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STUDY ON FLEXURAL STRENGTH OF REINFORCED FLYASH AGGREGATE CONCRETE BEAMS

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ABSTRACT

Aggregate is most widely used in reinforced concrete construction. In this investigation, fly ash aggregates are used in concrete and its effect on Flexural strength of concrete are studied.Fly ash is considered as one of the waste industrial product that cannot be easily disposed. If it is used in construction industry, it solves the problem of disposal of fly ash and at the same time it reduces the cost of construction. Therefore, fly ash is considered as eco-friendly sustainable material produced with least energy demand.The fly ash was collected from Mettur Thermal Power plant. Then the cement fly ash proportion of 12.5:87.5, 15:85 & 17.5:82.5 are adopted to get fly ash aggregates. The Particle size distribution, Specific gravity test and all other basic properties on aggregates are determined.The mix design for conventional concrete M20 grade is adopted by using IS Method.The mix design of Fly Ash Aggregate Concrete will be done by Volume method.The Reinforced Conventional Concrete beams and Fly Ash Aggregate Concrete beams are cast and Flexural Strength is compared.

Keywords: Flexural strength, fly ash coarse aggregate, fly ash fine aggregate, pellets.

I. INTRODUCTION

Fly ash is not a polluting industrial waste, but a resource material useful for various construction applications, in cement and concrete. The utilization of fly ash in India has increased substantially in recent years.

Both coarse and fine aggregates for making concrete are become scarce, and many cities and towns worldwide including India, do not allow the quarrying of sand or stone. This problem will become very acute in the near future. These aggregates, in addition to being lightweight, are not subjected to alkali-aggregate reactions.

In the construction industry, fly ash is used in roof insulation, Trench reinstatement, Road formation, Bridge abutment, Land reclamation, void filling, Light weight pre cast blocks, Fire resistance, Insulation screed and soil stabilization.

1.1 Alternative Materials

- Fly ash coarse aggregates.
- Construction demolishing waste.

- Broken glasses.
- Rubber wastes.
- Silica sand.

Recycled concrete aggregate (RCA) is obtained mainly by crushing and processing concrete elements that have been previously used in construction, where the masonry content material, including approximately a 30-35 percent of material less than 4mm, is fed to a plant in which the fines are separated. The process has produced satisfactory aggregate and the research has proved that there is no decrease in the properties of medium grade concrete, with the use of 20 percent recycled aggregate and 80 percent natural stone. The above materials are used in construction works, but mainly sand and aggregates are widely used in concrete.

1.2 Fly ash

Fly ash is defined in Cement and Concrete Terminology (ACI Committee 116) as "the finely divided resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases." Fly ash is a by-product of coal – fired electric generating plants.

Two types of fly ash are produced, according to the type of coal used. Anthracite and bituminous coal produces fly ash classified as Class F. Class C fly ash is produced by burning lignite or sub-bituminous coal. Class C fly ash is preferable for the applications presented in the Green Building Guide and is the main type offered for residential applications from ready-mix suppliers.

Fly ash is one of three general types of coal combustion byproducts (CCBP'S). The use of these byproducts offers environmental advantages by diverting the material from the waste stream, reducing the energy investment in processing virgin materials, conserving virgin materials, and allaying pollution.

Although fly ash offers environmental advantages, it also improves the performance and quality of concrete. Fly ash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. Fly ash increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and reduces alkali-aggregate reaction. Fly ash reaches its maximum strength more slowly than concrete made with only Portland cement. The techniques for working with this type of concrete are standard for the industry and will not impact the budget of a job.

II. EXPERIMENTAL INVESTIGATION

2.1Study on Materials

The following are the materials has been studied such as cement, flyash, coarse and fine aggregate.

2.1.1 Cement

43 grade ordinary Portland cement (OPC) is used for the study programme and the specific gravity of cement was found to be 2.85.

2.1.2 Fly Ash

Fly ash was collected from Mettur thermal power plant at Mettur near Salem. Fly ash has been collected using electrostatic precipitator in the plant was taken directly from hopper in dry state. It has been categorized as class F-fly ash. It is usually produced by burning anthracite or bituminous coal. In the sum of the percentage of the three principle constitutes i.e. Sio_2, Al_2o_3, & Fe_2o_3 is equal to greater than 70%, so the fly ash is termed as class

F. Cement and fly ash were mixed in concrete mixer with 12.5:87.5, 15:85 and 17.5:82.5, ratios with w/c of 0.3 and is mixed until the pellets are formed.

2.1.3 Fine Aggregate

For ordinary Concrete River sand was used in preparing the concrete as it is locally available in sand quarry. The specific gravity was found to be 2.7. The natural fine aggregate was compared with fly ash aggregates prepared from various cement fly ash proportion.

