## **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	e strength	at 28 (	days			40	N/mm <sup>2</sup>
2-Margin streng	gth (M)						
M-specified M-calculated = 1	.64 × S		NS	N/mm <sup>2</sup>		(NS = not)	specified)
<b>S</b> =	Standard	deviat	ion =			8	N/mm <sup>2</sup>
M-calculated			1.64	×		8	(Fig. 3)
M =	13		N/mm <sup>2</sup>				
3-Target mean	strength (	f <sub>m</sub> ) (f <sub>cu</sub>	+ M)				
			$f_m =$	53	N/mm <sup>2</sup>		
4-Cement type			OPC				
5-Aggregate							
	Coarse:	Crush	ned	(Crushed or Uncrushed)			
	Fine:	Crush	ned	(Crushed or	Uncrushed	l)	
6-Free-water ce	ment rati	o (w/c)					
	Concrete	age		28	days		
	Type of	cement		OPC			
	Coarse a	ggrega	te	Crushed			
Estimated compr	essive stre	ength (f	$f_{cu}) =$		49	N/mm <sup>2</sup>	(Table 2)
Target mean stre	ngth (f <sub>m</sub> ) =	=		53	N/mm <sup>2</sup>		
			w/c	0.46	(Graph	4)	
			w/c	NS			
			(Use the	lower value as	w/c)		
			w/c =	0.46			
7-Free-water co	ntent (W)	1					
Use Table 3							
Slump	60-18	30	mm	•			
Maximum aggre	gate size			20 mm			
Type of coarse a	ggregate			Crushed			
i ype of fine agg	regate		3	Crushed		2	
$W_{f} =$	195	1	kg/m <sup>°</sup>	2	$W_c = 2$	225 kg/m <sup>3</sup>	
$W = 2/3W_f + 1/3$	$W_c =$		205	kg/m <sup>3</sup>			

[When coarse and fine aggregation aggregation and fine aggregation aggregat	tes are of dif	ferent types]		
[When coarse and fine aggregation aggregation and fine aggregation aggregat	tes are of the	e same type - use	values in Table 3]	
Free-water content		<b>W</b> =	205	kg/m <sup>3</sup>
8-Cement content				
w/c ratio	0.46	(Fig. 4)		
Free-water content		205	kg/m <sup>3</sup>	
8.1-Cement content		446	kg/m <sup>3</sup>	Say 445 kg/m <sup>3</sup>
8.2-Maximum specified cement 8.3-Minimum specified cement ( Use 8.1 if $8.1 \le 8.2$ , or use 8.	t content content 3 if $8.3 > 8$ .	1, use 8.2 if 8.2 <	NS NS 8.1 )	
Cement content	445	kg/m <sup>3</sup>		
Modified free-water to cement	content (	).46		
9-Concrete density Relative density of aggregate (S	SSD) –		2.65 (Known)	
Free-water content –	JSD) –		$205 \text{ kg/m}^3$	
Wet concrete density of the mix	<i>,</i> _		$2360 \text{ kg/m}^3$	
wet concrete density of the min	X —		2300 kg/m	
10-Total aggregate content, T	AC (Coarse	and fine aggrega	nte)	(Graph 5)
TAC = Wet	density - Fr	ee-water content	- Cement content	
TAC =	1710	kg/m <sup>3</sup>		
<b>11-Proportion of fine and coa</b> Maximum aggregate size (mm) Percentage of fine aggregate pa Modified free-water content to Proportion of fine aggregate (% TAC = 1710 Fine aggregate content = FAC = Say Coarse aggregate content = <b>13-Summary of quantities for</b> Fine Coarse	rse aggrega ssing 600 $\mu$ cement ratio $kg/m^3$ = % Fine ag FAC= • 1 m <sup>3</sup> (SSD Cement Water e aggregate e aggregate	te (Graph 6) m sieve (%) gregate $\times$ TAC = 700 TAC - FAC = 445 = 205 = 700 = 1010	$c = \frac{kg/m^3}{c}$ $kg/m^3$ $kg/m^3$ $kg/m^3$ $kg/m^3$	20 54 0.46 41 (Graph 6) 701.1 kg/m <sup>3</sup> 1010 kg/m <sup>3</sup>
Coarse	Vot donsity -	- 2360	$kg/m^3$	
v	vet delisity -	- 2500	кg/Ш	
14-Proportion of gradients pe	er trial mix	(SSD)	of : 0.0083m <sup>3</sup>	(For small mixer)
Find Coarse This trial will make about 20 kg	Cement Water e aggregate e aggregate g of concrete	= 3.7 = 1.7 = 5.8 = 8.4 e; enough for slur	kg kg kg np and Vebe tests.	
15-IVIISCEIIaneous				
Material Cement W	ater C	oarse agg.	Fine agg.	

3.15

1

2.7

2.6

RD

15.1-Volumes of the mixture components						
Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2360	2200-2500

## B) RA

1-Characteristic strength at 28 days				40	N/mm <sup>2</sup>
2-Margin stren	gth (M)				
M-specified		NS	N/mm <sup>2</sup>	(NS= not specified)	
M-calculated =	1.64 × S				
<b>S</b> =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean	strength (	$f_m$ ) $(f_{cu} + M)$			
		$f_m =$	53	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Crushed	(Crushed or	Uncrushed)	
6-Free-water ce	ement ratio	<b>o</b> (w/c)			
	Concrete	eage	28	days	
	Type of	cement	OPC		
	Coarse a	ggregate	Crushed		
Estimated comp	ressive stre	ength $(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stre	ength (f <sub>m</sub> ) =	=	53	N/mm <sup>2</sup>	
0	C (	w/c	0.46	(Graph 4)	
		w/c	NS	(S-specified, NS-not s	specified)
		(Use the lo	ower value as	w/c)	
		w/c =	0.46		
7-Free-water co	ontent (W)				

(W)

