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Development of High Strength Concrete using Fly Ash and Alccofine

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Abstract: Mechanical properties of concrete is depend up on properties of ingredients and their relative proportion. since last few years the use of high strength concrete is globally used for the construction of strong and durable structure, to produced high strength concrete various supplementary cementitious material require to be used as mineral admixture. By considering the code, the present work deals with the development of fly ash , alccofine based concrete mix proportion to achieve high strength concrete. This paper presents the results of an investigation dealing with Concrete cubes of 150 mm size, to replace 10% and 17 % , cement with fly ash and Alccofine respectively. To acquire a different range of compressive strength of concrete various water cement ratio (W/C) of 0.2, 0.25, 0.3 and 0.35 were used for water content of 174 kg/m3 and 183 kg/m3 for a slump in the range of 1 to 2 inch and 2 to 3 inch. The effect of various parameters such as percentage replacement of mineral admixture, water to cement ratio and corresponding compressive strength is studied on fresh and hardened state of concrete. the objective of this study mainly consisted of developing relation between these parameters in the form of Graphs to specify proportioning of required fly ash, Alccofine based concrete.

Keywords: Mix design, W/C ratio compressive strength, fly ash, Alccofine.

1. Introduction

now a day's Concrete is a common material used for various infrastructure development .Concrete Mix proportioning related to the process of selecting the quantities of concrete ingredients using common materials, to achieve the specified characteristics of the concrete. A properly proportioned concrete mix need to be fulfill the qualities like minimum workability of the freshly mixed concrete, Durability, strength, and homogenous appearance of the hardened concrete along with Economy. ordinary concrete may fail to fulfill these qualities due to more pervious hence this lead to increase the use of high strength concrete. ordinary concrete normally consists of cement, fine aggregate, coarse aggregate and water, however modern high strength concrete is produced by adding supplementary cementitious material as a mineral and chemical admixtures also. Concrete strength has been categorized based on characteristic compressive strength at the age of 28 days. As per IS 456, High strength concrete is a concrete with strength between 60 to 80 MPa. High strength concrete is being produced due to hike in demand for multistoried and larger structures. Such a concrete require the use of supplementary cementitious materials and super plasticizer in order to reduce cement consumption, increase strength, decrease permeability, and improve durability. High strength Concrete is a material which is being used by construction industry for longer performance, strong , durable structures, better mechanical properties than normal strength concrete. due to the use of Mineral admixtures mechanical properties of the mixture get improved reason is that its pozzolanic , self cementitious nature. one more advantage of use of mineral admixtures is that it helps to decrease cost of the mixture upon enhancement of workability of fresh concrete. additionally, fresh concrete mixtures containing mineral admixtures are more cohesive hence help to reduce bleeding. The strength of the binding material in cement paste in concrete depends on the quality and quantity of the reacting paste ingredient and on the degree to which the hydration reaction has continued . Concrete becomes stronger with time when there is moisture and a suitable temperature available. Therefore, the strength at any age is depend on the original w/c ratio and the degree to which the cementitious materials have hydrated. Now a day's design of High strength Concrete mixes has became more complex with the addition of mineral as well as chemical admixture in concrete. Therefore Bureau of Indian standard has revised concrete mix proportioning code IS 10262 - 2009. This code is now in use to design concrete mixes using both mineral as well as chemical admixtures but not handy for developing high strength concrete. thus the aim of these work to study effect of various parameters such as percentage replacement of mineral admixture, water to cement ratio and corresponding compressive strength is studied on fresh and hardened state of concrete. the objective of this study mainly consisted of developing relation between these parameters in the form of Graphs to specify proportioning of required fly ash, Alccofine based concrete.

2. Experimental Programme

2.1 Selection Of Different Parameters: To proportioned High strength Concrete by using different cementitious martial like Fly Ash, Alccofine based concrete mixes were casted and tested in fresh and hardened state. Concrete cubes of 150 mm size were made for concrete mix proportioned to replace 10%, 17%, cement with fly ash and Alccofine respectively with fly ash, and Alccofine respectively. To cover a wide range of concrete mixes water to cement ratio (W/c) of 0.2,0.25, 0.3 and 0.35 were used for water content of 174 kg/m3 and 183 kg/m3 for a slump in the range of 1 to 3 inch. The dosages of super plasticizer keep constant throughout the work as 0.1% by mass of total cementitious material. In fresh state workability is measured in terms of slump. In hardened state, compressive strength is tested using Compression Testing Machine.

2.2. Design Data For Proportioning

1) Type of cement: OPC 53 grade, confirming to IS: 12269-1987
2) NMS of aggregate: 12.5mm
3) Exposure condition: Moderate
4) Degree of supervision: Good

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5) Type of aggregate: Crushed angular

6) Chemical admixture: S.P. 0.1% by mass of total cementitious material.

