THE PERFORMANCE OF BASALT FIBRE IN HIGH STRENGTH CONCRETE

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***ABSTRACT*:** *The aim of this research was to evaluate the performance of high strength concrete(HSC) 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 , infinite variability , 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 with locally available ingredient 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, durability of concrete and other test were conducted for cement, chemical admixture, coarse aggregate & fine aggregate.*

Key Words: basalt fibre, high strength concrete , durability, Spilt tensile , compressive, flexural strength.

I: INTRODUCTION

The use and definition of high-strength concrete (HSC) has seen a gradual and continuous development over many years. In the 1950s, concrete with a compressive strength of 5000 psi (34 MPa) was considered high strength. In the 1960s, concrete with compressive strengths of 6000 and 7500 psi (41 and 52 MPa) were produced commercially. In the early 1970s, 9000 psi (62 MPa) concrete was produced. Today, compressive strengths approaching 20,000 psi (138 MPa) have been used in cast-in-place buildings. Laboratory researchers using special materials and processes have achieved “concretes” with compressive strengths in excess of 116,000 psi (800 MPa) (Schmidt and Fehling 2004). As materials technology and production processes evolve, it is likely the maximum compressive strength of concrete will continue to increase and HSC will be used in more applications. Demand for and use of HSC for tall buildings began in the 1970s, primarily in the U.S.A. Water Tower Place in Chicago, IL, which was completed in 1976 with a height of 859 ft (260 m) and used 9000 psi (62 MPa) specified compressive strength concrete in the columns and shear walls. The 311 South Wacker building in Chicago, completed in 1990 with a height of 961 ft (293 m), used 12,000 psi (83 MPa) specified compressive strength concrete for the columns. In their time, both buildings held the record for the world’s tallest concrete building.

II:BASALT FIBRE

Basalt is a natural, hard, dense, dark brown to black volcanic igneous rock originating at a depth of hundreds of kilometers beneath the earth and resulting the surface as molten magma. And its gray, dark in colour, formed from the molten lava after solidification. The production of basalt fiber consists of melt preparation, extrusion, fiber formation, application of lubricates and finally winding. method is also known as spinning. A fiber is a material made into a long filament with density generally in the order of 300g/cm2 of 50cm. The aspect ratio of length and diameter can be ranging from thousand to infinity in continuous fibers. It is do not undergo any toxic reaction with water and donot pollute air also. The functions of the fibers are to carry the load and provide stiffness, strength, thermal stability and other structural properties in the BFRP.

Fig.1. basalt fibre

Basalt fibre is a "multi-performance" fibre. For example,

It is resistant to alkalis and acids; it is thermally, electrically and sound Insulated; its tensile strength can be greater than large-tow carbon fibre, its elongation is better than small carbon fibre. Basalt has a 3-dimentional molecule and when compared with single infiltrating linear polymeric fibres. It is cost effectiveness, anti-aging, as well as other excellent Characteristics. Basalt fibre for cement and concrete is not expensive, it is a competitive alternative product of poly propylene fibre and polyacrylonitrile fibre. Basalt fibre is a typical ceramic fibre, it's easy to disperse when mixed with cement concrete and mortar. Therefore, basalt fibre reinforced concrete serves the functions of reinforcement, crack resistance, and can extend the life of construction in the fields of housing, bridges, Highways, railways, urban elevated roads, runways, ports, subway tunnels, the coastal Protection works, plant facilities. Banthia et al(2005)Performance of conventional Concrete is enhanced by the addition of fibres in concrete. The brittleness in concrete is reduced and the adequate ductility of concrete is ensured by the addition of fibres in concrete. In this paper the behavior of RC beam structures strengthened by using hybrid fibre reinforced concrete (HFRC) is analyzed. Mattys et al(2005) experienced BFRP(basalt fibre reinforced polymer) is a new material in civil engineering compared to carbon, glass and aramid and has shown to be a promising material for infrastructure strengthening. They are made from basalt rocks through melting process and contain no other additives in the producing process which makes advantages in cost. Basalt fibres show comparable mechanical properties to glass fibres at lower cost and exhibit good resistance to chemical and high temperature exposure. Aggarwal et al(2007) presents the experimental investigations carried out to study the effect of use of bottom ash as a replacementof fine aggregates. The various strength properties studied consist of compressive strength, flexural strength and splitting tensile strength. The strength development for various percentages (0-50%) replacement of fine aggregates with bottom ash. Singaravadivelan et al (2012) conducted research iscurrently Basalt fiber reinforced polymer, is the (BFRP) application is very effective ways to repair and strengthen structures that have become structurally repair systems and materials. Experimental investigations of the cube, cylinder & flexural RC beams strengthened using basalt fiber unidirectional cloth is carried out. From the experiments it was found that Wrapping the concrete cube and cylinder specimen to 25%increase the strength compared to controlled specimens. The flexural strength of the element of the strengthened RC beams increases significantly after strengthening with BFRP cloth. There is little research concerning the application of basalt fibre in civil engineering and its strengthening efficiency on concrete elements. This paper presents the tests that were performed on BFC (Basalt fibre concrete) cubes and cylinder specimens under concentric compression loading and split tensile test. Basalt fibers are a single component fibers ob-tained by melting solidified volcanic lava. The struc-tural basalt fibers available on the market have high-er failure strain than carbon fibers (fib, 2007) and a strength to weight ratio 1.5 times higher than that of glass. Although just few studies are available in the literature, manufacturers claim basalt fibers to be highly resistant to corrosive environments, such as salt and acid solutions and, especially alkalis (Su-daglass, 2008). In addition, the fibers exhibit high resistance to impact and high temperature loads and are an environment-friendly natural material. Basalt can be formed into continuous fibers adopting the same technology used for glass fibers. The produc-tion process however, requires less energy and the raw materials are widely available all around the world. This justifies the lower cost of basalt fibers compared to that of glass fibers. Basalt fibres are significantly cheaper than carbon fibres (BFCMTD, 2007) and their mechanical and physical properties make basalt FRPs ideal solution for a range of struc-tural strengthening applications.