2.1.4 Coarse Aggregate

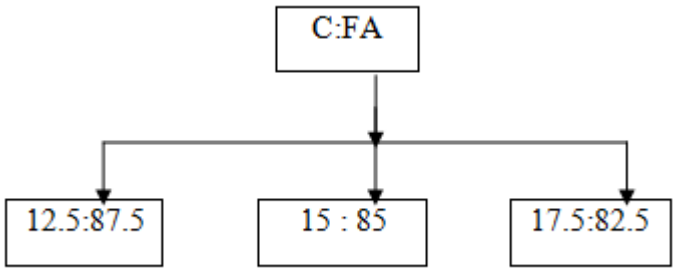
For ordinary concrete 20mm normal size grades aggregate was used. The specific gravity was found to be 2.58. The natural coarse aggregate was compared with fly ash aggregates prepared from various cement fly ash proportion.

2.1.5 Water

Ordinary tap water was used in the preparation of concrete.

2.2 Proportions of Cement and Fly Ash

Cement and fly ash are mixed in six different proportions as shown in the figure 3.2.1 below for the formation of fly ash aggregates.



2.3 Pelletisation

It is a process of agglomeration of moisturized fines in a rotating drum or disc, to produce 'fresh pellet' having enough for further handling. Formation of pellets is based on the mechanisms involved in balling phenomenon of powdery materials. When a fine-grained material is moisturized, a thin liquid film develops on the surface of each grain and bridges are formed at points where the moisturized particles contact each other. The particles rotated into balls bonding forces develop gradually. The initial bonding between particles is due to a water bridge or meniscus. When more liquid is added, the liquid film on the particle surface began to coalesce, but closed and air-filled cavities remain between the grains. The ball grows as more moisturized particles are coated onto the nucleus. Mechanical forces, produced by the balls bumping against each other and against the walls of the rotating device, expel the air enveloped in the balls.

At this capillary stage, the liquid fills the free space between the particles. The filled capillary forces affect the particle coherence throughout the whole ball. The concave membrane on the surface of the liquid seals surface pores. Under uneven or excessive moisturizing, particle clusters are enveloped in the droplets that tend to produce large, irregular entities. Grain size distribution and surface texture of material influence the efficiency of pelletisation process.

In the present study green pellets were produced from a mixture of fly ash, ordinary Portland cement and water as binder in the concrete mixer, which performed as a pelletiser.

Figure 2.2 Preparation of pellets

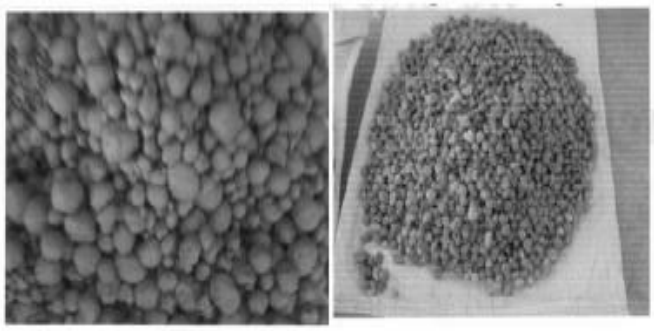


Figure2.3 Flyash Aggregates

2.4 Processing and Curing of Fly Ash Aggregates

The prepared green pellets are allowed to dry for a day. Fly ash aggregates are then placed under water for 7 days for curing.

III. TEST ON CONVENTIONAL AND FLYASH AGGREGATES

Table 3.1 Particle size distribution of conventional fine aggregate and fly ash fine aggregates

Sieve Size	Cumulative Percentage of aggregate Retained			
	Conventional	12.5:87.5	15:85	17.5:82.5
4.75mm	1.2	3.2	4	4.6
2.36mm	3.4	6.8	8.2	8.6
1.18mm	9.4	13.4	15.2	16.4
600µm	25.2	26.4	27	28.2
300µm	72.6	66.2	61	60.4
150µm	96.2	88.6	85.2	84
Retaining	100	100	100	100

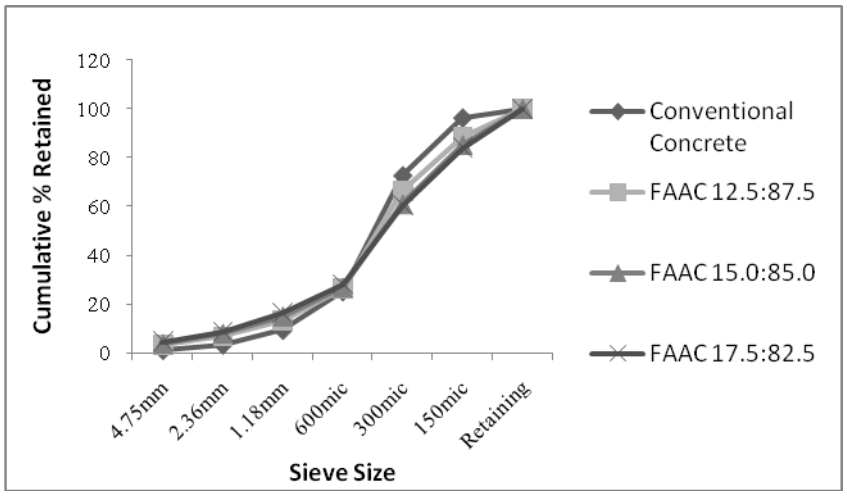


Figure 3.1 Grading curves for fine aggregates

Table 3.2 Particle size distribution of conventional coarse aggregate and fly ash coarse aggregates

