ABSTRACT OF THE CONCRETE MIX DESIGN (2024)

EVENT – CONSTRENGTHO

TEAM - CONCRETE MAGICIAN

SUBMITTED BY: -

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Given data :-

- Grade designation : M45
- Type of cement : OPC43
- Maximum nominal size of aggregate : 20 mm
- Exposure conditions : Moderate (IS 456 :2000 Table-3)
- Workability : 75-100 mm (slump)
- Minimum cement content : 300 kg/m3(IS 456 :2000 Table-5)
- Maximum cement content : 450 Kg/m3(IS 456 : 2000 cl.8.2.4.2)
- Chemical admixture type : Superplasticizer(High range water reducing)
- Specific gravity of cement : 3.15
- Properties of aggregate:

Properties	Coarse Aggregate		Fine Aggregate
	20mm	10mm	Zone 2 Sand
Specific Gravity	2.62	2.64	2.66
Dry rodded bulk density	1516.66 kg/m3 (1.51666 g/cc)	1448.52 kg/m3 (1.44852 g/cc)	----
Water absorption/adsorption	0.6%	0.45%	2.45%

- Grading proportion of coarse aggregate 20mm and 10mm is 30% and 70% respectively.
- Sand is zone-II

Step-1 TARGET STRENGTH FOR MIX PROPORTIONING

f'ck = fck+1.65*S or

f'ck = fck + X whichever is higher.

Where

f'ck = target average compressive strength at 28 days,

fck = characteristic compressive strength at 28 days,

S = standard deviation, and

X = factor based on grade of concrete.

From Table 2 and clause 4.2.1.3, Page No. 3 (IS 10262 : 2019), standard deviation, S = 5 N/mm^2.

From Table 1 and clause 4.2, Page No. 3 (IS 10262 : 2019), X = 6.5 N/mm^2

Therefore, target strength using both equations, that is,

a) f'ck = fck+1.65 S
   = 45+1.65 × 5 = 53.25 N/mm^2
b) f'ck = fck + 6.5
   = 45 + 6.5 = 51.5N/mm^2

The higher value is to be adopted. Therefore, target strength will be **53.25N/mm2** as 53.25 N/mm2 >51.5N/mm2.

Step 2 SELECTION OF WATER-CEMENT RATIO:-

By clause 5.1 , Page No. 3 and 4 (IS 10262 : 2019)

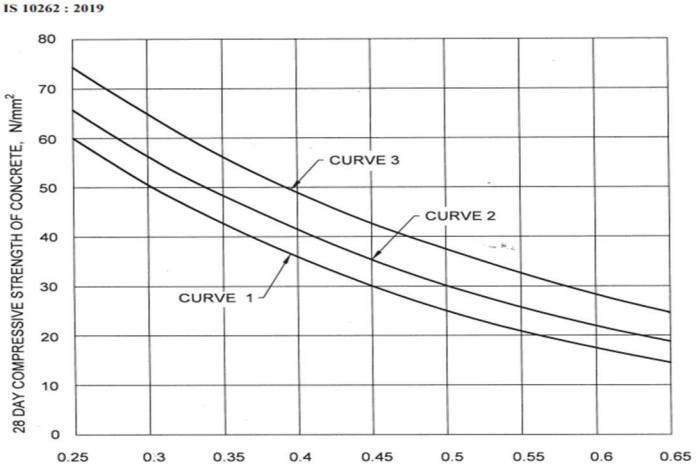

FIG 1. RELATIONSHIP BETWEEN FREE WATER CEMENT RATIO AND 28 DAYS COMPRESSIVE STRENGTHS OF CONCRETE FOR CEMENTS OF VARIOUS EXPECTED 28 DAYS COMPRESSIVE STRENGTHS

The free water-cement ratio required for the target strength of 53.25N/mm2 is 0.33 for OPC 43 grade curve. This is lower than the maximum value of 0.5 prescribed for 'Moderate' exposure for reinforced concrete as per Table 5 and clause 6.1.2, 8.2.4.1 and 9.1.2 as IS 456 : 2000.

0.33< 0.50 (OK)

Step-3 SELECTION OF WATER CONTENT :-

From Table 4 and clause 5.3 , Page No. 5 of IS 10262 : 2019
water content = 186 kg (for 25- 50 mm slump) for 20 mm aggregate.

