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AN EXPERIMENTAL INVESTIGATION TO USE OF BOTTOM ASH AND POND ASH IN S-GLASS FIBER CONCRETE

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ABSTRACT

This study investigates the feasibility of using bottom ash and pond ash as partial replacements for sand in S-Glass fiber concrete. The aim is to explore the potential of these waste materials to enhance the properties of concrete while simultaneously addressing environmental concerns related to their disposal. M30 grade concrete, Various mixtures of bottom ash, pond ash, sand, cement, and S-Glass fibers were prepared and tested for compressive strength, splitting tensile strength, and flexural strength. The results indicate that incorporating bottom ash and pond ash in concrete mixtures led to improvements in mechanical properties. Furthermore, the addition of S-Glass fibers contributed to enhanced durability and crack resistance.

The workability of nominal concrete Mix designation MC -1 is 73 mm and by using of bottom ash and pond ash in S-glass fiber concrete's workability MC-5 is 79 mm. Compressive strength of the nominal concrete Mix designation MC -1 is 24.10 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's compressive strength MC-5 is 26.15 MPa with Increase strength in 8.50% more at 7 days of curing of Cubes. Compressive strength of the nominal concrete Mix designation MC -1 is 31.99 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's compressive strength MC-6 is 36.40 MPa with Increase strength in 13.79 % more at 28 days of curing of Cubes. Splitting Tensile strength of the nominal concrete Mix designation MS -1 is 2.88 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's Splitting Tensile strength MS-6 is 3.33 MPa with Increase strength in 15.71 % more at 7 days of curing of Cylinders. Splitting Tensile strength of the nominal concrete Mix designation MS -1 is 3.21 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's Splitting Tensile strength MS-6 is 3.55 MPa with Increase strength in 10.57 % more at 28 days of curing of Cylinders. Flexural Tensile strength of the nominal concrete Mix designation N-Mix- B-(1-2-3) is 4.86 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's Flexural Tensile strength MB4-B-(13-14-15) is 5.35 MPa with Increase strength in 9.98 % more at 28 days of curing of Beams.

Keywords: Sand, Bottom Ash, Pond Ash , Nominal Concrete ,S-Glass Fiber Concrete, Compressive Strength, Cubes, Splitting Tensile Strength , Cylinders ,Flexural Tensile Strength, Beams.

1. INTRODUCTION

Use of Bottom Ash and Pond Ash in Concrete: In thermal power plants, bottom ash and pond ash are byproducts of burning coal. Because of their pozzolanic qualities, these minerals are frequently employed as additional cementitious ingredients in the formation of concrete. Through appropriate processing and utilization, bottom ash and pond ash can lessen the dependency on conventional cement sources such as Portland cement, hence improving the sustainability of concrete production.

1.1 Ordinary port land cement (OPC)

Ordinary port land cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction. It is of three types, 33 grades, 43 grades, 53 grades. One of the important benefits is the faster rate of development of strength. Portland slag cement is obtained by mixing Portland cement clinker, gypsum and granulated blast furnace slag in suitable proportion and grinding the mixture to get a thorough and intimate mixture between the constituents. This type of cement can be used for all purposes just like OPC. It has lower heat of evolution and is more durable and can be used in mass concrete production.

1.2 Fine Aggregate

Fine aggregate most of which passes through a 4.75 mm. IS sieve and contains only that much coarser material as is permitted by the specifications.

Sand is generally considered to have a lower size limit of about 0.07 mm. Material between 0.06 mm and 0.002 mm is classified as silt, and still smaller particles are called clay. The soft deposit consisting of sand, silt and clay in about equal proportions is termed loam.

1.3 Coarse Aggregates

In this study, coarse aggregates of size 40 mm and 20 mm conforming to specifications as given in IS: 383- 1970 is used. Pycnometer test is carried out to find the specific gravity of aggregates. Sieve analysis has been done to find the fineness modulus of aggregate.

