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Modeling, Analysis and Fabrication of Piston Using Al-Si/Fly ash/Granite Dust Reinforced Composite

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Abstract: This paper is aimed to process properties of the conventional hardness and microstructure of Al-Sic nano composites with grapheme flakes. It is planned to use various combinations with weight percentage of grapheme and Sic and to produce the Aluminum matrix composites by Compression Process. The use of AL-Blast furnace slag reinforced Composite materials is finding applications day by day in engineering fields such as aero-space, automotive, aircrafts constructions, etc. Glass fibre polymer composites are reinforced with granulated blast furnace slag (GBFS) ball milled to size of 5 nm in different weight fractions, i.e. (0%, 5%, 10% and 15%) and fabricated by using hand lay-up technique. These fabricated slabs are cut into required dimensions and the tests for mechanical properties like Tension test, Compression test, Flexural test Impact test and Hardness test were performed. Tension test, compression test and Flexural test were performed on Computerized Universal Testing Machine (UTM), Impact test was performed for Izod and Charpy specimens and Hardness test was performed on Brinell's Hardness Testing Machine. From the experimental results obtained, it was noticed that the mechanical properties were enhanced when the blast furnace slag percent was increased and also among these percentages of blast furnace slag, the specimen having 5% was possessing highest properties.

Key words:- *A356 Composite, Gr dust/fly ash.* Stir casting Metallurgical microscope, hardness, FEA.

Introduction: The term composite material has many meanings based on various literatures; one of them is the combination of different multifunctional material systems that provide excellent properties which are not possible in individual systems. Initial investigations were made with process development using fiber reinforcement, Anisotropy, expensive fabrication cost and restricted secondary processing has led to the use of short fiber / particulate / whisker reinforced composites. The combination of good transverse properties, low cost high workability and significant increase in performance over unreinforced alloys are the commercially attractive features of these discontinuous reinforced composites. Compared to dispersion strengthened systems, particulate reinforced composites contain coarse size reinforcement (1-100 μm) in relatively high weight fractions (1-30%). In particulate composites, both matrix and reinforcement bear substantial load. In addition, matrix strength as affected by precipitation and dislocation strengthening plays an important role in the load bearing capacity of these composites. Metal matrix composites reinforced with ceramic particles are widely used due to their high specific modulus, strength and wear resistance.

There has been an increasing interest in composites containing low density and low cost reinforcements. So far most of the research work have been carried out by incorporating hard ceramic particles such as Al_2O_3, SiC, Fly ash and graphite particles to soft matrix like pure aluminum, AA2024, A356, A356 and many more alloys and very few worked on combination of reinforcements (hybrid composites). In the current work, an attempt has been made by combining two types of ceramic particles like fly ash and Granite dust in equal proportions for preparation of hybrid composites, which significantly improves the mechanical properties.

Fabrication of Piston Material: In the present investigation, aluminum based hybrid metal matrix composites containing Granite dust and fly ash particulates of 53μm were successfully synthesized by vortex method. The matrix materials used in this study was Al-Si alloy.(A356) whose chemical composition. The synthesis of these composites was carried out by stir casting technique. The cylindrical fingers (18 mm Φ and 170 mm length) of A356 alloy were taken into a graphite crucible and melted in an electric furnace. After maintaining the temperature at 770 °C

A vortex was created using mechanical stirrer made of graphite.

While stirring was in progress, the preheated particulates Granite dust at 300^0C for 2 hrs were introduced into the melt.

Care has been taken to ensure continuous and smooth flow of the particles addition in the vortex. The molten metal was stirred at 400 rpm under argon gas cover. The stirring was continued for about 2 minutes after addition of particles for uniform distribution in the melt. Still, the melt with reinforcement was in stirring condition the same was poured into sand mound. Cast ingot of piston is homogenized at 110 ^{0}C for 24hrs to get relieve the internal stresses and minimize the chemical in homogeneities which may be present in the cast condition.

Figure: Stir casting - Cast fingers

Characterization of Composites:

Hardness tests: The hardness of the alloy and composites is shown in Figure 4.10. As the volume of fly ash and granite increases, the composite's hardness increased from 105 VHN to 125 VHN for 10 percentage reinforcement. The presence of hard silica and alumina in fly ash and granite may be the reason for improvement.