Use Table 3					
Slump	60-180	mm			
Maximum aggrega	ite size		20 mm Crushad		
Type of coarse agg	gregale		Crushed		
$W_{c} =$	195	$k\sigma/m^3$	erusiieu	$W = 225 \text{ kg/m}^3$	
$W_1 = 2/2W_1 + 1/2W_2$	1)5 I _	205	$k\alpha/m^3$	$W_c = 223$ kg/m	
$W = 2/3 W_f + 1/3 W_f$ [When coarse and	fine aggregat	es are of diffe	rent types]		
[When coarse and	fine aggregat	es are of the s	same type - use	values in Table 3]	
Free-water content	t		W =	205	kg/m <sup>3</sup>
8-Cement content	t				
w/c ratio			0.46 (Fig. 4)	)	
Free-water content	t		205 kg/m <sup>3</sup>		
8.1-Cement conter	nt		446 kg/m <sup>3</sup>	Say 445 kg/m <sup>3</sup>	
8.2-Maximum spe	cified cement	content		NS	
8.3-Minimum spec	cified cement	content		NS	
(Use 8.1 if $8.1 \le 3$	8.2, or use 8.3	8 if 8.3 > 8.1,	use 8.2 if 8.2 <	(8.1)	
Cement content		445	kg/m <sup>3</sup>		
Modified free-wat	ter to cement	content 0.4	-6		
9-Concrete densit	tv				
Relative density of	f aggregate (S	SD) =		2.55 (Known)	
Free-water content =				$205 \text{ kg/m}^3$	
Wet concrete dens	ity of the mix	=		$2325 \text{ kg/m}^3$	
10-Total aggregat	te content, TA	AC (Coarse a	nd fine aggrega	ate) (C	Graph 5)
,	TAC = wet c	iensity - Free	-water content	-Cement content	
	IAC =	16/5	kg/m <sup>2</sup>		
11-Proportion of	fine and coar	se aggregate	e (Graph 6)		
Maximum aggrega	ate size (mm)	00 0	20		
Percentage of fine	aggregate pas	ssing 600 µm	sieve (%)		54
Modified free-wat	er content to c	cement ratio		41	0.46
Proportion of fine	aggregate (%)	)		41	(Graph 6)
TAC =	1675	kg/m <sup>3</sup>			
Fine aggregate cor	itent = FAC =	• % Fine aggr	egate × TAC =	=	686.75 kg/m <sup>3</sup>
_	Say F	FAC=	685	kg/m <sup>3</sup>	
Coarse aggregate o	content =		TAC - FA	C =	990 kg/m <sup>3</sup>
13-Summary of q	uantities for	1 m <sup>3</sup> (SSD)			
		Cement =	445	kg/m <sup>3</sup>	
		Water =	205	kg/m <sup>3</sup>	
	Fine	aggregate =	685	kg/m <sup>3</sup>	
	Coarse	aggregate =	990	kg/m <sup>3</sup>	
	W	et density =	2325	kg/m <sup>3</sup>	

<b>14-Proportion of gradients per trial mix</b> (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 <sup>3</sup>	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)

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 <sup>3</sup> )	2360	2200-2500

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

A) NA					
1-Characteristic	strength	at 28 days	40	N/mm <sup>2</sup>	
2-Margin streng	gth (M)				
M-specified M-calculated = 1	.64 × S	NS	S N/mm <sup>2</sup>	(NS = not speci	fied)
<b>S</b> =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.6	i4 ×	8	(Fig. 3)
M =	13	N/mn	$n^2$		
3-Target mean s	trength (f	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m =$	53	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed	or Uncrushed)	
	Fine:	Crushed	(Crushed	or Uncrushed)	
6-Free-water cer	ment ratio	<b>o</b> (w/c)			
	Concrete	age	28	days	
	Type of o	cement	OPC		
	Coarse ag	ggregate	Crushec	1	2
Estimated compre	essive stre	$ength(f_{cu}) =$		49	$N/mm^2$ (Table 2)
Target mean stren	ngth $(f_m) =$	=	53	N/mm <sup>2</sup>	
		w/c	0.46	(Graph 4)	
		w/c	NS		
		(Use w/c	= 0.46	as w/c)	
7-Free-water co	ntent (W)				
Use Table 3					
Slump	30-6	0 mm			
Maximum aggreg	gate size		20 mm		
Type of coarse ag	ggregate		Crushed		
Type of fine aggr	egate		Crushed		
$\mathbf{W}_{\mathrm{f}} =$	210	kg/m	3	$W_c = 210 \text{ kg/r}$	n <sup>3</sup>
$W = 2/3W_f + 1/3V_f$	$W_c =$	21	$0   kg/m^3$		
[When coarse and [When coarse and	d fine aggi d fine aggi	regates are of regates are of	different types] the same type -	use values in Table 3	1
Free-water conter	nt	U	W	= 210	kg/m <sup>3</sup>
8-Cement conten	nt				
w/c ratio			0.46 (Fi	g. 4)	
Free-water conten	nt		210 kg/m	1 <sup>7</sup>	
8.1-Cement conte	ent		457 kg/m	n <sup>°</sup> Say 457 kg/	/m <sup>°</sup>
8.2-Maximum sp 8.3-Minimum sp	ecified cer	ment content nent content		NS NS	
( Use 8.1 if $8.1 \le$	8.2, or us	se 8.3 if 8.3 >	8.1, use 8.2 if 8.	2 < 8.1)	
Cement content		45	7 $kg/m^3$		

Modified free-	water to cer	ment conten	t 0.4	6		
9-Concrete de	nsity					
Relative densit	y of aggrega	ate $(SSD) =$			2.65 (Known)	
Free-water con	tent =				$210 \text{ kg/m}^3$	
Wet concrete d	lensity of the	e mix =			2400 kg/m <sup>3</sup>	
10-Total aggre	egate conter TAC =	n <b>t, TAC</b> (Co Wet density	oarse ai - Free-	nd fine aggrega water content	ate) ( -Cement content	Graph 5)
	TAC =	1	733	kg/m <sup>3</sup>		
11-Proportion	of fine and	coarse agg	gregate	(Graph 6)		
Maximum aggi	regate size (	mm)				20
Percentage of f	ine aggrega	te passing 6	00 µm	sieve (%)		42
Modified free-	water conter	nt to cement	ratio			0.46
Proportion of f	ine aggregat	te (%)	2			38 (Graph 6)
TAC =	173	3 kg/1	m <sup>3</sup>			
Fine aggregate	content = F	AC = % Fin	e aggre	egate $\times$ TAC =	=	658.5 kg/m <sup>3</sup>
		Say FAC=		660	kg/m <sup>3</sup>	
Coarse aggregate content =			TAC - FA	C =	1073 kg/m <sup>3</sup>	
13-Summary	of quantitie	s for 1 m <sup>3</sup> (	SSD)			
		Cer	ment =	457	kg/m <sup>3</sup>	
		Wa	ater =	210	kg/m <sup>3</sup>	
		Fine aggres	gate =	660	kg/m <sup>3</sup>	
	С	oarse aggres	gate =	1073	kg/m <sup>3</sup>	
		Wet den	sity =	2400	kg/m <sup>3</sup>	
14-Proportion	of gradien	ts per trial	mix (S	SD)	of : 0.0083m <sup>3</sup>	(For small mixer)
		Cen	nent =	3.8	kg	
		Wa	ater =	1.7	kg	
Fine aggregate = 5.5				5.5	kg	
	C	oarse aggreg	gate =	8.9	kg	
This trial will r	nake about 2	20 kg of con	crete; e	enough for slur	np and Vebe tests.	
15-Miscellane	ous					
Material	Cement	Water	Coa	rse agg.	Fine agg.	