1.4 Pond Ash

Certain materials used in civil engineering replace cement with Silica fume, a binding agent. This article covers the methods Pond ash, a by-product of thermal power plants, exhibits distinct chemical properties that are crucial for its potential applications in construction and environmental management. The characterization of pond ash typically involves analyzing its chemical composition, which includes the presence of various oxides and elements.

1.5 Bottom ash

Bottom ash is a non-combustible residue left over after the combustion process in a power plant, boiler, furnace, or incinerator. It's the coarser part of coal ash, making up about 10% of the waste, and settles at the bottom of the boiler instead of floating into the exhaust stacks. Bottom ash is made up of inert materials like sand, stones, and ash from burnt material, as well as metals that are embedded in the residual waste. It has an angular texture and a color that ranges from gray to black, with grain sizes that can be as fine as sand or as coarse as gravel.

1.6 S -Glass fiber

S-Glass fiber is a type of glass fiber that is known for its high strength and excellent thermal stability. It is primarily used in applications where superior mechanical properties are required, such as in aerospace, military, and high-performance sporting goods. The composition of S-Glass fiber typically includes silica (SiO_2) and other oxides that enhance its performance characteristics.

1.7 Water

Concrete is a composite material made primarily of four key ingredients: cementitious material, fine aggregates, coarse aggregates, and water. Among these components, water plays a crucial role in the formation and strength of concrete. The following sections will detail the importance of water in concrete, the effects of excess water, and considerations regarding water quality.

Cement (OPC) Fine Aggregate Coarse Agg. Pond Ash Bottom ash S -Glass fiber Water

Figure no 1; Ingredients of Mix Concrete

2. THE OBJECTIVES OF THE STUDY ARE

1. To find the workability of concrete for different percentage replacement of FA with pond ash and bottom ash.
2. Replace a portion of the natural fine aggregate and the fine aggregate at varied ratios of 10%, 20%, 30%,40% and 50% with pond ash and bottom ash.
3. The Compressive-strength, and split tensile-strength behavior should be studied by using available equipment's in the laboratory.
4. To determine compressive strength of hardened concrete at 7 & 28 days of curing & compare various mixes in Cube (150mm x150mm x150mm).
5. To determine Split tensile-strength at 7 & 28 days of curing & compare various mixes in Cylindrical (150mm x 300mm).
6. To determine Flexural tensile-strength at 28 days of curing & compare various mixes in Beams (150mm x150mm X 700mm).

3. METHODOLOGY

Their use in S-Glass fiber concrete improves the strength and durability of the material. The goal of the current study is to determine the impact of replacing Pond Ash and Bottom Ash with fine aggregate, respectively, on the performance of in S-Glass fiber concrete grade M30. The ratios of cement, fine aggregate, and coarse aggregate were Mix design with a water/cement ratio of 0.45 and the addition of super plasticizer Conplast 430. The mix design was based on the IS: 10262-2009 method. Pond Ash and Bottom Ash was used partially replace the natural fine aggregate in concrete at various ratios of 10%, 20%, 30%, 40% & 50% An experiment was carried out using M30 grade concrete. Results are taken as a Cylindrical and Cubes are casted to check the Split tensile strength and compressive of concrete at 7 days and 28 days.

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4. OBSERVATIONS & RESULT DISCUSSION

Table 1: Test matrix for Cube in %

Mix	C %	FA%	PA%	BA%	CA%	Water %	S-Glass Fiber %
MC -1	100	100	0	0	100	100	100
MC -2	100	50	0	50	100	100	100
MC -3	100	50	10	40	100	100	100
MC -4	100	50	20	30	100	100	100
MC -5	100	50	30	20	100	100	100
MC -6	100	50	40	10	100	100	100
MC -7	100	50	50	0	100	100	100

