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APPENDIX A

Properties of Ground Fluidized Bed Fly Ash and Ground Bagasse Ash

Table A.1 Specific gravity of ground fluidized bed fly ash

Material Identification		Sample	
		1	2
The initial temperature of water	°C	27.5	27.5
Volume of kelosine, A	ml	0.4	0.4
Weight of flask + kelosine, B	g	341.92	344.14
Weight of flask + kelosine + ground fly ash, C	g	387.84	391.69
Weight of ground fly ash : C-B	g	45.92	47.55
The final temperature of water	°C	27.5	27.5
Volume of kelosine + ground fly ash, D	ml	19.5	19.9
Volume of kelosine is replaced : D-A	ml	19.1	19.5
Specific gravity of ground fly ash : (C-B)/(D-A)		2.404	2.438
Average specific gravity		2.421	

Table A.2 Specific gravity of ground bagasse ash

Material Identification		Sample	
		1	2
The initial temperature of water	°C	27.5	27.5
Volume of kelosine, A	ml	0.4	0.9
Weight of flask + kelosine, B	g	341.65	344.03
Weight of flask + kelosine + ground bagasse ash, C	g	385.87	389.60
Weight of ground bagasse ash : C-B	g	44.22	45.57
The final temperature of water	°C	27.5	27.5
Volume of kelosine + ground bagasse ash, D	ml	19.8	21.0
Volume of kelosine is replaced : D-A	ml	19.4	20.1
Specific gravity of ground bagasse ash : (C-B)/(D-A)		2.279	2.267
Average specific gravity		2.273	

APPENDIX B

Properties of Aggregates

Table B.1 Specific gravity and absorption of river sand

Material Identification	Sample 1	Sample 2	Average
Weight of flask + water, B (g)	653.62	658.84	
Weight of sand in SSD, S (g)	500.01	500.47	
Weight of flask + water + sand, C (g)	963.99	966.77	
Weight of sand in oven-dry state, A (g)	495.59	495.89	
Bulk specific gravity (Oven-Dry) : A/(B+S-C)	2.61	2.58	2.59
Bulk specific gravity (SSD) : S/(B+S-C)	2.64	2.60	2.62
Apparent specific gravity : A/(A+B-C)	2.68	2.64	2.66
Absorption : (S-A)/A×100%	0.89	0.92	0.91

Table B.2 Specific gravity and absorption of crushed limestone

Material Identification	Sample 1	Sample 2	Average
Weight of crushed limestone in SSD, B (g)	3031.33	3015.62	
Weight of crushed limestone in water, C (g)	1905.22	1915.27	
Weight crushed limestone in Oven-Dry, A (g)	3000.81	3000.92	
Bulk specific gravity (Oven-Dry) : A/(B-C)	2.71	2.73	2.72
Bulk specific gravity (SSD) : S/(B+S-C)	2.72	2.74	2.73
Apparent specific gravity : A/(A-C)	2.74	2.76	2.75
Absorption : (B-A)/A×100%	0.42	0.49	0.45

Table B.3 Specific gravity and absorption of recycled aggregate

Material Identification	Sample 1	Sample 2	Average
Weight of recycled aggregate in SSD, B (g)	3048.37	3049.12	
Weight of recycled aggregate in water, C (g)	1820.49	1823.30	
Weight recycled aggregate in Oven-Dry, A (g)	2907.35	2910.05	
Bulk specific gravity (Oven-Dry) : A/(B-C)	2.37	2.37	2.37
Bulk specific gravity (SSD) : S/(B+S-C)	2.48	2.49	2.49
Apparent specific gravity : A/(A-C)	2.67	2.68	2.68
Absorption : (B-A)/A×100%	4.85	4.78	4.81

Table B.4 Sieve analysis of river sand

Sieve No.	Sieve Opening (mm)	Sieve Weight (g)	Sieve and Agg. (g)	Agg. Retained (g)	Percent Retained (%)	Cum. Percent Retained (%)	Percent Passing (%)
#4	4.75	721.71	721.71	0.00	0.00	0.00	100.00
#8	2.36	473.38	539.75	66.37	13.27	13.27	86.73
#16	1.18	629.70	748.90	119.20	23.83	37.10	62.90
#30	0.60	569.04	709.28	140.24	28.04	65.14	34.86
#50	0.30	374.06	512.98	138.92	27.78	92.92	7.08
#100	0.15	478.98	507.90	28.92	5.78	98.70	1.30
Pan	-	299.44	305.94	6.50	1.30	-	0.00
Sum				500.15	100.00	307.13	-
Fineness Modulus = 3.07							

