STUDY OF TENSILE PROPERTIES OF ALUMINIUM 6061 – FLYASH COMPOSITE

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Abstract— *A composite material is a 'material system' composed of a combination of two or more micro or macro constituents that differ in form, chemical composition and which are essentially insoluble in each other. In the present scenario the Metal Matrix Composites are exceeding in the field of composites for its wide variety of application in the field of aerospace, automobile, pressure vessel and pipes, wear resistance material and power conduction. The scope of the experimental study in this article is limited to prepare different volume fraction of fly ash reinforced Al 6061 MMC composite using stir casting process and to conduct the tensile test on UTM machine for fabricated composites, study of the tensile properties for different composition of fly ash Al 6061 MMC's. The following study documents all the results related to the studies conducted.*

Keywords— MMC (metal matrix composites), UTM (Universal Testing machine), casting, Tensile

1. INTRODUCTION

Composite material is a material consisting of two or more physically and chemically distinct phases. The composite by and large has prevalent qualities than those of each of the individual segments. Typically the reinforcement part is dispersed in the persistent or grid segment. At the point when the framework is a metal, the composite is termed as metal-matrix composite (MMC). In MMCs, the reinforcement for the most part takes the type of particles, stubbles, short filaments, persistent strands.

Metal matrix composites (MMCs) are progressively getting to be appealing materials for cutting edge aviation applications however their properties can be customized through the expansion of chose support. Specifically particulate reinforced MMCs have as of late discovered extraordinary interest as a result of their particular quality and particular firmness at room or hoisted temperatures. It is surely understood that the flexible properties of the metal matrix composite are unequivocally affected by smaller scale basic parameters of the reinforcement, for example, shape, size, introduction, dispersion and volume or weight part.

Reason for utilizing MMC

- Higher specific modulus and strength.
- Better properties at elevated temperature.
- Lower coefficient of thermal expansion.
- Better wear resistance.

2.0 OBJECTIVES:

- To prepare different volume fraction of fly ash reinforced AL 6061 MMC composite using stir casting process.
- To conduct the tensile on UTM machine for fabricated composites

To study the tensile properties for different composition of fly ash Al 6061 MMC's

3.0 METHODOLOGY

- Cast the aluminum 6061 fly-ash composite material for 5%, 10% and 15% composition.
- The casted material is machined by E-8 standard.
- Investigation of tensile conducted for various rate change in composition.
- Utilization of UTM machine for tensile test.

4.0 MATERIAL SELECTION

A16061 combinations have most astounding quality and flexibility with great machinability, great bearing and wear properties. The vast majority of the particulate strengthened metal Grid composites are created by liquid metallurgy, sometimes known as the vortex techniques, albeit a wide range of procedures for manufacturing these cast composites are additionally accessible which have been accounted for by different specialists.

4.1 Various Properties of Aluminium 6061 Alloy

Melting point: 582-652°C
Boiling Point: 2519°C
Density:2700 kg/m3
Relative atomic mass: 26.981
Atomic radius: 143pm
Ionic radius: 57pm
Electrical resistivity : 0.040x10-6Ω–m
Specific Heat capacity: 0.896J/g °c

4.2 Chemical composition of Al6061

Material	%
Silicon	0.69
Iron	0.29
Copper	0.22
Magnesium	0.83
Chromium	0.067
Zinc	0.046
Titanium	0.026
Aluminium	97.831

Table1: Chemical composition of Al6061

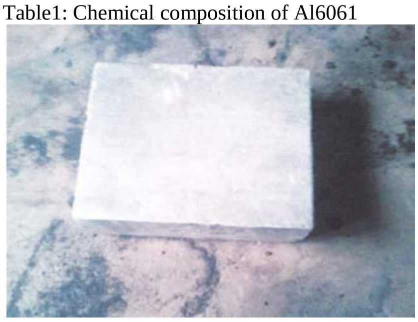


Fig1 : Aluminium 6061 alloy (block)

4.3 Fly Ash

Fly-ash is one of the deposits produced in the ignition of coal. It is a byproduct recuperated from the fine gas of coal blazing electric power plant.

Chemical Composition of Fly Ash

Table 2 : chemical composition of fly ash

Al_2O_3	SiO_2	Fe_2O_3	TiO_2	Loss of Ignition
28.44	59.96	8.85	2.75	1.43

Fig 2: Flyash

5.0 CASTING PROCESS

Stir casting is utilized here as a part of preparing composite examples. This strategy could disseminate silicon carbide particles homogeneously in the aluminum. The casting utilized electric heater with four loops.
The study conducted with MMCs casting is done for four reinforcement rates that is 5%, 10%, and 15%

5.1 Calculation of amount of aluminium

Density =Mass/Volume
Density of Al=2700kg/m3
Volume of Die =0.21*0.22*0.008
=3.696* 10-4m3
Mass = Density *Volume
=1.245kg

5.2 Calculation of amount fly ash

According to weight fraction, the amount of fly ash and Al is as shown table 3.

