INVESTIGATION ON TENSILE PROPERTY OF ALUMINIUM ALLOY REINFORCED COMPOSITES

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ABSTRACT

This paper deals with experimental investigation of the mechanical properties of SiC, flyash reinforced with aluminium alloy composites samples, processed by stir casting method are reported and analysed. Aluminium alloy is a heat treatable alloy which can be used for liquid state fabrication. Four sets of composites with a varying percentage of reinforcements were casted. The main mechanical properties studied were their tensile strength. In our study we varied the reinforcing material in smaller quantity in order to avoid mixing problem. Stir casting method is most commonly used for liquid state fabrication to provide better homogeneity in the composites. The result shows that addition of percentage of reinforcements like SiC, flyash improves tensile strength.

Keyword: - *investigation, SiC, flyash, tensile strength*

1. INTRODUCTION

Nowadays, Metal Matrix Composites are under serious considerations to replace conventional materials for large number of structural application such as those in aeronautical/aerospace, transportation, defence and sports industries because of their superior properties. The excellent mechanical property and the comparatively low cost make them as an attractive option. A large number of fabrication techniques are currently used to manufacture the MMC materials according to their type of reinforcement used like stir casting, liquid metal infiltration , squeeze casting and pressure infiltration. Metal matrix composites (MMCs) have received substantial attention due to their excellent strength,

Stiffness, lighter, and wear resistance in tribolgological, aerospace & marine industries. Though MMCs possess superior properties, they have not been widely applied due to the complexity of fabrication .The conventional stir casting is an attractive processing method for fabrication, as it is relatively inexpensive and offers wide selection of materials and processing conditions. Stir casting offers better matrix particle bonding due to stirring action of particles into melts.

High homogeneity is required to attain optimum mechanical properties for the composite material. Therefore, the important parameters controlling the process must be identified and corrected in order to achieve a good quality composite. The microstructure is also a very important parameter which influences the properties of the composite. It was done earlier by trial and error methods which were later replaced by scientific based techniques. Aluminium alloys are mostly applicable in space and automobile industries because of their high Specific strength, modulus and high thermal conductivity. These materials display poor tribological properties that lead to seizure

under adverse conditions. Hence there was a need to develop new materials with greater resistance to wear and good tribological properties which ultimately led to the development of aluminium metal matrix composites. This project investigates about the mechanical properties like tensile strength , impact strength, hardness for all the composition of composites and to study which composition provides the better results amongst all , so that it can be used in industries like aerospace and structural applications which are very challenging for material fields.

COMPOSITES

A composite material is one which composes of two or more constituent material which significantly consists of two phases, matrix phase and reinforcement phase. Such composite materials include metal composites ceramic composites, reinforced plastics, mortars, ceramics etc. The significance of composite materials are:

- Increase in yield and tensile strength at elevated temperatures
- Increase in creep resistance
- Increase in fatigue strength at higher temperatures
- Improvement of wear and tear, thermal shock, and corrosion resistance.

MMC's are composed of two or more chemically non-reactive materials, with enriched mechanical properties such as ductility, hardenability, tensile, strength etc. and such materials include titanium, aluminium, magnesium and commonly used reinforcement materials are silicon carbide, fly ash or graphite, boron nitrite, etc., . One such metal matrix composite used in many applications is aluminium. Thus aluminium metal matrix composites play a significant role in automotive industries especially due to its light weight. Apart from automotive industries it is widely used in aerospace, marine and other engineering applications.

Aluminium metal matrix composites have excellent material characteristics such as

- light in weight
- good erosion resistance
- withstand high temperature
- very good recycling possibility

In this project aluminium is chosen. Its mechanical properties of various reinforcements are studied and the results are discussed.

