# ALUMINUM COMPOSITES REINFORCED WITH CARBON AND BASALT FIBERS: A STUDY OF MECHANICAL STRENGTH

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## ABSTRACT

Since its beginning, Human is always try to sustainable actions in all the direction associated with human. It's may be for energy saving, environment protection, reduce to effort, cost reducing and so on. It's also applicable in case of composite. Intensively developed polymer composite materials (PCM) are used in different sectors of industry and technology. They are successfully replacing traditional construction materials and also permit the conditions that exclude use of metals. One of the basic reinforcing elements of composite materials is fibers. A composite is a material, that consist of at least two material macroscopically, that work together to achieve the better and favorable properties [1] from the previous materials. In the composite these components do not dissolve into each other and remain visible macroscopically.

The main purpose of this paper to investigate the mechanical strength of Carbon fiber reinforced metal matrix composite (CFR-MMC) and compare with mechanical strength of Basalt fiber reinforced metal matrix composite (BFR-MMC). The investigated specimen is composed of aluminum oxide and carbon fiber and compare the mechanical strength of (CFR-MMC) with Basalt fiber reinforced metal matrix composite (BFR-MMC). To investigate the mechanical strength there is mainly do two strength test i.e. compressive strength, tensile strength on the universal testing machine and analysis specimen deformation and their load Vs displacement curve. With the help of load-displacement curve, we will be able to conclude the behavior and strength of investigated specimen and their functionality and applications areas.

**KEYWORDS:** Macroscopically, Composite, Matrix, Fiber.

## 1. INTRODUCTION

In the modern age, Increasing interest in enhancement of properties including lighter weight, higher strength, low thermal expansion, more wear resistance and high operating temperature has driven the automotive and aircraft industry to focus on application of composites as engine components and space structures as means to increase the performance, efficiency and durability of engine components. The stability of the components and structures made of MMCs over a long period of time in severe thermal environments becomes the crucial design concern [2]. It is essential to evaluate new materials for their thermal stability and to measure their physical properties. The limitations of conventional metallic materials have led to increased focus on fiber reinforced MMCs as potential candidates for a variety of uses [3]. Fibers are subjected to strong shear stresses and friction phenomena that reduce their length and their aspect ratio as well. One of the main factors affecting fiber breakage is fiber–fiber interaction [4]. A composite is a material, that consist of at least two material macroscopically, that work together to achieve the better and favorable properties from the previous materials. In the composite these components do not dissolve into each other and remain visible macroscopically. Its mean that these are attach to each other by the physical contact. It creates the different between composite and alloys because in the alloy material are mixed chemically and after the mixing there cannot be separation of materials [5]. Fibers reinforced composites are versatile engineering materials that associate strong fibers with lighter and low cost matrix in order to attain superior performance [6]. Like the fiber reinforced composites there are metal matrix composites (MMC) are also available. Polymer matrix composites are predominantly used for the aerospace industry, but the decreasing price of carbon fiber is widening the applications of these composites to

include the automobile, marine, sports, biomedical, construction and other industries [7]. The favorable properties of fiber and matrix are utilized to the maximum while the unfavorable properties of one component are compensate by the other components as much as possible [8].

## 2. MATERIALS AND METHODS

Two categories of aluminum rod viz. two hollow rods of aluminum oxide of 19 mm diameter, of length 155 mm and two solid rods of aluminum oxide of diameter 16mm, of length 155 mm and seven layers of 0.2 mm thickness of carbon fiber. A composite of carbon fiber reinforced metal matrix composite (CFR-MMC) has been made by a solid rod of 16 mm diameter and the outer surface of rod is layed with carbon fiber with the help of adhesive resin. The outer surface is covered by the seven layers (thickness of one layer equal to 0.2 mm). This process occurs on the two aluminum oxide rods of 16mm diameter. And these two rods are inserted into two hollow rods of 19 mm diameter. Now two samples of carbon fiber reinforced metal matrix composite (CFR-MMC) is ready for testing. Similarly, we prepare two samples of basalt fiber reinforced metal matrix composite (BFR-MMC). Now we have two specimen of CFR-MMC and two specimen of BFR-MMC of 19 mm diameter and 155 mm length. Two specimen is for compressive testing and two for tensile testing and compare there mechanical properties.

The specimen of aluminum oxide-basalt fiber & carbon fiber composite is shown in Fig.1.

