

APPENDIX A

Table A.1 Details of Trial Mixes

Trial Mix	Fly Ash	Fine Agg.	Coarse Agg.	Sodium Hydroxide		Sodium Silicate	Alkaline/ Fly ash	SP	Extra water	Curing		Slump Flow	Comp. strength	Remarks
	kg/m ³	kg/m ³	kg/m ³	kg/m ³	Mol.	kg/m ³	Ratio	%	%	Time	Temp	mm	N/mm ²	
1	325	875	1000	50	12	125	0.54	5	20	24	70	410	12.22	Alkaline solution, SP and extra water were added separately during the mixing
2	350	875	1000	50	12	125	0.50	5	20	24	70	415	12.47	
3	400	810	980	50	12	125	0.44	5	15	24	70	430	20.97	
4	400	810	980	50	12	125	0.44	6	15	24	70	440	21.08	
5	400	850	950	57	12	143	0.50	5	15	24	70	425	19.32	
6	400	850	950	57	12	143	0.50	6	15	24	70	435	19.21	
7	400	850	950	57	12	143	0.50	5	20	24	70	515	13.72	
8	400	850	950	57	12	143	0.50	6	20	24	70	540	13.98	
9	400	850	950	57	12	143	0.50	7	15	24	70	490	19.82	
10	400	850	950	57	12	143	0.50	7	20	24	70	575	14.58	
11	400	850	950	57	12	143	0.50	7	15	24	70	765	38.43	Alkaline solution, SP and extra water were mixed together prior to mixing
12	400	850	950	57	12	143	0.50	7	10	24	70	625	54.21	
13	450	850	950	57	12	143	0.44	7	10	24	70	615	55.30	
14	450	850	950	57	12	143	0.44	7	15	24	70	730	39.09	

APPENDIX B

Calculation of Molar Ratio of Mixtures M₁ to M₄, M₁₅ to M₁₇ and SCGCM₁ to SCGCM₄

1. Mixture Proportions (kg/m³)

Mix Code	Fly ash	Silica Fume	Sodium Hydroxide	Molarity of NaOH	Sodium Silicate	Extra water
M ₁	400	-	57	12	143	40
M ₂	400	-	57	12	143	48
M ₃	400	-	57	12	143	60
M ₄	400	-	57	12	143	80
M ₁₅	400	-	57	8	143	48
M ₁₆	400	-	57	10	143	48
M ₁₇	400	-	57	14	143	48
SCGCM ₁	400	0	57	10	143	48
SCGCM ₂	380	20	57	10	143	48
SCGCM ₃	360	40	57	10	143	48
SCGCM ₄	340	60	57	10	143	48

2. Chemical Compounds (% by mass) in Fly ash, Silica Fume and Sodium silicate solution

Oxides	Fly ash	Silica Fume	Sodium Silicate Solution
SiO ₂	51.30	90.2	29.43
Al ₂ O ₃	30.10	0.82	-
Na ₂ O	0.26	0.10	14.26
Water (H ₂ O)	-	-	56.31

3. % of NaOH Pellets and Water in Various Molarity

NaOH Molarity	NaOH Pellets (%)	Water (%)
8 M	29.4	70.6
10 M	36.7	63.3
12 M	44.1	55.9
14 M	51.4	48.6

4. Molecular weight of Oxides

Element	Atomic weight (gm)	Oxides	Molecular weight (gm)
Al	26.98	SiO ₂	60.09
Na	22.99	Al ₂ O ₃	101.96
Si	28.09	Na ₂ O	61.98
H	1.01	NaOH	40.00
O	16.00	H ₂ O	18.02

5. Calculation of Molar Ratio

Mix Code	Fly ash			Sodium Silicate Solution			Sodium Hydroxide Solution			Extra water
	SiO ₂	Al ₂ O ₃	Na ₂ O	SiO ₂	Na ₂ O	H ₂ O	NaOH Pellets		Water	H ₂ O
							Na ₂ O	H ₂ O	H ₂ O	
M ₁	3414.88	1180.86	16.78	700.36	329.01	4468.55	314.21	314.21	1768.20	2219.76
M ₂	3414.88	1180.86	16.78	700.36	329.01	4468.55	314.21	314.21	1768.20	2663.71
M ₃	3414.88	1180.86	16.78	700.36	329.01	4468.55	314.21	314.21	1768.20	3329.63
M ₄	3414.88	1180.86	16.78	700.36	329.01	4468.55	314.21	314.21	1768.20	4439.51
M ₁₅	3414.88	1180.86	16.78	700.36	329.01	4468.55	209.48	209.48	2233.18	2663.71
M ₁₆	3414.88	1180.86	16.78	700.36	329.01	4468.55	261.49	261.49	2002.28	2663.71
M ₁₇	3414.88	1180.86	16.78	700.36	329.01	4468.55	366.23	366.23	1537.29	2663.71

