Machining Behaviour of Aluminium 6063 with Strengthen Aluminium Oxide and Chicken Bone Ash Produced by Modern Technique

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Abstract: In this experimental investigation the Aluminium 6063 is treated with Aluminium Oxide (Al2O3) and Chicken Bone Ash (CBA). This Aluminium metal matrix composite is mixed at certain compositions and observed with the mechanical properties. Two main mechanical properties which includes Surface roughness and corrosion behavior is mainly focused in this research work. In this Research work aluminium hybrid metal matrix composite (AHMMC) is fabricated through stir casting process. Al6063 shows good mechanical properties and corrosion behavior changes, when combined with reinforcements, Al2O3 and Chicken Bone Ash (CBA). Stir casting is an efficient cycle for the manufacture of aluminum hybrid composites. There are numerous boundaries in this cycle, which influence the behavior of corrosion and mechanical properties of the composites. Stir casting is a fluid state technique for the manufacture of composite materials, in which a scattered stage is blended in with a liquid network metal by methods for mechanical mixing. Stir Casting is the least difficult and the most financially savvy strategy for fluid state manufacture. Finally in this research work, when the compositions of each and every reinforcement increase, simultaneously the surface roughness of the composite also get increases.

Keywords: Aluminium 6063 (Al6063); Surface roughness, Chicken Bone Ash, Stir casting, Aluminium Oxide (Al2O3), Reinforcement.

Introduction:

S.Baskar et al [1] made a study on the aluminium combined with fly ash and alumina particles. This combination results in a improved sort of mechanical properties and of course the addition of alumina and fly ash depends upon the application to be used and hardness needed. A.Bharadwaj et al [2] made a experimentation by adding boron carbide and fly ash with aluminium 6063. This combination increased the tensile and hardness property to an extent but the hardness property gets decreased by weight addition of boron carbide.

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Narasa Raju Gosangi et al [3] studied the property of aluminium matrix composite combined with the Nano fly ash particles processed using stir casting method. The weight percentage of fly ash greatly influenced the hardness value of the composite and also the tensile strength. Of course the tool rotational speed during welding also shared a great job in increasing the tensile strength of the specimen. T.Prasad et al [4] made a comparative study between pure aluminium 6061 and varying composition of rice husk ask, fly ash with aluminium 6061. The better results are obtained for 10% of fly ash and rice husk mixed with aluminium 6061 respectively. Sulaiman et al [5] made a aluminium composite with help of cow bone and periwinkle shell. Addition of cowbone and periwinkle shell made the composite to be lightweight as well gave an improved range of mechanical properties such as hardness and tensile strength. Reddy et al [6] studied the tribological characteristic of aluminium 6063 reinforced with titanium carbide composite stating that the wear characteristics increased with increasing tic and proved it using the anova technique.Venkatesulu et al [7] experimented aluminium 6063 with boron carbide. Varying matter of composition of boron carbide yielded different results for this composite especially hardness of this composite gets increased due to the addition of boron carbide. Microstructural results shows good result of bonding for boron carbide added with less than 5%.Zhang et al [8] made an experiment on Nano silicon carbide based aluminium 2014 composite which showed an increased range of ductility even at its elevated range of temperature. This showed an improved range of strength of due to the Nano sized particles. Annigeri et al [9] made a review on of the casting technique called stir casting. Most probably the material heated in a crucible and the stirrer fixed various based on the homogeneity needed. Metal matrix composite of best property is obtained based on stirrer speed, size, stirring speed etc., Rajesh et al [10] made a comparative study on pure aluminium6063 and varying composition of magnesium, silicon carbide and fly ash. The results showed a improved range of mechanical property with aluminium, magnesium and silicon carbide composition respectively.Kant et al [11] suggested that the stir casting process is simplest and cheapest method wherein having a disadvantage of agglomeration wherein this can be solved through coating of reinforcement. Manojkumar et al [12] investigated the wear behavior of aluminium composite made of fly ash and graphite. The results of the dry wear test made with this composite showed an increased range of wear resistance. Nithyanandhan [13] stated that the Corrosion rate of the reinforced component is slightly decreased with the comparison of pure Aluminium 6061. The corrosion resistances of Al- B4C -RHA composites have increased with percentage increase of Boron carbide and rice husk ash. The maximum percentage of reinforced metal like boron carbide decreased the corrosion rate and increased the corrosion Resistance.