Table B.5 Sieve analysis of crushed limestone

Sieve No.	Sieve Opening (mm)	Sieve Weight (g)	Sieve and Agg. (g)	Agg. Retained (g)	Percent Retained (%)	Cum. Percent Retained (%)	Percent Passing (%)
3/4"	19.00	661.30	731.74	70.44	3.52	3.52	96.48
3/8"	9.50	592.50	2252.50	1660.00	82.97	86.49	13.51
#4	4.75	558.30	826.10	267.80	13.38	99.87	0.13
#8	2.36	532.50	534.30	1.80	0.09	99.96	0.04
Pan	-	500.50	501.27	0.77	0.04	-	0.00
Sum				2000.81	100.00	289.84	-
Fineness Modulus = 6.89							

Table B.6 Sieve analysis of recycled aggregate

Sieve No.	Sieve Opening (mm)	Sieve Weight (g)	Sieve and Agg. (g)	Agg. Retained (g)	Percent Retained (%)	Cum. Percent Retained (%)	Percent Passing (%)
3/4"	19.00	661.30	661.30	0.00	0.00	0.00	100
3/8"	9.50	592.50	1608.30	1016.00	50.77	50.77	49.23
#4	4.75	558.30	1478.10	919.80	45.96	96.73	3.27
#8	2.36	532.50	596.80	64.30	3.21	99.94	0.06
Pan	-	500.50	501.63	1.13	0.06	-	0.00
Sum				2001.23	100.00	247.44	-
Fineness Modulus = 6.47							

Table B.7 Unit weight and void of river sand

Material Identification		Sample 1	Sample 2	Average
Weight of measuring cylinder	kg	7.55	7.52	
Weight of measuring cylinder + Water	kg	21.95	22.03	
Temperature of water	°C	28	28	
Unit weight of water	kg/l	0.9965	0.9965	
Weight of water	kg	14.40	14.51	
Volume of measuring cylinder	m^3	0.0145	0.0146	
Weight of measuring cylinder + Sand	kg	32.59	32.57	
Weight of sand	kg	25.04	25.05	
Unit weight of sand, M	kg/m^3	1732.80	1720.35	1726.58
Water absorption, A	%	0.94	0.94	
Bulk specific gravity (Oven-Dry), S		2.62	2.62	
Unit weight (SSD) : M[1+(A/100)]	kg/m^3	1749.09	1736.52	
Void content : 100[(S×W)-M]/(S×W)	%	33.73	34.21	33.97

Table B.8 Unit weight and void of crushed limestone

Material Identification		Sample 1	Sample 2	Average
Weight of measuring cylinder	kg	7.40	7.31	
Weight of measuring cylinder + Water	kg	22.16	22.03	
Temperature of water	°C	28	28	
Unit weight of water	kg/l	0.9965	0.9965	
Weight of water	kg	14.76	14.72	
Volume of measuring cylinder	m^3	0.0148	0.0148	
Weight of measuring cylinder + Sand	kg	32.27	31.33	
Weight of crushed limestone	kg	24.87	24.02	
Unit weight of crushed limestone, M	kg/m^3	1679.06	1626.08	1652.57
Water absorption, A	%	0.46	0.46	
Bulk specific gravity (Oven-Dry), S		2.73	2.73	
Unit weight (SSD) : M[1+(A/100)]	kg/m^3	1686.79	1633.56	
Void content : 100[(S×W)-M]/(S×W)	%	38.37	40.32	39.34

Table B.9 Unit weight and void of recycled aggregate

Material Identification		Sample 1	Sample 2	Average
Weight of measuring cylinder	kg	7.33	7.64	
Weight of measuring cylinder + Water	kg	22.03	22.06	
Temperature of water	°C	28	28	
Unit weight of water	kg/l	0.9965	0.9965	
Weight of water	kg	14.70	14.42	
Volume of measuring cylinder	m^3	0.0148	0.0145	
Weight of measuring cylinder + Sand	kg	29.36	28.87	
Weight of RCA	kg	22.03	21.23	
Unit weight of RCA, M	kg/m^3	1493.39	1467.11	1480.25
Water absorption, A	%	5.61	5.61	
Bulk specific gravity (Oven-Dry), S		2.49	2.49	
Unit weight (SSD) : M[1+(A/100)]	kg/m^3	1577.17	1549.41	
Void content : 100[(S×W)-M]/(S×W)	%	39.90	40.96	40.43

Table B.10 Abrasion loss of crushed limestone

Material Identification		Sample 1	Sample 2
Total weight of aggregate	g	5000.00	5000.00
Weight of container	g	2177.20	2177.60
Weight of Agg. retained on No.12+Container	g	6006.50	6007.80
Weight of Agg. retained on No.12	g	3829.30	3830.20
Weight of Agg. passing No.12	g	1170.70	1169.80
Abrasion Loss	%	23.41	23.40
Average Abrasion Loss	%	23.41	