2.3. Materials

Locally available river sand passing through 4.75 mm IS sieve confirming to grading zone II as per IS-383 1970 [9] with fineness modulus 2.71 and was of specific gravity 2.73. coarse aggregate maximum size of 12.5 mm as well as graded crushed granite stone with a specific gravity of 2.88, Confirming to IS 383 were used. fly ash Pozzocrete P-100 grade of dirk India Pvt Ltd and Alcofine were used as mineral admixtures. the Polycarboxyle based super plasticizer was used to obtain the required workability. water absorption of coarse and fine aggregate found to be 1.25% and 0.18% respectively.

Alccofine- Alccofine 1203 is proprietary low calcium silicate based mineral additive Controlled granulation process results in unique particle size distribution. Alccofine has particle range 3.5 to 6.5 microns, average particle size is 4.1 micron. specific gravity of Alccofine is 2.

Table: 1. Physical Properties of Alccofine

Property	Unit	Value
Average Particle Size	Micron	3.5 to 6.5
Fineness	Cm2 / gm	13100
Specific Gravity	-----	2.83
Bulk Density	Kg / M3	620 to 715

Fly Ash- Fly ash used as cementitious material is a product of DIRK India Private Ltd Maharashtra, India confirming to IS-3812-part I and is of pozzocrete P100grade of class F.

Table: 2. Physical Properties of Fly Ash-

Sr. No.	Description of Test	Results
01	Specific Gravity	2.78
02	Colour	whitish Gray
03	Bulk Weight	Approx. 0.93 metric ton per cubic meter
04	Specific density	Approx. 2.43 metric ton per cubic meter
05	Average Particle size	0.135mm
06	Particle shape	Spherical

Superplastisizer- superplastisizer used was Polycarboxyle base super plasticizer with 43% solid content and a specific gravity of 1.98. The superplastisizer was added in all mixes and the content was adjusted slightly for some mixes to maintain the same degree of workability.

Fine aggregates- Locally available river sand was used as fine aggregate. The sand used was having fineness modulus 2.73 confirmed to grading zone-II as per IS: 383-1970 specification.

3. Mix Proportions for different W/C ratio :

Table: 3.1 for 1M^3 concrete (w/c -0.2, slump 1-2 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	495.37
2	Fly Ash (10 % of CM)	115.36
3	Alccofine	67.86
4	Fine Aggregate	584.06
5	Coarse Aggregate	1039
6	Water	149
7	Super plasticizer	6.78
8	Water cement Ratio	0.2

Table: 3.2 for 1M^3 concrete (w/c -0.25, slump 1-2 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	396.3
2	Fly Ash (10 % of CM)	92.28
3	Alccofine	54.28
4	Fine Aggregate	633.24
5	Coarse Aggregate	1130.55
6	Water	150.99
7	Super plasticizer	5.43
8	Water cement Ratio	0.25

Table: 3.3 for 1M^3 concrete (w/c -0.3, slump 1-2 Inch)

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Sr. No	Material	Weight of Material in kg/m^3
1	Cement	330.25
2	Fly Ash (10 % of CM)	77
3	Alccofine	45.24
4	Fine Aggregate	665
5	Coarse Aggregate	1187.5
6	Water	152
7	Super plasticizer	4.53
8	Water cement Ratio	0.3

Table: 3.4 for 1M^3 concrete (w/c -0.35, slump 1-2 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	283.4
2	Fly Ash (10 % of CM)	65.92
3	Alccofine	38.78
4	Fine Aggregate	682
5	Coarse Aggregate	950
6	Water	148.2
7	Super plasticizer	3.89
8	Water cement Ratio	0.35

Table: 3.5 for 1M^3 concrete (w/c -0.2, slump 2-3 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	499
2	Fly Ash (10 % of CM)	143
3	Alccofine	71.37
4	Fine Aggregate	575
5	Coarse Aggregate	1002.4
6	Water	156.3
7	Super plasticizer	7.13
8	Water cement Ratio	0.2

Table: 3.6 for 1M^3 concrete (w/c -0.25, slump 2-3 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	416.8
2	Fly Ash (10 % of CM)	97.06
3	Alccofine	57.09
4	Fine Aggregate	616.81
5	Coarse Aggregate	1100.5
6	Water	157.6
7	Super plasticizer	5.7
8	Water cement Ratio	0.25

Table: 3.7 for 1M^3 concrete (w/c -0.3, slump 2-3 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	347.33
2	Fly Ash (10 % of CM)	80.88
3	Alccofine	47.58
4	Fine Aggregate	649.85
5	Coarse Aggregate	1160.2
6	Water	158.40
7	Super plasticizer	4.75
8	Water cement Ratio	0.3

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Table: 3.8 for 1M^3 concrete (w/c -0.35, slump 2-3 Inch)

Sr. No	Material	Weight of Material in kg/m^3
1	Cement	297.71
2	Fly Ash (10 % of CM)	69.33
3	Alccofine	40.78
4	Fine Aggregate	670.47
5	Coarse Aggregate	1199.62
6	Water	158.85
7	Super plasticizer	4.07
8	Water cement Ratio	0.35