III: EXPERIMENTAL PROGRA

A.) Cement

The cement used was Ordinary Portland cement (53Grade) with a specific gravity of 3.15. Initial and final setting times of the cement were 69 min and 195 min, respectively. Its chemical composition is given in Table 1.

Table 1: Chemical composition of cement and Basalt Fibre (%)

Oxide	Cement	Basalt Fibre
SiO_2	19.71	69.51
Al_2O_3	5.20	14.18
Fe_2O_3	3.73	3.92
CaO	62.91	5.62
MgO	2.54	2.41
K_2O	0.90	1.01
Na_2O_3	0.25	2.74

Test on Cement:

53 Grade OPC cement was used throughout the investigation. The various physical properties of cement were determined in accordance with BIS specification and the results are listed in Table 2.

Table 2: Results of tests on Cement

Tests	Results
Normal Consistency %	29.50 %
Initial setting time test	69
Final setting time test	195
Fineness test	5% retained
Specific gravity	3.15
Soundness test	2.00
Compressive strength	
7 days	37 N/mm^2
28 days	58 N/mm^2

B). Aggregate:

1. Fine Aggregate (Sand):

Good quality river sand was used as a fine aggregate.Ref. Code : IS: 383 & 2386

Table 3: Results of tests on Fine Aggregate

Description	Results
Fineness Modules	3.50
Zone	II

Water Absorption	2.10
Specific Gravity	2.59
Silt Content	1.00

2. Coarse Aggregate:

Ref. Code: IS: 2386 & 383

Table 4: Results of tests on Coarse Aggregate

Tests	Results
Coarse aggregate (kapchi)	
Water Absorption	1.80
Specific Gravity	2.77
Impact Value	10.70
Crushing Value	13.90
Coarse Aggregate (Grit)	
Water Absorption	2.10
Specific Gravity	2.78

C. Super plasticizer:

In modern concrete practice, it is essentially impossible to make high performance concrete at adequate workability in the field without the use of super plasticizers. Conplast SP-430 (200ml per 50kg) was used for the experimental work.

Use of Super plasticizer: Conplast-SP430

Properties:

Specific gravity - 1.220 to 1.225 at 300C

Chloride content- Nil to IS: 456

Air entrainment - Approx. 1% additional air is entrained.

D). Basalt fibre

Basalt is a natural, hard, dense, dark brown to black volcanic igneous rock originating at a depth of hundreds of kilometers beneath the earth and resulting the surface as molten magma. And its gray, dark in colour, formed from the molten lava after solidification. The production of basalt fiber consists of melt preparation, extrusion, fiber formation, application of lubricates and finally winding. method is also known as spinning. A fiber is a material made into a longfilament with density generally in the order of 300g/cm2 of 50cm. The aspect ratio of length and diameter can be ranging from thousand to infinity in continuous fibers.. The functions of the fibers are to carry the load and provide stiffness, strength, thermal stability and otherstructural properties in the BFRP.