Table B.11 Abrasion loss of recycled aggregate

Material Identification		Sample 1	Sample 2
Total weight of aggregate	g	5000.00	5000.00
Weight of container	g	2177.00	2177.20
Weight of Agg. retained on No.12+Container	g	5330.40	5329.80
Weight of Agg. retained on No.12	g	3153.40	3152.60
Weight of Agg. passing No.12	g	1846.60	1847.40
Abrasion Loss	%	36.93	36.95
Average Abrasion Loss	%	36.94	

Table B.12 Material finer than 75 micron of recycled aggregate

Material Identification		Sample 1	Sample 2
Total weight of aggregate	g	1000.00	5000.00
Weight of container	g	138.48	138.50
Weight of Agg. (Oven-Dry)+Container	g	1133.88	1134.65
Material finer than 75 micron	%	0.46	0.38
Average Material Finer than 75 Micron	%	0.42	

APPENDIX C

Compressive Strength and Modulus of Elasticity

Table C.1 Compressive strength and modulus of elasticity of 45CON concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.20	199.10	3.796	2418	2414	266.00	33.73	37.62	-	-
	2	100.90	202.40	3.903	2412		321.10	40.16		-	
	3	100.30	201.50	3.838	2411		289.70	36.67		-	
	4	100.40	201.60	3.857	2417		316.00	39.91		-	
28	1	100.00	201.70	3.846	2428	2419	355.00	45.20	44.39	39.704	38.769
	2	100.20	203.30	3.876	2418		318.00	40.33		38.459	
	3	100.40	201.20	3.849	2416		375.00	47.37		37.434	
	4	101.30	199.80	3.887	2414		360.00	44.67		39.479	
60	1	100.00	200.80	3.824	2425	2427	392.70	50.00	49.12	40.903	40.704
	2	99.76	200.00	3.800	2431		379.20	48.51		41.113	
	3	100.19	201.10	3.844	2425		385.10	48.85		40.097	
90	1	100.10	200.00	3.848	2445	2429	437.04	55.53	52.75	41.842	41.214
	2	100.10	200.70	3.834	2427		398.97	50.70		40.649	
	3	100.60	201.60	3.869	2414		413.49	52.02		41.150	
180	1	100.60	200.20	3.878	2437	2435	420.20	52.87	53.06	-	-
	2	99.90	201.00	3.818	2423		417.60	53.28		-	
	3	100.40	200.90	3.887	2444		419.90	53.04		-	

Table C.2 Compressive strength and modulus of elasticity of 45RC concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.10	201.70	3.668	2311	2306	272.80	34.66	34.09	-	-
	2	101.70	200.70	3.772	2314		278.00	34.22		-	
	3	101.40	200.00	3.718	2302		275.00	34.05		-	
	4	101.50	200.20	3.719	2296		270.40	33.42		-	
28	1	101.20	199.76	3.714	2311	2314	315.88	39.27	40.95	29.330	29.287
	2	100.20	200.10	3.653	2315		326.87	41.45		29.500	
	3	101.10	201.90	3.757	2318		330.00	41.11		29.319	
	4	100.50	200.50	3.674	2310		333.00	41.98		29.000	
60	1	100.30	200.80	3.685	2323	2319	370.40	46.88	46.74	32.267	32.986
	2	101.20	200.58	3.716	2303		372.10	46.26		33.381	
	3	99.99	200.98	3.680	2332		369.80	47.09		33.309	
90	1	100.10	201.00	3.681	2327	2327	391.70	49.77	50.72	33.675	33.699
	2	100.30	199.25	3.667	2329		407.90	51.63		34.015	
	3	99.98	199.75	3.647	2326		398.48	50.76		33.407	
180	1	100.60	201.00	3.713	2324	2340	407.70	51.29	51.31	-	-
	2	99.90	202.50	3.761	2370		399.10	50.92		-	
	3	100.40	201.20	3.705	2326		409.50	51.72		-	

