Experimental Investigation Onductility of Fly Ash Aggregate Concrete

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Abstract- *Aggregate in concrete is structural filler, which occupies the most of the volume of the concrete. It is the cement paste coats and binds together. The composition, shape and size of the aggregate have significant impact on the workability, durability, strength, weight and shrinkage of the concrete. In recent period some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. Aggregate occupy 60- 80% of the volume of concrete is considerable. The utilization of fly ash in concrete as partial replacement of cement is gaining immense importance today, mainly on account of the improvement in the long term durability of concrete combined with ecological benefits. Three grades of ordinary Portland cement (OPC) are 33,43 and 53 as classified by Bureau of Indian Standard (BIS) are commonly used in construction industry. The main variable investigated in this study is variation of fly ash dosage in 10%, 20%, 30% and 40%. The compressive strength, durability and shrinkage of concrete were mainly studied.In the investigation, fly ash aggregates will be used in concrete and its effect on strength of concrete will be studied. The fly ash is collected in Mettur Thermal Power Plant. Then the cement and fly ash proportions of 12.5:87.5, 15:85 and 17.5:82.5 will be adopted to get fly ash aggregates. The particle size distribution, specific gravity, bulk density, impact test on aggregate will be conducted.The M20 grade of concrete will be considered. The fresh concrete tests Slump test and Compacting factor test will be conducted. For the plain concrete and fly ash aggregate concrete of beams (Plain concrete and RCC beams), cubes and cylinders will be cast. All the specimens will be cured in a curing tank.The Ductility test and compressive strength test will be conducted on these plain and fly ash aggregate concrete specimens.*

I. INTRODUCTION

Fly ash is generated as by-product from coal based thermal power plants. In India every year nearly 200 million ton fly ash is generated from major thermal plants. It is likely to increase to 400 million ton per year within next decade as more than 70% power generation in India is through coal based power plants.

The disposal of such large quantity of fly ash not only involves huge expenditure but also creates numerous ecological and environmental problems. In the interest of economy, environment and sustainability, it is essential that this large quantity of fly ash is gainfully used.

Fly ash is an extremely fine powder consisting of spherical particles less than 50 microns in size. Fly ash is one of the construction industry's most commonly used pozzolans. Pozzolans are siliceous or siliceous/alumino materials possessing the ability to form cementitious compounds when mixed with lime (calcium hydroxide, or Ca(OH)2,) and water.

When portland cement is mixed with water, most of the cement forms insoluble cementitious compounds; Ca(OH)2 is formed as part of this reaction. When fly ash is introduced into concrete, it reacts with the Ca(OH)2 to form additional cementitious compounds. In a properly proportioned mix, fly ash can improve many of the properties of concrete, including workability and consolidation, flexural and compressive strengths, pumpability, and decreased permeability.

Fly ash provides a significant contribution to sustainable construction. Its use in concrete production consumes less energy and offers improved efficiency and building performance. Fly ash can be used to help achieve LEED (Leadership in Energy and Environmental Design) points.

It is used as a substitute material of the Portland cement content concrete. Fly ash, a supplementary cementitious material, when used in combination with Portland cement contributes to the properties of the hardened concrete through pozzolanic and/or hydraulic activity.

Fly ash is a residual product produced in combustion of coal and comprises of fine particles. The most important use of fly ash in found in Portland cement. It is used as a substitute material of the Portland cement content concrete. Fly ash, a supplementary cementitious material, when used in combination with Portland cement contributes to the properties of the hardened concrete through pozzolanic and/or hydraulic activity.

Fly ash has been used as a supplementary cementitious material in concrete since the last century, but its use became widespread in the mid-1900s. Historically, the use of fly ash in concrete ranged between the levels of 15% to 25% by mass. However, the actual quantity used depends on the properties of the fly ash, its application, specification limits and the location and climate of the site. In the last few decades, the content of fly ash in concrete has raised up to 40% to 60% producing concrete with higher durability and good mechanical properties.

SELECTION OF INGREDIENTS:

- Cement
- Fly ash
- Fine aggregates
- Coarse Aggregates
- Water
- Pellestisation

PROPORTIONS OF CEMENT FLY ASH: 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.

