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Microstructure and Mechanical Properties of Rice husk ash reinforced aluminium alloy (A356.2) metal matrix composite.

A.P.S.V.R.Subrahmanyam[1], G.Naresh[2],V.Venkatesu[3]
[1&2]Assistant Professor Dept. of Mechanical Engineering, Anil neerukonda Institute of Technology and Sciences, Visakhapatnam, A.P-531163, India.
[3] Assistant professor, Dept.of Mechanical Engineering, Lakireddy Balireddy College of Engineering,Milavaram,Vijayawada,A.P-521230, India
Corresponding Author: A.P.S.V.R.Subrahmanyam

Abstract: In this present work an attempt was made to explore the effect of abundantly available agricultural waste rice husk ash (RHA) on the A356.2 alloy, which finds wide application in aviation and marine sectors. Interesting facts were revealed out when rice husk ash is added to aluminium alloy A356.2 at 2, 4 and 8 % of weight by volume (w/v) to obtain metal matrix composites (MMC). The mechanical tests like tensile test, percentage elongation hardness test and impact test were conducted for all casted composites and pure alloy. The mechanical properties of MMC were increased with addition of RHA. The composite with 8%RHA showed superior mechanical properties. The micro structures given clear picture of uniform distribution of RHA reinforcement particles into the A356.2 matrix. The MMC micro structures were related to corresponding mechanical results.

Keywords: Aluminum alloy A356.2, Rice Husk Ash (RHA), mechanical properties, Metal Matrix Composite (MMC) and micro structures.

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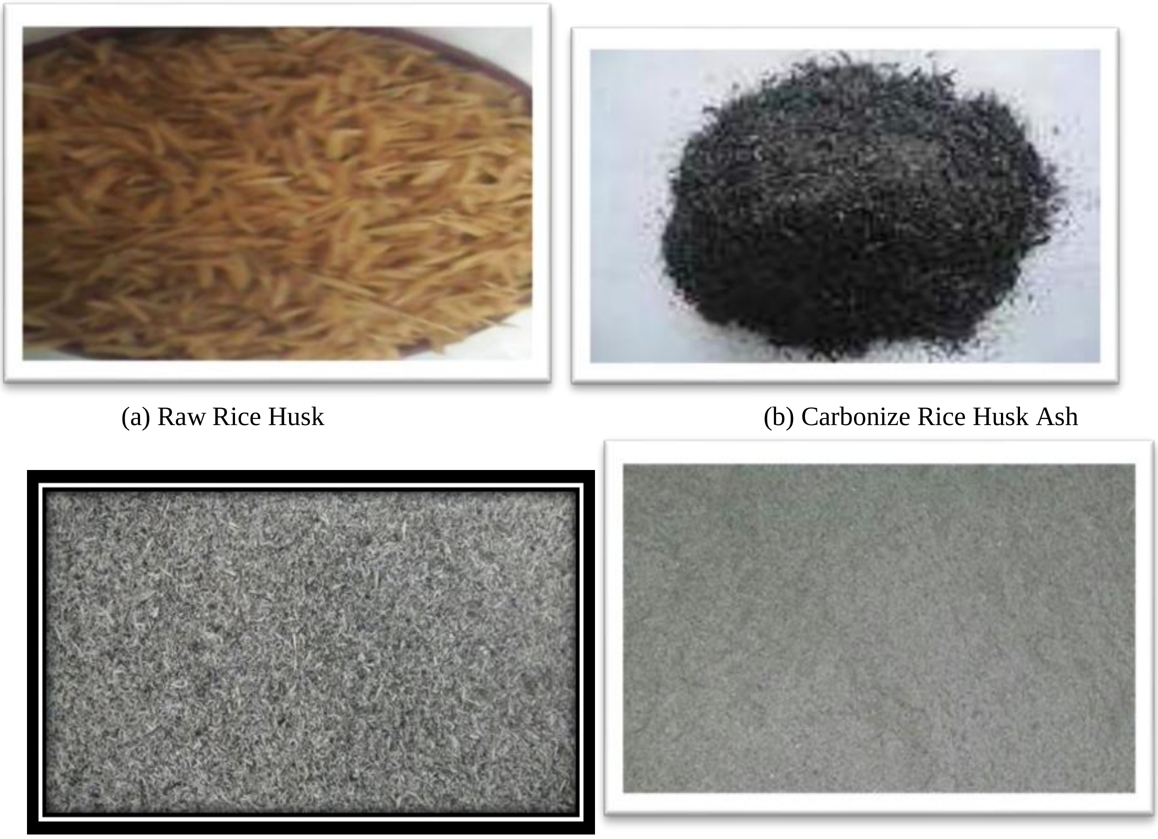
I. INTRODUCTION

