Experimental Investigation on Effects of Basalt Fibre Reinforced Concrete

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ABSTRACT: This paper presents the art of knowledge of basalt fiber, it is relatively new material. Basalt fiber is a high performance non-metallic fiber made from basalt rock melted at high temperature. Basalt fiber reinforced concrete offers more Characteristics such as light weight, good fire resistance and strength. In future it is very beneficial for construction industry. Many applications of basalt fiber are residential, industrial, highway and bridges etc. In this study trial test for concrete with basalt fiber and without basalt fiber are conducted to show the difference in compressive strength and flexural strength by using cubes and concrete beams. Various application of BFRC shown in the study, the experimental test result, Techno-financial comparison with other type presented, indicate the tremendous potential of BFRC as an alternative construction material.

Introduction

In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of fibres added in specific percentages to concrete improves the mechanical properties, durability and serviceability of the structure. It is now established that one of the important properties of fibre reinforced concrete (frc) is its superior resistance to cracking and crack propagation. Fibre-reinforced concrete (frc) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres–each of which lend varying properties to the concrete. In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and density. The weak matrix in concrete, when reinforced with fibres, uniformly distributed across its entire mass, gets strengthened enormously, thereby rendering the matrix to behave as a composite material with properties significantly different from conventional concrete. Because of the vast improvements achieved by the addition of fibres to concrete, there are several applications where fibres reinforced concrete (frc) can be intelligently and beneficially used. These fibres have already been used in many large projects involving the construction of industrial floors, pavements, highway-overlays, etc. In india. These fibres are also used in the production of continuous fibres and are used as a replacement to reinforcing steel. High percentages of steel fibres are used extensively in pavements and in tunneling. Use of basalt fibres are picking up in western countries. Fibres are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion, and shatter-resistance in concrete.

Fibre is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The Fibre is often described by a convenient parameter called “aspect ratio”. The aspect ratio of the Fibre is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150.

Fibre-reinforcement is mainly used in shotcrete but can also be used in normal concrete. Fibre-reinforced normal concrete is mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pliers, foundations etc) either alone or with hand-tiedrebars.

Concrete reinforced with Fibres (which are usually steel, glass or “plastic” Fibres) is less expensive than hand-tied rebar, while still increasing the tensile strength many times. Shape, dimension and length of Fibre is important. A thin and short Fibre, for example short hair-shaped glass Fibre, will only be effective the first hours after pouring the concrete (reduces cracking while the concrete is stiffening) but will not increase the concrete tensile strength.

Many fibres are used in the construction industry suchas glass polyethylene, carbon fibre etc., one of the new fibre called Basalt rock fibre is added to this list. Basaltis usually brown or dark in color formed fromvolcanic lava after solidification. It has better strength characteristics of good hardness and thermalproperties. Basalt rock fibres give high strength andlow cost high performance to solve the problem in thelarge project like cracking, structural failure ofconcrete. The structure of Basalt fibre is shown infigure below(Figure1).
It is generally used for reinforcement in CivilConstruction, Road Repairing and infrastructure. Itdoes not get affected by Acid or Base or any organicchemicals. These fibres are heat resistant and notaffected by temperature upto 650^0 C to 700^0 C.
It isvery strong & light in weight. One Kg of basalt fibrereplaces 9.6 Kg steel reinforcement.

FIG. NO. 1 CHOPPED BASALT FIBER

EXISTING TECHNIQUES

Basalt is usually grey to black in colour, but rapidly weathers to brown or rust-red due to oxidation of its mafic (iron-rich) minerals into rust. Although usually characterized as "dark", basaltic rocks exhibit a wide range of shading due to regional geochemical processes. Due to weathering or high concentrations of plagioclase, some basalt rocks are quite light coloured, superficially resembling rhyolite to untrained eyes.

As we know that from last few decades the construction field has seen a growing interest in the advantages by using fiber reinforced concrete structures. Between the different types of fibers available, basalt fiber is considered a promising new material to use. It has extremely good strength characteristics and thermal resistance, high resistance to an alkaline environment, and is cheap product, making it an excellent material to reinforce concrete. In view of the significance of basalt fibers for concrete, and because different lengths and proportions of basalt fibers have an effect on the mechanical properties of concrete, it is proposed to review the effect of using different hybrid fibers with basalt fibers lengths and content on the mechanical properties of concrete. Basalt is well known as rock found in virtually every country around the world. Its main use is as a rock used in construction of industrial, highway engineering and infrastructural engineering projects. However, it is not commonly known that basalt can be used in manufacturing and made into fine, superfine and ultra-fine fibers. Comprised of single-ingredient raw material melt, basalt fibers are superior to other fibers in terms of thermal stability, heat and sound insulation properties, vibration resistance. In this research review various journal papers are being referred and studied carefully before carrying out further dissertation.