3.15

1

2.7

2.6

RD

## 15.1-Volumes of the mixture components

Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2400	2200-2500

## B) RA

1-Characteristic	e strength	at 28 days		40	N/mm <sup>2</sup>
2-Margin streng	gth (M)				
M-specified M-calculate	d = 1.64	NS × S	N/mm <sup>2</sup>	(NS = not specified)	
$\mathbf{S} =$	Standard	l deviation =		8	N/mm <sup>2</sup>
M-calcula	ted	1.64	×	8	(Fig. 3)
<b>M</b> =	13	N/mm <sup>2</sup>			
3-Target mean	strength (	$f_m$ ) ( $f_{cu} + M$ )			
		$\mathbf{f}_{m}$ =	53	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or Uncrushed)		
	Fine:	Crushed	(Crushed or Uncrushed)		
6-Free-water ce	ment rati	<b>o</b> (w/c)			
	Concrete	e age	28	days	
	Type of	cement	OPC		
	Coarse a	Iggregate	Crushed		
Estimated compr	essive stre	ength $(f_{cu}) =$		49	N/mm <sup>2</sup>
Target mean stre	ngth (f <sub>m</sub> ) =	=	53	N/mm <sup>2</sup>	(Table 2)
		w/c	0.46	(Graph 4)	
		w/c	NS		
		(Use the l	ower value as w/c)		
		w/c =	0.46		

7-Free-water cont	ent (W)				
Slump	30.60	mm			
Maximum aggrega	te size	11111	20 mm		
Type of coarse age	regate		Crushed		
Type of fine aggres	vate		Crushed		
i jpe of fille uggreg	Suite		erusiidu	$W_{c} = 210$	
$W_{f} =$	210	kg/m <sup>3</sup>		kg/m <sup>3</sup>	
$W = 2/3W_f + 1/3W_c$	. =	210	kg/m <sup>3</sup>		
[When coarse and f [When coarse and f	fine aggrega fine aggrega	tes are of diffe tes are of the s	rent types] ame type - use values ir	n Table 3]	
Free-water content			W =	210	kg/m <sup>3</sup>
8-Cement content			0.46 (Fig. 4)		
w/c 1au0			0.40 (Fig. 4)		
Free-water content			210 kg/m <sup>3</sup>	0 457	
8.1-Cement conten	t		457 kg/m <sup>3</sup>	$\frac{\text{Say 457}}{\text{kg/m}^3}$	
8.2-Maximum specified cement content 8.3-Minimum specified cement content (Use 8.1 if $8.1 \le 8.2$ or use 8.3 if $8.3 \ge 8.1$ use 8.2 if $8.2 \le 8.1$ )				NS NS	
Cement content Modified free-wate	er to cement	$457 \text{ kg/m}^3$ content 0.4	6		
9-Concrete densit	y			2.55	
Relative density of	aggregate (S	SSD) =		2.55 (Known)	
Free-water content	=			$210 \text{ kg/m}^3$ 2350	
Wet concrete densi	ty of the mix	<b>x</b> =		kg/m <sup>3</sup>	
10-Total aggregat	e content, T TAC = Wet	AC (Coarse and density - Free-	nd fine aggregate) water content -Cement	(Graph 5) content	
Т	TAC =	1683	kg/m <sup>3</sup>		
11-Proportion of f	ine and coa	rse aggregate	(Graph 6)		
Maximum aggrega	te size (mm)				20
Percentage of fine a	aggregate pa	ssing 600 µm	sieve (%)		42
Modified free-wate	er content to	cement ratio			0.46
Proportion of fine a	aggregate (%	5)			38 (Graph 6)
TAC =	1683	kg/m <sup>3</sup>			
Fine aggregate con	tent = FAC	= % Fine aggre	egate $\times$ TAC =		589.05 kg/m <sup>3</sup>
	Say	FAC=	590	kg/m <sup>3</sup>	
Coarse aggregate c	ontent =		TAC - FAC =	-	1073 kg/m <sup>3</sup>
13-Summary of qu	uantities for	• 1 m <sup>3</sup> (SSD)			
		Cement –	457	$k\sigma/m^3$	

Cement =	457	kg/m <sup>3</sup>
Water =	210	kg/m <sup>3</sup>
Fine aggregate =	590	kg/m <sup>3</sup>
Coarse aggregate =	109	$kg/m^3$
Wet density =	235	$kg/m^3$

## **14-Proportion of gradients per trial mix** (SSD) of $: 0.0083 \text{ m}^3$ (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: enoug	h for slump and W	abo tosts

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

15-Miscellane	ous					
Material	Cement	Water		Coarse agg.	Fine agg.	
RD	3.15	1	2.5	2.6		
15.1-Volumes	of the mixt	ure components	5			
Material		kg/m <sup>3</sup>		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 = Relativ	e Density, P	V = Paste Volur	me, MV =	Mortar Volume)		

		Common
Quantity	Value	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  $\ensuremath{N/mm^2}$  concrete mix (28 day strength)

A) NA					
1-Characteristic	strength	at 28 days		50	N/mm <sup>2</sup>
2-Margin streng	gth (M)				
M-specified M-calculated = 1	.64 × S	NS	N/mm <sup>2</sup>	(NS = not specifie	ed)
S =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	4 ×	8	(Fig. 3)
M =	13	N/mm	2		
3-Target mean s	s <b>trength</b> (f	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m \;=\;$	63	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed of	or Uncrushed)	
	Fine:	Crushed	(Crushed o	or Uncrushed)	
6-Free-water cer	ment ratio	<b>o</b> (w/c)			
	Concrete	age	28	days	
	Type of c	cement	OPC		
	Coarse ag	ggregate	Crushed		2
Estimated compre	essive stre	$\operatorname{ngth}(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stren	ngth $(f_m) =$	:	63	N/mm <sup>2</sup>	
		w/c	0.4	(Graph 4)	
		W/C (Uso f	NS ha lawar yalua a	s w/c)	
		w/c =	= 0.4	.s w/c)	
7-Free-water co	ntent (W)				
Use Table 3					
Slump	10-3	0 mm			
Maximum aggreg	gate size		20 mm		
Type of coarse ag	ggregate		Unrushed		
Type of fille aggi		1	Uniusited	W. 100 ha /m <sup>3</sup>	
$w_f = W - 2/3W_{c+1}/3V_{c+1}$	100 W -	kg/m 170	$k \sigma / m^3$	$w_c = 190 \text{ kg/m}$	
$w = 2/5 w_{\rm f} + 1/5$	••• <sub>c</sub> =	170	, Kg/III		
[When coarse and [When coarse and	d fine aggi d fine aggi	regates are of c regates are of t	htterent types] he same type - u	use values in Table 3]	
Free-water conten	nt		W =	= 170	kg/m <sup>3</sup>
8-Cement conten	nt				
w/c ratio			0.4 (Fig. 4	.)	
Free-water conten	nt		170 kg/m <sup>3</sup>		
8.1-Cement conte	ent		425 kg/m	$^3$ Say 425 kg/m <sup>3</sup>	
8.2-Maximum sp	ecified cer	ment content		NS	
8.3-Minimum spe	ecified cer	nent content		NS	
(Use 8.1 if $8.1 \le$	8.2, or us	se 8.3 if $8.3 > 8$	8.1, use 8.2 if 8.2	2 < 8.1)	
Cement content		425	kg/m <sup>3</sup>		