The selection of suitable material to satisfy the needs of ever increasing demand in the field of marine and aviation is a tough task. Despite of satisfying engineering needs the material should be an environmental friendly and abundantly available. The effective utilization of naturally available reinforcement in the fabrication of composite would be the best method. Taking the advantage of less weight and better life aluminium matrix composites (AMCs) were developed to improve the performance to meet the requirement of modern engineering products. Aluminium matrix composites (AMCs) exhibit high strength, high elastic modulus and good wear resistance than the unreinforced aluminium alloys. Aluminium matrix composites (AMCs) are prevalent to produce several components in aerospace, automotive, marine and nuclear industries [1-3].There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, rice husk ash is one of the agricultural by product. During milling of paddy about weight percentage of 78% broken rice and rice bran. Out of 22% weight is received as husk. It is therefore expected that the incorporation of rice husk ash particles in aluminium alloy will promote the low cost aluminium products. Itskos et al. in their investigation that A356 alloy is used as a matrix for preparation of composites.Which have an enhanced wear resistance and promising mechanical properties at room temperature. [4]. Prasad et al. studied damping performance of various hybrid combinations of composites by using dynamic analyser (DMA).The incompatibility between the matrix andreinforcement of composites has a great influence on the damping capacity of hybrid composites [5]. Sahoo et al. suggested that aluminium matrix composites potentially suitable for the tribological applications [6]. D.Siva Prasad et al. concluded the hardness of A356.2/RHA composites increases with increase in rice husk ash content. Incorporation of rice husk ash particles in aluminium matrix can lead to the production of low cost aluminium composites with improved hardness and strength [7]. Md. Rahat Hossain,et al. concluded that the mechanical properties of aluminium metal matrix hybrid composites have increased with the increasing percentages of rice husk ash (RHA) in the hybrid metal matrix composites except the area reduction property due to the elongation decreases with the increase in rice husk ash content. Production of cost effective aluminium composites could have incorporated by using rice husk ash to get improved hardness, and strength. [8].

The above literature reveals that few works have been done on Al356.2+RHA but the effect of microstructure on mechanical properties of the composite not yet done. So an attempt has been made for the estimation of microstructure and mechanical characterization of Al 356.2 as matrix rice husk ash as a reinforcement by using stir casting process.



(a) Raw Rice Husk (b) Carbonize Rice Husk Ash

(c) Ground Carbonized Rice Husk Ash (d) Combusted Rice Husk Ash

Figure1: Preparation of Rice Husk Ash

II. MATERIALS AND METHODS

2.1 Reinforcement Material Rice Husk Ash (RHA)

Rice Husk is the outermost layer of protection encasing a rice grain. It has convex shape and yellowish colour. It is plenty of available and light in weight. The range of density is 340kg/m^3 to 400kg/m^3.The washed Rice Husk Ash was then heated to 1000^C for 2hrs in order to remove the moisture and organic matter. Lastly the RHA was again heated in furnace (Owen) to 500^0 C for 12hrs. The Ash was obtained by burring Rice Husk in a steel vessel. The chemical composition of RHA is listed in table1.