PELLETISATION: It is a process of agglomeration of moisturised fines in a rotating drum or disc, to produce 'fresh pellets' 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 particle 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 into the nucleus. Mechanical forces, produced by the balls bumping against each other and against the walls of 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**.**

Fig: Fly ash Aggregates

PROCESSING AND CURING OF FLY ASH AGGREGATES: The prepared green pellets are allowed to dry for a day. Fly ash aggregates are than placed under water for 7 days curing.

CONCRETE MIX DESIGN: The desired properties of concrete can be obtained by using the ingredients in a certain proportion and determining the relative amount of material is known as mix design. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing the concrete of the required strength as economically possible is termed as concrete mix design.Concrete mix design is economically proportioning of concrete ingredients for better strength and durability based on properties. The proportions resulting from the concrete mix design are tested for their strength with the help of test to conduct. The mix design proves to provide better quality economically.

TYPES OF MIX DESIGN

- ACI mix design method
- British mix design method
- Mix design method according to Indian standard recommended guidelines for concrete mix design.

MIX DESIGN BY IS METHOD

Is method of mix design is based on **IS 10262-1982**

PREPARATION OF TEST SPECIMENS

- **Compressive strength Test**
- **Flexural strength Test**
- **Split Tensile Strength Test**

PROCEDURE OF TEST SPECIMENS

COMPRESSIVE STRENGTH TEST

The concrete cubes of size 150mm x 150mm x 150mm will be tested as per IS 456-2000. The load will be applied on the specimens on Universal Testing Machine. The load will be applied without shock until the failure occurs.

FLEXURAL STRENGTH TEST

The Plain concrete and RCC beams of size 200mm x 150mm x 1000mm were tested as per IS 516-1959. The load will be applied through two similar rollers mount over the beam for the two span continuous beam specimens. The load will be applied without shock until the failure occurs.

SPLIT TENSILE STRENGTH TEST

The concrete cylinders of size 150mm x 300mm will be tested as per IS 456-2000. The load will be applied on the specimens on Universal Testing Machine. The load will be applied without shock until the failure occurs.

TEST RESULT DISCUSSION

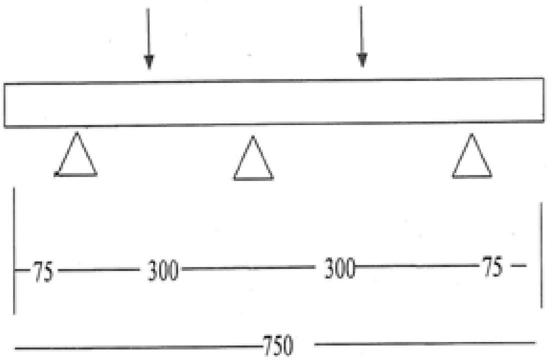
1. COMPRESSIVE STRENGTH TEST

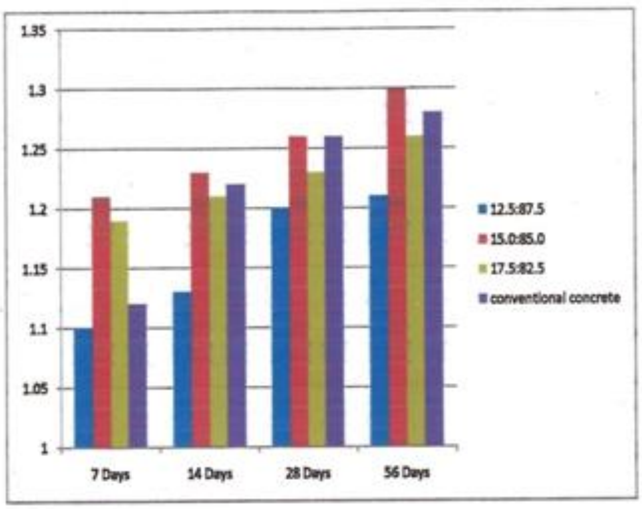
Age of Testing	**Cement : Fly ash**	**Compressive Strength in N/mm2**
7 days	12.5:87.5	12.56
	15:85	15.13
	17.5:82.5	12.95
	Control concrete	14.02
14 days	12.5:87.5	14.92
	15:85	19.85
	17.5:82.5	16.52
	Control concrete	16.73
28 days	12.5:87.5	16.23
	15:85	22.56
	17.5:82.5	17.35
	Control concrete	19.74
56 days	12.5:87.5	18.13
	15:85	26.01
	17.5:82.5	20.57
	Control concrete	22.14
90 days	12.5:87.5	18.68
	15:85	28.14
	17.5:82.5	21.41
	Control concrete	25.22

