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An Experimental Study On Enhancing The Mechanical Properties Of Fly Ash Blended Concrete Beam By Using Artificial Fibers

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Abstract—The quantity of flyash produced from thermal power plants in India is approximately80 million tons each year, and its percentage utilization is less than10%. During the last few years, some cement companies have start educing fly ash in manufacturing cement, known as 'Pozzolana Portland Cement', but the overall percentage utilization remains very low and most of the flyash is dumped at landfills. An attempt has been made to utilize these cheaper materials in concrete production. Since flyash possesses cementitious properties, it is used to replace cement partially. Artificial fibres will be added by weight of the flyash blended cement in various proportions to enhance its mechanical strengths, microstructural properties. This thesis aims at investigating the characteristics of fresh concrete and various strengths of hardened concrete made with flyash blended cement, along with artificial fibers in various proportions. M25 grade concrete is considered for experimental studies with 53 grade Ordinary Portland Cement blended with varying percentages of flyash. The maximum size of coarse aggregateusedis20mmsize.Artificialfibers such as glass fibers and polypropylene fibres will be added in various percentages from0.5%to3%. The optimum percentage of flyash replacement in cement and various mechanical test will be carried out after the addition of artificial fibers in the fly ash blended cement concrete mix. Eventually the most effective fiber and its optimal dosages will be arrived.

Keywords— flyash; polypropylene fibres; Artificial Fibers; glass fibers; Blended Concrete;

I. INTRODUCTION

Concrete is an artificial material which has wider range of applications in the construction industry. The basic ingredients of concrete are cement, sand, coarse aggregate and water. Since the cost of cement have increased due to increased cost of production or increased demand, there is an urgent need to replace them partially or wholly by cheaper materials.Concrete is very strong in compression, but its tensile strength is only about 10% of its compressive strength. Also, concrete is brittle in nature. In plain concrete, structural cracks develop even before loading, particularly due to drying shrinkage or other causes of volume change. The width of these initial cracks seldom a few microns, but their other two dimensions may be of higher magnitude. Also this becomes a major cause for the reduction in the compressive strength of the concrete.

Mineral admixtures are finely divided siliceous materials which are added to mixtures in relatively large quantities.They are classified as follows

a. Reactive minerals which are either pozzolanic or cementitious or both. The example of a pozzolanic admixture is low-calcium fly ash. The example of a cementitious admixture is ground granulated blast-furnace slag. High calcium fly ash is both pozzolanic and cementitious.
b. Inert mineral fillers which have no pozzolanic or cementitious properties

Fly ash is an industrial byproduct that has refocused and rekindled the interests of scientists and engineers on the material and structural implications of incorporating it as an essential cementitious component of concrete. It is now universally recognized that the needs of environment protection and sustainability of concrete construction demand that fly ash is not used in landfills or dumped as a waste material but instead utilize the availability of these pozzolanic and cementitious admixtures to enhance the quality of concrete construction Since fly ash possesses pozzolanic property, it can be used for partial replacement of cement in concrete.

Reaction mechanism for fly ash can be basically explained as pozzolanic reaction mechanism. Pozzolans are materials, which, though not cementitious in themselves, contain certain constituents, which at ordinary temperatures in the presence of water, will combine with lime to form stable insoluble compounds with cementitious properties.

II. MINERAL ADMIXTURES

2.1 Fiber Reinforced Concrete

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity.

Effects of fiber in concrete Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce the bleeding of water. Some types of fibers produce greater impact, abrasion and impact resistance in concrete.

Polypropylene fibers are environmental friendly and non hazardous. They can easily disperse and separate in the matrix. Polypropylene fiber prevents shrinkage cracks developed during curing making the structure or the component inherently stronger. Further, when the load imposed on concrete approaches to failure, cracks will propagate rapidly.

Fig.1: Polypropylene fiber

Polypropylene fibers can

- Improve mix cohesion, improving pumpability over long distances Improve freeze-thaw resistance
- Improve resistance to explosive spalling in case of a severe fire Improve impact resistance
- Increase resistance to plastic shrinkage during curing

Glass fiber

Fiber glass, is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Fiberglass is a lightweight, extremely strong, and robust material. The material is typically far less brittle, and the raw materials are much less expensive.