Constituent	SiO_2	Al_2O_3	C	CaO	MgO	KaO	Fe_2O_3
(%)	90.23	3.54	1.23	1.58	0.53	0.39	0.21

Table: 2.1: Chemical Composition of Rice Husk Ash

2.2Matrix material

In this study, Al356.2 alloy is used as the matrix material and RHA isused as the reinforcement.The chemical composition of A356.2 alloy is presented in the Table 2. Testspecimens are made which are classified based on the wt. %(0, 2, 4 and 8) rice hush ash particles.

Si	Fe	Cu	Mn	Mg	Zn	Ni	Ti
6.5-7.5	0.15	0.03	0.10	0.4	0.07	0.05	0.1

Table 2.2: Chemical composition of A356.2 Al Alloy matrix

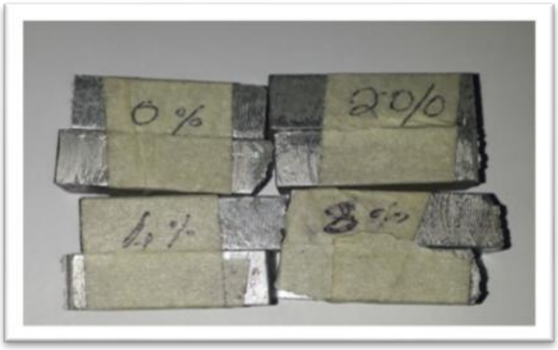
III. EXPERIMENTAL PROCEDURE

Initially, A356.2 Al alloy 89% by weight was melted in a resistance heated muffle furnace and casted in a clay graphite crucible and heated to about 750ºC till the entire alloy in the crucible was melted. The reinforcement particles RHA is preheated to 800^0 C for 1 hour before incorporation into the melt. Concurrently 1 % by weight magnesium was added to the melt in order to enhance the wettability between rice husk particles and the alloy melt. The stainless steel stirrer was lowered into the melt slowly to stir the molten metal at the speed of 500 -700 rpm. The preheated RHA particles 2 % by weight were added to the molten metal at a constant rate during the stirring. The stirring was continued for another 10 min even after the completion of particle feeding. The mixture was poured into the mold was cooled to room temperature for 1 day to obtain uniform solidification. Thus (98% A356.2+1%Mg+2%RHA) aluminum composite metal matrix composite was prepared. By repeating the same procedure the remaining other two composites with 4 and 8% RHA were prepared. A356.2 pure alloy casting was also done.

Melting alloy

Castings

Tensile test Specimens



Hardness and Impact test Specimens

Figure2: Specimens for mechanical tests

IV. RESULTS AND DISCUSSIONS

1.3 Hardness Test:

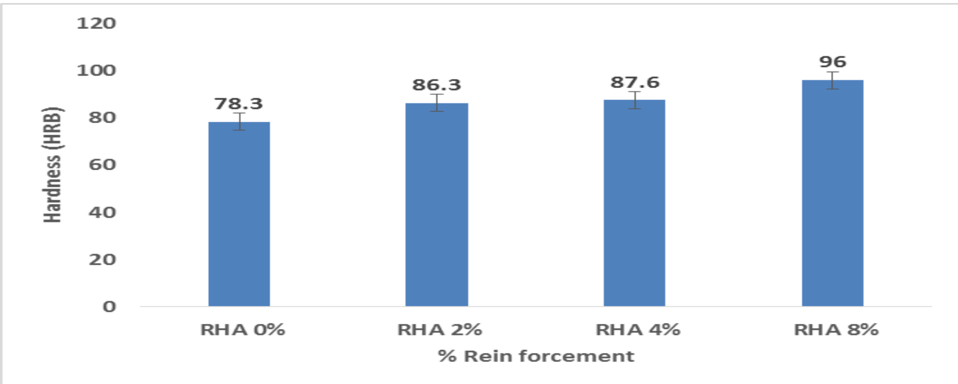


Fig: 3Variation of hardness with Weight % RHA.