Modified free-w	water to cen	nent conten	t 0.40				
9-Concrete den	sity						
Relative density	of aggrega	te $(SSD) =$			2.65 (Known)		
Free-water conte	ent =				170 kg/m <sup>3</sup>		
Wet concrete de	ensity of the	e mix =			$2430 \text{ kg/m}^3$		
10-Total aggreg	gate conter TAC = V	<b>it, TAC</b> (C Wet density	oarse an - Free-v	d fine aggrega vater content	ate) ( -Cement content	Graph 5)	
	TAC =	1	835	kg/m <sup>3</sup>			
<b>11-Proportion</b> Maximum aggre Percentage of fin Modified free-w Proportion of fin	of fine and egate size (1 ne aggregat vater conten ne aggregat	<b>coarse agg</b> nm) e passing 6 t to cement e (%)	<b>gregate</b> 00 μm s: ratio	(Graph 6) ieve (%)		20 53 0.40 30 (Graph 6)	
TAC =	1835	5 kg/	m <sup>3</sup>				
Fine aggregate of	content = F.	AC = % Fir	ne aggreg	gate $\times$ TAC =	=	550.5 kg/m <sup>3</sup>	
		Say FAC=		550	kg/m <sup>3</sup>		
Coarse aggregat	e content =	=		TAC - FA	C =	1285 kg/m <sup>3</sup>	
13-Summary of	f quantities	s for 1m <sup>3</sup> (S	SSD)				
		Cer	nent =	425	kg/m <sup>3</sup>		
		Wa	ater =	170	kg/m <sup>3</sup>		
		Fine aggre	gate =	550	kg/m <sup>3</sup>		
	Co	barse aggre	gate =	1285	kg/m <sup>3</sup>		
		Wet den	sity =	2430	kg/m <sup>3</sup>		
14-Proportion	of gradient	s per trial	mix (SS	D)	of : 0.0083m <sup>3</sup>	(For small mixer)	
		Cen	nent =	3.5	kg		
		Wa	ater =	1.4	kg		
		Fine aggre	gate =	4.6	kg		
	Co	barse aggre	gate =	10.7	kg		
This trial will m	ake about 2	0 kg of cor	icrete; er	nough for slu	mp and Vebe tests.		
15-Miscellaneo	us						
Material	Cement	Water	Coars	se agg.	Fine agg.		
RD	3.15	1	2.	.7	2.6		

## 15.1-Volumes of the mixture components

Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2430	2200-2500

## A) RA

1-Characteristic strength at 28 days				50	N/mm <sup>2</sup>
2-Margin stren	gth (M)				
M-specified		NS	N/mm <sup>2</sup>	[NS= not specified]	
M-calculated = 1	1.64 × S				
<b>S</b> =	Standard	Deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean	strength (	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m =$	63	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Crushed	(Crushed or	Uncrushed)	
6-Free-water ce	ement ratio	<b>o</b> (w/c)			
	Concrete	age	28	days	
	Type of	cement	OPC		
	Coarse a	ggregate	Crushed		
Estimated comp	ressive stre	$ength(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stre	ength (f <sub>m</sub> ) =	=	63	N/mm <sup>2</sup>	
e	0	w/c	0.4	(Graph 4)	
		w/c	NS	-	
		(Use the l	ower value as	w/c)	
		w/c =	0.4		
7-Free-water co	ontent (W)	)			

Use Table 3					
Slump	10-30	mm			
Maximum aggregate s	size		20 mm		
Type of coarse aggreg	ate		Crushed		
Type of fine aggregate	3		Unrushed		
$W_{f} =$	160	kg/m <sup>3</sup>		$W_c = 190 \text{ kg/m}^3$	
$W = 2/3W_f + 1/3W_c =$		170	kg/m <sup>3</sup>		
[When coarse and fine [When coarse and fine	e aggregates e aggregates	s are of differ s are of the sa	ent types] ame type - use	values in Table 3]	
Free-water content			$\mathbf{W} =$	170	kg/m <sup>3</sup>
8-Cement content					
w/c ratio			0.4 (Fig. 4)		
Free-water content			170 kg/m <sup>3</sup>		
8.1-Cement content			425 kg/m <sup>3</sup>	Say 425 kg/m <sup>3</sup>	
8.2-Maximum specifie	ed cement c	ontent		NS	
8.3-Minimum specifie	d cement co	ontent		NS	
(Use 8.1 if $8.1 \le 8.2$ ,	or use 8.3 i	f 8.3 > 8.1, u	se 8.2 if 8.2 <	8.1)	
Cement content Modified free water t	o comont o	425	$kg/m^3$		
Woulled nee-water t		Jittent 0.40	)		
9-Concrete density					
Relative density of ag	gregate (SS	D) =		2.55 (Known)	
Free-water content =				$170 \text{ kg/m}^3$	
Wet concrete density	of the mix =	=		2365 kg/m <sup>3</sup>	
<b>10-Total aggregate c</b> TAC	ontent, TA C = Wet de	<b>C</b> (Coarse ar nsity - Free-	nd fine aggrega water content -	te) (Gra Cement content	aph 5)
TAG	C =	1770	kg/m <sup>3</sup>		
11-Proportion of fine	and coars	e aggregate	(Graph 6)		
Maximum aggregate s	size (mm)	e uggi egute	(Oruph 0)		20
Percentage of fine agg	gregate pass	ing 600 µm s	sieve (%)		53
Modified free-water c	ontent to ce	ment ratio			0.40
Proportion of fine agg	regate (%)				30 (Graph 6)
TAC =	1770	kg/m <sup>3</sup>			
Fine aggregate conten	t = FAC = 9	% Fine aggre	gate $\times$ TAC =		531 kg/m <sup>3</sup>
	Say FA	AC=	530	kg/m <sup>3</sup>	
Coarse aggregate cont	ent =		TAC - FAG	C =	1240 kg/m <sup>3</sup>
		3			
13-Summary of quar	itities for 1	m <sup>°</sup> (SSD)		2	
		Cement =	425	kg/m <sup>3</sup>	
		Water =	170	kg/m <sup>3</sup>	

Cement =	425	kg/m <sup>5</sup>
Water =	170	kg/m <sup>3</sup>
Fine aggregate =	530	kg/m <sup>3</sup>
Coarse aggregate =	1240	kg/m <sup>3</sup>
Wet density =	2365	kg/m <sup>3</sup>

#### **14-Proportion of gradients per trial mix** (SSD)

of : 0.0083m<sup>3</sup>

(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 <sup>3</sup>	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)

Quantity		Value	Common range
w/c		0.4	0.30 - 0.60
Coarse agg. / 7	Fotal agg. (%)	70	60 - 75%
Fine agg. / Tot	al agg. (%)	30	30-45%
Total agg. / Ce	ement	4.2	2-5
Density	$(kg/m^3)$	2365	2200-2500

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

A) NA					
1-Characteristic	strength	at 28 days		60	N/mm <sup>2</sup>
2-Margin streng	gth (M)				
M-specified M-calculated = 1	.64 × S	NS	N/mm <sup>2</sup>	(NS = not specified)	
<b>S</b> =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean s	strength (1	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m =$	73	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Crushed	(Crushed or	Uncrushed)	
6-Free-water cer	ment ratio	o (w/c)			
	Concrete	age	28	days	
	Type of o	cement	OPC Constant		
	Coarse a	ggregate	Crusned	10	2 (5.11.2)
Estimated compressive strength $(f_{cu}) =$				49	N/mm <sup>2</sup> (Table 2)
Target mean stre	ngth ( $f_m$ ) =	=	73	$N/mm^2$	
		W/C	0.33 NS	(Graph 4)	
		(Use the lo	ower value as y	w/c)	
		w/c =	0.33		
7-Free-water co	ntent (W)				
Use Table 3					
Slump	30-60	mm	•		
Maximum aggreg	gate size		20 mm Crushed		
Type of fine ager	egate		Unrushed		
W <sub>c</sub> -	210	$kg/m^3$	emusiidu	$W - 210 \text{ kg/m}^3$	
$W_{\rm f} = 2/3W_{\rm f} + 1/3$	$W_c =$	210	kg/m <sup>3</sup>	$W_c = 210 \text{ kg/m}$	
[When coarse and	d fine agg	regates are of diffe	erent types]		
[when coarse and	u nne aggi	regates are of the s	ame type - use	e values in Table 5	1 / 3
Free-water conten	nt		W =	210	kg/m <sup>3</sup>
8-Cement conten	nt				
w/c ratio			0.4 (Fig. 4)		
Free-water conten	nt		210 kg/m <sup>°</sup>	2	
8.1-Cement conte	ent		$636 \text{ kg/m}^3$	Say 636 kg/m <sup>3</sup>	
8.2-Maximum sp	ecified cer	ment content		NS	
8.3-Minimum spe	ecified cer	nent content $x_0 \otimes x_1 \neq 0 $	1100 8 1 ; f 0 1 .	NS - 8 1 )	
$(Use 0.1   I 0.1 \leq$	o.2, or us	0.0 11 0.0 ~ 0.1,	usc 0.2 II 0.2 < 11 0.2 < 11 0.2 < 11 0.2 < 11 0.2 < 11 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12 0.2 < 12	~ 0.1 )	
Cement content		030	Kg/III		