Fig.2 : Glass fiber

2.2 Constituent Materials

- For this research work Ordinary Portland Cement (OPC) 53 grade conforming to IS

8112 – 1989 was used. American Society for Testing Materials (ASTM) has designated ordinaryPortland cement as Type I cement used for general concrete constructions

- Aggregates are the major ingredients of concrete constituting 70-75% of the total volume
- Potable water was used to cast the concrete specimens. The water was free from oils, acids and alkalis and had a water soluble chloride content of 140 mg/litre which is very much less than the permissible limit. As per IS 456 -2000, the permissible limit for chloride is 500 mg/litre for reinforced concrete.PH value for portable water is 7.0

2.3 Fibres

- Glass Fibre
- Polypropylene

Table 1: Properties of Glass fiber

S. No	Property	Specifications
1.	Shape of fibre	Mat form
2.	Modulus of elasticity	72 Gpa
3.	Filament Diameter	14 Microns
4.	Specific gravity	2.68
5.	Fibre Length	12 mm
6.	Aspect Ratio	857.1
7.	Tensile strength	360-500 MPa
8.	Strain at failure	3.6-4.8%

Table 2: Properties of Polypropylene Fiber

S. No	Property	Specifications
1.	Shape of fiber	Mat form
2.	Filament Diameter	30 Microns
3.	Specific gravity	0.9
4.	Fiber Length	25 mm
5.	Aspect Ratio	833.33
6.	Tensile strength	80-110 MPa
7.	Strain at failure	8%

The grade of concrete selected is M30 and water cement ratio adopted was 0.45. Concrete is mixed in roller type of mixing machine

Table 3: Mix Proportion for various percentage of fly ash and fiber

Symbol	FLY ASH (%)	Cement (Kg)	F.A (Kg)	C.A (Kg)	Fiber (%)	Fly ash (Kg)	Water (litre)
	0	413	706	1117	0	0	186
S1	5	392	575.66	1102.75	0.5	20	186
S2	10	372	575.66	1102.75	1.0	37	186
S3	15	351	575.66	1102.75	1.5	35	186
S4	20	330	575.66	1102.75	2.0	33	186
S5	25	309	575.66	1102.75	2.5	30.9	186
S6	30	289	575.66	1102.75	3	28.9	186

III. CASTING AND CURING

The mould specification, preparation of mould method of casting and curing are discussed below.

3.1 Casting

During moulding, the human is formed and concrete is conveyed in pans from hand to hand. The concrete shall be put gently in the Ace shape mould thickness not exceeding 6cm and compacted by the mechanical compressive machine with help of unskilled labour.
The materials were weighed as per the designed mix proportion and they were mixed using concrete mixer. The mixing operation was continued till a good uniform, homogeneous concrete was obtained. General mixing time of 5 to 10 minutes was followed. Steel moulds were used for casting the specimens.

3.2 Compressive strength

Concrete cube specimen used to find out the compressive strength of concrete. Testing on concrete cubes

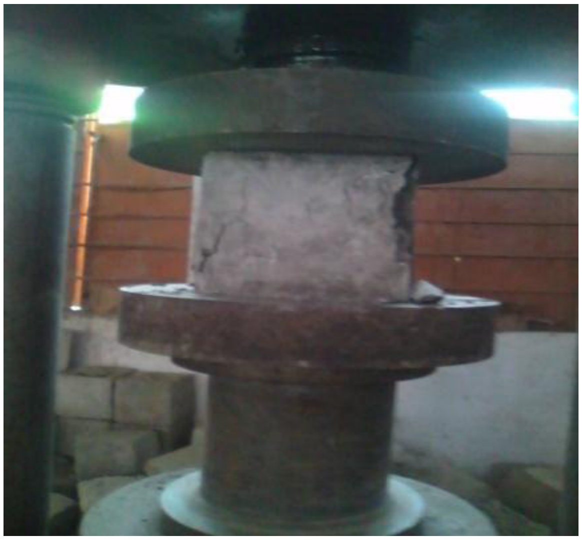

Fig . 3: compressive strength test for specimen

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Table 4: Compressive strength of concrete cubes

