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A review on Tensile strength and Hardness using Aluminium as Matrix Material and E-glass, Rice Husk Ash, and Fly ash as Reinforcement

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Abstract - *For advanced aerospace applications aluminum metal matrix composites are gradually becoming more attractive because their properties can be improved by the addition of selected reinforcements. Since, their good specific strength & higher specific stiffness at room or elevated temperatures particulate reinforced MMC's have recently found special interest. Among the MMC's aluminum composites are most commonly used because of their low weight and high strength. This paper presents a review on the tensile strength and Hardness of stir cast aluminium-7075 matrix composites containing single and multiple reinforcement. The addition of reinforcements like E-glass and flyash has shown an increase in hardness and tensile strength as the % of E-glass increases, also the addition of organic reinforcement like Rice husk ash (RHA) and flyash improved the Tensile strength, yield strength and hardness of the AMMC's.*

***Key Words*: Aluminium-7075, Flyash, RHA Reinforcements, MMC.**

1. INTRODUCTION

Composites technology is developing very rapidly to keep up with the momentum of change in a wide variety of industrial sectors, notably aerospace, automotive and electrical. New fibers, new matrices, novel composite architectures and innovative manufacturing processes continue to provide exciting opportunities for improvements in performance and reductions in cost, which are essential to maintain competitiveness in increasingly globalized world markets. Predicting composite behavior continues to improve with enhanced scientific understanding and modeling capability, allowing much more effective and reliable use of these complex materials [1]. The rank of composites as manufacturing materials is reflected by the fact that out of over 1600 business materials existing in the market today more than 200 are composite. Conformist massive materials have limitations with respect to achievable combinations of strength, stiffness, and density. In order to speechless these shortcomings and to meet the ever-increasing engineering demands of up-to-the-minute technology, metal matrix composites are gaining importance. Aluminum Metal matrix composites (MMCs) are a range of advanced materials providing properties which are not achieved by conventional materials. These resources range from usual materials (e.g., copper, cast iron, brass), which have been accessible for several hundred years, to the more recently developed, advanced materials (e.g., composites, ceramics, and high-performance steels). Owing to the wide choice of supplies, today's engineers are modeled with a big test for the right assortment of a material. Amongst all materials, composite materials have the potential to replace widely used steel and aluminum, and many times with better presentation. Swapping steel components with composite components can save 60 to 80% in component weight, and 20 to 50% weight by replacing aluminum parts. Merged materials have become common engineering materials and are designed and man-made for various applications including automotive components, even-handed goods, aerospace parts, consumer goods, and in the marine and oil industries.

2. LITERATURE SUVEY

Kenneth Kanayo Alaneme and Kazeem Oladiti Sanusi et al. [1] studied the Microstructural characteristics, mechanical and wear behaviour of aluminium matrix hybrid composites reinforced with alumina, rice husk ash and graphite. Alumina, RHA and graphite mixed in varied weight ratios were utilized to prepare 10 wt% hybrid reinforced Al-Mg-Si alloy based composites using two-step stir casting. Hardness, tensile properties, scanning electron microscopy, and wear tests were used to characterize the composites produced. The results show that Hardness decreases with increase in the weight ratio of RHA and graphite in the composites; and with RHA content greater than 50%, the effect of graphite on the hardness becomes less significant. The tensile strength for the composites containing o.5wt% graphite and up to 50% RHA was observed to be higher than that of the composites without graphite. The wear resistance decreased with increase in the graphite content from 0.5 to 1.5 wt%. Soorya Prakash Kumarasamy et al. [2] investigated mechanical and machinability behaviour of Aluminium Metal Matrix Composite (AMMC) developed through two-step compocasting method by reinforcing constant amount of flyash cenosphere (10%) and varying quantity of graphite (2%, 4% and 6%). Morphological analysis result shows the presence of dendritic arms and homogeneous distribution of the cenosphere and graphite in Al7075 matrix. The hardness and tensile strength upturn with addition of cenosphere and vice versa for the addition of graphite. M. Sreenivasa Reddy et al. [3] evaluated Hardness and Tensile Properties of Aluminium 7075 alloy reinforced with E-glass and fly ash particulates to form MMC using graphite die for casting. Hardness of the Al-cast alloy produced in this work is lower at 2% of E-Glass when compared to 4% and6%. However, after thermal treatment the water quenched specimens exhibit higher hardness. The ultimate tensile strength (UTS) of the new alloy produced is higher in 2% of E-Glass and lower in 4 and 6% E-Glass However, after thermal treatment the water quenched specimens exhibit higher hardness. The ultimate tensile strength (UTS) of the new alloy produced is higher in 2% of E-Glass and lower in 4 and 6% E-Glass. Pardeep Sharma et al. [4] studied the effect of graphite particles addition on the microstructure of Al6082 metal matrix composites manufactured by conventional stir casting process. The reinforcement content was varied from 0% to 12% in a step of 3%. The microstructures of the manufactured composites were analyzed by scanning electron micrographic test. The hardness of composites decreased by 11.1% with respect to addition of weight percentage of Gr (0–12%). The main outcome of present investigation is that it would not be beneficial to reinforce Gr particles to Al6082 metal matrix as a non-uniform microstructure and a decrease in hardness at all weight percentages of Graphite reinforcement have been observed. As far as tribological properties are concerned, as evident from the previous research, it would be advantageous to reinforce aluminium metal with Gr reinforcement. Johny James.S et al. [5] prepared hybrid aluminium metal matrix composite to study its machining and mechanical properties. Preparation of hybrid aluminium metal matrix composite is made by reinforcing Silicon carbide and Titanium di boride. The hardness test shows addition of reinforcement SiC and TiB2 increases hardness value. But increase in reinforcement up to 15 wt % reveals reduction in hardness value. From tensile test results it has been observed that addition of reinforcement SiC to base metal added 20% strength to the composite but addition of TiB2 reduction in 50 - 60% strength is recorded.