Modified free-	water to cement cont	ent 0.33			
9- Concrete de	nsity				
Relative density	Relative density of aggregate (SSD) =				
Free-water cont	Free-water content =				
Wet concrete density of the mix =				2400 kg/m <sup>3</sup> (Graph	n 5)
10-Total aggre	gate content, TAC ( $TAC = Wet$ densite	Coarse and	l fine aggreg	gate)	
	TAC = wet densi	1554	leg/m <sup>3</sup>	-Cement content	
	IAC =	1554	kg/m		
11-Proportion	of fine and coarse a	ggregate	(Graph 6)		
Maximum aggr	egate size (mm)				20
Percentage of fi	ne aggregate passing	, 600 μm si	eve (%)		50
Modified free-v	vater content to ceme	nt ratio			0.33
Proportion of fi	Proportion of fine aggregate (%)				
TAC =	1554 k	g/m <sup>3</sup>			
Fine aggregate	content = $FAC = \%$ I	Fine aggreg	ate × TAC	=	481.74 kg/m <sup>3</sup>
	Say FAC	=	480	kg/m <sup>3</sup>	
Coarse aggrega	te content =		TAC - FA	AC =	1074 kg/m <sup>3</sup>
13-Summary o	f quantities for 1 m	<sup>3</sup> (SSD)			
	C	lement =	636	kg/m <sup>3</sup>	
	v	Water =	210	kg/m <sup>3</sup>	
	Fine agg	regate =	480	kg/m <sup>3</sup>	
	Coarse agg	regate =	1074	kg/m <sup>3</sup>	
	Wet de	ensity =	2400	kg/m <sup>3</sup>	
14-Proportion	of gradients per tri	al mix (SSI	D)	of : 0.0083m <sup>3</sup>	(For small mixer)
	С	ement =	5.3	kg	
	v	Water =	1.7	kg	
	Fine agg	regate =	4.0	kg	
	Coarse agg	regate =	8.9	kg	
This trial will m	ake about 20 kg of c	oncrete; en	ough for slu	mp and Vebe tests.	
15-Miscellaneo	us				
Material	Cement Water	Coars	e agg.	Fine agg.	

2.6

RD

3.15 1 2.7

## 15.1-Volumes of the mixture components

Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2400	2200-2500

## A) RA

1-Characteristic strength at 28 days				60	N/mm <sup>2</sup>
2-Margin streng	gth (M)				
M-specified		NS	N/mm <sup>2</sup>	(NS = not specified)	
M-calculated = 1	.64 × S				
<b>S</b> =	Standard	Deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean s	strength (	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m \;=\;$	73	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Crushed	(Crushed or	Uncrushed)	
6-Free-water ce	ment ratio	o (w/c)			
	Concrete	eage	28	days	
	Type of o	cement	OPC		
	Coarse a	ggregate	Crushed		
Estimated compr	essive stre	$ength(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stream	ngth (f <sub>m</sub> ) =	=	73	N/mm <sup>2</sup>	
		w/c	0.33	(Graph 4)	
		w/c	NS		
		(Use the 1 $w/c =$	ower value as 0.33	w/c)	

7-Free-water co	ntent (W)				
Use Table 3					
Slump	30-60	mm			
Maximum aggreg	gate size		20 mm		
Type of coarse ag	ggregate		Crushed		
Type of fine aggr	regate	3	Unrushed		
$W_{\rm f}$ =	210	kg/m³	2	$W_c = 210 \text{ kg/m}^3$	
$W = 2/3W_f + 1/3V_f$	$W_c =$	210	kg/m <sup>3</sup>		
[When coarse and [When coarse and	l fine aggrega l fine aggrega	tes are of differ tes are of the sa	ent types] ame type - use	values in Table 3]	
Free-water conter	nt		W =	210	kg/m <sup>3</sup>
8 Comont conto	at				
w/c ratio	n		0.4 (Fig. 4)		
Free-water conter	nt		$210 \text{ kg/m}^3$		
8 1-Cement conte	•nt		$636 \text{ kg/m}^3$	Say 636 $kg/m^3$	
8.2-Maximum sn	ecified cemen	t content	050 Kg/III	NS	
8.3-Minimum sp	ecified cement	t content		NS	
(Use 8.1 if $8.1 \leq$	8.2, or use 8.	3 if 8.3 > 8.1, u	use 8.2 if 8.2 <	(8.1)	
Cement content		636	kg/m <sup>3</sup>		
Modified free-wa	ater to cement	content 0.3	3		
9-Concrete dens	ity f a composite ()			2.55 (V )	
Relative density (	of aggregate (	SSD) =		2.55 (Known )	
Free-water content =				210 kg/m <sup>3</sup>	
Wet concrete den	sity of the mi	x =		2350 kg/m <sup>3</sup> (Graph	5)
10-Total aggrega	ate content, T	AC (Coarse ar	nd fine aggrega	ate)	
	TAC = Wet	density - Free-	water content	-Cement content	
	TAC =	1504	kg/m <sup>3</sup>		
11-Proportion of	f fine and coa	rse aggregate	(Graph 6)		
Maximum aggreg	gate size (mm)	)			20
Percentage of fine	e aggregate pa	ssing 600 µm	sieve (%)		50
Modified free-wa	ter content to	cement ratio			0.33
Proportion of fine	e aggregate (%	5)			31% (Graph 6)
TAC =	1504	kg/m <sup>3</sup>			
Fine aggregate co	ontent = FAC	= % Fine aggre	egate $\times$ TAC =	=	466.24 kg/m <sup>3</sup>
	Say	FAC=	465	kg/m <sup>3</sup>	
Coarse aggregate	content =		TAC - FA	C =	1039 kg/m <sup>3</sup>
13-Summary of	quantities for	• 1 m <sup>3</sup> (SSD)			
		Cement =	636	kg/m <sup>3</sup>	
		Water =	210	kg/m <sup>3</sup>	
	Fin	e aggregate =	465	$kg/m^3$	
	Coars	e aggregate =	1039	$kg/m^3$	
	Cours V	Vet density –	2350	$k\sigma/m^3$	
	,	, or definity –	2330	K5/111	

#### **14-Proportion of gradients per trial mix (SSD)**

of : 0.0083m<sup>3</sup>

(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 <sup>3</sup>	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)

