A STUDY ON THE CONCRETE MIX DESIGN WITH FLY ASH FOR MULTISTORIED BUILDINGS

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***Abstract*:**
Fly ash, a waste generated by thermal power plants is as such a big environmental concern. The report is carried out to study the utilization of fly ash in cement concrete as a partial replacement of cement as well as an additive so as to provide an environmentally consistent way of its disposal and reuse and analysis of Mix Design. The use of fly ash in concrete has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Fly ash use is also cost effective. When fly ash is added to concrete, the amount of Portland cement may be reduced. The main objective of using fly ash in most of the cement concrete applications is to get durable concrete at reduced cost. The selection of concrete proportions involves a balance between economy and requirements for workability and consistency, strength, durability, density and appearance for a particular application. As per clause 5.2 of IS 456-2000 Plain and Reinforced cement concrete code of practice, fly ash conforming to IS 3812 part:1 up to 35% can be used as part replacement of OPC in the concrete. This paper focuses on study on the concrete mix design with fly ash for multistoried buildings.

Keywords: **Fly ash, Admixture, Concrete mix design, for multistoried buildings, M40 grade**

I. INTRODUCTION

The Modern high-rise concrete buildings are models of design skill in the use of materials. It is now a common place to specify high strength concrete for compression members in the lower stories of multi-story buildings. Concentration of reinforcing bars in these members is very high. The trend toward buildings other than rectilinear in shape is producing some unusual structural members. All of these factors spell placing problems unless a mix design is formulated that produces concrete of considerable flow ability and high quality. The problem of obtaining uniform, high quality concrete in this work hinges mainly on two basic considerations: (1) mix design; and (2) placing and curing procedures. The narrow, high forms often used for columns and shear walls aggravate the tendency of mixes to bleed and produce laitance. These problems are quite common in tall building construction field, but they can be prevented by close attention to two aspects of the mix design: (1) cement paste consistency and physical composition; and (2) characteristics of the aggregate. Air entrainment and minimum water content can also play and important role in halting bleeding, formation of laitance and segregation. Without proper placing procedures, however, even the best designed concrete will segregate and bleed, resulting in honeycombing, poor bond to steel and other woes. Because column and wall forms are usually rather high and reinforcing bars are often spaced quite closely, workmen must be careful in depositing and vibrating concrete in this work. Concrete should be dropped in a true vertical plane and have a free fall of no more than four feet. Vibration can be a great help in concreting high-rise buildings because it permits use of lower water contents. However, vibration can be misused if it is employed with wet mixes or continued for important bearing on the quality of concrete flatwork these desirable proportioning and placing practices will also largely hold true for lightweight concrete. However, uniform workability of the mix is more difficult to maintain with lightweight aggregates. This can be improved with air entraining and water reducing agents.

The use of fly ash in Portland cement concrete (PCC) has many benefits and improves concrete performance in both the fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Fly ash use is also cost effective. When fly ash is added to concrete, the amount of Portland cement may be reduced.

II. METHODOLOGY

The aim of present project is to study the performance of mix design with fly ash for high rise buildings. To Study how compressive strength is affected due to with various proportions of cement & Fly ash in a concrete. Design the concrete mix of concrete as well as to compare fly ash-based concrete with ordinary Portland cement concrete according experimental analysis. This project work is explained with the help of following points:

1) Use of Fly as based concrete for high rise building and its effects.
2) To study what is the change in compressive strength properties of concrete from partial replacement of cement with Fly ash?
3) Preparing the mix design for fly ash-based concrete with different proportions.
4) Preparing blocks of concrete and testing for compressive strength
5) To study experimental analysis for best mix design of high-rise building to find optimum proportion of fly ash and dust
6) To find out the optimum percentage of fly ash for particular grade of concrete by trial mix

III. CONCEPTS

a) Fly Ash –Fly ash is a group of materials that can vary significantly in composition it is residue left from burning coal which is collected on an electrostatic precipitator especially if it is can be used in concrete as a substitute for cement. Most fly ash is a pozzolanic, which means it's a siliceous or siliceous and aluminous material that reacts with calcium hydroxide to form a cement. When Portland cement reacts with water, it produces a hydrated calcium silicate (CSH) and lime. The hydrated silicate develops strength and the lime fills the voids properly selected fly ash react with the lime to form CHS- is the same cementing product as in Portland cement. This reaction of fly ash with lime in concrete improves strength. Typically fly ash is added to structural concrete at 15-35 percent by weight of the cement, but up to 70 percent is added for mass concrete used in dams, roller compacted concrete pavements, and parking areas. Special care must be taken in selecting fly ash to ensure improved properties in concrete.