***Fig.1. Specimen of aluminum oxide-basalt fiber & carbon fiber composite***

## 3. RESULTS AND DISCUSSION

**3.1. Compression strength test**

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. Compression test is used to determine how a product or material reacts when it compressed its determined specimen behavior under a compressive load. These include an elastic limit. This is also called proportional limit. Some materials are subject to a compressive force show initially a linear. **E = Stress (s) /Strain (e)**

Where E is known as Young's modulus for compression its significance that how much the material will deform under applied compressive load before plastic deformation.

The specimen dimension and ultimate load is shown in Table.1.
The setup of compressive testing is shown in Fig.2 and result of compressive test with comparison is shown in Fig.3, Fig.4 and Fig.5.


*Fig.2. Setup of compressive testing*

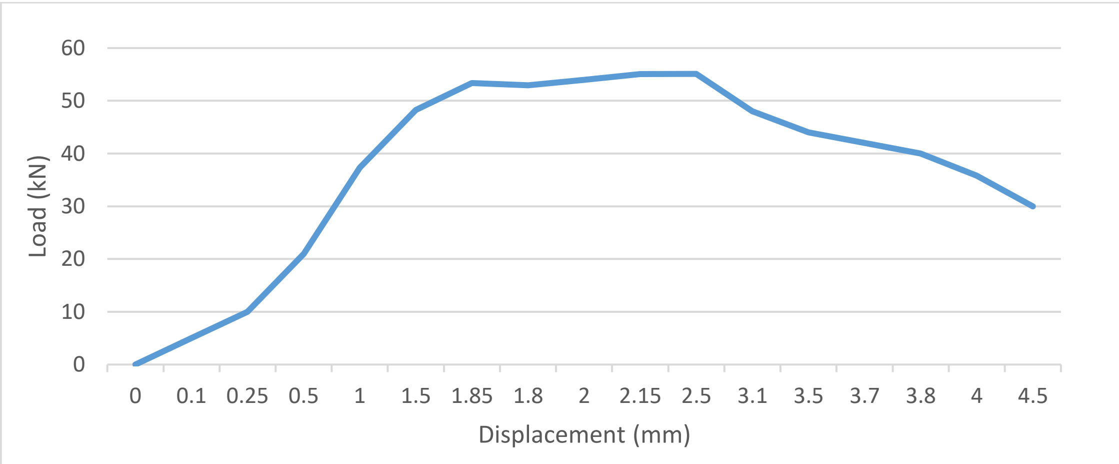


