APPENDIX 2

MIX DESIGNS

All mixes in this study were designed in accordance with the Building Research Establishment (BRE 1992) method, recommended by the UK Department of the Environment. Reference should be made therein to tables and graphs alluded to and available for use in this design method.

All abbreviations and acronyms in the mix design sheets are those used in BRE's 1992 method.

Chapter 4: mix design calculation sheet for 40 N/mm^2 concrete mix (28 day strength)

A) NA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 53 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 53 N/mm^2

w/c 0.46 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.46

7-Free-water content (W)

Use Table 3

Slump 60-180 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Crushed

W_f = 195 kg/m^3 W_c = 225 kg/m^3

W = 2/3W_f + 1/3W_c = 205 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 205 kg/m^3

8-Cement content

w/c ratio 0.46 (Fig. 4)

Free-water content 205 kg/m^3

8.1-Cement content 446 kg/m^3 Say 445 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 $\leq$ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 445 kg/m^3

Modified free-water to cement content 0.46

9-Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 205 kg/m^3

Wet concrete density of the mix = 2360 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content - Cement content

TAC = 1710 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 µm sieve (%) 54

Modified free-water content to cement ratio 0.46

Proportion of fine aggregate (%) 41 (Graph 6)

TAC = 1710 kg/m^3

Fine aggregate content = FAC = % Fine aggregate $\times$ TAC = 701.1 kg/m^3

Say FAC= 700 kg/m^3

Coarse aggregate content = TAC - FAC = 1010 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	445	kg/m^3
Water =	205	kg/m^3
Fine aggregate =	700	kg/m^3
Coarse aggregate =	1010	kg/m^3
Wet density =	2360	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.7	kg
Water =	1.7	kg
Fine aggregate =	5.8	kg
Coarse aggregate =	8.4	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	445	0.141	14	19
Water	205	0.210	21	9
Coarse agg.	1010	0.370	37	43
Fine agg.	700	0.269	27	30
Total agg.	1710	0.658	64	72
Total	2360	0.990	97	-
Paste volume	-	0.346	-	-
% PV	-	35.6	-	-
Mortar volume	-	0.616	-	-
% MV	-	62	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.46	0.30 - 0.60
Coarse agg. / Total agg. (%)	59	60 - 75%
Fine agg. / Total agg. (%)	41	30- 45%
Total agg. / Cement	3.8	2-5
Density (kg/m^3)	2360	2200-2500

B) RA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS= not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 53 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 53 N/mm^2

w/c 0.46 (Graph 4)

w/c NS (S-specified, NS-not specified)

(Use the lower value as w/c)

w/c = 0.46

7-Free-water content (W)

Use Table 3

Slump 60-180 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Crushed

W_f = 195 kg/m^3 W_c = 225 kg/m^3

$W = 2/3W_f + 1/3W_c$ = 205 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 205 kg/m^3

8-Cement content

w/c ratio 0.46 (Fig. 4)

Free-water content 205 kg/m^3

8.1-Cement content 446 kg/m^3 Say 445 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 445 kg/m^3

Modified free-water to cement content 0.46

9-Concrete density

Relative density of aggregate (SSD) = 2.55 (Known)

Free-water content = 205 kg/m^3

Wet concrete density of the mix = 2325 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1675 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 µm sieve (%) 54

Modified free-water content to cement ratio 0.46

Proportion of fine aggregate (%) 41 (Graph 6)

TAC = 1675 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 686.75 kg/m^3

Say FAC= 685 kg/m^3

Coarse aggregate content = TAC - FAC = 990 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	445	kg/m^3
Water =	205	kg/m^3
Fine aggregate =	685	kg/m^3
Coarse aggregate =	990	kg/m^3
Wet density =	2325	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.7	kg
Water =	1.7	kg
Fine aggregate =	5.7	kg
Coarse aggregate =	8.2	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	445	0.141	14	19
Water	205	0.210	21	9
Coarse agg.	990	0.400	37	43
Fine agg.	685	0.263	26	30
Total agg.	1675	0.644	63	72
Total	2325	1.006	96	-
Paste volume	-	0.346	-	-
% PV	-	34.6	-	-
Mortar volume	-	0.610	-	-
% MV	-	61	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.46	0.30 - 0.60
Coarse agg. / Total agg. (%)	59	60 - 75%
Fine agg. / Total agg. (%)	41	30- 45%
Total agg. / Cement	3.8	2-5
Density (kg/m^3)	2360	2200-2500