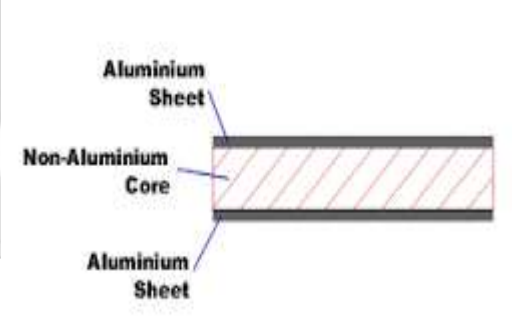

Figure 1.1 aluminium composite

WHY ALUMINIUM ALLOY AS PARENT METAL

Aluminium is most abundant metal in earth's crust and third most abundant element, after Oxygen & Silicon. It makes up about 8% by weight of Earth's solid surface. They are widely used due to easy availability, highstrength to weight ratio, easy machinability , durable ,ductile & malleable. Further, Aluminium based Metal Matrix composites (MMC) have received increasing attention in recent decades as engineering materials due to their enhanced high strength, hardness and wear resistance over conventional Al alloy .

A metal matrix composite (MMC) is composite material with at least two constituent parts in which a metal used as matrix. The other material may be ceramic or organic compound. Generally, a MMC is composed of reinforcement (fibers, particles, flakes) embedded in a matrix (metals). The matrix is monolithic material into which reinforcement is embedded & which is completely continuous. The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. A good matrix should possess ability to deform easily under applied load, transfer the load

onto the reinforcement and evenly distributive stress concentration . Here, matrix material Aluminium has advantage of lighter weight & major silicon content of alloy may helps to improve castability.

2 FABRICATION PROCEDURE

2.1 STIR CASTING METHOD

The composites are fabricated mainly by liquid metal stir casting techniques. The aluminium alloy is melted in a clay graphite crucible using resistance-heated furnaces. The composite synthesis is carried out in 10 Kg capacity furnace. The alloy melt is mechanically stirred using an impeller driven by an electrical motor. The rotational speed of the stirrer is controlled to around 350 rpm. The stirring speed is controlled by a dynamometer. The SiC particles and flyash are preheated to about 600°C prior to the addition. The preheated particles are added to the melt with a known feed rate of around 1 gm/sec, stirring speed of 220 rpm and melt temperature of 740°C. Before powder addition 1% Mg is added at 730°C to compensate the loss of Mg in the melt due to the oxidation. The particles are added to the molten metal in the crucible via manual powder addition mechanism.

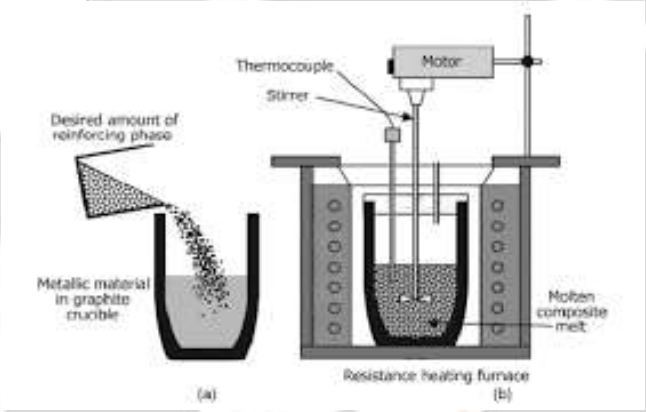

Figure 2.1 stir casting process

After the powder addition baffle is introduced in the crucible for uniform mixing of the composite. With the baffle allow stirring for 15 minutes, after that degassing should be done. Degassing is done to avoid the hydrogen entrapment. Degassing is done by passing N2 gas to the molten metal through the sulphuric acid. Sulphuric acid will act as purifier and the N2 gas will remove the H2 from the molten metal. Degassing is done for about 20 minutes till the temperature reaches 760°C and after manual stirring the composite is poured to the rotating centrifugal mould.

In this composites specimen we have fabricated four specimen each containing different proportion of reinforcements. Keeping parent metal as constant and varying the proportion of reinforcements and they are clearly tabulated below.

Composition	Base metal (LM-25)	Silicon carbide (SiC)	flyash
C1	98%	1%	1%
C2	96%	2%	2%
C3	94%	3%	3%
C4	92%	4%	4%

Table 2.1 proportion of metal & reinforcements

3 TESTING

3.1TENSILE TEST

The ability of the material to withstand a static load can be determined by testing the material in tension or compression. Mechanical testing plays an important role in evaluating the fundamental properties of engineering of

materials as well as in developing new composite materials and to control the quality of materials used in design and construction. In this work the test is carried out using a universal testing machine. The specimen is prepared as per ASTM: B-557 standards. In our research we have analysed the tensile strength of the aluminium composite for all the four composite specimen.