Now, Water corrections:-

Correction-1:-

$$\boldsymbol{Void\ percent} = \frac{\textbf{specific gravity} - \textbf{bulk density}}{\textbf{specific gravity}} \times \mathbf{100}$$

And **Angularity =** $\boldsymbol{Void\ percent - 33}$

If the void is 33 percent, the angularity of such aggregate is considered to be zero. If the void is 44 percent, the angularity of such aggregate is considered to be 11. The normal aggregates which are suitable for making the concrete may have the angularity number anything from 0 to 11. Angularity zero represents the most practicable rounded aggregates and the angularity 11 indicates the most angular aggregates.

Angularity	Water Reduced
0	20
3	15
8	10
11	0

For 20mm :-

$$Void\ percent = \frac{2.62 - 1.51666}{2.62} \times 100 = 42.11\ \%$$

For 10mm:-

$$Void\ percent = \frac{2.64 - 1.44852}{2.64} \times 100 = 45.13\ \%$$

Average Void ratio :-

$$Average\ Void\ percent = \frac{42.11 \times 30 + 45.13 \times 70}{10} = 44.22\ \%$$

Angularity No. = $Average\ Void\ percent - 33$
= 44.22-33
= 11.22 ≈ 12

Here, the Angularity No. is 12 . So, there is no requirement of water reduction.

Correction-2:-

For increasing of 25mm slump after 50mm slump -> add 3% (IS 10262 : 2019 cl.5.3,Page No. 5)
Estimated water content for 75 -100 mm slump = $186 + 6 \times \frac{186}{100}$
= **197.16 Kg**

Correction-3:-

Water reducing admixture or super plasticizing admixtures usually decrease water content by 20 to 30 percent. (IS 10262 : 2019 cl.5.3, Page No. 5)

Assuming decrease water content 25 %

Now water content:-

water content = 197.16 - $\frac{25}{100} \times 197.16$

water content = 147.87 Kg

Step-4 CALCULATION OF CEMENT CONTENT:-

Water-cement ratio = 0.33

Cement Content = $\frac{water\ Content}{water\ cement\ ratio} = \frac{147.87}{0.33} = 448.10\ Kg/m3$

Cement Content = 448.10 Kg/m3 > 300 Kg/m3 (IS 456 Table-5) .....**OK**

Cement Content = 448.10 Kg/m3 < 450 Kg/m3 (IS 456 cl.8.2.4.2) .....**OK**

Step-5 AGGREGATE PROPORTION BETWEEN COARSE AGGREGATE AND FINE AGGREGATE :-

IS 10262 : 2019, Table 5 , cl.5.5.1,Page-5

The proportionate volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 = 0.62. In the present case water-cement ratio is 0.33.

For a water-cement/water cementitious materials ratio of 0.5, which may be suitably adjusted for other ratios, the proportion of volume of coarse aggregates to that of total aggregates is increased at the rate of 0.01 for every decrease in water-cement/cementitious materials ratio by 0.05 and decreased at the rate of 0.01 for every increase in water cement ratio by 0.05.

$$\textbf{Coarse aggregate proportion} = 0.62 + 0.01 \times \left(\frac{0.5-0.33}{0.05}\right) = 0.654$$

Volume of fine aggregate content = 1 – 0.654 = 0.346

Step-6 MIX CALCULATIONS:-

The mix calculations per unit volume of concrete shall be as follows:

a) **Total volume** = 1 m3

b) **Volume of entrapped air in wet concrete** = 0.01 m3

c) **Volume of cement** =

$$\frac{\text{Mass of cement}}{\text{Specific gravity of cement} \times 1000} = \frac{448.10}{3.15 \times 1000} = 0.142\ m\text{^}3$$

d) **Volume of water** =

$$\frac{\text{Mass of water}}{\text{Specific gravity of water} \times 1000} = \frac{147.87}{1 \times 1000} = 0.148\ m\text{^}3$$

e) **Volume of chemical admixture (superplasticizer) (@ 0.7 percent by mass of cementitious material)** =

$$Mass\ of\ chemical\ admixture = \frac{0.7}{100} \times 448.10 = 3.137\ Kg$$

$$\frac{Mass\ of\ chemical\ admixture}{\text{Specific gravity of } admixture \times 1000} = \frac{3.137}{1.17 \times 1000} = 0.0027\ m\text{^}3$$

f) Volume of all in aggregate = [(a-b)-(c+d+e)]

= [(1-0.01)-(0.142+0.148+0.0027)]

= 0.6973 m^3

g) Mass of 20mm coarse aggregate =

= 0.30 × f × Volume of coarse aggregate × Specific gravity of 20mm coarse aggregate × 1000