Chapter 5: mix design calculation sheet for 40 N/mm^2 concrete mix (28 day strength)

A) NA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 53 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 53 N/mm^2

w/c 0.46 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.46

7-Free-water content (W)

Use Table 3

Slump 30-60 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Crushed

W_f = 210 kg/m^3 W_c = 210 kg/m^3

W = 2/3W_f + 1/3W_c = 210 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 210 kg/m^3

8-Cement content

w/c ratio 0.46 (Fig. 4)

Free-water content 210 kg/m^3

8.1-Cement content 457 kg/m^3 Say 457 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 457 kg/m^3

Modified free-water to cement content 0.46

9-Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 210 kg/m^3

Wet concrete density of the mix = 2400 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1733 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20
Percentage of fine aggregate passing 600 µm sieve (%)	42
Modified free-water content to cement ratio	0.46
Proportion of fine aggregate (%)	38 (Graph 6)

TAC = 1733 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 658.5 kg/m^3

Say FAC= 660 kg/m^3

Coarse aggregate content = TAC - FAC = 1073 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	457	kg/m^3
Water =	210	kg/m^3
Fine aggregate =	660	kg/m^3
Coarse aggregate =	1073	kg/m^3
Wet density =	2400	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.8	kg
Water =	1.7	kg
Fine aggregate =	5.5	kg
Coarse aggregate =	8.9	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	457	0.145	15	19
Water	210	0.210	21	9
Coarse agg.	1073	0.400	40	45
Fine agg.	660	0.254	25	28
Total agg.	1733	0.667	65	72
Total	2400	1.006	99	-
Paste volume	-	0.355	-	-
% PV	-	35.5	-	-
Mortar volume	-	0.609	-	-
% MV	-	61	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity		Value	Common range
w/c		0.46	0.30 - 0.60
Coarse agg. / Total agg. (%)		62	60 - 75%
Fine agg. / Total agg. (%)		38	30- 45%
Total agg. / Cement		3.8	2-5
Density	(kg/m^3)	2400	2200-2500

B) RA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 53 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2

Target mean strength (f_m) = 53 N/mm^2 (Table 2)

w/c 0.46 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.46

7-Free-water content (W)

Use Table 3

Slump	30-60	mm		
Maximum aggregate size			20 mm	
Type of coarse aggregate			Crushed	
Type of fine aggregate			Crushed	
				W_c = 210
W_f =	210	kg/m^3		kg/m^3
W =2/3W_f + 1/3W_c =		210	kg/m^3	

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 210 kg/m^3

8-Cement content

w/c ratio	0.46 (Fig. 4)	
Free-water content	210 kg/m^3	
8.1-Cement content	457 kg/m^3	Say 457 kg/m^3
8.2-Maximum specified cement content		NS
8.3-Minimum specified cement content		NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 457 kg/m^3

Modified free-water to cement content 0.46

9-Concrete density

Relative density of aggregate (SSD) =	2.55 (Known)
Free-water content =	210 kg/m^3
Wet concrete density of the mix =	2350 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1683 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20
Percentage of fine aggregate passing 600 µm sieve (%)	42
Modified free-water content to cement ratio	0.46
Proportion of fine aggregate (%)	38 (Graph 6)

