EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF CONCRETE INCORPORATED WITH FLYASH AND BOTTOMASH

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***Abstract*—**In developing countries like India the requirement of concrete is increasing day to day due to the faster construction activities.But at the same time these construction activities had continously exploiting the natural resources for the requirement of raw materials.So here the experimental work had been done to evaluate the application of flyash as the partial replacement for cement and bottom ash as the partial replacement of fine aggregate.The incorporation of flyash and bottom ash will considerably enhance the engineering properties of concrete. This work discuss about the concrete incorporated with flyash in various percentage like 5%, 10%, 15%, 20%, 25%, 30%, 35% and the bottom ash have been replaced with 5%, 10%, 15%, 20%, 25%, 30%, 35% . The end results shows that the concrete added with 15% of flyash and 15% of bottomash have shown better results.

KEYWORDS

Concrete, Flyash,Bottomash ,Compressive strength , Tensile strength

INTRODUCTION

In India the electricity are produced through various sources and one of the major source of producing electricity is through thermal power plant.These themal power plant will produce tons and tons of ash among these only 60% to 70% of ash are used.The remaining ash are either dumped or disposed in water bodies.These activities causes huge impact on environment.Disposal of ash in water bodies leads to water pollution which will directly affect the living beings in that waer.On the other hand due to the rapid development of construction industry the requirement of aggregates for the construction activities have been increasing day by day which is the major threat to environment .

Based on various research work the materials such as flyash,bottomash and various other materials from thermal power plant were added to improve the characteristics of concrete.In many cases the replacement materials which we are adding are more or less similar to the conventional materials hence this paves the way for the sustainable development.

Flyash will found its use due to its natural pozzolonic property and it is more familiar.Addition flyash in concrete will considerably increase the workability of concrete.Hence the inclusion of flyash will considerably increase the durability and strength of concrete.Hence flyash will used as a partial replacement of cement.

Bottom ash are fine , solid mineral and porous in nature.Here bottom ash are used as the partial replacement of fine aggregate.The inclusion of bottom ash in concrete will reduce its environmental impact .

MATERIALS

Cement

Ordinary Portland Cement (53 grade) cement with respect to the code IS 8112 was used.Various tests were done to determine the standard consistency, initial and final setting time which is according to IS 4031 and IS 269.The outcomes were limited to the IS code recommendations.Refer table 1.

Table-1.Properties of cement

S. No.	Test conducted	Result
1	Standard consistency	32%
2	Initial setting time	36minutes
3	Final setting time	300 minutes
4	Specific gravity	3.1

Water

The faucet water accessible in the area was utilized and fundamental tests are done to decide its properties such as pH, chloride content, total hardness, and total dissolved solids were evaluated.Refer table 2

Table-2. Properties of water

S.No.	Description	Obtained value	Permissible value as per IS456
1.	pH value	8.2	Not less than 6.0
2.	Chloride content	112.5 mg/l	500 mg/l*
3.	Total hardness	105 mg/l	200 mg/l
4.	Total dissolved solids	150 mg/l	-

Fine aggregate

Fine aggregate used in this experiment are locally collected and confined to zone II. All the tests had been carried out as per specification IS: 383.Refer table 3.

Table-3. Physical Properties of fine aggregate

S.No	Test conducted	Result
1	Bulk density	1.709 gm/cc
2	Specific gravity	2.58
3	Void ratio	0.468
4	Fineness modulus	2.25

Flyash

Flyash used in this experiment belongs to the class F.Because the class F flyash has mainly silica and alumina and it has lower calcium content. All the tests had been carried out as per specification IS: 383.Refer table 4.

