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Experimental Study on Basalt Fibre Concrete at Elevated Temperatures on Medium and High Strength Concrete

V.Jhansi Rani[1], D.Srinivasa Rao[2]
[1,2]Assistant Professor Civil Engineering Department, Viswanadha Institute of Technology & Management, Visakhapatnam, Andhra Pradesh.

Abstract*: The research is to study the performance of basalt fiber concrete at elevated temperatures to exhibit it as a fire resister, and also compare the compressive and split tensile strengths of M30 (normal concrete) and M60 (high strength concrete) grade concretes mixed with basalt fibers of 0.3% by volume . These specimens were exposed to temperatures of 27°C, 200°C, 400°C, 600°C & 800°C at 7 days and 28 days of curing. The temperature is maintained for 3 hours in the bogie hearth furnace for sustained temperature condition. The weight loss, spilling, bonding and colour change is determined for both medium & high strength concrete. The specimens were tested for its compressive and split tensile strength and found that the use of basalt fibers in High Strength Concrete is a good advantage than Medium Strength Concrete.
Keywords*: Basalt Fibre Concrete, Compressive Strength, Split tensile Strength, Elevated temperatures

I. INTRODUCTION

Concrete is widely used as a primary structural material in construction due to numerous advantages, such as strength, durability, ease of fabrication, and no combustibility properties, it possesses over other construction materials. The behaviour of a concrete structural member exposed to fire is dependent, in part, on thermal, mechanical, and deformation properties of concrete of which the member is composed. The disadvantages of using concrete include poor tensile strength, low strain of fracture and formwork requirement. The major disadvantage is that concrete develops micro cracks during curing. Basalt fibers are a single component material obtained by melting crushed volcanic rocks. Basalt is claimed to be the one of the strongest natural silicates and is widely available worldwide. that basalt fibers offer resistance to high and low temperatures, low-water absorption, high-corrosion resistance, resistance to acids and alkalis, high strength, thermal stability, high impact and fatigue resistance, natural resistance to ultraviolet and high-energy electromagnetic radiation, and entirely inert with no toxic reaction with air or water.

II. LITERATURE REVIEW

Gore Ketan.R et al.[1] studied on the performance of basalt fibre in high strength concrete by taking M40 grade mix and concluded that at 7 and 14 days test strength decreses and for 28 days test gives more strength. Nihat Morova et al[2]studied on the usability of basalt fibers in order to bear the stresses occurring at the surface layer of pavement, which are directly subjected to the traffic effects, Gorde Pravin Jaysing et al[3]studied on that increase of basalt fiber mix in concrete will reduce the strength of concrete when compared to normal, upto a limited quantity of basalt mix is preferable. Kiang H.T. et al.[4] FRP systems when the elevated temperature was less than approximately 700°C. BFRP Strenthened beams showed a smaller deterioration in ultimate strength than GPRF-Strength

III. MATERIALS

Materials used in the experiment are namely cement, coarse aggregate, fine aggregate and other admixtures have tested in the laboratory.

A. Cement

A cement is a binder, a substance that sets and hardens and can bind other materials together. Ordinary Portland cement of 53 grades available in local market is used in the investigation. The physical properties of cement is shown

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S.No	Particulars of test	Test results	Requirement as per IS code	IS Code Number
1.	Standard consistency	33%	26-33%	IS 4031 (part-4)
2.	Specific gravity	3.08	3-3.2	IS 2720(part-3)
3.	Fineness	8.26	Min 3.7	IS 4031 (part-2)
4.	Setting time Initial setting time	56	30-60mins	IS 4031 (part-5)
	Final setting time	192	Max. 600mins	
5.	Compressive strength			IS 4031 (part-7)
	@3-Days (MPa)	$26 N/mm^2$	27	
	@7-Days(MPa)	$37 N/mm^2$	37.5	
	@28-Days(MPa)	$52 N/mm^2$	53	

B. Basalt Fiber

Basalt is a well-known as a rock found in virtually every country round the world. It is not commonly known that basalt can be used in manufacturing and made into fine, super fine and ultra-fine fibers. Basalt rock can be used to make not only basalt bars but also basalt fabrics, chopped basalt fiber strands, continuous basalt filament wires and basalt mesh.

