LABORATORY EXPERIMENT ON MIX DESIGN AS PER IS CODE USING FIYASH AND PLASTICIZER

Shivani singh baghel[1], Sandeep K Shrivastava[2]

[1]Mtech Research Scholar, OIST Bhopal-462021, India
[2]Prof.& Head, Department of Civil Engineering, OIST Bhopal-462021, India

Abstract: *Concrete is most widely used material which includes cement as binding material. Fly Ash an industrial waste is rich in silica and being industrial waste it is difficult to dispose. Fly ash and presence of lime released by Hydration of cement act as binding material Therefore Fly Ash can replace the cement. This study was undertaken with to study available design methods incorporating Fly ash and suggest a most suitable one for future use. In order to achieve this objective the cubes were cast of M20, M25 of concrete by method of mix design as per IS10262:2009.This Thesis work focuses at the replacement effects (strength) brought by Fly Ash in substitution of concrete. We casted concrete cubes, beams, and are kept for curing for a period of 28days.In this thesis work cement are replaced by fly ash in 5%,10%,15%,20% by weight in concrete and also chemical admixture polygon (water reducer) added in 15%,20% cement replaced by fly ash cubes which increases compressive strength gradually and also cost effectives.*

Keywords: cement, fly ash, admixture (polygon), strength, mix design

1. INTRODUCTION

Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. It is obtained by mixing cementing materials, water and aggregates, and sometimes admixtures, in required proportions. The mixture when placed in forms and allowed to cure hardens into a rock-like mass known as concrete. The hardening is caused by chemical reaction between water and cement and it continues for a long time, and consequently the concrete grows stronger with age. The hardened concrete may also be considered as an artificial stone in which the voids of larger partials (coarse aggregate) are filled by the smaller particles (fine aggregate) and the voids of fine aggregate are filled with cement. Concrete mix design involves a process of preparation in which a mix of ingredients creates the required strength and durability for the concrete structure. Because every ingredient in the mix consists of different properties, it's not an easy task to create a great concrete mix. It is imperative that all ingredients be tested to determine their physical properties and the bearing capacity of the project location. The ingredients to be tested: water, fine aggregate (sand), coarse aggregate, cement, chemicals, reinforcement, and soil. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as

possible, is termed the concrete mix design.

2. METHODLOGY

Methodology

The first step in methodology was to establish the properties of the material used. Further Optimum Fly Ash content was determined so that Fly Ash can be added most efficiently and according to properties. After the determination of optimum Fly Ash content the mix was prepared according to IS 10262:2009 and IS 456:2000.

Design Mix of M20

As per IS 10262:2009 and IS 456:2000

1. **Stipulation of proportion**

Grade = M20

Type of cement = PPC53 (IS: 1489-2015 part 1)

Mineral Admixture = Fly Ash

Max. Size of Aggregate = 20 mm

Workability = 50-80 mm (slump)

Max w/c ratio = 0.45

Exposure = severe

2. **Test data of Material**

Cement – PPC53 (IS: 1489-2015 part 1)

Specific gravity

1. Cement = 3.15
2. Coarse aggregate = 2.61
3. Fine aggregate (Narmada sand) = 2.74
4. Fly Ash = 2.2

Water Absorption

1. Coarse Aggregate (Compact basalt) = 0.5%
2. Fine Aggregate (Narmada sand) = 1%

Zone of fine aggregate = Zone 3 (IS383)

3. Target Strength of Mix Proportions

Ft = fck +1.65D

Ft = 20 + 1.65*4 [from table IS 10262:2009 page no.1]

Ft = 26.60 N/mm2

4. Selection of W/C Ratio:

Assuming W/C ratio = 0.45

(Taking value from IS 10262:2009 page no.2 and IS 456 table 5)

5. Selection of Water Content

Max. Water content for max. Size of 20 mm aggregate = 186 liters (IS 10262:2009 table 2 page no.3)

6. Calculation for Cement content

W/C Ratio = 0.45

Cement =186/0.45
= 413.33 kg/m3 >320 kg/m3 (min.cement content)
413.33 kg/m3<450 kg/m3 (max.cement content)
As per 1.8.4.2/19 hence ok

