Experiment of Fly-Ash with the Mix of Silica for Variation of Strength in Concrete

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Abstract— The chemical compositions of various fly ashes show a wide range, indicating that there is a wide variations in the coal used in power plants all over the world Fly ash that results from burning sub-bituminous coals is referred as ASTM Class C fly ash or high calcium fly ash, as it typically contains more than 20 percent of CaO. On the other hand, fly ash from the bituminous and anthracite coals is referred as ASTM Class F fly ash or low calcium fly ash. It consists of mainly an aluminosilicate glass, and has less than 10 percent of CaO. The colour of fly ash can be tan to dark grey, depending upon the chemical and mineral constituents. The chemical composition is mainly composed of the oxides of silicon (SiO2), aluminium (Al2O3), iron (Fe2O3), and calcium (CaO), whereas magnesium, potassium, sodium, titanium, and sulphur are also present in a lesser amount. The major influence on the fly ash chemical composition comes from the type of coal. The chemical compositions of various fly ashes show a wide range, indicating that there is a wide variations in the coal used in power plants all over the world Fly ash that results from burning sub-bituminous coals is referred as ASTM Class C fly ash or high calcium fly ash, as it typically contains more than 20 percent of CaO. On the other hand, fly ash from the bituminous and anthracite coals is referred as ASTM Class F fly ash or low calcium fly ash.

Keywords: concrete, Fly-Ash mix silica, compressive strength, microstructure, Portland cement, Variability, Poisson's ratio

I. INTRODUCTION

Fly-Ashmaterials are very small sized materials with particle size in Fly-Ashmetres. These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size. The small size of the particles also means a greater surface area. Since the rate of a pozzolanic reaction is proportional to the surface area available, a faster reaction can be achieved. Only a small percentage of cement can be replaced to achieve the desired results. These Fly-Ash materials improve the strength and permeability of concrete by filling up the minute voids and pores in the microstructure.

Hydration has to be studied properly and better substitutes to it have to be suggested. Different materials known as supplementary cementitious materials or SCMs are added to concrete improve its properties. Some of these are fly ash, blast furnace slag, rice husk, silica fumes and even bacteria. Of the various technologies in use, Fly-Ash-technology looks to be a promising approach in improving the properties of concrete.

II. LITERATURE REVIEW

Fly-Ashmaterials in concrete has been discussed in brief. A great number of researches have been performed to understand the nature of Fly-Ashmaterials and their effect on the properties of concrete. A number of Research & Development work dealing with the use of Fly-Ashmaterials like Fly-Ash silica, colloidal Fly-Ash Silica (CNS), Al2O3, TiO2, ZrO2,Fe2O3, carbon Fly-Ashtubes (CNT) in cement based materials are discussed in the literature.

[N. K. Sethi (2012)] the results showed that cement could be replaced up to 2% for improving mechanical properties of concrete, but Al2O3 Fly-Ash particles decreased percentage water absorption of concrete.

[M. Collepardi et.al. (2010)] studied the effect of combination of silica fume, fly ash and ultrafine amorphous colloidal silica (UFACS) on concrete.

[M.S. Morsy et. al. (2010)] Studied the effect of Fly-Ash-clay on the mechanical properties and microstructure of Portland cement mortar and observed that the tensile and compressive strength increased by 49% and 7% respectively at 8% Fly-Ash-metakaolin (NMK).

III. FLY-ASH MATERIALS USE IN CONCRETE

Fly-Ash materials are very small sized materials with particle size in Fly-Ash meters. These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size. The small size of the particles also means a greater surface area. Since the rate of a pozzolanic reaction is proportional to the surface area available, a faster reaction can be achieved. Only a small percentage of cement can be replaced to achieve the desired results. These Fly-Ash materials improve the strength and permeability of concrete by filling up the minute voids and pores in the microstructure.

Fig. 1: Fly-Ash Mix Concrete Material

The use of Fly-Ash silica in concrete mix has shown results of increase in the compressive, tensile and flexural strength of concrete. It sets early and hence generally requires admixtures during mix design. Fly-Ash-silica mixed cement can generate Fly-Ash-crystals of C-S-H gel after hydration. These Fly-Ash-crystals accommodate in the micro pores of

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the cement concrete, hence improving the permeability and strength of concrete.

IV. MATERIAL PROPERTIES

The materials used to design the mix for M25 grade of concrete are cement, sand, coarse aggregate, water and Fly-Ash SiO2. The properties of these materials are presented below.

Fig. 2:

A. Properties of Cement

Portland slag cement of 43 grade conforming to IS: 455-1989 is used for preparing concrete specimens. The properties of cement used are given below.

Specific Gravity	Fineness by sieve analysis	Normal consistency
3.014	2.01%	33%

Table 1: Properties of Portland slag cement

B. Properties of fine and coarse aggregate

Sand as fine aggregates are collected from locally available river and the sieve analysis of the samples are done. It is found that the sand collected is conforming to IS: 383-1970. For coarse aggregate, the parent concrete is crushed through mini jaw crusher. During crushing it is tried to maintain to produce the maximum size of aggregate in between 20mm to 4.75mm. The coarse aggregate particle size distribution curve is presented in Fig. 3.1. The physical properties of both fine aggregate and recycled coarse aggregate are evaluated as per IS: 2386-1963 and given below.