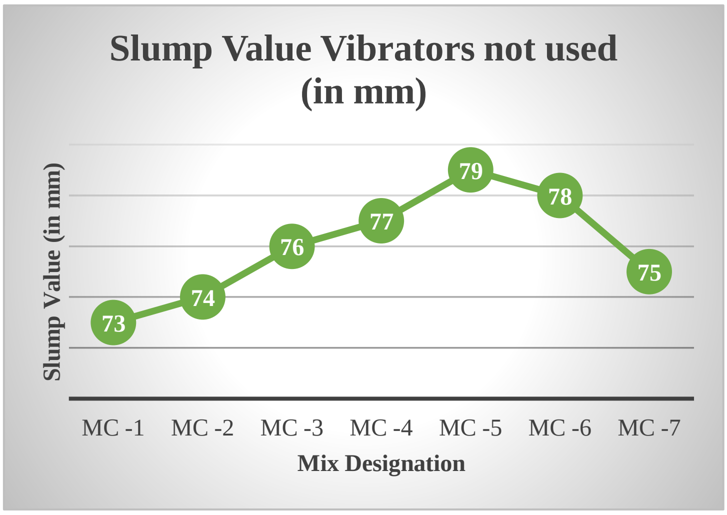
Table 2: Test matrix for Cube in Weight

Mix	C kg/m3	FA kg/m^3	PA kg/m3	BA kg/m^3	CA kg/m^3	W kg/m	S-Glass Fiber
MC -1	414.00	837.02	0.00	0.00	1124 .79	186.00	0.00
MC -2	414.00	418.51	0.00	418.51	1124 .79	186.00	3.00
MC -3	414.00	418.51	83.70	334.81	1124 .79	186.00	3.00
MC -4	414.00	418.51	167.40	251.11	1124 .79	186.00	3.00
MC -5	414.00	418.51	251.11	167.40	1124 .79	186.00	3.00
MC -6	414.00	418.51	334.81	83.70	1124 .79	186.00	3.00
MC -7	414.00	418.51	418.51	0.00	1124 .79	186.00	3.00

4.1 Workability of various concrete mixes design for slump cone test

Table 3: Workability of various concrete mixes design

Mix Designation	Slump Value Vibrators not used (in mm)
MC -1	**73**
MC -2	**74**
MC -3	**76**
MC -4	**77**
MC -5	**79**
MC -6	**78**
MC -7	**75**



Graph 1: Workability of various concrete mixes design for slump cone test

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4.2 Compressive Strength

Table 4 : Compressive strength for M30 at 7 days.

Mix designation	Load (KN)	Compressive Strength (N/mm2)	Strength (N/mm2) Average	% Increase in strength at 7 days
MC-1	541.00	24.04	24.10	0.00
	541.00	24.04		
	545.00	24.22		
MC-2	552.00	24.53	24.64	2.23
	553.00	24.58		
	558.00	24.80		
MC-3	556.00	24.71	24.93	3.46
	561.00	24.93		
	566.00	25.16		
MC-4	575.00	25.56	25.66	6.47
	576.00	25.60		
	581.00	25.82		
MC-5	586.00	26.04	26.15	8.50
	587.00	26.09		
	592.00	26.31		
MC-6	589.00	26.18	26.03	8.01
	585.00	26.00		
	583.00	25.91		
MC-7	570.00	25.33	25.75	6.84
	585.00	26.00		
	583.00	25.91		

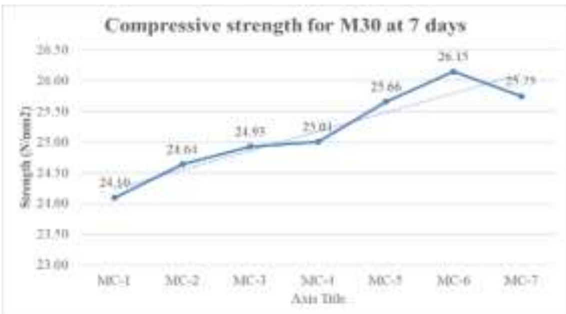
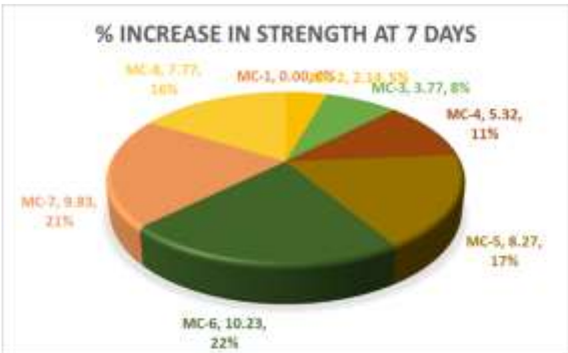


Figure 2 : Compressive strength for M30 at 7 days.