PROPERTIES	VALUES
Density, g/cm3	2.70
Filament diameter, microns	9-23
Tensile strength, MPa	4830
Compression, psi	550,000
Elastic modulus, G Pa	87
Linear expansion coefficient, x10 /K	5.5
Elongation at break, %	3.18
Absorption of humidity, 65% RAH%	<0.1
Stability at tension, 20 C°%	100
Stability at tension, 200 C° %	95
Stability at tension , 400 C° %	81

C. Super Plasticizers

High range water reducing admixture called as super plasticizers are used for improving the flow or workability for lower water cement ratios without sacrifice in the compressive strength. These admixtures when they disperse in cement agglomerates significantly decrease the viscosity of the paste by forming a thin film around cement particles. In this experiment super plasticizer is used for M60 grade concrete for both normal and basalt mix.

D. Fine Aggregate

Fine aggregate is natural sand which has been washed and sieved to remove particles larger than 5 mm and coarse aggregate is gravel which has been crushed, washed and sieved so that the particles vary from 5 up to 50 mm in size The reason for using a mixture of fine and coarse aggregate is that by combining them in the correct proportions, a concrete with very few voids or spaces in it can be made and this reduces the quantity of comparatively expensive cement required to produce a strong concrete.

S. No	Particulars of test	Test results	IS CODE NUMBER
1	Specific gravity	2.68	IS 2386 (Part-3) -1963
2	Water absorption, %	0.4	IS 2386 (Part-3) -1963
3	Bulk density, $\left(\frac{gm}{cm3}\right)$	1.72	IS 383 -1970
4	Fineness	3.62 Zone II	IS 2386 (Part-1) -1963

E. Coarse Aggregate

Properties of aggregates which influence the properties of both the fresh and the hardened concretes are mainly the particle size distribution, the maximum size of particles and the shape and the surface texture of the particles. Furthermore, the density and porosity together with water absorption and moisture content have to be consider when the concrete have to be considered when the concrete is proportioned.

S.No	Particulars of test	Test Results	IS CODE NUMBER
		Coarse Aggregate	
1.	Specific gravity	2.67	IS 2386 (Part III) – 1963
2.	Water Absorption (%)	3.80	IS 2386 (Part III) – 1963
3.	Fineness modulus	7.35	IS 2386 (Part I) - 1963
4.	Bulk density $\frac{kg}{m3}$	1584	IS 2386 (Part III) – 1963
5.	Impact value (%)	21.66	IS 4031 (Part IV) – 1996
6.	Crushing value (%)	25.74	IS 4031 (Part IV) – 1996
7.	Flakiness Index (%)	29	IS 2386 (Part I) – 1963
8.	Elongation Index (%)	27	IS 2386 (Part I) – 1963

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F. Water

Water used for mixing and curing is taken from the surroundings. Which is free from any amount of oils, acids etc that may be deleterious to concrete or steel confirming to different parts of IS : 30251964[101]. The pH value is less than 6.

IV. METHODOLOGY

A. Mix Design Procedure

The main object of concrete mix design is to select the optimum proportions of the various ingredients of concrete which will yield fresh concrete of desirable properties like workability and hardened concrete possessing specific characteristic compressive strength and durability

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The following basic data is required to be specified for the design of a concrete mix:

1) Characteristic compressive strength (That is, below which only a specified proportion of test results are allowed to fall) of concrete at 28 days fck (Grade designation)
2) Type of cement
3) Maximum nominal size of aggregate
4) Minimum cement content
5) Limitations on the W/C ratio and the minimum cement content to ensure adequate durability as per IS456.
6) Standard deviation of compressive strength of concrete
7) Workability
8) Degree of quality control
9) Exposure conditions as per IS:456
10) Specific gravity of cement, fine and coarse aggregates Fineness modulus of fine aggregate.

B. Preparation Of Testing Specimen

1) Mixing of ingredients is done in a pan of capacity 50L, the materials are thoroughly blended by adding aggregates water and super plasticizers
2) After mixing cast iron moulds with this concrete mix
3) These moulds are surface finished as per IS 516-1969.
4) After 24hrs curing is done to the specimens.
5) Now, these specimens are tested in a compressive testing machine and readings are noted for 7days and 28days for M30 & M60 grade concrete with and without basalt mix.
6) Again specimens are tested in a split tensile testing machine and reading to be noted for 7days and 28days for M30 & M60 grade concrete with and without basalt mix.

