Concrete Mix Proportioning

1. IS 10262 : 2009
2. IS 456 : 2000

Concrete mix design

A-1 Stipulation for proportioning

1. Grade designation → M-25
2. Type of cement → OPC 53 grade confirming to IS 12269 - 1987
3. Maximum nominal aggregate size → 20 mm
4. Minimum cement content → 310 kg/m³
5. Maximum water cement ratio → 0.45
6. Workability → 50 - 75 mm (slump)
7. Exposure condition → Normal
8. Degree of supervision → Good
9. Type of aggregate → Crushed angular aggregate
10. Maximum cement content → 540 kg/m³
11. Chemical admixture type → Superplasticiser
1. cement used → coromandal king
   opc - 53 grade
2. Specific gravity of cement → 3.15
3. Specific gravity of water → 1.00
4. chemical admixture → BABF chemicals company
5. Specific gravity of 20mm aggregate → 2.884
6. Specific gravity of 10mm aggregate → 2.878
7. Specific gravity of sand → 2.605
8. water absorption of 20mm aggregate → 0.97%
9. water absorption of 10mm aggregate → 0.83%
10. water absorption of sand → 1.23%
11. Free (surface) moisture of 10mm aggregate → nil
12. Free (surface) moisture of 20mm aggregate → nil
13. Free (surface) moisture of sand → nil
14. Sieve analysis of combined coarse aggregate → separate analysis done
15. Sieve analysis of individual coarse aggregate → separate analysis done
16. Specific gravity of combined coarse aggregate → 2.882
17. Sieve analysis of fine aggregate → Separate analysis done
A-3 Tangent G+10

Target strength for mix proportioning

1. Target mean strength → 3.6 N/mm²
2. Characteristic strength → 25 N/mm²
   at 28 days

A-4

Selection of water cement ratio

1. Maximum water cement ratio → 0.45
2. Adopted water cement ratio → 0.43

A-5

Selection of water content

1. Maximum water content → 186 lit
   [10262 - Table 2]
2. Estimated water content for 50 - 75 mm
   slump → 128 lit
3. Superplasticiser used → 0.5% by weight
   of cement.
M30 Mix designs as per IS- 10262 - 2009

A - 1 Stipulation for proportioning

1. Grade designation → M-30
2. Type of cement → OPC 53 grade confirming to IS- 12269 - 1987
3. Maximum nominal aggregate size → 20 mm
4. Minimum cement content → 310 kg/m³
5. Maximum water cement ratio → 0.45
6. Workability → 50 - 75 mm (slump)
7. Exposure condition → Normal
8. Degree of Supervision → Good
9. Type of aggregate → Crushed angular aggregate
10. Maximum cement content → 540 kg/m³
11. Chemical admixture type → Super plasticiser

A - 2 Test data for materials

1. Cement used → Coromandal King OPC - 53 grade
2. Specific gravity of cement → 3.15
3. Specific gravity of water → 1.00
4. Chemical admixture → BABF chemicals
5. Specific gravity of 20mm aggregate → 2.384
6. Specific gravity of 10mm aggregate → 2.378
7. Specific gravity of sand → 2.605
8. Water absorption of 20mm aggregate → 0.94%
9. Water absorption of 10mm aggregate → 0.83%
10. Water absorption of sand → 1.23%
11. Free (surface) moisture of 10mm aggregate → nil
12. Free (surface) moisture of 10mm aggregate → nil
13. Free (surface) moisture of sand → nil
14. Sieve analysis of individual coarse aggregate → separate analysis done
15. Sieve analysis of combined coarse aggregate → separate analysis done
16. Specific gravity of combined coarse aggregate → 2.882
17. Sieve analysis of fine aggregate → separate analysis done
Target Strength for mix proportions