Table-4. Chemical composition of flyash class F

S.No	Proporties	Result
1	Specific gravity	2.21
2	Silica (SiO_2%)	59
3	Alumina (Al_2O_3%)	34
4	Iron Oxide (Fe2O3%)	5
5	Calcium oxide (CaO%)	3
6	Magnesium Oxide(MgO%)	0.78
7	SO_3	1.2

Coarse aggregate

To determines the flow characteristics size and shape of the aggregate are very important. To produce concrete at desired quality, the properties of aggregate such as moisture content, water absorption and grading of all aggregates should be supervised continuously. Coarse aggregate incorporated in this experiment is of the size 20 mm.Refer table 5.

Table-5. Physical Properties of Coarse aggregate

S.No	Test conducted	Result
1	Bulk density	1.679 gm/cc
2	Specific gravity	2.85
3	Void ratio	0.75
4	Fineness modulus	2.72

Bottomash

Bottom ash used in this experiment are collected from thermal power plant.They are fine solid mineral.All the basic tests have been done .Refer table 6.

Table-6. Physical Properties of Bottomash

S.No	Test conducted	Result
1	Specific gravity	2.31
2	Fineness modulus	3.5
3	Water absorption	14%

Mix Design

The corresponding mix design(Grade M30) for the concrete had been done and the amount of bottom ash and flyash which are to be added are calculated.Then the fresh concrete has been prepared and the necessary test had been carried out. Refer table 7

Table-7.Composition of Conventional Concrete

Contents	Weight per m^3 of concrete (kg)
Cement	439
Fine Aggregate(Total)	675.8
Coarse Aggregate	1068
Water	197.5 liter

EXPERIMENTAL INVESTIGATION

The test which include slumpcone , Vee Bee Consistometer,Compaction factor test are the preliminary test which are necessary to determine the workability of concrete.Compressive and split tensile strength are necessary to determine the strength of concrete.Flyash and bottom ash both are replaced uniformly as 5%, 10%, 15%, 20%, 25%, 30%, 35% to the cement and fine aggregate.

Slumpcone test

Slumpcone test are performed with different percentages of flyash and bottomash.It is necessary to determine the workability of concrete.First Slump cone is placed on a water tight levelled surface and the concrete is filled in it in three layers.After filling the concrete the top surface is levelled with help of trowel.Then the mould was lifted vertically and allowing the concrete to subside and its height was measured.

Table-8.Slump cone value of Concrete

S.NO	Mix	Initial height (mm)	Final height (mm)	Slump value (mm)
1	Conventional	300	280	20
2	5%	300	260	40
3	10%	300	250	50
4	15%	300	200	100
5	20%	300	160	140
6	25%	300	130	170
7	30%	300	120	180
8	35%	300	80	220

Compaction factor test

Compaction factor test are performed with different percentage of flyash and bottomash. First the concrete is poured in upper hopper and the trap door is opened and allowed to fall in the lower hopper.Now the trap door of lower hopper is opened and

then it is allowed to fall in cylinder.Excess concrete above the surface are levelled .Then it is weighed to nearest 10 gram and it is known as weight of partially compacted concrete(W1).Then the cylinder is emptied and then cylinder is refilled with concrete in layers and each layer had been ramed fully to obtain perfect compaction.Now the cylinder is weighed and it is known as weight of fully compacted concrete(W2) .Now the compaction factor is determined by the relation.

Table-8.Compaction factor value of Concrete

S.NO	Mix	Wt.of Partially Compacted Concrete (W1 g)	Wt.of Fully Compacted Concrete (W2 g)	Compaction factor
1	Conventional	20475	21780	0.88
2	5%	19550	21770	0.81
3	10%	19095	22125	0.86
4	15%	20565	21865	0.94
5	20%	20365	21965	0.92
6	25%	19685	21765	0.90
7	30%	19225	21655	0.88
8	35%	18895	21955	0.84

Vee-Bee Consistometer test

Vee-Bee Consistometer test are performed with different percentage of flyash and bottomash.First slump cone is placed on the sheet metal cone of the consistometer.Next the disc attached on the arm is moved and placed on the top of the cone.Then the cone is lifted up the slump noted on the graduated rod by lowering the disc .Then the electrical vibrator is switched on and the concrete is allowed to subside.The vibration is continued till the concrete reaches the cylindrical shape and the time for the concrete to attain levelled surface is noted and it is known as vee-bee seconds.

