Micro Tensile Behaviour of LM25 Aluminium Alloys by Stir Cast Method Compared with Finite Element Method

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ABSTRACT

Composites Materials consists of two or more detach materials combined in a structural unit. In composite materials can be divided into three basic sorts like that metals, polymers, and ceramics. In the present Investigation based on the literature review the mechanical testing of LM Aluminium alloys were discussed and also Finite element Method Code used to investigate. In this investigation the preparation of material LM25 shaped by liquid metal stir casting technique. This process is special for the fabrication of the composite as it is both trouble-free and less pricey. The tensile types of mechanical testing were carrying out. The specimen prepared for the mechanical testing using American Society for Testing and Materials (ASTM) international standards. The Micro tensile test is present by means of digital tensometer and also finds the values of breaking load, peak load and elongations. The comparison of the experimental work and Finite element method was discussed in this article.

Keywords: Al metal matrix, tensile test, stir casting, FEA.

1. INTRODUCTION

Aluminium and its alloys have attracted the most attention as matrix material in metal matrix composites [1].Aluminium metal matrix composites with particular alloys as matrix reinforced with ceramic particles are finding application in aircraft, military, space, automobile, sporting goods, marine, infrastructure, form machinery equipments because of their improved mechanical and tribological properties[2-7].LM25 is a common purpose alloy of aluminium which is used where good mechanical properties are needed. It has a good resistance to corrosion and has a high strength. It responds well to heat treatment and is available in four different conditions. Its uses are increased by its availability in as-cast and partially heat treated condition as well. Common applications of LM25 are electrical, food, chemical, marine for example plus numerous other wide ranging uses. It is extensively used in automotive sector where cylinder blocks, wheels, heads and other parts are regularly cast in this aluminium alloys. LM25 offers a good machinability [8].

Boron Carbide is one of the hardest materials known, ranking third behind diamond and cubic boron nitride. It is the hardest material produced in tonnage quantities. Boron carbide is characterised by its [9]: Extreme hardness, Difficult to sinter to high relative densities without the use of sintering aids, Good chemical resistance, Good nuclear properties, and Low density. Carbon has two natural crystalline allotropic forms: graphite and diamond. Each has its own distinct crystal structure and properties. Graphite is unique in that it has properties of both a metal and a non-metal. It is flexible but not elastic, has a high thermal and electrical conductivity, and is
highly refractory and chemically inert. Graphite has a low adsorption of X-rays and neutrons making it a particularly useful material in nuclear applications [9]. The LM25 Aluminium alloys/Boron Carbide/Graphite mixed with stir cast method. The advantage of stir cast method easily fabricates less time and low cost [10]. This paper presents Tensile Behaviour of LM25 Al alloys composites and also determines the strength of the materials such as breaking load, peak load, percentage of elongation, stress and strain.

2. EXPERIMENTAL SETUP AND METHODOLOGY

2.1 Material Selection

In this study, commercially pure Al alloys was used as the material. Chemical compositions of the matrix materials are given in Table 1.

| Table 1 Chemical Composition of LM 25 Aluminium alloys (% weight) |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Si    | Fe    | Cu    | Mn    | Mg    | V    | Limits | Al    |
| 0.25  | 0.40  | 0.05  | 0.05  | 0.05  | 0.05 | 0.03   | 99.5 min |

Aluminium alloys were produced by Stir casting technique.

2.2 Preparation of the Specimen

The Photograph view of the Stir casting furnace used for the fabrication of the composites is shown in Fig. 1.

Figure-1. Shows the Stir Casting Setup Furnace
Figure-2 shows tensile test specimen.

2.3 Tensile Testing

The dimensions of the tensile specimen are given in table 2.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Material Case</th>
<th>Weight (in gram)</th>
<th>Dimension (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Case 1</td>
<td>12.38</td>
<td>GL=30.1, d=6.1</td>
</tr>
</tbody>
</table>

The tests were carried out using the micro tensile for the elongation, load capacity ,tensile properties ,feed rate with respect to the speed, for the each sample, Five tensile readings were taken for the average readings for analysis

<table>
<thead>
<tr>
<th>S.No</th>
<th>Material Case</th>
<th>Elongation value and Load value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>1.</td>
<td>Case 1</td>
<td>3541</td>
</tr>
</tbody>
</table>