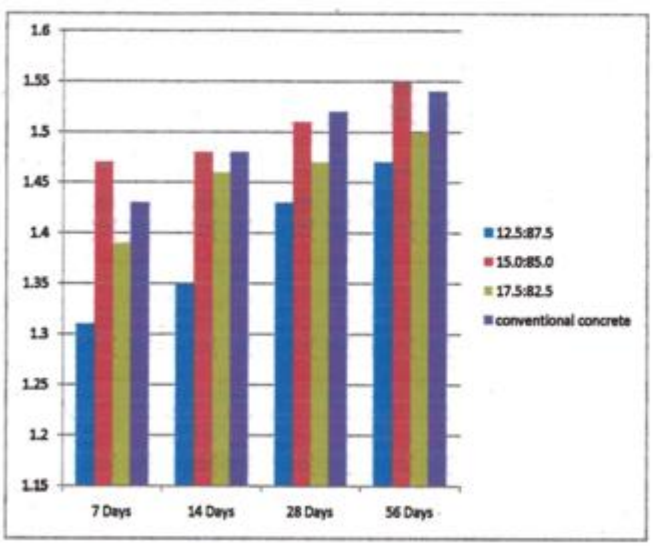
FLEXURAL STRENGTH TEST

Age of testing	**Cement : Fly ash**	**Flexural strength in N/mm2**
7 days	12.5:87.5	4.15
	15:85	**5.68**
	17.5:82.5	3.12
	Control concrete	4.23
14 days	12.5:87.5	4.08
	15:85	**5.73**
	17.5:82.5	3.41
	Control concrete	4.55
28 days	12.5:87.5	3.85
	15:85	**6.75**
	17.5:82.5	4.56
	Control concrete	5.75

Ductility Test: e beams of size 20cm x 15cm x 75cm were tested as per IS 516 1959. The load was applied through two similar rollers mounted over the beam for the two span continuous beam specimen as shown in figure 3.7.1. The load was applied without shock until the failure occurs.







II. CONCLUSION

The basic properties of Cement and Fly ash are studied.

The Fly ash aggregates are formed under the three ratios of cement and fly ash proportions are 12.5:87.5, 15:85 and 17.5:82.5.

The Specific gravity test and sieve analysis test were conducted on the both conventional and fly ash fine and coarse aggregate.

The cube compressive strength of conventional concrete and fly ash aggregate concrete will be tested for 7 days, 14 days, 28 days, 56 days and 90 days of curing.

Fly ash aggregate concrete cube with fly ash aggregates prepared from cement fly ash proportions 15:85 showed 11%, 15%, 14%, 13% and 8% increase in Compressive strength at the ages of 7days, 14days, 28days, 56days and 90days respectively over the control concrete.

Fly ash aggregate concrete cube with fly ash aggregates prepared from other cement fly ash proportions 12.5:87.5 and 17.5:82.5, showed reduction in compressive strength at the ages of 7days, 14days, 28days, 56days and 90days respectively over control concrete.

The beam flexural strength of conventional concrete and fly ash aggregate concrete will be tested for 7 days, 14 days and 28 days of curing.

The fly ash aggregate concrete beam containing fly ash aggregate made from cement fly ash proportion 15:85 showed increase in flexural strength of 11%, 13% and 16% respectively at the ages of curing in 7days, 14 days and 28days than the control concrete beam.

The cement fly ash proportions 12.5:87.5 and 17.5:82.5 showed reduction in flexural strength of 9% and 11% respectively at the age of curing in 7days and 11% and14% respectively at the age of curing in 28days than control concrete beam.

The fly ash aggregate concrete cylinders with fly ash aggregate made from cement fly ash proportion 15:85 showed an increase in split tensile strength of 12%, 13% and 15% respectively at the ages of 7days, 14 days and 28days compared with control concrete specimens.

The cement fly ash proportions of 12.5:87.5 and 17.5:82.5, showed reduction in split tensile strength of16% and 22%respectively at the age of curing in 7days and 15% and19% respectively at the age of curing in 28 days than control concrete specimen.

Considering the depletion of natural sources and the effect on environment, the disposal problems involved in disposing fly ash, light weight characteristics of fly ash aggregates with good mechanical properties(Compression strength, Split Tension strength and Flexural strength) as seen in the above investigation, a particular attention may be focused on the usage of fly ash aggregates in concrete.

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