Table-9.Vee-Bee Consistometer value of Concrete

S.NO	Mix	Slump value (mm)	Vee – Bee time (sec)
1	Conventional	20	10
2	5%	40	8
3	10%	50	7
4	15%	100	6
5	20%	140	5
6	25%	170	4
7	30%	180	5
8	35%	10	10

Compressive strength

Compressive strength are tested with cube of size 150mmx150mmx150mm. compressive strength test had been conducted at the both 7 and 28 days. Refer table 8 and fig 3

Table-10. Compressive strength of concrete

S.NO	Mix	7 Days (N/mm^2)	28 Days (N/mm^2)
1	Conventional	23	30.5
2	5%	24	24.33
3	10%	22.20	30.88
4	15%	23.62	31.63
5	20%	22.17	30.36
6	25%	21.52	30.06
7	30%	21.64	22.08
8	35%	21.17	22.42

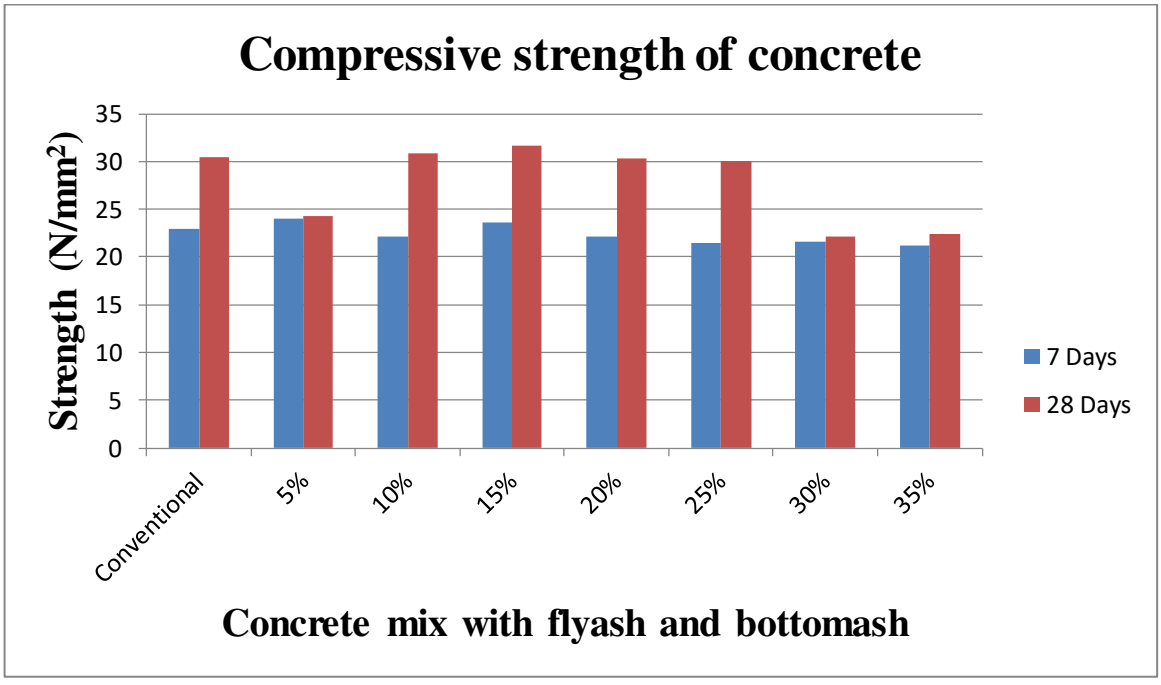

Fig1-Graph representing Compressive Strength

Split tensile strength test

The split tensile strength test is performed with the cylindrical specimens which are of size 150 X 300 mm.The required results have been taken at both 7 and 28 days. Refer Table 10 and fig 5.