The results of hardness measurement on the base metal and reinforced materials are shown in Fig3. The results reveal that an increase in the percentage of rice husk ash particulates in MMC increases the material hardness. The increase in hardness is due to the presence of silicon particles formed as a result of reaction between RHA particles and molten alloy. It can be observed that the hardness values are increased with increase in percentage of reinforcement. The increase in hardness is due to the uniform distribution of reinforced particles that can increase strengthening mechanism and the other is due the changes in coefficient of thermal expansion (CTE) among reinforcing particles and metal matrix resulting in elastic and plastic incompatibility. There is a little increment of hardness between 2 % and 4 % weight fractions of RHA further increase in weight fraction enhancement of hardness to greater extent [16].

1.4 Tensile Test.

The tensile test specimens were prepared according to ASTM E8 standards. The tensile test was performed on INSTRON universal material testing machine. The ultimate tensile strength obtained during tensile test of all specimens was shown in Fig 4. It was found that the addition of rice husk ash has significant effect on the tensile properties. The addition of the rice husk ash particles increases strength mainly by the load transfer from matrix to the reinforcement due to the differences in the elastic constants.

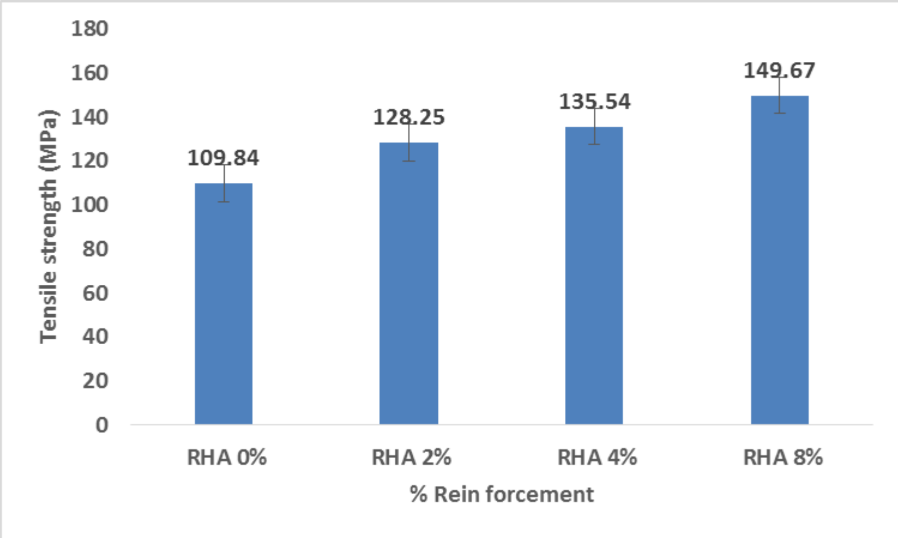


Fig: 4Variation of tensile strength with Weight % RHA.

It is clear from the figure 4 that, tensile strength of composites increases with increase in weight fraction. The enhancement in tensile strength of the composite is attributed to the fact that, the reinforcement material of rice husk ash holds higher resistance to loads and strong strengthening capacity of load transfer. With 8% RHA the tensile strength is 149.67MPa. There is no increase beyond 9% RHA and further increase in reinforcement there is the possibility of decrease in tensile strength, and with an Increase in RHA powder content, there is possibility of agglomerations or poor wettability of the reinforcement [2]

1.5 Impact test

Impact tests were carried out on all test specimens as per ASTM – D790. Estimation of Impact energy is work done to fracture of a test specimen.