MATERIAL SELECTION

ALUMINIUM 6063

AA6063 is one of the standards of aluminium alloy with alloying elements such as magnesium and silicon. The aluminium association is having the control over these standards of the alloys. It possesses good mechanical properties with great effect of heat resistant and weldability. AA6063 is most commonly applied in areas like extrusion, forming complex shapes.

It is quite popular in architectural applications like door frames, window frames, roofs, and sign frames. Chemical composition is mentioned in the table 1.

Table.1 Represents chemical composition of AA6063

Elements	Mg	Al	Zn	Si	Mn	Cr	Fe	O
Wt.%	0.6	97.5	0.01	0.6	0.02	0.01	0.13	0.02

It has various physical and chemical properties which have a great impact in this project study is displayed in the tables 2.

Table.2 Represents AA6063 properties

Properties	Value
Poison's ratio	0.33
Tensile strength	214 Mpa
Melting point	616-654
Specific heat capacity	0.9 J/g
Thermal conductivity	200 W/mk

ALUMINA ($Al_2 O_3$)

A chemical compound of aluminium and oxygen with the chemical formula Al2 O3 is called Aluminium oxide or Alumina. It may also be referred as aloxide, aloxite and alundum based on various forms and applications. Al2O3 is important as it has its benefits to produce aluminium metal, as abrasives due to its hardness, and as a high melting refractory material with also popular in cutting tools. It acts as a great electrical insulator with high thermal conductivity. The property of alumina was mentioned in table 3.

Table.3 Represents Alumina (Al2 O3) properties

Property	Value
Boiling point	3000°C
Melting point	2054°C
Solubility	No solubility in water
Vapor pressure	0.00001 mmHg
Density	3.97 g/cm^3

As it is helpful in producing aluminium metal it will be a best suited composite for the aluminium alloy to improve its properties. Over 90% of the Al2 O3, normally called Smelter Grade Alumina (SGA), is used for the production of aluminium, usually by the Hall–Heroult process. Speciality alumina is used in a wide variety of applications which replicate its inertness, temperature resistance and electrical resistance [14-22].

CHICKEN BONE ASH PREPARTION

The Chicken bone collected from chicken stall was soaked in hot water at100 ℃ for 2 hours, In order to remove meat remnant, remove fat and oil. The bone is cooled in air. The meat remnant were scraped and scrubbed by using wire brush. Calcination of the Chicken bone were processed in Muffle furnace at 500 ℃to 800℃for 3 hours to ensure elimination of protein and moisture content. The coal after the process is crushed into fine particles by using hammer. The hammering is done to get a fine particle size of 300µm [23-29].

EXPERIMENTAL PROCEDURE

STIR CASTING PROCESS

Stir casting is convenient method to produced metal matrix composites in large quantities compared to other metal forming processes. Aluminum alloy was used as metal matrix, and Al2O3 and CBA particulates were used as reinforcements. The Aluminium Alloy 6063 rod with 25mm diameter was cut into pieces according to the weight percentage in chemical composition. Then the Aluminium Alloy was melted at 800℃by placing it in the furnace in order to obtain the molten metal. Reinforcements (Aluminium Oxide (Al2O3) and Chicken Bone Ash (CBA) was previously heated at 500-600℃in an Electrical furnace for about 30 minutes to remove moisture. According to the various compositions the reinforcements were added to the molten metal. The semi-liquid composition was stirred in the machine for 10 minutes at a constant speed of 400 rpm in-order to get proper mixing [30-37].

Finally the semi-liquid was poured into the cylindrical mold die. Then the component is left open to the atmosphere for solidification and curing. Later the component was casted and removed from the mold.