1. Target mean strength → 42 N/mm²
2. Characteristic strength → 30 N/mm² at 28 days

Selection of water cement ratio

1. Maximum water cement ratio → 0.45
2. Adopted water cement ratio → 0.42

Selection of water content

1. Maximum water content → 186 Lit
2. Estimated water content for 50 - 75mm slump → 160 Lit
3. Super plasticiser used → 0.5% by weight of cement
A-1 Stipulations for proportioning

a) Grade designation: m:40
b) Type of cement: OPC 43 grade
c) Maximum nominal size of aggregate: 20 mm
d) Minimum cement content: 0.45 to 0.60 kg/m³
e) Maximum water-cement ratio: ≤ 0.45
f) Workability: → 75 mm (slump)
g) Exposure condition: moderate [Reinforced concrete]

h) Method of concrete placing: pumping

i) Degree of supervision: Good

j) Type of aggregate: crushed angular aggregate

k) Maximum cement content: 450 kg/m³

l) Chemical admixture type: Superplasticizer

A-2 Test data for materials:

Workability: ≥ 75 mm (slump)

Admixture: Super plasticizers
Specific gravity

cement — 3.15
coarse aggregate — 2.59
Fine aggregate — 2.42

1. Target strength = 31.6 mpa / 32.92 mpa
2. water cement ratio = 0.5
3. cement content (min.) = 300 kg / m³
4. water content = 186 kg + \( \frac{3}{100} (186) \)
   = 191.6 kg
   = 192 kg (1 ut = 1 kg for water) super

- If the admixture given is plasticizer, reduce the water content up to 20 percent.
- If the admixture given is super plasticizer, reduce the water content up to 29%. Can be done.
- If the admixture is hyper plasticisers, 31% of water content is reduced.
- If the admixture is water reducing agent, then we can assume the plasticizer or superplasticizer or hyper plasticizer and reduce water content all together.
- If it is air entraining agent, then no need to reduce water content.
\[
\frac{AB}{BE} = \frac{CD}{DE}
\]

\[
CD = \frac{29}{10} \times 4
\]

\[
CD = 8.8
\]

\[
\therefore \text{For 16 mm size of aggregates}
\]

\[
8.8 + 186
\]

\[
\Rightarrow 194.8
\]

For water content

\[
\frac{192}{100-29} = 192 \times 0.71 = 136.32
\]

\[
= 137 \text{ litres}
\]

cement content

\[
\frac{\text{water}}{\text{cement}} = 0.45
\]

\[
\frac{137}{0.45} = 304.4 \text{ kg/m}^3 = \text{cement}
\]

\[
\approx 305
\]

\[
0.1 \downarrow w/c \rightarrow C.A. 70.02
\]

\[
300 \text{ kg} < 305 < 450 \text{ kg/m}^3
\]

\[
f/c
\]

0.5

\[
= 0.6
\]

0.40

\[
= 0.6 + 0.02 = 0.62
\]

0.45

\[
= 0.6 + 0.01 = 0.61
\]

The method of compaction of concrete is through pump, the volume of coarse aggregate are reduced by 10%.
CA + FA = 1

FA = 1 - CA

= 1 - 0.55

= 0.45

Mix calculation:

CA + FA + C + A + W

Total volume = 1

Volume of cement = \( \frac{m_C}{SP\ \text{gravity of cement}} \times \frac{1}{1000} \)

= \( \frac{305}{3.15} \times \frac{1}{1000} \)

= 0.096 m³

= 0.1 m³

Volume of water = \( \frac{\text{mass of water}}{\text{sp. gr. of water}} \times \frac{1}{1000} \)

= \( \frac{137}{0.127} \times \frac{1}{1000} \)

= 0.137 m³

Volume of admixture = \( \frac{a}{100} \times 305 \)

= \( \frac{6.1}{1.145} \times \frac{1}{1000} \)

= 0.005 m³
volume of all in aggregate = 
\[ a - \left( b + c + d \right) \] 
\[ 1 - \left( 0.1 + 0.137 + 0.005 \right) \] 
= 0.758 m³

mass of coarse aggregate =
\[ e \times \text{volume of CA} \times \text{specific gravity of CA} \times 1000 \]
= 0.758 \times 0.55 \times 2.59 \times 1000
= 1079.771 \approx 1080

