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AN EXPERIMENTAL STUDY ON EFFECT OF BOTTOM ASH AND SILICA FUME IN CONCRETE

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ABSTRACT

River sand is one of the important constituent in concrete. Due to lack of availability, high cost and its demand in construction sector, it is being replaced with different materials. In thermal power plants when pulverized coal is fed in to a furnace with a temperature of 1300-1500 ^{0}C, the unburnt coal that is left is known as bottom ash. Silica fume which is also known as micro silica or condensed silica fume is by-product in the manufacturing of silicon metal. An experimental study has been done in order to reduce the fine aggregate content in concrete by replacing it with the industrial waste by-product like bottom ash in various percentages ie.(5-40%) along with addition of 5% of Silica fume by weight to cement for M30 & M40 mix to determine the compressive strength, split tensile strength , flexural strength and durability of concrete and are compared for both grades and results are tabulated and the optimum percentages are concluded.

Keywords— Bottom ash,Silica fume ,Compressive Strength ,Split tensile strength,Flexural strength and durability.

I.INTRODUCTION

Concrete is a material composed of Cement, fine aggregate, Coarse aggregate and water. High consumption of the natural sources, high volume of production of industrial wastes and environmental pollution obtaining new solutions for a sustainable development.

The developing country like India facing the shortage of good quality of natural sand and particularly in India, there is a lack of availability, rivers are degrading and creating serious problem to environment and society. The sand mining from riverbeds is causing a serious threat to environment such as erosion of riverbed and banks, degrading landslides, loss of vegetation on the river banks, lowering the underground water table. Hence, the sand mining from riverbeds is being limited or banned by the authorities in India.

The usage of Cement in construction industry and the Cement manufacturing industries are releasing large amount of CO_2 into the atmosphere. This results in increasing the global warming there by increasing the environmental pollution. Cement plants are a significant source of sulphur oxides, the nitrogen oxide and the carbon monoxide. Nitrogen oxide (NO_x) is responsible for various health problems and effects the environment, such as ground-water table, acid rain, global warming, and water quality deterioration. Sulfur dioxide (SO_2) in high concentrations causes breathing problems and cardiovascular diseases. Carbon monoxide (CO) reduces the oxygen percentage in atmosphere. So the need of alternatives for Cement is necessary in the present era.

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II.MATERIALS

Cement used is of Ordinary Portland Cement of 53 grade confirming to IS 12269-1987. Fine aggregate used are of Natural River sand from nearest locality and Bottom ash from VTPS Vijayawada. The maximum size of coarse aggregates of 20 mm is used. The coarse aggregates are of crushed granite aggregates obtained from nearest crusher unit.

A good quality of Silica fume is obtained from bureau veritas,Visakhapatnam and it is grey in colour. Silica Fume is used as mineral admixture to fill the microscopic voids and for better results. Detailed sieve analysis is done for both sand and Bottom ash

And they are confirming to Zone-II.

PROPERTIES OF MATERIALS

are shown below in Table.1

Material	Specific gravity	Fineness modulus
Cement	3.15	285 m^2/kg
Sand	2.60	2.60
Bottom ash	2.15	2.86
Coarse aggregate	2.80	7.01
Silica fume	2.20	20000 m^2/kg

EXPERIMENTAL INVESTIGATIONS

The mix design is prepared according to the guidelines in the code ACI 211.1-91. The W/C ratios for M30 grade are taken as 0.45 and for M40 grade is 0.38. Several trail mixes have been done to finalize the mix ratios for both these grades.

The final mix ratios for both grades are given in the Table.2

Table.2 Mix proportion ratios

Grade	Mix Ratio	W/C ratio
M30	1: 1.794 : 3.29	0.45
M40	1: 1.736 : 3.18	0.38

For calculating the compressive strength, cube specimens are casted of size 150mm x 150mm x 150mm. For split tensile strength cylindrical specimens are of size 300mm height and 150mm diameter are used. Flexural strength is calculated by casting beam specimens are of size 500mm x 100mm x 100mm. These are tested for 7days and 28days curing.

For testing fresh concrete workability is the main property of concrete. Workability of concrete is calculated by Slump Cone method.