Table 3: Amount of Al6061 and flyash

Specimen composition	Mass of aluminium 6061 alloy used (gram)	Mass of fly ash used (gram)
5% fly ash +95% aluminium	260.24	11.32
10% flyash+90% aluminium	253.84	22.98
15% flyash+85% aluminium	245.28	35.25

The Amount of 5%, 10% and 15% of fly ash is taken and separated in packets as shown in the figure given below.

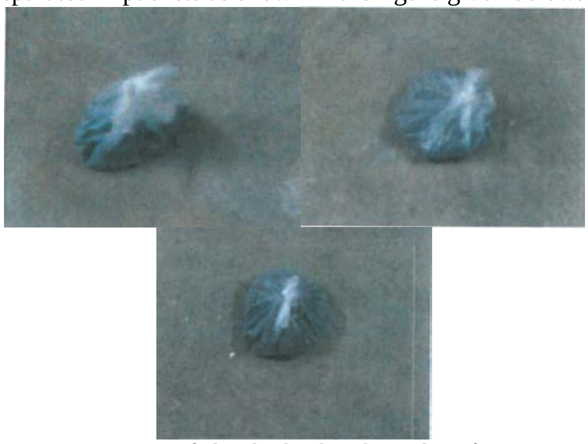


Fig3: Amount of Fly ash taken based on volume fraction

5.3 Degasifier Tablets

To dispose of blow gaps in the specimen and to get sound casting this Degasifier tablets are utilized. These tablets permit the gasses to escape which are caught in the Liquid metal.

Fig 4: Degasifier tablet

5.4 Heating Setup

To melt the solid aluminium to around 700°C a heating setup is required which consist of 4 electrical coil arrangement as shown in figure 5 .To these coils a electrical power of 2 kW is provided.

Fig 5: Crucible containing Al with heating coils

Fig6: melting furnace

5.5 Pre-heating of Die

To eliminate moisture content present inside the die material, it is pre-heated; set up for pre heating is as shown in fig 7.

Fig7: Pre-Heating of Die

5.6 Mixing of Fly ash in Molten Metal

When Al reaches its melting temperature it gets phase of molten metal with uniform stirring the fly ash is added to molten metal in order to get a uniform distribution in molten metal. As shown in the figure8

Fig8: Mixing of Fly ash in Molten Metal

5.7 Metal Casting:

The casting method used for preparation of specimens is metal casting process characterized by using metal Die;

- Metal casting components.
- Details of pattern used for process.
- Die material – mild steel.
- Die type – finger mould casting.

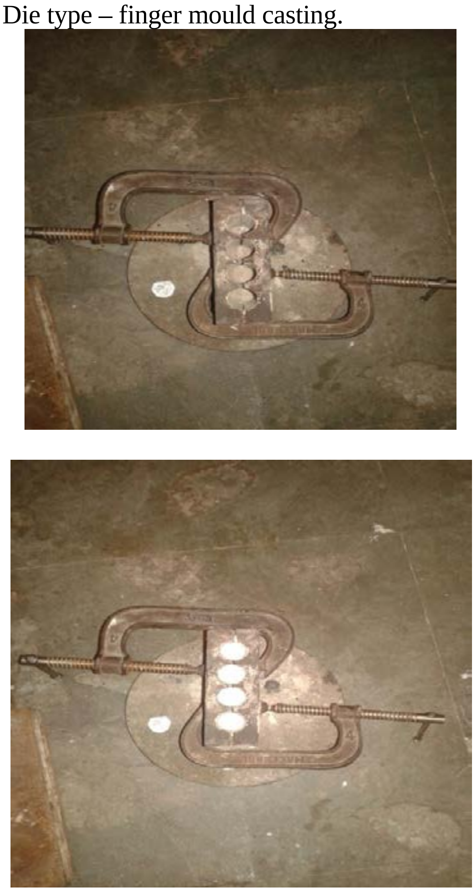


Fig9: Finger mould

The casting product having dimensions length 110 mm, diameter 25mm is to be machined in the dimensions as mentioned in ASTM E8 standard

5.8 Machining

For conducting the tensile tests, the specimens are machined so as to confirm to the standards of ASTM E8. (ASTM E8= Standard Test Methods for Tension Testing of Metallic Materials)

5.9 Specimens before and Machining Operation:

Fig10: specimen before machining

Fig11: specimen after machining

Fig12: Machined specimen confirming to E8 standard

6.0 EXPERIMENTAL PROCEDURE

TENSILE TESTING:

Tensile testing is a principal materials science test in which a specimen is subjected to a controlled tension until failure. The outcomes from the test are ordinarily used to choose a material for an application, for quality control, and to foresee how a material will respond under different sorts of forces.

