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Strengthening of RC Beams by using Basalt Fibre and Foundry sand

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ABSTACT:

This Paper represents the study of Strengthening of RC beam structures by using basalt chopped strands fiber and Foundry Sand concrete. For this research work, Total 8 nos. of beams can be taken. The fiber is added to the concrete for various proportions of (ie., 0%, 0.5%, 0.75%,1.0%, 1.5%, 2.0%,)and foundry sand at a proportion of 0%, 20%, 30%, 40%, 50%,100% concrete mixes. A mixture of silica sand coated with a thin film of burnt carbon and residual binder with traces of dust is termed as foundry sand. This concrete beams are casted for a grade M-25 as per according to IS- 10262: 2009. From the previous available literature it was found that replacement of sand by foundry sand and addition of basalt fiber by certain initial percentages gives a marginal increase in hardened properties of normal strength concrete. In the present work, fine aggregate is replaced by foundry sand and certain basalt fiber with certain percentages and tests were performed for hardened properties of modified high strength concrete for all replacement levels.

Keywords— Cement, River sand, Foundry sand, Coarse aggregate, Basalt chopped strands fiber

1. INTRODUCTION :

Concrete is composite materials which composed of Cement, sand and aggregates are essential needs for any construction industry. Sand is a major material used for preparation of mortar and concrete and plays a most important role in mix design. In general consumption of natural sand is high, due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. Basalt rock is a volcanic rock and can be divided into small particles then formed into continues or chopped fibers. Basalt fiber has a higher working temperature and has a good resistance to chemical attack, impact load, and fire with less poisonous fumes. Some of the potential applications of these basalt composites are plastic polymer reinforcement, soil strengthening, bridges and highways, industrial floors, heat and sound insulation for residential and industrial buildings, bullet proof vests and retrofitting and rehabilitation of structures.

1.1 INTRODUCTION OF FOUNDRY SAND

A foundry is a manufacturing facility that produces metal castings by pouring molten metal into a preformed mold to yield the resulting hardened cast. The primary metals cast include iron and steel from the ferrous family and aluminum, copper, brass and bronze from the nonferrous family. Foundry sand is high

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quality silica sand that is a by-product from the production of both ferrous and nonferrous metal castings.

Table 1 : Composition of foundry sand

SiO_2	87.9
Al2O 3	4.7
Fe2O 3	0.94
CaO	0.14
MgO	0.3
SO3	0.09
Na2O	0.19
K2O	0.25
TiO2	0.15
Mn2 O3	0.02
SrO	0.03
LOI	(0.45 to 9.47)

1.2 INTRODUCTION OF BASALT FIBER

Basalt fibers are manufactured in a single-stage process by melting pure raw material.
They are environmentally safe and non-

Fig: 1.1 Basalt Fibre

toxic, possess high heat stability and insulating characteristics and have an elastic structure. When used for composite materials, they provide unique mechanical properties. They can be easily processed into fabric with high reliability. The tensile strength of continuous basalt fibers is about twice that of E-glass fibers and the modulus of elasticity is about 15-30% higher. Basalt fibers in an amorphous state exhibit higher chemical stability than glass fibers. When exposed to water at70^{o} C (1580 F), basalt fibers maintain their strength for 1200 hours, whereas the glass fibers do so only for 200 hours.

2.0 EXPERIMENTAL INVESTIGATIONS:

2.1 CEMENT

The most common cement used is an ordinary Portland cement. The Ordinary Portland Cement of 53 grade (ULTRA TECH cement OPC) conforming to IS: 8112-1989 is be use. Many tests were conducted on cement; some of them are consistency tests, setting tests, soundness tests, etc

Table 2 Physical Properties of Cement

Sl. No	Physical Properties Of Opc 53 Grade Cement	Results
1	Specific Gravity	3.10
2	Standard Consistency (%)	30.5
3	Initial Setting Time(Min)	30
4	Final Setting Time(Min)	214

2.2 Coarse Aggregates:

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 is being use.

Sl. No	Particulars	Natural Aggregate
1	Max Aggregate Size	20mm
2	Specific Gravity	2.82
3	Finess Modulus	7.09
4	Density	1805kg/m^3

Table :3 Physical Properties of Coarse Aggregate

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2.3 Fine Aggregate:

A foundry is a manufacturing facility that produces metal castings by pouring molten metal into a preformed mold to yield the resulting hardened cast. . Green sand consists of 85-95% silica, 0- 12% clay, 2-10% carbonaceous additives, such as sea coal, and 2-5% water. Green sand is the most commonly used molding media by foundries.