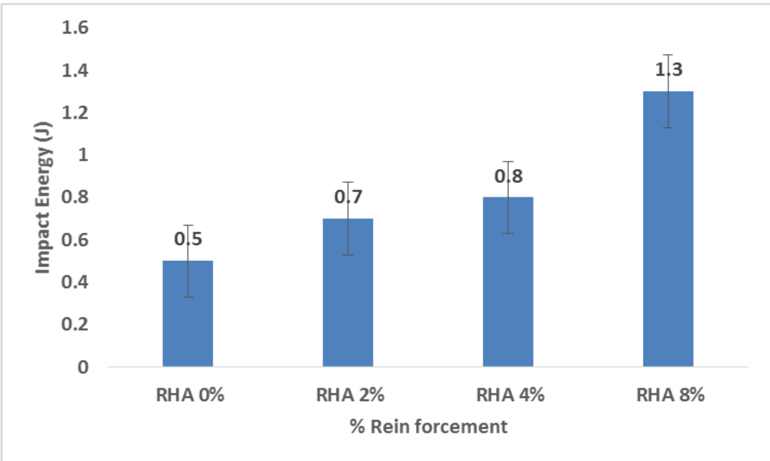


Fig: 5Variation of impact energy with Weight % RHA.

Impact Energy for the composite material with 8 % RHA exhibits maximum Impact energy of 1.3 joules while 0% RHA Reinforced composites has less amount of impact energy of 0.5 joules.The impact energy increased as the percent rice husk ash addition increased in the alloy matrix.RHA particles in the matrix acts as barriers to take up the load as they were tightly packed in the composite.

1.6 Percentage of elongation.

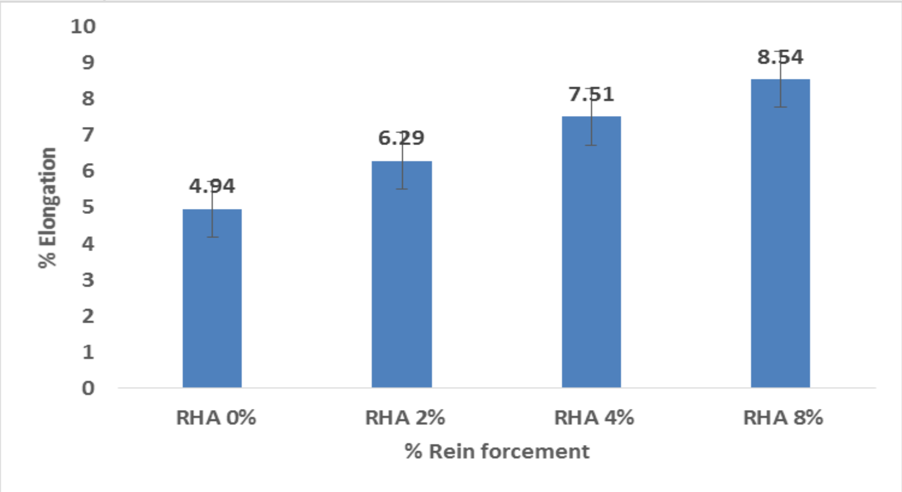


Fig: 6 Variation of %Elongation with Weight % RHA.

It was observed that the percentage elongation of the composite linearly increasing with the increase in reinforcement of the rice husk ash particles. This take place due to increases in surface area of the matrix and thus the grain sizes are reduced. Since RHA particles in the matrix improves the bonding between the grains of matrix by acting as barriers.

V. MICRO STRUCTURES

The micro structure plays an important role for analyzing the distribution of distinct phases in an Aluminium matrix material. The micro structure was studied by using optical electron microscope and which shows that the phases are near uniformly distributed in the metal matrix. And the OEM Images of the three specimens were as shown below.

