MICROSTRUCTURE AND DEFORMATION PROPERTIES OF ALFA COMPOSITES

Dr.D.Venkara Rao, N.Vijaya Kumar, Dr.J.Babu Rao

Abstract- Cold upsetting experiments were carried out on as cast and homogenized AA2024/Fly ash composite billets. The study was aimed to evaluate the deformation behavior. Optical and scanning electron micrographic examination of the samples was also undertaken. Hardness measurements were carried out to observe changes, if any, before and after the forging. Specimens were deformed in compression between two flat platens to predict the metal flow at room temperature. The circumferential stress component σ_θ increasingly becomes tensile with continued deformation. On the other hand the axial stress, σ_z increased in the very initial stages of deformation but started becoming less compressive immediately as barreling develops. FEM simulation analysis of the forging of composite cylinders was then undertaken using Ansys software with a specified diameter-to-height ratio. Detailed comparisons of the experimental variables with the finite element method (FEM) results were carried out to ascertain the accuracy with which the deformation process can be modeled. Predictions from the simulation results were found to be in good agreement with the actual experimentation.

Index Terms - Friction, Upsetting, Fly ash, Finite Element Analysis

1. INTRODUCTION

In the recent years, usage of ceramic particle - reinforced metal matrix composites (MMCs) is steadily increasing because of their advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components Fly Ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants.

Finite element methods and optimization techniques of forging process is still of considerable interest. There are many objectives for these techniques, for example, material flow behavior, fold-over, improper die filling, tool wear and excessive forging loads, especially with a new materials emerging every day with very attractive properties to automobile.

This paper is an attempt to study the deformation behavior Al-fly ash composites (Al- 2%, 6% and 10% fly ash by wt.) Attempts have also been made to simulate forging (upsetting) conditions by FEM methods. The simulated and experimental results have also been compared in the paper.

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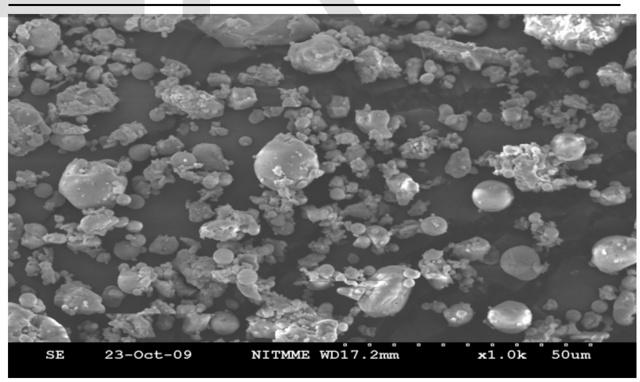
2. EXPERIMENTAL PROCEDURE

The composite used in this study was AA2024 Alloy reinforced with (2-10% fly ash by wt.) particles which were carried out by stir casting technique. Cylindrical fingers (18 mm Φ and 170 mm length) of pure aluminum were taken into a graphite crucible and melted in an electric furnace.

Table 1: Chemical composition of as received fly ash, wt. %

SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	Loss on Ignition
58.41	30.40	8.44	2.75	1.3	1.53	1.0	1.98	2.4



SEM micrograph of fly ash particles used in fabricating the composite

3. COMPRESSION TESTS

Compression tests were carried out on cylindrical specimens of pure aluminum and Al-fly ash composites (2-10% Fly Ash) of 16 mm Ø with H0/D0 ratio of 1.0. These cylindrical specimens of standard dimensions were prepared using conventional machining operations of turning, facing and drilling. Specimen edges were chamfered to minimize folding. Concentric v- grooves of 0.5mm deep were made on the flat surfaces to have a low

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friction between die and work piece during compression. Standard samples were compressed by placing between the flat platens at a constant cross head speed of 0.5mm/min in dry condition, using a computer controlled servo hydraulic 100T universal testing machine (Model: FIE-UTE). Cold work die steel dies (flat flattens) were machined to produce smooth finish to yield low friction. Online plotting of load versus displacement was done continuously through a data acquisition system.