TAC = 1683 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 589.05 kg/m^3

Say FAC= 590 kg/m^3

Coarse aggregate content = TAC - FAC = 1073 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	457	kg/m^3
Water =	210	kg/m^3
Fine aggregate =	590	kg/m^3
Coarse aggregate =	1093	kg/m^3
Wet density =	2350	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.8	kg
Water =	1.7	kg
Fine aggregate =	4.9	kg
Coarse aggregate =	9.1	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	457	0.145	15	19
Water	210	0.210	21	9
Coarse agg.	1093	0.440	44	47
Fine agg.	590	0.227	23	25
Total agg.	1683	0.647	66	72
Total	2350	1.019	100	-
Paste volume	-	0.355	-	-
% PV	-	35.5	-	-
Mortar volume	-	0.582	-	-
% MV	-	58	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.46	0.30 - 0.60
Coarse agg. / Total agg. (%)	65	60 - 75%
Fine agg. / Total agg. (%)	35	30- 45%
Total agg. / Cement	3.7	2-5
Density (kg/m^3)	2350	2200-2500

Chapter 5: mix design calculation sheet for 50 N/mm^2 concrete mix (28 day strength)

A) NA

1-Characteristic strength at 28 days 50 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 63 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 63 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump 10-30 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 160 kg/m^3 W_c = 190 kg/m^3

W = 2/3W_f + 1/3W_c = 170 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 170 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 170 kg/m^3

8.1-Cement content 425 kg/m^3 Say 425 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 425 kg/m^3

Modified free-water to cement content 0.40

9-Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 170 kg/m^3

Wet concrete density of the mix = 2430 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1835 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 µm sieve (%) 53

Modified free-water content to cement ratio 0.40

Proportion of fine aggregate (%) 30 (Graph 6)

TAC = 1835 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 550.5 kg/m^3

Say FAC= 550 kg/m^3

Coarse aggregate content = TAC - FAC = 1285 kg/m^3

13-Summary of quantities for 1m^3 (SSD)

Cement =	425	kg/m^3
Water =	170	kg/m^3
Fine aggregate =	550	kg/m^3
Coarse aggregate =	1285	kg/m^3
Wet density =	2430	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.5	kg
Water =	1.4	kg
Fine aggregate =	4.6	kg
Coarse aggregate =	10.7	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	425	0.135	13	17
Water	170	0.170	17	7
Coarse agg.	1285	0.480	48	53
Fine agg.	550	0.212	21	23
Total agg.	1835	0.706	69	76
Total	2430	0.992	97	-
Paste volume	-	0.305	-	-
% PV	-	30.5	-	-
Mortar volume	-	0.516	-	-
% MV	-	52	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity		Value	Common range
w/c		0.4	0.30 - 0.60
Coarse agg. / Total agg.(%)		70	60 - 75%
Fine agg. / Total agg. (%)		30	30- 45%
Total agg. / Cement		4.3	2-5
Density	(kg/m^3)	2430	2200-2500

A) RA

1-Characteristic strength at 28 days 50 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 [NS= not specified]

M-calculated = 1.64 × S

S = Standard Deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 63 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 63 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump	10-30	mm	
Maximum aggregate size		20 mm	
Type of coarse aggregate		Crushed	
Type of fine aggregate		Unrushed	
W_f =	160	kg/m^3	W_c = 190 kg/m^3
W = 2/3W_f + 1/3W_c =		170 kg/m^3	

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 170 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 170 kg/m^3

8.1-Cement content 425 kg/m^3 Say 425 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 $\leq$ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 425 kg/m^3

Modified free-water to cement content 0.40

9-Concrete density

Relative density of aggregate (SSD) = 2.55 (Known)

Free-water content = 170 kg/m^3

Wet concrete density of the mix = 2365 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1770 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20
Percentage of fine aggregate passing 600 μm sieve (%)	53
Modified free-water content to cement ratio	0.40
Proportion of fine aggregate (%)	30 (Graph 6)

TAC = 1770 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 531 kg/m^3

Say FAC= 530 kg/m^3

Coarse aggregate content = TAC - FAC = 1240 kg/m^3

13-Summary of quantities for 1m^3 (SSD)