Fig: 1.2 Foundry sand

Table 4: Properties of Fine Aggregate(Recycled and Natural)

Sl.No	Particulars	Natural River Sand(Nrs)	Manufacture Sand(Foundry Sand)
1	Specific Gravity	2.50	2.40
2	Finess Modulus	2.75	5.40
3	Density	1752kg/m 3	890Kg/m^3

2.4 Properties of Basalt Fibre:

Basalt fiber has high density it's tensile strength at break is close to the E-glass fibers. It's modulus of elasticity is higher than that of E-glass fibers and close to the S glass fibers.

Table 5: Properties of Basalt Fibre

Sl.No	Particulars	Basalt Fiber
1	Length of the	6mm

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	fiber	
2	Dia of Fiber	0.03mm
3	Specific Gravity	2.7
4	Tensile Strength	2800-4800 Mpa
5	Elastic modulus	86-90 Gpa
6	Strain at Break	0.0315
7	Melting temp	2,700° F

3.0 Mix Proportion:

Concrete mix has been designed based on the Indian Standard code IS 10262-2009.The proportions of M20 grade concrete are estimated

Table 6: Concrete Design Mix Proportion

W/C Ratio	**Proportion**	**Cement (Kg/M^3)**	**Fine Aggregate (Kg/m^3)**	**Coarse Aggregate (Kg/m^3)**	**Water**
0.43	1:1.57:2.9	433	681	1258	186

3.1Workability Tests of Fresh Concrete

3.1.1 Slump cone test

The slump is taken for each mixing of concrete with 0 %, 20%, 30%, 50%,100% replacement of Foundry Sand and replaced with basalt fiber 0%,0.5%,0.75%,1.5%,2% . The results show that slump of concrete made with natural aggregates is higher while the concrete with 100% replacement of Foundry Sand and 2% of Basalt Fiber has less slump.

Table 9: Workability Test for Slump Value

Mix	W/C Ratio	Height Of The Cone (In Cm)
0 %	0.43	29
20 %	0.43	28
30 %	0.43	28.5
40 %	0.43	26
50 %	0.43	26.5
100%	0.43	26

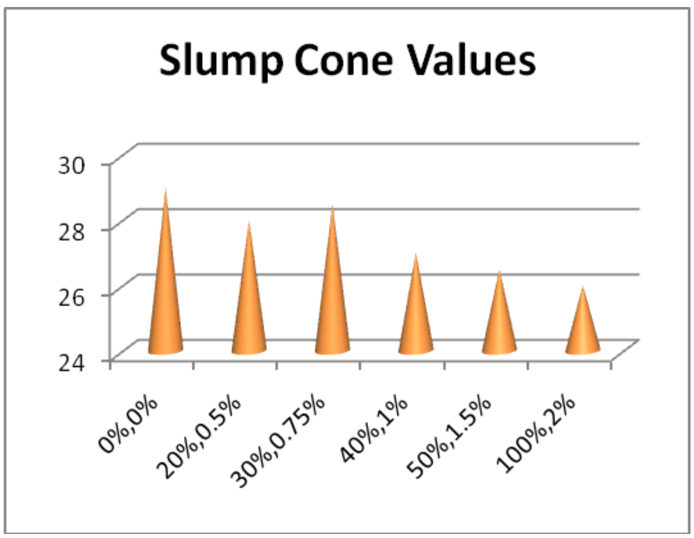

Fig: 1.3 Slump Cone Graph

3.1.2 Compaction factor test

Compacting factor test also used to determine the workability of fresh concrete. It is not used on site testing because the apparatus is very heavy. According to Streetworks the compacting factor test gives a more accurate workability of fresh concrete than slump test. It mentioned that the compacting factor test also known as the “drop test”, which measures the weight of fully compacted concrete and compare it with the weight of partially compacted concrete

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Table 10: Compaction Factor Value for M25 Grade Mix

Sl.No	Mix		Compaction Factor
	Foundry Sand	**Basalt fiber**	
1	0%	0%	0.87
2	20%	0.5%	0.86
3	30%	0.75%	0.88
4	40%	1.0%	0.87
5	50%	1.5%	0.86
6	100%	2.0%	0.84

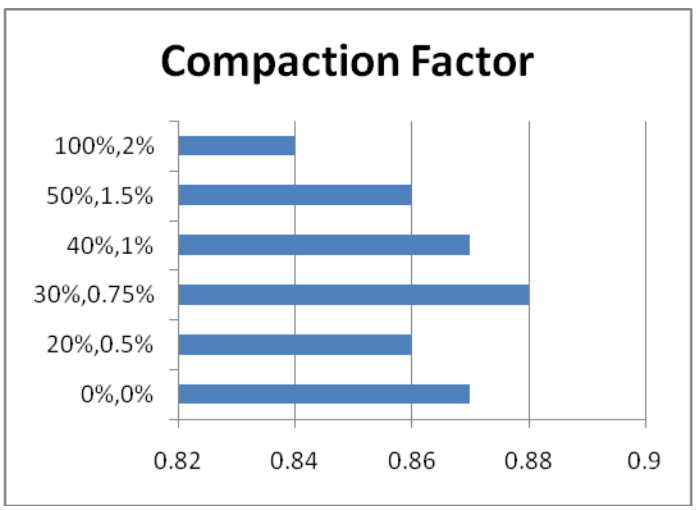

Fig 1.4: Percentage of foundry Sand & Basalt Fiber Concrete Mix V/S Compaction Factor

