Experimental Analysis of Aluminium Hybrid Material using Analytical and Experimental Method

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ABSTRACT

Aluminium (Al) is the second-most plentiful element on earth and it became an economic competitor in the engineering applications at the end of the 19th century. The emergence of three important industrial revolutions would, by demanding material characteristics consistent with the unique qualities of Aluminium and its alloys, greatly benefit growth in the production hybrid composite materials. Among the most striking characteristics is its versatility. Aluminium alloys and its composite materials are extensively used as materials in transportation (aerospace and automobiles), engine components and structural applications. Thus it becomes all the more vital to study the tribological characteristics of Aluminium alloys and its composite materials. Addition of Silicon to Aluminium gives high strength to weight ratio, low thermal expansion coefficient, and high wear resistance. Hybrid Composite Materials show improved strength and wear properties as the silicon content is increased beyond eutectic composition. Such properties warrant the use of these materials as structural components in automotive industries. Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. The composites industry has begun to recognize that the commercial applications of hybrid composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. The detailed review of the Metal matrix composite is given as follow.

Keyword: - *Hybrid Material, Yield strength, Reinforcement*

1. INTRODUCTION:

Aluminium (Al) is the second-most plentiful element on earth and it became an economic competitor in the engineering applications at the end of the 19th century. The emergence of three important industrial revolutions would, by demanding material characteristics consistent with the unique qualities of Aluminium and its alloys, greatly benefit growth in the production hybrid composite materials. Among the most striking characteristics is its versatility. Aluminium alloys and its composite materials are extensively used as the materials in transportation (aerospace and automobiles), engine components and structural applications. Thus it becomes all the more vital to study the tribological characteristics of Aluminium alloys and its composite materials. Addition of Silicon to Aluminium gives high strength to weight ratio, low thermal expansion coefficient, and high wear resistance. Hybrid Composite Materials show improved strength and wear properties as the silicon content is increased beyond eutectic composition. Such properties warrant the use of these materials as structural components in automotive industries.
Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. The composites industry has begun to recognize that the commercial applications of hybrid composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. The detailed review of the Metal matrix composite is given as follow.

1.1 Problem Definition:

To obtain sufficient wetting of particle by liquid metal and to gate a homogeneous dispersion the fly ash and alumina particles in present study Aluminium metal matrix composite were fabricated by different processing temperature with different holding time to understand the influence of process parameter on the distribution of particle in the matrix and result mechanical properties. Conventional stir casting process has been employed for producing discontinuous particle reinforced metal matrix composites for decades. The distribution is examined by hardness distribution, tensile testing, compressive testing and impact testing.

1.2 Objectives:

The key objectives of current work are as given below:

1. Manufacturing of Aluminum alloy composite by using stir casting method.
2. To use Stir casting method as it simple and flexible.
3. To Study the mechanical & wear characteristics of the composite material and to observe the change in wear resistance of composite material with Al 356.
4. To analyze the effect of composite reinforcement on Al356.
5. To compare the properties of hybrid reinforced composite with individually reinforced composite.
6. To develop mathematical model to predict result of composite reinforcement by using regression Analysis.

2. LITERATURE REVIEW

Sharanabasappa R Patilet.al. [1] Have investigated the results of an experimental investigation of the mechanical properties of fly ash and Alumina reinforced aluminum alloy (LM25) composites samples, processed by stir casting route. Tensile strength, impact strength & hardness were studied. It was found that the tensile strength & hardness of the aluminum alloy (LM25) composites increases with the increase in % wt of Al_2O_3 up to certain limit. The charpy test shows that as decrease in impact load absorption with increase in % weight reinforcement. The main objective of study is to fabricate the hybrid metal matrix composite successfully by using Fly ash and Alumina as particulate. Results of hybrid composite are also compared with simple composite and with parent metal. microstructure study shows the near uniformly distributed phases in the metal matrix. .The poor wettability of the phases in the matrix is the major problem at higher weight fraction of reinforcement , due to this problem the strength decreases after certain limit. From this problem we can overcome by adding small amount of Magnesium and by pre heating the composites and the die.

