



- Answer all the following questions
- Illustrate your answers with sketches when necessary.
- The exam. consists of one page
- No. of Questions 3
- Total Mark: 30 Marks

Question No. 1 (10 marks)

Design concrete mix to achieve Target mean strength = 45 N/mm² at 28 days. Use Ordinary Portlan cement CEM I, 42.5, Uncrushed aggregate with maximum aggregate size 20 mm, fine aggregate with 60% passing 600 μm sieve. The required slump 30-60 mm. The relative density of combined aggregate is equal to 2.65.

Required free water = 180 kg/m³.

Starting point at w/c = 0.5 and strength = 42 N/mm².

To achieve strength of 45 n/mm², use w/c = 0.47 (Figure 2),

Weight of cement = 383 → 385 kg/m³,

Fresh concrete density = 2410 kg/m³,

Weight of aggregate = 2410 – 385 – 180 = 1845 kg/m³,

Proportion of fine aggregate = 32% (Figure 6).

Weight of fine aggregate = 590 kg/m³,

Weight of coarse aggregate = 1255 kg/m³.

Question No. 2 (10 marks)

Determine the Target Mean strength for concrete with characteristic strength of 30 N/mm², in the following cases;

- 1) Concrete mix with no previous strength data, and 5% defective.

$$F_m = 30 + 8 \times 1.64 = 43 \text{ N/mm}^2.$$

- 2) Concrete mix with more than 40 test results and standard deviation of 30 kg/cm², 10% defective.

$$F_m = 30 + 4 \times 1.28 = 35 \text{ N/mm}^2.$$

- 3) Concrete mix with more than 40 test results and standard deviation of 60 kg/cm², 1% defective.

$$F_m = 30 + 6 \times 2.33 = 46 \text{ N/mm}^2.$$

Determine the Target Mean strength for concrete with characteristic strength of 18 N/mm², in the following cases;

- 1) Concrete mix with no previous strength data, and 5% defective.

$$F_m = 18 + 0.4 \times 18 \times 1.64 = 29.8 \text{ N/mm}^2.$$

2) Concrete mix with more than 40 test results and standard deviation of 25 kg/cm², 1% defective

$$0.2 \times 18 = 3.6 > 2.5 \text{ N/mm}^2$$

$$\text{Use Standard deviation} = 3.6 \text{ N/mm}^2$$

$$F_m = 18 + 0.2 \times 18 \times 2.33 = 26.5 \text{ N/mm}^2.$$

Question No. 3 (10 marks)

Design **5% air entrained** concrete mix to achieve Target mean strength = 35 N/mm² at 28 days. Use Ordinary Portlan cement CEM I, 42.5, crushed aggregate with maximum aggregate size 10 mm, fine aggregate with 40% passing 600 μm sieve. The required slump 30-60 mm. The relative density of combined aggregate is equal to 2.65.

$$\text{Target mean strength of air entrained concrete, } F_m = \frac{35}{1 - 0.055 \times 5} = 48.3 \text{ N/mm}^2$$

Required free water = 205 kg/m³.

Starting point at w/c = 0.5 and strength = 42 N/mm².

To achieve strength of 45 n/mm², use w/c = 0.5 (Figure 2),

Weight of cement = 410 kg/m³,

Fresh concrete density = 2370 kg/m³ (Figure 5),

Corrected value of wet density = 2370 - 10 x 5 x 2.65 = 2277 kg/m³,

Weight of aggregate = 2277 - 410 - 205 = 1662 kg/m³,

Proportion of fine aggregate = 0.48% (Figure 6).

Weight of fine aggregate = 798 kg/m³,

Weight of coarse aggregate = 864 kg/m³.