Miss proportion

mass of fine aggregate =
\[ e \times \text{volume of fine aggregate} \times \text{specific gravity of fine aggregate} \times 1000 \]
= 0.758 \times 0.45 \times 2.72 \times 1000
= 924.791 \approx 928 \text{ kg/m³}

Miss proportioned

cement = 305 \text{ kg/m³}
Water = 132 \text{ kg/m³}
CA = 1080 \text{ kg/m³}
FA = 928 \text{ kg/m³}
Admixture = 61 \text{ kg/m³}
Cement : FA : CA

\[
\begin{array}{ccc}
305 & : & 928 \\
305 & : & 1080 \\
305 & : & 305 \\
\end{array}
\]

\[
1 : 3.04 : 3.54
\]

mix ratio

with 0.45 w/c ratio and admixture = 2% of cementitious material.

Fly ash as partial replacement to cement

minimum cement content = 320 kg/m³  
maximum water cement ratio = 0.45

(1) Target strength

\[
f_{ck} = f_{ck} + 1.65 \times 5 = 60 \text{ N/mm}^2
\]

\[
f'_{ck} = 40 + 1.65 \times 5 = 48.75 \text{ N/mm}^2
\]

(2) maximum water cement ratio = 0.45 
reduce it to 0.40

\[
mc_c = 320 \text{ kg/m}^3
\]

(3) water content = 186 kg + \( \frac{5}{100} \times 186 \)

\[
= 197 \text{ kg}
\]

Super plasticizers as admixtures

water content = \( (0.71) \times 197 \times (\frac{100 - 29}{100}) \times 194 \)

= 140 kg
Specific gravity = 1
water/cement ratio = 0.4

cementitious material \[\text{[cement + fly ash]}\]

\[\frac{140}{0.4} = 350 \text{ kg/m}^3\]

320 < 350 < 340 450

cementitious material content

\[= 350 \times 1.10\]
\[= 385 \text{ kg/m}^3\]

\[\text{So water - cement ratio} = \frac{140}{385}\]
\[= 0.36 = \text{water cement ratio (new)}\]

\[385 \times 0.3 = 115 \text{ kg/m}^3\]
\[\text{cement (OPC)} = 385 - 115 = 270 \text{ kg/m}^3\]

Solving of cement = 250 - 270
\[= 80 \text{ kg/m}^3\]

Volume of concrete = 1 m³

Volume of cement = \[\frac{\text{mass of cement}}{\text{e.g. of cement}} \times \frac{1}{1000}\]

\[= \frac{270}{3.15} \times \frac{1}{1000}\]
\[= 0.086 \text{ m}^3\]
(c) Volume of fly ash = \( \frac{\text{mass of fly ash}}{\text{specific gravity of fly ash}} \times \frac{1}{1000} \)

\[ = \frac{115}{2.2} \times \frac{1}{1000} \]

\[ = 0.052 \, \text{m}^3 \]

Volume of water = \( \frac{\text{mass of water}}{\text{specific gravity of water}} \times \frac{1}{1000} \)

\[ = \frac{140}{1} \times \frac{1}{1000} \]

\[ = 0.14 \, \text{m}^3 \]

Volume of chemical admixture

\[ = \frac{\text{mass of admixture}}{\text{specific gravity of admixture}} \times \frac{1}{1000} \]

\[ = \frac{0.006}{1.145} \times \frac{1}{1000} \]

\[ = 0.052 \, \text{m}^3 \]

Volume of all in aggregate

\[ = [a - (b + c + d + e)] \]

\[ = 1 - (0.086 + 0.052 + 0.140 + 0.007) \]

\[ = 0.715 \, \text{m}^3 \]