Sandeep Kumar Raveshet.al. [2] fabricated hybrid MMCs containing Aluminium 6061,SiC and Fly ash .Composites were fabricated by varying Wt % fraction of SiC (2.5%,5%,7.5% and 10%) From results ,may found that tensile strength ,hardness & toughness increases with increases with increasing Wt percentage of SiC.Aluminium based metal matrix composite up to 10% silicon carbide have been successfully fabricated by stir casting technique with fairly uniform distribution of Silicon Carbide & Fly ash. The hardness of Metal Matrix Composite increased with increase in SiC content. It appears in this study that Tensile Strength starts increases with increase in weight percentage of SiC. The best result of tensile strength has been obtained at 10% weight percentage of SiC& 5% of Fly Ash. It is found that elongation tend to decrease with increasing particles weight percentage which conforms that Silicon Carbide & Fly Ash addition increases brittleness.

MahendraBoopathiet.al. [3] evaluated physical properties of Al2024 reinforced withSiC and fly ash SiC (5%) + fly ash (10%) and fly ash (10%) + SiC (10%)] . It was observed that tensile strength and hardness were increased as compared to Al-SiC and Alfly ash composites. Al-SiC, Al-fly ash, Al-SiC-fly ash (various concentrations) composites were successfully fabricated by two-step stir casting process. Wetting of reinforcements with the aluminium matrix was further improved by the addition of magnesium. Tensile strength, yield strength and hardness were determined for the test materials. Increase in area fraction of reinforcement in matrix result in improved tensile strength, yield strength and hardness. With the addition of SiC and fly ash with higher percentage the rate of elongation of the hybrid MMCs is decreased significantly. Optical micrographs revealed that both the SiC and flay ash particles are well distributed in aluminium matrix. Density of the composites decreased by increasing the content of the reinforcement. Hence, it was found that, instead of Al-SiC and Al-fly ash composites, Al-SiC-fly ash composites show better performance. So these composites can be used in applications where to a great extent weight reductions are desirable.

3.EXPERIMENTAL WORK

Tensile Test

Fig-1 Tensile Test Specimen

The tensile testing of the composite was done, on Universal testing machine. Standard specimens with 62.5 mm gauge length were used to evaluate ultimate tensile strength. Comparison of the properties of the composite material was made with the commercially pure Al356.

Tensile strength dictates how the material will react to forces being applied in tension. Tensile test is fundamental test of mechanical where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of specimen over some distance. Tensile tests are used to determine the modulus of elasticity, elongation, proportional limit, reduction area, tensile strength, yield strength and ultimate tensile strength.

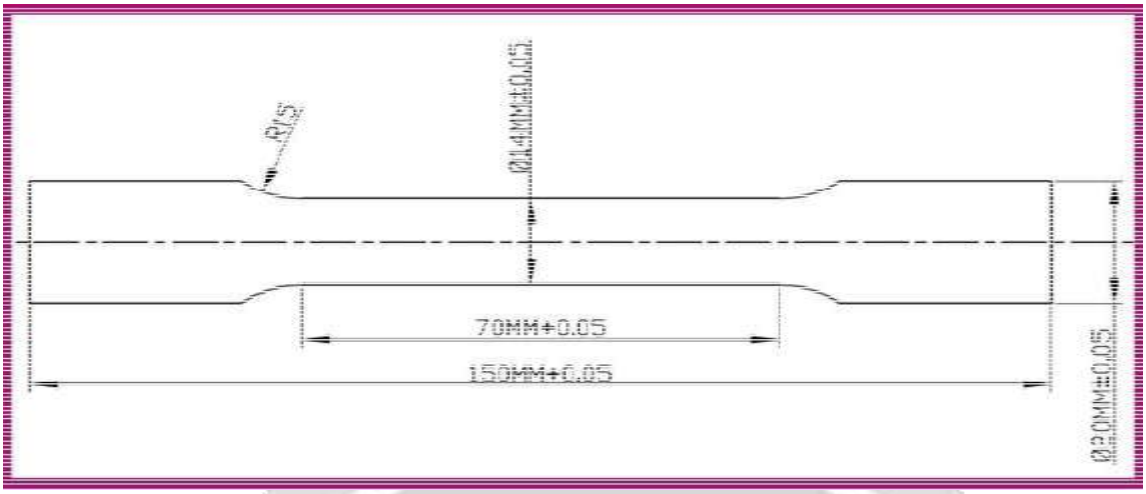

Fig-2 Tensile test specimen

Procedure to find out Gauge diameter and Gauge length:

As per BS 1490 standard, Tensile stress of Al356 alloy is 150 MPa.