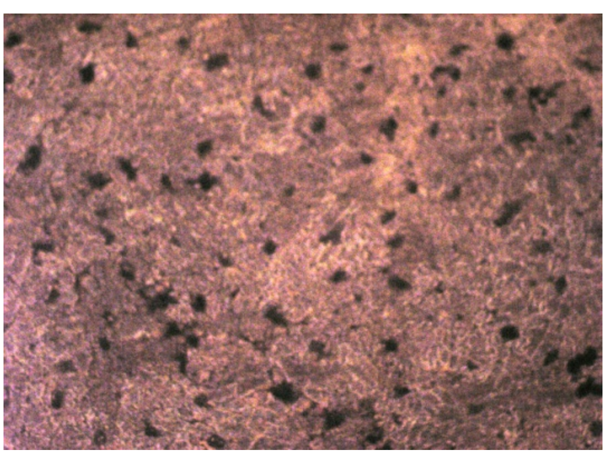
4. FINITE ELEMENT SIMULATION

Finite element simulation (FEM) of the forged specimens by lagrangian finite element model of the cold upset forging process under unlubricated condition is developed using Ansys software. Rigid-flexible contact analysis was performed for the forming process. For such analysis, rigid tools need not be meshed. The billet geometry was meshed with 10-node tetrahedral elements (solid 92 in ANSYS Library). Material models were selected based on the properties of the tooling and billet materials. Due to high structural rigidity of the tooling, only the following elastic properties of tooling (H13 steel) were assigned assuming the material to be isotropic Young's Modulus E = 210 GPa and Poisson's ratio γ = 0.30. For billet material model selected is isotropic Mises plasticity with E = 73 GPa, γ = 0.375 and plastic properties obtained from Hollomon power law equation

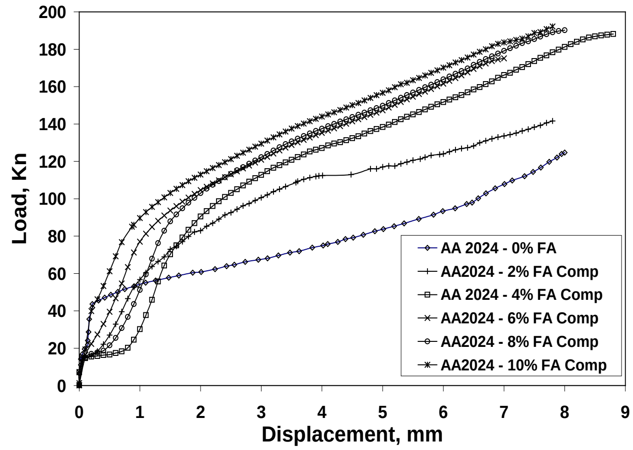
5. RESULTS AND DISCUSSION

Mechanical properties of ALFA composites

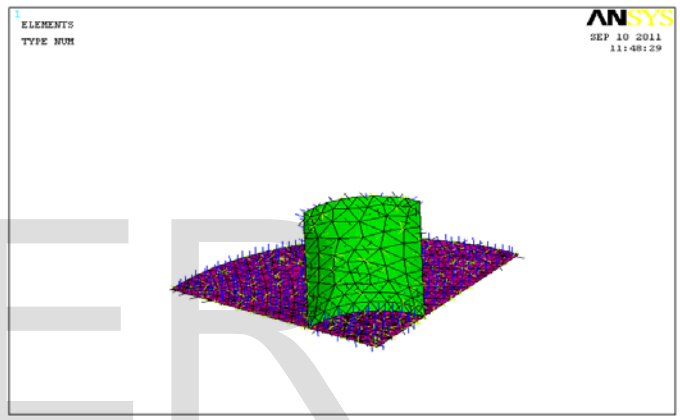
5.1 Optical microstructures of AA 2024-% (by wt) Fly