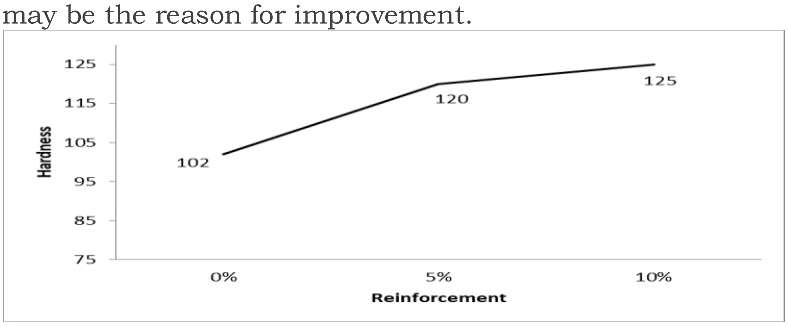

Figure: Hardness of A356 alloy and composites

Metallography: The studies of morphology for Alloy and composites were conducted using both optical and scanning electron microscopy. Standard polishing techniques were used to prepare samples for metallographic observations. The specimen's microstructures were studied using optical microscopy. The etching reagent was used as HF= 1.0 cc, HCL= 1.5 cc, HNO3= 2.5 cc and H2O= 95 cc.

The microstructures of base alloy and composite is shown in the figures blow

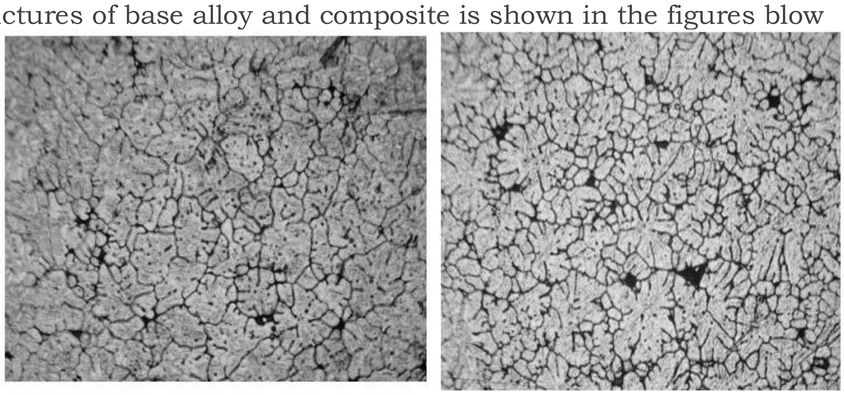

Figure: Microstructure of base alloy and composite

Introduction to CATIA V5R16: **CATIA** started as an in-house development by French aircraft

Manufacturer Avionics Marcel Dassault, at that time customer of the CADAM CAD software.

The software name was initially CATI (Conception Assisted Tridimensional Interactive - French for Interactive Aided Three Dimensional Design), but was renamed to **CATIA** in 1981.

CATIA, developed by dassault systems, is one of the world's leading CAD/CAM/CAE packages. Being a solid modeling tool, it not only unites the 3d parametric features with 2d tools, but also addresses every design through manufacturing process. Besides providing an insight into the design content, the package promotes collaboration between companies and provides them with an edge over they competitors.

Application Of CATIA

- Aerospace
- Automotive
- Shipbuilding

CATIA V5 serves the basic design task by providing different workbenches. A workbench is defined as a specified environment consisting of set of tools, which allows the user to perform specific design task in a particular area. The basic workbenches in catia v5 are:

- Sketcher
- Part design
- Wireframe and surface design
- Assembly design
- Drafting

The Modeling Process:

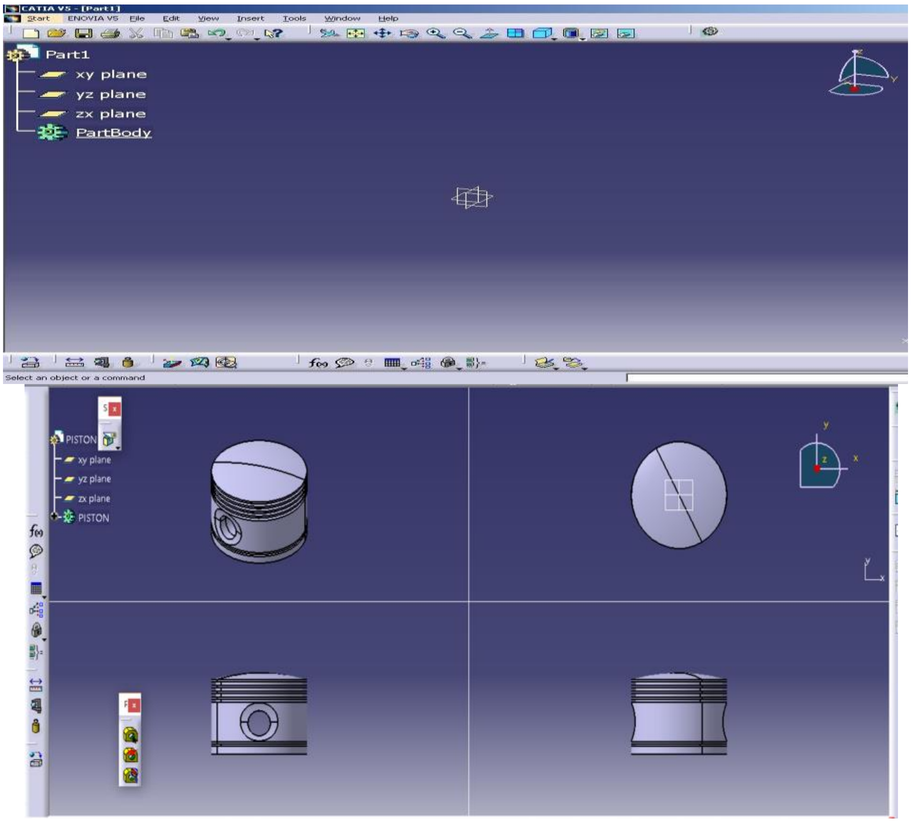

Figure: Modelling of piston

Structural analysis on piston Material- aluminum alloy356/sic/flyash

Save catia Model as .iges format
→Ansys → Select analysis system → static structural → double click
→Select geometry → right click → import geometry → select browse →open part → ok
→ Select mesh →smartsize→ mesh all.

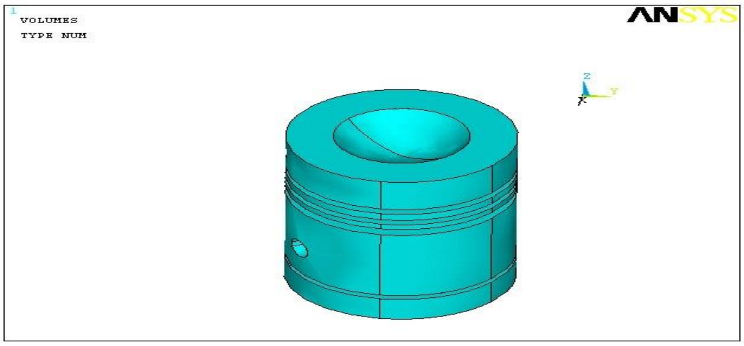

Figure: Piston Geometry

Double click on geometry → select geometries → edit material

Density: 2.70 g/cm^3

Young's modulus : 69000 Mpa

Poisson's ratio : 0.33

Select mesh on left side part tree → right click → generate mesh →

Meshed View of the Piston

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	2.7	g cm^-3		
3	Isotropic Secant Coefficient of Thermal Expansion				
4	Coefficient of Thermal Expansion	23.4	C^-1		
5	Reference Temperature	25	C		
6	Isotropic Elasticity				
7	Derive from	Young's M...			
8	Young's Modulus	69000	MPa		
9	Poisson's Ratio	0.33			
10	Bulk Modulus	6.7647E+10	Pa		
11	Shear Modulus	2.594E+10	Pa		
12	Bilinear Isotropic Hardening				
13	Yield Strength	276	MPa		
14	Tangent Modulus	0	MPa		
15	Tensile Yield Strength	310	MPa		

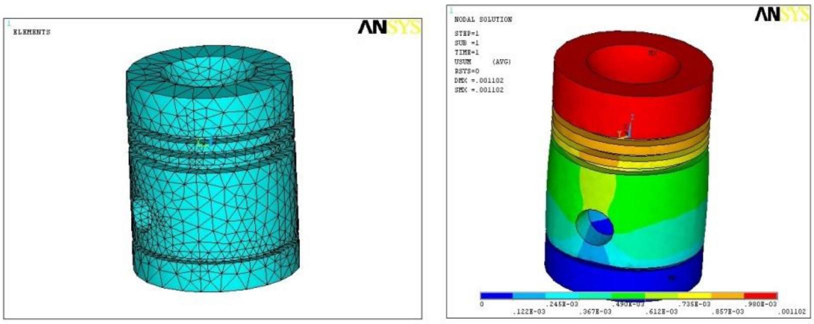

Figure: Meshed model and Deformation

Conclusion: In this paper. A356/Granite dust/flyash composites were produced by stir casting route successfully. There was a uniform distribution of granite dust particles in the matrix phase. From the microstructure during hardness, it clearly shows that there were no voids and discontinuities in the composites. The hardness of the composites increased with increasing the amount of granite dust than the base alloy. FEA Modelling and analysis was sucessfully performed.

References

1. Emmanuel Gikunoo "Effect of Fly Ash Particles on the Mechanical Properties and Microstructure of Aluminium Casting Alloy A535" M.S Thesis, p.97, 2004.
2. G G Sozhamannan, S Balasivanandha Prabu and V S K Venkatagalapathy "Effect of Processing Paramters on Metal Matrix Composites: Stir Casting Process", *Journal of Surface Engineered Materials and Advanced Technology*, 2012, 2, pp 11-15.
3. S.Madhusudan, M.M.M.Sarkar, N.R.M.R Bhargava "Fabrication , characterization of aluminium-copper composites International Journal of Alloys and Compounds, vol. 47, 2009, pp 116-118.