Fig. 1 Fly Ash sample and Crusher Dust

b) Crusher Dust: -Crusher dust is made of Stone dust. It is a waste material obtained from crusher plants. It has potential to be used as partial replacement of natural river sand in concrete. In the present study workability and compressive strength of concrete made using stone dust as partial replacement of fine aggregate in the range of 10%-100%. Use of stone dust in concrete not only improve the quality of concrete but also conserve the natural river sand for future.

c) Admixture: - An admixture is defined as "a material other than water, aggregates, cementitious materials, and fiber reinforcement, used as an ingredient of a cementitious mixture to modify its freshly mixed, setting, or hardened properties and that is added to the batch before or during its mixing" (ACI Committee 212, 2010).

i. Any concrete hot/cold weather with extended transportation and workability time
ii. Suitable for a wide range of applications with high or low W/C and /or high or low environment temperatures
iii. Define the workability time based on project requirements without a negative effect on early strength development
iv. Master Polyheed 8383 is an admixture of a new generation based on modified poly-carboxylic ether. The product has been primarily developed for applications in Ready-mix & Site-batched concrete where the highest performance is required.

d) Concrete mix design: - The concrete mix design is a process of selecting the suitable ingredients of concrete and determining their most optimum proportion which would produce, as economically as possible, concrete that satisfies a certain compressive strength and desired workability.

The main object of mix design is to decide the proportions of materials which will produce concrete of required properties. The mix proportions should be selected in such a way that the resulting concrete is of desired workability while fresh and it could be placed and compacted easily for the intended purpose.

e) Process Method: The methodology in this study is listed below: -

i. Cube casting–Mix raw material in certain ratio as per required and produce concrete. Placing this mixed concrete in moulds.
ii. Cube curing – Cube removing from moulds after 16 hours of concrete placed and cured by water for 7&28 days for different type of moulds age required
iii. Testing - Testing of compressive strength of casted cube by Digital Universal Testing Machine at site lab for various age of cube of different mix
iv. Comparison- Comparison of the various trail results

IV. RESEARCH DESIGN

The five steps described below give the path of the research.

1)Literature study: Literature study is carried out for better understanding of fly ash based concrete mix design for high rise building. In that some information collected form books, journals and some from internet in this stage we get theoretical knowledge regarding our subject.

2)Data collection: This step and next step were the main practice activities of the research. The empirical data of the use of Fly ash in concrete was mainly picked up from the publications, Site QMS plan, journal, ECC news, as well as online research.

3)Open interviews: To collect information of concrete mix design for high rise building with fly ash, procedure of mix design, its casting, curing, several interviews were conducted with specialists like quality manager, construction head of project and some QA/QC team members of project who work at various levels.

4)Data analysis and interpretation: In this stage of research, the collected data analyzed and it gives the result which gives us the appropriate proportion of fly ash which gives us optimum strength and economic mix design report prepared on the analysis and test reports data. All the information, calculations and findings are recorded for further reference.

Table 1 shows the design stipulation used for M40 grade concrete. Table 2 shows Test data for concrete ingredients which include type of cement, Specific gravity of admixture, Specific gravity of coarse & fine aggregate and Water absorption of coarse & fine aggregate.

Example of mix design for a fly ash concrete M40 grade is given below

Table 1: Concrete mix design data for M40

Sr. No.	Design stipulations
1	Characteristic compressive strength at 28 days
2	Maximum size of aggregate-20 mm
3	Degree of workability-600 mm flow
4	Degree of quality control-good
5	Type of exposure-severe
6	Minimum cement content-as per is456 - 2000
7	Maximum free water cement ratio-as per IS 456 - 2000

Table 2: Test data for concrete ingredients

Sr. No.	Particulars
1	Type of cement - OPC 53 grade
	Specific gravity of cement - 3.15
	Specific gravity of fly ash - 2.20
2	Specific gravity of admixture - 1.11
3	Specific gravity of coarse & fine aggregate
	20MM - 2.81
	10MM - 2.80
	C/SAND -2.70
4	Water absorption of coarse & fine aggregate
	20MM - 1.82
	10MM - 1.83
	C/SAND -4.60

Table 3 and Table 4 gives information regarding test data for concrete ingredients and quantities of ingredients (by absolute vol method) respectively.