And Load capacity of UTM machine is 30000 N (i.e. safe load 10% of 300 KN)

- Diameter of Tensile bar calculated as,

Stress = Load Capacity of UTM / Cross-sectional Area of Test Bar

$150 = [(30000) / (3.14*d^2/4)]$

∴d≅ 14.00 mm

And gauge length as per Indian Standard is,

$L_0 = 5.65\sqrt{\text{Area of bar}}$

$=5.65*\sqrt{(3.14 * d /4)}$

$=5.65*\sqrt{(3.14 * 14 * 14 /4)}$ $L_0 =$ 70.00 mm

∴ Gauge length of specimen is 70 mm and gauge diameter is 14 mm.

4.RESULT AND DISCUSSION

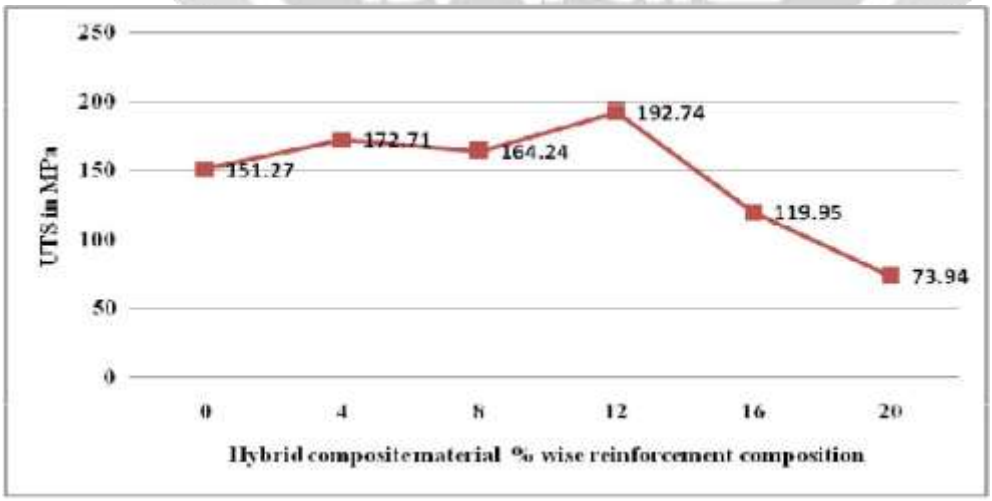

Fig-3 Graph of yield tensile strength Vs %wise increase in reinforcement

Fig-3 graph shows tensile test of hybrid composite material from the graph it is found that Ultimate tensile strength is increasing from 151.27 Mpa to192.74 Mpa while the % of reinforcement increasing, upto 12% of reinforcement .After certain limit while the percentage of hybrid reinforcement increases the ultimate tensile strength also decreases in U.T.S.