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The trail mixes finalized are shown below in Table.3

Table.3 trail mix details

Mix	Cementitious material (%)		Fine aggregate (%)	
	Cement	SF	Sand	Bottom Ash
Control	100%	0%	100%	0%
Trail 1	100%	5%	95%	5%
Trail 2	100%	5%	90%	10%
Trail 3	100%	5%	85%	15%
Trail 4	100%	5%	80%	20%
Trail 5	100%	5%	75%	25%
Trail 6	100%	5%	70%	30%
Trail 7	100%	5%	65%	35%
Trail 8	100%	5%	60%	40%

WORKABILITY OF CONCRETE:

The workability of concrete is observed by the Slump Cone method. The range of slump was selected from the Table A1.5.3.1 of ACI 211.1-91. The slump range was 25-100mm.

The value of slump for both grades are shown below in Table 4

Table 4: slump obtained for M30 and M40

Mix	Slump (mm)	
	M30	M40
Control	35	30
5% B.A	35	30
10% B.A	32	28
15% B.A	30	25
20% B.A	30	25
25% B.A	28	23
30% B.A	25	22
35% B.A	22	15
40% B.A	20	15

III.RESULTS AND DISCUSSIONS

Compressive strength:

The compressive strength results are tabulated below in Table.5

Table.5 compressive strength

Mix	Compressive Strength (N/mm^2)			
	M30 Grade		M40 Grade	
	7 Days	28 Days	7 Days	28 Days
Control Mix(C.M)	25.2	38.35	31	48.35
Trail 1	25.8	38.82	31.32	48.82
Trail 2	26	39	31.84	49
Trail 3	26.25	39.59	32	49.51
Trail 4	26.84	39.8	32.2	49.88
Trail 5	27.1	40.72	32.31	50.24
Trail 6	**27.4**	**41.4**	32.5	50.98
Trail 7	23.1	38.1	**32.8**	**52.34**
Trail 8	22.1	37.6	30.8	48.0

Split tensile strength:

The split tensile strengths are listed below in Table.6

Table.6 Split tensile strength

Mix	Split tensile Strength(N/mm^2)			
	M30 Grade		M40 Grade	
	7 Days	28 Days	7 Days	28 Days
Control Mix(C.M)	2.28	2.84	3.18	3.98
Trail 1	2.29	2.91	3.24	3.99
Trail 2	2.32	2.97	3.38	4.1

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Trail 3	2.38	3.04	3.42	4.25
Trail 4	2.40	3.18	3.51	4.34
Trail 5	2.41	3.24	3.59	4.39
Trail 6	**2.43**	**3.4**	3.74	4.41
Trail 7	2.2	3.1	**3.8**	**4.5**
Trail 8	2.0	2.8	3.0	3.8

Flexural strength:

The modulus of rupture is calculated here and the results are tabulated below in Table.7

Table.7 Flexural strength

Mix	Flexural Strength(N/mm^2)			
	M30 Grade		M40 Grade	
	7 Days	28 Days	7 Days	28 Days
Control Mix(C.M)	3.99	4.98	4.56	5.3
Trail 1	4.1	5.0	4.58	5.32
Trail 2	4.2	5.15	4.61	5.38
Trail 3	4.28	5.2	4.67	5.4
Trail 4	4.3	5.28	4.7	5.54
Trail 5	4.38	5.3	4.74	5.61
Trail 6	**4.43**	**5.45**	4.85	5.7
Trail 7	3.9	4.9	**4.9**	**5.9**
Trail 8	3.7	4.5	4.1	5.0

