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Study of mechanical strength of aluminium-carbon fiber reinforced composite

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Abstract
The main purpose of this paper to investigate the mechanical strength of Carbon fiber reinforced metal matrix composite (CFR-MMC) and compare with parent metal mechanical strength. the investigated specimen is composed of aluminum oxide and basalt fiber and compare the mechanical strength of CFR-MMC with aluminium oxide (Al_2O_3).to investigate the mechanical strength there is mainly do three strength test, i.e. compressive strength, tensile strength and shear strength test on the universal testing machine and analysis specimen deformation and their load Vs displacement curve with the help of load-displacement curve we will able to conclude the behavior and strength of investigated specimen and their functionality and applications areas.

Keywords: CFR-MMC, composite, matrix, fiber, macroscopically

Introduction

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. Many composites used today are at the leading edge of materials technology, with performance and costs appropriate to ultra-demanding applications such as spacecraft. But heterogeneous materials combining the best aspects of dissimilar constituents have been used by nature for millions of years [2] We are forward to the 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 [3]. A good dispersion of fibers in the matrix is another important factor for getting a high performance composite. Good dispersion implies that there will be no clumps of fiber in the finished product, ie, the fiber will be separated from each other during the mixing operation and surrounded by the matrix. Dispersion of fibers depends on the nature of the fibers, especially its length and also is greatly influenced by the amount of the fiber [4] 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 [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] The favorable properties of fiber and matrix are utilized to the maximum while the unfavorable properties of one components are compensate by the other components as much as possible [7].Limitations of Composites are Costly, Difficult to fabricate, Moisture effects etc., [8].

Preparation of Specimen

Three categories of aluminium rod viz. three hollow rods of aluminium oxide of 19mm diameter, of length 155 mm and three solid rods of diameter 16mm of length 155 mm and three solid rods of 19 mm diameter and 155 mm length and 0.2 mm thickness of basalt fiber. Now first of all to formed a composite of carbon fiber reinforced metal matrix composite (CFR-MMC) we will take the solid rod of 16 mm diameter and at the outer surface of rod layering of carbon fiber with the help of adhesive resin there are covering by the seven layers (thickness one layer equal to 0.2 mm).this processing occurs on the three aluminium oxide rod of 16 mm diameter. And these rods are inserted into another rod of 19 mm diameter with the help of pressure. Now basalt fiber reinforced metal matrix composite (CFR-MMC) is ready for testing. Parent material i.e. aluminum Oxide.

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 [9]. 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.

$$E = \text{Stress (s)} / \text{Strain (e)}$$

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.