Mass of worse aggregate = \( f \times \text{volume of worse aggregate} \times \text{specific gravity of worse aggregate} \times \frac{1}{1000} \)
mass of fine aggregate = \( f \times \) volume of fine aggregate \( \times \) specific gravity of fine aggregate \( \times 1000 \)

\[
= 0.715 \times 0.44 \times 2.74 \times 1000
\]

\[
= 862 \text{ kg}
\]

mix proportions

- cement = 270 kg/m³
- Fly ash = 115 kg/m³
- water = 140 kg/m³

fine aggregate = 862 kg/m³

coarse aggregate = 1094 kg/m³

chemical admixture = 4.7 kg/m³

water - cement ratio = 0.364

mix ratio

cement : fine aggregate : coarse aggregate

\[
\frac{270 + 115}{385} : \frac{862}{385} : \frac{1094}{385}
\]

1 : 2.23 : 2.84
Design a M-30 grade concrete using OPC 43 grade cement and using ricehusk ash as mineral admixture replacing 35% of cement content. The maximum nominal size of aggregate being 25 mm and the desired slump to be 85 mm. The concrete is exposed to moderate exposure condition [reinforced cement concrete]. A pumping method is used to place the concrete under a good supervising condition. Type of aggregate used are crushed angular in nature and hyperplasticizers are used as a high range water reducers. The specific gravity of cement, coarse aggregate, fine aggregate and ricehusk ash and hyper plasticizer are 3.15, 2.62, 2.71, 2.18, 1.2 respectively. The water absorption of coarse aggregate and fine aggregate being 0.8% and 0.9% respectively. The free surface moisture and coarse and fine aggregate is nil. The grading of coarse aggregate is conforming according to table 2 of IS 383 and fine aggregate belonging to zone II of table No 4 IS 383.
a) Grade designation: M 30
b) Type of cement: OPC 43 grade
c) Type of mineral admixture: ricehusk ash
d) maximum nominal size of aggregate: 25 mm

e) minimum cement content:
f) maximum water-cement ratio:
g) workability: 89 mm (bump)
h) Exposure condition: moderate (Reinforced concretes)
i) method of concrete placing: pumping
j) Degree of supervision: Good
k) Type of aggregate: crushed angular aggregate
l) maximum cement (OPC) content
m) chemical admixture type: hyperplasticiser

Specific gravity of cement: 3.15
Specific gravity of coarse aggregate: 2.62
Specific gravity of fine aggregate: 2.71
Specific gravity of ricehusk ash: 2.18
Specific gravity of hyperplasticizer: 1.2
Water absorption of coarse aggregate: 0.8%
Water absorption of fine aggregate: 0.9%
(1) Target strength
\[ f'_{ck} = f_{ck} + 1.65 \varepsilon \]
\[ f'_{ck} = 30 + 1.65 \times 5 \]
\[ f'_{ck} = 38.25 \text{ N/mm}^2 \]

(2) Maximum water cement ratio = 0.45
Reduce it to 0.45

(3) Water content
\[ \frac{40 - 20}{40 - 25} = \frac{186 - 185}{\alpha} \]
\[ \frac{90}{15} = \frac{21}{\alpha} \]
\[ \alpha = 15.75 \]

⇒ For 25 mm size of aggregate
\[ 185 + 15.75 = 180.75 \text{ kg} \]
Water content =
\[ 180.75 \text{ kg} + \frac{6}{100} \times 180.75 \]
\[ = 191.59 \]
\[ \approx 192 \text{ kg} \]

Since it is 80 mm slump is given, we are considering it as 100 mm slump, add water content by 6%. 