BASALT FIBRE

Properties of Basalt Fiber

a) Physical Properties

Color: It is available in golden brown in color. Diameter: It is available in different diameter like 5.8 micron. Length: - Available in 6mm,8mm,12mm etc. Density: - density of basalt fiber is 2.75 g/cm^3

Coefficient of friction: - The coefficient of friction may be between 0.42 to 0.50.

b) Chemical Properties

Basalts are more stable in strong alkalis. Weight loss in boiling water, Alkali and acid is also significantly lower. Possess resistance to UV- Light & biologic and fungal contamination. Are compatible with phenolic resins. Absorption of humidity comes to less.

c) Thermal Properties

With a thermal range of -260^0C to 982^0C and melt point of 1450^0C as well as low thermal conductivity 0.031 – 0.038w/mk, the basalt fibers are ideal for fire protection and insulation applications. Basalt fibers are most cost effective than the other high-temper Materials including E-glass, silica, ceramics, stainless steel and carbon by preventing rapid overheating and improving brake life. Offer three times the thermal efficiency of asbestos with no Mental and heat hazards. Basalt fiber is the best solution for asbestos replacement. Basalt fiber is non- combustible and explosion proof. After exposition less than 400^0C the basalt fibers loss on their initial strength, while the E-glass loss more 50%.

d) Mechanical Properties

The specific tenacity (rupture stress to density ratio) of basalt fibers exceeds that of steel, many times. Basalt fibers are non-capillary and non-hygroscopic, giving good moisture resistance. Basalt has shot content generally less than 3%.

OUR CONTRIBUTION

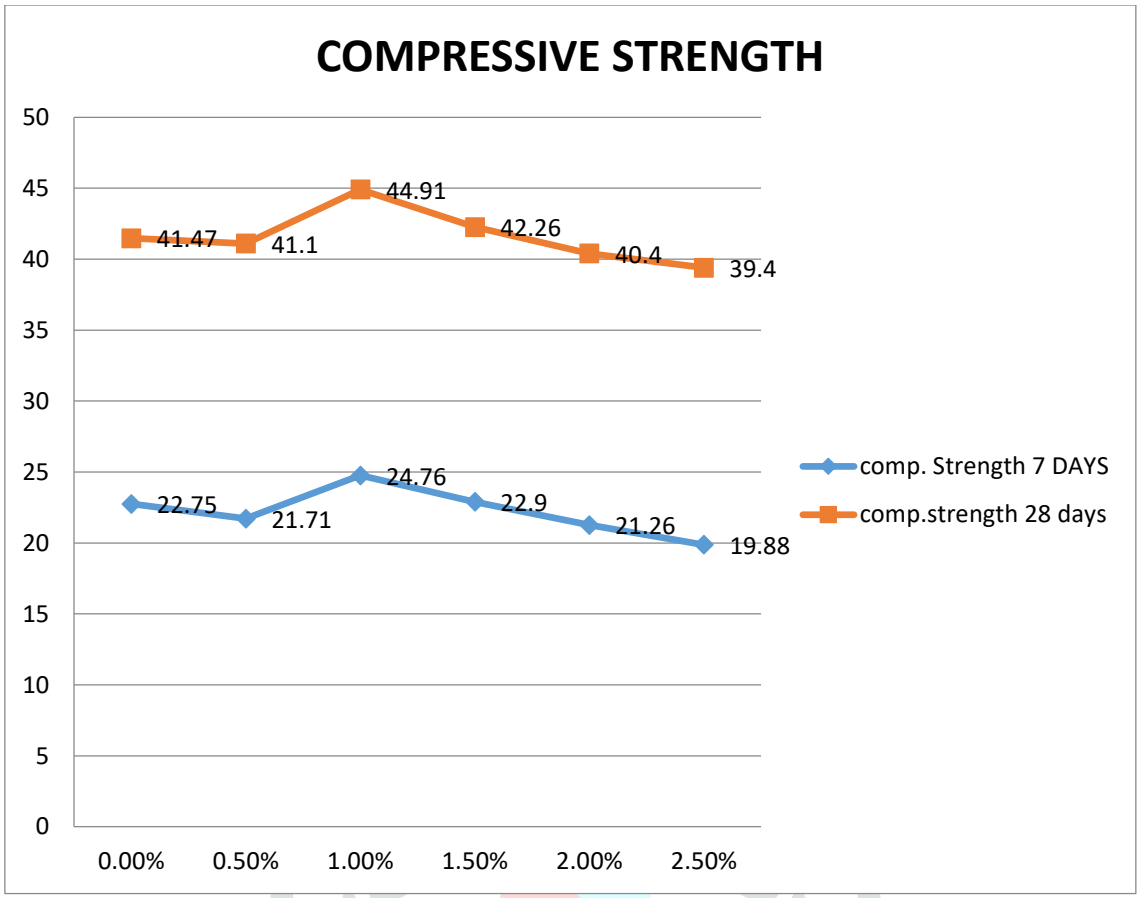
The aim of this research was to evaluate the performance of M30 concrete containing supplementary cementations materials. Concrete had a good future and is unlikely to get replaced by any other material on account of its ease to produce, uniformity, durability and economy with using of basalt Fibre in high strength concrete. The main aim of the investigation program is first to prepare the strength of concrete of grade M40 and then to study the effect of different proportion of basalt Fibre in the mix and to find optimum range of basalt Fibre content in the mix. The concrete specimens were tested at different age level for mechanical properties of concrete, namely, cube compressive strength, split tensile strength, flexural strength, of concrete and other tests were conducted for cement, chemical admixture, coarse aggregate & fine aggregate.