Compressive Testing

Split tensile testing

Mix design for different grades of concrete

S.No	Grade designation	Target strength MPa	Cement, Kg/m^3	Fine Aggregate, Kg/m^3	Coarse Aggregate, Kg/m^3	Water Kg/m^3	w/c ratio	Basalt Fiber µm	Compressive strength		Slump, mm	SP %
									7 days	28 days		
1	M60	71	450	670	1250	128	0.284	-	49	65	5	1
2	M60 + Basalt	71	450	670	1250	128	0.284	0.3%	55	70	5	1
3	M30	37	330	730	1250	152	0.46		32	39.20	10	-
4	M30 +Basalt	37	330	730	1250	152	0.46	0.3%	36	45.60	10	-

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V. RESULTS AND DISCUSSIONS

The total cubes casted are exposed to temperature between 200^{0}c to 800^{0}c at an interval of 200^{0}c for duration of 3 hours in a bogie hearth furnace.

Bogie hearth furnace testing cubes

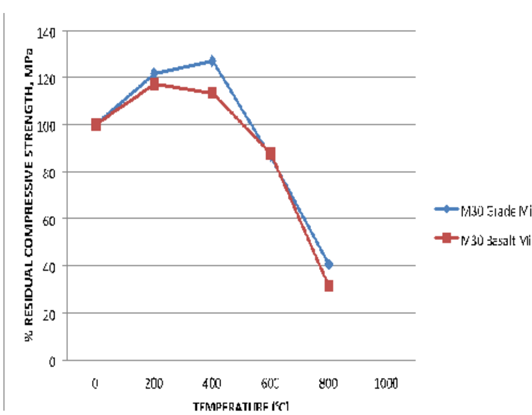
Bogie hearth furnace testing cylinders

A. Compressive Strength Test Results

The casted cubes of M30 & M60 grade concretes exposed to temperatures and tested for compressive strength at 7 and 28 days after it cools.

Residual compressive strength of m30 concrete with and without basalt for 7 & 28 days.

Temp. (°C)	7 DAYS, MPa				28 DAYS, MPa			
	Without Basalt		With Basalt		Without Basalt		With Basalt	
	With out Basalt Fibers	Percentage Residual Comp. Strength	With Basalt Fibers	Percentage Residual Comp. Strength	With out Basalt Fibers	Percentage Residual Comp. Strength	With Basalt Fibers	Percentage Residual Comp. Stress
27	38.00	100	36.00	100	41.00	100	39.33	100
200	44.00	115	41.00	114	46.00	112	44.67	114
400	42.00	110	39.60	111	44.67	109	41.33	105
600	33.00	88	31.67	91	38.00	94	37.00	94
800	15.00	33	11.00	26	19.67	46	16.90	40



For 7 days result

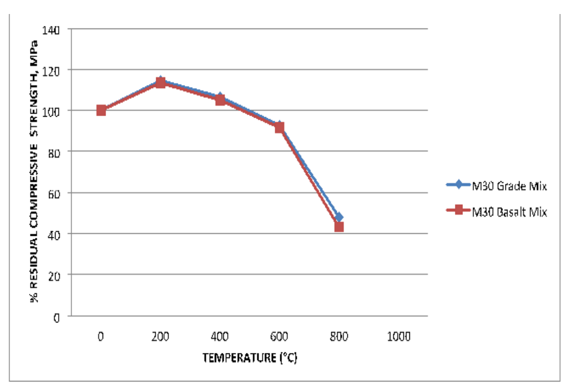


Fig:2 Temperature versus Percentage residual strength of normal and basalt mix concrete of

for 28days result

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Residual compressive strength of m60 concrete with and without basalt mix at 7 & 28 days.

Temp. (°C)	7 DAYS, MPa				28 DAYS, MPa			
	Without Basalt		With Basalt		Without Basalt		With Basalt	
	With out Basalt Fibers	Percentage Residual Comp. Strength	With Basalt Fibers	Percentage Residual Comp. Strength	With out Basalt Fibers	Percentage Residual Comp. Strength	With Basalt Fibers	Percentage Residual Comp. Stress
27	54.30	100	50.33	100	58.00	100	54.00	100
200	55.90	103	51.32	102	62.30	107	59.30	109
400	45.67	85	44.27	88	56.30	97	54.10	100
600	41.00	74	36.02	70	48.67	84	38.00	70
800	21.00	28	18.00	28	22.00	38	19.00	35

