

STUDY THE MICROSTRUCTURE AND IMPACT STRENGTH OF LM 25 ALUMINIUM ALLOY REINFORCED WITH STEEL WIRE

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Abstract: Today the MMC (Metal matrix composites) have find wide applications in all the engineering fields due to their light weight and high strength parameters, especially in the field of automobile and mechanical industries The aluminium MMC have got wide applications due to their excellent mechanical properties. In automobile industries the LM 25 aluminium is used in manufacturing of alloy wheels, connecting rod, engine blocks, engine heads etc. In LM25 if they are reinforced with steel wires then their total weight can be reduced and mechanical properties can be improved. In this sense we have selected the material as LM 25 reinforced with steel wire. Where LM 25 Al alloy is used as a matrix material and steel wire as a reinforcement.

The mechanical test results revealed that the LM 25 MMC's have excellent impact strength .And microstructure shows better bonding of steel wire with base LM 25 material. Which enhances properties of MMC due to integral part of wire and weight of the MMC component reduces and mechanical properties will be improved.

Since the LM 25 Al alloy chosen as a Matrix and steel wire as reinforcement which results in a MMC. The microstructure study by using optical microscope reveals about good bonding between LM 25 Al and steel wire. And impact tests are performed to locate the mechanical properties. The results revealed that the impact strength is increased stupendously.

Keywords: LM25, Steelwire, Density, Microstructure and Impact strength.

1. INTRODUCTION

Satyanarayan, Dominic Roystan, and Shreesaravanan studied the tensile test,hardness and microstructure of Lm 25 and silicon composites by using stir casting method[1], R. M. Arunachalam , R. Sasikumar and S m suresh and team their research shown about hardness,strength and microstructure of Nano Al₂O₃ particle reinforced withLM

25 Aluminium composites[2], Mohammd Farooq and B motgi studied on the microstructure and tribological behavior of LM 25 ,silicon and mica hybrid composites [3],Anoop agarwal,Harwind singh and Gurdyal singh studied about Fly ash based aluminium omposites[4],Kumarvel,Venkatachalan and Arunkumar studied the microstructure of modified Lm 25 Al alloy [5], Eddy S.Siradj, Bambang Suharno, Bondan T. Sofyan and team developed steel wire rope reinforcement in aluminium composites in armour material using squeeze Casting Process[6].

The LM 25 aluminum alloy actually used where high strength is required .it has resistance to corrosion is the main advantage, better weldability and has got wide applications like in automobiles, food ,marine, and in transport where it is used as a alloy wheels, wheel rims, engine blocks, engine heads and other engine body parts. It has got very good casting and moulding characteristics.

After reinforcement i.e LM 25 aluminum alloy with steel wire. The combinations of these two materials is a resulting AMMC (Aluminium metal matrix composite)where reinforced steel wire becomes a integral part of LM25 and responsible to take higher loads which results in improved mechanical properties like improved impact strength and microstructure study shows good bonding between matrix and reinforcement.

To get accurate results the casting and moulding should be done with good care and components should be free from impurities and blow holes and specimens are prepared as per ASTM standards and mechanical tests are conducted to know the strength of the composites.

2 METHODOLOGY

2.1 PREPARATION OF COMPOSITES

Table 1-Chemical composition of LM 25 Al alloy

composition Content	In Percentage (%)
Copper	0.2 max
Magnesium	0.2-0.6
Silicon	6.5-7.5
Iron	0.5 max
Manganese	0.3 max
Nickel	0.1 max
Zinc	0.1 max
Lead	0.1 max
Tin	0.05 max
Titanium	0.2 max
Aluminium	Remainder

Table 2-Chemical composition of steel wire

Content	Percentage (%)
Carbon	0.35 to 0.45
Manganese	0.65 to 0.95
Phosphorous	0.0055 max
Sulphur	0.55 max

The LM 25 Al alloy and steel wire materials can be combined together to form a MMC composite by die casting and prepared specimens are studied for Density ,Hardness, microstructure and Impact strength .

2.2 STIR CASTING PROCESS

The LM 25 aluminium ingots are cut into small pieces and 1.5 kg of LM 25 pieces are melted in crucible by using a stir casting electric furnace up to 700 to 750°C (Melting point of LM 25 is 450°C)[1] at this temperature the LM 25 Al alloy is in completely in liquid state. The degasifier tablets are added to avoid blow holes and complete molten is stirred by ceramic stirrer (at 200-400 rpm) for uniformity of the molten state.

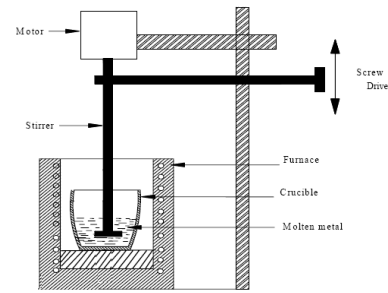


Figure 1 -Stir casting

2.3 CASTING PROCESS

The standard metallic die of 20 mm diameter and of length 200 mm is preheated up to 400°C for better flowability of molten metal into all the holes of the die.