TEST RESULTS AND OBSERVATIONS

COMPRESSION TEST

Sr.No.	Percentage(%) of Basalt Fiber	Mean Compressive Strength of 7 days	Mean Compressive Strength of 28 days (N/mm2)
1	0.0%	22.75	41.47
2	0.5%	21.71	41.10
3	1.0%	24.76	44.91
4	1.5%	22.90	42.26
5	2.0%	21.26	40.40
6	2.5%	19.88	39.40

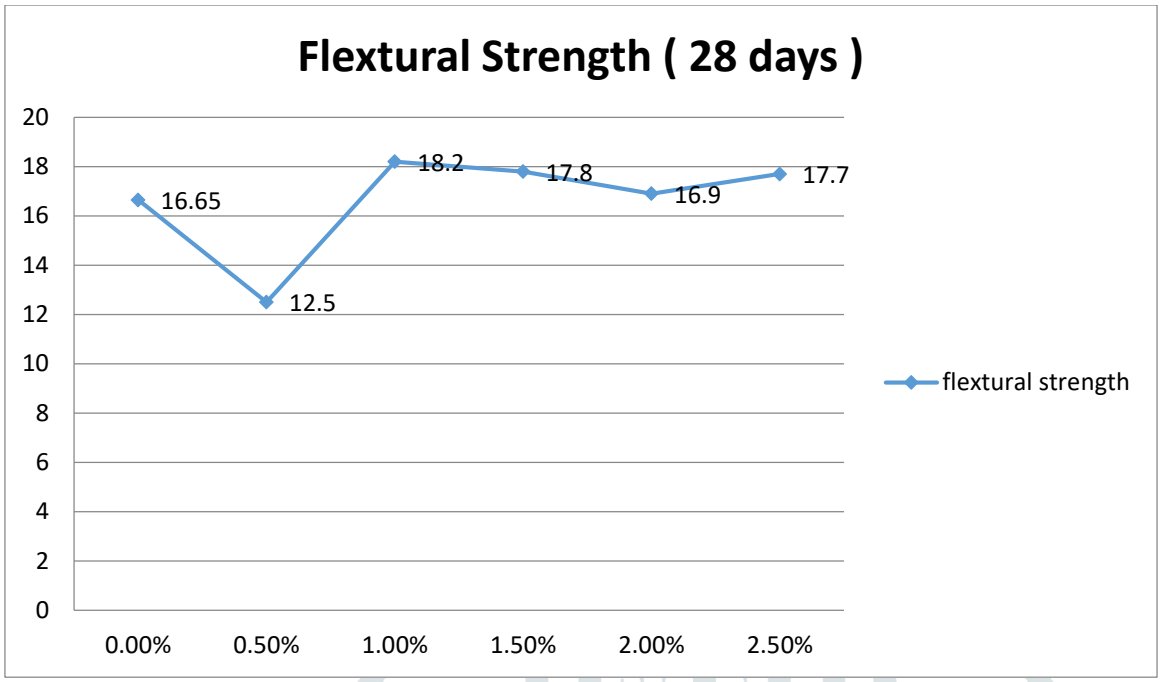
TABLE NO. 1 COMPRESSIVE TESTING TAKEN ON CONCRETE CUBE



FLEXURAL STRENGTH (BEAM)

Sr.No.	Percentage % of Basalt Fiber	Flexural Strength of 28 days (N/mm2)
1	0.0%	16.650
2	0.5%	12.500
3	1.0%	18.200
4	1.5%	17.800
5	2.0%	16.900
6	2.5%	17.700