Since hyper plasticizers are used

\[ = 192 \times \left( \frac{100 - 3}{100} \right) \]

\[ = 132.48 \]

\[ = 133 \text{ lit} \]

Cement content

\[ \frac{\text{water}}{\text{cement}} = 0.45 \]

\[ \frac{133}{0.45} = \text{cementitious material} \]

Cementitious material = 295.55

Take minimum value 300

Cementitious material content

\[ = 300 + \left( 300 \times \frac{10}{100} \right) \]

\[ = 330 \]

Water - cement ratio = \[ \frac{133}{330} \]

\[ = 0.403 \]

Rice husk ash @ 25% of total cementitious material content \[ = 330 \times 25\% \]

\[ = 82.5 \text{ kg/m}^3 \]

Cement (OPC) = 330 - 82.5

\[ = 247.5 \text{ kg/m}^3 \]

\[ \approx 248 \]
Saving of cement while using rice husk ash
\[ = 300 - 248 \]
\[ = 52 \text{ kg/m}^3 \]

Rice husk ash being utilized \[ = 82 \text{ kg/m}^3 \]

Volume of concrete \[ = 1 \text{ m}^3 \]

Volume of cement \[ = \frac{\text{mass of cement}}{\text{specific gravity of cement}} \times \frac{1}{1000} \]
\[ = \frac{948}{315} \times \frac{1}{1000} \]
\[ = 0.308 \text{ m}^3 \]

w. c \[ \rightarrow \text{CA} \]
\[ \frac{0.09}{20} = \frac{x}{15} \]
\[ x = 0.0225 \]

Zone 2 \[ \rightarrow 0.64 \]

0.5 \[ \rightarrow 0.64 \]
0.05 \[ \rightarrow 0.65 \]

Method of compaction of concrete is through pumping, the volume of coarse aggregate reduced by 10%.

\[ \text{CA} = 0.65 (0.9) \]
\[ \text{CA} = 0.585 \]
\[ \text{CA} \approx 0.59 \]

\[ \text{CA} + \text{FA} = 1 \]
\[ \text{FA} = 1 - \text{CA} = 1 - 0.59 = 0.41 \]
Volume of water = \frac{mass \ of \ water}{specific \ gravity \ of \ water} \times \frac{1}{1000}

\[ \text{misc calculations} \]

(a) volume of concrete = 1 m\(^3\)

(b) volume of cement = \frac{mass \ of \ cement}{specific \ gravity \ of \ cement} \times \frac{1}{1000}

\[ = \frac{244}{3.15} \times \frac{1}{1000} \]
\[ = 0.078 \ m^3 \]

(c) volume of rice husk ash = \frac{mass \ of \ ash}{specific \ gravity \ of \ rice \ husk \ ash} \times \frac{1}{1000}

\[ = \frac{83}{2.18} \times \frac{1}{1000} \]
\[ = 0.0380 \ m^3 \]

(d) volume of water = \frac{mass \ of \ water}{specific \ gravity \ of \ water} \times \frac{1}{1000}

\[ = \frac{133}{1} \times \frac{1}{1000} \]
\[ = 0.133 \ m^3 \]
(e) Volume of chemical admixture 2% = mass of admixture / specific gravity of admixture

= 6.6 / 2 x 1 / 1000

= 0.003 m³

v. volume of all in aggregates = (a - (b + c + d + e))

= 1 - [0.078 + 0.0380 + 0.133 + 0.005]

= 1 - 0.254

= 0.746 m³

g) mass of CA = f x volume of coarse aggregate x specific gravity of CA x 1000

= 0.746 x 0.585 x 2.62 x 1000

= 1142 kg

h) mass of fine aggregate = f x volume of fine aggregate x specific gravity of fine aggregate x 1000

= 0.746 x 0.415 x 2.71 x 1000

= 838 kg
mix proportion

cement = 947 kg/m^3
Rice husk ash = 83 kg/m^3
water = 133 kg/m^3
Fine aggregate = 838 kg/m^3
Coarse aggregate = 1142 kg/m^3
Chemical admixture = 6.6 kg/m^3

mix ratio

330 kg/m^3 : 838 kg/m^3 : 1142 kg/m^3
1 : 2.53 : 3.46

Water absorption of CA = 0.8%.
Water absorption of FA = 0.9%.

Water content = 133 + \left[ \frac{0.8}{100} \times 1142 \right] + \left[ \frac{0.9}{100} \times 838 \right]
= 133 + 9.136 + 7.542
= 149.678 kg/m^3