4 RESULTS AND DISCUSSION

The tensile test is done using universal testing machine and the specimens are cut as per the ASTM: B-557M standard. The results obtained are furnished in table 4.8

Al alloy – 98%, Silicon Carbide - 1%, Flyash – 1%

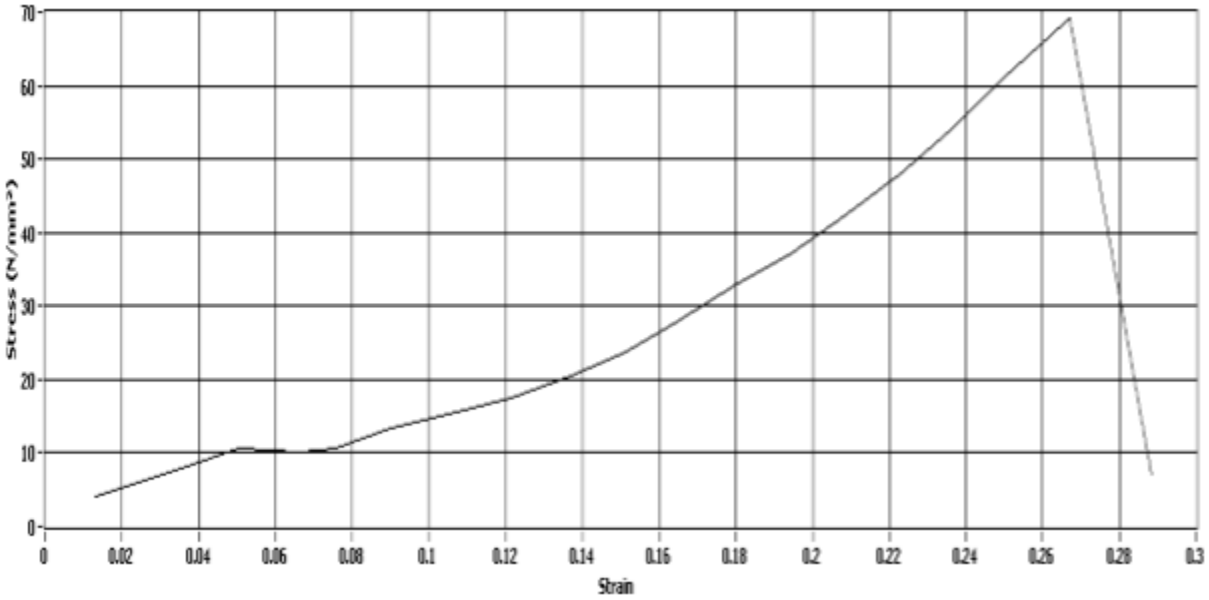

Figure 4.1 stress & strain for C1

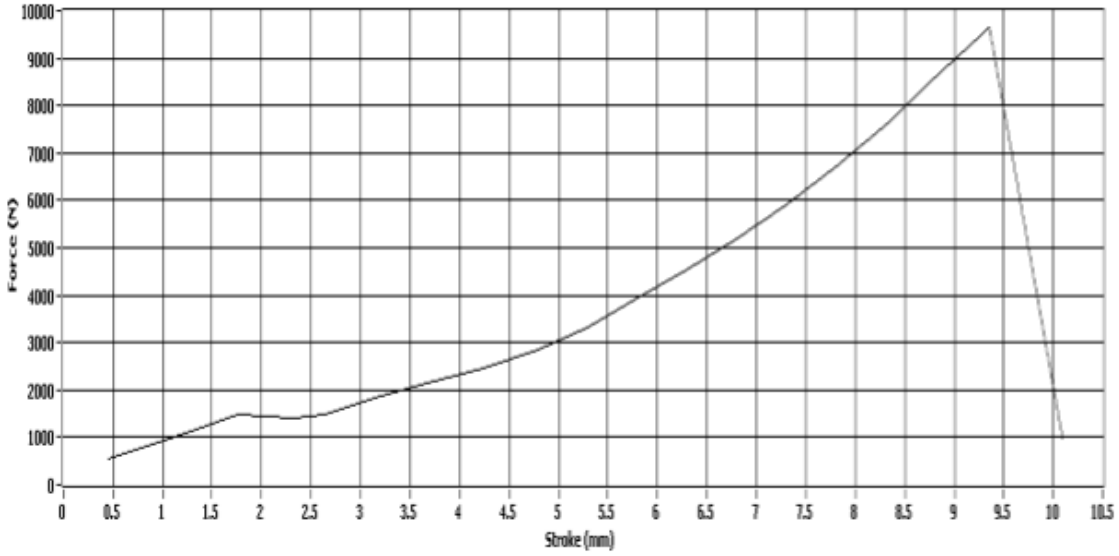

