Study on Flexural Strength Characteristics of Fiber Glass Reinforced Concrete

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ABSTRACT

The present research work is carried to study flexural behaviour of concrete reinforced with glass fiber. Due to urbanization demand for construction materials are increased drastically in last few decades, now a days, the demand of river sand is very high so it's better to use the industrial by-product of Bottom Ash which is easily available and eco-friendly. In this present study Bottom ash (BA) as taken as replacement of natural sand for different variations of 0 %,10%,20%,30% and 40% BA with the addition of 0.2 % glass fibres as an extra ingredient to improve the strength properties.The laboratory experiment is carried out on concrete with respect to the M25 Grade of concrete .The laboratory programme includes the strength properties such as Compressive strength ,Split tensile strength, and flexural behaviour of reinforced slab was determined by two point loading using loading frame. The flexural behaviour in terms of deflection, cracking load, crack width is determined Finally the results shows that 30% replacement of bottom ash to the natural sand achieves optimum strength.

INTRODUCTION:

Concrete is important popular building material in the universe. For the present construction world is a challenge in the civil industry concrete with high strength aspects made with sustainable resources .concrete is a composite material is a mixture of cement, fine aggregate, course aggregate, water so that fills the space among the aggregate particles and glue them together . finally the mixture is placed in the forms and allowed to cure it becomes harden in the form of rock known as concrete .concrete is widely used to making for constructions work ,architectural structures, foundations, brick and pavements.

Bottom ash:

We can say that energy is the main support of modern civilization of the world over and the electric power from the thermal power stations is the important source of energy. In India about 70% of electricity generated is by burning of fossil fuels, out of which approximately 61% is continued by coal-fired plants. For about 380 million tonnes annual ash production which is more than the rest of all industrial wastes in India and china.

Coal bottom ash is a course granular and incombustible by product from coal burning furnaces .it is mainly composed of alumina ,silica and iron with small amount of magnesium, calcium sulphate etc. the particle size and appearance of bottom ash is same as the natural river sand. It will make more attractive by comparing these properties of bottom ash used as fine aggregate in concrete.

OBJECTIVES OF EXISTING RESEARCH:

The study targeted to use industrial waste to reduce the consumption of natural sand to ensure the strength of the concrete. The aim of the project research work is Bottom ash is introduced as replacement to natural sand at percentage variation of 0%, 10%, 20%, 30%, and 40 % and glass fiber is produced as wastes in the glass manufacturing industries are used at a constant 0.2% by volume of concrete as an extra ingredient to increase the strength properties of concrete slab panel have been casted for M25 grade of concrete.

To determine the basic strength characteristics of split tensile strength and compressive strength.

- To determine the flexural behaviour of slabs by two point loading
- To determine the deflection using LVDT (Longitudinal deflection) and DEMEC GAUGE (Lateral deflection)

RESEARCH METHODOLOGY:

Basic Test on Materials:

Cement: In the present experimental work is carried out by using **BIRLA SUPER OPC 53 grade** is utilized confirming to IS:12269 – 1987.

Table No 3.1:Physical properties of cement of 53 grade

Sl No	Properties	Results
1	Specific-gravity	3.15
2	Initial-setting time	35 mint
3	Final-setting time	480 minutes
4	Normal consistency	30%
5	Fineness Modulus	3%

Fine aggregate:

River sand was collected from naturally availability local area kodigenahally Bangalore.

Table No 3.2:Physical properties of river sand

Sl No	Properties	Results
1	Specific-gravity	2.58
2	Fineness modulus	3.25
3	Bulk density (loose)	1459 kg/m^3
4	Bulk density (compacted)	1639 kg/m^3
5	Water absorption	0.2%

Coarse aggregate

Course aggregate was obtained in the form of crushed stone with a maximum nominal size 12.5mm and down collected and brought from meeteganahaali plant near Bangalore

Table No 3.3 :Physical Properties of Course aggregate

Sl No	Properties	Results
1	Specific-gravity	2.7
2	Fineness modulus	6.42%
3	Bulk density (loose)	1473 kg/m^3
4	Bulk density (compacted)	1598 kg/m^3
5	Water absorption	0.2%

Bottom ash:

In the present experiment investigation bottom ash is brought from Raichur Thermal Power Station (RTPS)

Table No 3.4:Physical properties of Bottom ash

Sl No	Properties	Results
1	Specific-gravity	2.6
2	Fineness modulus	2.85
3	Bulk density (loose)	1183 kg/m^3
4	Bulk density (compacted)	1296 kg/m^3
5	Water absorption	17%

Glass Fiber:
Glass fiber is a type of raw material which is more particularly as fine fibers of glass .the glass are made possible with the new device of quality machine tools and also glass fiber is a hard fiber.

