Fabrication and Experimental Investigation on Mechanical Properties of Aluminium Metal Matrix Composites by Using Stir Casting

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Abstract— **Metal Matrix Composites (MMCs) have evoked a strong fascination with ongoing times for likely applications in aviation and auto enterprises attributable to their prevalent strength and high durability. The boundless reception of particulate metal grid composites for designing applications has been impeded by the significant expense of delivering parts. Albeit a few specialized difficulties exist with projecting innovation yet defeating this problem can be utilized. Accomplishing a uniform dissemination of support inside the network is one such test, which influences straight forwardly on the properties and nature of composite material. The mix projecting strategy has been embraced and ensuing property examination has been made. Al-7075 has been picked as a base metal and Al2O3and B4C as support materials which are accessible on the lookout. Tests have been directed by fluctuating weight part of Al2O3 (2%, 4%, 6%, 8%, 10%), B4C (2%,4%, 6%, 8%, 10%) and furthermore blended synthesis of the two materials. With a rising pattern of Hardness, Impact examination tests are finished by adding Al2O3 and B4C to the base metal Al-7075.**

Index Terms: **Aluminium Alloy 7075, boron carbide, silicon carbide, material composite, casting.**

I.INTRODUCTION

Use of aluminium combination improved day by day because of its less thickness, exhaustion habits, creep quality, machining and creation ability, crack sturdiness, wear opposition limit. Metal Matrix Composite (MMC) strengthened with ceramic particles has a huge extent of use in car parts, aviation parts, protection applications and some more. The choice of lattice compound and support particles relies upon its end application. A few sorts of fortifications are included aluminium compound lattice, for example, SiC, Al2O3, B4C, fly debris, and so forth as filaments, particulates, and hairs. Among all the various structures, the particulate supported aluminium framework composite has a greater documentation to the prior research work because of its huge properties. As of late the interest for Aluminium Matrix Composite (AMC) expanded because of its simple improvement of mechanical properties. Aluminium based metal lattice composite mulled over a superior substitution over customary materials in constructional utilizations of aviation and auto industry. Silicon Carbide molecule supported composites have better hardness and solidness because of which its utilization in manufacture of car motors with chamber heads, chamber, cylinders, and brake engines is supplanted the conventional project iron and other heavyweight metal amalgams make. The essential explanations behind the creation of Al-Si-Bramalgams are because of its low thickness. Wear conduct of Al-Si-Br composite firmly relies upon other amalgam structure and support content, applied load. For the most part three various sorts of blending processes are utilized for making metal grid composites like fluid way strategy, semisolid blending and powder metallurgy development. Mix projecting is an extensively utilized fluid pivoting manufacture strategy for making metal framework composite by mechanical stirrer or by the ordinary strategy which blends both grid material homogeneously and builds up particles. Mix projecting speeds up the blending of built-up particles with fired powders into liquid metal by the car mechanical mixing. Al/SiC aluminium grid composite has turned into the created metal for making a few sections in business. Al/SiC/B4c aluminium framework composite acquire better solidarity to weight proportion and low wear rate, which lessen generally vehicular weight extensively bringing about mileage.

II. CLASSIFICATION OF METAL MATRIX COMPOSITES

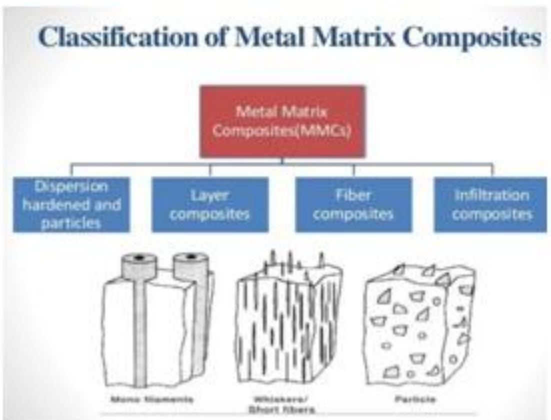
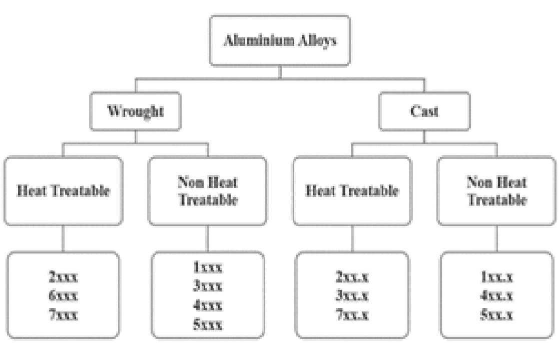


Fig 1: Classification of Metal Matrix Composites

III.MATERIALS OF METAL MATRIX COMPOSITES

There are Different materials like Aluminium, Magnesium, Copper, Titanium, etc., are used as the base metal for metal matrix composites. Among them, aluminium is predominantly used because of its availability and good mechanical properties when it forms as an alloy.

