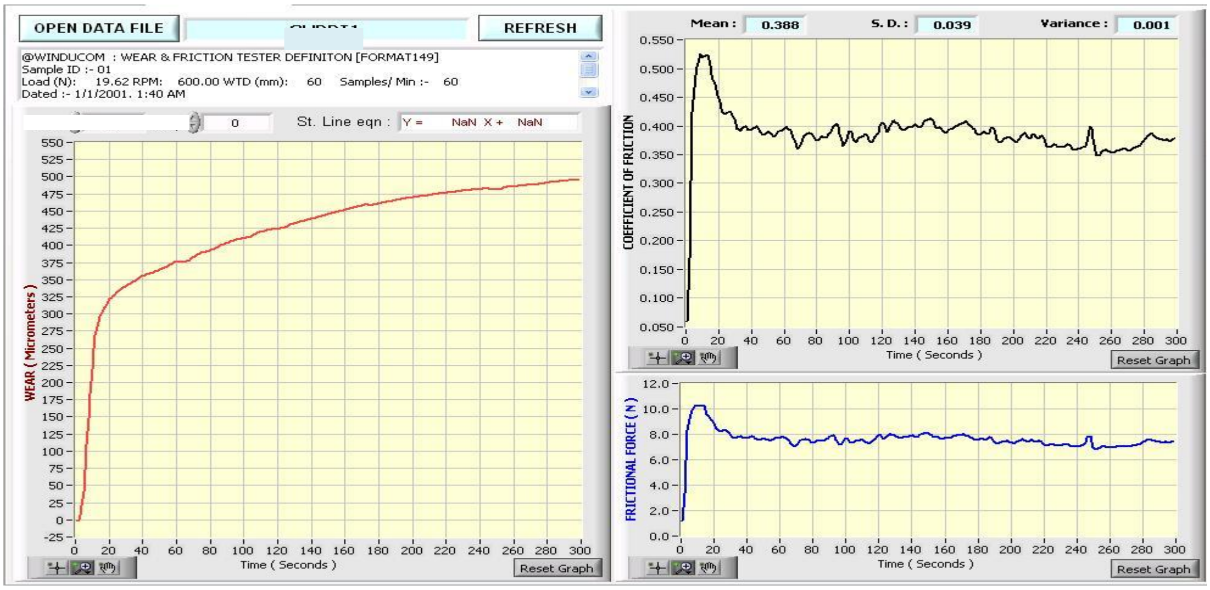
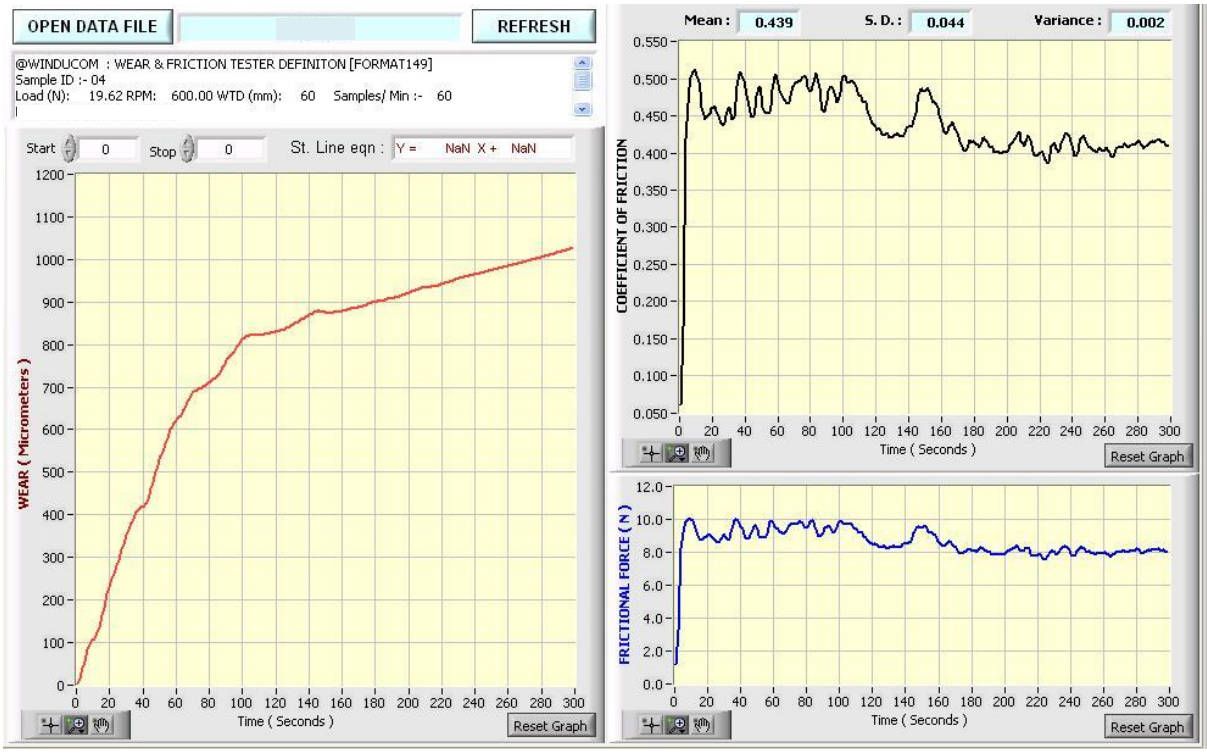