Table C.3 Compressive strength and modulus of elasticity of 45RCF20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.40	202.20	3.664	2289	2295	268.00	33.85	35.23	-	-
	2	99.90	201.40	3.631	2300		283.30	36.14		-	
	3	100.00	200.10	3.608	2296		283.00	36.03		-	
	4	99.40	201.00	3.578	2294		270.80	34.90		-	
28	1	100.30	201.10	3.651	2298	2300	320.00	40.50	42.74	31.662	32.347
	2	98.70	202.60	3.567	2301		335.00	43.78		33.102	
	3	100.10	199.30	3.612	2303		347.00	44.09		32.125	
	4	100.40	202.80	3.691	2299		337.00	42.57		32.498	
60	1	99.64	202.60	3.652	2312	2312	373.70	47.93	48.00	33.648	33.706
	2	99.34	202.00	3.629	2318		373.90	48.24		34.160	
	3	99.80	200.80	3.625	2308		374.10	47.82		33.309	
90	1	100.00	199.55	3.639	2322	2318	408.59	52.02	51.76	34.460	34.198
	2	100.05	200.50	3.653	2317		406.62	51.72		34.032	
	3	100.55	199.30	3.661	2313		409.27	51.54		34.103	
180	1	100.40	199.80	3.687	2331	2334	417.00	52.67	52.54	-	-
	2	99.90	200.00	3.662	2336		413.20	52.72		-	
	3	100.00	201.00	3.686	2335		410.20	52.23		-	

Table C.4 Compressive strength and modulus of elasticity of 45RCF35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.80	200.20	3.610	2305	2290	267.70	34.22	33.93	-	-
	2	100.00	201.28	3.628	2295		269.60	34.33		-	
	3	101.84	201.28	3.746	2285		269.90	33.13		-	
	4	100.60	201.60	3.648	2277		270.60	34.04		-	
28	1	100.30	201.10	3.641	2291	2304	340.00	43.03	40.79	32.632	31.542
	2	99.50	201.20	3.612	2309		328.14	42.20		31.727	
	3	100.00	200.30	3.621	2302		324.91	41.37		31.758	
	4	99.80	200.00	3.599	2300		285.96	36.56		30.050	
60	1	99.99	200.40	3.617	2299	2301	339.00	43.17	46.36	32.833	32.508
	2	100.00	201.70	3.643	2300		373.90	47.61		32.262	
	3	99.60	201.80	3.622	2304		376.30	48.30		32.430	
90	1	99.65	202.55	3.632	2299	2304	391.91	50.25	50.36	33.566	33.580
	2	100.50	202.30	3.701	2306		400.55	50.49		33.830	
	3	100.00	200.65	3.635	2307		395.34	50.34		33.345	
180	1	100.30	202.20	3.701	2317	2310	408.30	51.68	50.87	-	-
	2	100.20	199.30	3.630	2310		394.80	50.07		-	
	3	99.80	202.40	3.645	2302		354.80	45.36		-	

Not included for analysis.

Table C.5 Compressive strength and modulus of elasticity of 45RCF50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.36	200.30	3.620	2285	2286	254.30	32.15	32.47	-	-
	2	100.00	200.30	3.593	2284		253.80	32.31		-	
	3	99.90	200.74	3.594	2284		253.70	32.37		-	
	4	99.72	200.70	3.589	2290		258.20	33.06		-	
28	1	99.60	203.40	3.626	2288	2292	302.83	38.87	39.26	30.120	30.866
	2	100.10	200.70	3.630	2298		313.92	39.89		31.596	
	3	100.10	202.20	3.643	2289		307.05	39.02		30.883	
60	1	101.88	200.80	3.718	2271	2294	356.90	43.78	43.86	31.700	31.964
	2	100.10	200.60	3.640	2306		345.50	43.90		31.968	
	3	99.70	202.00	3.636	2306		342.80	43.91		32.225	
90	1	101.55	198.80	3.644	2263	2288	395.83	48.87	47.37	33.503	33.025
	2	99.30	202.40	3.599	2296		345.80	44.65		33.040	
	3	100.00	202.65	3.666	2303		381.61	48.59		32.532	
180	1	99.70	202.50	3.651	2309	2299	384.40	49.24	48.07	-	-
	2	100.00	202.10	3.630	2287		372.40	47.42		-	
	3	99.80	201.60	3.630	2302		371.90	47.54		-	

Table C.6 Compressive strength and modulus of elasticity of 45RCB20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.50	199.00	3.559	2300	2295	264.50	34.02	34.53	-	-
	2	99.90	200.10	3.592	2290		258.50	32.98		-	
	3	99.72	200.15	3.585	2293		275.00	35.21		-	
	4	100.30	200.10	3.633	2298		283.60	35.89		-	
28	1	99.90	199.80	3.591	2293	2297	321.96	41.08	41.18	30.820	30.865
	2	100.20	200.90	3.644	2300		326.38	41.39		31.021	
	3	100.50	202.20	3.684	2297		325.89	41.08		30.755	
60	1	100.00	199.18	3.618	2313	2310	348.00	44.31	47.12	32.682	32.759
	2	100.10	199.22	3.633	2317		373.30	47.44		32.252	
	3	99.88	200.40	3.612	2300		388.80	49.62		33.344	
90	1	100.00	199.18	3.628	2319	2314	408.59	52.02	51.30	34.095	33.945
	2	100.10	199.22	3.623	2311		397.30	50.48		33.968	
	3	99.88	200.40	3.632	2313		402.55	51.38		33.771	
180	1	100.40	201.20	3.727	2340	2329	408.60	51.61	51.93	-	-
	2	100.00	201.20	3.689	2334		408.60	52.02		-	
	3	99.80	202.00	3.653	2312		407.90	52.14		-	