Fig 1: Setup off compressive test

Result OF Compressive Test

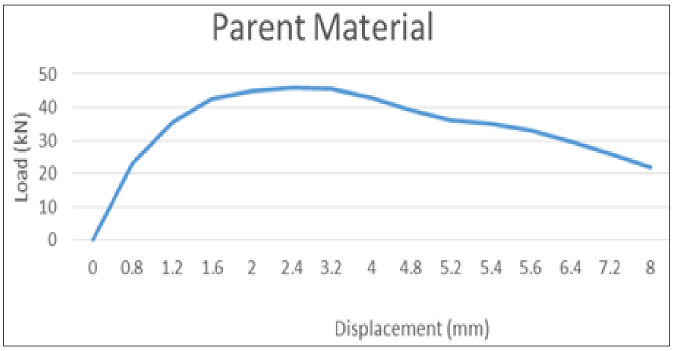

Fig 2

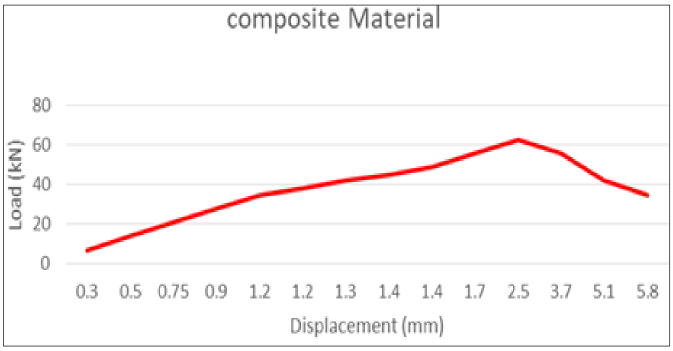

Fig 3

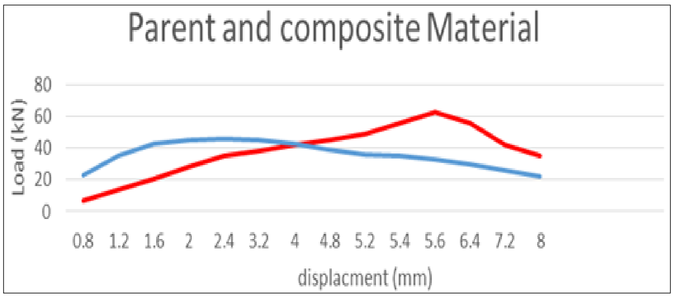

Fig 4

Table 1

Parameter	Parent material	Composite material
Diameter (mm)	18.97=19	19
Cross-sectional Area (mm^2)	282.63	282.63
Compression Load load(kN)	46.08	65.98

Shear test

A shear stress, often denoted by t (Greek: tau), is the component of stress coplanar with a material cross section. Shear stress arises from the force vector component parallel to the cross section of the material.in other words we can say Shearing stress is a force that causes layers or parts to slide upon each other in opposite directions. An example of shearing stress is the force of two connecting rocks rubbing in opposite directions(s = P/A).

Fig 5: Setup up off shear test

Fig 6: Composite with fixture

Result of compressive Test

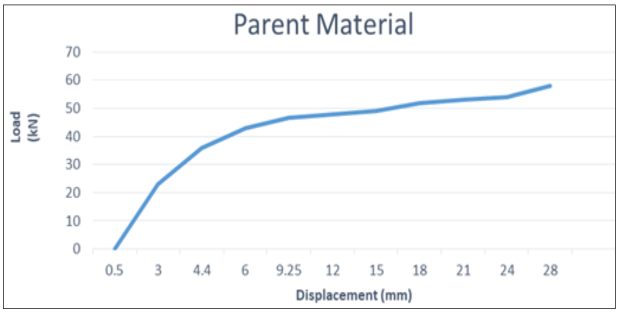

Fig 7

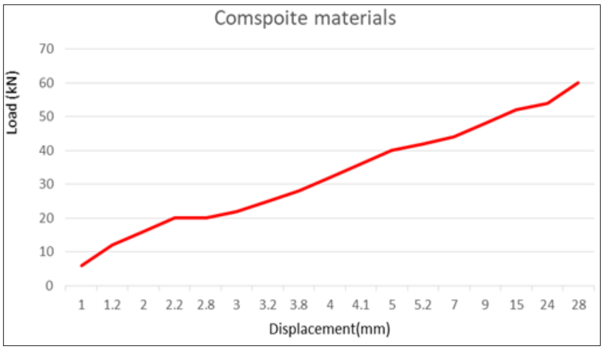

Fig 8

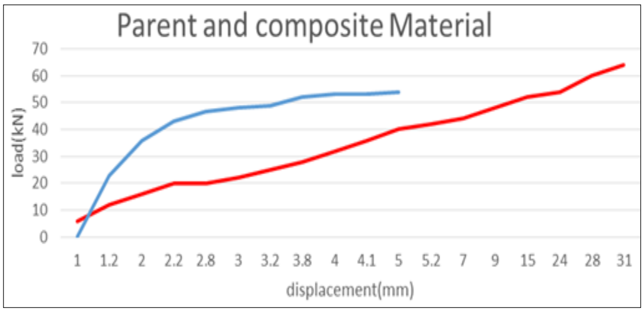

Fig 9

Table 2

Parameter	Composite Material
Ultimate shear load (KN)	63.93
Ultimate shear strength (MPa)	109.9

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.