3. MODELLING OF TENSILE SPECIMEN

Figure-3 shows the modelling of tensile specimen

<table>
<thead>
<tr>
<th>S.No</th>
<th>Material</th>
<th>E</th>
<th>µ</th>
<th>K</th>
<th>£</th>
<th>MHR</th>
<th>α</th>
<th>k</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aluminium Alloy LM25</td>
<td>70 GPa</td>
<td>0.35</td>
<td>76 Gpa</td>
<td>26 Gpa</td>
<td>2.75</td>
<td>(25°C) 23.1 μm·m·K^{-1}·s^{-1}</td>
<td>237 W·m^{-1}·K^{-1}</td>
<td>(20°C) 28.2 nΩ·m</td>
</tr>
</tbody>
</table>
Table 5. The boundary conditions of Aluminium alloy

<table>
<thead>
<tr>
<th>S. No</th>
<th>Boundary conditions of Aluminium alloy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As cantilever beam (one end is fixed and other end is free)</td>
</tr>
<tr>
<td></td>
<td>Length : X – 0.1m, Y – 0.1m, Z - 0.4m</td>
</tr>
<tr>
<td></td>
<td>Load : 5.7158 kg</td>
</tr>
</tbody>
</table>

By conducting the Tensile test on Aluminium alloy LM25, we can conclude that this material can withstand high load and great tensile strength. So we can use the Aluminium alloy LM25 materials for the experiment.

4. RESULT AND DISCUSSION

Experimental Result

Figure-3A: shows the Stress Vs Strain of Aluminium alloy Composite. In this graph Stress plot in X-axis and Strain plot in Y-axis.

Software Result

Figure 4
Figure 5
Figure 6
Figure 7
Figure 8 shows plotted on the ANSYS 14.0. This figure shows the Free Square Mesh. It consists of 1m length in X-axis. The number of node points is selected using Mesh tool.

Figure 5 shows the image of Total Deformation. It consists of minimum and maximum Young’s modulus values. The unit is measured in m. It consists of total static Structural deformation. The cycle time is 1 minute. The minimum and maximum static structural value is 8.3285e-5 and the blue colour in the diagram shows the Structural deformation in the Aluminium alloy LM-25.

Figure 6 shows the image of Equivalent Elastic Strain. The unit is measured in m/m. It consists of total static structural equivalent elastic strain deformation. The cycle time is 1 minute. The minimum equivalent elastic strain value is 3.7366e-5, the average equivalent elastic Strain value is 0.00016488 and maximum equivalent elastic strain value is 0.00039177. The Colour blue indicates the minimum equivalent elastic strain, the colour green indicates the equivalent elastic strain and the colour red indicates the equivalent elastic strain value in Aluminium alloy LM-25.

Figure 7 shows the image of Shear Elastic Strain along XY plane. The unit is measured in M/m. It consists of static structural shear elastic strain deformation in XY plane. Global coordinate system is used in this static structural shear elastic strain Deformation in XY plane. The cycle time is 1 minute. The minimum static Structural shear elastic strain deformation value is -7.7685e-5, the average Static structural shear elastic strain deformation value is -8.6017e-6 and maximum Static structural shear elastic strain deformation value is 7.7753e-5. The colour blue Indicates the minimum static structural shear elastic strain deformation, the colour Green indicates the static structural shear elastic strain deformation and the colour Red indicates the static structural shear elastic strain deformation value Aluminium alloy LM-25.

Figure 8 shows the image of Static Structural Equivalent (Von-Mises) Stress. The unit is measured in Pa. It consists of static structural Equivalent (Von-Mises) Stress. The cycle time is 1 minute. The minimum static Structural Equivalent (Von-Mises) Stress value is 2.602e6, the average Static structural Equivalent (Von-Mises) Stress value is 1.6608e7 and maximum Static structural Equivalent (Von-Mises) Stress value is 2.7812e7. The colour blue Indicates the minimum static structural Equivalent (Von-Mises) Stress, the colour Green indicates the static structural Equivalent (Von-Mises) Stress and the colour Red indicates the static structural Equivalent (Von-Mises) Stress value in Aluminium alloy LM-25.
5. CONCLUSION AND FUTURE DISCUSSION

Based on this experimental and analytical method having a good result obtained this comparison work. The tensile strength experimental work LM 25 is one of the good and high strength materials. It was fabricated by stir cast method. It is a rapid and cheapest method. In this Tensile test of Aluminium alloy LM25 consists of high tensile strength, Compressive Ultimate Strength, Compressive Yield Strength, Tensile Yield Strength, Tensile Ultimate Strength and Relative Permeability. For an analytical method Finite element code ANSYS was used. Analysis of the both method was investigated this article. It is also initial stage of the research of aluminium alloy based composite. Further add some different reinforcement materials such as Silicon carbide, ferrous oxide, graphite, boron carbide and others. The application of Aluminium alloy composite making of cylinders, pistons and other automobile parts.

6. REFERENCES