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 <sup>3</sup> )	2350	2200-2500

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

A) NA						
1-Characteristic	strength	at 28 days			40	N/mm <sup>2</sup>
2-Margin streng	th (M)					
M-specified M-calculated = 1.	.64 × S	1	NS ]	N/mm <sup>2</sup>	(NS = not specified)	
<b>S</b> =	Standard	deviation =	=		8	N/mm <sup>2</sup>
M-calculated		1	.64	×	8	(Fig. 3)
M =	13	N/m	m <sup>2</sup>			
3-Target mean s	<b>trength</b> (f	[m])				
		$f_m =$		53	N/mm <sup>2</sup>	$(f_{cu} + M)$
4-Cement type		OPC				
5-Aggregate						
	Coarse:	Crushed	(	(Crushed or U	Uncrushed)	
	Fine:	Uncrushed		(Crushed or U	Uncrushed)	
6-Free-water cer	nent ratio	<b>o</b> (w/c)				
	Concrete	age		28	days	
	Type of c	cement		OPC		
	Coarse ag	ggregate		Crushed		2
Estimated compre	essive stre	ngth $(f_{cu}) =$			49	$N/mm^2$ (Table 2)
Target mean strer	$f_m = f_m$	:		53	$N/mm^2$	
		W/C		0.4 NS	(Graph 4)	
		(Use	e the low	ver value as w	<i>i</i> /c)	
		w/	c =	0.4		
7-Free-water con	ntent (W)					
Use Table 3						
Slump	30-6	0 mm		20		
Maximum aggreg	gate size			20 mm Crushed		
Type of fine ager	egate			Unrushed		
$W_{c} =$	180	ko/r	m <sup>3</sup>	e in asire a	$W = 210 \text{ kg/m}^3$	
$W = 2/3W_f + 1/3V_f$	$V_c =$	1	90 I	kg/m <sup>3</sup>	$W_c = 210$ kg/m	
[When coarse and [When coarse and	l fine aggi	egates are o	of differe	nt types] ne type - use	values in Table 31	
Free-water conter	nt			W –	190	$kg/m^3$
Thee-water conten	n			•• =	190	Kg/III
8-Cement conter	nt					
w/c ratio			(	0.4 (Fig. 4)		
Free-water conter	nt			190 kg/m <sup>3</sup>		2
8.1-Cement conte	ent			475 kg/m³		Say 475 kg/m <sup>3</sup>
8.2-Maximum sp	ecified cei	ment conten	t		NS	
8.3-Minimum spectrum (Use 8.1 if $8.1 \le$	ecified cer 8.2, or us	nent content se 8.3 if 8.3	: > 8.1, us	e 8.2 if 8.2 <	NS 8.1)	
Cement content		4	75	kg/m <sup>3</sup>		

9-Concrete density Relative density of aggregate (SSD) = 2.65 (Known)  $190 \text{ kg/m}^3$ Free-water content =  $2400 \text{ kg/m}^3$ Wet concrete density of the mix = **10-Total aggregate content, TAC** (Coarse and fine aggregate) (Graph 5) TAC = Wet density - Free-water content -Cement content  $kg/m^3$ TAC =1735 11-Proportion of fine and coarse aggregate (Graph 6) 20 Maximum aggregate size (mm) 20 54 Percentage of fine aggregate passing 600 µm sieve (%) Modified free-water content to cement ratio 0.4 Proportion of fine aggregate (%) 35 (Graph 6) kg/m<sup>3</sup> TAC = 1735 Fine aggregate content = FAC = % Fine aggregate  $\times TAC =$  $607.25 \text{ kg/m}^3$ Say FAC= 610 kg/m<sup>3</sup> Coarse aggregate content = TAC - FAC = 1125 kg/m<sup>3</sup> 13-Summary of quantities for 1 m<sup>3</sup> (SSD) kg/m<sup>3</sup> Cement = 475  $kg/m^3$ Water = 190 kg/m<sup>3</sup> Fine aggregate = 610 Coarse aggregate = 1125 kg/m<sup>3</sup>  $kg/m^3$ Wet density = 2400 of : 0.0083m<sup>3</sup> 14-Proportion of gradients per trial mix (SSD) (For small mixer) 3.9 Cement = kg Water = 1.6 kg 5.1 Fine aggregate = 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. 2.7 RD 3.15 1 2.6

Modified free-water to cement content 0.4

#### **15.1-Volumes of the mixture components**

Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2400	2200-2500

## B) RA

M =

1-Characteristic strength at 28 days	40	N/mm <sup>2</sup>
2-Margin strength (M)		

M-specified	Ν	NS	N/mm <sup>2</sup>	[NS = not specified]	
M-calculated = 1.	$64 \times S$				
S =	Standard deviation =	=		8	N/mm <sup>2</sup>
M-calculated	1	.64	×	8	(Fig. 3)

N/mm<sup>2</sup>

OPC

#### 3-Target mean strength $(f_m)$

13

$f_m = 53 \qquad N/mm^2 \qquad (f_{cu} + $	· M)
--	------

## 4-Cement type

5-Aggregate

	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Uncrushed	(Crushed or	Uncrushed)	
6-Free-water co	ement ratio	o (w/c)			
	Concrete	age	28	days	
	Type of	cement	OPC		
	Coarse a	ggregate	Crushed		
Estimated comp	ressive stre	ength $(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stre	ength (f <sub>m</sub> ) =	=	53	N/mm <sup>2</sup>	
		w/c	0.4	(Graph 4)	
		w/c	NS		
		(Use the	lower value as	w/c)	
		w/c =	0.4		

7-Free-water conten	t (W)				
Use Table 3					
Slump	30-60	mm	• •		
Maximum aggregate	size		20 mm		
Type of coarse aggregat			Unrushed		
W <sub>-</sub>	180	$k\alpha/m^3$	Omusiicu	W = 210  kg/m	3
$W_{f} =$	160	Kg/III 100	13	$W_c = 210$ kg/m	
$w = 2/3 w_f + 1/3 w_c =$		190	kg/m		
[When coarse and fin [When coarse and fin	e aggregate e aggregate	es are of differes are of the sa	ent types] ame type - use	values in Table 3]	
Free-water content			W =	190	kg/m <sup>3</sup>
					C
8-Cement content					
w/c ratio			0.4 (Fig. 4)		
Free-water content			190 kg/m <sup>3</sup>		
8.1-Cement content			475 kg/m <sup>3</sup>	Say 475 kg/m	3
8.2-Maximum specifi	ed cement	content		NS	
8.3-Minimum specifi	ed cement o	content		NS	
(Use 8.1 if $8.1 \le 8.2$	, or use 8.3	if 8.3 > 8.1, u	use 8.2 if 8.2 <	< 8.1)	
Cement content		475	kg/m <sup>3</sup>		
Modified free-water	to cement c	content 0.4			
9-Concrete density					
Relative density of ag	gregate (SS	SD) =		2.55 (Known)	
Free-water content =				190 kg/m <sup>3</sup>	
Wet concrete density	of the mix	=		2325 kg/m <sup>3</sup>	
<b>10-Total aggregate c</b> TA	content, TA	C (Coarse ar ensity - Free-	nd fine aggrega water content	ate) -Cement content	(Graph 5)
ТА	C =	1660	kg/m <sup>3</sup>		
11-Proportion of fin	e and coar	se aggregate	(Graph 6)		
Maximum aggregate	size (mm)	se uggi egute	(Graph 0) 20		
Percentage of fine ag	gregate pas	sing 600 µm s	sieve (%)		54
Modified free-water of	content to c	ement ratio			0.4
Proportion of fine agg	gregate (%)			35	(Graph 6)
TAC =	1660	kg/m <sup>3</sup>			
Fine aggregate conter	t = FAC =	% Fine aggre	gate × TAC =	=	581 kg/m <sup>3</sup>
	Say F	AC=	580	kg/m <sup>3</sup>	
Coarse aggregate con	tent =		TAC - FA	.C =	1080 kg/m <sup>3</sup>
13-Summary of quar	ntities for 1	1m <sup>3</sup> (SSD)			
		Cement =	475	kg/m <sup>3</sup>	
		Water =	190	kg/m <sup>3</sup>	
	Fine	aggregate =	580	kg/m <sup>3</sup>	
	Coarse	aggregate =	1080	kg/m <sup>3</sup>	
	W	et density =	2325	kg/m <sup>3</sup>	