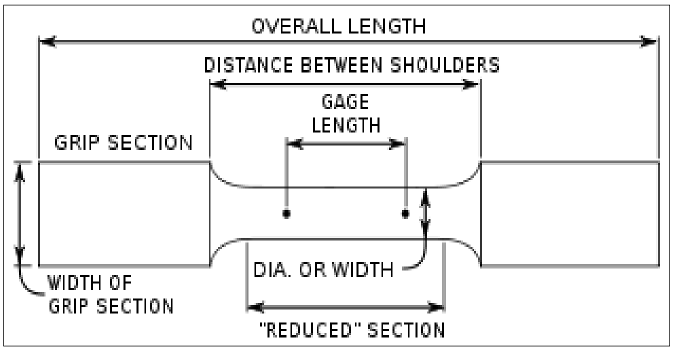

Fig 10

Fig: 11 Setup off tensile testing

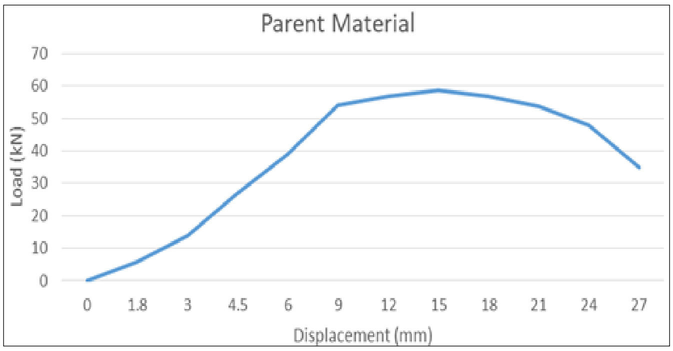

Fig 12

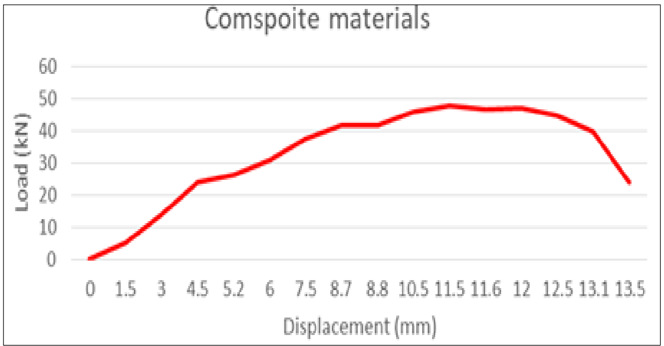

Fig 13

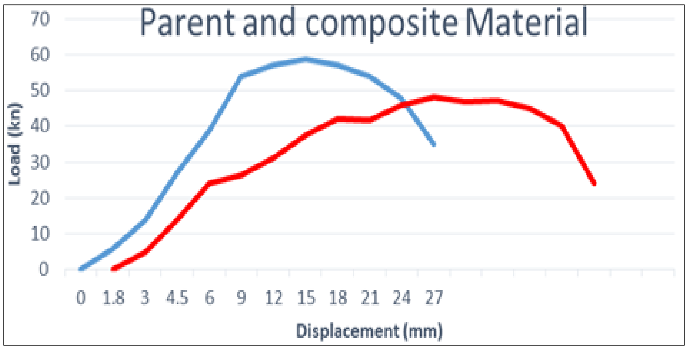

Fig 14

Comparison between parent material and composite

Table 3

Parameter	Composite material	Parent material
Diameter (mm)	18.97	18.97
Cross-sectional Area (mm^2)	282.63	282.63
Gauge Length (mm)	50	50
Elongation Length (mm)	52.2	62.5
Elongation (%)	4.4	25.0
Ultimate Load (kN)	54.60	58.88
Ultimate Tensile Strength(MPa)	208	208
Yield load (kN)	53.98	53.98
Yield Stress(MPa)	191	191

Conclusions

This experimental work report on the mechanical properties of aluminum basalt fiber composite with a view to broadening the industrial applications of natural fiber reinforced basalt fiber which was significantly enhanced the mechanical properties of composite. Finally we have reached on the conclusions these are:

1. Aluminium oxide carbon fiber Composite have the higher compressive strength than Aluminium oxide rod.it is more suitable for the compressive load.
2. (2)Aluminium oxide carbon fiber Composite has the higher shear strength than aluminium oxide.it have more value of shear stress that it can withstand without undergoing a shear failure.
3. Aluminium oxide carbon fiber Composite has the less tensile strength than aluminium oxide.so it is less suitable for tensile load than aluminium oxide rod.
4. Aluminium oxide rod is more ductile than aluminium oxide carbon fiber Composite.

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