EWCE 201

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Answer to the question no. 02

Step 1: Choice of slump = 4 inch (given)

Step 2: Max aggregate size = 3/4 inch (given)

Step 3: Estimation of water & air content

Using table 6.3.3, for slump of 3 to 4" and max aggregate size of 3/4" in non-air entrained concrete,

water content = 340 lb/yd^3

Air content = 2% (given)

Step 4: Selection of w/c ratio

Using table 6.3.4(a), for compressive strength of 4500 psi at 28 days in non-air entrained concrete,

w/c ratio to be less than $0.48 + \frac{0.57 - 0.48}{1000} * 500$

$= 0.53$

The given w/c ratio of 0.50 satisfies that.

w/c ratio = 0.50

Step 5: calculation of cement content

$$\text{Cement content} = \frac{\text{water content}}{\text{w/c ratio}}$$

$$= \frac{340}{0.5} \text{ lb/yd}^3$$

$$= 680 \text{ lb/yd}^3$$

Step 6: Estimation of coarse aggregate content

Using table 6.3.6, for max aggregate size of 3/4" and assumed F.M. of fine aggregate of 2.70,

$\frac{0.64+0.62}{2}$ unit volume of CA (OD) per unit volume concr

or, 0.63 ft^3 CA (OD) per 1 ft^3 concrete

or, $0.63 * 110 = 69.30$ lb / ft^3 concrete

or, $69.30 * 27 = 1871$ lb / yd^3 concrete

∴ CA (OD) content = 1871 lb/yd^3

CA (SSD) content = $1871 \left(1 + \frac{2}{100}\right)$ lb/yd^3

= 1908 lb/yd^3

Step 7 : Estimation of fine aggregates content

vol(FA) = vol(concrete) − vol(cement) − vol(water)
− vol(CA) − vol(air)

$= 27 - \frac{680}{3.15 * 62.4} - \frac{340}{62.4} - \frac{1908}{2.70 * 62.4} - 0.02 * 27 \ ft^3/yd^3$

$= 6.23 \ ft^3/yd^3$

FA (SSD) content = $6.23 * 2.65 * 62.4 \ lb/yd^3$

$= 1030 \ lb/yd^3$

Step 8 : Adjust for moisture

water included in aggregates = moisture(FA) + moisture(CA)

$= 1030 * \frac{1}{100} + 1908 * \frac{1}{100} \ lb/yd^3$

$= 10 + 19 \ lb/yd^3$

∴ water content = $340 - 10 - 19 \ lb/yd^3$

$= 311 \ lb/yd^3$

FA (SSD) content = $1030 - 10 \ lb/yd^3$

$= 1020 \ lb/yd^3$

CA (SSD) content = $1908 - 19 \ lb/yd^3$

$= 1889 \ lb/yd^3$

Concrete mix for 1 cubic yard:

Material	Quantity (lb)
Cement	680
Coarse aggregate	1889
Fine aggregate	1020
Water	311

Hence, mix ration are,

Cement : FA : CA

680 : 1020 : 1889

1 : 1.50 : 2.78

Table 6.3.1 — Recommended slumps for various types of construction*

Types of construction	Slump, in.	
	Maximum†	Minimum
Reinforced foundation walls and footings	3	1
Plain footings, caissons, and substructure walls	3	1
Beams and reinforced walls	4	1
Building columns	4	1
Pavements and slabs	3	1
Mass concrete	2	1

*Slump may be increased when chemical admixtures are used, provided that the admixture-treated concrete has the same or lower water-cement or water-cementitious material ratio and does not exhibit segregation potential or excessive bleeding.

†May be increased 1 in. for methods of consolidation other than vibration.

Figure 1

Table 6.3.3 — Approximate mixing water and air content requirements for different slumps and nominal maximum sizes of aggregates

Slump, in.	Water, lb/yd³ of concrete for indicated nominal maximum sizes of aggregate							
	⅜ in.*	½ in.*	¾ in.*	1 in.*	1-½ in.*	2 in.*†	3 in.†‡	6 in.†‡
Non-air-entrained concrete								
1 to 2	350	335	315	300	275	260	220	190
3 to 4	385	365	340	325	300	285	245	210
6 to 7	410	385	360	340	315	300	270	—
More than 7*	—	—	—	—	—	—	—	—
Approximate amount of entrapped air in non-air-entrained concrete, percent	3	2.5	2	1.5	1	0.5	0.3	0.2
Air-entrained concrete								
1 to 2	305	295	280	270	250	240	205	180
3 to 4	340	325	305	295	275	265	225	200
6 to 7	365	345	325	310	290	280	260	—
More than 7*	—	—	—	—	—	—	—	—
Recommended averages† total air content, percent for level of exposure:								
Mild exposure	4.5	4.0	3.5	3.0	2.5	2.0	1.5**,‡‡	1.0**,‡‡
Moderate exposure	6.0	5.5	5.0	4.5	4.5	4.0	3.5**,‡‡	3.0**,‡‡
Severe exposure§§	7.5	7.0	6.0	6.0	5.5	5.0	4.5**,‡‡	4.0**,‡‡