Graph 2 : Pi-Chart of increase Compressive strength for M30 at 7 days.

Table 4 : Compressive strength for M30 at 7 days.

Mix designation	Load (KN)	Compressive Strength (N/mm2)	Strength (N/mm2) Average	% Increase in at 28 days
MC-1	31.82	24.04	24.10	0.00
	32.09	24.04		
	32.04	24.22		
MC-2	32.87	24.53	24.64	2.23
	33.58	24.58		
	33.84	24.80		
MC-3	33.76	24.71	24.93	3.46
	34.42	24.93		
	34.32	25.16		
MC-4	34.92	25.56	25.66	6.47
	35.07	25.60		
	35.33	25.82		
MC-5	35.47	26.04	26.15	8.50
	35.60	26.09		
	35.78	26.31		
MC-6	36.22	26.18	26.03	8.01
	36.44	26.00		
	36.53	25.91		
MC-7	35.02	25.33	25.75	6.84
	34.36	26.00		
	34.44	25.91		

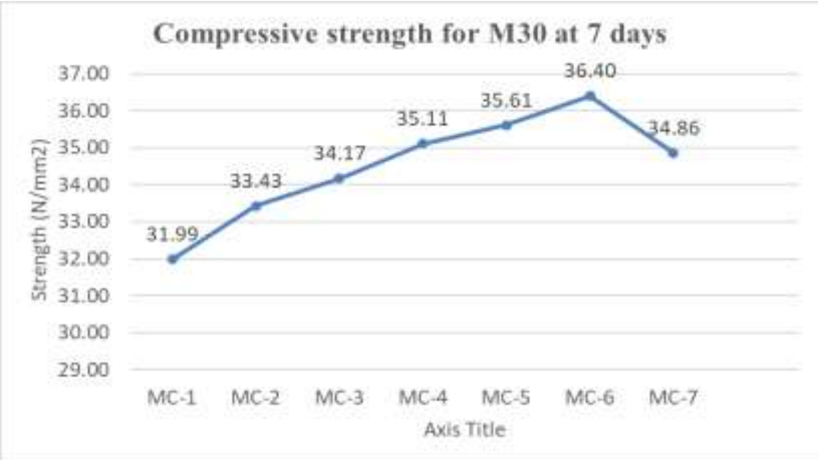
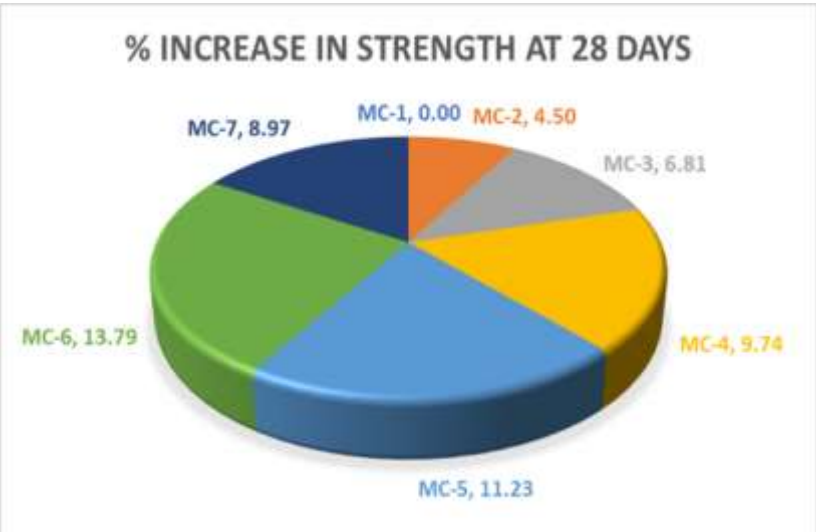


Figure 3 : Compressive strength for M30 at 28 days.