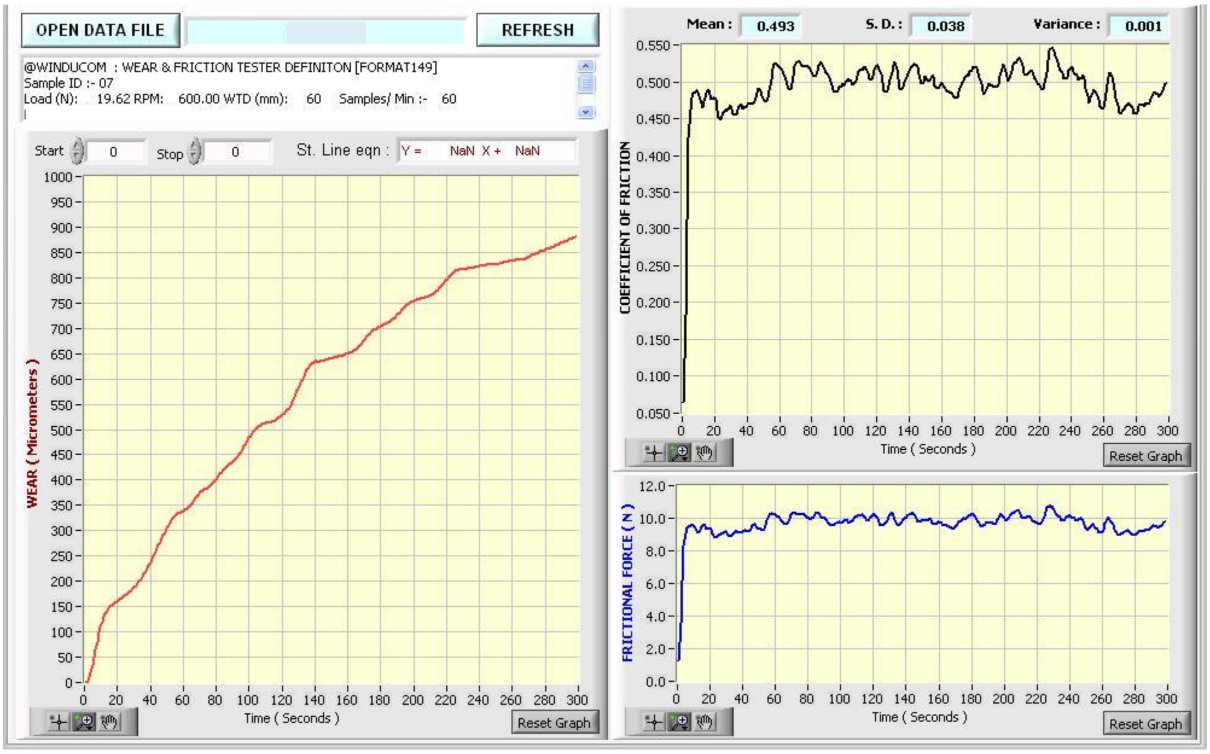