Mix Code	Total Moles (per m ³)				Molar Ratio				
	SiO ₂	Al ₂ O ₃	Na ₂ O	H ₂ O	SiO ₂ /Al ₂ O ₃	SiO ₂ /Na ₂ O	Na ₂ O/Al ₂ O ₃	Na ₂ O/SiO ₂	H ₂ O/Na ₂ O
M ₁	4115.24	1180.86	660	8770.72	3.48	6.23	0.559	0.160	13.29
M ₂	4115.24	1180.86	660	9214.67	3.48	6.23	0.559	0.160	13.96
M ₃	4115.24	1180.86	660	9880.59	3.48	6.23	0.559	0.160	14.97
M ₄	4115.24	1180.86	660	10990.47	3.48	6.23	0.559	0.160	16.65
M ₁₅	4115.24	1180.86	555.27	9574.92	3.48	7.41	0.470	0.135	17.24
M ₁₆	4115.24	1180.86	607.28	9396.03	3.48	6.78	0.514	0.147	15.47
M ₁₇	4115.24	1180.86	712.02	9035.78	3.48	5.78	0.603	0.173	12.69

Mix Code	Fly ash			Silica Fume			Sodium Silicate Solution			Sodium Hydroxide Solution			Extra water
	SiO ₂	Al ₂ O ₃	Na ₂ O	SiO ₂	Al ₂ O ₃	Na ₂ O	SiO ₂	Na ₂ O	H ₂ O	NaOH Pellets		Water	H ₂ O
										Na ₂ O	H ₂ O	H ₂ O	
SCGCM ₁	3414.88	1180.86	16.78	0.00	0.00	0.00	700.36	329.01	4468.55	261.49	261.49	2002.28	2663.71
SCGCM ₂	3244.13	1121.81	15.94	300.22	1.61	0.32	700.36	329.01	4468.55	261.49	261.49	2002.28	2663.71
SCGCM ₃	3073.39	1062.77	15.10	600.43	3.22	0.64	700.36	329.01	4468.55	261.49	261.49	2002.28	2663.71
SCGCM ₄	2902.65	1003.73	14.26	900.65	4.83	0.97	700.36	329.01	4468.55	261.49	261.49	2002.28	2663.71

Mix Code	Total Moles (per m ³)				Molar Ratio				
	SiO ₂	Al ₂ O ₃	Na ₂ O	H ₂ O	SiO ₂ /Al ₂ O ₃	SiO ₂ /Na ₂ O	Na ₂ O/Al ₂ O ₃	Na ₂ O/SiO ₂	H ₂ O/Na ₂ O
SCGCM ₁	4115.24	1180.86	607.28	9396.03	3.48	6.77	0.514	0.147	15.47
SCGCM ₂	4244.71	1123.42	606.44	9396.03	3.78	7.00	0.539	0.143	15.49
SCGCM ₃	4374.18	1065.99	605.60	9396.03	4.10	7.22	0.568	0.138	15.51
SCGCM ₄	4503.66	1008.56	604.76	9396.03	4.46	7.45	0.600	0.134	15.54

APPENDIX C

Calculation of Water/geopolymer solids Ratio of Mixtures M₁ to M₄ and M₁₅ and M₁₇

1. Mixture Proportions (kg/m³)

Mix Code	Fly ash	Sodium Hydroxide	Molarity of NaOH	Sodium Silicate	Extra water
M ₁	400	57	12	143	40
M ₂	400	57	12	143	48
M ₃	400	57	12	143	60
M ₄	400	57	12	143	80

2. Chemical Composition of Sodium silicate solution (% by mass)

Oxides	(%)
SiO ₂	29.43
Na ₂ O	14.26
Water (H ₂ O)	56.31

3. % of NaOH Pellets and Water in Various Molarity

NaOH Molarity	NaOH Pellets (%)	Water (%)
8 M	29.4	70.6
10 M	36.7	63.3
12 M	44.1	55.9
14 M	51.4	48.6

4. Calculation of Water/geopolymer solids Ratio

Mix Code	Fly ash (kg/m ³)	Sodium Silicate Solution (kg/m ³)		Sodium Hydroxide Solution (kg/m ³)		Extra water (kg/m ³)	Total Mass (kg/m ³)		Water/Solids ratio
		Solids	Water	Solids	Water		Water	Solids	
M ₁	400	62.48	80.52	25.14	31.86	40	152.38	487.62	0.312
M ₂	400	62.48	80.52	25.14	31.86	48	160.38	487.62	0.329
M ₃	400	62.48	80.52	25.14	31.86	60	172.38	487.62	0.353
M ₄	400	62.48	80.52	25.14	31.86	80	192.38	487.62	0.394
M ₁₅	400	62.48	80.52	16.76	40.24	48	168.76	479.24	0.352
M ₁₆	400	62.48	80.52	20.92	36.08	48	164.60	483.40	0.341
M ₁₇	400	62.48	80.52	29.30	27.70	48	156.22	491.78	0.318