S. No.	Identification	7 Days N/mm2	28 Days N/mm2
1	CM - Control mix (without fly ash)	16.31	26.53
2	FA 5 (fly ash 5%)	15.11	26.22
3	FA 10 (fly ash 10%)	14.35	25.51
4	FA 15 (fly ash 15%)	14.18	25.06
5	FA 20 (fly ash 20%)	14.22	25.55
6	FA 25 (fly ash 25%)	14.60	25.91
7	FA 30 (fly ash 30%)	13.87	24.84

3.3 Flexural strength

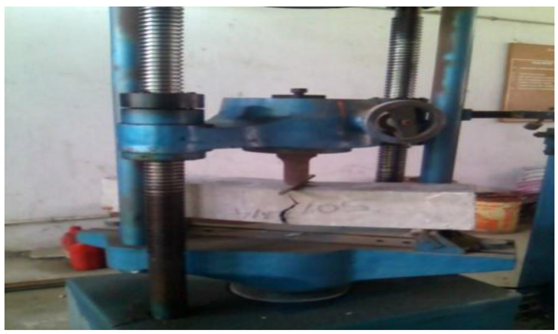

Fig. 4: Testing on beam

Table 5 Flexural strength of concrete beams

S. No.	Identification	7 Days N/mm^2	28 Days N/mm^2
1	CM - Control mix (without fly ash)	3.20	5.60
2	FA 5 (fly ash 5%)	3.20	5.40
3	FA 10 (fly ash 10%)	3.00	5.60
4	FA 15 (fly ash 15%)	2.80	5.80
5	FA 20 (fly ash 20%)	2.40	4.60
6	FA 25 (fly ash 25%)	2.40	4.40
7	FA 30 (fly ash 30%)	2.20	4.40

3.4 Split Tensile Strength Test

As there are no standardized methods to measure the tensile strength of concrete directly, an indirect method called cylinder splitting tension test was performed on cylindrical concrete specimens placed horizontally between the loading surfaces of a compression testing machine and the load was applied until failure of the cylinder along the vertical diameter.

Fig.5 : Split tensile test on concrete cylinders

S. No.	Identification	7 Days	28 Days
		N/mm2	N/mm2
1	CM - Control mix	1.68	3.03
2	FA 5 (fly ash 5%)	1.50	2.94
3	FA 10 (fly ash 10%)	1.38	2.83
4	FA 15 (fly ash 15%)	1.27	2.79
5	FA 20 (fly ash 20%)	1.22	2.76
6	FA 25 (fly ash 25%)	1.14	2.74
7	FA 30 (fly ash 30%)	1.11	2.67

IV. DISCUSSION ON THE TEST RESULTS

Fly ash, when used in concrete upto certain proportions contributes to the mechanical strength of concrete due to its pozzolanic reactivity. However, since the pozzolanic reaction proceeds slowly, the initial mechanical strengths of fly ash concrete tends to be lower than that of the concrete without fly ash.
From the results of the mechanical strength tests it is observed that, in comparison with the control specimens, the values tend to decrease gradually for the increase in the fly ash percentages. It is noted that the rate of decrease in the values obtained after 7 days of curing is greater than the values obtained after 28 days of curing and the results of the fly ash blended concrete mix is still being slightly lower than that of the control mix.

This phenomenon was observed in all the mechanical strength tests performed until the 28 days strength. 56 and 90 days strength tests will further be carried out in the course of study. Study of literature reveals that concrete with fly ash tends to develop greater strength at later ages exceeding that of concrete without fly ash. This is due to the continued pozzolanic reactivity taking place in the blended cement hydration development at the curing cessation time. Pozzolanic reaction can only proceed in the presence of water or enough moisture should be available for long time. Therefore fly ash concrete require longer curing period. Hence to achieve this, the specimens are being continuously cured by complete immersion in water.

V. CONCLUSIONS

After curing period of 56 and 90 days, mechanical strength tests on the specimens will be conducted in order to determine the rate of gain of strengths and hence to ascertain the optimum percentage of fly ash that could replace cement for maximum strength values.

fibre content which will vary from 0.5% to 3% by weight of the optimal percentage of fly ash blended cement added to the concrete. From the results obtained, it is proposed to conclude on the most effective fibre and its optimal dosage in the fly ash blended cement concrete.

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