Aluminium alloys are classified as shown below in Fig 1.2



IV. ALUMINIUM ALLOY TYPES AND ITS CHARACTERISTICS

Aluminium alloy materials can be classified into two types cast alloys and wrought alloys. Wrought alloys are such as plates, bars, rods, and wire, and cast/die-cast alloys for sand/mold casting. They all have various characteristics and are designated by four-digit numbers. The alloys are assigned 1000 class numbers and the lower two digits denote the associated information. For example, 99.7% aluminium is Al1070 and AL-Zn alloy is Al7075. The 2000 series Aluminium alloy contains Cu proportion. So, Al-Cu alloy is in the second series. Similarly, the 3000 series contains Mn and the 4000 series contains SiC in appropriate proportion. The 5000 series has the Mg proportion. So, Al-Mg aluminium alloy is in the fifth series. The 6000 series is a combination of Mg and SiC. So the sixth series Aluminium alloy is designed as Al-Mg-SiC.

IV.1. CAST ALUMINIUM ALLOYS

Aluminium and its alloys are used in a variety of cast and wrought form and conditions of heat treatment. Forgings, sections, extrusions, sheets, plate, strips, foils and wires are some of the examples of wrought form while castings are available as sand, pressure and gravity die- castings e.g: Al-Si and Al-Mg alloys.

IV.2. WROUGHT ALUMINIUM ALLOYS

To meet various requirements, aluminium is alloyed with copper, manganese, magnesium, zinc and silicon as major alloying elements.

V.ALUMINIUM ALLOYS IN DIFFERENT PROCESS

Selecting the right alloy for a given application entails considerations of its tensile strength, density, ductility, formability, workability, weld ability, and corrosion resistance. Aluminium alloys are alloys in which aluminium (Al) is the predominant metal. The most important cast aluminium alloy system is Al-Si, where the high levels of silicon (4.0% to 13%) contribute to give good casting characteristics. Aluminium alloys are widely used in engineering structures and components where light weight and corrosion resistance is required.

Wrought aluminium alloys are used in the shaping processes like rolling, forging, extrusion, pressing, stamping.

Cast Aluminium alloys are comes after sand casting, permanent mould casting, die casting, investment casting, centrifugal casting, squeeze casting and continuous casting.

VI. TEST PROCEDURE

The compression test is done to determine material properties in front of a negative axial load. This load pretends to compress the testing sample.

Determination of materials properties: example – EN 196-1 standard. Mechanical strength on cements and mortars. The objective is to find absolute values of cement strength, independently of sample shape, dimension or preparation procedure. With this values comparison between cements can be done, independently on the lab where they have been obtained.

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compression- testing machine by a gradually applied load.

Compressive strength formula = Maximum Load/cross sectional area

2.1 COMPRESSIVE STRENGTH MACHINE-HYDRAULIC PRESS

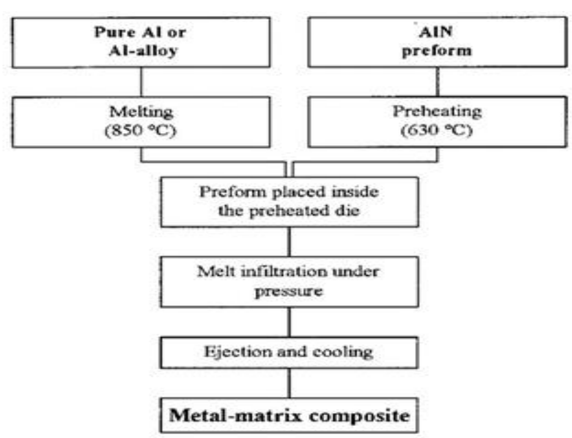
Fig 2.1 Before compression of specimen

fig 2.2 After compression of specimen

VII. ADVANTAGES OF METAL MATRIX COMPOSITES

- Increase the strength of conducting materials while maintaining the high conductivity.
- Improve the low temperature creep resistance (reaction less materials).
- Improve the burnout behaviour (switching contact).
- Improve the wear behaviour (sliding contact).
- Increase the operating time of spot-welding electrodes by reduction of burn outs.
- Production of layer composite materials for electronic components.
- Production of ductile composite superconductors.
- Production of magnetic materials with special properties.