7. Proportion of volume of CA and FA contents

From Table 3. volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone 3) for water-cement ratio of 0.50 =0.64. In the present case water-cement ratio is 0.45. Therefore. Volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.05. The proportion of volume of coarse aggregate is increased by 0.01 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio). Therefore. Corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.45 = 0.64+0.01=.65

For pumpable concrete these values should be reduced by 10 percent. Therefore,
Volume of coarse aggregate = 0.65 x 0.9 = 0.58
Volume of fine aggregate content = 1 - 0.58 = 0.42

8. Mix Calculations for 1m3 of concrete

a) Volume of concrete = 1m3
b) Volume of cement
= mass of cement/ (specific gravity*1000)
= 413.33/3.15*1/1000 = 0.131 cum
c) Volume of water
= mass of water/ (specific gravity*1000)
186/1000 = 0.186 cum
d) Volume of all aggregate e = [a-(b+c)]
= [1-0.317] = 0.683 cum
e) Mass of coarse aggregate
= e* volume of ca* sp. gravity* 1000
= 0.683* 0.58*2.74*1000 = 1085.423 kg/m3
f) Mass of fine aggregate
= 0.683*0.42*2.61*1000 = 748.7046 kg/m3

9. Mix Proportions by weight

Cement	= 413.333 kg/m3
Water	= 186 liter
Fine aggregate (Narmada sand)	= 748.704 kg/m3
Coarse aggregate (Compact basalt)	= 1085.423 kg/m3
W/C Ratio 0.45	

10. Mix Proportions for our deign- 150×150×150 mm3 of concrete

150×150×150 = 0.003375 m3 of concrete

Cement	=	413.332	×	0.003375	= 1.394 kg
Water	=	186	×	0.003375	= 0.627 liter
Fine aggregate	=	748.704	×	0.003375	= 2.526 kg
Coarse aggregate	=	1085.423	×	0.003375	= 3.663 kg

W/C Ratio 0.45

QUANTITY OF MATERIAL for one cube of each M20 and M25 for our design

1) Normal concrete cube

Mix	Cement	Coarse aggregate	Fine aggregate	Water
M20	1.394 kg	3.663 kg	2.526 kg	0.627 liter
M25	1.436kg	3.541 kg	2.469 kg	0.646 liter

2) 5% cement replaced with fly ash

Mix	Cement	Fly Ash	Coarse aggregate	Fine aggregate	Water
M20	1.324kg	0.697kg	3.663 kg	2.526 kg	0.627 liter
M25	1.364kg	0.071kg	3.541 kg	2.469 kg	0.646 liter

3) 10% cement replaced with fly ash

Mix	Cement	Fly Ash	Coarse aggregate	Fine aggregate	Water
M20	1.254kg	0.139kg	3.663 kg	2.526 kg	0.627 liter
M25	1.292 kg	0.143 kg	3.541 kg	2.469 kg	0.646 liter

4) 15% cement replaced with fly ash and also added admixture

Mix	Cement	Fly Ash	Coarse aggregate	Fine aggregate	Admixture	Water
M20	0.949kg	0.167kg	3.979kg	2.734kg	0.017kg	0.502liter
M25	0.977kg	0.172kg	3.947kg	2.712kg	0.017kg	0.517liter

5) 20% cement replaced with fly ash and also added admixture

Mix	Cement	Fly Ash	Coarse aggregate	Fine aggregate	Admixture	Water
M20	0.893kg	0.223kg	3.979kg	2.734kg	0.017kg	0.502liter
M25	0.920kg	0.229kg	3.947kg	2.712kg	0.017kg	0.517liter

3. RESULT AND DISCUSSIONS

Each set of 3 cubes of M20 grade and M25 grade of concrete were tested in Compression Testing Machine with 5%, 10%, 15% and 20% replacement of cement with fly ash to determine the compressive strength after 28 days of curing. Average value of these 3 readings gives the average compressive strength of concrete. The compressive strength of M20 grade and M25 grade of concrete for different proportions of fly ash after 28 days of curing are listed below in table respectively.