***Fig.3. Compressive Test of Aluminum Basalt Fiber Composite***

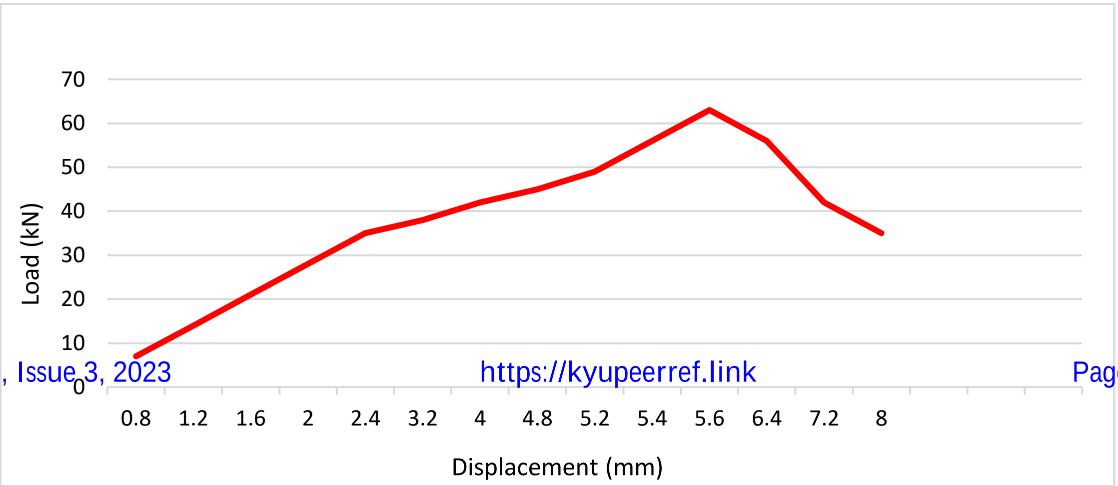

*Fig.4. Compressive Test of Aluminum Carbon Fiber Composite*

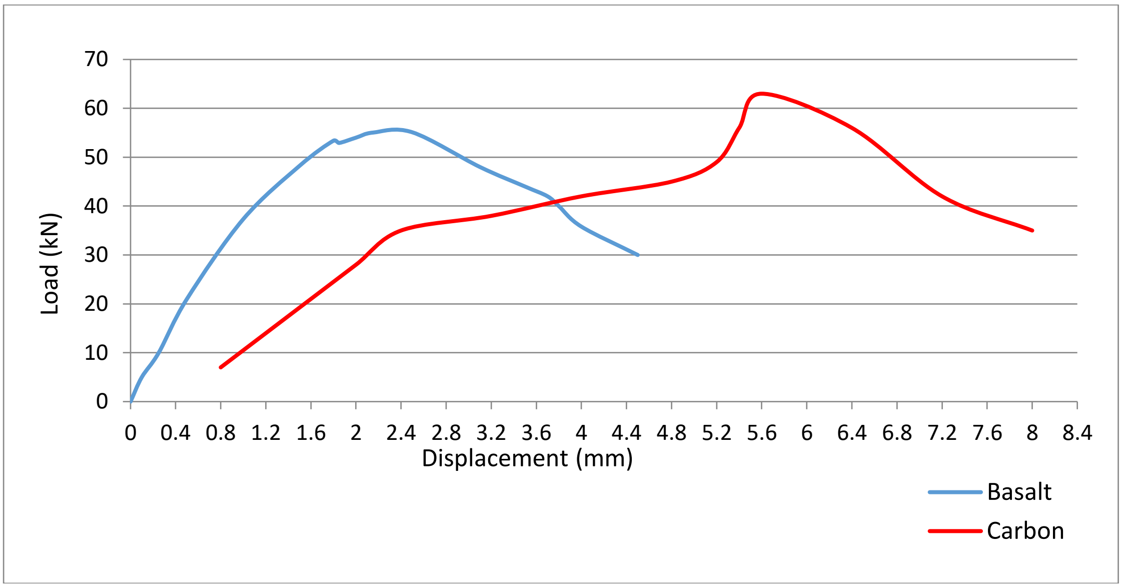


*Fig.5. Comparison Between Carbon Fiber and Basalt Fiber Composite*

*Table 1. The specimen dimension and ultimate load*

| Parameter | Carbon Fiber Composite | Basalt Fiber Composite |
|---|---|---|
| Diameter (mm) | 19 | 19 |
| Cross-sectional Area (mm2) | 282.63 | 282.63 |
| Ultimate Load (kN) | 65.98 | 55.04 |

### 3.2. Tensile test

The stress applied to a material is the force per unit area applied to the material. The maximum stress a material can stand before it breaks is called the breaking stress or ultimate tensile stress. Tensile means the material is under tension. The forces acting on it are trying to stretch the material. The specimen dimensions and results parameters is shown in Table 2. The setup of tensile testing is shown in Fig.6 and result of tensile test with comparison is shown in Fig.7, Fig.8 and Fig.9.