3. MATERIAL SELECTION:

3.1 Matrix Material:

Aluminium 7075 and Aluminium-6063 were selected as matrix material.

3.1.1 Aluminium-7075

Table-1: Chemical composition of Aluminium-7075

Element (constituent)	Content wt%
Zinc, Zn	5.1-6.1
Magnesium, Mg	2.1-2.9
Copper, Cu	1.1-2.0
Chromium, Cr	0.18-0.28
Aluminium	90

3.1.2 Aluminum-6063

Table-2: Chemical composition of Aluminium-7075

Element	Content wt%
Magnesium (Mg)	0.48
Silicon (Si)	0.52
Manganese (Mn)	0.073
Copper (Cu)	0.068
Zinc (Zn)	0.11
Titanium (Ti)	0.015
Iron (Fe)	0.058
Aluminium (Al)	balance

3.2 Reinforcements:

3.2.1 Rice Husk Ash:

Table-3: Chemical composition of the rice husk ash

Element	Content wt%
Silica (SiO_2)	91.56
Carbon	4.8
Calcium oxide, CaO	1.58
Magnesium oxide, MgO	0.53
Potassium oxide, K_2O	0.39
Hematite, Fe_2O_3	0.21
Others	0.93

3.2.2 Flyash:

Table-4: Chemical composition of the Flyash

Element	Content wt%
Silica (SiO_2)	56.92
Aluminium oxide-Al_2O_3	30.4
Hematite, Fe_2O_3	8.44
Titanium dioxide TiO_2	2.75
Carbon	1.43

3.2.3 E-glass:

It is also called as electrical grade glass which has excellent fiber forming abilities. The chemical composition is given below

Table-5: Chemical composition of the E-glass

Element	Content wt%
Silica (SiO_2)	54
Aluminium oxide-Al_2O_3	14
CaO + MgO	22
B_2O_3	10
$Na_2O + K_2O$	< 2

Composition Ratio between Rice husk and graphite:

Sample designation	Composition of Reinforcements
A0	100%Al_2O_3+0%RHA+0% Gr
A1	99.5%Al_2O_3+0%RHA+0.5% Gr
A2	99%Al_2O_3+0%RHA+1.0% Gr
A3	98.5%Al_2O_3+0%RHA+1.5% Gr
B0	75%Al_2O_3+0%RHA+0% Gr
B1	74.5%Al_2O_3+0%RHA+0.5% Gr
B2	74%Al_2O_3+0%RHA+1.0% G
Sample designation	**Composition of Reinforcements**
B3	73.5%Al_2O_3+0%RHA+1.5% Gr
C0	50%Al_2O_3+0%RHA+0% Gr
C1	49.5%Al_2O_3+0%RHA+0.5% Gr
C2	49%Al_2O_3+0%RHA+1.0% Gr
C3	48.5%Al_2O_3+0%RHA+1.5% Gr
D0	25%Al_2O_3+0%RHA+0% G
D1	24.5%Al_2O_3+0%RHA+0.5% Gr
D2	24%Al_2O_3+0%RHA+1.0% Gr
D3	235%Al_2O_3+0%RHA+1.5% Gr
E0	0%Al_2O_3+0%RHA+0% Gr
E1	0%Al_2O_3+0%RHA+0.5% Gr
E2	0%Al_2O_3+0%RHA+1.0% Gr
E3	0%Al_2O_3+0%RHA+1.5% Gr