Table 3: Test data for concrete ingredients

Sr. No.	Details
1	C. Characteristic strength =40 N/mm^2
2	Target mean strength {Assumed Standard Deviation 5.0 As per 456:2000 table No.08} Target mean strength=fck+ (1.65*S.D)= 40+1.65*5=48.25 N/mm^2

Table 4: Quantities of ingredients (by absolute vol method)

Sr. No.	Parameters
1	Actual cement used = 400 kg/m^3
2	Actual fly ash used = 134 kg/m^3
3	Fly ash content percent = 25.00%
4	W / c fixed = 0.29
5	Absolute volume of cement = 0.127m^3
6	Absolute volume of fly ash = 0.061m^3
7	Absolute volume of admixture = 0.006m^3
8	Absolute volume of free water =0.157
9	M3 total volume of coarse & fine aggregate 1-(0.127+0.061+0.006+0.157) = 0.649m^3
10	Ratio of coarse & fine aggregate (%)
11	20mm = 21.00
12	10mm = 32.00
13	C/sand = 47.00
14	Total quantity of coarse & fine aggregate = [(2.81*0.21) + (2.80*0.32) + (2.70*0.47) x 0.649*1000] (383 + 581 + 824) = 1788 kg/m3
15	Aggregate=1:3.35

Mix proportion used for the experimentation is given in Table 5

Table 5: Mix proportion

MIX PROPORTION	C	C/SAND	10 MM	20MM
0.29	1.0	1.543	1.088	0.717

Quantity of ingredients required kgs for 1 m^3 of concrete

Quantity of ingredients as Cement OPC 53gr, fly ash, aggregates, C/sand, Water and Admixture is given in Table No. 6

Table 6: Quantity of ingredients

Sr. No.	Parameter
1	Cement OPC 53gr 400 kg/m^3
2	Fly ash 134 kg/m^3
3	20mm 383 kg/m^3
4	10mm 581 kg/m^3
5	C/sand 824 kg/m^3
6	Water 157 ltr/m^3
7	Admixture 6.75 kg/m^3
	(@ 0.8 - 1.5% by wt of c+f+ms)

NOTE:

1) Dosage of admixture will depend on the ambient temperature conditions and the slump/Flow requirement at site.
2) Depending on the gradation of coarse aggregate and fine aggregate, keeping the Agg / cement ratio constant, we can change the proportion of coarse aggregate and fine aggregate by (+/-) 5 %
3) The admixture used are BASF Polyheed 8383

V. EXPERIMENTAL ANALYSIS

For experimentation proportion of materials used for various trials is given in Table 7 and Table 8 gives information of different trials of M40 grade.

Table 7: Proportions of materials

Type	Cement (kg/m^3)	Fine aggr. (kg/m^3)	Course aggr. (kg/m^3)	Water (kg/m^3)
TRIAL 1	510	822	1002	153
RATIO	1	1.61	1.96	0.30
TRIAL 2	525	850	1027	152
RATIO	1	1.62	1.21	0.15
TRIAL 3	534	824	964	157
RATIO	1	1.54	1.17	0.16
TRIAL 4	550	835	1011	157
RATIO	1	1.52	1.21	0.16
TRIAL 5	550	877	992	151
RATIO	1	1.59	1.13	0.15

Table 8: Different trails of M40 Grade

DIFFERENT TRAILS OF M40 GRADE						
Trail No.		**1**	**2**	**3**	**4**	**5**
Grade		M40	M40	M40	M40	M40
W/C		0.3	0.29	0.29	0.29	0.27
Cement		385	395	400	410.00	415.00
FLY ASH		125	130	134	140	135
20 mm		446	486	383	489	489
10 mm		556	541	581	522	503
Cr. Sand		822	850	824	835	877
Water		153	152	157	157	151
Admixture	BASF Polyheed 8383	1.30%	1.28	1.18	1.25	1.3
Observation		Mix found cohesive and Pumpable	Mix Cohesive & Pumpable	Mix found cohesive and Pumpable.	Mix found cohesive and Pumpable	Mix found harsh
Workability	Initial	590 mm	590 mm	670mm	670mm	650mm
	60 min.	510 mm	570 mm	610 mm	600mm	590mm
	120 min.	490 mm	540 mm	580 mm	550 mm	480mm
	180 min.	400 mm	460 mm	540 mm	480 mm	330mm
Comp. Strength	7 days	28.22	31.93	37.04	32.74	34.96
	28 days	44.59	49.48	50.15	50.59	58.96

VI. COMPRESSION TEST RESULTS OF TRAILS

Table No.9 to 13 shows results of compression test results of trails.