Cement =	425	kg/m^3
Water =	170	kg/m^3
Fine aggregate =	530	kg/m^3
Coarse aggregate =	1240	kg/m^3
Wet density =	2365	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.5	kg
Water =	1.4	kg
Fine aggregate =	4.4	kg
Coarse aggregate =	10.3	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	425	0.135	13	18
Water	170	0.170	17	7
Coarse agg.	1240	0.500	50	52
Fine agg.	530	0.204	20	22
Total agg.	1770	0.681	70	75
Total	2365	1.005	98	-
Paste volume	-	0.305	-	-
% PV	-	30.5	-	-
Mortar volume	-	0.509	-	-
% MV	-	51	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.4	0.30 - 0.60
Coarse agg. / Total agg. (%)	70	60 - 75%
Fine agg. / Total agg. (%)	30	30- 45%
Total agg. / Cement	4.2	2-5
Density (kg/m^3)	2365	2200-2500

Chapter 5: mix design calculation sheet for 60 N/mm^2 concrete mix (28 day strength)

A) NA

1-Characteristic strength at 28 days 60 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 73 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 73 N/mm^2

w/c 0.33 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.33

7-Free-water content (W)

Use Table 3

Slump 30-60 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 210 kg/m^3 W_c = 210 kg/m^3

W = 2/3W_f + 1/3W_c = 210 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 210 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 210 kg/m^3

8.1-Cement content 636 kg/m^3 Say 636 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 636 kg/m^3

Modified free-water to cement content 0.33

9- Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 210 kg/m^3

Wet concrete density of the mix = 2400 kg/m^3 (Graph 5)

10-Total aggregate content, TAC (Coarse and fine aggregate)

TAC = Wet density - Free-water content -Cement content

TAC = 1554 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20
Percentage of fine aggregate passing 600 µm sieve (%)	50
Modified free-water content to cement ratio	0.33
Proportion of fine aggregate (%)	31 (Graph 6)

TAC = 1554 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 481.74 kg/m^3

Say FAC= 480 kg/m^3

Coarse aggregate content = TAC - FAC = 1074 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	636	kg/m^3
Water =	210	kg/m^3
Fine aggregate =	480	kg/m^3
Coarse aggregate =	1074	kg/m^3
Wet density =	2400	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	5.3	kg
Water =	1.7	kg
Fine aggregate =	4.0	kg
Coarse aggregate =	8.9	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	636	0.202	20	27
Water	210	0.210	21	9
Coarse agg.	1074	0.400	40	45
Fine agg.	480	0.185	18	20
Total agg.	1554	0.598	58	65
Total	2400	0.994	97	-
Paste volume	-	0.412	-	-
% PV	-	41.2	-	-
Mortar volume	-	0.597	-	-
% MV	-	60	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.33	0.30 - 0.60
Coarse agg. / Total agg.(%)	69	60 - 75%
Fine agg. / Total agg. (%)	31	30- 45%
Total agg. / Cement	2.4	2-5
Density (kg/m^3)	2400	2200-2500

A) RA

1-Characteristic strength at 28 days 60 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard Deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 73 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Crushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 73 N/mm^2

w/c 0.33 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.33

7-Free-water content (W)

Use Table 3

Slump 30-60 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 210 kg/m^3 W_c = 210 kg/m^3

$W = 2/3W_f + 1/3W_c$ = 210 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 210 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 210 kg/m^3

8.1-Cement content 636 kg/m^3 Say 636 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 636 kg/m^3

Modified free-water to cement content 0.33

9-Concrete density

Relative density of aggregate (SSD) = 2.55 (Known)

Free-water content = 210 kg/m^3

Wet concrete density of the mix = 2350 kg/m^3 (Graph 5)

10-Total aggregate content, TAC (Coarse and fine aggregate)

TAC = Wet density - Free-water content -Cement content

TAC = 1504 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 µm sieve (%) 50

Modified free-water content to cement ratio 0.33

Proportion of fine aggregate (%) 31% (Graph 6)