1. CONTROLLER BOARD 4. MOLTEN METAL OUTLET
2. STIR CAST FURNACE 5. MOLTEN METAL INLET
3. FLAT PLATE DIE 6. STIRRER

Fig. 1.Stir casting setup

COMPOSITIONS

Table1. Represents the compositions of the Al6063 metal matrix composites

SAMPLE	WEIGHT % OF Al	WEIGHT % OF Al2O3	WEIGHT % OF CBA
1	100	0	0
2	92	6	2
3	92	5	3
4	92	4	4
5	92	3	5
6	92	2	6

RESULTS AND DISCUSSION

SURFACE ROUGHNESS

Generally surface roughness is termed as the irregular changes which are inherent in the manufacturing process. For example: the tool which is used for the machining process, the abrasives used for various surface related processing etc..Since the surface variations in a metal are very tiny and difficult to see through our naked eye, a measuring instrument is used for the analysis of the surface roughness. A small mark is drawn across the surface layer at a constant rpm for a set distance [38-41]. A signal is observed and electrified to create a high vertical magnification. This signal may be projected on both graph and monitor outputs with values to characterize the comparison of various surface textures.

Table 2. Displays the surface roughness results for the specimen 1

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	1.385	1.153	6.400
2	1000	0.2	1	2.340	1.850	11.83
3	1400	0.3	1.5	6.407	5.305	23.97

Table 3. Represents the surface roughness results for the specimen 2

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	5.134	4.002	21.441
2	1000	0.2	1	5.999	5.007	23.442
3	1400	0.3	1.5	6.492	5.371	24.452

Table 4. Represents the surface roughness results for the specimen 3

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	1.472	1.085	7.558
2	1000	0.2	1	4.865	4.044	19.501
3	1400	0.3	1.5	6.759	5.833	24.320

Table 5. Represents the surface roughness results for the specimen 4

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	5.459	4.576	21.533
2	1000	0.2	1	6.253	5.260	24.192
3	1400	0.3	1.5	7.048	5.820	28.863

Table 6. Represents the surface roughness results for the specimen 5

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	2.748	2.109	13.464
2	1000	0.2	1	5.403	4.481	21.382
3	1400	0.3	1.5	6.572	5.666	24.863

Table 7.Represents the surface roughness results for the specimen 6

S.NO	SPEED (RPM)	FEED (mm)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS(RQ)	SURFACE ROUGHNESS(Ra)	SURFACE ROUGHNESS(R2)
1	600	0.1	0.5	3.118	2.211	12.803
2	1000	0.2	1	4.799	4.083	18.227
3	1400	0.3	1.5	7.505	6.320	28.028

Table 2 represents the surface roughness of the specimen 1, it shows that the Specimen have good surface roughness value 5.305Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut. Table 3 represents the surface roughness of the specimen 2, it shows that the Specimen have good surface roughness value 5.371Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut. Table 4 represents the surface roughness of the specimen 3, it shows that the Specimen have good surface roughness value 5.833Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut. Table 5represents the surface roughness of the specimen 4, it shows that the Specimen have good surface roughness value 5.820Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut. Table 6 represents the surface roughness of the specimen 5, it shows that the Specimen have good surface roughness value 5.666Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut. Table 7 represents the surface roughness of the specimen 6, it shows that the Specimen have good surface roughness value 6.320Ra for the following different parameters 1400RPM,0.3mm Feed and 1.5 mm depth of cut.

GRAPHS REPRESENTING ALL SAMPLES AT VARIOUS DEPTH OF CUT, FEED, SPEED:

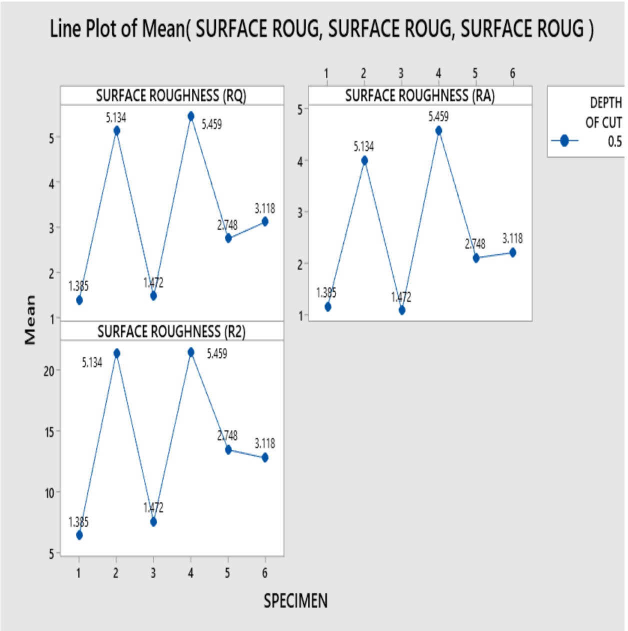

Fig 2. 0.5mm Depth of cut

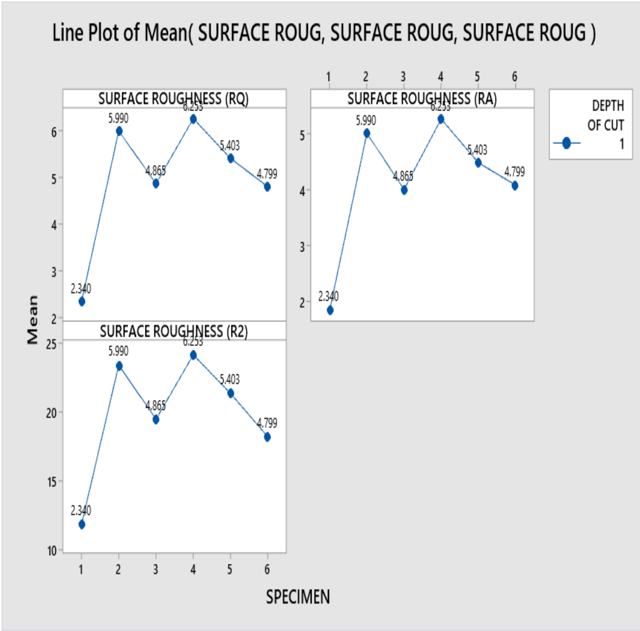

Fig 3. 1mm Depth of cut

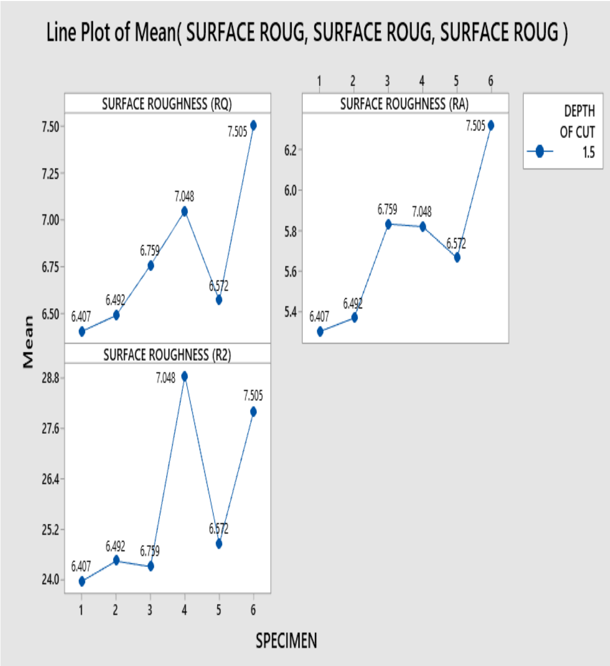

Fig 4. 1.5 mm Depth of cut

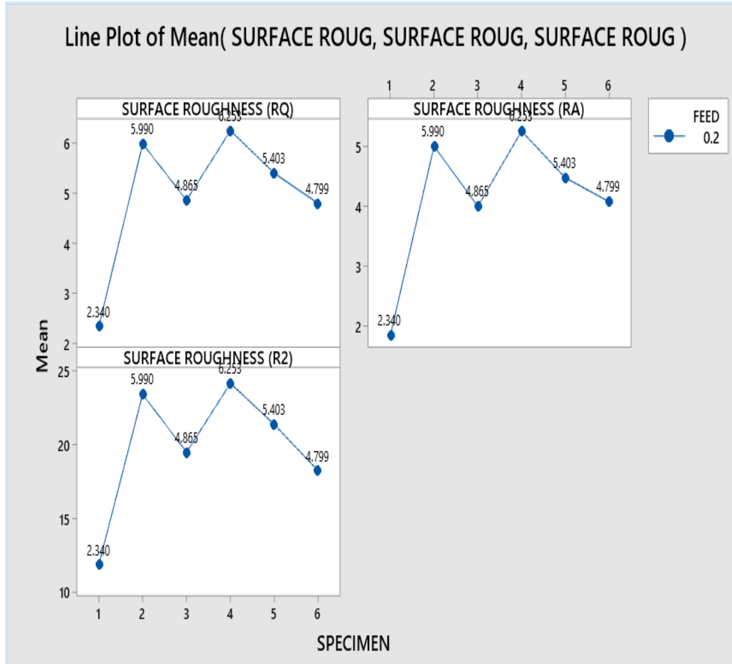

Fig 6. 0.2 mm Feed

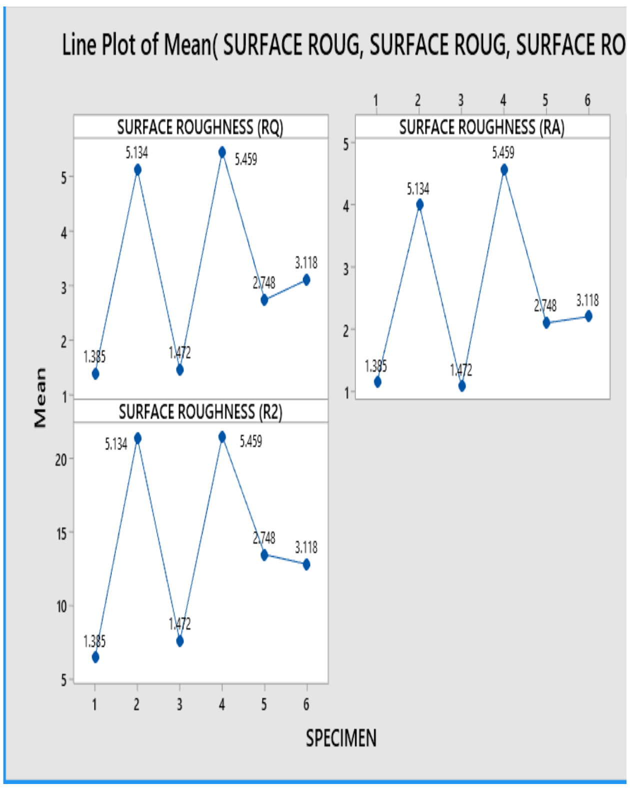

Fig 5. 0.1 mm Feed

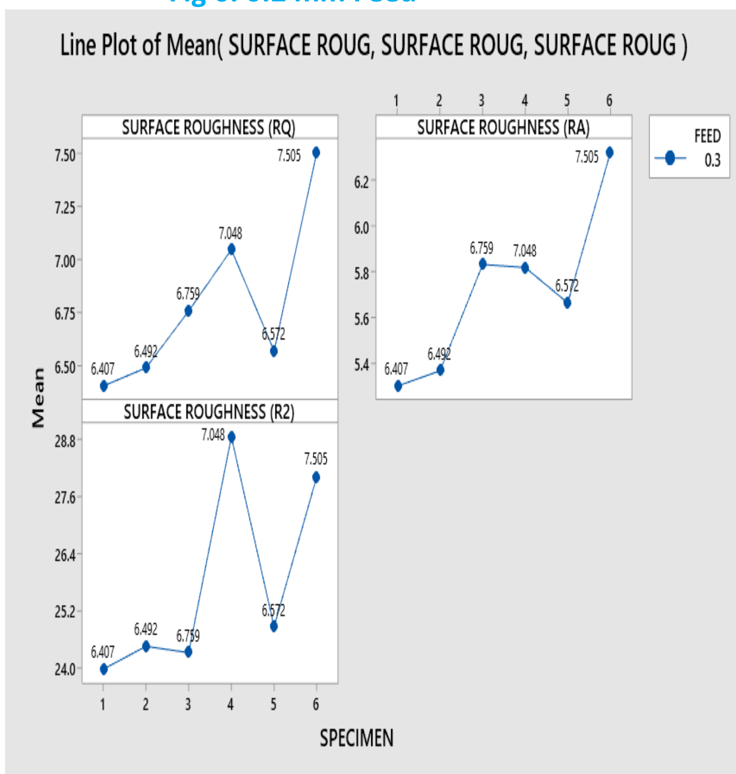

Fig 7. 0.3 mm Feed

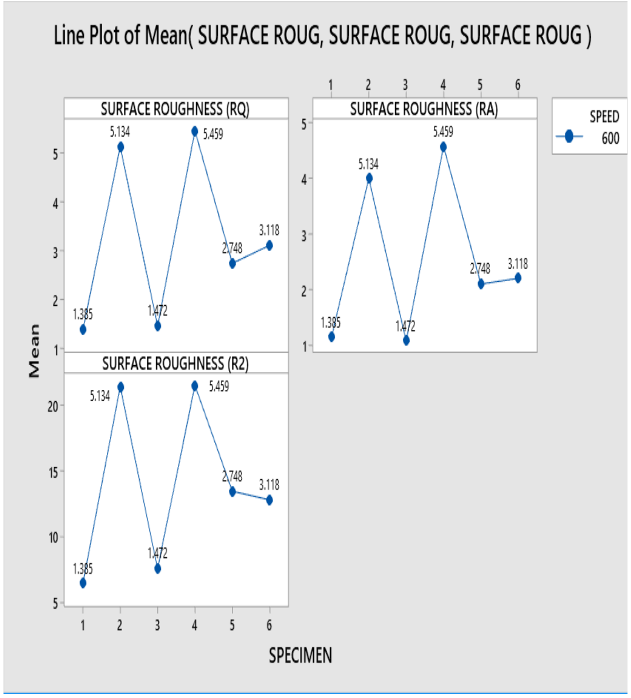

Fig 8. 600RPM Speed

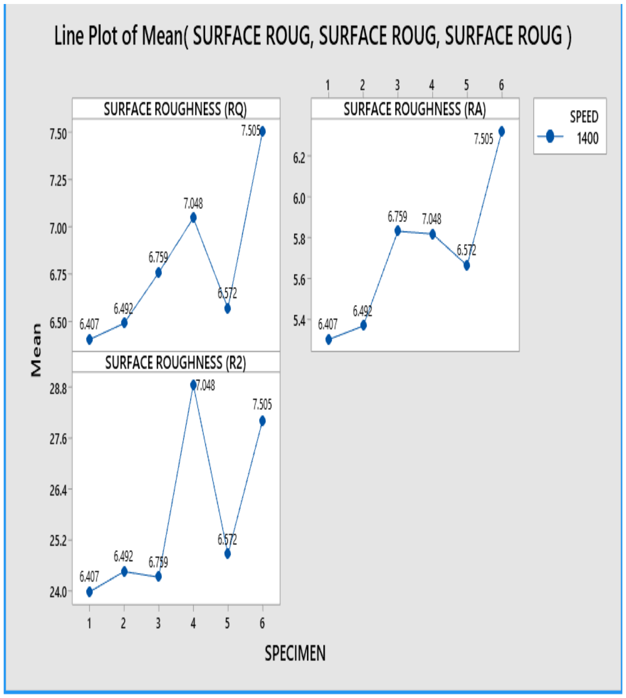

Fig 9. 1000 RPM Speed

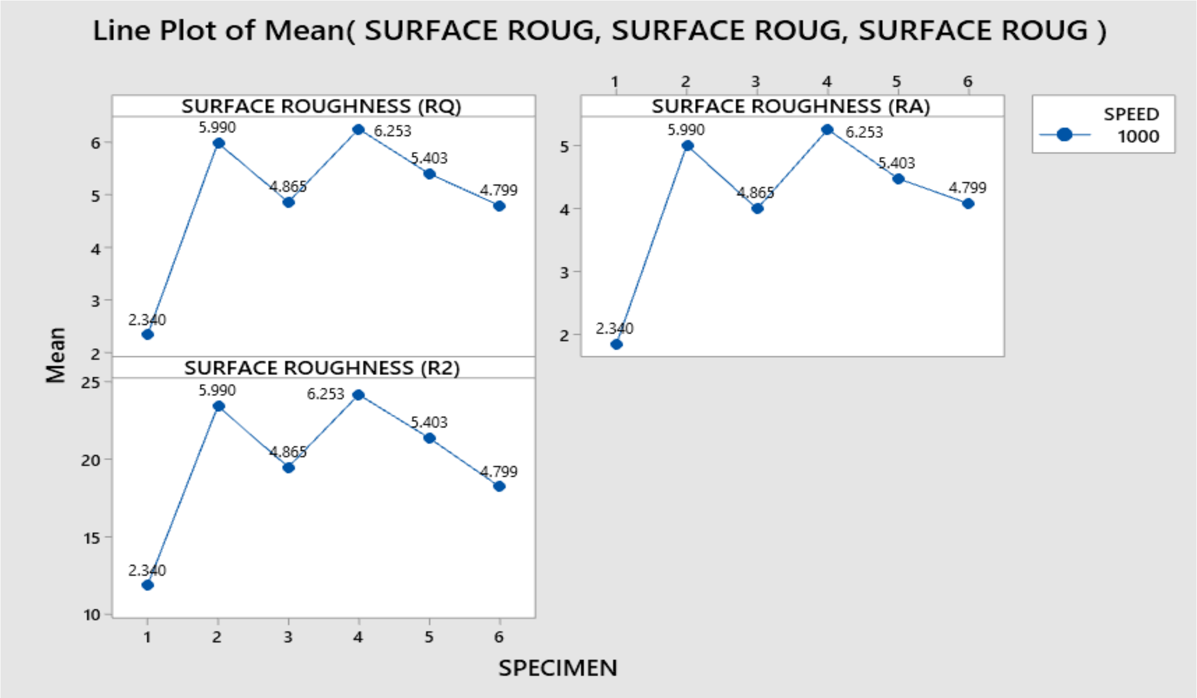

Fig 10. 1400RPM Speed