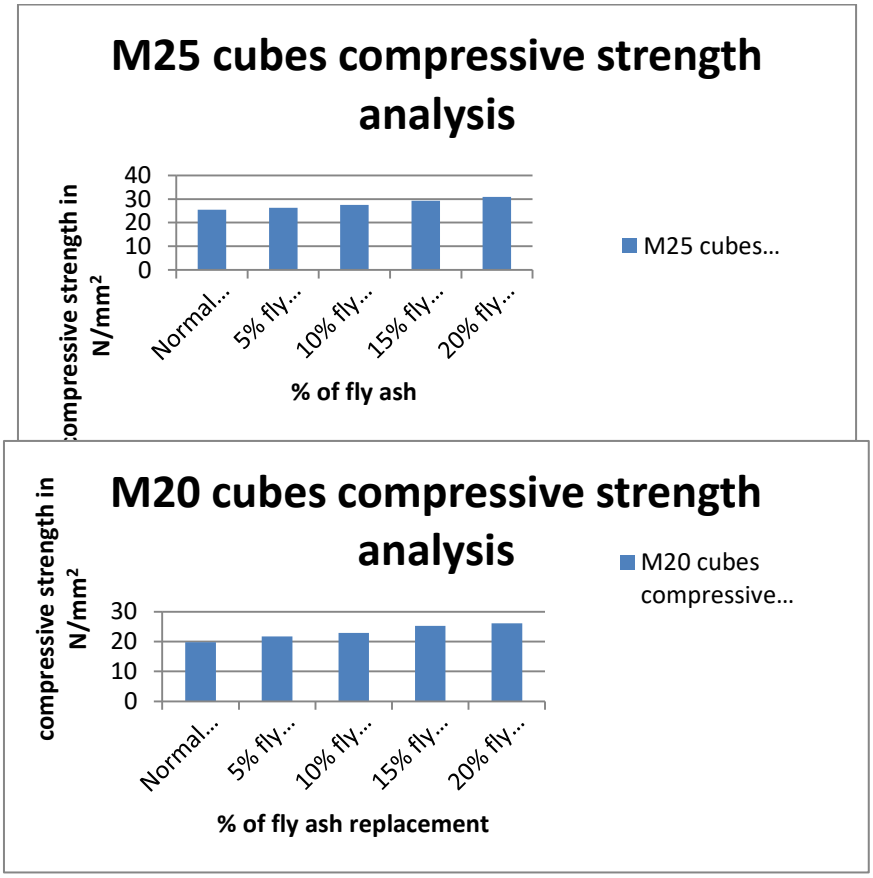
M20 Cubes compressive strength in N/mm^2

Material	Sample1	Sample2	Sample3	Average compressive strength
Normal concrete cube	19.822	20.044	20.266	20.044 N/mm^2
5% cement replaced with fly ash	21.111	21.733	22.311	21.718 N/mm^2
10% cement replaced with fly ash	22.444	23.022	22.377	22.947 N/mm^2
15% cement replaced with fly ash and also added admixture	24.488	25.511	25.866	25.288 N/mm^2
20% cement replaced with fly ash and also added admixture	25.911	26.400	26.133	26.148 N/mm^2

M25 Cubes compressive strength in N/mm^2

Material	Sample1	Sample2	Sample3	Average compressive strength
Normal concrete cube	25.022	25.644	25.911	25.525 N/mm^2
5% cement replaced with fly ash	25.866	26.444	26.711	26.340 N/mm^2
10% cement replaced with fly ash	26.888	27.511	28.044	27.481 N/mm^2
15% cement replaced with fly ash and also added admixture	28.622	29.288	29.911	29.273 N/mm^2
20% cement replaced with fly ash and also added admixture	30.533	31.066	30.977	30.858 N/mm^2

Graphical compression of compressive strength and various percentage of fly ash with or without admixture in M20 and M25 cubes:-



1. The compressive strength of M20 grade of concrete increase with increase in fly ash content. Increase in compressive strength of concrete at the age of 28 days was found to be 1.674% with 5% fly ash, 2.903% with 10% fly ash and when we added admixture with 15 and 20% fly ash compressive strength increases rapidly like 5.244% for 15%, and 6.104 for 20% replacement of cement with fly ash.
2. The compressive strength of M25 grade of concrete increase with increase in fly ash content. Increase in compressive strength of concrete at the age of 28 days was found to be 0.815% with 5% fly ash,1.956% with 10% fly ash and when we added admixture with 15 and 20% fly ash compressive strength increases rapidly like 3.748% for 15%, and 5.3333 % for 20% replacement of cement with fly ash.