4. RESULTS AND DISCUSSION:

4.1 Tensile strength:

According to Sreenivasa Reddy et al. [3], tensile test was conducted as per ASTM E-8 standard for cast and heat treated specimen and results are shown in figure-1

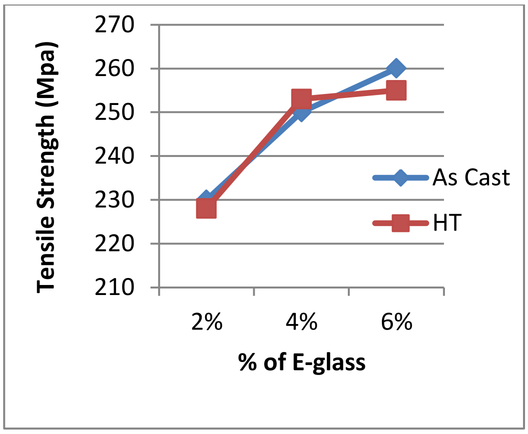

Fig-1(a): Tensile strength for keeping 1% of flyash

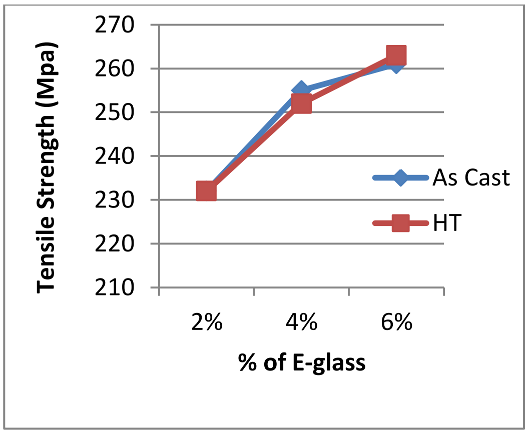

Fig-1(b): Tensile strength for keeping 3% of flyash

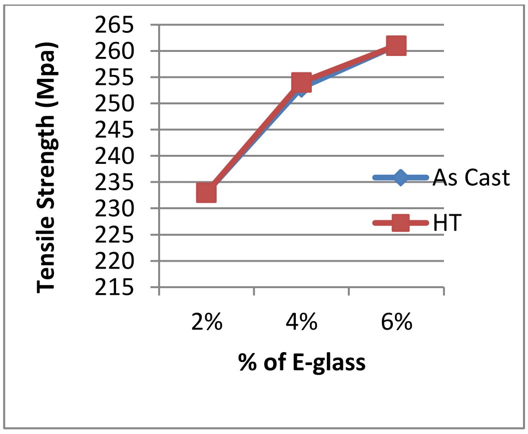

Fig-1(c): Tensile strength for keeping 5% of flyash

Kenneth Kanayo Alaneme et al. [1] prepared AMMC's by reinforcing Al-6063 with Gr, Alumina and RHA. He carried out the tensile test as per ASTM E-8 standard and results are plotted in figure-2

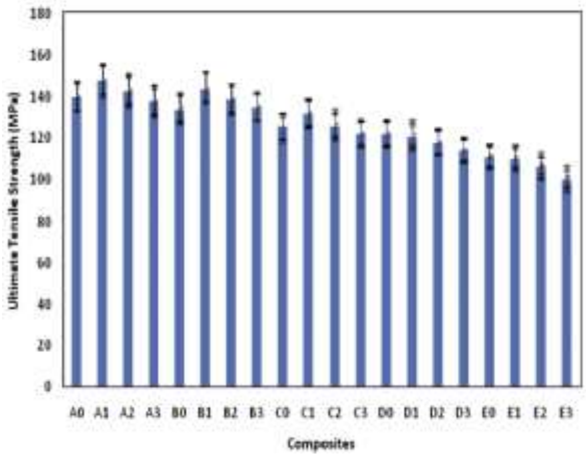

Fig-2(a): Variation of tensile strength of the composites.

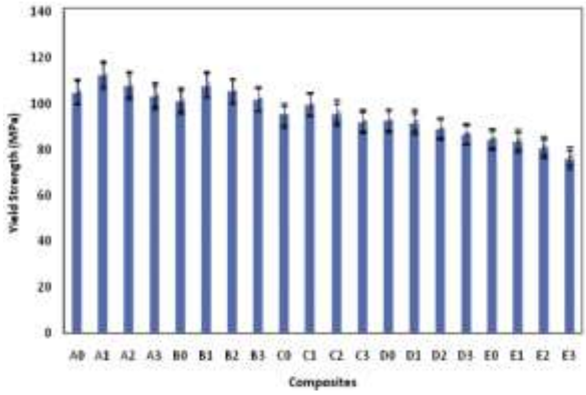

Fig-2(a): Variation of tensile strength of the composites.