The steel wires (IS 6902-1973) of diameter 2 mm and length 250 mm are preheated up to 500°C for better weldability with LM 25 and from microstructure study it clear that there is a proper bonding between LM 25 and steel wire .



Figure 2 -Standard die and Product

The preheated wires are held exactly at the center of metallic die by using tongs and wooden jigs and fixtures then molten metal is poured in to the die .The care should be taken so that wire should be held exactly at the center and after solidification the die is opened and the solidified composites are machined to prepare the specimens to conduct mechanical tests as per ASTM standards.

3. METALLOGRAPHIC STUDY OF LM 25 ALUMINIUM ALLOY REINFORCED WITH STEEL WIRE

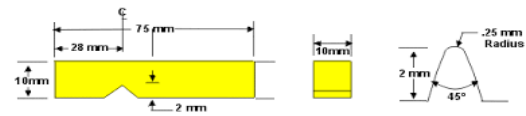


Figure3- Izod test specimen
Dimensions in mm (ASTM E23)
 Finish requirements 2 μm on notched surface and opposite face; 4 μm on other two surface.

3.2 Charpy test (ASTM E23) Dimension in mm ASTM. Vol 33 Part 1, 1933

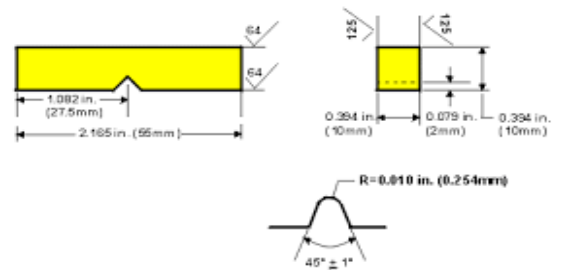


Figure5-Charpy test specimen
 Proceedings, ASTM, Vol 33 Part 1, 1933.

To study the proper bonding of steel wire with LM 25 Al alloy .Metallographic study of LM 25 Al alloy reinforced with steel wire can be determined by metallurgical microscope. From the different magnification lenses of microscope we came to know that there is good bonding between LM 25 Al alloy and steel wire. Observed micro structures of LM 25 reinforced with steel wire specimens are shown in figures.

3.1 Preparation of specimen.

The specimen (LM 25 aluminium alloy reinforced with steel wire) selected is of 20 mm diameter and of 20 mm length. one surface of the specimen is grinded to make it flat then polishing of surface is started on different grade papers in single stroke and each time specimen is rotated by 90° and after that Polishing is continued on fine grade polish papers then buffing is done by applying the carborundum paste and polished first on chamois leather and then on velvet cloth to remove burs and to obtain a mirror finish . Then drops of etching agent (Keller etchant) are applied and surface is dried with hot air by dryer. Then micro structures are observed by the microscope by (5x10) X, (10x10) X and (45x10) X.



Etching Agent Metallurgical microscope

Figure4- Microscope and Etching agent

The observed structures are recorded by using hi resolution mobile camera (zooming again up to 4X by camera).

3.1 Izod & Charpy test specimens (ASTM E23). Izode test (ASTM E23) in mm



Figure 6-Impact testing Machine

4 RESULTS AND DISCUSSION

4.1 DENSITY

1) Density of LM 25 Aluminium alloy (pure)

Density of the specimen carried out on two specimens each

- 1) Diameter of the specimen (d) = 1.2 cm
- 2) Length of the specimen (l) = 10 cm
- 3) Weight of the specimen (w) = 30 gm

$$\text{Density } (\rho_{\text{LM 25}}) = \frac{\text{Weight}}{\frac{\pi}{4}d^2 \times l} = \frac{30}{\frac{\pi}{4}1.2^2 \times 10} = 2.65 \text{ g/cm}^3$$

Density of LM 25 + steel wire is = 2.65 g/cm³

2) Density of LM 25 Aluminium alloy reinforced with steel wire

- 1) Diameter of the specimen (d) = 1.2 cm
- 2) Length of the specimen (l) = 10 cm
- 3) Weight of the specimen (w) = 32 gm

$$\text{Density } (\rho_{\text{LM 25+steel wire}}) = \frac{\text{Weight}}{\frac{\pi}{4}d^2 \times l} = \frac{32}{\frac{\pi}{4}1.2^2 \times 10} = 2.83 \text{ g/cm}^3$$

Density of LM 25 + steel wire is = 2.83 g/cm³

Results.

	Density
LM 25 Al Alloy	2.65 g/cm ³
LM 25 Al Alloy reinforced with steel wire	2.83 g/cm ³

From the above test it is clear that density of LM 25 reinforced with steel wire has slightly higher than that of pure LM 25 Aluminium alloy due to higher density value of steel wire.