Fig13: Before testing

Fig14: After testing

DENSITY TEST

Fly ash particles are having low density compared with aluminum. In the present study, fly ash particles were used with a density less than 2.2 g/cm3. The density of the composite specimens was determined experimentally by the Archimedes principles.

Then theoretical density values were calculated using the following expressions.

Theoretical density is given by equation,

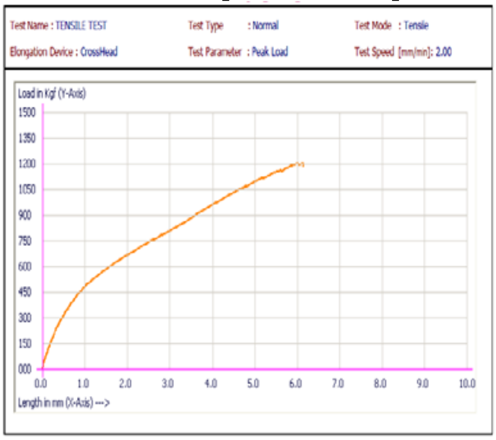
$d_c = d_m v_m + d_f v_f$

Where dc is the density of composite, d_m is the density of materials, v_m is the volume fraction of material, d_f is the density of fly ash, v_f is the volume fraction of fly ash.

Percentage of fly ash %	Practical density (gm/cm3)	Theoretical density (gm/cm3)
0	2.7041	2.7035
5	2.681	2.675
10	2.652	2.650
15	2.630	2.625

7.0 RESULT & DISCUSSION

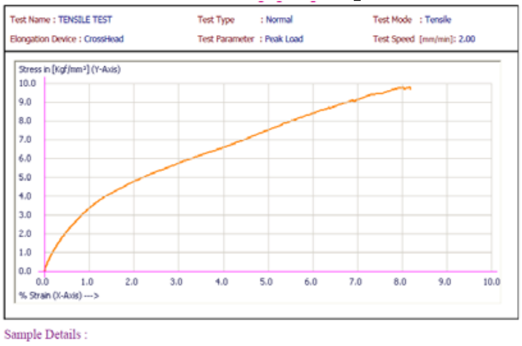
Load Vs Displacement Graph For 5%



Sample Details :

Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	1,200.00	8.20	0.26	9.77	119.13

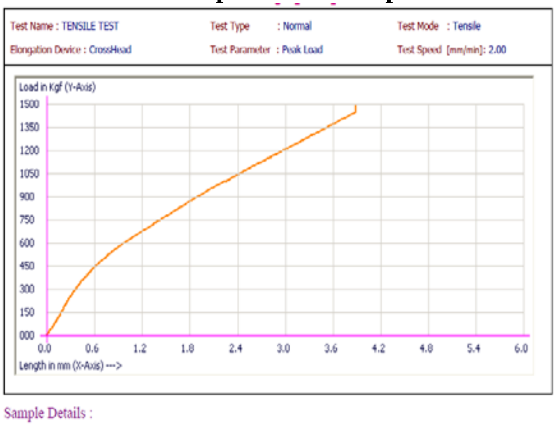
Stress Vs Strain Graph For 5%



Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	1,200.00	8.20	0.26	9.77	119.13

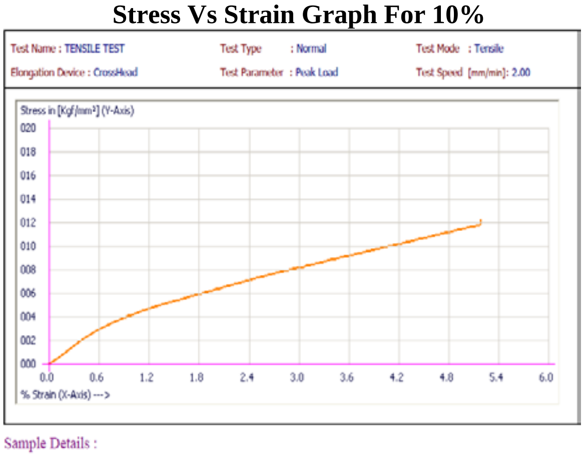
The graph above shows Variation of stress and strain Ultimate tensile strength obtained is 95.84 MPa (1 kgf/mm2 =9.81 MPa)

Load Vs Displacement Graph For 10%



Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	1,497.00	5.39	221.07	12.19	226.18