4.2 Hardness:

Hardness measurements were made on different sections of the as cast and heat treated material as per ASTM E10 standards and the results are plotted in Fig-3 (According to Sreenivasa Reddy et al. [3])

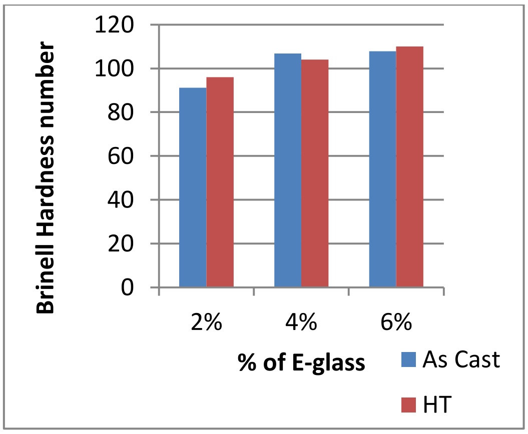

Fig-3(a): Tensile strength for keeping 1% of flyash

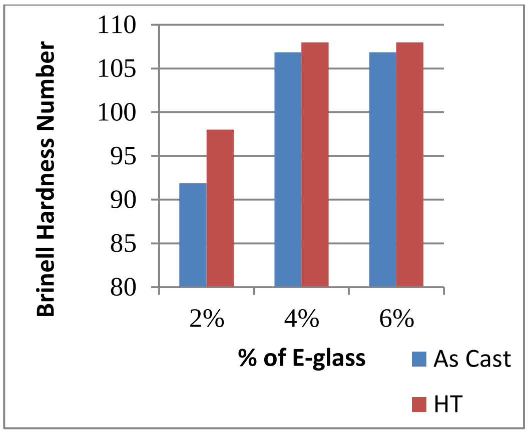

Fig-3(b): Tensile strength for keeping 3% of flyash

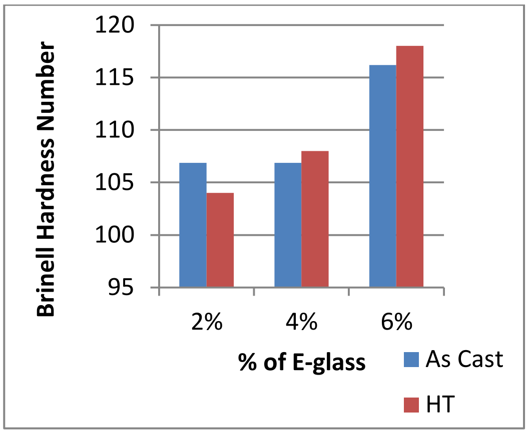

Fig-3(c): Tensile strength for keeping 5% of flyash

Kenneth Kanayo Alaneme et al. [1] used the Vickers hardness test to determine of the hardness of the prepared composites. The results are plotted in figure-4.

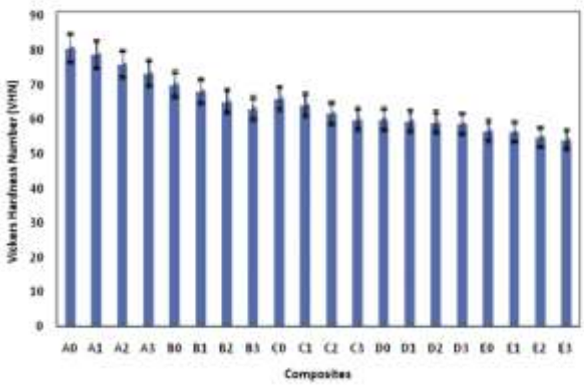

Fig-4: Variation of hardness value of the composites.

5. CONCLUSION:

The above review for the Aluminium matrix composites leads to following conclusions,

- The composites of Al-7075 reinforced with the E-glass and flyash is found to have improved tensile strength and hardness when compared to Al 7075 alloy alone.

- As the weight % of E-glass and flyash increases the hardness also increases.
- The tensile strength (UTS) has increased in thermally treated condition.
- Hardness decreases with increase in the weight ratio of RHA & graphite in the composites; and with RHA content greater than 50%, the effect of graphite on the hardness becomes less significant.
- The tensile strength for the composites containing 0.5wieght% of graphite and up to 50% of RHA was observed to be higher compared to the composites without graphite. The toughness values for the composites containing 0.5weight% graphite were in all cases higher compared to the composites without graphite.
- The % Elongation for all composites produced was within the range of 10-13% and the values were invariant to the RHA and graphite content.

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