HIGH STRENGTH CONCRETE DESIGN (M80)

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Abstract: *Since a very long time, concrete has been a key component of building a solid and dependable infrastructure. In the past, construction projects have generally employed concrete with compressive strengths of 20–40N/mm². Long-term poor performance of a due to degradation, desire for increasingly complex structural forms typical concrete sped up research to create concrete that would be successful in all areas. workability, durability, and affordability that a novel material is assessed on, allowing the development of in addition to delivering materials that will have extra-ordinary lean designs, ecological and economical structures. Long-term improved performance and lower maintenance requirements. High Strength Concrete's development has been a significant development in concrete technology. A significant advance in concrete technology has been the creation of high strength concrete. Although greater strengths have been obtained and employed, high strength concrete (HSC) is defined as concrete having a specific characteristic cube strength between 40 and 100 N/mm2. For both precast and in situ works, strength values between 80 and 100 N/mm2 and even higher are being utilised. When weight reduction is crucial or when architectural considerations call for fewer load-bearing parts, high strength concrete is required.*

Keywords: *High strength concrete (HSC), compressive strength, cost-effective*

1. INTRODUCTION:

High-quality materials are carefully chosen, and mixing patterns are adjusted to produce high-strength concrete. Due to the very low w/b ratio of 0.25 to 0.35, such concrete often has low water-binder ratios, making superplasticizers necessary to ensure appropriate workability. It's also highly advised to employ a mineral additive. The coarse aggregates have to be square or spherical. A hsc is in order to create high strength concrete, it is necessary to use concrete that is stronger and more durable than regular concrete. This concrete includes one or more cementitious components, such as fly ash, silica fumes, or powdered granulated blast furnace slag, as well as a super plasticizer, in most cases. Complete understanding of the varied qualities of these constituent elements is necessary for the design of the concrete mix. Because they need less mixing water than standard super plasticizers—more specifically, pc (polycarboxylate ether) or naphthalene-based super plasticizers—they are utilised A pc-based super plasticizer (which can reduce the amount of mixing water by 30%) and 5–10%silica fume will be needed for high strength concrete (m60 and above) mixes, which are typically OPC 53-grade. In this study, mix design is done with m80 grade concrete.

2. USED MATERIALS:

- Cement: In concrete, cement serves as a binding component. OPC 53 grade cement is employed in this study. The cement is grey in tone. The cement has a specific gravity of 3.15. Initial and ultimate setup times are 30 and 600 minutes, respectively.

- Fine gravel: Fine aggregate is made of river sand. The fine aggregate has a specific gravity of 2.16. One percent of fine aggregate can absorb water. According to sieve analysis, fine aggregate belongs to zone II and has a fineness modulus of 2.319.

- Coarse aggregate: In this research, stones obtained from crushed rocks are employed as coarse aggregate. weight of the fine. The total is 2.74. It absorbs 0.5% more water than usual. length of 40% of aggregates between 4 and 10 mm are considered coarse. 60 percent of 10mm to 20mm aggregate. The aggregates are pure. robust, durable particles without coatings or absorbed compounds of fine materials, like as clay.

- Water: The lone factor with the greatest impact on most of the quantity of water used in the mixture determines all of the qualities. Water that is suitable for human consumption generally use water for mixing. Free water should be utilised to prepare concrete. from biological substances and soil.

- Super plasticizer: The next generation of these admixtures is represented by super plasticizers made of polycarboxylate ether. Due to their chemical composition and relatively moderate dose (0.15-0.3% by cement weight), they provide a water reduction of up to 40%. A configuration that promotes effective particle dispersion