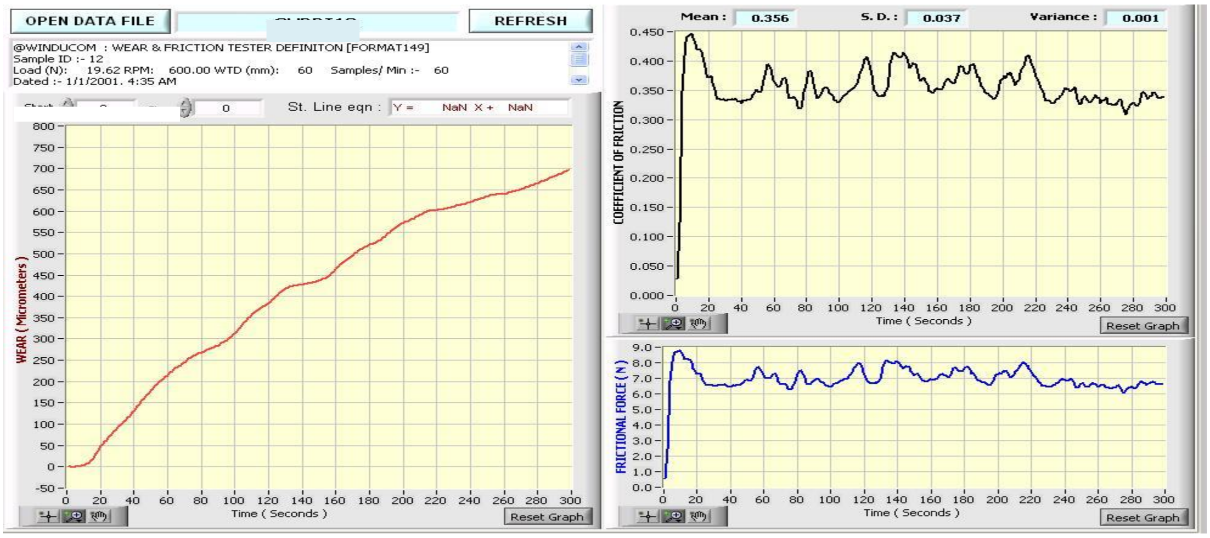
Graph 4: Specimen S1



Graph 5: Specimen S2

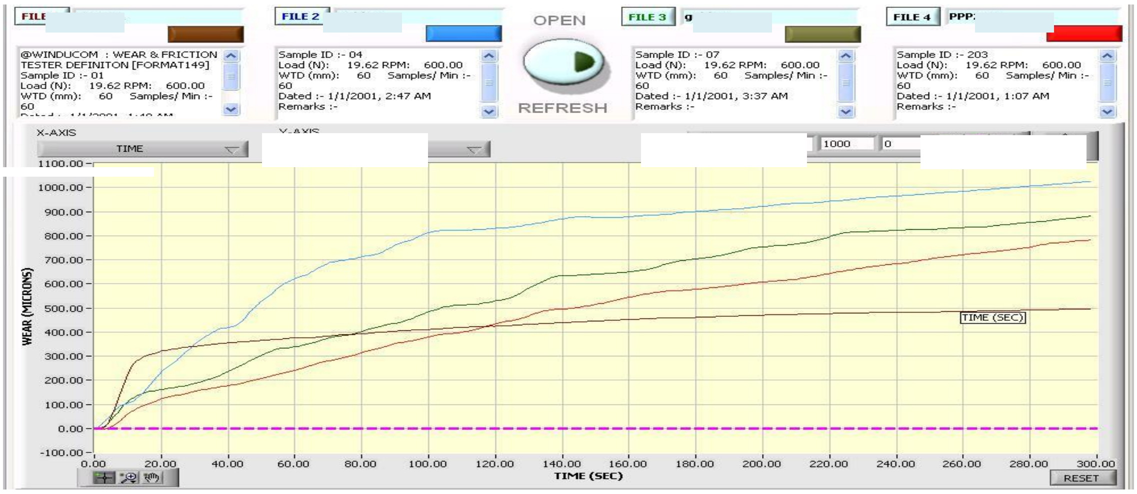


Graph 6: Specimen S3



Graph 7: Specimen S4

Graph 8: Comparison of specimens S1, S2, S3, and S4



Graph 9: Comparison of Specimens S, S1, S2, S3

VI. CONCLUSION AND SCOPE FOR FUTURE WORK

6.1 CONCLUSION

The following are the results of studies conducted on hybrid metal matrix composites of the Al7068/SiC/Tur Husk type.