4. Results and Discussion:

Workability in terms of slump: To study the behavior of concrete in fresh state, two different water content i.e. 174 kg/m3, 183 kg/m3 were selected for each W/C ratio. and dosage of superplastisizer was kept constant as 1% by weight of cementitious material and fly ash alcofine were used as 10% and 17% respectively. for these data Graph 1 and Graph 2 shows the behavior of workability in terms of slump, for W/C ratio of 0.2, 0.25, 0.3 and 0.35. from the result it is observed that for a given W/C ratio and for given water content the w/c ratio 0.2 needs higher dosage of superplastisizer to achieved required workability. To achieve required workability for a particular water cement ratio, water content can be selected from Graph 1 and Graph 2, for considered percentages of fly ash and alcofine

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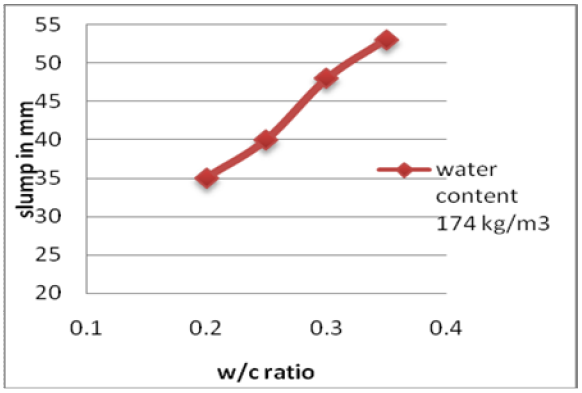
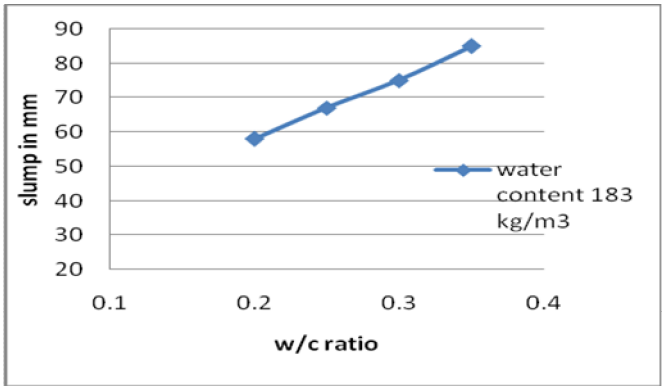
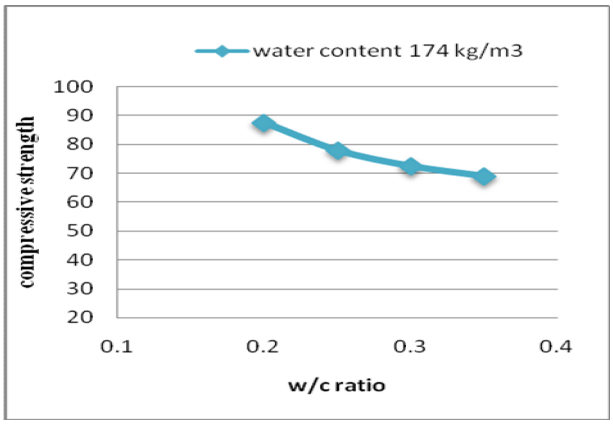


Graph-01

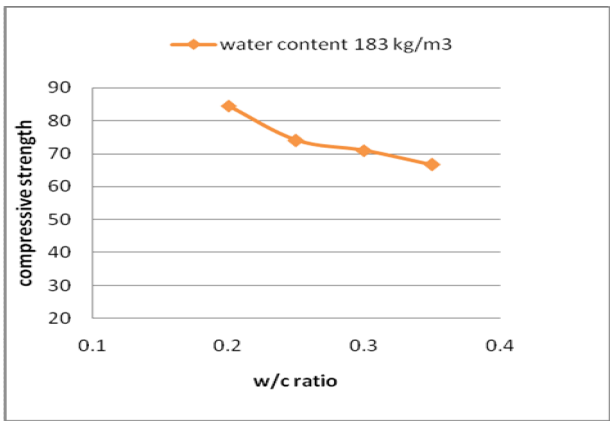


Graph-02

Compressive strength: The results for compressive strength for 28 days obtained from the experimental investigation for water content 174 kg/m3 and 183 kg/m3 are represented graphically in Graph 3 and Graph 4 respectively. from the graph it is observed that as the water content increases workability increase but simultaneously its strength decreases for the same w/c ratio but different water content.



Graph-03



Graph-04

5. Conclusion

Following conclusions are drawn based on the experimental results.

1. The compressive strength of concrete containing different amount of water content for same w/c ratio , are within +/- 10 percent of average value.
2. Graph 1 and Graph 2 shows the workability in terms of slump for w/c ratio of 0.25, 0.3 and 0.35, from these graph one can select the water content directly for reference mix.
3. To obtained desired workability for same amount of fly ash and alccofine as a replacing material for different water content for 0.2 w/c ratio needs to be use of more dosage of superplastisizer.
4. from the relationship between water cement ratio and 28 days compressive strength of concrete one can select w/c ratio from graph 3 and 4.
5. cementitious material content can calculated by referring water content and w/c ratio from these graph.

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