3. MIX DESIGN

1) Design Stipulations:

a) Grade Designation : M80

b) Type of Cement : OPC - 53 Grade

c) Maximum nominal size of the aggregate: 10mm

d) Exposure condition: Severe (IS456-2000 reinforced concrete)

f) Workability or slump: 75 mm-100mm (IS 456-2000)

g) Method of Concrete placing: Direct Pouring - Manual

h) Degree of supervision: Good

j) Type of Aggregates : Crushed, angular aggregates

k) Minimum cement content 450 kg/m3(IS 456-2000 - reinforced concrete)

m) Chemical admixture: Superplasticizer

2) Test Data of Material:

a) Type of Cement: OPC - 53 Grade
b) Specific Gravity of Cement: 3.15
c) Specific Gravity of Aggregates:
1)Coarse Aggregates M2, M1: 2.93
2) Fine Aggregates - Sand : 2.61
3) GGBS: 2.85
4) Ultrafine: 2.90
5) Chemical Admixture: 1.08
d) Water absorption of aggregates:
1) Coarse Aggregates M2, M1: 0.5%
2) Fine Aggregates - Sand: 1.00%
e) Free Moisture Content of aggregates:
1) Coarse Aggregates M2, M1: Nil
2)Fine Aggregates – Sand: Nil

3) Target Mean Strength

a) Characteristic Strength of Concrete, Fck: 80N/mm^2
b) Standard Deviation: 8.00 (Table 1&2 - IS 10262) Multiplying Factor: 1.65
c) Target Average Strength of Concrete, f'ck: fck+1.65x Standard Deviation
d) Target Mean Strength: 93.2 N/mm^2

4) Entrapped Air: 1.00(IS10262 - 2019, Table 6)

5) Selection of Water to Cementitious material Ratio: Recommended W/CM ratio for High Strength Concrete made with or concrete with 10 mm nominal size of aggregates.

Water–Cementitious Materials Ratio: 0.32
(IS 10262 - 2019, Table 8)

6) Selection of Water Content:

a) Water Content for concrete with 10 mm nominal size of aggregate: 200 Kg/m^3. For Slump = 50 mm without using the Plasticizers
(IS 10262 - 2019, Table 7)

b) As per clause - 6.2.4: The required water content may be increased or decreased by about 3 percent for each increase or decrease of 25 mm slump or may be established by trial mix.

c) Estimated Water Content for Slump of 75 mm: {200+ (3 /100) *200} : 206.54 Kg/m^3
Say: 206 Kg/m^3

d) We are using the super plasticizer, as per clause - 6.2.4: by using super plasticisers reduces water content by 30 percent Reduced Water Content for Slump of 75 mm :206 x 0.70
:144.2 Kg/m^3

e) As we are using Maximum Nominal size of the aggregate as 10 mm, we can reduce the water content by 5 %
: 144.2 x 0.95
: 136.99 Kg/m^3
Say: 135 Kg/m^3

7) Calculation of Cement Content:

a) Water–Cementitious Materials Ratio: 0.32
b) Water Content for Slump of 75 mm: 135 Kg/m^3
Cementitious Materials Content: 135/0.32
:421.875 Kg/m^3
Required - Cementitious material: 425 Kg/m^3
c) It is planned to add GGBS and Ultra fines to the concrete. We are using the following proportion
Planned to use OPC 53 Grade Cement
: 445 Kg/m^3
Planned to use GGBS @ 30% : 127.5 Kg/m^3

Say GGBS : 135 Kg/m^3
Planned to use Ultrafine 8 % : 34 Kg/m^3

Say Ultrafine : 37.5 Kg/m^3
Total Cementitious Materials : 617.5 Kg/m^3

d)Revised Water Cement Ratio
Water Cement Ratio= Water Content /Total Cementitious Material= 0.219

8) Proportionating the Volume of Coarse Aggregates and Fine Aggregates:

(IS 10262 - 2019, Table 10), The Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Zone I Fine Aggregate for Water-Cement/Water-Cementitious Material Ratio of 0.28

a) The fine aggregates confirm to Zone – Coarse Aggregate Volume: For 10 mm nominal maximum size. Hence from Table 10, the ratio Volume of the coarse aggregates 0.52 per unit volume of the total aggregates

b) Fine Aggregate Volume :1- 0.52 = 0.48 per unit volume of the total aggregates.

