Deformation Studies On Aa7075 Reinforced With Sic/Fa/Graphite Quad Metal Matrix Composite (Qmmc)

Kiran Kumar Bunga, Dr. L. V. Venugopala Rao, Dr D Lingaraju, Uppada Sri Ramakanth

Abstract: The present research work aim is to find the compression characteristics of AA7075 metal matrix composite using a traditional analytical method and finite element method. Regarding AA7075 is reinforced with Silicon carbide, fly ash and graphite particulates in vertex method under stir casting route. The samples are fabricated by considering silicon carbide 3, 4.5, and 6 weight percentages, fly ash and graphite equal weight percentage ratios of 3, 4.5 and 6 were reinforced with AA7075. The fabricated samples are machined using computer numerical control machine to acquiring the required dimensions of the samples. There are four standard different geometrical shapes are manufactured for this analysis The deformation or homogenous compression test was performed on UTM (Instron machine) for the three different reinforcements of AA7075 under no friction condition between the sample and contact surfaces. The deformation in axial and circumferential direction was found for base AA7075 and reinforced composites for aspect ratios 1.0 and 1.5. The deformation in height with diameter is maximum for 9% of reinforced composite compare to AA7075 and other composites for aspect ratio 1.0, the maximum deformation was observed for 12% of composite composites compare to other materials for H/D ratio 1.5. The strength coefficient K and strain hardening n are good for the 9% of reinforced composite it indicates the good plastic behaviour compare to base and other composites for H/D ratio 1.0, whereas for H/D ratio 1.5 the a good plastic behaviour exhibit for the 6%of composite At beginning of the deformation the axial stress are increased after upset of the sample it was decreased for aspect ratios, for AA7075 base material the axial stress are in tension it indicates the sample was not fractured. The circumferential stress are always in compression for all the cases for lower aspect ratio the circumferential and hydro static stress are high compare to higher aspect ratio of base and reinforced composites.

Key words: Compression, AA7075, Metal Matrix, Reinforcements, Hydro static stress

INTRODUCTION

Many projects in the manufacturing sector, particularly in the forging process, such as rolling and extrusion, to work together and become part of are subject to compressive forces. A compression experiment in which it undergoes compressing an ideal weight provides very useful information, like those. The experiment by compressing the solid plane of two cylindrical specimens died. At the expense of the precedent, and the friction between the die itself, and with a cylindrical shape, is a copy of the ugliness on the couch and in the gaping of the dissimilar parts, in the upper part of the lower surface, and can guarantee that ideally it will expand freely. Effective due to fire, and strength, and the other from the effects of the amount of lubricant in the process of variable data such as high temperature, pressure and speed, which are important. The ideal form after compression largely depends on the aspect ratio (h / day) as an example, compression test modes in the drawing. (a) Buckling when H / D> 5. (b) Shearing H / D> 2.5. (c) Double barrelling H / D> 2.0 is present as friction contact surfaces. (d) Barrelling with H / D <2.0 present as friction contact surfaces. (e) Uniform compression, where h / d <2.0, and now no longer has a contact surface. In the process of developing the metal part of any changes in the cross-sectional area. Thus, time and stress on things that in accordance with these measures should be in accordance with aspects of work was difficult in an instant.