TAC = 1504 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 466.24 kg/m^3

Say FAC= 465 kg/m^3

Coarse aggregate content = TAC - FAC = 1039 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	636	kg/m^3
Water =	210	kg/m^3
Fine aggregate =	465	kg/m^3
Coarse aggregate =	1039	kg/m^3
Wet density =	2350	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	5.3	kg
Water =	1.7	kg
Fine aggregate =	3.9	kg
Coarse aggregate =	8.6	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	636	0.202	20	27
Water	210	0.210	21	9
Coarse agg.	1039	0.420	42	44
Fine agg.	465	0.179	18	20
Total agg.	1504	0.578	59	64
Total	2350	1.006	99	-
Paste volume	-	0.412	-	-
% PV	-	41.2	-	-
Mortar volume	-	0.591	-	-
% MV	-	59	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.33	0.30 - 0.60
Coarse agg. / Total agg. (%)	69	60 - 75%
Fine agg. / Total agg. (%)	31	30- 45%
Total agg. / Cement	2.4	2-5
Density (kg/m^3)	2350	2200-2500

Chapter 6: mix design calculation sheet for 40 N/mm^2 concrete mix (28 day strength)

A) NA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m)

f_m = 53 N/mm^2 (f_{cu} + M)

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Uncrushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 53 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump 30-60 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 180 kg/m^3 W_c = 210 kg/m^3

W =2/3W_f + 1/3W_c = 190 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 190 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 190 kg/m^3

8.1-Cement content 475 kg/m^3 Say 475 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 475 kg/m^3

Modified free-water to cement content 0.4

9-Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 190 kg/m^3

Wet concrete density of the mix = 2400 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1735 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20	20
Percentage of fine aggregate passing 600 µm sieve (%)		54
Modified free-water content to cement ratio		0.4
Proportion of fine aggregate (%)		35 (Graph 6)

TAC = 1735 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 607.25 kg/m^3

Say FAC= 610 kg/m^3

Coarse aggregate content = TAC - FAC = 1125 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	475	kg/m^3
Water =	190	kg/m^3
Fine aggregate =	610	kg/m^3
Coarse aggregate =	1125	kg/m^3
Wet density =	2400	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.9	kg
Water =	1.6	kg
Fine aggregate =	5.1	kg
Coarse aggregate =	9.3	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	475	0.151	15	19
Water	190	0.190	19	9
Coarse agg.	1125	0.420	42	43
Fine agg.	610	0.235	23	30
Total agg.	1735	0.667	65	72
Total	2400	0.992	97	-
Paste volume	-	0.341	-	-
% PV	-	34.1	-	-
Mortar volume	-	0.575	-	-
% MV	-	58	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity		Value	Common range
w/c		0.4	0.30 - 0.60
Coarse agg. / Total agg. (%)		65	60 - 75%
Fine agg. / Total agg. (%)		35	30- 45%
Total agg. / Cement		3.7	2-5
Density	(kg/m^3)	2400	2200-2500

B) RA

1-Characteristic strength at 28 days 40 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 [NS = not specified]

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m)

f_m = 53 N/mm^2 (f_{cu} + M)

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Uncrushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 53 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump 30-60 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 180 kg/m^3 W_c = 210 kg/m^3

W =2/3W_f + 1/3W_c = 190 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 190 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 190 kg/m^3

8.1-Cement content 475 kg/m^3 Say 475 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 475 kg/m^3

Modified free-water to cement content 0.4

9-Concrete density

Relative density of aggregate (SSD) = 2.55 (Known)

Free-water content = 190 kg/m^3

Wet concrete density of the mix = 2325 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1660 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 μm sieve (%) 54

Modified free-water content to cement ratio 0.4

Proportion of fine aggregate (%) 35 (Graph 6)