- The addition of 8%SiC and 2% Tur Husk to AL7068 boosts both the material's tensile strength and yield stress by up to 40%.
- The addition of 8%SiC and 2% Tur Husk to AL 7068 increases the material's impact energy absorption by up to 53%.
- Al7068+2% SiC + 8% Tur Husk had the lowest wear rate of the four composites.
- When compared to Al-7068 Alloy, the tensile strength of AL7068+8% SiC+2%Tur Husk is the highest among the four compositions.
- Compared to Al-7068 Alloy, AL7068+ 8% SiC+ 2%Tur Husk showed superior results in terms of energy absorption.
- AL7068+ 2%SiC+ 8%Tur Husk outperformed other composites and alloys in a wear resistance enhancement study.

6.2 SCOPE FOR FUTURE WORK

Production techniques like powder metallurgy and die casting should be considered. Changing the geometric stirrer angle and the stirring speed will allow us to go further deeper into this topic. Altering the reinforcement weight % may provide various outcomes. Changes in reinforcing Grain Size provide for a wide range of outcomes. It is possible to alter the characteristics by heat treatment.

REFERENCE

1) Sachin Malhotra, Ram Narayan and R.D Gupta, “Synthesis and Characterization of Aluminium 6061 Alloy-
2) Flyash and Zirconia Metal Matrix Composite” , Int. J curr Eng. Tech., vol. 3, pp.1717-1719, 2013.
3) M.Sreenivasa Reddy, Soma V. Chetty and Sudheer Premkumar , “Effect of reinforcements and heat treatment on tensile strength of Al-Si-Mg based hybrid composites” , Int. J. Appl. Sci. Eng. Res., vol. 1, pp.176- 183, 2012.
4) J.Jebeen Moses, I.Dinaharan, S.Joseph Sekhar , “Characterization of silicon carbide particulate reinforced AA6061 aluminum alloy composites produced via stir casting” , Proc. Mat. Sci., vol. 5, pp.106 – 112, 2014.
5) R. Pradeep, B.S Praveen Kumar, and B.Prashanth, “Evaluation Of Mechanical Properties Of Aluminium Alloy 7075 Reinforced With Silicon Carbide And Red Mud Composite”, Int. J. Eng. Res. Gen. Sci., vol. 2, pp.1081-1088, 2014.
6) J.Jenix Rino, D. Sivalingappa, Halesh Koti and V.Daniel Jebin, “Properties of Al6063 MMC Reinforced With Zircon Sand and Alumina”, J Mech. and Civil Eng., vol.5, pp.72-77, 2013.
7) R. Flores-Campos, D.C. Mendoza-Ruiz, P. Amezaga-Madrid, I. Estrada- Guel, M. Miki-Yoshida, J.M. Herrera Ramirez and R. Martinez-Sanchez , „Microstructural and mechanical characterization in 7075 aluminum alloy reinforced by silver nanoparticles dispersion" , J. of Alloys and Comp., Vol. 495, pp.394–398, 2010.
8) R.N.Rao and S.Das, “Effect of matrix alloy and influence of SiC particle on the sliding wear characteristics of aluminum alloy composites” Materials and Design 31 (2010) 1200-1207
9) T.S Srivastan et al. “The tensile response and fracture behavior of 2009 aluminum alloy metal matrix composite” Materials and Engineering A346 (2003) 91-100.
10) T. Miyajima and Y. Iwai, “Effects of reinforcements on sliding wear behaviour of aluminium matrix composites Wear” 255(1-6), 2003, p 606-616.
11) M K Surappa “Aluminium matrix composites: Challenges and opportunities” Vol. 28, Parts 1 & 2, February/April 2003.
12) Jasmi Hashim “The production of cast Metal matrix composite by a modified stir casting method” Dec 2001.
13) S.V. Prasada and R. Asthana, “Aluminum metal–matrix composites for automotive applications: tribological considerations” Vol. 17, No. 3, October 2004.