LITERATURE

Wei Wei, Wei Zhang, Kun XiaWei, Yi Zhong, Gang Cheng, Jing Hu [1] presents deformation behavior of the pure copper rod in the continuous ECAP process is analyzed by using DEFORM-2D. The effect of die angle and the friction between the die channels and the specimen on the stress and strain distribution, strain homogeneity, the feature of shear deformation and the torque was investigated. M. Gopi Krishna, K. Praveen Kumar J. Babu Rao, NMRB Bhargava, K. VjayaBhaskar [2] report that, the deformation behaviour of a hybrid matrix A2024 aluminium composite alloy, reinforced silicon carbide, and fly ash. This is becoming more and more part of it also unceasing in the direction of circumflex tensile strain. On the other hand, with axial stress, in oz, and also, at one time, in the very initial stages of deformation and compression, it develops a little, so started to bulge. J Babu Rao, D Venkata Rao, I Narasimha Murthy and NMR Bhargava [3] Investigation, AA 2024 alloy – 2 to 10 wt% fly ash composites were made by stir casting route. Phase identification and structural characterization was carried out on fly ash by X-ray diffraction studies. Scanning electron microscopy and optical microscopy was used for microstructure analysis. With increasing the amount of fly ash the density of the composites was decreased and the hardness was increased. The increase in compression strength was observed with increase in amount of fly ash. Uppada Rama Kanth, Putti Srinivasa Rao, MallarapuGopi Krishna [4-6] reports that Al-Zn/fly ash/SiC reinforced composites are fabricated through vortex method using stir casting route. This paper reports the microstructural evaluation and mechanical behaviour of aluminium-zinc alloy reinforced with fly ash and silicon carbide (SiC) has been investigated. The incorporation of fly ash particles enhanced the hardness and tensile properties like ultimate tensile and yield strengths were improved by the addition of SiC particles and also discussed the wear and corrosion properties. J. Babu Rao, Syed Kamaluddin and N.R.M.R. Bhargava [7] investigate the new method of optical strain measurement (Machine vision system) was proposed for the analysis of flow behaviour of pure aluminium as a function of friction, aspect ratio and specimen geometry. Online video images of square grid were recorded during the deformation process till the crack initiation. The distortions of grid from recorded images were analyzed offline. Finite element software.
ANSYS has been applied for the analysis of the upset forming process. S Madhusudan, M MMSarcar, K Sunil RatnaKumar [8] report deformation (cold upsetting) studies are carried out and behavior is recorded using PC based logging system. Failure of the billet before 50% deformation has been observed for higher concentration of reinforcement composites. Comparative studies are made with the alloy having similar composition.

EXPERIMENTAL SET UP
The ingots of A7075 alloy raw materials are collected from the Indira Casting Company from Mumbai, the A7075 alloy matrix reinforced with hard ceramics silicon carbide, fly ash and graphite in the grain size of 40 micro metre the quad metal matrix were prepared using stir casting method as shown in Fig1.1. The weight percentages of reinforcements are taken as 6, 9 and 12 with respect to the weight of AA7075. The cylindrical samples are fabricated using cast iron die as shown in Fig 1.2. The samples are machined in CNC machine, the compression samples are prepared in the two types of aspect ratios like H/D ratio 1 and 1.5 for base alloy 7075 and different reinforcements (6, 9 and 12) of composites. The compression test was conducted on computer controlled universal testing machine at the speed of 0.25mm/sec and maximum load of 100KN for the H/D ratio 1.0 and 1.5 samples of base and different reinforced composites as shown in Fig 1.3. The load and displacement data generated by the universal testing machine, the compression test was carried up to 50 percentage of deformation or the fracture takes place on the surface of the sample whichever is first observed in the experiment. The load and displacement data is in MS office XL file, this data is very crucial for analysing the plastic behaviour of the base metal and reinforcements of composites using analytical equations.
ANALYSIS ON AA7075 ALLOY AND COMPOSITES
The deformation analysis was found on AA7075 alloy and 6.9 and 12 weight percentage of composites with two different aspect ratios of H/D 1.0 and H/D 1.5. The height of the sample is 20mm and diameter of the sample is 20 and 300mm are taken. The two aspect ratio samples are shown in Fig 1.4 below before compression test and after.

The true stress and true strain was calculated for each data point in MS office XL file generated by the universal testing machine before found the compressive stress and compressive strain of the samples in the compression test using the following a traditional formulas. In the compression test the free surface of the specimen the stress and strain components increments are shown in the orthogonal reference axis as shown in Fig 1.5, assuming that throughout the test the principle axis of stress and strain increments are coincide the shear stress are zero on the free surface of the sample. The detailed calculations are represent in below for compression test.

\[ H_0 = \text{is the initial height of the sample}, \ D_0 = \text{is the initial diameter of the sample}. \]
\[ H_i = \text{is the final height of the sample}, \ D_i = \text{is the final diameter of the sample}. \]
\[ H_i = H_0 - \Delta H \] (Where \( \Delta H \) is the change in height in the every load and displacement data point)