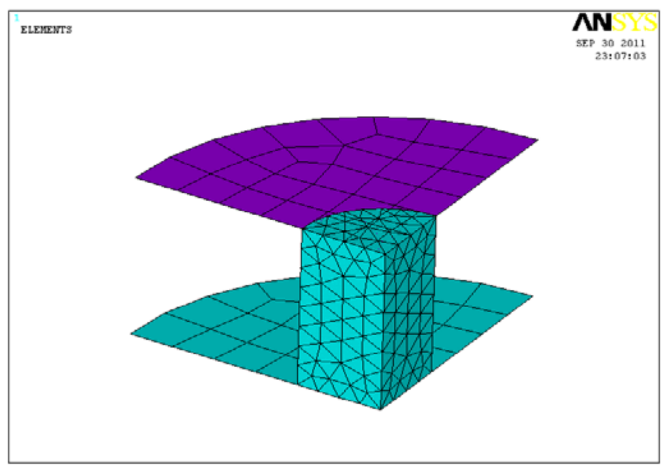
5.2.compressive strength



6. FINITE ELEMENT SIMULATION

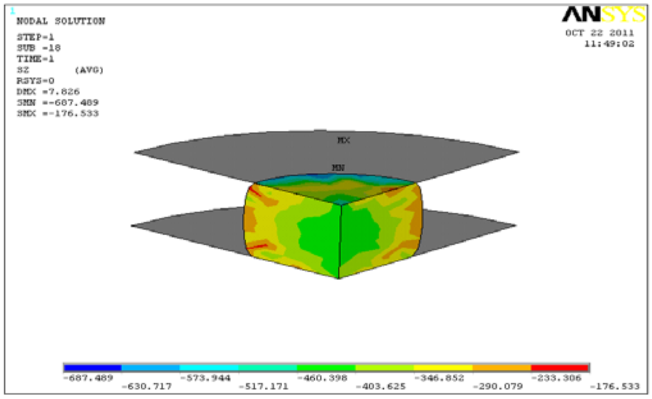


Contact Pair between Die and Alloy model

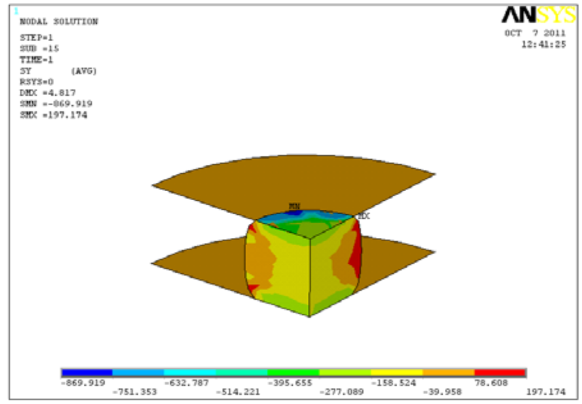


Specimen before deformation

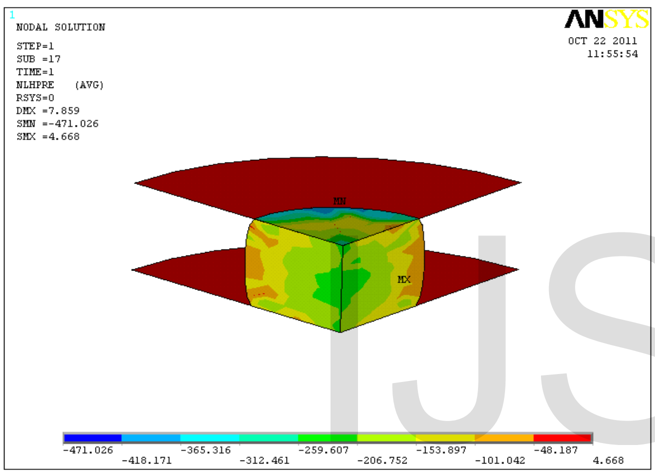
(A) AA 2024 0 % FLY-ASH (BASE)



Axial Stress (H/D=1)

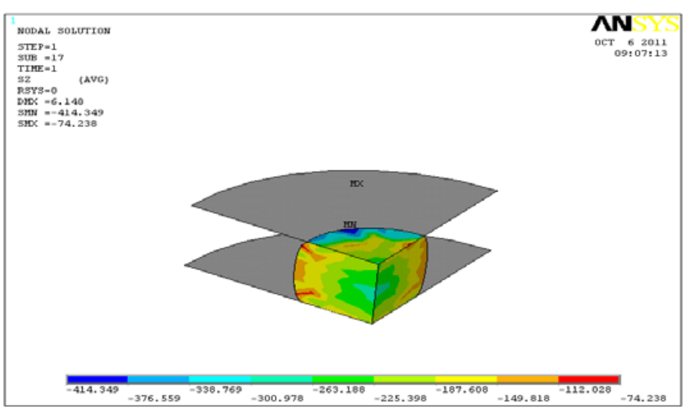


Circumferential Stress (H/D=1)



Circumferential Stress (H/D=1)

AA2024 10 % FLY-ASH COMPOSITE AT 50% DEFORMATION



Axial Stress (H/D=1)

7 CONCLUSIONS:

1..Al - fly ash (ALFA) composites were produced by stir casting route successfully. There was a uniform distribution of fly ash particles in the matrix phase and also existing a good bonding between matrix and fly ash reinforcements.

2. The hardness of the composites increased whereas the density of the composites decreased with increasing the amount fly ash than the base alloy.Enhanced mechanical properties were observed with increasing amount of fly ash under compression.

3. The cold upsetting process was modeled, simulated and analyzed with a sufficient accuracy and The time history data is useful in designing the intermediate dies for new materials.

4. The analysis is useful in reducing the lead time of design cycle.

5. The machine down time can be reduced at production stage.

6.FEA modeling and analysis was successfully performed from the experimentally obtained friction factor values.

7.Results obtained by finite element analysis closely matched with the experimental values and hence the model is validated.

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