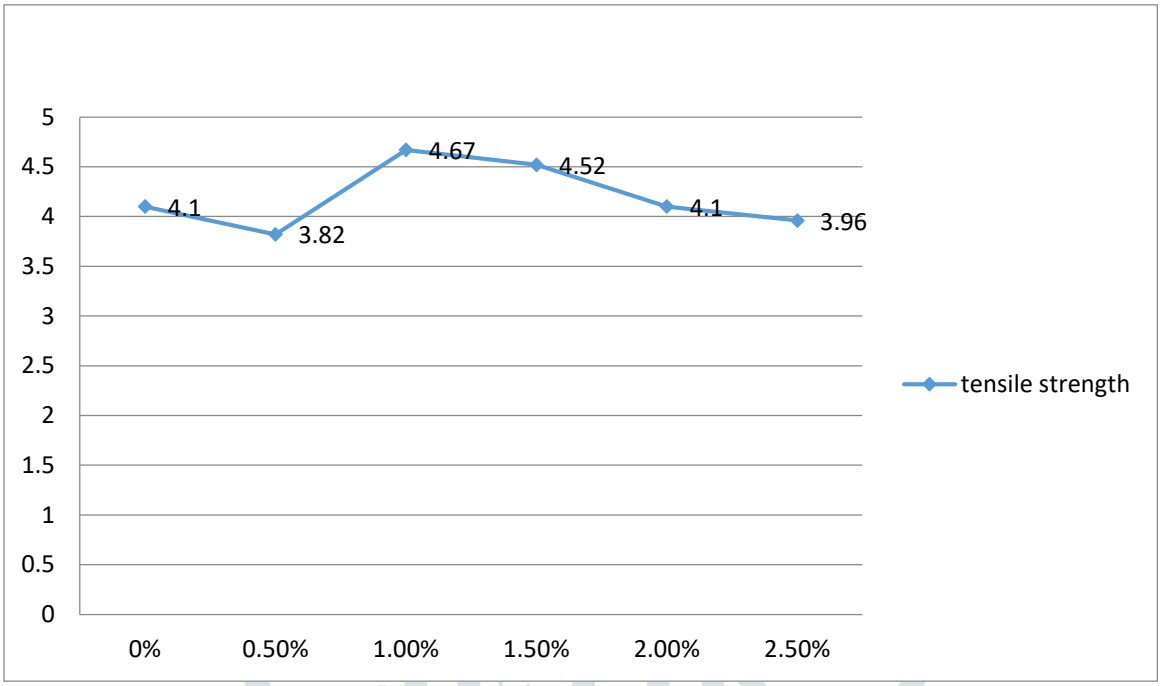
TABLE NO.2 FLEXURAL TESTING ON CONCRETE BEAM



TENSILE STRENGTHTEST(CYLINDER)

Sr.No.	Percentage(%)of Basalt Fiber	Tensile Strength of 28 days (N/mm2)
1	0%	4.10
2	0.5%	3.82
3	1.0%	4.67
4	1.5%	4.52
5	2.0%	4.10
6	2.5%	3.96

TABLE NO. 3. TENSILE TESTING TAKEN ON CONCRETE CYLINDER



DISCUSSIONS

COMPRESSIVE STRENGTH

Compression test is any test in which a material experience forces that push in ward upon the specimen from opposite sides or is otherwise compressed. The test sample is generally placed in between two plates that distributes the applied load across the entire surface area of two opposite faces of the test samples and the plates are pushed together by Universal test machine causing the sample to flatten. A compressed sample is usually shortened in the direction of the applied forces and expands in the direction perpendicular to the forces. A compression test is essentially the opposite of the more common tension test.

FLEXURAL STRENGTH

Flexural testing is predominately used in industries were material are subject to some form of bending forces The construction industries is a typically example is the most common test for structural steel, concrete beam , timber joists, GRC panels ceramics tiles in flexural testing. Flexural testing is also widely used evaluate materials can be difficult to test in in tensile mode. The technique requires specialist fixtures and precision displacement measurement coupled with advanced flexural testing software. Test metric offer a comprehensive range of 3 and 4 point band fixtures , displacement systems and dedicated software to suit all applicable material. The flexural testing is widely used to evaluate material that can be difficult to test in tensile mode. So that the strength of the material that would be used in industry could be determined and could increase the technology and also explore more about the user of materials in the industries.

TENSILE STRENGTH

The tensile strength of concrete is one of the basic and important properties which greaty affect the extent and size of cracking in structure. Moreover, the concrete is very weak in tension due to brittle nature. Hence it is not expected to resist the direct tension. So concrete develops crack when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength to concrete to determine the load at which the concrete member may crack.

CONCLUSION

Fibre Reinforced concrete has a great demand in Construction Industry. Basalt fibre may be effectively utilized in FRC since it is a non-corrosive, good flexural strength and high heat resistant material. It has no toxic reaction with air or water and can get high strength at 28 days. From the result it is very clear that the compressive strength and flexural strength is comparatively increasing than any other traditional Fibre Reinforced Concrete. Since the Compressive strength, Tensile strength and Flexural strength has increased by certain percentage within acceptable limit, this material can be used in structural members like Beam Column joints and also in all kinds of Tension and Compression members.

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