TAC = 1660 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 581 kg/m^3

Say FAC= 580 kg/m^3

Coarse aggregate content = TAC - FAC = 1080 kg/m^3

13-Summary of quantities for 1m^3 (SSD)

Cement =	475	kg/m^3
Water =	190	kg/m^3
Fine aggregate =	580	kg/m^3
Coarse aggregate =	1080	kg/m^3
Wet density =	2325	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.9	kg
Water =	1.6	kg
Fine aggregate =	4.8	kg
Coarse aggregate =	9.0	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

14.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	475	0.151	15	20
Water	190	0.190	19	8
Coarse agg.	1080	0.430	43	46
Fine agg.	580	0.223	22	25
Total agg.	1660	0.638	66	71
Total	2325	0.996	98	-
Paste volume	-	0.341	-	-
% PV	-	34.1	-	-
Mortar volume	-	0.564	-	-
% MV	-	56	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.4	0.30 - 0.60
Coarse agg. / Total agg. (%)	65	60 - 75%
Fine agg. / Total agg. (%)	35	30- 45%
Total agg. / Cement	3.5	2-5
Density (kg/m^3)	2325	2200-2500

Chapter 7: mix design calculation sheet for standard 50 N/mm^2 (28 day strength) concrete mix (0% PFA)

A) NA

1-Characteristic strength at 28 days 50 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 (NS = not specified)

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 63 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Uncrushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 63 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump 10-30 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 160 kg/m^3 W_c = 190 kg/m^3

W = 2/3W_f + 1/3W_c = 170 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 170 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 170 kg/m^3

8.1-Cement content 425 kg/m^3 Say 425 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 ≤ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 425 kg/m^3

Modified free-water to cement content 0.40

9-Concrete density

Relative density of aggregate (SSD) = 2.65 (Known)

Free-water content = 170 kg/m^3

Wet concrete density of the mix = 2420 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1825 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm)	20	20
Percentage of fine aggregate passing 600 µm sieve (%)		53
Modified Free-water content to cement ratio		0.40
Proportion of fine aggregate (%)		30 (Graph 6)

TAC = 1825 kg/m^3

Fine aggregate content = FAC = % Fine aggregate × TAC = 547.5 kg/m^3

Say FAC= 545 kg/m^3

Coarse aggregate content = TAC - FAC = 1280 kg/m^3

13-Summary of quantities for 1 m^3 (SSD)

Cement =	425	kg/m^3
Water =	170	kg/m^3
Fine aggregate =	545	kg/m^3
Coarse aggregate =	1280	kg/m^3
Wet density =	2420	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.5	kg
Water =	1.4	kg
Fine aggregate =	4.5	kg
Coarse aggregate =	10.6	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.7	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	425	0.135	13	18
Water	170	0.170	17	7
Coarse agg.	1280	0.470	47	53
Fine agg.	545	0.210	21	23
Total agg.	1825	0.702	68	75
Total	2420	0.989	97	-
Paste volume	-	0.305	-	-
% PV	-	30.5	-	-
Mortar volume	-	0.515	-	-
% MV	-	51	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.4	0.30 - 0.60
Coarse agg. / Total agg. (%)	70	60 - 75%
Fine agg. / Total agg.(%)	30	30- 45%
Total agg. / Cement	4.3	2-5
Density (kg/m^3)	2420	2200-2500

A) RA

1-Characteristic strength at 28 days 50 N/mm^2

2-Margin strength (M)

M-specified NS N/mm^2 [NS = not specified]

M-calculated = 1.64 × S

S = Standard deviation = 8 N/mm^2

M-calculated 1.64 × 8 (Fig. 3)

M = 13 N/mm^2

3-Target mean strength (f_m) (f_{cu} + M)

f_m = 63 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Uncrushed (Crushed or Uncrushed)

6-Free-water cement ratio (w/c)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength (f_{cu}) = 49 N/mm^2 (Table 2)

Target mean strength (f_m) = 63 N/mm^2

w/c 0.4 (Graph 4)

w/c NS

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content (W)

