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Evaluation of Hardness and Compression Strength Properties for Al6061 Hybrid Composite

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Abstract: *Rice husk ash- rock dust- A16061 alloy hybrid composite having 2 wt of rice husk ash constant value and 2 wt%, 4 wt%, and 6 wt% were fabricated by stir casting method. The casted composite specimens were machined as per the ASTM standard. Hardness and compression strength properties were evaluated for the different wt% of reinforcements. The wt% of Rock dust increases the hardness and compressive strength with rice husk ash constant of 2 wt%. The comparisons were made with and without reinforcements of Al6061 with respect to different weight percentage basis. It has been observed that addition of reinforcements significantly improves hardness and compressive strength properties as compared with that of unreinforced matrix.*

Keywords: Rice husk ash, Rock dust, A16061, stir casting, mechanical properties

I. INTRODUCTION

Aluminium alloys are materials which find worldwide industrial applications, including automobiles, ship buildings, aerospace etc.., The strength of pure aluminium is inadequate for structural applications. A composite material is defined as a structural material created synthetically or artificially by combining two or more materials having dissimilar characteristics. Particle-reinforced aluminum alloys have the potential to use in a ample range of such engineering applications due to their high strength and stiffness when compared with straight aluminum alloys.

Al6061is precipitation hardened aluminium alloy, containing magnesium and silicon as its major alloying elements. It was developed in 1935. It has good mechanical properties and exhibits good weldability. It is one of the most common alloys of aluminium for general-purpose use [1-10]. Al6061 is used extensively as a construction material, most commonly in the manufacture of automotive components.Al6061 is well-suited to the construction of motorcycles, bicycle frames, scuba tanks, camera lenses, fishing reels, electrical fittings, couplings and valves. It is used in the construction of aluminum cans, and the inside foil wrapper on food containers is often made with 6061 aluminum alloy [11-20].

II. LITERATURE REVIEW

Narender Panwar et al. [1] have studied aluminium metal matrix composite has been the best suited materials for research in this direction. Fabrication methods used for aluminium metal matrix composite can be broadly of two types solid state processing and liquid state processing. Stir casting is the most common liquid state process used for fabrication of AMMCs. It is simple in operation and cost effective and provides a fairly uniform distribution of particles.

Manish Shukla et al. [2] have carried out on fabrication techniques, mechanical properties and surface texture of aluminium matrix composites (AMCs) reinforced by silicon carbide (SiC). The varying SiC content in AMCs is (0, 5, 10, 20 Wt. %) were fabricated by stir casting process. mechanical properties Hardness, Tensile Strength, Toughness and Microstructure of composites were analyzed. This composites show that the reinforcement of silicon carbide into Al matrix increased tensile strength and hardness, maximum tensile strength show at 20 Wt. % SiC reinforced in AMCs. Ajay Kumar Yadav et al. [3] have done the scanning electron micrographs of composite showed that rice husk ash is distributed homogeneously throughout the aluminium matrix. At high temperature wear of aluminium alloy changes from micro cutting to oxidation wear. Due to difference in the coefficient of thermal expansion between matrix material and reinforcement material strain fields created and wear resistance of composite material is improved.

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Ayush Awasthi et al. [4] have studied stir casting has been mostly viewed fabrication process for the hybrid aluminium composites. Aluminium matrix composite reinforced with ceramic particles have higher wear resistance than the unreinforced metal or alloys. Vickers micro-hardness, Rockwell, brinell hardness of hybrid composite increased with increase in reinforcement content as compared to base metal matrix. Impact strength and elongation of aluminium composite decreases with addition of hard ceramic reinforcement.

Srikanth Tiwari et al. [5] have discussed rice husk is the outer layer of the paddy crop. It is enormously available throughout the world wide as an agro waste. Rice husk is widely used in the industries as a fuel. RHA mainly contains silica as a major component, due to which RH as well as RHA has efficiently used in different field of industries like as raw material in the production of steel, concrete, refractories industries used as a prime reinforcing agent in order to improve the mechanical properties of alloys.

Himanshu Kala et al. [6] have discussed aluminum matrix composite due their high strength to weight ratio, low cost and high wear resistance are widely manufactured and used in structural applications along with aerospace and automobile industry. Also a simple and cost effective method for manufacturing of the composites is very essential for expanding their application. Reinforcements like particulate alumina, silicon carbide, graphite, fly ash etc., can easily be incorporated in the melt using cheap and widely available stir casting method

Selection of matrix and reinforcement materials.

Matrix Material

Fig.1. Ingot of Al6061 alloy

Fig.1 Shows the Al6061 alloy chosen as matrix material. The following table shows the chemical composition of Al6061 alloy.