4.0 TESTS ON HARDENED CONCRETE

Strength is defined as the ability of a material to resist stress without failure. The failure of concrete is due to cracking. Under direct tension, concrete failure is due to the propagation of a single major crack. In compression, failure involves the propagation of a large number of cracks, leading to a mode of disintegration which is commonly referred to as crushing.

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4.1 COMPRESSIVE STRENGTH TEST

The compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. The material compresses and shortens it is said to be in compression. The ultimate compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely.The compressive strength is usually obtained experimentally by means of a compressive test.

Table 11: Compressive strength test results

% of Foundry sand and Basalt fiber	7 days	14 days	28 days
Conventional Concrete	26.85	28.22	32.58
20%,0.5%	27.35	29.90	32.51
30%,0.75%	26.98	30.24	34.98
40%,1.0%	15.88	28.53	29.74
50%,1.5%	1.45	2.86	5.34
100%,2.0%	1.20	1.23	3.22

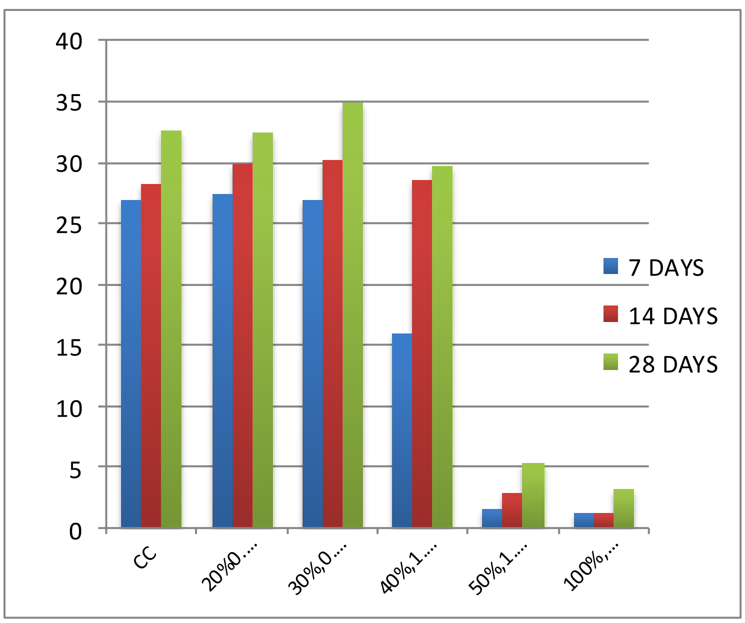

Figure 1.5 Compression strength graph

The Strength increases upto 40%,1% addition of foundry sand and basalt fibre and thengoes on decreasing.

4.2 SPLIT TENSILE TEST

Tensile strength is defined as a stress, which is measured as force per unit area or maximum stress that a material can withstand while being stretched or pulled before failing or breaking. Tensile strength value does not depend on *the* size of the test specimen. However, it is dependent on other factors, such as the preparation of the specimen, the presence or otherwise of surface defects, and the temperature of the test environment and material. Cylinder specimen as per BS: 1881-198 (Part 117) of specimen size 150 x 300mm cylinder is taken. The splitting test is carried out by applying compression loads along two axial lines that are diametrically opposite. Under vertical loading acting on the two ends of the vertical diametrical line, uniform tension is introduced along the central part of the specimen.

Table 12: Split Tensile strength test results

% of Foundry sand and Basalt fibre	**7days**	**14 days**	**28 days**
Conventional Concrete	1.83	1.96	2.24
20%,0.5%	2.12	2.68	2.83
30%,0.75%	2.26	3.12	2.95
40%,1.0%	2.43	2.58	2.89
50%,1.5%	1.98	2.0	1.86
100%,2.0%	1.57	1.42	1.22