Use Table 3

Slump 10-30 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed

Type of fine aggregate Unrushed

W_f = 160 kg/m^3 W_c = 190 kg/m^3

$W = 2/3W_f + 1/3W_c$ = 170 kg/m^3

[When coarse and fine aggregates are of different types]

[When coarse and fine aggregates are of the same type - use values in Table 3]

Free-water content W = 170 kg/m^3

8-Cement content

w/c ratio 0.4 (Fig. 4)

Free-water content 170 kg/m^3

8.1-Cement content 425 kg/m^3 Say 425 kg/m^3

8.2-Maximum specified cement content NS

8.3-Minimum specified cement content NS

(Use 8.1 if 8.1 $\leq$ 8.2, or use 8.3 if 8.3 > 8.1, use 8.2 if 8.2 < 8.1)

Cement content 425 kg/m^3

Modified free-water to cement content 0.40

9-Concrete density

Relative density of aggregate (SSD) = 2.55 (Known)

Free-water content = 170 kg/m^3

Wet concrete density of the mix = 2360 kg/m^3

10-Total aggregate content, TAC (Coarse and fine aggregate) (Graph 5)

TAC = Wet density - Free-water content -Cement content

TAC = 1765 kg/m^3

11-Proportion of fine and coarse aggregate (Graph 6)

Maximum aggregate size (mm) 20

Percentage of fine aggregate passing 600 µm sieve (%) 53

Modified free-water content to cement ratio 0.40

Proportion of fine aggregate (%) 30 (Graph 6)

TAC = 1765 kg/m^3

Fine aggregate content = FAC = % Fine aggregate $\times$ TAC = 529.5 kg/m^3

Say FAC= 530 kg/m^3

Coarse aggregate content = TAC - FAC = 1235 kg/m^3

13-Summary of quantities for one cubic meter (SSD)

Cement =	425	kg/m^3
Water =	170	kg/m^3
Fine aggregate =	530	kg/m^3
Coarse aggregate =	1235	kg/m^3
Wet density =	2360	kg/m^3

14-Proportion of gradients per trial mix (SSD) of : 0.0083m^3 (For small mixer)

Cement =	3.5	kg
Water =	1.4	kg
Fine aggregate =	4.4	kg
Coarse aggregate =	10.3	kg

This trial will make about 20 kg of concrete; enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.
RD	3.15	1	2.5	2.6

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	% by Vol.	% by mass
Cement	425	0.135	13	18
Water	170	0.170	17	7
Coarse agg.	1235	0.460	46	52
Fine agg.	530	0.204	20	22
Total agg.	1765	0.679	66	75
Total	2360	0.966	99	-
Paste volume	-	0.305	-	-
% PV	-	30.5	-	-
Mortar volume	-	0.509	-	-
% MV	-	51	-	-

(RD = Relative Density, PV = Paste Volume, MV = Mortar Volume)

15.2-Other important values and ratios

Quantity	Value	Common range
w/c	0.4	0.30 - 0.60
Coarse agg. / Total agg.(%)	70	60 - 75%
Fine agg. / Total agg. (%)	30	30- 45%
Total agg. / Cement	4.2	2-5
Density (kg/m^3)	2360	2200-2500

Chapter 8: mix design calculation sheet for standard 50 N/mm^2 (28 day strength) concrete mix (0% PFA)

A) NA

1-Characteristic strength at 28 days = 50 N/mm^2

2-Margin strength (M)

M-Specified NS N/mm^2 (NS= Not Specified)

M-calculated = 1.64 x S

S = Standard Deviation = 8 N/mm^2

M-calculated 1.64 x 8 (Fig. 3)

M = 13 N/mm^2

3-Target Mean strength fm (fm = fc+M)

fm = 63 N/mm^2

4-Cement type OPC

5-Aggregate

Coarse: Crushed (Crushed or Uncrushed)

Fine: Uncrushed (Crushed or Uncrushed)