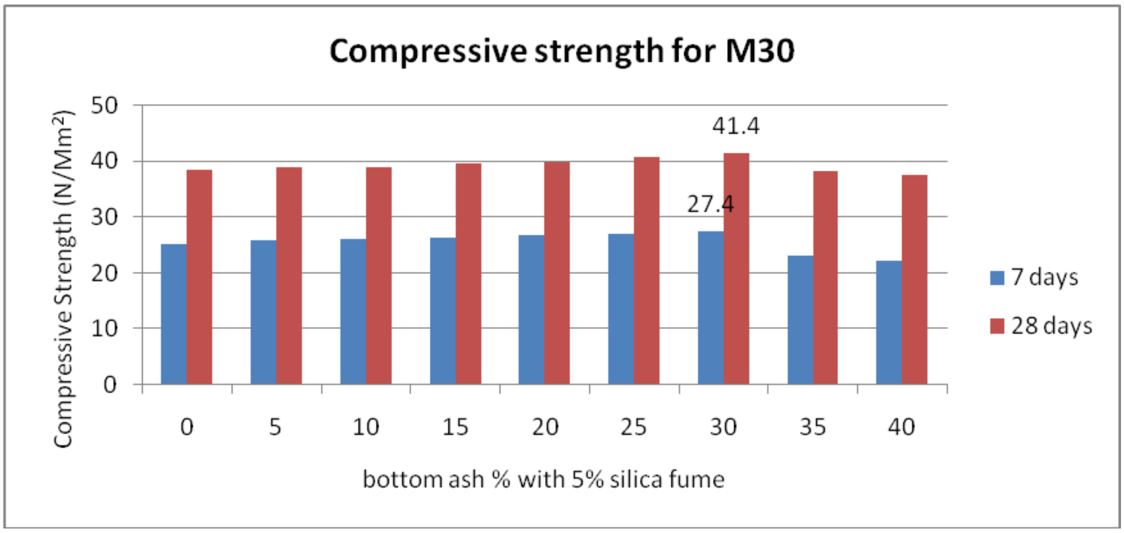

Fig.1: Compressive strengths for M30 at 7 & 28days

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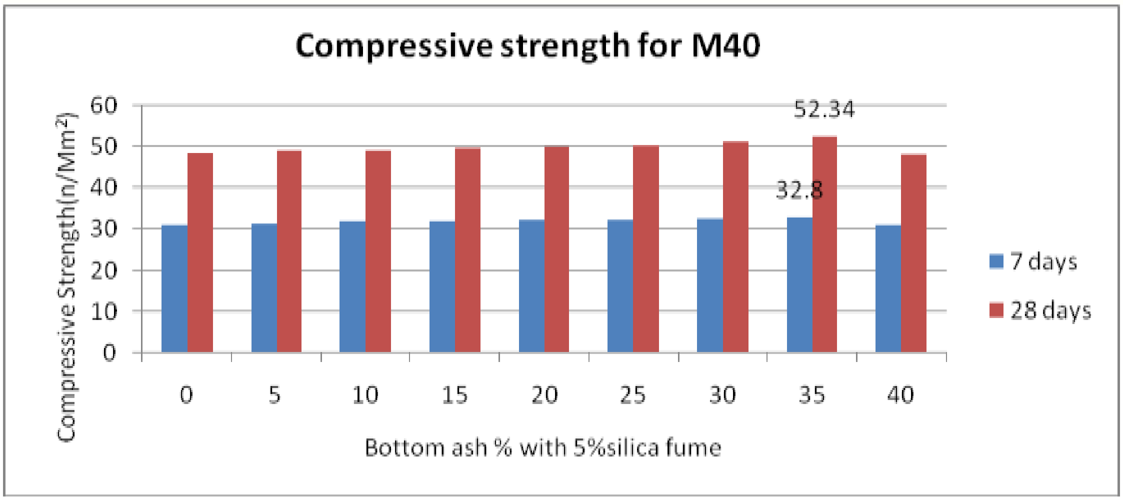