Property	Coarse Aggregate	Fine Aggregate
Specific Gravity	2.72	2.65
Bulk Density (kg/L)	1.408	-
Loose Bulk Density (kg/L)	1.25	-
Water Absorption (%)	4.469	0.0651
Impact Value	26.910	-
Crushing Value	26.514	-
Fineness Modulus	3.38	2.84

Table 2: Properties of coarse aggregate and fine aggregate

Only subsequent to steel and aluminum. On the alternative aspect, the abundance and availability of fly ash global create opportunity to utilize this derivative of burning coal, as partial substitute or as performance enhancer for OPC.

V. FLY-ASH BASED POLYMER MATERIAL

In this paintings, fly ash-based totally Polymer is Analysis as the binder, in place of Portland or every other hydraulic cement paste, to produce concrete. The fly ash-based totally Polymer paste binds the unfastened coarse aggregates, exceptional aggregates and other un-reacted materials collectively to shape the Polymer material, with or without the presence of admixtures. The manufacture of Polymer material is achieved using the standard concrete era methods. As within the OPC concrete, the aggregates occupy the biggest extent, i.e. approximately 75-80% through mass, in Polymer material. The silicon and the aluminum in the low calcium (ASTM Class F) fly ash are activated through a mixture of sodium hydroxide and sodium silicate solutions to shape the Polymer paste that binds the aggregates and other un-reacted substances.

Si/Al	Application
1	Bricks, ceramics, fire protection
2	Low CO2 cements, concrete, radioactive & toxic waste Encapsulation
3	Heat resistance composites, foundry equipments, fibre glass Composites
>3	Sealants for industry
20<Si Al<35	Fire resistance and heat resistance fibre composites

Table 3: Applications of Polymer Material

VI. EXPERIMENTAL PROGRAM

In order to simplify the improvement manner, the compressive electricity turned into selected as the benched mark parameter. This isn't always uncommon compressive power has an intrinsic importance in the structural design of concrete systems. Although Polymer material can be made using various supply materials, the existing observe Analysis best low calcium (ASTM Class F) fly ash. Also, as inside the case of OPC, the aggregates occupy seventy five-80 % of the whole mass of concrete. In order to reduce the impact of the homes of the aggregates at the homes of fly ash primarily based Polymer, the study Analysis aggregates from most effective one source.

Therefore, the present have a look at followed a rigorous trial and mistakes system as a way to increase the fly ash-based totally Polymer material era. The awareness of the examiner changed into to pick out the salient parameters that impact the mixture residences and the properties of fly ash-based totally Polymer material. As far as possible, the technology that is currently in analysis to manufacture and check ordinary Portland cement (OPC) become Analysis. The intention of this action changed into to ease the promotion of this 'new' material later on to the concrete industry.

VII. MATERIALS

A. Fly Ash

In the present experimental work, low calcium, Class F (American Society for Testing and Materials 2001) dry fly ash received from the silos of Collie PowerStation, Western Australia, become Analysis as the base fabric. Three exceptional batches of fly ash have been Analysis; the primary batch become obtained in the center of 2001, the

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second one batch arrived in the middle of 2003, and the remaining batch was obtained in 2004. The chemical compositions of the fly ash from all batches, as determined by means of X-Ray Fluorescence (XRF) analysis. The XRF analysis changed into performed by the Department of Applied Chemistry. For fly ash from Batch I, 80% of the debris had been smaller than 55 µm, and the Specific Surface Area was 1.29 m2/cc. For Batch II,eighty% of the particles were smaller than 39 µm, and the Specific Surface Area was1.94 m2/cc. For fly ash from Batch III, 80% of the debris had been smaller than forty six µm, and the Specific Surface Area changed into 1.52 m2/cc.

B. *Aggregates*

Aggregates presently Analysis by way of the neighbour hood concrete industry in Western Australia, andsupplied by means of BGC Concrete and Asphalt have been Analysis. Both coarse and satisfactory aggregates had been in saturated surface dry (SSD) situation, according to applicable Indian Standards, AS 1141.Five-2000 and AS 1141.6.1-2000 (2000; 2000). Coarse aggregates were received in beaten shape; majority of the particles were of granite type. The quality mixture was received from the sand dunes in uncrushed form.

VIII. MANUFACTURING PROCESS

Fig. 3: Different Materials

A. *Preparation of Test Specimen*

For conducting compressive strength test on concrete cubes of size 150×150×150 mm are casted. A rotary mixture is used for thorough mixing and a vibrator is used for good compaction. After successful casting, the concrete specimens are de-moulded after 24 hours and immersed in water for 28 days maintaining 27 +/- 1 C°. Fig. shows some concrete specimen casted in laboratory.

Fig. 4: concrete cubes casted in the mould

IX. CONCLUSION

From the test results, the SEM micrographs and the relative chemical composition of the specimen a number of conclusions can be drawn. These conclusions are justified in the next section. The conclusions drawn are:

1) From the compressive strength results, it can be observed that increase in compressive strength of concrete is observed on addition of a certain minimum quantity of Fly-Ash Mix SiO2. The increase in strength is maximum for NS 1% b.w.c and least for NS 0.3% b.w.c.
2) On addition of Fly-Ash Mix SiO2 there is a substantial increase in the early-age strength of concrete compared to the 28 day increase in strength.
3) The UPV test results show that the quality of concrete gets slightly affected on addition of Fly-Ash Mix SiO2 but the overall quality of concrete is preserved.
4) The FESEM micrograph shows a uniform and compact microstructure on addition of Fly-Ash Mix-SiO2.

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