6-Free-Water cement ratio (W/C)

Concrete age 28 days

Type of cement OPC

Coarse aggregate Crushed

Estimated compressive strength fcu 49 N/mm^2

Target Mean strength fm = 63 N/mm^2 (Table 2)

w/c 0.4 (Graph No 4)

(Use the lower value as w/c)

w/c = 0.4

7-Free-water content W

UseTable No 3

Slump 60 to 180 mm

Maximum aggregate size 20 mm

Type of coarse aggregate Crushed (Crushed or Uncrushed)

Type of fine aggregate Unrushed (Crushed or Uncrushed)

W_f = 195 kg/m^3 W_c = 225 kg/m^3

$W = 2/3W_f + 1/3W_c$ = 205 kg/m^3
[When coarse and fine aggregates are of different types]

W = Values in Table 3
[When coarse and fine aggregates are of the same types- use values in table 3]

Free-water content W = 205 kg/m^3

8-Relative density

Relative density of aggregate (SSD) =	2.55	(Known)	
PFA percentage	30	%	
Amount of water reduced for PFA (Table 9)	20	kg/m^3	
Free-water content adjusted for PFA =	185	kg/m^3	
Wet density of the mix =	2340	kg/m^3	(Graph 5)

9-Cement and PFA content

Cement content	=	409.8	kg/m^3	Say	410	kg/m^3
RGD content	=	176	kg/m^3	Say	175	kg/m^3
C+RGD	=	585				
w/b = w/ (C+RGD)	=	0.32				

10-Total aggregate content ,TAC (Coarse and fine aggregate)

TAC = Wet density - Free-water content -Cement content
TAC = 1570 kg/m^3

11-Proportion of fine and coarse aggregate
Graph 6
Maximum aggregate size 20 mm

Percentage of fine aggregate passing 600µm sieve 53 %

Modified Free-water content to cement ratio 0.32

Proportion of fine aggregate (%) 38 (graph 6)

TAC = 1570 kg/m^3

Fine aggregate content = FAC = % Fine agg. x TAC = 596.6 kg/m^3

Say FAC= 600 kg/m^3

Coarse aggregate content = TAC - FAC = 970 kg/m^3

13-Summary of quantities for one cubic meter (SSD)

Cement =	410	kg/m^3
PFA =	175	
Water =	185	kg/m^3
Fine aggregate =	600	kg/m^3

Coarse aggregate = 970 kg/m^3

14-Proportion of gradients per trial mix (SSD) of 0.0083 (For Small mixer)

Cement =	3.4	kg
PFA =	1.45	kg
Water =	1.5	kg
Fine aggregate =	5.0	kg
Coarse aggregate =	8.1	kg

This trial will make about 20 kg concrete, enough for slump and Vebe tests.

15-Miscellaneous

Material	Cement	Water	Coarse agg.	Fine agg.	PFA
RD	3.15	1	2.5	2.6	2.25

15.1-Volumes of the mixture components

Material	kg/m^3	Vol. (m^3)	Vol. (%)	% by mass
Cement	410	0.130	13	18
PFA	175	0.078	8	7
Water	185	0.19	19	8
Coarse agg.	970	0.39	39	41
Fine agg.	600	0.231	23	26
Total agg.	1570	0.604	62	67
Total	2340	1.012	99	-
Paste volume	-	0.393	-	-
% PV	-	39	-	-
Mortar volume	-	0.624	-	-
% MV	-	62	-	-
Mortar	1370			

(RD = Relative Density, PV= Paste Volume, MV= Mortar Volume)

15.2-Other important values and ratios

Quantity		Value	Common range
Powder content	kg/m^3	585	400-600
w/b	-	0.32	0.28-0.42 %
Coarse aggregate content	(%)	39	29-35 % (by vol.)
PV.	(%)	39	30-42 % (by vol.)
Fine agg./ Mortar	(%)	44	40-52%
Density	Kg/m^3	2340	2200-2500