Table5: Thermo physical properties

Working Temperature,(°c)	-267 to 700
Bond temperature,(°c)	1050
Thermal Conductivity, w/m(°K)	0.03-0.038

Table 6: Physical Properties

Sr. No.	Filament Diameter(Mm)	7 to 15
1.	Density (kg/m3)	2650
2.	Elastic Modulus (kg/mm2)	10000 to 11000
3	Tensile Strength (Mpa)	4150 to 4800
4.	20(°c)	100
5.	200(°c)	95

6.	400(°c)	82

IV:MIXTURE PROPORTIONING

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262-2009.The target mean strength was 40 MPA for the OPC control mixture, the total binder content was 400 kg/m ,fine aggregate is taken 698.27 kg/m and coarse aggregate is taken 1185.01 kg/m the water to binder ratio was kept constant as 0.42, the Super plasticizer content was varied to maintain a slump of (50-100 mm) for all mixtures. The total mixing time was 5 minutes, the samples were then casted and left for 24 hrs before demoulding They were then placed in the curing tank until the day of testing Cement, sand, Basalt fibre and fine and coarse aggregate were properly mixed together in accordance with IS code in the ratio 1:1.73:3.02 by weight before water was added and was properly mixed together to achieve homogenous material. Water absorption capacity and moisture content were taken into consideration and appropriately subtracted from the water/cement ratio used for mixing. Reported the blending of Basalt fibre in cement is recommended in most international building codes now. Hence, cement was replaced in percentages of 0%, 1%, 1.5%, 2%with Basalt fibre150 × 150 × 150mm3, Beam and Cylinder moulds were used for casting. Compaction of concrete in three layers with 25 strokes of 16 mm rod was carried out for each layer. The concrete was left in the mould and allowed to set for 24 hours before the cubes were de moulded and placed in curing tank. The concrete cubes were cured in the tank for 7, 14 days.

V: TESTING METHODS

Experimental investigation of fresh mix Properties of fiber reinforced basalt fibre concrete were conducted based on IS: 516 - 1959 using a slump cone. Compressive and Flexural strength of each specimen was determined using IS: 516 - 1959 and splitting tensile strength of each specimen was determined using IS: 5816 - 1959.Length change was measured according to IS: 516 - 1959. Compressive strength were measured 7, 14, days and flexural tensile strengths were measured 7 days of testing. Splitting tensile strengths were measured at 7 days. Specimens were cube with a 150 mm side for compressive strength, prism with dimensions of 150 * 150 * 700 mm for flexural tensile strength, cylinder with 150 mm diameter and 300 mm height for splitting tensile strength.

VI: TESTING PROGRAMME

A). Compressive Strength

The cube specimen was placed in the machine, of 2000kN capacity. The load was applied at a rate of approximately 140 kg/sq.cm/min until the resistance of the specimen to the increasing load can be sustained, was shown in Figure 1. Results are presented in Tables 7.

Fig. 2: Test for Compressive Strength

B. Flexural Strength:

The specimen was placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould, along two lines spaced 13.33cm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was applied through two similar steel rollers, 38mm in diameter, mounted at the third points of the supporting span that is spaced at 13.33cm centre to centre. The load was applied with out shock and increasing continuously at a rate of 180 kg/min until the specimen filed. Test results are presented in Table 8.The failure pattern has been presented in Figure 2.

Figure 3: Test for Flexural Strength of Concrete

C. Splitting Tensile Strength:

The cylinder specimen was placed horizontally in the centering with packing skip (wooden strip)/or loading pieces carefully positioned along the top and bottom of the plane of loading of the specimen. The load was applied without shock and increased continuously at a nominal rate with in the range 1.2 N/mm2/min to 2.4 N/mm2/min until failure the specimen. The maximum load applied was recorded at failure. Appearance of concrete and unused features in the type of failure was also observed are shown in Figure 3.The test results are presented in Table.9

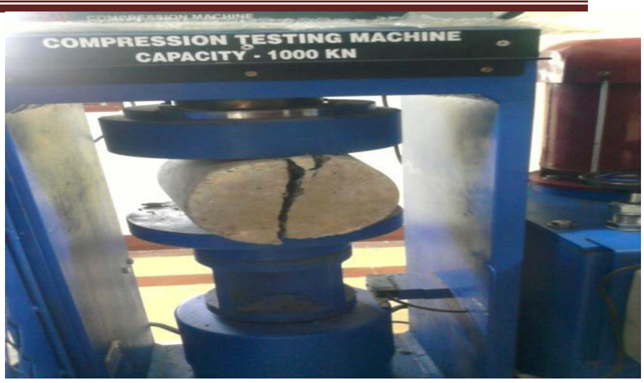

Figure 4: Test for Splitting Tensile Strength

VII: RESULT

Table 7: Compressive Strength of M40 Grade Bsalt fibre Concrete

Basalt fibre	Compressive Strength	
	7 days	14 days
0%	32.51 N/mm^2	35.34 N/mm^2
1%	31.46 N/mm^2	34.69 N/mm^2