Sieve Size	Cumulative Percentage of Aggregates Retained			
	Conventional	12.5:87.5	15:85	17.5:82.5
80mm	-	-	-	-
40mm	-	-	-	-
37.5mm	-	-	-	-
20mm	29.8	58.4	52.6	44.8
12.5mm	97.4	88.6	90.4	92.6
10mm	98.8	96.8	96.8	97.2
Retaining	100	100	100	100

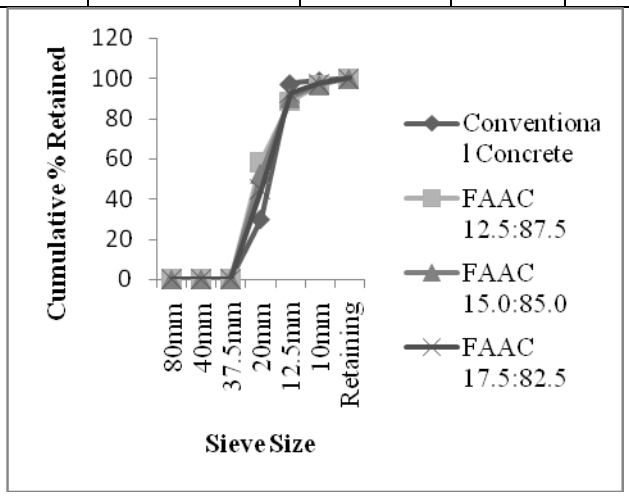


Figure 3.2 Grading curves for Coarse aggregates

IV.PREPARATION OF TEST SPECIMEN

The Reinforced Conventional concrete beams (control specimens 6 nos each) of size 100mm x 100mm x 500mm are cast using conventional fine aggregate (CFA) and conventional coarse aggregate (CCA).The Specimens are cured for 7,14, and 28days. For FAAC, the specimens were cast with flyash fine aggregates (FAFA) and flyash coarse aggregates (FACA) obtained from the ratios as 12.5:87.5, 15:85 & 17.5:82.5 three cement :flyash proportions were taken. The specimens are demoulded after 1 day and immersed in water for7,14, and 28 days for curing. The Flexural strength is compared between the conventional concrete and Fly ash Aggregate Concrete with above three cement fly ash proportions.

V. FLEXURAL STRENGTH OF CONCRETE TEST PROCEDURE

The specimens were the concrete beams of size 10cm x 10cm x 50cm supported on rollers, so that their centre to centre distance is 40cm for 10cm specimens. The load is applied through two similar rollers mounted at third points of the supporting span. The load is applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/cm^2/min until failure occurs. The maximum load is recorded.

Let 'a' be the distance between the line of fracture and the nearer support, measure on the center line of the tensile side of the specimen.

- When 'a' is greater than 13.3 cm for 10cm specimen.

  Flexural strength,

  $$\mathbf{Fb = PL/bd^2}$$

  Where,

  P = Maximum load,

  L = Span of specimen,

  B = Width of specimen,

- When 'a' is less than 13.3cm but greater than 11cm for 10cm specimen

  $$Fb = 3\ Pa/bd^2$$

- When 'a' is less than 11cm for 10cm specimen the test results are discarded.

VI. RESULTS AND DISCUSSION

Table 6.1 Flexural Strength of Fly Ash Aggregate Concrete And Conventional Concrete with Different Ages of Testing.

Age of testing	Proportion Cement: Fly ash	Flexural Strength (MPa)
7 days	12.5:87.5	4.50
	15 :85	**5.49**
	17.5:82.5	4.40
	Conventional concrete	5.36
14 days	12.5:87.5	4.60
	15 :85	**6.00**
	17.5:82.5	4.50
	Conventional concrete	5.40
28 days	12.5:87.5	4.75
	15 :85	**6.22**
	17.5:82.5	4.60
	Conventional concrete	5.49

VII. CONCLUSION

- Basic properties of Cement and Fly ash are studied.
- Fly ash aggregates are formed from the three Cement Fly Ash Proportions 12.5:87.5, 15:85 & 17.5:82.5.
- The Flexural Strength of Reinforced Conventional Concrete Beams and Reinforced Fly Ash Aggregate Concrete Beams with Three Cement Fly Ash Proportions will be Considered and Compared with the Conventional Reinforced Concrete Beams.
- The cylindrical compressive strength of fly ash aggregate concrete with fly ash proportions 15:85 at 7,14 and 28 days increased as compared to that conventional concrete.

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