

# Review on Application of Basalt Fiber in Civil Engineering

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**Abstract**— Use of fiber reinforced polymer in civil engineering is increasing rapidly. Various types of fibers are used such as glass, carbon, aramid, steel and basalt. Basalt fiber is formed by melting of basalt rocks, which are being applied in construction industry for various purposes. The various experimental investigations for determination of properties of basalt fibers are discussed in present work. This paper, reviews in detail the application of basalt fiber in civil engineering field.

**Index Terms**— Basalt Rock, Basalt Fiber, BFRP, Basalt Wrapping, CBF, Basalt Concrete

## 1 INTRODUCTION

Basalt is rock available in large amount at Deccan Trap of Maharashtra. It is a natural, hard, dense, dark, and brown to black volcanic igneous rock which is formed due to molten lava after solidification. Since it is available in solid rock, and due to advanced techniques and development in construction industry, fibers can be made from it. Researchers started working on basalt rock and the process of making fibers by melting the basalt rock at high temperature 1500-1700oC to form the continuous basalt fiber has been developed. The fibers further can be used in the form of straps, sheet, chopped fiber, mat, net, and rod. The application of basalt fiber in construction field is increasing rapidly. Literature review shows that use of basalt fiber in concrete has got high potential in increasing strength. It has higher tensile strength as compared to steel fiber.

## 2 PROPERTIES OF BASALT FIBER

The rock was available in molten lava in earth crust which rises up and cools down slowly. The solid part of basalt rock was collected and heated. The liquid was formed and continuous basalt fiber was collected in roving form. It has low Young's Modulus, light weight and no thermal conductivity. Fibrous material has certain property hardness, abrasion resistance, unique chemical and mechanical properties. [1] Basalt fiber are manufactured in continuous roving fiber. It is chemically bonded by oxygen and primary metallic element in one dimensional longitudinal quasi-amorphous structure. The conclusion was chemical property of basalt fiber composite gives higher chemical stability as compared to glass fiber. [2] Many fibers get affected by moisture present in atmosphere and lose their original properties. For

these specimens of basalt fiber, reinforced composite was made and immersed in distilled water for 100 days. Results concluded that concrete composite with fiber gel coated avoids loss of mechanical properties. The mechanical properties degradation of basalt fiber composites according to result of the measurement of moisture absorption, was smaller than that of glass fiber composites by about 20%. [3] The properties of basalt fibers used in various research works is presented in Table No.1.

**Table No. 1- Comparison of Physical properties of basalt fiber by respective authors.**

Sr. No.	Author	Density ( $g/cm^3$ )	Tensile modulus (GPa)	Tensile strength (MPa)	Elongation at break (%)
1	R Singaravadivelan, et al (2012)	1.9-2.1	>50	>1000	>1.8
2	Wu Zhishen, et al (2012)	2.65	91	2100	2.3
3	Yun-Hae Kim, et al (2011)	2.6	89	2500	3.15
4	Dr. Patnaik (2009)	2.8	25-95	3100-4800	3.15
5	Dr. Richard Parnas et al (2007)	2.7	89	4840	3.15

### 3. APPLICATION

Basalt woven fabrics can have a huge potential in several applications like heat insulation, sound insulation, fire resistance, mats and veils for fire

protection, geo grids for road and land reinforcements, wind mill blade production and boat building. Basalt fiber can be converted into Yarn, Chopped Strands, Textured Yarn, Rope, Sleeve, Chopped Strand Mat, Surfacing Mat (Tissue), Unidirectional Fabrics, Multi-axial Fabrics, Rebar, Needle Mat, Geo grid (geo-mesh), 3-D Fabrics, Sewing thread and so on. [11] This composition was used for pipes, base, fitting, fabrics, structural plastic, automotive part, concrete reinforcement and basalt reinforced polymer as a reinforcement for transportation infrastructure. If structural elements are exposed to deicing salts, highly corrosive environment, then glass and carbon fiber was used. The tests for tensile strength, acid resistance, inert, corrosion resistance, radiation, UV light, vibration, impact loading have been conducted by the researcher. Basalt fiber have been used for road construction and found durable. [7] FRP of basalt is introduced in many engineering fields especially in civil and environmental engineering. basalt have excellent mechanical, chemical properties. The continuous basalt fiber is also typical energy saving, environmental friendly, CBF used against high temperature condition, anti u-v property, low moisture absorption, corrosion resistance and there are many others. CBF is used for defense industry aerospace civil construction, transport infrastructure, energy infrastructure, petrochemical, fire protection, ship building and ocean engineering. [6]