9) Mix Calculations:

a) Total Volume: 1 Cu. M.

b) Volume of Entrapped air is 1 %: 0.010 Cu. M. in wet concrete

c) Volume of cement:

$$\frac{\text{Mass of Cement}}{\text{Specific Gravity of Cement}} \times \frac{1}{1000}$$

$$\frac{445}{3.15} \times \frac{1}{1000}$$

= 0.141 m^3

d)Volume of Water:

$$\frac{\text{Mass of Water}}{\text{Specific Gravity of Water}} \times \frac{1}{1000}$$

$$\frac{135}{1} \times \frac{1}{1000}$$

= 0.135m^3

e) Volume of GGBS:

$$\frac{\text{Mass of GGBS}}{\text{Specific Gravity of GGBS}} \times \frac{1}{1000}$$

$$\frac{135}{2.85} \times \frac{1}{1000}$$

=0.047 m^3

f) Volume of Ultrafine:

$$\frac{\text{Mass of Ultrafine}}{\text{Specific Gravity of Ultrafine}} \times \frac{1}{1000}$$

$$\frac{37.5}{2.90} \times \frac{1}{1000}$$

=0.047 m^3

g) Volume of Admixture:

Superplasticizer @ 1% by mass of cementitious materials

$$\frac{\text{Mass of Admixture}}{\text{Specific Gravity of Admixture}} \times \frac{1}{1000}$$

$$\frac{617.5 \times 1\%}{1.08} \times \frac{1}{1000}$$

=0.0062 m^3

h) Volume of All in Aggregates:

[(a-b)-(c+d+e+f+g)]

(1-0.010) - (0.141 +0.135 +0.047 +0.013 +0.0062)

= 0.647 m^3

i) Mass of Fine Aggregates:

(h) x Volume of Fine aggregates x Sp. Gravity of Coarse Aggregates x 1000

(0.647) x (0.480) x (2.61) x 1000

=0.647 m^3

k) Mass of Coarse Aggregates:

(h) x Volume of coarse aggregates x Sp. Gravity of Coarse Aggregates x 1000

(0.647) x (0.520) x (2.93) x 1000

986.159 Kg

950 Kg

10) Mix Proportions for Trial Mix with Aggregates In - SSD Condition

Cement:	445 kg/ m^3
GGBS:	135 kg/ m^3
Ultrafine:	37.5 kg/ m^3
Water:	135 kg/ m^3
Fine aggregates, sand:	775 kg/ m^3
Coarse Aggregates C.A. - 10 mm:	950 kg/ m^3
Admixture:	6.67 kg/ m^3
W/ cm ratio:	0.219 kg/ m^3
Density of the concrete Mix:	2484.4 kg/ m^3
Density of the concrete Mix:	2.484 Tons / m^3

4. RESULTS.

Trial A (compressive test results)

The 7-day and 28-day compressive test result of Trial

A are given in the following table

a) 7-day Cube Test:

Date of Casting	Date of Testing	Weight in Kg	Load taken by cube in (KN)	Compressive strength In N/mm^2	Average compressive test
1/2/22	8/2/22	8.43	1316.7	58.52	59.85N/m^2
		8.44	1371.4	60.95	
		8.56	1351.6	60.07	

a) 28-day Cube Test:

Date of Casting	Date of Testing	Weight in Kg	Load taken by cube in (KN)	Compressive strength In N/mm^2	Average compressive test
1/2/22	1/3/22	8.58	1966.1	87.38	83.56N/m^2
		8.62	1844.7	81.99	
		8.55	1834.2	81.32	

5. CONCLUSION

Superplasticizer is necessary for workability because the water cement ratio in high strength concrete mixtures is low. In this project superplasticizers were used about 2%. The compressive strength after 7 days of curing was 59.85N/mm^2. The compressive strength after 28 days of curing was 83.56 N/mm^2. High-strength concrete is necessary for high rise buildings. Construction of high-rise buildings frequently involves the use of high-strength concrete. It has been utilised in foundations, shear walls, columns (particularly on lower levels where the weights are greater). Bridge applications can occasionally make use of high strengths.

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