IX. METHODOLOGY



VIII. WORKING PRINCIPLE: STIR CASTING

Stir casting is the prudent, easy and most industrially taken on strategy, and it is known as 'vortex method'. In this cycle, supporting phases (ceramic particles, short fibres) present by the mean of mechanical mixing into liquid metal. AMMC was stirred by S. Ray first time in 1968, where aluminium (Al2O3) particles are brought into liquid aluminium by mechanical stirring. Significant drawback of this cycle is agglomeration of particles during manufacture process. steps involved in stir casting process is shown in fig 3.1. In this process, the matrix material are kept in the bottom pouring furnace for melting. Simultaneously, reinforcements are preheated in a different furnace at certain temperature to remove moisture, impurities etc. After melting the matrix material at certain temperature, the mechanical stirring is started to form vortex for certain time period then reinforcements particles are poured by the feeder provided in the setup at constant feed rate at the center of the vortex, the stirring process is continued for certain time period after complete feeding of reinforcements particles. The molten mixture is then poured in preheated mold and kept for natural cooling and solidification. Further, post casting process such as heat treatment, machining, testing, inspection etc. has been done.

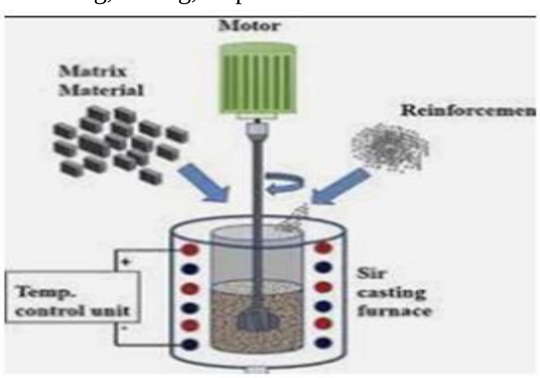


Fig 3.1 A schematic diagram of stir casting

IX. RESULTS AND DISCUSSION

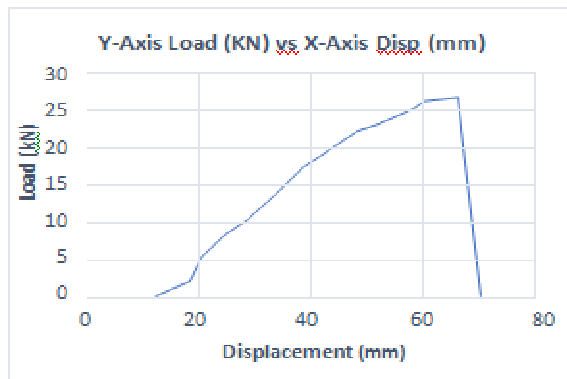
The Results and Discussion of the Aluminium Metal Matrix is discussed in below:
We can conclude the Three Results:
1. Tensile Test
2. Hardness Test.
3. Impact Test.

1. TENSILE TEST

Result

Specimen 1	**AA7075+Al_2O_3(2%)+B_4C(2%)**
Yield Load (kN)	18.75
Yield Stress (N/mm^2)	155
Elongation %	12.2
Maximum Load (KN)	200
Maximum Tensile Strength (MPa)	**196.28**
Specimen diameter (mm)	20.0
Initial Gauge Length (mm)	100.08
Final Gauge Length (mm)	102.63
Load at Peak	28.2

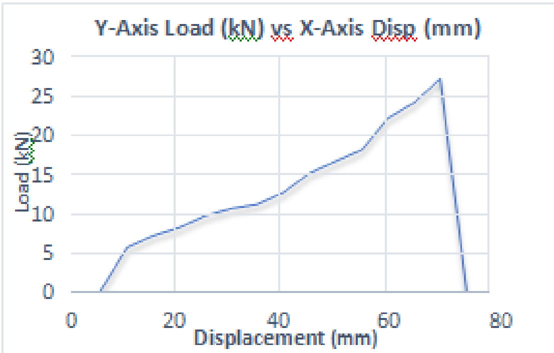
Specimen2: AA7075+Al_2O_3(4%)+B_4C(4%)