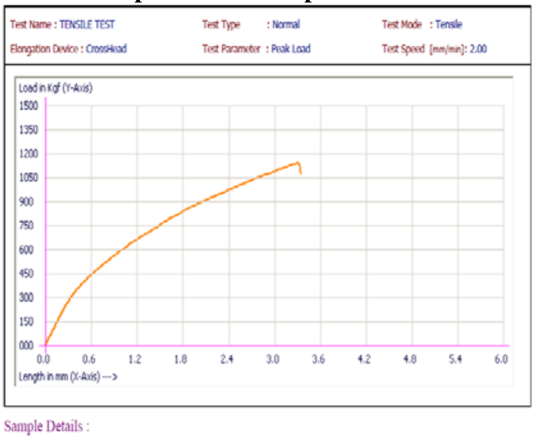
Stress Vs Strain Graph For 10%



Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	1,497.00	5.39	221.07	12.19	226.18

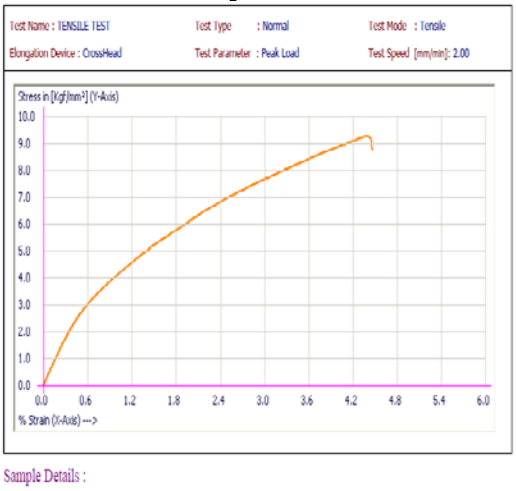
The graphs above shows Variation of stress and strain Ultimate tensile strength obtained is 119.58Mpa (1 kgf/mm2 =9.81 MPa)

Load Vs Displacement Graph For 15%



Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	3,723.00	4.47	0.38	30.33	678.43

Stress Vs Strain Graph For 15%



Sample No.	CS Area (mm²)	Peak Load (Kgf)	%Elongation	Break Load (Kgf)	UTS (Kgf/mm²)	Youngs Modulus (Kgf/mm²)
000001	122.77	3,723.00	4.47	0.38	30.33	678.43

The graph shows Variation of stress and strain Ultimate tensile strength obtained is 297.53Mpa (1 kgf/mm2 =9.81 MPa)

REFERENCES

[1]. H.C.Anilkumar, H.S.Hebbar and K.S.Ravishankar, “Mechanical properties Of Fly Ash Reinforced Aluminium Alloy (al6061) Composites”, IJMME, 2011, Vol.6, Issue.1, pp. 41-45.

[2]. Vivekanandan.P, Arunachalam.V.P, “The Experimental Analysis of Stir Casting Method on Aluminium-Fly Ash Composites”, IJCET, 2013, Vol.3.

[3]. Sandeep Kumar Ravesh, Dr. T. K. Garg, “Preparation & Analysis for Some Mechanical Property of Aluminium Based Metal Matrix Composite Reinforced with Sic & Fly Ash”, IJERA, 2012, vol.2, issue6, pp.727-731.

[4]. K.N.P.Prasad, M.Ramachandra, "Effect of Squeeze Pressure on The Hardness and Wear Resistance of Aluminium Fly Ash Composite Manufactured by Stir-Squeeze Casting", IJEI, 2013, vol.3, issue 4, pp.01-08.

[5]. K.N.P. Prasad, M. Ramachandra, "Evaluation Of Factors Affecting Sliding Wear Behaviour Of Al-Fly Ash Metal Matrix Composites By Using Design Of Experiments", IJMER, 2013, Vol.3, Issue 5, pp 2591-2599.

[6]. A. AnandhaMoorthy, Dr. N. Natarajan, R. Siva Kumar, M. Manoj Kumar, M. Suresh, " Dry Sliding Wear and Mechanical Behaviour of Aluminium/Fly ash/Graphite Hybrid Metal Matrix Composite Using Taguchi Method", IJMER, 2012, Vol.2, Issue.3, pp-1224-1230.

[7]. K.V.Mahendra, K.Radhakrishna, "Fabrication of Al–4.5% Cu Alloy with Fly Ash Metal Matrix Composites and its Characterization", material science, 2007, vol.25.

[8]. J. Bienia, M. Walczak, B. Surowska, J. Sobczaka, "Microstructure and Corrosion Behaviour of Aluminium Fly Ash Composites", Journal of Optoelectronics and Advanced Materials, Vol. 5, No. 2, 2003, pp. 493 – 502.

[9]. B.S.Motgi, R Patil, "A Study on Mechanical Properties of Fly Ash and Alumina Reinforced Aluminium Alloy (LM25) Composites", IOSR,Vol. 7, Issue 6, 2013, pp.41-46.

[10]. Arun Kumar M. B. and R. P.Swamy, "Evaluation of Mechanical Properties of al6061, Fly Ash and e-glass Fiber Reinforced Hybrid Metal Matrix Composites", ARPN, 2011, Vol.6, Issue.5.