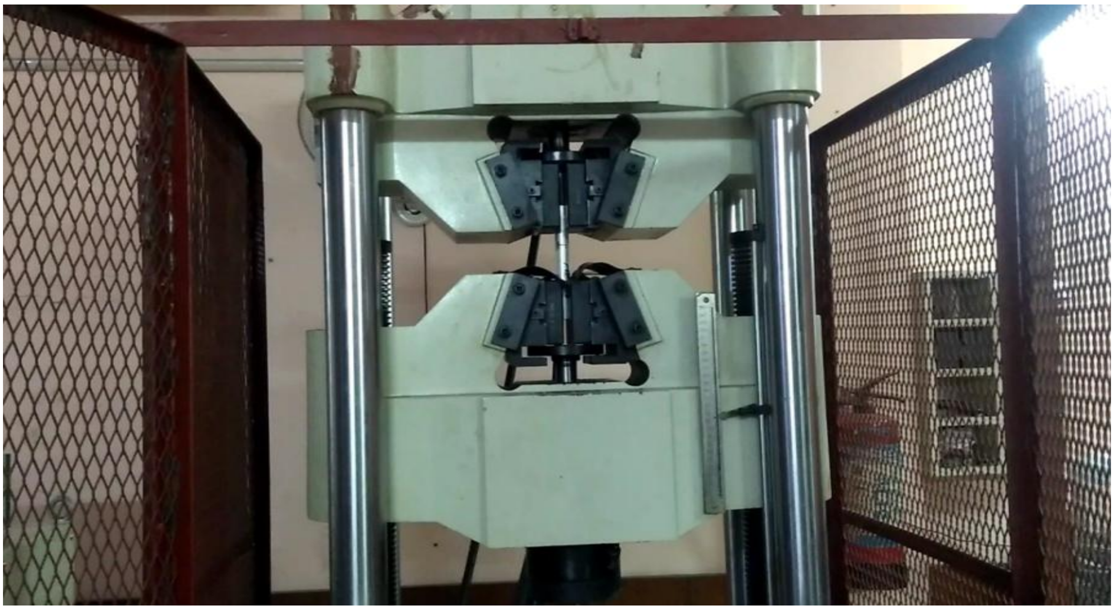

*Fig.6. Setup of tensile testing*

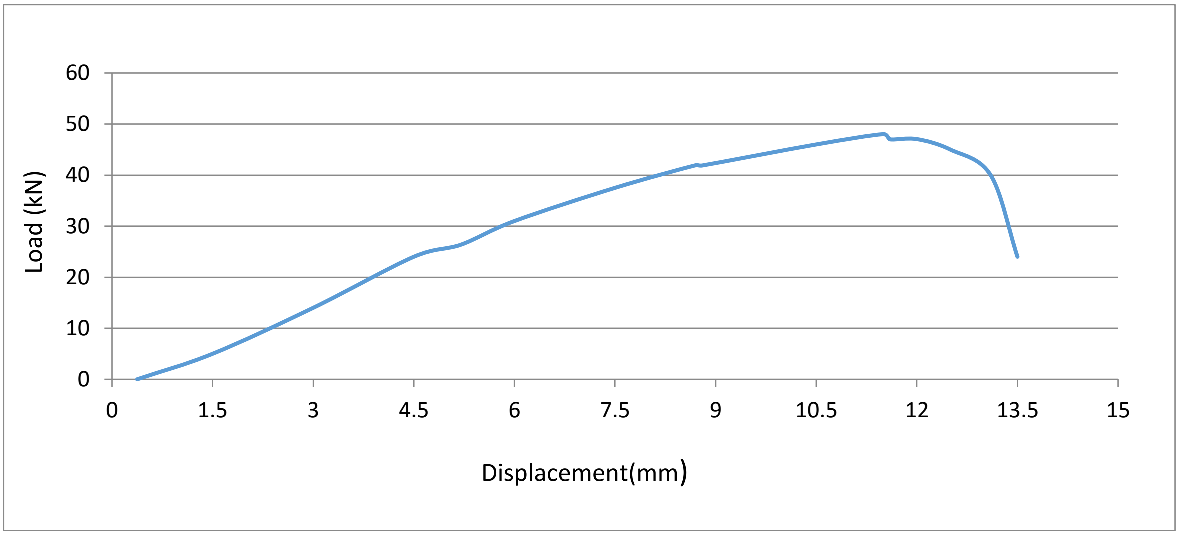


*Fig.7. Tensile Test of Aluminum Basalt Fiber Composite*

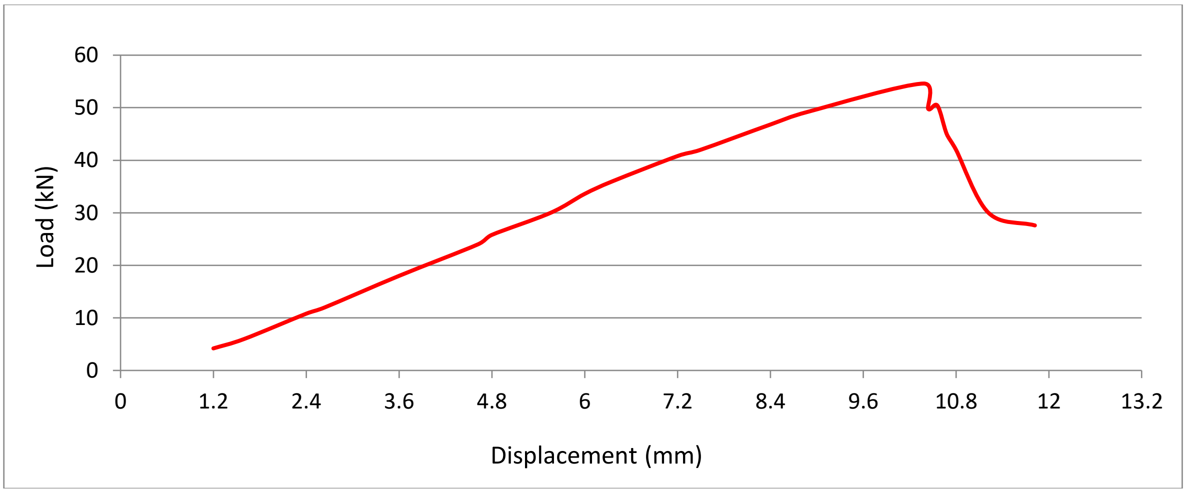


*Fig.8. Tensile Test of Aluminum Carbon Fiber Composite*

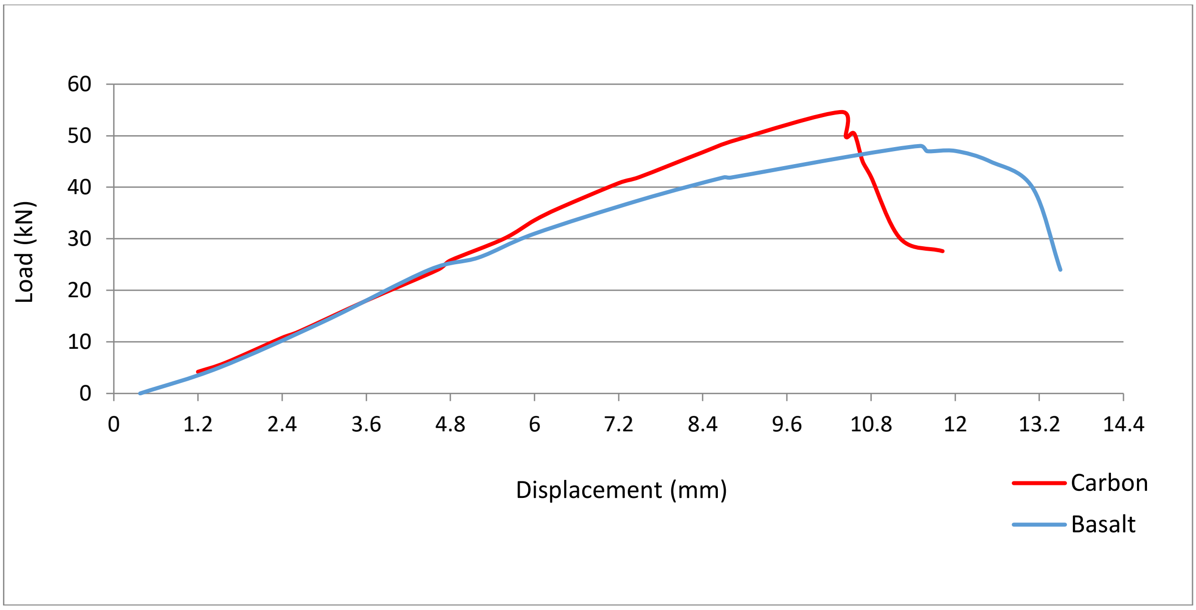


*Fig.9. Comparison Between Carbon Fiber and Basalt Fiber Composite*

*Table 2. The specimen dimensions and results parameters*

| Parameter | Carbon Fiber Composite | Basalt Fiber Composite |
|---|---|---|
| Diameter (mm) | 19.20 | 19.20 |
| Cross-sectional Area (mm2) | 289.53 | 289.53 |
| Gauge Length (mm) | 50 | 50 |
| Elongation Length (mm) | 52.2 | 52.1 |
| Elongation (%) | 4.4 | 4.2 |
| Ultimate Load (kN) | 54.60 | 48.02 |
| Ultimate Tensile Strength (MPa) | 189 | 166 |
| Yield load (kN) | 54.60 | 41.92 |
| Yield Stress (MPa) | 189 | 145 |

## 4. CONCLUSION

With the help of this experiment we have reached on the conclusions. These are -

**1.** Aluminum carbon fiber reinforced composite have the higher compressive strength than aluminum basalt fiber reinforced composite and it is more suitable for the compressive load.

**2.** Aluminum carbon fiber reinforced composite have the higher tensile strength than aluminum basalt fiber reinforced composite and it is more suitable for tensile load.

**3.** Yield stress of aluminum carbon fiber reinforced composite is high than aluminum basalt fiber reinforced composite.

**4.** Elongation of aluminum carbon fiber reinforced composite is high than aluminum basalt fiber reinforced composite so that ductility of aluminum carbon fiber reinforced composite have the higher than aluminum basalt fiber reinforced composite ductility..

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