Graph 3 : Pi-Chart of increase Compressive strength for M30 at 28 days.

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4.3 Flexural Strength(fb)N/mm2

Table no. 5; Flexural Strength(fb)N/mm2 at 28 Days

Beam No.	Weight	Length	Distance Between fracture & the nearer support(a)	Load at failure (P)	Flexural Strength (fb)	Average Strength	% Increase in strength at 28 days
	gm	mm	mm	KN	N/mm^2	N/mm^2	%
N-Mix-B-(1-2-3)	41600.00	600.00	213.00	27.15	4.83	4.86	0.00
	41425.00	600.00	212.00	27.35	4.86		
	41600.00	600.00	215.00	27.50	4.89		
MB1-B-(4-5-6)	41550.00	600.00	213.00	27.45	4.88	4.92	1.15
	41600.00	600.00	214.00	27.65	4.92		
	41600.00	600.00	211.00	27.85	4.95		
MB2-B-(7-8-9)	41425.00	600.00	210.00	28.10	5.00	5.04	3.75
	41600.00	600.00	209.00	28.55	5.08		
	41600.00	600.00	211.00	28.45	5.06		
MB3-B-(10-11-12)	41425.00	600.00	211.00	29.05	5.16	5.17	6.45
	41600.00	600.00	209.00	28.90	5.14		
	41550.00	600.00	211.00	29.35	5.22		
MB4-B-(13-14-15)	41600.00	600.00	214.00	30.10	5.35	5.35	9.98
	41425.00	600.00	214.00	29.85	5.31		
	41600.00	600.00	213.00	30.25	5.38		
MB5-B-(16-17-18)	41550.00	600.00	215.00	29.45	5.24	5.18	6.63
	41600.00	600.00	213.00	29.15	5.18		
	41600.00	600.00	214.00	28.85	5.13		
MB6-B-(19-20-21)	41425.00	600.00	211.00	28.55	5.08	5.02	3.34
	41600.00	600.00	210.00	28.25	5.02		
	41600.00	600.00	209.00	27.95	4.97		
MB7-B-(22-23-24)	41425.00	600.00	214.00	28.10	5.00	5.02	3.22
	41550.00	600.00	214.00	28.30	5.03		
	41600.00	600.00	213.00	28.25	5.02		

5. CONCLUSION

1. The primary objective of the work is to analyze the use of bottom ash and pond ash in S-glass fiber concrete. M30 grade concrete that contains bottom ash and pond ash along with fine particles was compared to conventional concrete.
2. The workability of nominal concrete Mix designation MC -1 is 73 mm and by using of bottom ash and pond ash in S-glass fiber concrete’s workability MC-5 is 79 mm.
3. Compressive strength of the nominal concrete Mix designation MC -1 is 24.10 MPa and by using of bottom ash and pond ash in S-glass fiber concrete’s compressive strength MC-5 is 26.15 MPa with Increase strength in 8.50% more at 7 days of curing of Cubes .
4. Compressive strength of the nominal concrete Mix designation MC -1 is 31.99 MPa and by using of bottom ash and pond ash in S-glass fiber concrete’s compressive strength MC-6 is 36.40 MPa with Increase strength in 13.79 % more at 28 days of curing of Cubes .

5. Flexural Tensile strength of the nominal concrete Mix designation N-Mix- B-(1-2-3) is 4.86 MPa and by using of bottom ash and pond ash in S-glass fiber concrete's Flexural Tensile strength MB4-B-(13-14-15) is 5.35 MPa with Increase strength in 9.98 % more at 28 days of curing of Beams.

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