Table No 3.5 : Properties of Glass fiber

Sl No	Trade name	Cem-FIL anti-crack high dispersion glass fibers
1	Color	White or colorless
2	Aspect ratio for 12mm	857.14
3	Tensile strength	1700Mpa
4	Modulus of elasticity	73Gpa
5	Corrosion resistance	Excellent
6	Specific-gravity	2.6
7	Density	26kN/m3
8	Diameter	14 microns
9	Length	12mm

Superplasticizer:
In this project investigation super plasticizer utilized as “MASTER GLENIUM SKY 8233” .It is fabricated by BASF development substance India Pvt.Ltd .Glenium B233 is free of chloride and low alkali .it is comfortable for a wide range of bonds

Table 3.6 :Physical properties of Glenium 8233

Sl No	Type	Poly carboxylic based ethers
1	Color	Dark brown
2	Form	Viscous liquid
3	pH	6.61-30
4	Relative density	1.1 at 20

Reinforcement:
In the present investigation Fe500 steel bars of diameter 10mm (longer and shorter span) were used as reinforcement. And mix design for reinforcement as formulated in appendix.

Table No 3.7 :Reinforcement details

Span	Type of Reinforcement	Diameter of bars	Spacing provided at c/c	Effective cover
Shorter span	Fe 500	10 mm	180 mm	10 mm
Longer Span	Fe 500	10 mm	225 mm	10 mm

Fig 1 :Reinforcement

RESULTS AND DISCUSSION:

Compressive Strength:

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material and the ability of the material to recover after a specified compressive force is applied and even held over a defined period of time. Compression tests are used to determine the material behaviour under a load. Compressive strength of each concrete cube casted for 7 days and 28 days curing are given in the table 5.

Table No 4: Mix Proportion for Bottom Ash 0%,10%, 20%, 30% and 40% Replacement

% of Replacement	Cement in Kg	FA in Kg	CA in Kg	Bottam Ash in Kg	Glass fiber in gram	Water In ml	Super Plasticizer in ml
CC	1.3	2.8	4.35	0	18.5	650	5.19
0% BA	1.3	2.8	4.35	0	18.5	650	5.19
10% BA	1.3	2.51	4.35	0.280	18.5	650	5.19
20% BA	1.3	2.23	4.35	0.565	18.5	650	5.19
30% BA	1.3	1.95	4.35	0.850	18.5	650	5.19
40% BA	1.3	1.68	4.35	1.125	18.5	650	5.19

Table No 5 : Compression strength test result values of M25 Grade of concrete

Sl No	% of replacement of Bottom ash	7days compressive strength (N/mm^2)	28 days compressive strength (N/mm^2)	56 days compressive strength (N/mm^2)
1	CC	28.34	30.41	31.98
2	0% BA	24.56	31.25	32.77
3	10% BA	27.76	32.54	35.26
4	20% BA	29.13	33.64	36.78
5	30% BA	32.34	34.98	38.24
6	40% BA	27.54	31.37	33.52

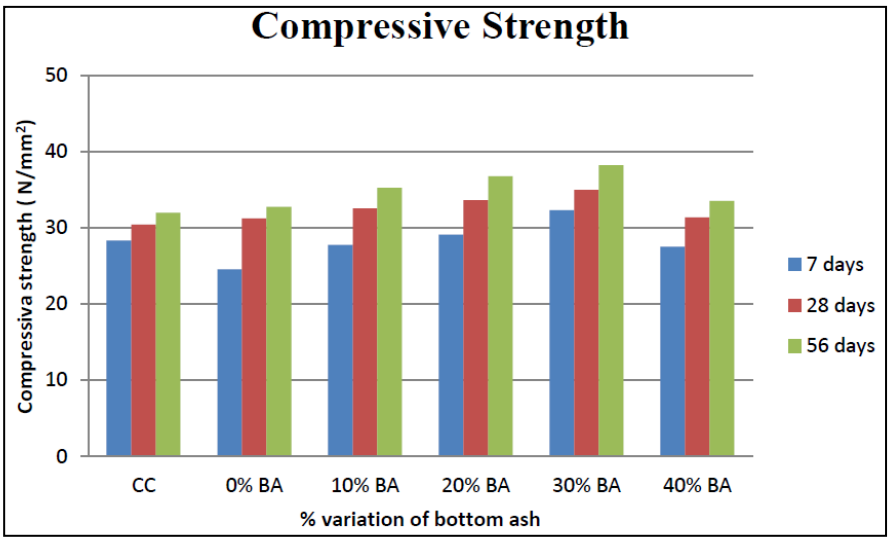

Fig 2: Graph showing compressive strength test results of M25 grade of concrete

The results shows that the strength of the concrete is increased when compared to the conventional concrete. The test results are given in the table illustrated with figures. In this experimental investigation the compressive strength at 7 days, 28days,56 days is increased at 30% partial replacement of bottom ash by natural sand and with 0.2 % glass fiber is added as extra ingredient for strength characteristics. Finally the strength increased at 30% replacement of bottom ash hence it is found to be the optimum percentage.