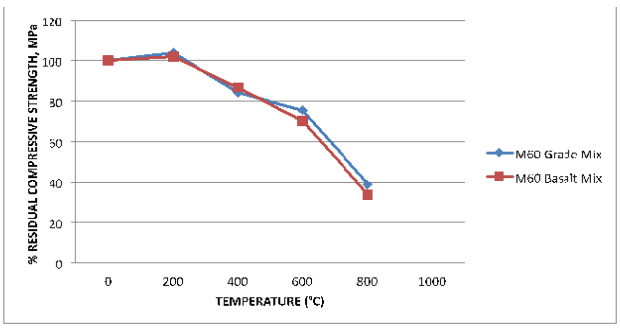


Fig:3 Temperature versus Percentage residual strength of normal and basalt mix concrete of For 7 days result

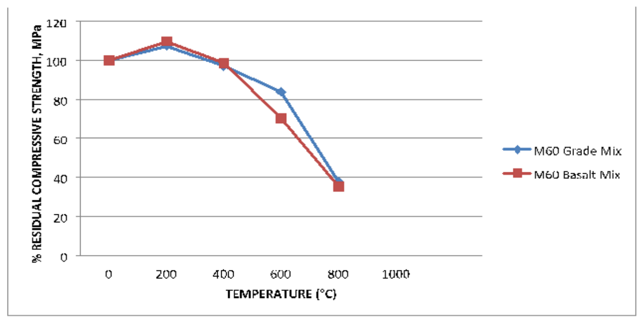


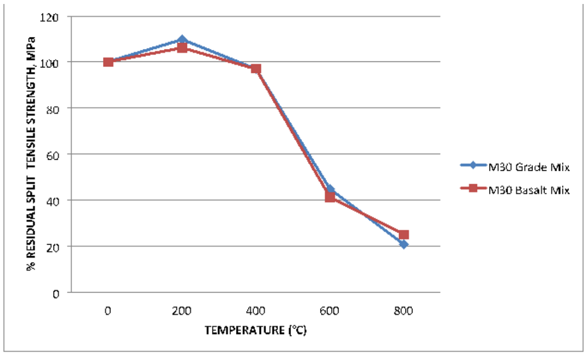
Fig:4 Temperature versus Percentage residual strength of normal and basalt mix concrete of for 28days result

B. Split Tensile Strength Test Results

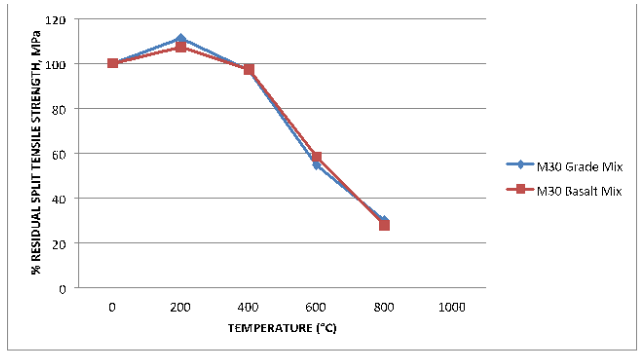
The casted cubes of M30 & M60 grade concretes exposed to temperatures and tested for compressive strength at 7 and 28 days after it cools.

Residual Split Tensile Strength of M30 Concrete with and Without Basalt Mix of 7 & 28 Days.

Temp. (°C)	7 DAYS, MPa				28 DAYS, MPa			
	Without Basalt		With Basalt		Without Basalt		With Basalt	
	With out Basalt Fibers	Percentage Residual Split Tensile Strength	With Basalt Fibers	Percentage Residual Split Tensile Strength	With out Basalt Fibers	Percentage Residual Split Tensile Strength	With Basalt Fibers	Percentage Residual Split Tensile Strength
27	3.10	100	3.40	100	3.30	100	3.51	100
200	3.36	108	3.51	103	3.71	112	3.86	108
400	3.00	97	3.30	97	3.20	98	3.48	98
600	1.39	45	1.42	42	1.80	54	2.20	61
800	0.71	23	0.86	25	0.99	28	1.02	28