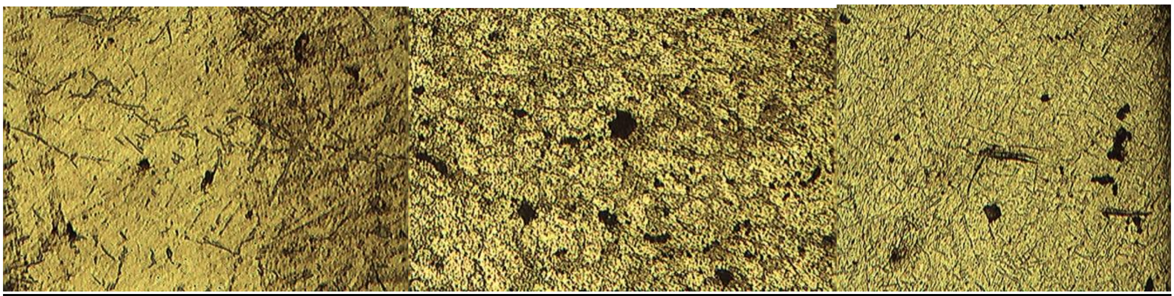


Fig: 7.1(a) Al 356.2 +2% RHA   Fig: 7.1(b) Al 356.2 +4% RHA   Fig: 7.1(c) Al 356.2 +8% RHA

Fig:7 Polished images of Al356.2 composite

Figure 7.1(a) shows the uniform distribution of reinforcement material in Al 356.2 alloy. The microstructure of the parent metal shows fine scripts of Al-Si eutectics in primary alpha luminous solid solution. The dark particles are the reinforcement particles in metal matrix of aluminium. The fine composite particles have dragged during polishing as being very soft and lighter. The reinforcement particles are isolated in this field. The composite particles are lighter and appear as fine wood chips.The composite particles have dispersed as fine particles in one line during solidification and some particles have also occupied the grain boundary voids during solidification.

Figure 7.1(b) shows the dispersion of reinforcement particles in Aluminium metal matrix. The micrograph shows uniform distribution of the reinforcement particles in metal matrix.The effect of composite material which has left the Al-Si eutectic particles as fine needles. The reinforcement particles invariably occupied the grain boundary sites and larger particles have appeared in the metal matrix. The reinforcement particles are present both as clusters and as fine isolated particles.

Figure 7.1(c) very high addition of reinforcement particles leads to the formation of clusters of composite particles. The reinforcement particles have agglomerated in metal matrix. However, it has not changed the morphology of the Al-Si eutectic particles which are fine needle shaped. This field shows isolated particles of reinforcement in metal matrix. The photo-micrograph also shows long fiber like husk particles at many locations. The husk particles occupied all voids possible and acts like barriers to fill the gap and there by improves the strength of the composite

VI. CONCLUSIONS

- A356.2/RHA composites were synthesized successfully by using stir casting technique.
- The analysis of micro structures revealed that rice husk ash particles were distributed uniformly in aluminium alloy matrix. The microstructure also revealed good interfacial bond between matrix and RHA particles.
- The microstructure with high amount of reinforcement (8%) revealed that RHA particles are distributed uniformly and tightly packed when compared to other combinations of reinforcements probably due to the surface formed by reinforcement combination with the matrix alloy
- The composite with 8% RHA showed superior mechanical properties than other combinations. However, composites with more than 9% weight fraction of rice husk ash particles, there was no enhancement in mechanical properties.
- In aluminium matrix and combination of rice husk ash particles can lead to the production of light weight, low cost metal matrix composite materials.
- All composite cases have better mechanical properties than pure alloy (Al356.2).

REFERENCES

[1]. V.P.Della, V. P., Kühn, I., and Hotza, D,“ Rice husk ash as an alternate source for active silica production” , Materials Letters, 57(4), pp. 818– 82

[2]. S. D. Saravanana and M. Senthil Kumar.(2013) “ Effect of Mechanical Properties on Rice Husk Ash Reinforced Aluminum alloy (AlSi10Mg) Matrix Composites” , International Conference On design and manufacturing, icondm 2013, procedia engineering, vol. 64, , pp. 1505-1513.

