Study of Compressive Strength of Concrete Mix Cubes Made by the Partial Replacement of Fly Ash with Cement

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Abstract— This paper present the effect of fly ash on concrete mix cubes. Fly ash is partially replaced at different percentage by weight of cement because it has very similar property as that of cement. Cement and fly ash both are pozzolanic material so it can be replaced by cement. The replacements are done at 5%, 10%, 15%, 20%, 25%, and 30% by weight of cement. Compressive strength of fly ash partially replaced cubes is then tested on CTM (compression testing machine) after curing it for 7 days, 14 days and 28 days. Results of CTM are listed in paper.

Key words: Fly Ash, Class F Fly Ash

I. INTRODUCTION

In the recent past years the awareness about the environment pollution is increasing. Household waste, industrial waste and other types of waste creating the major problem of their disposal due to which environmental pollution is coming serious these days. Today the cost is most important aspect in construction. The aim behind the use of Fly ash is to make cement more economical and also conserve the natural resources for future use and better consumption of waste materials which control pollution. Fly ash when partially mixed in concrete also increases the workability and durability. So the best alternative that can be used in place of cement is Fly ash. Cement manufacturing consumes large amount of energy and also emits huge amount of co_2 gas in atmosphere. So use of fly ash is environment friendly.

II. FLY ASH

Fly ash is produced in abundance in electricity generation industry, steel and iron industry, cement industry and other. As the waste material, fly ash has also some environmental issue and storage problem related to it. Fly ash is the residue material or waste generated after combustion of coal particle in thermal power plant for electricity generation. Fly ash is very fine material produced after combustion, due to its abundance and similar properties it is replaced with cement. When coal is burnt in thermal power plant two types of ash is produced, 20% bottom ash and 80% fly ash. Bottom ash is clinker type ash collected in water impounded hopper. Ash which is carried away by the flue gas is trapped and collected at economizer, ESP hopper and air pre heater. Due to the high temperature in furnace the clay mineral present in coal get transformed into fused fine particles comprises of aluminum silicates.

III. COMPOSITION

Component	Bituminous	Sub Bituminous	lignite
SiO_2 %	20-60%	40-60	15-45
Al_2O_3 %	5-35	20-30	20-25
Fe_2O_3 %	10-40	5-10	5-15
CaO %	1-10	5-30	15-40
LOI%	0-15	0-4	0-5

Table 1: Composition

IV. TYPES OF FLY ASH

Depending upon the percentage of silica, calcium, iron and aluminum fly ash is sub divided in two classes.

A. *Class F Fly Ash:*

class F fly ash is produced by the burning of aged and older coal like anthracite and bituminous coal. It does not have self cementing property. It has pozzolanic in nature and contains less than 20% of lime(CaO). Possessing pozzolanic property, the silica and alumina class F fly ash requires some cementing agent such as quick lime, hydrated lime with the presence of water in order to react and produce cementations compounds.

B. *Class C Fly Ash:*

Class C fly ash is produced by the burning of new and younger lignite and sub bituminous coal in which lime is present more than 20%. It has self-cementing property. In presence of water class C fly ash become harden and gain strength.

C. *Property of Fly Ash*

Serial no.	Property	Value
1.	Average particle size	6.85 micron
2.	Color	Whitish grey
3.	Specific gravity	2.28
4.	Class	F
5.	Moisture content	3.14%
6	Bulk density	0.983

Table 2: Property of Fly Ash

D. *Mix Design*

Serial no.	Material	Content	Ratio
1.	Cement	398.70kg/m^3	1
2.	Water	179.415	0.45
3.	Fine aggregate	669.847	1.68
4.	Coarse aggregate	1175.24	2.947
5.	Super plasticizers	3.98	0.01
6.	Water cement ratio		0.45

Table 3: Mix Design

V. WORKABILITY OF M-30 GRADE CONCRETE

serial no.	Cement	Water	Coarse aggregate	Fine aggregate	Super plasticizer	slump
1.	3.13	1.40	5.23	9.18	2%	118
2.	3.13	1.40	5.23	9.18	1%	93

Table 4: M-30 GRADE CONCRETE

VI. TEST RESULTS AT DIFFERENT PERCENTAGE OF FLY ASH

A. 7 Days Testing

Percentage of fly ash replaced by cement	Average weight (kg)	Average Strength (N/mm^2)
5%	8.830	21.450
10%	8.703	22.335
15%	8.523	23.225
20%	8.430	22.445
25%	8.320	20.560
30%	8.240	19.450

Table 5: 7 Days Testing

B. 14 Days Testing

Percentage of Fly Ash Replaced By Cement	Average weight (kg)	Average Strength (N/mm^2)
5%	8.830	28.115
10%	8.703	29.225
15%	8.523	29.890
20%	8.430	28.445
25%	8.320	27.785
30%	8.240	27.005

Table 6: 14 Days Testing

C. 28 Days Testing

Percentage Of Fly Ash Replaced By Cement	Average weight (kg)	Average Strength (N/mm^2)
5%	8.830	33.230
10%	8.703	33.785
15%	8.523	34.775
20%	8.430	33.225
15%	8.320	31.445
30%	8.240	30.335

Table 7: 28 Days Testing

VII. CONCLUSION

Various tests are conducted at different percentage of fly ash. The data shows that with increase in the percentage of fly ash in concrete mixture, the weight of concrete cubes is also decreasing. Decreasing weight of concrete cubes refers to the light weight concrete material and with 15% replacement of fly ash by cement the strength of concrete cube is 34.775 N/mm^2.this result represent that the partial replacement of fly ash with cement has also justified the strength and economical criteria in construction.

VIII. RESEARCH SIGNIFICANCE

In the year 2008-09, the net production of cement in India is 181.61 million tones. By the significant increase in production of cement the emission of CO_2 has also increased to about 181 million tones (1 tones of CO_2 is emitted during production of 1 tones of cement). The production of fly ash is about 68.88 million tones in year 1996-97 which has increased to 116.69 million tones in year 2008-09. So by the replacement of 15% of fly ash with cement can reduce the surplus emission of CO_2 in atmosphere and also make the effective use of waste materials. According to this about 27.15 million tones of fly ash is used in cement production and we can also save the same amount of Portland cement for future use.

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