Table 1. Chemical Composition of Al6061 alloy

Elements	Weightage (%)
Silicon	0.60
Iron	0.19
Copper	0.22
Magnesium	1.121
Tin	0.028
Zinc	0.066
Manganese	0.116
Chromium	0.154
Aluminium	Balance

Preparation of Reinforcement Materials

Rice husk ash:

- Collection of rice husk.
- Cleaning the rice husk.
- Drying the rice husk.
- Burning the rice husk.
- Collection of rice husk ash.

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- Sieve analysis.

Rock dust:

- Collection of rock dust.
- Drying the rock dust.
- Sieve analysis.

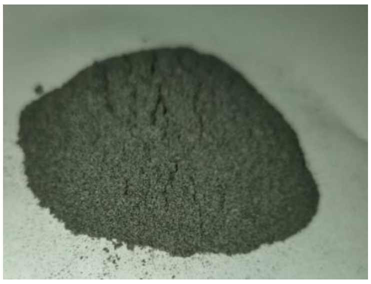

Figure 2(a): Rice husk ash

Figure 2(b): Rock dust

Fig..2 (a) shows Rice husk ash and Figure 2 (b) shows Rock dust Particulates chosen as reinforcement material having the size 50-75 µm.

Table1. Mixture of matrix material and reinforcement materials on weight % basis.

Sl. No	% of AL6061	% of RHA	% of Rock Dust
1	100	00	00
2	96	2	2
3	94	2	4
4	92	2	6

Composite Formation

Fig. 3. Electric Pit Furnace.

The Fig.3 represent the electric pit furnace having maximum melting temperature of 1800 ºC made up refractory bricks, heating coils which are arranged in alternative manner surrounded by glass wool and a terminal box which is provided at the side surface of the furnace for electrical power supply [21-31].

Fig. 4.Pre-heating of crucible.

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The Fig. 4 shows preheating of crucible. The crucible is placed inside the furnace by using tong and top lid is closed.

Fig. 5. Removal of slag.

The furnace lid is opened and a stirrer made up of stainless steel was lowered into the melt slowly to stir the composite for uniform mixing of Rice husk ash and Rock dust particulates in the molten metal for a period of 5 min and a slag is removed manually as shown in the Fig. 5.

II. EXPERIMENTAL SETUP

Specimens Preparation

Compression test specimen

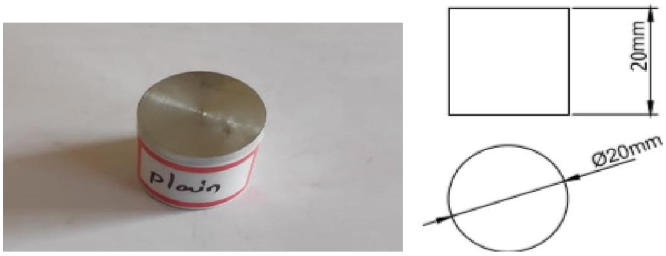

Fig. 6. Compression test specimen as per ASTM E9 standard.

Fig. 6 Shows the Compression test specimen is prepared as per ASTM E9 standards. Specimen is having diameter of 20mm and length 20mm.

Hardness test specimen

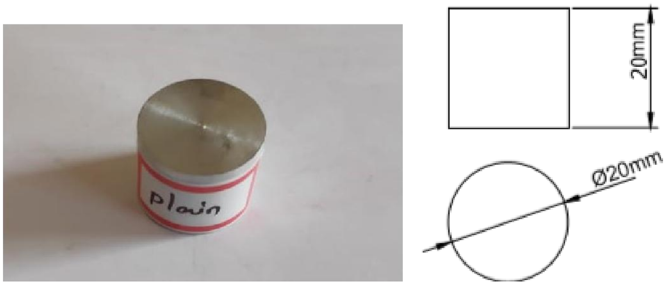

Fig. 7. Hardness test specimen as per ASTM E9 standard.

Fig. 7 Shows the Hardness test specimen is prepared as per ASTM E9 standards. Specimen is having diameter of 20mm and length 20mm

Tests

Hardness test

Hardness test carried out for Al6061 Hybrid composite with using the RAS model and applied load is 100kgs/1/16" Ball Indenter

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Table 1 Shows the Hardness values for Al6061 Hybrid composite.