Table 9: TRIAL 1

DAYS	WEIGHT			LOAD			STRENGTH			AVG. STRENGTH
	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	
7	8.46	8.53	8.37	700	605	600	31.11	26.89	26.67	28.22
28	8.47	8.46	8.53	950	990	1070	42.22	44	47.56	44.59

Table 10: TRIAL 2

DAYS	WEIGHT			LOAD			STRENGTH			AVG. STRENGTH
	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	
7	8.89	8.81	8.76	705	660	790	31.33	29.33	35.11	31.93
28	8.75	8.84	8.96	1050	1190	1100	46.67	52.89	48.89	49.48

Table 11: TRIAL 3

DAYS	WEIGHT			LOAD			STRENGTH			AVG. STRENGTH
	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	
7	8.540	8.525	8.475	800	810	890	35.56	36.00	39.56	37.04
28	8.625	8.58	8.69	1200	1110	1075	53.33	49.33	47.78	50.15

Table 12: TRIAL 4

DAYS	WEIGHT			LOAD			STRENGTH			AVG. STRENGTH
	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	
7	8.89	8.81	8.90	750	795	665	33.33	35.33	29.56	32.74
28	8.43	8.32	8.56	1250	1065	1100	55.56	47.33	48.89	50.59

Table 13: TRIAL 5

DAYS	WEIGHT			LOAD			STRENGTH			AVG. STRENGTH
	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	CUBE 1	CUBE 2	CUBE 3	
7	8.67	8.63	8.70	690	870	800	30.67	38.67	35.56	34.96
28	8.74	8.70	8.76	1310	1295	1375	58.22	57.56	61.11	58.96

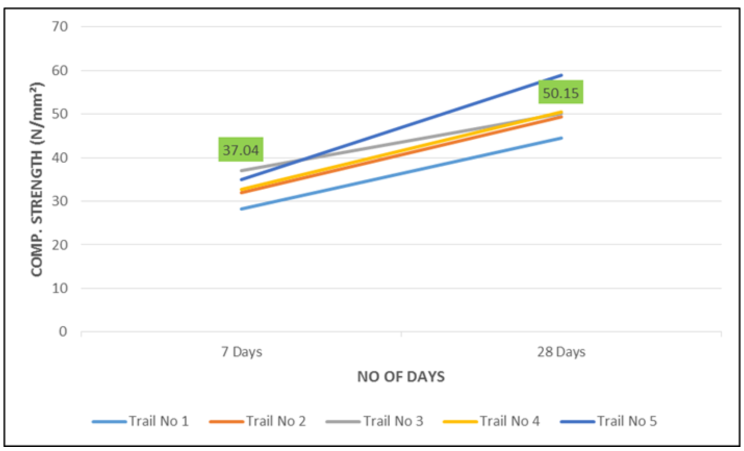

Fig. Result Graph

From the graph Trail no 3 got maximum compressive strength in 7 days and at 28th days get maximum strength i.e. 50.15 N/mm² for M40 grade. In this trail the cement content is less compared to trail no 5 so Trail No 3 is economical Mix

VII. CONCLUSION

The paper presents the results of the fly ash based concrete mix design for High rise building. In that the fly ash mixed concrete mix shows good strength, workability and various other parameters for optimum proportion of fly ash which is economical and it has many advantages. Based on analysis of test results there upon the following conclusion can be drawn:

1. The use of fly ash in concrete resulted in increase in initial and final setting time of concrete.
2. Optimum use of fly ash saves cement cost and save environment.
3. For high rise building use of this concrete give extended initial and final setting time which helpful for pumping and finishing operation.
4. Fly ash concrete get maximum workability compared to ordinary cement concrete.
5. Use of fly ash reduce the water demand.
6. From 5 trail results it’s concluded that Trail No 3 gives maximum strength.
7. Use of fly ash increase the ultimate strength.

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