Figure 4.2 force & stroke for C1

Al alloy – 96%, Silicon Carbide - 2%, Flyash – 2%

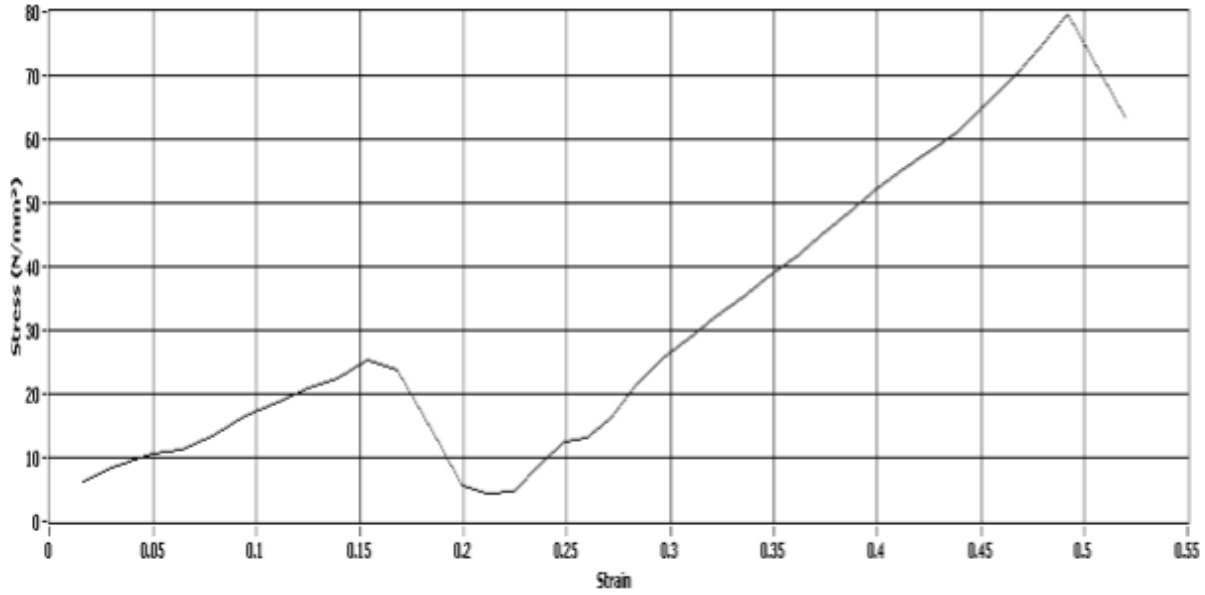

Figure 4.3 stress & strain for C2

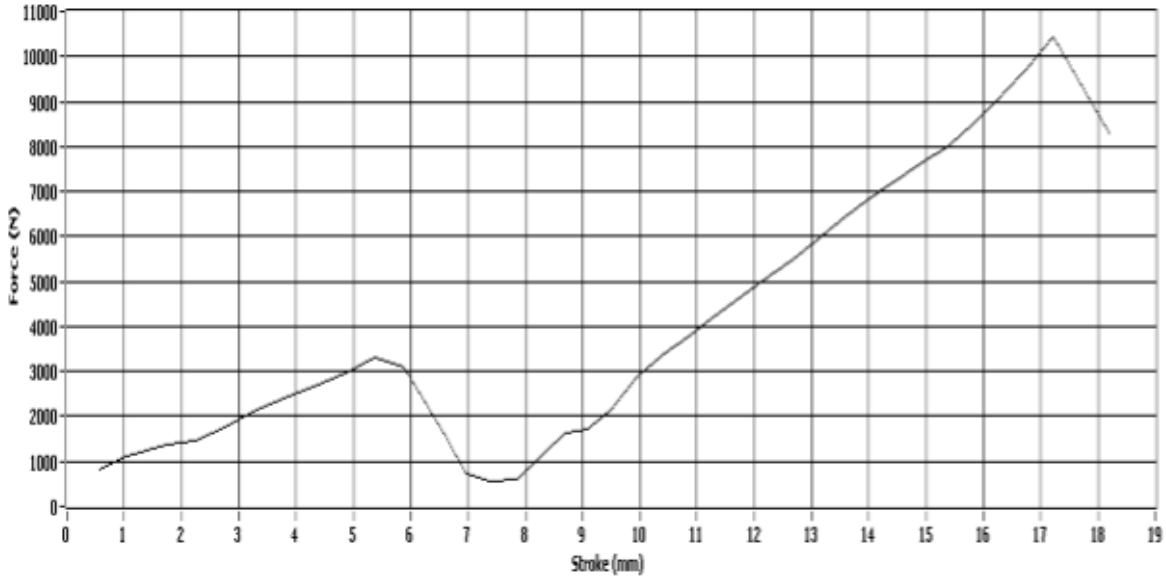

Figure 4.4 force & stroke for C2

Al alloy – 94%, Silicon Carbide - 3%, Flyash – 3%

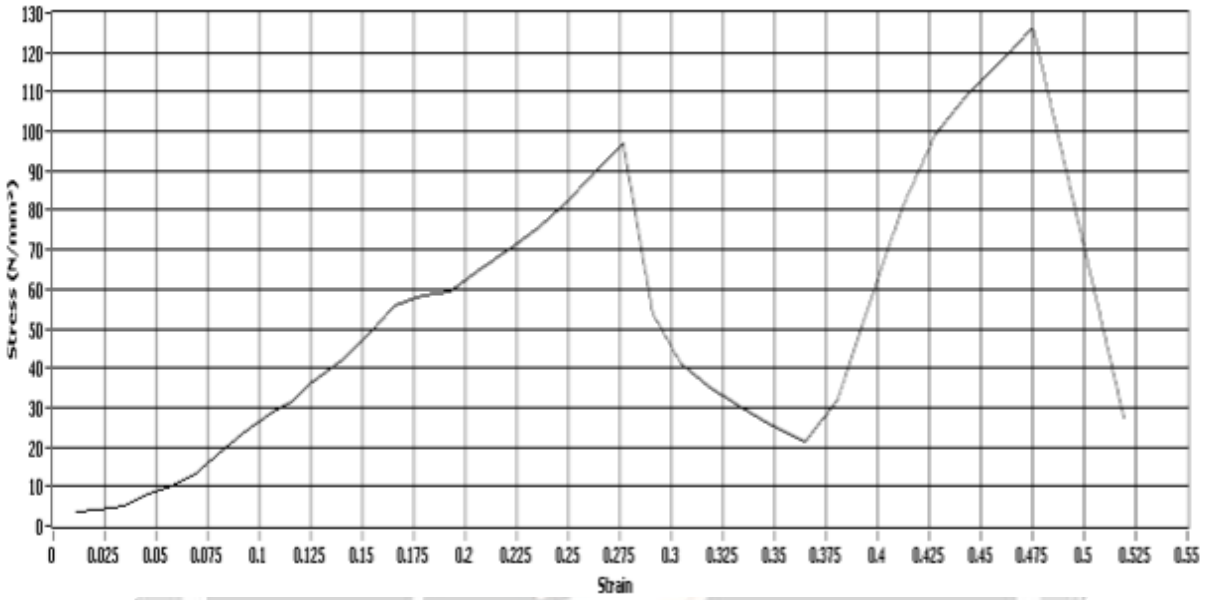

Figure 4.5 stress & strain for C3

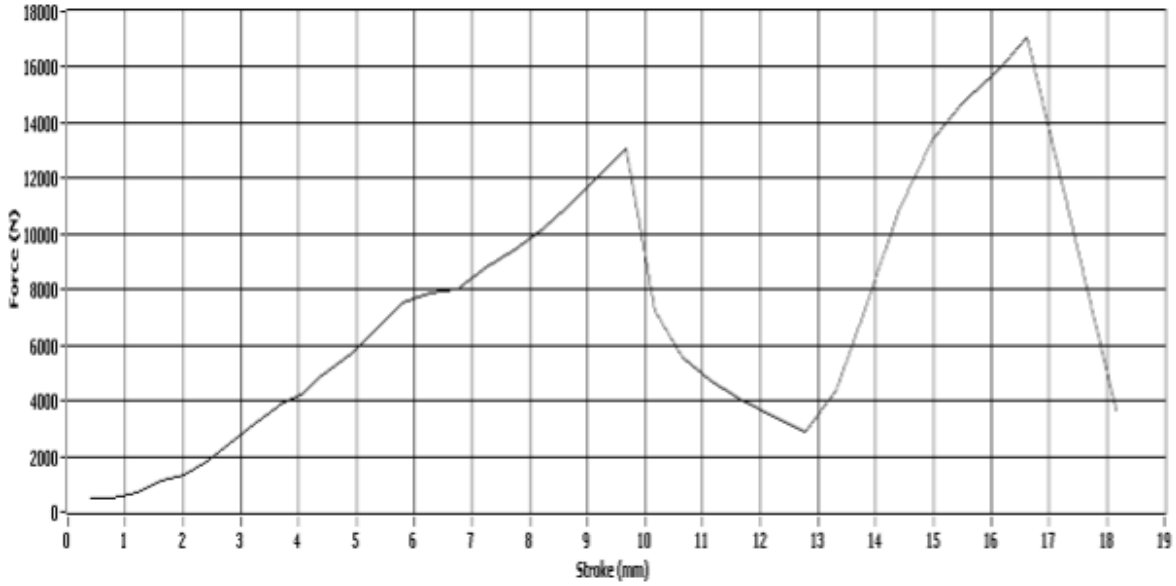