#### **14-Proportion of gradients per trial mix** (SSD)

of : 0.0083m<sup>3</sup>

(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 <sup>3</sup>	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)

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 <sup>3</sup> )	2325	2200-2500

A) NA					
1-Characteristic	strength	at 28 days		50	N/mm <sup>2</sup>
2-Margin streng	th (M)				
M-specified M-calculated = 1.	64 × S	NS	N/mm <sup>2</sup>	(NS = not specified)	
<b>S</b> =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean s	<b>trength</b> (f	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m \;=\;$	63	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Uncrushed	(Crushed or	Uncrushed)	
6-Free-water cer	nent ratio	• (w/c)			
	Concrete	age	28	days	
	Type of c	cement	OPC		
	Coarse ag	ggregate	Crushed		2
Estimated compre	essive stre	ngth $(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stren	$f_m = f_m$		63	N/mm <sup>2</sup>	
		w/c	0.4	(Graph 4)	
		W/C (Use the l	INS lower value as y	w/c)	
		w/c =	0.4	w/c)	
7-Free-water con	ntent (W)				
Use Table 3					
Slump	10-30	0 mm	• •		
Maximum aggreg	ate size		20 mm		
Type of fine ager	egate		Unrushed		
$W_c =$	160	$kg/m^3$	emusiiea	$W = 190 \text{ kg/m}^3$	
$W_{\rm f} = 2/3W_{\rm f} + 1/3W_{\rm f}$	$W_{\rm c} =$	170 kg/m	kg/m <sup>3</sup>	$W_c = 100 \text{ kg/m}$	
[When coarse and	l fine aggr	regates are of diff	erent types]	e values in Table 31	
Free-water conter	, 11110 uggi	egates are of the	W –	170	$k \alpha/m^3$
Thee-water conten	IL		•• -	170	Kg/III
8-Cement conter	nt				
w/c ratio			0.4 (Fig. 4)		
Free-water conter	it		$170 \text{ kg/m}^3$	2	
8.1-Cement conte	ent		425 kg/m <sup>3</sup>	Say 425 kg/m <sup>3</sup>	
8.2-Maximum spe 8.3-Minimum spe	ecified cen	ment content nent content	1100 8 7 : 60 7	NS NS	
$(0sc 0.1   l 0.1 \leq Compart contact$	0.2, or us	0.3 11 0.3 ~ 8.1,	$1 \cos (-11)^3$	~ 0.1 J	
Cement content		425	кg/m <sup>-</sup>		

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

Modified free	e-water to cer	nent conten	t 0.40			
9-Concrete d	lensity					
Relative dens	ity of aggrega	ate (SSD) =			2.65 (Known)	
Free-water co	ontent =				170 kg/m <sup>3</sup>	
Wet concrete	density of the	e mix =			2420 kg/m <sup>3</sup>	
10-Total agg	regate conter TAC =	n <b>t, TAC</b> (C Wet density	oarse and - Free-wa	fine aggreg ater content	ate) -Cement content	(Graph 5)
	TAC =	1	825 1	kg/m <sup>3</sup>		
11-Proportio	n of fine and	l coarse agg	gregate	(Graph 6)		
Maximum ag	gregate size (	mm)		20		20
Percentage of	fine aggrega	te passing 6	600 μm sie	eve (%)		53
Modified Fre	e-water conte	nt to cemen	t ratio			0.40
Proportion of	fine aggregat	te (%)				30 (Graph 6)
TAC =	182	5 kg/	m <sup>3</sup>			
Fine aggregat	te content = F	AC = % Fin	ne aggrega	ate × TAC :	=	547.5 kg/m <sup>3</sup>
		Say FAC=		545	kg/m <sup>3</sup>	
Coarse aggreg	gate content :	=		TAC - FA	AC =	1280 kg/m <sup>3</sup>
13-Summary	of quantitie	s for 1 m <sup>3</sup>	(SSD)			
J	1	Cer	ment =	425	kg/m <sup>3</sup>	
		W	ater =	170	kg/m <sup>3</sup>	
		Fine aggre	gate =	545	kg/m <sup>3</sup>	
	С	oarse aggre	gate =	1280	kg/m <sup>3</sup>	
		Wet den	sity =	2420	kg/m <sup>3</sup>	
14-Proportio	n of gradien	ts per trial	mix (SSE	<b>D</b> )	of : 0.0083m <sup>3</sup>	(For small mixer)
		Cer	nent =	3.5	kg	
		W	ater =	1.4	kg	
		Fine aggre	gate =	4.5	kg	
	С	oarse aggre	gate =	10.6	kg	
This trial will	make about 2	20 kg of cor	ncrete; en	ough for slu	mp and Vebe tests.	
15-Miscellan	eous					
Material	Cement	Water	Coarse	e agg.	Fine agg.	
RD	3 1 5	1	27	7	2.6	

## 15.1-Volumes of the mixture components

Material	kg/m <sup>3</sup>	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 <sup>3</sup> )	2420	2200-2500

## A) RA

1-Characteristic strength at 28 days				50	N/mm <sup>2</sup>
2-Margin streng	gth (M)				
M-specified M-calculated = 1	1.64 × S	NS	N/mm <sup>2</sup>	[NS = not specified]	
<b>S</b> =	Standard	deviation =		8	N/mm <sup>2</sup>
M-calculated		1.64	×	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target mean	strength (	$f_m$ ) ( $f_{cu} + M$ )			
		$f_m =$	63	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate					
	Coarse:	Crushed	(Crushed or	Uncrushed)	
	Fine:	Uncrushed	(Crushed or	Uncrushed)	
6-Free-water ce	ement ratio	<b>o</b> (w/c)			
	Concrete	eage	28	days	
	Type of o	cement	OPC		
	Coarse a	ggregate	Crushed		
Estimated comp	ressive stre	$ength(f_{cu}) =$		49	N/mm <sup>2</sup> (Table 2)
Target mean stre	ength (f <sub>m</sub> ) =	=	63	N/mm <sup>2</sup>	
		w/c	0.4	(Graph 4)	
		w/c	NS		
		(Use the l	ower value as	w/c)	
		w/c =	0.4		