4.2 Microstructure of LM 25 Aluminium alloy reinforced with steel wire

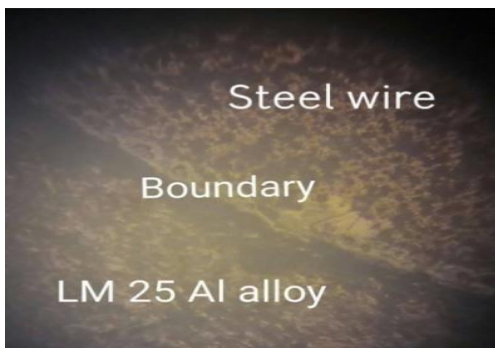


Fig4. 1 Microstructure [Magnification: (100X) x4]



Fig4. 2-Microstructure [Magnification: (450X) x4]

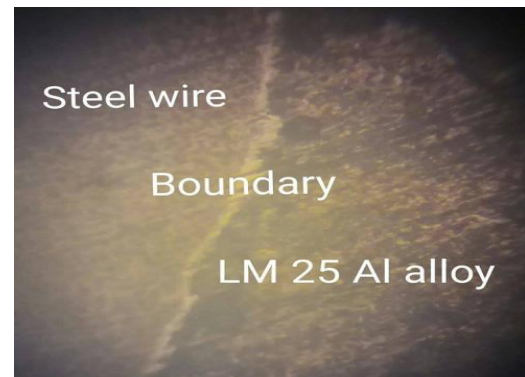


Fig 4.3-Microstructure [Magnification: (100X) x4]

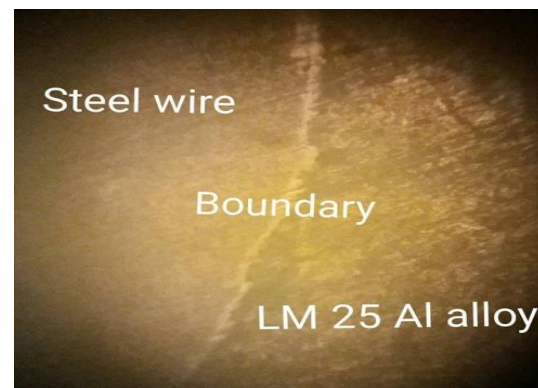


Fig4. 4-Microstructure [Magnification: (100X) x4]

From the microstructure study it's clear from the figures shown in 1,2,3,4 that. The dispersed material along the boundary shows there is a good bonding between steel wire and LM 25 Al alloy and there will be no voids observed in the bonding area.

Specimens prepared for hardness tests as per ASTM standard one is LM 25 Al alloy base and other is LM 25 reinforced with steel wire.

The specimen prepared for Izode and charpy should be as per ASTM standards as shown below.

4.3 IZOD TEST

The Izod test is carried out on two specimens and results are as shown in below.

1) LM 25 Aluminium alloy (Pure)



Figure 4.5 –LM 25 Al alloy after Izod test
2) LM 25 Al alloy reinforced with Steel



Figure 4.6 –LM 25 Al alloy reinforced with steel wire after Izod test

4.4 CHARPY TEST

1) LM 25 Aluminium alloy (Pure)



Figure 4.7 –LM 25 Al after charpy test
2) LM 25 Al Alloy reinforced with steel wire.

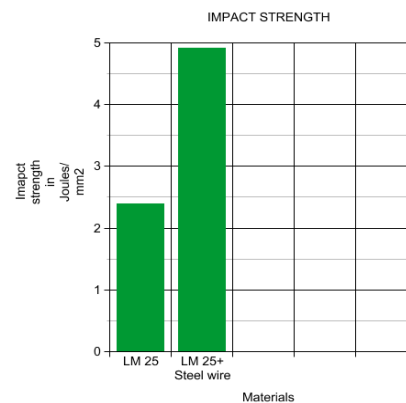


Figure 4.8 –LM 25 Al alloy reinforced with steel wire after charpy test

Results

Tests	Pure LM 25 Al Alloy	LM 25 Al Alloy reinforced with steel wire
Izod	1.67 J/mm ²	2.39 J/mm ²
Charpy	4.8 J/mm ²	4.92 J/mm ²

From the above tests it clear that energy absorbing capacity of LM 25 reinforced with steel wire has higher than pure LM 25 Al alloy.



Graph 1-Impact strength V/s materials

From the graph it shows that the impact strength of the LM 25 Al alloy reinforced with steel wire has a high energy absorbing capacity than base LM 25 .

6. CONCLUSIONS

The Microstructure study shows clear indication about good bonding between LM 25 Al alloy and steel wire as the material is dispersed along the boundary and there will be no defects like voids and porosity in the boundary area.From the Izod and Charpy test it is clear that The impact strength is also increased by 45% as compared to base LM 25 Al alloy which shows better impact absorbing capacity of composite.

Density is also increased slightly as compared with base LM 25 al alloy.

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ACKNOWLEDGEMENT.

We would like to thanks our BLDE engineering college principal and HOD of mechanical and Automobile engineering departments those who helped us to carry out this research and helped us to use the machines in workshop.

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