Table C.7 Compressive strength and modulus of elasticity of 45RCB35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.04	201.50	3.575	2257	2259	246.20	31.32	32.25	-	-
	2	100.97	201.10	3.579	2223		244.20	30.50		-	
	3	100.00	201.22	3.598	2277		274.30	34.92		-	
	4	100.36	201.48	3.636	2281		255.20	32.26		-	
28	1	99.80	200.00	3.560	2275	2270	300.68	38.44	38.62	29.480	29.327
	2	99.70	200.50	3.558	2273		295.97	37.91		28.995	
	3	100.70	202.30	3.643	2261		314.61	39.50		29.505	
60	1	99.90	199.42	3.537	2263	2272	322.45	41.14	43.35	31.454	31.494
	2	98.92	199.76	3.501	2280		341.90	44.49		31.478	
	3	99.80	201.08	3.575	2273		347.60	44.44		31.551	
90	1	100.80	202.00	3.643	2260	2262	357.08	44.75	46.90	31.779	32.136
	2	100.50	200.60	3.608	2267		389.46	49.10		32.664	
	3	100.50	199.70	3.580	2260		371.80	46.87		31.964	
180	1	100.20	201.10	3.622	2284	2277	375.50	47.62	47.46	-	-
	2	100.20	200.90	3.595	2269		378.00	47.94		-	
	3	100.10	201.20	3.604	2276		368.60	46.84		-	

Table C.8 Compressive strength and modulus of elasticity of 45RCB50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.98	200.50	3.500	2224	2224	227.00	28.91	29.03	-	-
	2	100.02	201.10	3.508	2220		229.10	29.16		-	
	3	100.12	200.08	3.511	2229		228.50	29.02		-	
28	1	99.90	198.00	3.465	2233	2228	273.50	34.89	35.14	28.174	28.320
	2	101.00	201.40	3.585	2222		278.00	34.70		28.094	
	3	100.30	201.00	3.540	2229		283.20	35.84		28.691	
60	1	99.98	199.80	3.522	2245	2241	316.45	40.31	40.36	30.221	30.492
	2	100.10	201.00	3.515	2222		262.91	33.41		27.632	
	3	99.75	200.05	3.528	2257		315.77	40.41		30.763	
90	1	100.64	199.60	3.547	2234	2233	350.60	44.07	43.83	30.851	31.159
	2	99.86	201.90	3.519	2225		343.05	43.80		30.409	
	3	100.00	200.34	3.524	2240		342.56	43.62		31.217	
180	1	101.40	200.20	3.624	2242	2241	356.00	44.08	44.40	-	-
	2	100.10	202.30	3.565	2239		350.40	44.53		-	
	3	100.00	201.90	3.557	2243		350.10	44.58		-	

Not included for analysis.

Table C.9 Compressive strength and modulus of elasticity of 55CON concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.90	200.80	3.784	2404	2407	221.70	28.28	28.66	-	-
	2	100.34	199.88	3.805	2407		227.30	28.74		-	
	3	100.88	200.74	3.866	2410		231.40	28.95		-	
28	1	100.30	200.50	3.807	2403	2405	282.10	35.70	36.71	36.616	36.703
	2	100.00	199.60	3.773	2407		293.90	37.42		36.818	
	3	100.30	201.00	3.819	2405		292.30	36.99		36.676	
60	1	99.99	199.20	3.756	2401	2411	323.60	41.21	41.69	37.801	37.870
	2	98.56	201.00	3.708	2418		323.40	42.39		37.865	
	3	100.10	200.10	3.800	2413		326.38	41.47		37.943	
90	1	100.76	201.78	3.874	2408	2412	356.70	44.73	44.89	37.811	38.418
	2	100.50	201.66	3.867	2417		357.37	45.05		38.439	
	3	100.40	202.80	3.871	2411		355.37	44.89		39.005	
180	1	100.10	201.50	3.805	2400	2420	351.20	44.63	44.97	-	-
	2	100.20	202.80	3.958	2475		362.10	45.92		-	
	3	101.60	199.60	3.860	2385		359.70	44.37		-	