7-Free-water conten	t (W)				
Use Table 3					
Slump	10-30	mm			
Maximum aggregate	size		20 mm		
Type of coarse aggreg	gate		Crushed		
Type of fine aggregat	e	2	Unrushed		2
$W_{f} =$	160	kg/m <sup>3</sup>		$W_{c} = 190 \text{ kg/}$	m°
$W = 2/3W_f + 1/3W_c =$	:	170	kg/m <sup>3</sup>		
[When coarse and fin	e aggregate	es are of differ	rent types]	waluog in Tabla	21
	e aggregate	es are or the s	ame type - use	e values in Table	
Free-water content			<b>W</b> =	170	kg/m <sup>°</sup>
8-Cement content					
w/c ratio			0.4 (Fig. 4)		
Free-water content			170 kg/m <sup>3</sup>		
8.1-Cement content			425 kg/m <sup>3</sup>	Say 425 kg/	$m^3$
8.2-Maximum specifi	ed cement	content		NS	
8.3-Minimum specifi	ed cement	content		NS	
(Use 8.1 if $8.1 \le 8.2$	, or use 8.3	if 8.3 > 8.1, u	use 8.2 if 8.2 <	< 8.1)	
Cement content		425	kg/m <sup>3</sup>		
Modified free-water	to cement o	content 0.4	0		
9-Concrete density					
Relative density of ag	gregate (S	SD) =		2.55 (Known)	
Free-water content =				170 kg/m <sup>3</sup>	
Wet concrete density	of the mix	=		2360 kg/m <sup>3</sup>	
10-Total aggregate of	ontent, TA	C (Coarse a	nd fine aggreg	rate)	(Graph 5)
TA	C = Wet d	ensity - Free-	water content	-Cement content	(oruph c)
ТА	C =	1765	kg/m <sup>3</sup>		
11-Proportion of fin	e and coar	se aggregate	(Graph 6)		
Maximum aggregate	size (mm)		20		
Percentage of fine ag	gregate pas	sing 600 µm	sieve (%)		53
Modified free-water of	content to c	ement ratio			0.40
Proportion of fine agg	gregate (%)			30	(Graph 6)
TAC =	1765	kg/m <sup>3</sup>			
Fine aggregate conter	nt = FAC =	% Fine aggre	egate × TAC	=	529.5 kg/m <sup>3</sup>
	Say F	AC=	530	kg/m <sup>3</sup>	
Coarse aggregate con	tent =		TAC - FA	AC =	1235 kg/m <sup>3</sup>
13-Summary of quar	ntities for	one cubic me	eter (SSD)		
· 1		Cement =	425	kg/m <sup>3</sup>	
		Water =	170	kg/m <sup>3</sup>	
	Fine	aggregate =	530	$kg/m^3$	
	Coarse	aggregate =	1235	$kg/m^3$	
		00 0000		U	

Wet density =

2360

kg/m<sup>3</sup>

#### **14-Proportion of gradients per trial mix** (SSD)

of : 0.0083m<sup>3</sup>

(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 <sup>3</sup>	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)

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 <sup>3</sup> )	2360	2200-2500	

<ul> <li>A) NA</li> <li>1-Characteristic strength</li> <li>2-Margin strength (M)</li> <li>M-Specified</li> </ul>	at 28 day	vs = NS	N/mm <sup>2</sup>	50	N/mm <sup>2</sup> (NS= Not Specified)
M-calculated = $1.64 \times$	S				(
S =	Standard =	Deviation		8	N/mm <sup>2</sup>
M-calculated		1.64	х	8	(Fig. 3)
M =	13	N/mm <sup>2</sup>			
3-Target Mean strength	fm (fm =	fc+M)			
		fm =	63	N/mm <sup>2</sup>	
4-Cement type		OPC			
5-Aggregate	Coarse	Crushed	(Crushed or I)	(ncrushed)	
	Coarse.	Clushed	(Crushed of O	(nerusnea)	
	Fine:	Uncrushed	(Crushed or U	Incrushed)	
6-Free-Water cement rat	io				
((((()))))	Concrete	age	28	days	
	Type of c	cement	OPC		
	Coarse ag	ggregate	Crushed		
Estimated compressive stre fcu	ength			49	N/mm <sup>2</sup>
Target Mean strength fm =	:		63	N/mm <sup>2</sup>	(Table 2)
		w/c	0.4	(Graph N	o 4)
		(Use the lo	wer value as w/c	2)	
		w/c =	0.4		
<b>7-Free-water content W</b> UseTable No 3					
Slump	60 to	180 mi	m		
Maximum aggregate			<b>c</b> 2		
size Type of coarse aggregate			20 Crushed	mm	(Crushed or Uncrushed)
Type of fine aggregate			Unrushed		(Crushed or Uncrushed)

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

$W_{f} =$	195	kg/m <sup>3</sup>		$W_c =$	225	kg/m <sup>3</sup>
$W = 2/3W_f + 1/3W_c =$ [When coarse and fine	aggregates ar	205 e of different t	kg/m <sup>3</sup> ypes]			
W =	Values in	n Table 3				
[When coarse and fine	aggregates ar	e of the same t	ypes- use valu	es in table 3	]	
Free-water content			W =		205 kg/m <sup>3</sup>	
8-Relative density						
Relative density of agg	regate (SSD)	=	2.55	(Known)		
PFA percentage			30	%		
Amount of water reduc	ed for PFA (	Table 9)	20	$kg/m^2$		
Free-water content adju	isted for PFA	=	185	$kg/m^3$		
Wet density of the mix	=		2340	kg/m <sup>3</sup>	(Graph 5)	
9-Cement and PFA co	ontent					
Cement content	=	409.8	kg/m <sup>3</sup>	Say	410	kg/m <sup>3</sup>
RGD content	=	176	kg/m <sup>3</sup>	Say	175	kg/m <sup>3</sup>
C+RGD	=	585				
w/b = w/(C+RGD)	=	0.32				
	TAC =	1570	kg/m <sup>3</sup>			
<b>11-Proportion of fine</b>	and coarse a	ggregate				
Maximum aggregate si	ze		20	mm		
Percentage of fine aggr	egate passing	600µm sieve			5	3 %
Modified Free-water co	ontent to ceme	ent ratio			0.3	2
Proportion of fine aggr	egate (%)			38	(graph 6)	
		TAC =	1570	kg/m <sup>3</sup>		
Fine aggregate content	= FAC = % F	Fine agg. x TA	C =		596.6	kg/m <sup>3</sup>
		Say FAC=	600	kg/m <sup>3</sup>		
Coarse aggregate conte	ent =		TAC - FAG	C =	970	kg/m <sup>3</sup>
13-Summary of quant	tities for one	cubic meter (S	SSD)			
		Cement = PFA =	410 175	kg/m <sup>3</sup>		
		Water =	185	kg/m <sup>3</sup>		
		water -	105	⊾g/Ш		

Fine aggregate =

kg/m<sup>3</sup>

600

Coarse aggregate =	970	kg/m <sup>3</sup>
66 6		U

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 ag	gg. PFA
RD	3.15	1	2.5	2.6	2.25
15.1-Volumes of the mi	xture compo	nents			
Material		kg/m <sup>3</sup>	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)

Quantity		Value	Common range
Powder content	kg/m <sup>3</sup>	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 <sup>3</sup>	2340	2200-2500