Fig.2: Compressive strengths for M40 at 7 & 28days

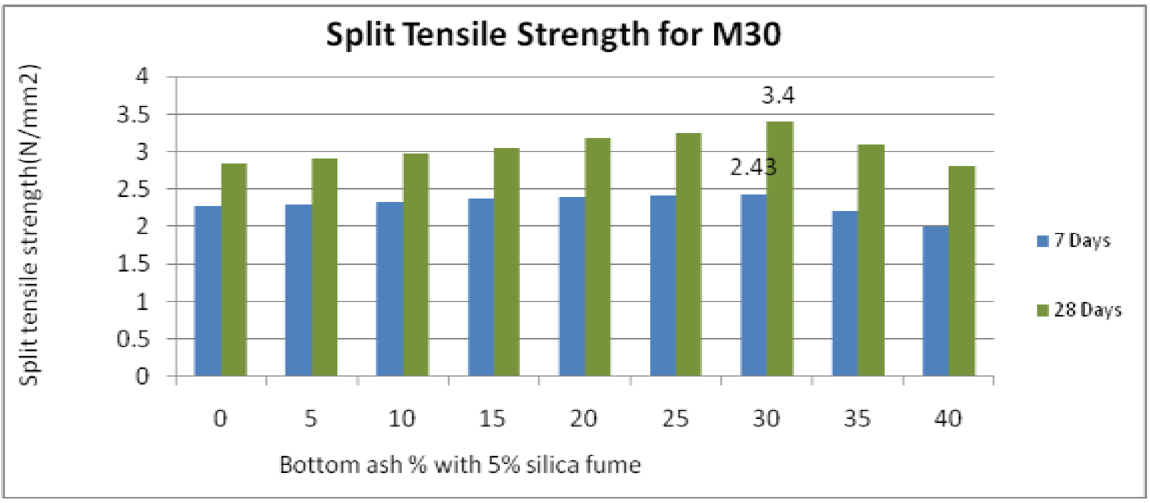

Fig.3: Split tensile strengths for M30 at 7 & 28days

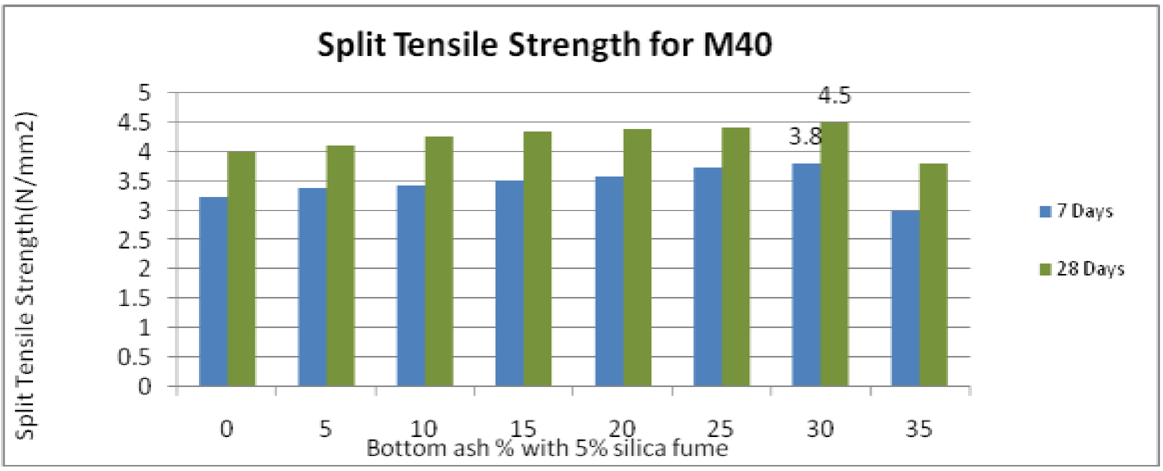

Fig.4: Split tensile strengths for M40 at 7 & 28days

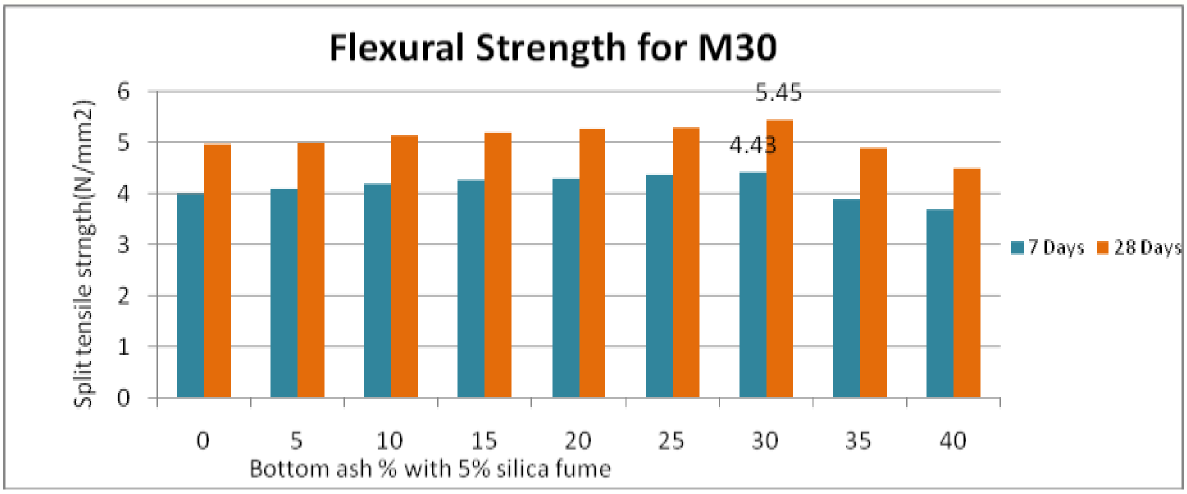

Fig.5: Flexural strengths for M30 at 7 & 28days

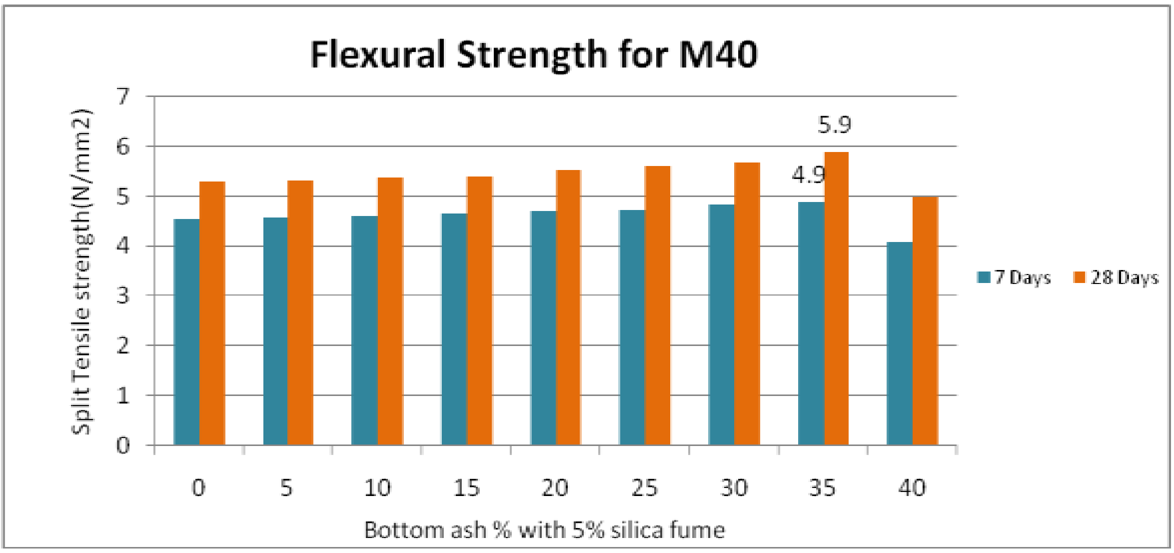

Fig.6: Flexural strengths for M40 at 7 & 28days

IV.CONCLUSIONS

After the analysis of the result of the experimental programme the following conclusions were arrived.

- The workability of concrete is reduced with the increase in bottom ash percentage.
- The Compressive strength, split tensile strength, flexural strength for 7,28 days was increased up to 30% replaCement of bottom ash with fine aggregate along with 5% Silica fume for M30.
- The Compressive strength, split tensile strength, flexural strength are increased by 107 %,119 %,109% than that of conventional concrete for 30% replaCement of bottom ash with fine aggregate along with 5% Silica fume for M30.
- The Compressive strength, split tensile strength, flexural strength for 7,28 days was increased up to 35% replaCement of bottom ash with fine aggregate along with 5% Silica fume for M40.

- The Compressive strength, split tensile strength, flexural strength are increased by 108 %,113 %,111 % than that of conventional concrete for 35% replaCement of bottom ash with fine aggregate along with 5% Silica fume for M40.
- The percentage weight loss is less i.e.1.42 % for HCL and 11 % for H_2SO_4 in 28 days for 30 % replaCement of bottom ash with fine aggregate along with 5% Silica fume for M30
- The percentage weight loss is less i.e.1.38 % for HCL 10 % for H_2SO_4 in 28 days for 35 % replaCement of bottom ash with fine aggregate along with 5% Silica fume for M40
- The Compressive strength is maximum i.e.33.534% with a loss in strength of 19 % for HCL and 24.59 % with a loss in strength of 40.6% for H_2SO_4 for 30% replaCement of bottom ash with fine aggregate along with 5% Silica fume forM30.
- The Compressive strength is maximum i.e.42.9 % with a loss in strength of 18 % for HCL and 31.5 % with a loss in strength of 39.8 % for H_2SO_4 for 35% replaCement of bottom ash with fine aggregate along with 5% Silica fume for M40.

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