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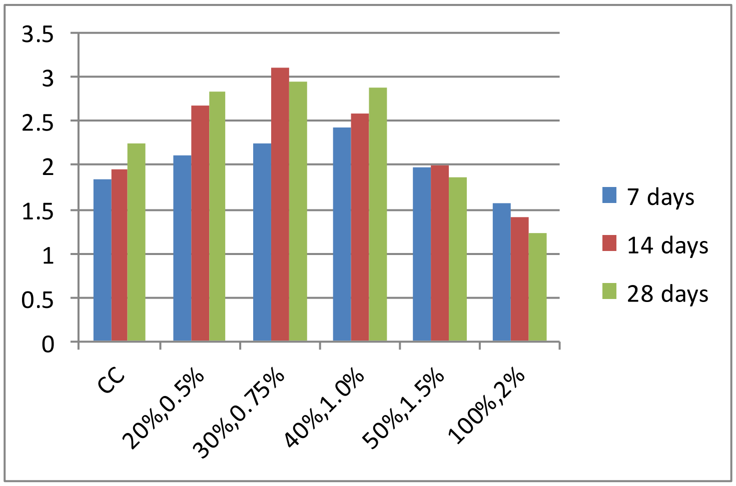

Figure 1.6 Split Tensile strength graph

43 FLEXURAL STRENGTH TEST:

The Beam specimens were tested for flexural strength. The load shall be applied through two similar plates mounted at the third points of the supporting span that is, spaced at 20 or 13.3 cm centre to centre. The load shall be divided equally between the two loading plates.

CALCULATION

The Flexural Strength or modulus of rupture (**f_b**) is given by

$F_b = pl/bd^2$ (when **a** > 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen) or

Where,

a = Distance between the line of fracture and the nearer support

b = Width of specimen

d = Failure point depth

l = Supported length

p = Max. Load

Table 12: Split Tensile strength test results

% of Basalt Fiber And Foundry sand	7days	14days	28days

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0%, 0%	2.59	3.24	4.22
20%,0.5%	3.25	3.89	4.63
30%,0.75%	3.22	3.62	5.19
40%,1%	3.86	4.63	6.10
50%,1.5%	3.33	4.46	4.82
100%,2%	3.12	3.61	4.65

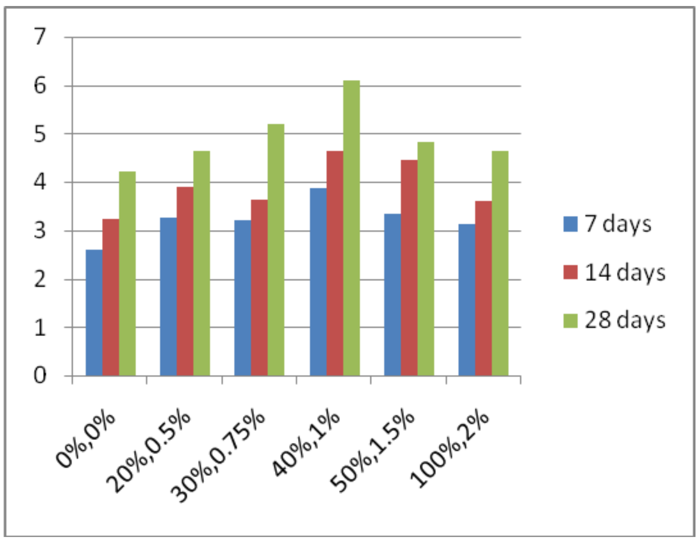

Fig: 1.7 Graph showing the Flexural strength of Foundry sand and Basalt Fiber Concrete

The flexural strength of the concrete increases upto 40%,1% of foundry sand and basalt fibre concrete and then decreases on further addition of foudry sand and basalt fibre.

CONCLUSIONS:

Research on the replacement of suitable materials for fine aggregate is very important because of the increase demand of river sand.After detailed study of the result and analysis the following conclusions were made for M25 grade concrete.

1.) Compression strength of concrete increases as the increase in curing period of the concrete for both the control specimen and foundry sand replaced concrete.

2.) Compression strength of concrete increases up to 40%,1% percent replacement level of waste foundry sand and basalt fibre and then decreases gradually when compared to conventional concrete.

3.) Split Tensile strength of Concrete increases upto 30% , 0.75% replacement of Foundry sand and baslt fibre and then decreases when replaced with 100%,2% of foundry sand and basalt fibre concrete when compared with conventional concerete.
4.) Flexural strength of the concrete increases upto40%,1% of foundry sand and basalt fibre concrete and then decreases when the percentage of foundry sand and basalt fibre is increased when compared to conventional concrete.
5.) The percentage of cost reduces upto 40% replacement of foundry sand and 1% of basalt fibre.
6.) The waste foundry sand can be partially replaced for river sand upto 40% and 1% of basalt fibre.
7.) It will be both economical and high strength when added to certain extent of 40% of foundry sand and 1% of basalt fibre.
8.) The problems of disposal of waste foundry sand and the demnd for river sand can be reduced to certain extent.
9.) The maintenance cost of land filling is reduced.
10.) The basalt fibre materials does not undergo any reaction with water,air and also do not have any side effects on human health.
11.) They also have several properties like high elasticity modulus and excellent heat resistance.

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