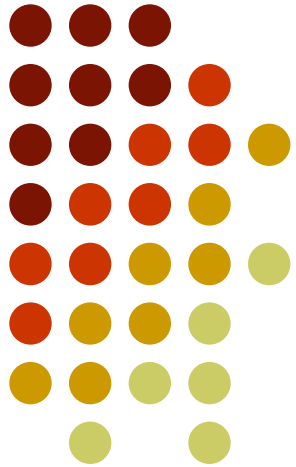
Plain & Reinforced Concrete-1

CE-314

Additives and Admixtures



ADDITIVES AND ADMIXTURES

- Any chemical / substance added to cement during its manufacture to improve the quality of concrete or to obtain any desired effect on concrete is called ***Additive***.
- Any substance added to concrete during its mixing to improve its quality in a desired way is called ***Admixture***.

The admixtures may be of the following general types:

- Accelerators.
- Set-retarders.
- Plasticizers or water-reducers.
- Super-plasticizers.
- Cementing admixtures.
- Gas forming or air-entraining agents.
- Bonding admixtures.
- Sealing agents.

1. Accelerators

- The admixtures that accelerate the hardening of concrete in order to get development of early strength are called accelerators.
- Quick-setting admixtures are also available which cause flash set, such as washing soda or sodium carbonate.

2. Set-Retarders

- These admixtures cause delay in setting of concrete.
- These are useful for mass concreting, concreting in hot weather, improving the construction joints and for obtaining special architectural surface finishes.

3. Plasticizers Or Water- Reducers

- These admixtures reduce the amount of water required for a desired workability.
- This reduction in the water-cement ratio increases the strength of concrete.
- In other cases, maintaining same strength, workability may be increased for placing of concrete in congested locations.
- Still in other cases, maintaining the same strength and workability, cement content may be reduced for economy and for control of heat of hydration in mass concrete.

- These admixtures act by coating the cement particles with agents that cause repulsion between them and the air bubbles.
- Better dispersion is obtained and the water freed from the particle surfaces causes effective lubrication and further increases the workability.
- By greater dispersion of the cement particles and more area available for hydration, the initial rate of gain of strength is also improved.

4. Super-Plasticizers

- These are preferably sulphonated naphthalene formaldehyde condensates and sulphonated melamine formaldehyde condensates used to cause very effective dispersion qualities and retarding properties up to certain extent.
- These are used to make flowing concrete that can be compacted into difficult places without any vibrations.
- These are helpful in maintaining very low water / cement ratios and to achieve very high strength concrete.
- As a rough guide-line, these admixtures may increase the slump from 75mm to 300 mm for the same strength and cement content.

5. Cementing Admixtures

- The use of pozzolans, blast-furnace slag and lime in concrete provides cementitious properties besides other desirable effects.
- ***Pozzolans*** are the materials that provide cementitious properties and may replace cement up to about 40 per cent.
- Their greater advantage is slow rate of hydration and heat development.
- Volcanic ash, pumicite, opaline shales, calcined diatomaceous earth, burnt clay, fly ash and pulverized fuel ash (PFA) may act as pozzolanas.

6. Gas Forming Or Air Entraining Admixtures

- Gas forming admixtures are used to liberate gas in fresh concrete so as to form aerated or foam concrete, which is lightweight and provides better thermal insulation.
- The air-entraining agents introduce very fine air bubbles into the concrete in order to improve their resistance against frost action and to provide more flexibility in the material.

7. Bonding Admixtures

These admixtures improve the bond of fresh concrete with the already hardened concrete.

8. Sealing Agents

These admixtures reduce the capillary absorption of water by the concrete.

Combining Different Aggregates To Get A Required Grading

Example 22.3: Calculate the ratio in which the aggregate-A (19mm down) and aggregate-B (37.5mm down) must be combined to get a percentage passing value of 20% for the 9.5mm sieve. The grading of the two materials is shown in Table 22.10.

Table 22.10. Grading of Aggregates A and B for Example 22.3.

Sieve Size	**Cumulative Percentage Passing**	
mm or mic	**Aggregate-A**	**Aggregate-B**
37.5	100	100
19	96	20
9.5	39	12
4.75	4	3
2.38	1	0

Let x = the fraction of aggregate-A (can be taken as one to find the others)

and y = the fraction of aggregate-B

Then, the condition of getting 20% passing on 9.5mm sieve may be satisfied as under:

$$0.39\,x + 0.12\,y = 0.20\,(x + y)$$

$$0.39 + 0.12\,y = 0.20 + 0.20\,y$$

$$y = 2.375$$

The grading of the combined aggregate is obtained as in Table 22.11.

Table 22.11. Combined Grading for Example 22.3

Sieve Size	**Cumulative Percentage Passing**			
mm or mic	**Agg - A x 1**	**Agg - B x 2.375**	**(2) + (3)**	**(4) / 3.375**
(1)	(2)	(3)	(4)	(5)
37.5	100	237.5	337.5	100
19	96	47.5	143.5	43
9.5	39	28.5	67.5	20
4.75	4	7.125	11.125	3
2.38	1	0	1	0

Example 22.4: Calculate the ratio in which three aggregates, namely, aggregate-A (19mm down), aggregate-B (37.5mm down) and aggregate-C, must be combined to get percentage passing values of 60% for 19mm sieve and 25% for 2.38mm sieve. The grading of the three materials is shown in Table 22.12.

Table 22.12. Grading of Aggregates A, B and C for Example 22.4.			
Sieve Size	**Cumulative Percentage Passing**		
mm or mic	**Aggregate-A**	**Aggregate-B**	**Aggregate-C**
37.5	100	100	100
19	96	20	100
9.5	39	12	100
4.75	4	3	95
2.38	1	0	71
1.18			52
600			31
300			9
150			3

Let x = the fraction of aggregate-A

(can be taken as one to find the others)

y = the fraction of aggregate-B

and z = the fraction of aggregate-C

Then, the condition of getting 60% passing on 19mm sieve may be satisfied by Eq.1 and the 2nd condition of getting 25% passing on 2.38mm sieve may be satisfied by Eq.2, as follows:

$$0.96x + 0.20y + 1.00z = 0.60(x + y + z)$$

$$0.40y - 0.40z = 0.36 \qquad \text{(Eq.1)}$$

$$0.01\,x + 0.00\,y + 0.71\,z = 0.25\,(x + y + z)$$

$$0.25\,y - 0.46\,z = -0.24$$

$$-0.40\,y + 0.736\,z = 0.384 \quad \text{(Eq.2)}$$

Eq.1 + Eq.2: $0.336\,z = 0.744$

$\Rightarrow z = 2.214$ and $y = 3.114$

Hence, Agg-A : Agg-B : Agg-C = 1 : 3.114 : 2.214, and the grading of the combined aggregate is estimated in Table 22.13.

Table 22.13. Combined Grading for Example 22.4.

Sieve Size	**Cumulative Percentage Passing**				
mm or μm	**Agg-A x 1**	**Agg-B x 3.114**	**Agg-B x 2.214**	**(2)+(3)+(4)**	**(5) / 6.328**
(1)	(2)	(3)	(4)	(5)	(6)
37.5	100	311.4	221.4	632.8	100
19	96	62.28	221.4	379.68	60
9.5	39	37.368	221.4	297.768	47
4.75	4	9.342	210.33	223.672	35
2.38	1	0	157.194	158.194	25
1.18	0	0	115.128	115.128	18
600	0	0	68.634	68.634	11
300	0	0	19.926	19.926	3
150	0	0	6.642	6.642	1

Concluded