Table C.10 Compressive strength and modulus of elasticity of 55RC concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.90	202.06	3.633	2294	2297	191.10	24.38	24.83	-	-
	2	100.00	201.08	3.630	2299		198.10	25.22		-	
	3	99.70	202.52	3.634	2298		194.30	24.89		-	
28	1	99.80	200.35	3.623	2312	2306	247.80	31.68	33.31	28.467	28.722
	2	100.05	201.35	3.672	2320		266.50	33.90		29.616	
	3	100.35	200.90	3.635	2288		271.80	34.37		28.082	
60	1	99.78	199.98	3.615	2312	2312	288.20	36.86	38.13	30.230	31.209
	2	97.98	202.10	3.526	2314		295.94	39.25		32.119	
	3	100.10	200.00	3.635	2309		301.17	38.27		31.277	
90	1	100.14	200.40	3.651	2313	2315	322.64	40.97	41.65	32.482	32.730
	2	100.64	201.00	3.685	2316		332.45	41.79		32.534	
	3	100.40	200.04	3.669	2317		333.92	42.18		33.174	
180	1	99.80	201.50	3.663	2324	2324	333.70	42.66	42.45	-	-
	2	100.20	201.30	3.685	2321		331.40	42.03		-	
	3	100.00	200.80	3.670	2327		335.20	42.68		-	

Table C.11 Compressive strength and modulus of elasticity of 55RCF20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.70	201.74	3.655	2275	2277	191.90	24.09	24.42	-	-
	2	100.78	201.28	3.659	2279		197.10	24.71		-	
	3	101.20	201.04	3.682	2277		196.60	24.44		-	
28	1	99.90	201.10	3.596	2281	2280	271.90	34.69	34.75	29.255	28.506
	2	100.00	200.50	3.585	2277		269.60	34.33		28.356	
	3	100.30	202.00	3.643	2283		278.30	35.22		27.907	
60	1	99.98	200.12	3.605	2295	2293	316.18	40.27	39.92	32.586	33.145
	2	98.75	199.98	3.516	2296		310.79	40.58		33.012	
	3	100.00	200.50	3.605	2289		305.55	38.90		33.837	
90	1	100.14	200.18	3.627	2300	2298	345.79	43.90	43.60	34.139	34.186
	2	99.68	201.18	3.606	2297		339.09	43.45		34.323	
	3	100.40	202.00	3.672	2296		343.89	43.44		34.096	
180	1	100.20	203.90	3.714	2310	2305	353.70	44.85	44.05	-	-
	2	99.80	199.40	3.587	2300		340.70	43.55		-	
	3	100.40	203.30	3.710	2305		346.20	43.73		-	

Table C.12 Compressive strength and modulus of elasticity of 55RCF35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.34	199.60	3.507	2267	2265	174.50	22.51	22.22	-	-
	2	99.80	201.04	3.564	2266		175.50	22.44		-	
	3	102.56	197.99	3.698	2261		179.40	21.72		-	
28	1	100.25	200.45	3.575	2259	2270	245.40	31.09	30.79	26.378	26.407
	2	100.15	201.40	3.627	2286		247.70	31.44		26.944	
	3	100.35	199.00	3.566	2266		235.90	29.83		25.899	
60	1	98.75	201.10	3.504	2275	2273	279.04	36.43	36.17	30.708	30.385
	2	99.98	200.00	3.569	2273		286.04	36.43		30.749	
	3	100.00	200.31	3.573	2271		279.97	35.65		29.697	
90	1	100.40	199.48	3.597	2278	2275	318.60	40.24	39.81	32.899	32.609
	2	100.50	202.52	3.656	2276		314.79	39.68		32.204	
	3	100.80	201.20	3.647	2271		315.28	39.51		32.724	
180	1	99.90	202.00	3.622	2288	2286	311.70	39.77	40.31	-	-
	2	99.40	202.70	3.588	2281		316.80	40.82		-	
	3	99.90	201.80	3.620	2289		316.20	40.34		-	