From the fig 2,3&4 shows that the surface roughness for all the specimens are noted for the different parameters of the depth of cut like 0.5mm,1mm,1.5mm Respectively .It clearly shows that the specimen 6have good surface Roughness value of 7.505 (Ra,Rq,Rz) for 1.5mm depth of cut. From the fig 5, 6&7 shows that the surface roughness for all the specimens are noted for the different parameters of the Feed like 0.1mm,0.2 mm,0.3mm Respectively. It clearly shows that the specimen 6 have good surface Roughness value of 7.505 (Ra, Rq, Rz) for 0.3mm Feed. From the fig 8, 9&10 shows that the surface roughness for all the specimens are noted for the different parameters of the Speed like 600RPM, 1000RPM, 1400RPM Respectively .It clearly shows that the specimen 6 has good surface Roughness value of 7.505Ra for 1400RPM. The result of this From all the graphs displayed above the specimen 4 has the highest surface roughness value (Ra,Rq,Rz) of 4.576, 5.459, 21.533 for the speed (600rpm), feed (0.1), depth of cut (0.5) respectively and the specimen 4 has the highest surface roughness value (Ra,Rq,Rz) of 5.26, 6.253, 24.192 for the speed (1000rpm), feed (0.2), depth of cut (1) respectively and the specimen 6 has the highest surface roughness value (Ra,Rq,Rz) of 6.32, 7.505, 28.028 for the speed (1400rpm), feed (0.3), depth of cut (1.5) respectively.

CONCLUSION

The surface roughness of aluminium metal matrix composites is carried out with different proportions of Chicken Bone Ash and Al2O3 as reinforcements. The Surface roughness of the composites is carried out with different parameters of Speed, Feed& Depth of cut. The result shows:- From this paper it is concluded that the surface roughness Value (6.320Ra) of the specimen 6 is best for the Different parameters of speed (1400 rpm), Feed (0.3mm), Depth of cut (1.5mm). It is concluded that the 2% of AL2O3 & 6% of CBA Reinforcement have good surface roughness Compared to the others.

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