Result

Specimen 2	AA7075+Al_2O_3 (4%) + B_4C(4%)
Yield Load (kN)	18.26
Yield Stress (N/mm^2)	148
Elongation %	11.6
Maximum Load (KN)	200
Maximum Tensile Strength (MPa)	200.12
Specimen diameter (mm)	20.0
Initial Gauge Length (mm)	100.08
Final Gauge Length (mm)	101.63
Load at Peak	25.28

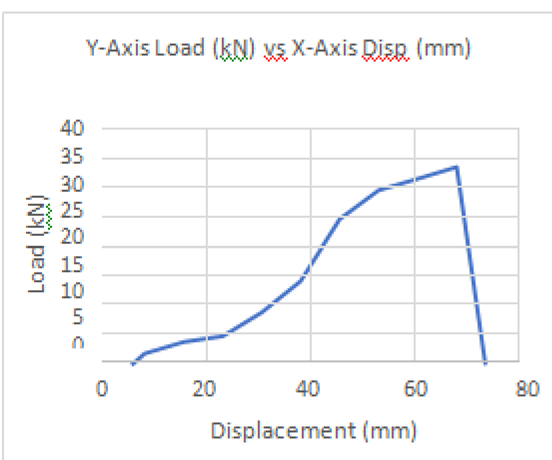
Specimen1: AA7075+Al_2O_3(2%)+B_4C(2%)



Result

Specimen 3	AA7075+Al_2O_3(6%)+B_4C(6%)
Yield Load (kN)	18.89
Yield Stress (N/mm^2)	155
Elongation %	13.2
Maximum Load (KN)	200
Maximum Tensile Strength (MPa)	**200.64**
Specimen diameter (mm)	20.0
Initial Gauge Length (mm)	100.02
Final Gauge Length (mm)	101.63
Load at Peak	33.8

Specimen3: AA7075+Al_2O_3(6%)+B_4C(6%)



2. HARDNESS TEST

Result

LOCATION	HARDNESS					
AA7075+Al_2O_3(2% +B_4C(2%)	92	91.6	92.7	92.6	91.9	Average: 100.2
AA7075+Al_2O_3(4% +B_4C(4%)	89	89.5	88.6	87.8	86.8	Average: 88.34
AA7075+Al_2O_3(6%)+B_4C(6%)	93.5	93.8	92.4	93.5	93.7	Average: 93.38
AA7075+Al_2O_3(8% +B_4C(8%)	94.1	94.8	94.3	95.6	95.2	Average: 94.80
AA7075+Al_2O_3(10 +B_4C(10%)	95.4	95.7	96.5	96.2	96.9	Average: 96.14

3. IMPACT TEST

Result

Sample	IMPACT	Average
1.AA7075+Al_2O_3(2%)+B_4C (2%)	18	18.0
2.AA7075+Al_2O_3(4%)+B_4C (4%)	21	21.0
3.AA7075+Al_2O_3(6%)+B_4C (6%)	20	20.0
4.AA7075+Al_2O_3(8%)+B_4C (8%)	19	19.0
5.AA7075+Al_2O_3(10%)+B_4C (10%)	22	22.0

X.CONCLUSION

The review of investigations reveals that the different parameters like the Fabrication technique, Microstructure, and various mixes of reinforcements will lead to several conclusions on the Aluminium Metal Matrix Composites (AMMCs). Firstly, the microstructures of the AMMCs created by the stir casting technique have been viewed to be stable with uniformed distribution of reinforcement particles. Thus, the AMMCs can be manufactured with various mixes of reinforcements to accomplish advantageous mechanical properties. It has additionally been seen from the writing that the reinforcements like SiC, alumina, B4C can be joined with complimentary reinforcements to get advantageous properties for the composite. The review uncovers that the AMMCs can be considered as a swap for conventional materials in ongoing the high-level applications. The current audit affirms that the usage of AMMCs in different structural, electrical, thermal, and environmental applications seems to be feasible.

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