#### 3.1 Basalt as admixture in concrete

Experimental research has been carried out on concrete with basalt as admixtures. R. singaravadivelan et al, (2012) have tested mixed basalt fiber is added as additional material in concrete. The specimen of M20 grade concrete cubes, cylinder and prism with fiber proportion are

prepared (0 to 25%). The specimens are cured for 28 days and compressive strength, tensile strength, flexure strength and slump of concrete is calculated. The work results in good quality basalt fiber, useful for sound insulation technique, fire protection, concrete pipe and regular concrete work. Hamadallah M. Al-Baijat et al, (2009) have same experiment set up for beams. The bonding between steel and concrete is analyzed and compressive, flexural, load strain curve are calculated. The basalt fiber content is increased step by step and result shows strength of beam gets increased. Deflection decreases by about 36% to 50%, bond stress increases by 28% to 63%, compressive strength increases significantly from 9% to 43% and flexural strength of composite beam increases from 5% to 23% when the percentage of basalt is increased from 0% to 100%. It is determined that composite beam is stiffer than limestone beam. [9]

### 3.2 Wrapping of basalt fiber

Basalt fiber can be used for strengthening of structure. Researchers have conducted experiments for checking the enhancement in performance of structural members after wrapping with basalt fibers. Seven beams were casted and fiber sheet was attached with epoxy bonded cloth by basalt fiber to check flexural strength of specimen. [4] As Infrastructural decay is a continuous process, after some periods the members get repaired by this process. By these experiments it is found to be smart work under repairing concept and strengthening process. [4] Same concept is applied for column wrapping. Older structure has lack of transverse reinforcements for preventing buckling of column. The wrapping of FRP sheets around concrete column has been done. It was effective way for increasing strength. In this experiment circular concrete

specimens were casted. Wrapping of basalt fiber was done with help of epoxy binder. Flexural strength of column was determined and compared with carbon, glass. Experiment concluded better solution for infrastructure strengthening. [5]

### 3.3 Basalt-Plastic Pipes

Basalt-plastic pipes can be used in shaft lining, land reclamation, agriculture (to carry gases and water), and also as a protection shield during geological or geophysical works. Basalt-plastic composite pipes are manufactured by wrapping binder-impregnated basalt fibers around a tube that provides structural support, with subsequent polymerization. The equipment used to manufacture glass-reinforced plastic tubes should be adequate for basalt-plastic composite pipes. [11, 12]

### 3.4 Basalt-Cement Materials

Basalt fiber have used in cement. The concrete specimens were prepared using Portland cement mixed with 10-15% coarse basalt fibers. The extruded specimen (5mm thickness) containing Portland cement mixed with 3% chopped roving basalt fiber. Both the coarse and' chopped roving basalt fibers distributed uniformly throughout Portland cement provide strength (tensile, compression), fatigue, and flexural properties to the fiber-reinforced concrete two to four times higher than that of the conventional concrete. Chopped roving basalt fiber increases the mechanical characteristics of the fiber-reinforced concrete (stiffness, toughness and fracture properties) more than the low-cost coarse basalt fibers. [11, 13, 14]

### 3.5 Basalt Fiber-Reinforced Concrete

Concrete with composition of Portland cement, river sand, coarse basalt fibers, water, 30% prepared.

Tests on fiber-reinforced concrete using coarse basalt fibers consistently show increased stability and strength. Basalt-fiber concrete also possesses radio-transparent high-damping properties. The low-cost coarse fibers provide the cost effective use of basalt fiber-reinforced concrete in manufacturing a large assortment of high-strength, fire-resistant structures. [11]

**3.6 Geo-composites**

Basalt geo-mesh offers a number of advantages over glass or metals used for the pavement reinforcement. They are ecologically safe and can withstand very high temperature of molten asphalt. The basalt geo-meshes are chemically inert and lighter than metallic meshes. Basalt geo-mesh is also suitable for soil and embankment stabilization and environmental and ecological safety. [11, 15, 16]

**4. FIELDS OF APPLICATIONS**

**4.1 Construction**

Reinforcement of bridges, tunnels, external and internal heat and sound insulation, directional and dispersive reinforcement of concrete, repair (healing) of cracks, local damage to buildings, bridges, building constructions, soft roofing (of slate and tile type), reusable shutters, internal waste pipes, reinforced structures, heat-supply systems, cable conduits and hydraulic construction. [11]

**4.2 Road construction**

Reinforcement of concrete and asphalt pavements runways, construction of sound-absorbing barriers for highways, railways, and underground metro lines, curb stones, pavement linings (basalt casting) and small moulds. [11]

**4.3 Engineering networks**

Pipelines for heating and hot water supply, oil and gas pipelines, cable-conduit, telephone systems

protected against electromagnetic fields and information leakage through electronic surveillance.

**5 CONCLUSION**

Basalt fiber is being used in civil engineering application. Literature review shows that basalt fibers can be used successfully in following application

- dmixture in concrete A
- rapping technology W
- asalt plastics pipes B
- asalt Cement material B
- asalt fiber reinforced concrete B
- eo-composites G

Much research work is being done on glass on carbon fibers. Research in the area of basalt fiber is needed.

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