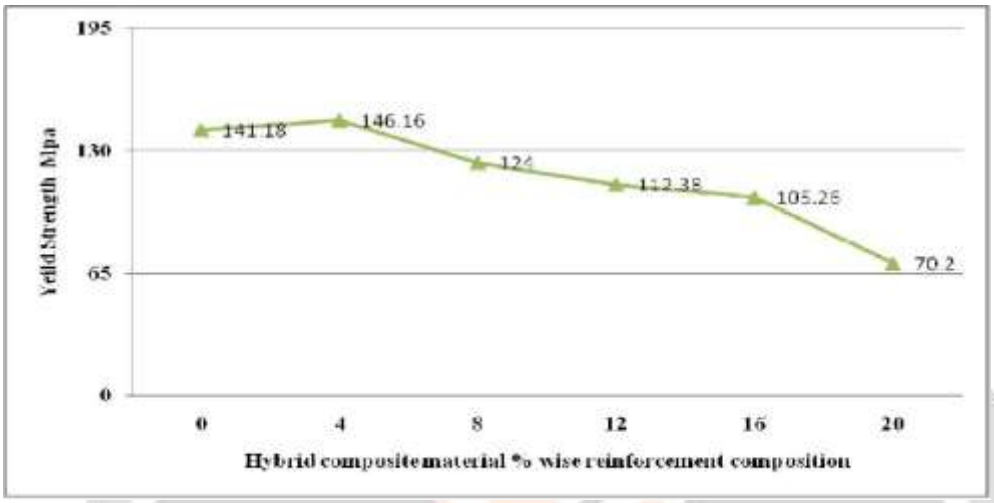

Fig-4 Graph of yield tensile strength Vs %wise increase in reinforcement

Fig-4 indicates that yield strength is decreasing from 141.18 Mpa to70.2 Mpa while the % of reinforcement decreasing, upto 20% of reinforcement

Specimen	Experimental analysis in Mpa	Theoretical analysis in Mpa	Errors in Mpa
Pure Al356	161.5235	161.0495	0.474
Al356 + 4% Fly ash and alumina	164.52	164.504	0.016
Al356 + 8% Fly ash and alumina	146.857	147.2782	0.4212
Al356 + 12% Fly ash and alumina	159.418	159.65625	0.23825

Table-1 Comparison of Experimental and Numerical analysis of U.T.S

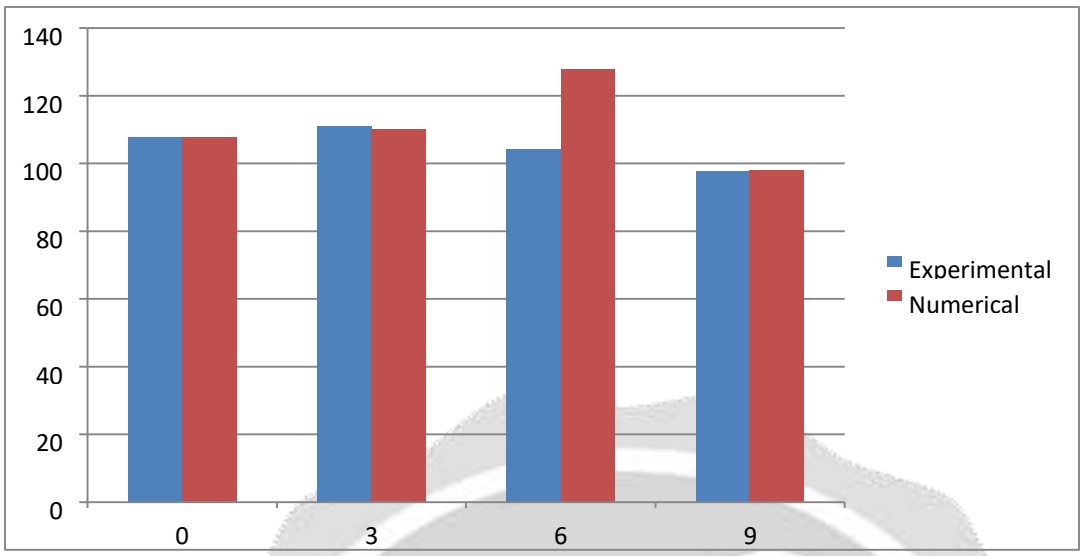

Chart-1 Comparison of Experimental and Numerical analysis of Y.T.S

5.CONCLUSION

- Tensile & Compressive Strength
- YTS increases up to 4% of reinforcement after it decreases
- UTS increases up to 12% of reinforcement after it decreases
- Elongation Decreases from 2.2% to 0.03%
- Compressive Strength increases 679.91 Mpa to 766.56 Mpa
- Hardness is increases up to 12% of reinforcement & then it decreases
- Toughness of all composite are remains same.

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