COST ANALYSIS:-

Cement (PPC) Cost = 50 kg = 340 Rs / beg
Fly ash class C collected from Chhabra power plant Rajasthan = 0.70 Rs / kg
Sand (Narmada sand) = 0.98 Rs / kg
Coarse aggregate (compact basalt) 20 mm = 0.78 Rs / kg
Plasticizer = 175 Rs / liter

MATERIAL	COST PER KG
Cement (PPC)	6.80Rs
Fly ash class C	0.70Rs
Sand (Narmada sand)	0.98Rs
Coarse aggregate (compact basalt) 20 mm	0.78Rs
Plasticizer	150Rs

COST ANALYSIS FOR M20 MIX DESIGN FOR $1m^3$.

Quantity of material and cost for M20 normal concrete 1 m^3 –

MATERIAL	Quantity	COST
Cement (PPC)	413.333 kg	2810.66Rs
Sand (Narmada sand)	748.704 kg	733.72Rs
Coarse aggregate (compact basalt) 20 mm	1085.423kg	846.62Rs
Water	186litre	

Total cost for M20 normal concrete 1 m^3 = 4391Rs

Quantity of material and cost for M20 1 m^3 when we replaced 20% cement with fly ash and also add plasticizer –

MATERIAL	Quantity	COST
Cement (PPC)	264.534 kg	1798.83Rs
Fly ash class C	66.133 kg	46.29Rs
Sand (Narmada sand)	810.264 kg	794.05Rs
Coarse aggregate (compact basalt) 20 mm	1179.186kg	919.76Rs
Plasticizer	5 kg	750Rs
Water	148.832 liter	

Total cost for M20 mix design 1 m^3 when we replaced 20% cement with fly ash and also add plasticizer – 4308.93Rs

RESULT AND DISCUSSION-

When we replaced 20% cement with fly ash and also add plasticizer compressive Strength increases of concrete and cost reduces as Compared to normal concrete Cubes **83 Rs** (**1.87%**) for $1m^3$ designs and also Quantity of water reduces up to **39 liter** without compromising quality of material.

4. CONCLUSIONS

1) The compressive strength of M20 grade of concrete increase with increase in fly ash Content.
2) The compressive strength of M25 grade of concrete increase with increase in fly ash Content.
3) When we added chemical admixture compressive strength will be shoot up.
4) The workability of concrete improves with the increase in fly ash content.
5) Not more than 30% of cement should be replaced with fly ash; otherwise it may lead to significant reduction in the compressive strength of concrete.
6) The consistency of cement increases with increase in fly ash content. This happens because the consistency of cement depends upon its fineness, and the fly ash molecules are finer than cement.
7) When we replaced 20% cement with fly ash and also add plasticizer compressive Strength increases of concrete and cost reduces as Compared to normal concrete Cubes 83 Rs (1.87%) for $1m^3$ designs and also Quantity of water reduces up to 39 liter without compromising quality of material.

REFERENCES

1. Jatale A, Tiwari K, Khandelwal S. Effects on compressive strength when cement is partially replaced by fly-ash. IOSR Journal of Mechanical and Civil Engineering. 2013; 5(4):34-43p.
2. Kiran TG, Ratnam MK. Fly ash as a partial replacement of cement in concrete and durability study of fly ash in acidic (H2So4) environment. International Journal of Engineering Research and Development. 2014 Dec; 10(12):1-3.
3. Pitroda J, Zala LB, Umrigar FS. Experimental Investigations on Partial Replacement of Cement with Fly ash in design mix concrete. International Journal of Advanced Engineering Technology, IJAET. 2012 Oct; 3(4):126-9.
4. Wankhede PR, Fulari VA. Effect of fly ash on properties of concrete. International Journal of Emerging Technology and Advanced Engineering (IJETAE), ISSN. 2014
5. Muthupriya, P., Subramanium, K., and Vishwaraman, B. (2011).“Investigation on Behaviour of High Performance Reinforced Concrete Columns with Metakaolin & Fly ash as Admixtures”, International Journal of AdvancedEngineering&Technology, Vol 11, Issue1, 190-202.
6. IS. 3812 (Part-I) – Specification for fly ash Bureau of Indian Standards, New Delhi.
7. Indian Standard, Ordinary Portland cement, 33 grade- specification, IS 269: Bureau of Indian Standards, 2000.
8. IS: 383 Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards, New Delhi, 1970.