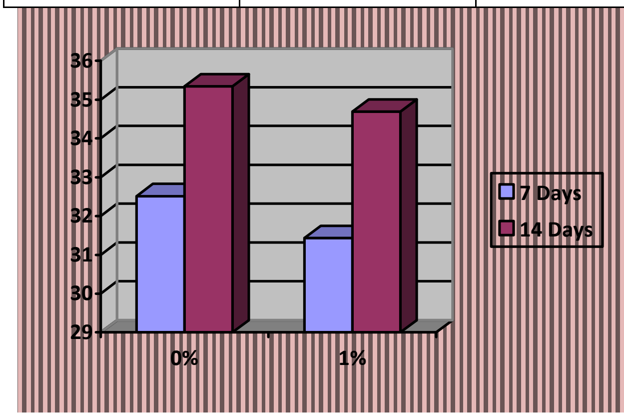

FIG.5. Compressive Strength of M40 Grade Bsalt fibre Concrete

Table 8: Flexural Strength of Concrete of M40 Grade Basalt fibre Concrete

Basalt fibre	Flexural Strength
	7 days
0%	4.56

1%	3.80

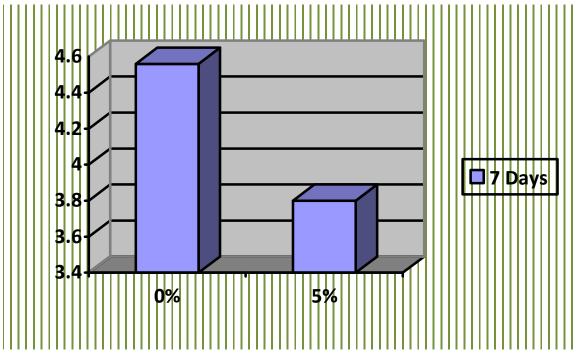

FIG.6. Flexural Strength of Concrete of M40 Grade Basalt fibre Concrete

Table 9: Splitting Tensile Strength of Concrete of M40 Grade Basalt fibre Concrete

Basalt fibre	Splitting Tensile Strength
	7 days
0%	2.49 N/mm^2
1%	1.36 N/mm^2

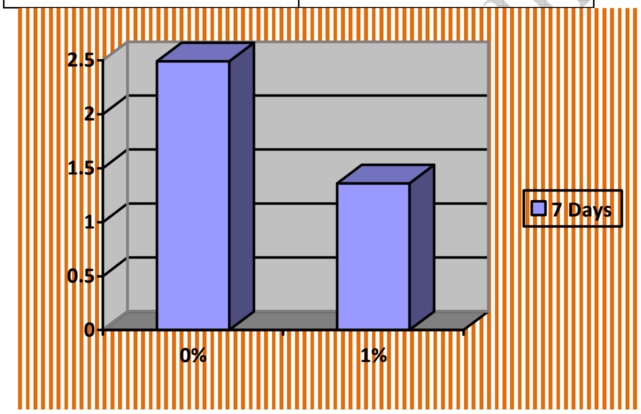

Fig.7 Splitting Tensile Strength of Concrete of M40 Grade Basalt fibre Concrete

VIII:CONCLUSION

As far from the work done that intial when adding fibre in high strength concrete the strength of high strength concrete is decreasing on 7 days and 14 days.

But as far from study of research paper that the strength of basalt fibre will gain more than the design mix after 28days .

Basalt Rock fibers have no toxic reaction with air or water, are non-combustible and explosion proof.

When in contact with other chemicals they produce no chemical reactions that may damage health or the environment.

Basalt base composites can replace steel and known reinforced plastics (1 kg of basalt reinforces equals 9.6 kg of steel).

Basalt can replace almost all applications of asbestos and has three times its heat insulating properties. Basalt is well known as a rock found in virtually every country round the world.

Basalt rock is more in India (specially in Maharashtra). The cost of basalt is 10 times lower than that of raw materials for fiberglass.

Basalt is more available than any other raw material. Also the melting temperature is lower, thus energy consumption lower.

Thus, the cost of basalt fibre is considerable lower than that of similar materials.

More workers are not required to operate the manufacturing plant.

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