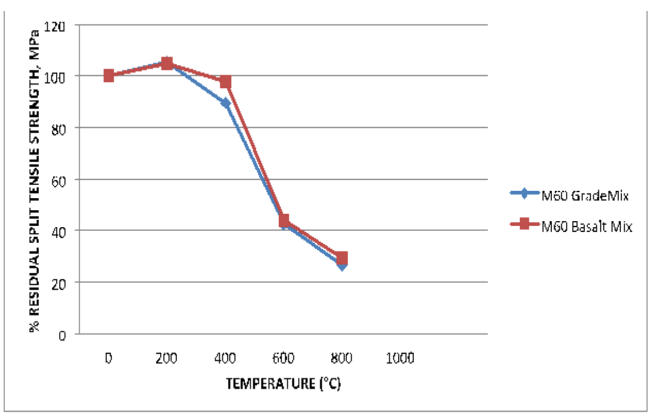
For 7 days result



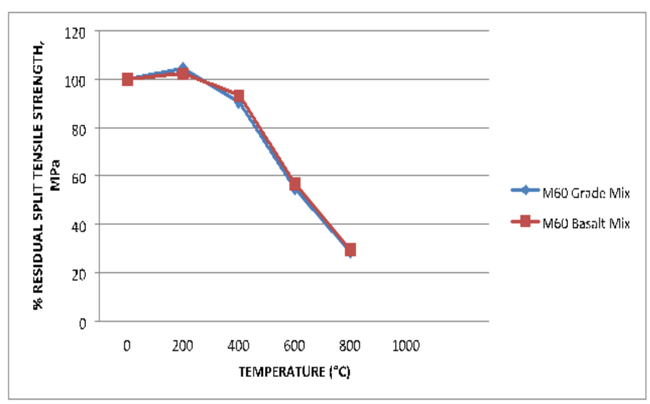
for 28days result

Residual Split Tensile Strength of M60 Concrete Mix With and Without Basalt Mix of 7 & 28 Days.

Temp. (°C)	7 DAYS, MPa				28 DAYS, MPa			
	Without Basalt		With Basalt		Without Basalt		With Basalt	
	With out Basalt Fibers	Percentage Residual Split Tensile Strength	With Basalt Fibers	Percentage Residual Split Tensile Strength	With out Basalt Fibers	Percentage Residual Split Tensile Strength	With Basalt Fibers	Percentage Residual Split Tensile Strength
27	3.80	100	4.10	100	4.20	100	4.40	100
200	4.10	108	4.30	105	4.39	105	4.51	103
400	3.40	91	3.90	96	3.80	91	4.10	94
600	1.60	38	1.79	42	2.31	52	2.52	55
800	0.99	26	1.21	26	1.20	28	1.30	29



For 7 days result



for 28days result

C. weight Loss

It has been represented in percentage in which we clearly observe increasing temperature decrease in weight.

D. Colour Change

No colour change up to 200°C, at 400°C - 600°C its grey and 800°C its yellowish grey.

E. Cracks

Cracks occurs at elevated temperatures i.e., hairline cracks at low and medium temperatures and most cracks at 800℃.

VI. CONCLUSION

A. Basalt fibers when used in concrete, reduces spalling, increases tensile strength, resist crack**.**
B. Compressive strength & split tensile strength for both the concretes of M30 & M60 grade increases up to 200°C due to evaporation of free moisture inside the concrete.
C. Split tensile strength got increased for basalt mix when compared to normal mix for both M30 & M60 concretes whereas compressive strength for basalt mix reduced when compared to normal.
D. Weight loss is more as temperature increases, maximum weight loss observed at 800°C of high strength concrete.
E. Spalling, cracks, colour change and bond failure observed more in M60 than in M30 concretes at high temperatures.

REFERENCES

[1] Mr.Gore Ketan R, 2prof. Suhasini M.Kulkarni**,** the performance of basalt fiber in high strength concrete. journal of information, knowledge and research in civil engineering, Issn: 0975 – 6744| Nov 12 To Oct 13 | Volume 2, Issue 2.
[2] Nihat Morova, Investigation of usability of basalt fibers in hot mix asphalt concrete, Construction and Building Materials 47 (2013) 175–180.
[3] Gorde Pravin Jaysing1, Deepa A. Joshi2**,** Performance of Basalt Fiber in Concrete, Volume 3 Issue 5, May 2014.
[4] Kiang Hwee Tan1 and Yuqian Zhou2, Performance of FRP-Strengthened Beams Subjected to Elevated Temperatures, Composites For Construction © Asce / May/June 2011 / 311.