Figure 2

Table 6.3.4(a) — Relationship between water-cement or water-cementitious materials ratio and compressive strength of concrete

Compressive strength at 28 days, psi*	Water-cement ratio, by weight	
	Non-air-entrained concrete	Air-entrained concrete
6000	0.41	—
5000	0.48 } .53	0.40
4000	0.57	0.48
3000	0.68	0.59
2000	0.82	0.74

Figure 3

Table 6.3.6 — Volume of coarse aggregate per unit of volume of concrete

Nominal maximum size of aggregate, in.	Volume of oven-dry-rodded coarse aggregate* per unit volume of concrete for different fineness moduli of fine aggregate+			
	2.40	2.60	2.80	3.00
⅜	0.50	0.48	0.46	0.44
½	0.59	0.57	0.55	0.53
¾	0.66	0.64	0.62	0.60
1	0.71	0.69	0.67	0.65
1½	0.75	0.73	0.71	0.69
2	0.78	0.76	0.74	0.72
3	0.82	0.80	0.78	0.76
6	0.87	0.85	0.83	0.81

*Volumes are based on aggregates in oven-dry-rodded condition as described in ASTM C 29.

Answer to the question no. 02

Step 1: Determination of w/c ratio

For assumed defectives of 5%, $k = 1.64$ and $s = 4$ for 20 or more results of characteristic strength of 38 mPa

∴ Additional strength, $m = k * s$

$= 1.64 * 4$ mPa

$= 6.56$ mPa

∴ Target mean strength = $38 + 6.56$ mPa

$= 44.56$ mPa

Provided w/c ratio = 0.4

To achieve the compressive strength of 38mPa and target mean strength of 44.56 mPa,

Cement strength class = 52.5

Type of coarse aggregate = crushed

Step 2: Determination of water content

Using table 2, for slump size of 75 mm (60-180), max aggregate size of 20 mm (crushed),

water content = 225 kg/m^3

Step 3: Determination of cement content

$$\text{Cement content} = \frac{\text{water content}}{\text{w/c ratio}}$$

$$= \frac{225}{0.4} \ kg/m^3$$

$$= 563 \ kg/m^3$$

Step 4: Determination of total aggregate content

Using figure 5, for crushed aggregate, at ~~w/c ratio~~ water content of 225 kg/m^3,

wet density of concrete mix = 2380 kg/m^3

$\therefore$ Total aggregate content = $2380 - 563 - 225 \ kg/m^3$

$= 1592 \ kg/m^3$

Step 5: Determination of fine & coarse aggregate conten

Using figure 6, for max aggregate size of 20mm, slump of 75 mm (60-180), w/c ratio of 0.4 and assumed fine aggregates passing through 600 μm sieve = 60%,

Proportion of fine aggregates = 36%

∴ FA content = $1592 * 0.36 = 573$ Kg/m^3

CA content = $1592 - 573 = 1019$ Kg/m^3

Thus, concrete mix for 1 cubic meter:

Material	Quantity (kg)
Cement	563
Coarse aggregate	1019
Fine aggregate	573
water	225

Mix ratios are:

Cement	FA	CA
563	573	1019
1	1.02	1.81

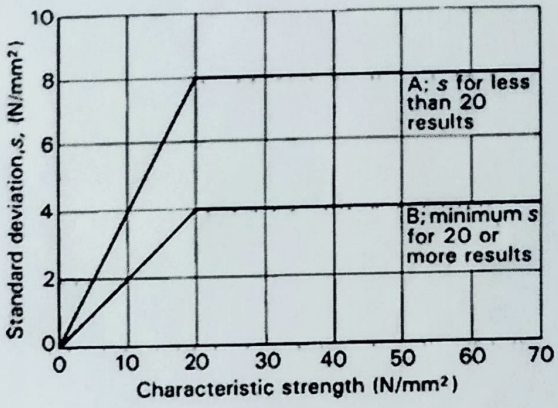


Figure 1

Table 1:

Cement strength class	Type of coarse aggregate	Compressive strengths (N/mm²) Age (days) 3	7	28	91
42.5	Uncrushed	22	30	42	49
	Crushed	27	36	49	56
52.5	Uncrushed	29	37	48	54
	Crushed	34	43	55	61

Throughout this publication concrete strength is expressed in the units N/mm².
1 N/mm² = 1 MN/m² = 1 MPa. (N = newton; Pa = pascal.)