= 0.30 × 0.6973 × 0.654 × 2.62 × 1000

= 358.443 Kg

h) Mass of 10mm coarse aggregate =

= 0.70 × f × Volume of coarse aggregate × Specific gravity of 10mm coarse aggregate × 1000

= 0.70 × 0.6973 × 0.654 × 2.64 × 1000

= 842.751 Kg

i) Mass of fine aggregate =

= f × volume of fine aggregate × Specific gravity of fine aggregate × 1000

= 0.6973 × 0.346 × 2.66 × 1000

= 641.767 Kg

Step-7 MIX PROPORTIONS FOR TRIAL NUMBER 1 :-

Cement	**448.10 Kg/m^3**
Water	**147.87 Kg/m^3**
Fine aggregate (SSD)	**641.767 Kg/m^3**
20mm Coarse aggregate (SSD)	**358.443 Kg/m^3**
10mm Coarse aggregate (SSD)	**842.751 Kg/m^3**
Chemical admixture	**3.137 Kg/m^3**
Free water-cement ratio	**0.33**

Step-8 ADJUSTMENT ON WATER, FINE AGGREGATE AND COARSE AGGREGATE (IF THE COARSE AND FINE AGGREGATE IS IN DRY CONDITION) :-

a) Fine Aggregate (Dry) :-

$$\frac{\text{Mass of fine aggregate in SSD condition}}{1+\frac{\text{Water Absorption}}{100}} = \frac{641.767}{1+\frac{2.45}{100}} = 626.42\ Kg/m\text{^}3$$

b) 20mm Coarse Aggregate (Dry)

$$\frac{\text{Mass of 20mm aggregate in SSD condition}}{1+\frac{\text{Water Absorption}}{100}} = \frac{358.443}{1+\frac{0.6}{100}} = 356.31\ Kg/m\text{^}3$$

c) 10mm Coarse Aggregate (Dry)

$$\frac{\text{Mass of 10mm aggregate in SSD condition}}{1+\frac{\text{Water Absorption}}{100}} = \frac{842.751}{1+\frac{0.45}{100}} = 838.98\ Kg/m\text{^}3$$

The extra water to be added for absorption by coarse and fine aggregate,

1) **For 20mm coarse aggregate** =

= Mass of 20mm coarse aggregate in SSD condition – mass of 20mm coarse aggregate in dry condition

= 358.443 - 356.31

= 2.133 Kg

2) **For 10mm coarse aggregate** =

= Mass of 10mm coarse aggregate in SSD condition – mass of 10mm coarse aggregate in dry condition

= 842.751- 838.98

= 3.771 Kg

3) **For fine aggregate** =

= Mass of fine aggregate in SSD condition – mass of fine aggregate in dry condition

= 641.767-626.42

= 15.347 Kg

The estimated requirement for added water, therefore, becomes

= 147.87 + 2.133 + 3.771 + 15.347

= 169.121 kg/m3

Step-9 MIX PROPORTIONS AFTER ADUSTMENT FOR DRY AGGREGATES :-

IN 1m^3 Concrete:-

Materials	Approx amount
Cement	**449 Kg/m^3**
Water	**169 Kg/m^3**
Fine aggregate (SSD)	**627 Kg/m^3**
20mm Coarse aggregate (SSD)	**357 Kg/m^3**
10mm Coarse aggregate (SSD)	**839 Kg/m^3**
Chemical admixture	**3.137 Kg/m^3**
Free water-cement ratio	**0.33**

Step-10 CONCRETE RATIO:-

CONCRETE RATIO

= Cement : Fine aggregate : 20mm coarse aggregate: 10mm coarse aggregate : water

= 449 : 627 : 357 : 839 : 169

= **1 : 1.40 : 0.80 : 1.87 : 0.38**

Density of concrete = (1 + 1.4 + 0.8+1.87 + 0.38) * 449

= 2447.05 Kg/m^3

Calculation for 3 concrete cubes:-

Volume of 3 cubes = 3 x 0.15 x 0.15 x 0.15
= 0.010125 m^3
Consider Wastage material of concrete = 25%

Total volume of concrete = 0.010125 x (1+0.25)
= 0.0127 m^3

CONCRETE RATIO :-

	Cement	FA	20mm	10mm	Admixture	water
1m^3	449 kg	627 kg	357 kg	839 kg	3.137 kg	169 kg
0.0127 m^3	5.7023 kg	7.96 kg	4.53 kg	10.66 kg	0.04 Kg	2.146
					34.3 ml	2.146 litre