Sl. No	% of AL6061	Observed Values In HV	Average Values in HV
1	Al 6061 Plain Sample	84,86,85	85HV
2	Al6061 with 2% Rice Husk ash & 2%Rock Dust	89,91,90	90HV
3	Al6061 with 2% Rice Husk ash & 4%Rock Dust	92,92,91	92HV
4	Al6061 with 2% Rice Husk ash & 6%Rock Dust	93,97,95	95HV

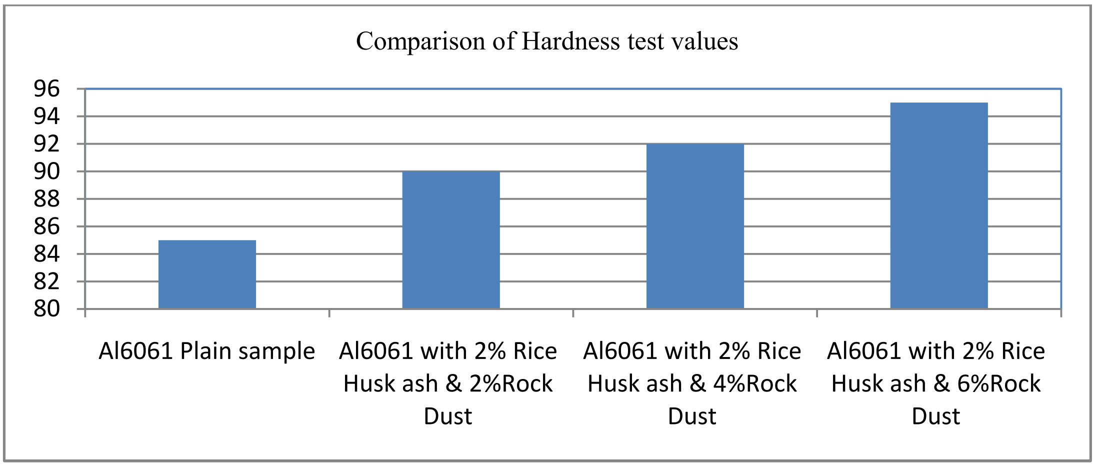

Fig. 8. Shows the comparison graph of hardness values for Al6061 Hybrid composites

It is observed from the comparison graph that addition of Rice husk ash and Rock dust into Al6061 improves the hardness of the hybrid composite, and also by adding the rock dust (in varies of 2%, 4%and 6%) increases the Hardness.

Compression test

Compression test carried out for the Al6061 Hybrid composite with using UTM Cap-60 T (600 k N).

Table 2.Shows the Compression strength values for Al6061 Hybrid composite.

Sl. No	% of AL6061	*Required parameter*	*Observed Values*
1	Al 6061 Plain Sample	Compression Strength	482.51Mpa
2	Al6061 with 2% Rice Husk ash & 2%Rock Dust	Compression Strength	491.93Mpa
3	Al6061 with 2% Rice Husk ash & 4%Rock Dust	Compression Strength	496.15Mpa
4	Al6061 with 2% Rice Husk ash & 6%Rock Dust	Compression Strength	507.29Mpa

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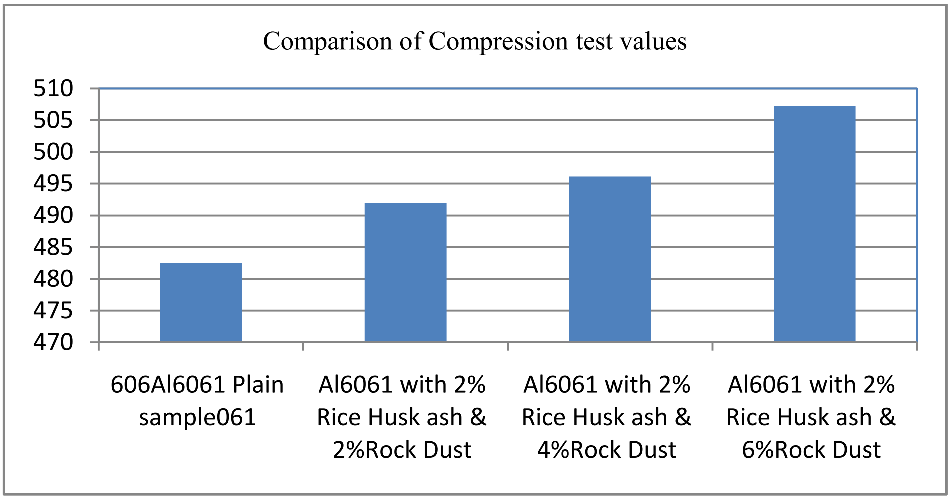

Fig. 9. Shows the comparison graph of Compression strength values for Al6061 Hybrid composites

The compression strenght of the Al6061 Hybrid composite will increases by adding the weight proportionate (2% of Rice husk ash and 2%, 4% and 6% of rock dust).

III. CONCLUSION

- Composites were successfully manufactured by adding Rice husk ash and Rock dust into Al6061 with using stir casting method.
- It is observed that addition of Rice husk ash and Rock dust into Al6061 improves the hardness of the hybrid composite, and also by adding the rock dust (in varies of 2%, 4% and 6%) increases the Hardness.
- The compression strenght of the Al6061 Hybrid composite will increases by adding the weight propostionates (2% of Rice husk ash and 2%, 4% and 6% of rock dust).

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