Figure 4.6 force & stroke for C3

Al alloy – 92%, Silicon Carbide - 4%, Flyash – 4%

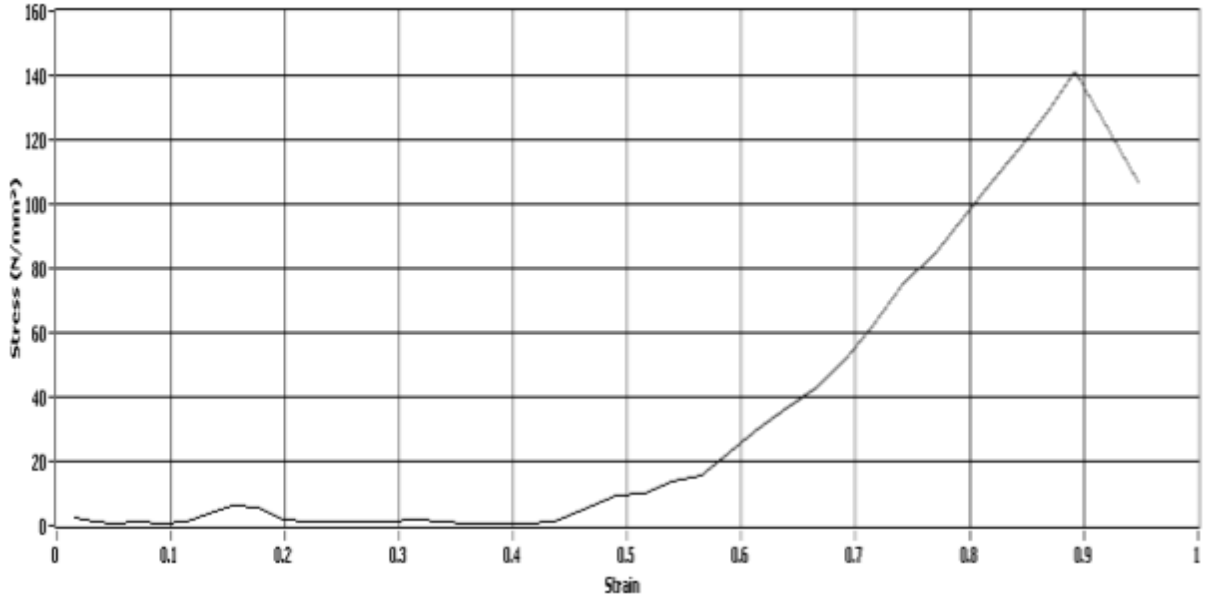

Figure 4.7 stress & strain for C4

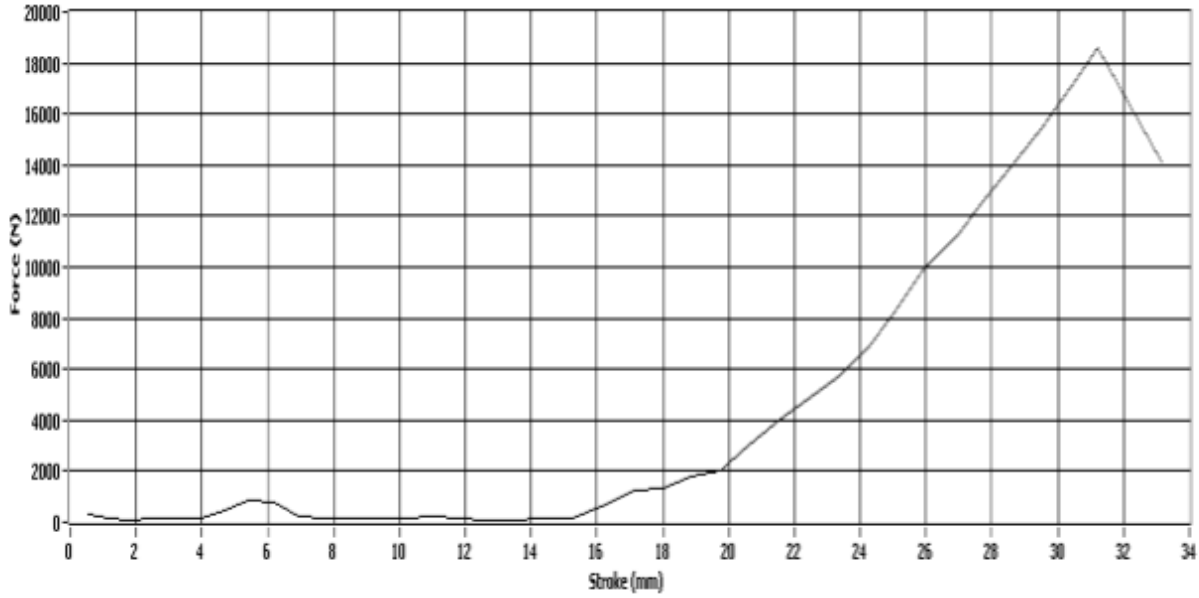

Figure 4.8 force & stroke for C4

From the above resukts the tensile tests for all the composition with respest to their ultimate strngth and yield strength are tabulated below.

sample	Composition of composite material	Ultimate strength (MPa)	Yield strength (MPa)
C1	Al-98% SiC-1% Flyash-1%	69.20	61.78
C2	Al-96% SiC-2% Flyash-2%	79.83	65.51
C3	Al-94% SiC-3% Flyash-3%	126.56	109.38
C4	Al-92% SiC-4% Flyash-4%	140.97	84.57

Table 4.8 Tensile strength

5 CONCLUTION

The composites are prepared using stir casting method to produce a uniform homogeneity. The tensile strength is increased with increasing the weight fraction of the reinforced flyash and Sic It is also found that there is decrease in strength due to increase in proportion of flyash. So it is evident that addition of flyash more than the limit result in poor strength.

6 REFERENCES

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