The plastic behaviour of the base alloy AA7075 and reinforced composites are found with knowing the different stress developed on the samples under loading condition. The hydro static stress plays an important role to analysing the plastic properties of the material is the algebraic sum of axial, circumferential and radial stress. The true stress and true strain data was well fitted into the Hollow Man power law of equation for determination of deformed properties of the material as given in below.

\[ \sigma_f = K \epsilon^n \]

Where \( K \) is strength coefficient and \( n \) is strain hardening exponent. The \( K \) and \( n \) values are found for the AA7075 base material and reinforced composites for the H/D ratio.
1.0 and 1.5. These stresses are determined using the following equations.

The hydrostatic stress \( \sigma_h = \frac{\sigma_z + \sigma_\theta + \sigma_r}{3} \)

Where \( \sigma_z, \sigma_\theta, \text{and} \sigma_r \) are axial, circumferential and radial stress respectively in the orthogonal axis on compression test.

Axial Stress \( \sigma_z = \sigma f \left( 1 - \left( \frac{1 + 2\kappa}{2 + \kappa} \right) \right)^{1/2} \), here \( \kappa \) is the slope between axial strain and circumferential strain and \( \sigma f \) is the flow stress of the material.

The circumferential stress \( \sigma_\theta = \sigma_z \left( \frac{1 + 2\kappa}{2 + \kappa} \right) \) and the radial stress are zero on the free surface of the material.

Results and Discussions

The deformation in axial and circumferential direction was found for base AA7075 and reinforced composites for aspect ratios 1.0 and 1.5. The deformation in height with diameter is maximum for 9% of reinforced composite compare to AA7075 and other composites for aspect ratio 1.0 as shown in Fig 1.6. The maximum deformation was observed for 12% of composite composites compare to other materials for H/D ratio 1.5 shown in Fig 1.7.

![Fig 1.5 Orthogonal Reference axis](image)

![Fig 1.6 Instantaneous diameter versus height for AA7075 and composites (H/D1.0)](image)
The strength coefficient $K$ and strain hardening $n$ are good for the 9% of reinforced composite it indicates the good plastic behaviour compare to base and other composites for H/D ratio 1.0, whereas for H/D ratio 1.5 the a good plastic behaviour exhibit for the 6% of composite. The Fig 1.8 and 1.9 shows the $k$ and $n$ values are increased with increasing of reinforcement content for H/D ratio 1.0 and H/D ratio 1.5.
**Fig 1.9** Effect of K and n Values versus reinforcements of Composite (H/D1.5)

**Fig 1.10** Effective strain Versus Stress of AA7075 H/D = 1.0

**Fig 1.11** Effective strain Versus Stress of AA7075+ 6%MMC (H/D1.0)
**Fig 1.12** Effective strain Versus Stress of AA7075 (H/D1.5)

**Fig 1.13** Effective strain Versus Stress of AA7075 + 6%MMC (H/D1.5)
The Fig 1.10 to Fig 1.13 shows the graph drawn between effective strain on x-axis and axial, circumferential, flow and hydrostatic stress are taken in Y-axis for different aspect ratios of base alloy and reinforced composites. The Table 1.1 represents the Effective strain Versus Stress of AA7075 and Composites for H/D1.0&1.5.

### CONCLUSIONS

1. The quad metal matrix was prepared successfully using stir casting route for AA7075, silicon carbide, fly ash and graphite particles under vertex method.
2. The different aspect ratios of H/D 1.0 and H/D1.5 cylindrical samples are fabricated using CNC machines successfully for base AA7075 and reinforced composites.
3. The compression test are carried on computer controlled universal testing machine, the load and displacement data is used for analysing the material properties of deformed samples.
4. The results are found by the fracture theory equations and discussed.
5. The strength coefficient (K) and straining hardening exponent (n) are increase with increasing of reinforcement content.
6. The axial stress are high initially at the beginning of the deformation after fracture they are low, the hydro static stress are high for lower aspect ratio compare to the higher aspect ratio for AA7075 and reinforced composites.

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### REFERENCES:


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