Figure 2

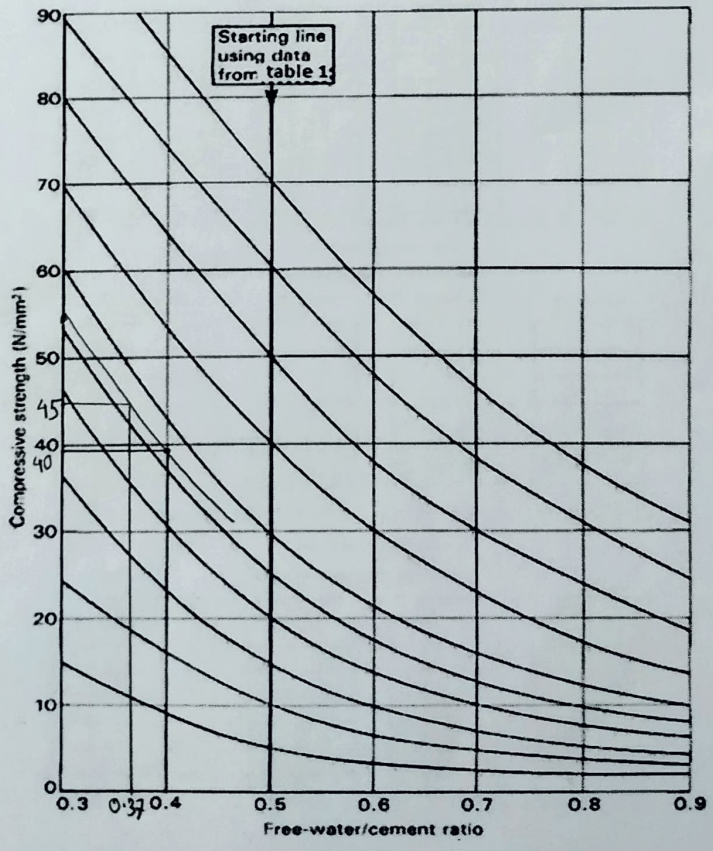


Figure 3

Table 2:

Slump (mm)		0–10	10–30	30–60	60–180
Vebe time (s)		>12	6–12	3–6	0–3
Maximum size of aggregate (mm)	Type of aggregate				
10	Uncrushed	150	180	205	225
	Crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	Crushed	170	190	210	225
40	Uncrushed	115	140	160	175
	Crushed	155	175	190	205

Figure 4

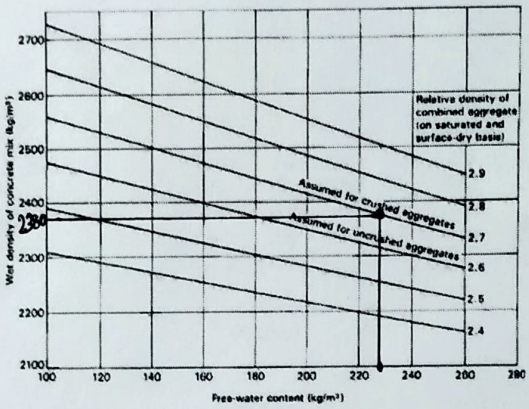


Figure 5

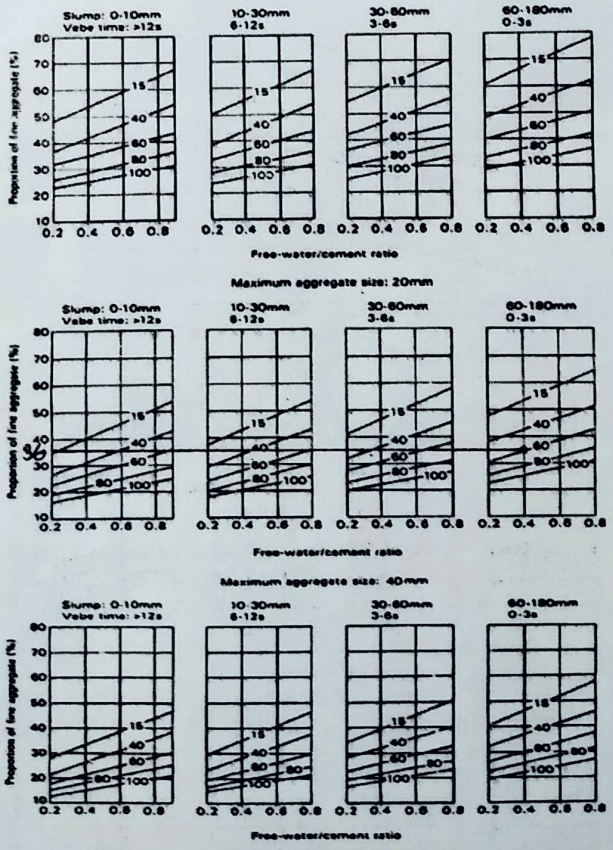


Figure 6