Split Tensile Strength:

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Table No 6 : Split Tensile Strength test result values of M25 Grade of concrete

Sl No	% Replacement of Bottam Ash	7 days Split Tensile Strength (N/mm2)	28 Days Split Tensile Strength (N/mm2)	56 Days Split Tensile Strength (N/mm2)
1	CC	2.51	3.4	4.27
2	0% BA	2.56	3.48	4.31
3	10% BA	2.64	3.51	4.35
4	20% BA	2.79	3.59	4.41
5	30% BA	2.94	3.64	4.56
6	40 % BA	2.33	3.32	4.33

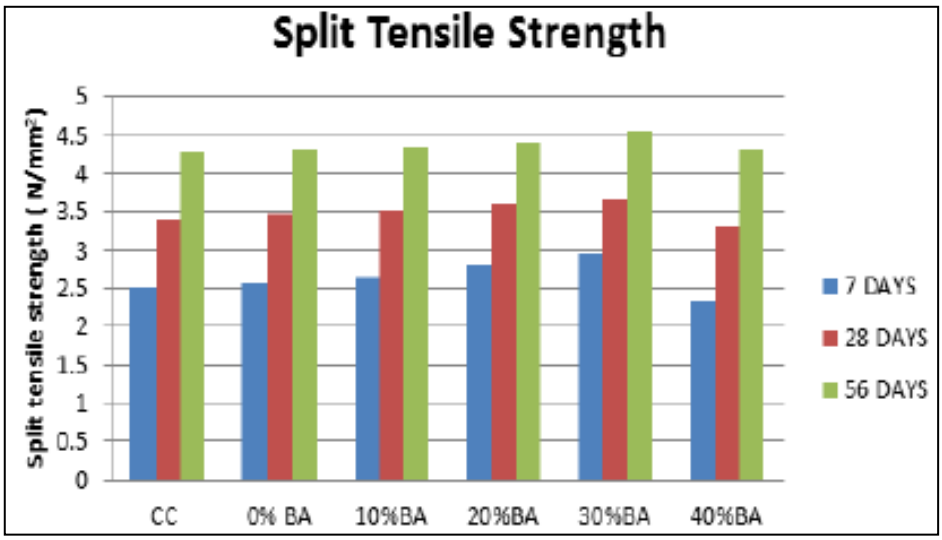

Fig 3: Graph showing Split tensile strength test results of M25 grade of concrete

In this experimental investigation the split tensile strength at 7 days, 28 days,and 56 days is increased at 30% partial replacement of bottom ash by natural sand and with 0.2 % glass fiber is added as extra ingredient for strength characteristics. Finally the strength increased at 30% replacement of bottom ash hence it is found to be the optimum percentage.

Test Results of Bottom ash Reinforced concrete Slab:

Table No 7: Test Results for Slab Panels

Slab No.	% of Replacement	Frist crack load (kN)	Ultimate failure load (kN)	Lateral Deflection (mm)		First crack width (mm)	Final crack width (mm)
				At initial crack	At final crack		
1	CC	60	90	0.002	0.019	0.15	1.20
2	0% BA	50	80	0.014	0.016	0.15	1.90
3	10% BA	60	90	0.002	0.004	0.10	1.90
4	20% BA	70	90	0.001	0.006	0.15	1.70
5	30% BA	80	100	0.002	0.032	0.10	1.80
6	40% BA	70	80	0.006	0.016	0.10	1.60

CONCLUSION:

- At 7 days, 28 days, 56 days glass fiber reinforced concrete shows good compressive strength and the optimum strength is achieved for 30% replacement of bottom ash for natural sand which is more than conventional concrete.
- Split tensile strength achieved good results for glass fiber reinforced concrete and was optimum at 30% replacement of bottom ash.
- The first crack load is obtained at 80kN for 30% replacement of bottom ash and the ultimate load reach up to 100kN. The flexural behaviour in terms of deflection is very low at centre when compare to the conventional concrete. So we concluded that 30% replacement of Bottom ash to natural sand achieves good strength and considered as optimum.
- By increasing the thickness of slab considerably increases the ductility and proficiency to fascinate energy of the panels.
- This study mentions it's successfully use of roofs, terraces, repair and renovation works.

- Finally concluded that the bottom ash is an industrial waste that can be used up to 30% replacement of bottom ash for natural sand. Now a days natural sand is heavy costly so that we can go for bottom ash which are available in freely and eco-friendly.

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