[3]. Baradeswaran A, Perumal AE. (2014) “ Study on mechanical and wear properties of Al 7075/Al2O3/graphite hybrid composites” . Composites Part B: Engineering.; 56:464-71.

[4]. Itskos, G., Rohatgi, P. K., Moutsatsou, A., Defouw, J. D., Koukouzas, N., Vasilators, C. & Schultz, B. F. (2012). “Synthesis of A356 Al-High-Ca fly ash composites by pressure infiltration technique and their characterization”. Journal of Materials Science, 47(9), 4042-4052

[5]. Prasad, D. S. &Shoba, C. (2016)” Experimental evaluation on to the damping behavior of Al/SiC/RHA hybrid composites” Journal of Materials Research and Technology, 5(2), 123-130.

[6]. Sahoo, P. & Ghosh, S. (2011) “ Tribologicalbehavior of aluminium metal matrix composites– A review” . Journal of Tribology Research, 2(1), 1-14.

[7]. D.Siva Prasad, Dr .A. Rama Krishna(2010) “ Fabrication and Characterization of A356.2-Rice Husk Ash Composite using Stir casting technique**” ,**International Journal of Engineering Science and TechnologyVol. 2(12), 7603-7608.

[8]. Md. Rahat Hossain, Md. Hasan Ali, Md. Al Amin, Md. Golam Kibria, and Md. Shafiul Ferdous(2017) “Fabrication and Performance Test of Aluminium Alloy-Rice Husk Ash Hybrid Metal Matrix Composite as Industrial and Construction Material” International Journal of Engineering Materials and Manufacture 2(4) 94-102.

[9]. Alaneme, K. K., Akintunde, I. B. &Olubambi, P. A. (2013) “ Fabrication characteristics and mechanical behaviour of rice husk ash – Alumina reinforced Al-Mg-Si alloy matrix hybrid composites” Journals of Materials Research and Technology. 2, 60-67.

[10]. Zahi, S. &Daud, A. R. (2011). “ Fly ash characterization and application in Al-based Mg alloys” . Materials and Design, 32(3), 1337-1346.

[11]. M. K.Surappa, “ Synthesis of fly ash particle reinforced A356 Al composites and their characterization” , Materials Science and Engineering, vol. 480, pp. 117-124, 2008.

[12]. Chandrasekhar. S., Satyanarayana.K. G. Pramada and Gupta. T. N. (2003), “ Review processing, properties and applications of reactive silica from rice husk - an overview” , Journal of Materials Science, 38(15), pp. 3159– 3168.

[13]. J. Narciso, A. Alonso, A. Pamies, C. G. Cordovilta and E. Louis, (1994), “ Wettability of binary and ternary alloys of the system Al-SiMg with SiC particulates” , ScriptaMetall, vol. 31, pp. 1495-1500.

[14]. Aigbodion VS, Hassan SB, Dauda ET, Mohammed RA,” Experimental study of ageing behaviour of Al-Cu-Mg/bagasse ash particulate composites” , Tribology in industry. 2011, PP.(28-35).

[15]. A. P. S. V. R. Subrahmanyam, G. Narsaraju and B. Srinivasa Rao. (2015) “ Effect of Rice Husk ash and Fly ash Reinforcements on Microstructure and Mechanical properties of Aluminium alloy (AlSi10Mg) Matrix Composites” , International Journal of Advanced Science and Technology, vol. 76, , pp. 1-8.

[16]. JittimaPrasara-A, Shabbir H. Gheewala(2017)” Sustainable Utilization of Rice Husk Ash from Power Plants: A Review” Elsevier Science Limited.

[17]. C.M. Sonsino, R. Franz(2016) “ Multiaxial fatigue of cast aluminium EN AC-42000 T6 (G-AlSi7Mg0.3 T6) for automotive safety components under constant and variable amplitude loading” C. M. Sonsinoetalii, Fratturaed Integrità Strutturale, 37 200-206; DOI: 10.3221/IGF-ESIS.37.26.

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