Table -11. Split tensile strength of concrete

S.NO	Mix	7 Days (Mpa)	28 Days (Mpa)
1	Conventional	2.06	3.28
2	5%	2.45	3.78
3	10%	2.9	4.83
4	15%	3.58	5.31
5	20%	3.31	5.18
6	25%	2.91	4.82
7	30%	2.88	4.59
8	35%	2.62	4.45

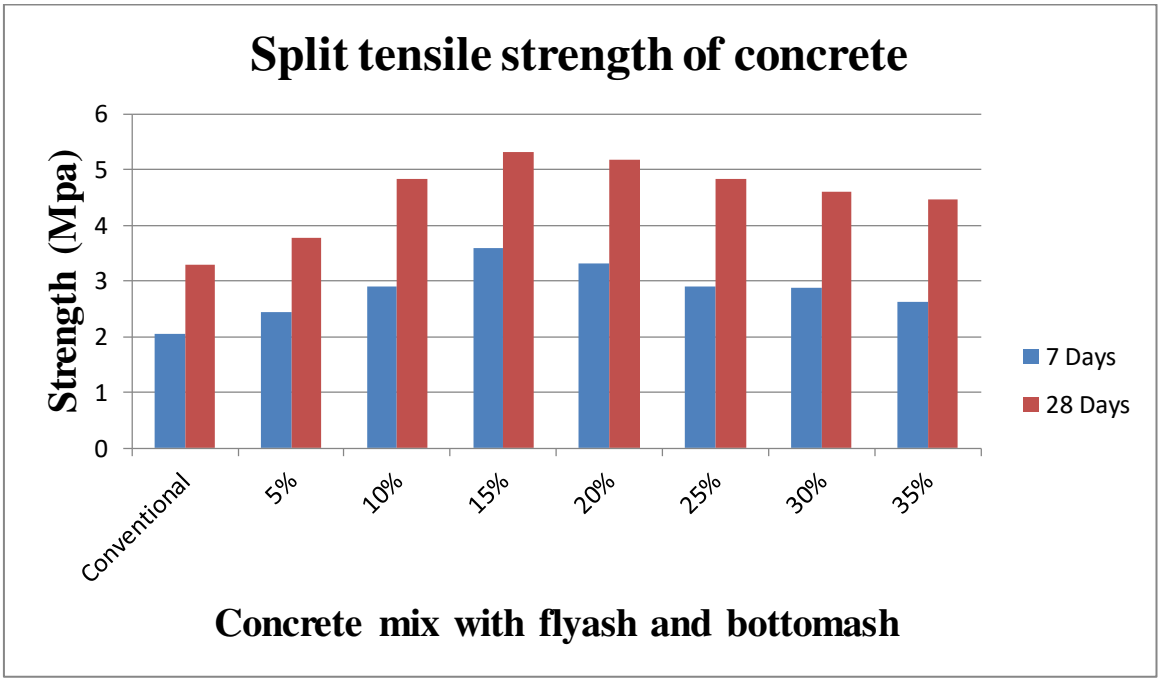

Figure-2. Graph representing Split tensile Strength

CONCLUSION

This research gives the information that the flyash and bottom ash can be used as a partial replacement for cement and fine aggreagate .But the incorpration of bottomash should be in optimum percentage because the excess of bottomash will alter the workability of concrete. Hence the necessary care should be taken towards the bottomash percentage. Regarding the strength of the concrete when fly ash is replaced in cement by 5%, 10%, 15%, 20%, 25%, 30%, 35% and when the bottom ash is replaced in fine aggregate by 5%, 10%, 15%, 20%, 25%, 30%, 35% it is evident that the concrete with 15% of fly ash and 15% of bottom ash had shown better results.Since bottom ash causes harmful to the environment when it is dumped or disposed in river we can use these kind of ash as an alternate to the fine aggregate.Similar kind of alternate approach will play a role towards sustainable development and eco-friendly technologies.

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