Table C.13 Compressive strength and modulus of elasticity of 55RCF50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	101.10	201.78	3.644	2250	2253	169.90	21.16	21.46	-	-
	2	99.74	202.64	3.572	2256		170.90	21.87		-	
	3	100.08	200.10	3.546	2253		167.80	21.33		-	
28	1	100.20	199.80	3.555	2256	2259	231.30	29.33	29.34	25.923	26.097
	2	100.30	202.50	3.621	2263		231.90	29.35		26.015	
	3	99.80	200.90	3.547	2257		229.50	29.34		26.353	
60	1	99.38	202.70	3.567	2269	2267	267.70	34.51	33.79	28.373	28.402
	2	99.99	203.60	3.621	2265		260.50	33.17		28.168	
	3	99.50	201.20	3.547	2267		261.90	33.68		28.666	
90	1	100.20	203.30	3.632	2266	2264	287.81	36.50	36.76	30.202	30.167
	2	100.00	200.20	3.578	2276		292.04	37.18		30.523	
	3	102.08	201.00	3.703	2251		299.40	36.58		29.776	
180	1	99.90	199.20	3.531	2261	2272	292.30	37.29	37.33	-	-
	2	100.00	201.00	3.606	2284		285.40	36.34		-	
	3	100.30	199.90	3.587	2271		303.10	38.36		-	

Table C.14 Compressive strength and modulus of elasticity of 55RCB20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.34	199.30	3.579	2271	2271	178.70	22.60	22.25	-	-
	2	100.24	198.70	3.579	2282		177.10	22.44		-	
	3	100.40	198.60	3.552	2259		171.90	21.71		-	
28	1	99.65	198.10	3.517	2276	2273	252.90	32.43	32.22	27.831	27.846
	2	100.30	200.80	3.605	2272		253.90	32.13		27.739	
	3	100.30	203.20	3.646	2271		253.70	32.11		27.968	
60	1	99.78	201.18	3.584	2278	2281	303.80	38.85	39.16	29.147	28.945
	2	99.64	201.00	3.585	2287		314.20	40.29		29.060	
	3	100.00	200.20	3.581	2277		301.00	38.32		28.627	
90	1	100.56	201.68	3.664	2287	2282	344.11	43.33	42.70	30.676	30.612
	2	101.00	201.00	3.669	2278		333.81	41.66		30.301	
	3	100.08	200.80	3.604	2282		339.21	43.12		30.860	
180	1	101.10	200.80	3.684	2285	2294	338.10	42.12	43.19	-	-
	2	100.40	202.30	3.689	2303		348.50	44.02		-	
	3	100.20	201.30	3.641	2294		342.40	43.42		-	

Table C.15 Compressive strength and modulus of elasticity of 55RCB35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Strength (MPa)		Modulus of Elasticity (GPa)	
7	1	100.60	203.04	3.621	2244	2242	159.50	20.07	19.73	-	-
	2	100.50	199.70	3.552	2242		158.80	20.02		-	
	3	99.70	200.80	3.511	2240		149.20	19.11		-	
28	1	99.80	202.60	3.571	2253	2251	251.60	32.16	29.00	27.377	26.945
	2	99.70	201.60	3.539	2249		240.30	30.78		26.872	
	3	101.30	202.40	3.672	2251		251.80	31.24		26.587	
60	1	100.30	201.20	3.580	2252	2252	274.40	34.73	34.72	27.565	27.259
	2	99.60	201.48	3.537	2253		272.70	35.00		26.602	
	3	99.90	200.42	3.534	2250		269.90	34.43		27.609	
90	1	100.68	201.90	3.621	2253	2255	303.70	38.15	38.10	28.544	28.880
	2	100.60	200.80	3.604	2258		304.68	38.33		29.000	
	3	100.80	201.40	3.625	2255		301.74	37.81		29.095	
180	1	100.90	200.60	3.624	2259	2256	308.30	38.56	38.64	-	-
	2	100.90	200.99	3.616	2250		312.10	39.03		-	
	3	100.00	200.50	3.556	2258		301.10	38.34		-	

Table C.16 Compressive strength and modulus of elasticity of 55RCB50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.90	199.84	3.547	2220	2222	142.70	17.85	18.18	-	-
	2	100.62	203.50	3.601	2225		147.40	18.54		-	
	3	100.00	199.60	3.480	2220		142.60	18.16		-	
28	1	101.20	200.00	3.580	2225	2224	216.10	26.87	26.76	25.683	25.004
	2	102.40	198.70	3.640	2224		216.50	26.29		24.099	
	3	100.60	200.00	3.535	2224		215.60	27.12		25.229	
60	1	100.00	200.60	3.525	2237	2232	253.30	32.25	31.63	26.025	26.432
	2	100.50	200.60	3.542	2226		248.70	31.35		26.895	
	3	100.30	200.70	3.540	2232		247.30	31.30		26.377	
90	1	100.72	201.58	3.588	2234	2236	276.53	34.71	34.90	27.062	26.992
	2	100.84	200.70	3.584	2236		280.04	35.06		27.145	
	3	101.28	200.00	3.605	2237		281.36	34.92		26.768	
180	1	100.10	201.80	3.555	2239	2238	280.30	35.62	35.45	-	-
	2	100.00	200.90	3.535	2240		281.90	35.89		-	
	3	100.60	201.50	3.579	2235		276.90	34.84		-	

Table C.17 Compressive strength and modulus of elasticity of 65CON concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.10	200.66	3.794	2403	2402	205.20	26.07	25.71	-	-
	2	100.00	199.00	3.773	2414		203.80	25.95		-	
	3	100.44	199.74	3.790	2395		197.60	24.94		-	
	4	100.44	199.72	3.793	2397		205.10	25.89		-	
28	1	100.30	200.60	3.806	2401	2404	238.93	30.24	30.38	34.722	35.00
	2	99.60	200.40	3.754	2404		237.79	30.52		34.740	
	3	100.00	201.00	3.798	2406		238.54	30.37		35.540	
60	1	100.26	201.14	3.823	2407	2408	300.30	38.04	37.19	36.811	36.581
	2	100.04	202.42	3.825	2404		277.10	35.25		36.446	
	3	100.14	200.24	3.803	2411		301.50	38.28		36.485	
90	1	102.20	197.80	3.910	2410	2410	317.16	38.66	38.76	38.887	38.638
	2	100.30	199.10	3.790	2409		312.94	39.61		38.828	
	3	100.60	201.20	3.857	2412		302.15	38.01		38.200	
180	1	99.80	201.90	3.834	2428	2413	320.90	41.02	40.67	-	-
	2	100.30	202.85	3.871	2415		318.50	40.31		-	
	3	100.00	201.70	3.794	2395		280.30	35.69		-	

Not included for analysis.

Table C.18 Compressive strength and modulus of elasticity of 65RC concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.30	201.90	3.661	2295	2291	160.40	20.30	19.89	-	-
	2	100.00	201.30	3.624	2292		152.00	19.35		-	
	3	101.18	201.52	3.693	2279		161.00	20.02		-	
	4	99.92	199.80	3.597	2296		152.20	19.41		-	
28	1	100.00	200.75	3.620	2296	2294	196.39	25.01	24.80	26.288	27.240
	2	100.70	200.80	3.663	2290		197.67	24.82		28.019	
	3	100.10	199.70	3.609	2296		193.45	24.58		27.413	
60	1	99.90	199.46	3.594	2299	2296	241.40	30.80	31.00	27.124	26.708
	2	100.08	200.92	3.633	2299		243.90	31.00		26.793	
	3	99.88	201.20	3.610	2290		244.50	31.21		26.207	
90	1	100.70	202.30	3.703	2298	2303	264.16	33.17	33.61	28.872	29.224
	2	101.10	201.00	3.715	2302		268.49	33.45		29.016	
	3	99.50	201.48	3.614	2307		266.12	34.22		29.785	
180	1	99.70	199.02	3.581	2305	2307	293.00	37.53	36.41	-	-
	2	100.90	200.60	3.695	2304		291.60	36.47		-	
	3	99.90	200.00	3.626	2313		276.10	35.22		-	

Table C.19 Compressive strength and modulus of elasticity of 65RCF20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.00	201.80	3.603	2273	2276	147.50	18.78	19.94	-	-
	2	99.92	200.94	3.586	2276		157.10	20.03		-	
	3	98.74	203.30	3.545	2277		154.40	20.16		-	
	4	99.80	200.74	3.578	2279		162.50	20.77		-	
28	1	100.25	201.00	3.617	2280	2279	198.65	25.17	25.01	24.016	24.666
	2	100.05	199.10	3.566	2278		195.30	24.84		25.151	
	3	100.10	201.35	3.610	2278		197.02	25.04		24.832	
60	1	99.96	201.52	3.610	2283	2286	245.30	31.26	31.66	26.559	27.508
	2	101.36	201.18	3.716	2289		263.20	32.62		29.597	
	3	99.99	199.52	3.580	2285		244.30	31.11		26.367	
90	1	100.10	200.14	3.613	2294	2293	271.14	34.45	34.26	29.530	29.347
	2	100.70	201.88	3.684	2291		273.10	34.29		29.463	
	3	100.00	200.50	3.611	2293		267.32	34.04		29.049	
180	1	100.00	200.00	3.611	2299	2298	301.90	38.44	37.87	-	-
	2	100.80	201.40	3.696	2300		304.20	38.12		-	
	3	100.00	202.20	3.644	2295		291.00	37.05		-	

Table C.20 Compressive strength and modulus of elasticity of 65RCF35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.20	200.84	3.566	2252	2256	134.20	17.02	17.37	-	-
	2	100.50	201.10	3.602	2258		132.50	16.70		-	
	3	101.00	201.00	3.642	2262		144.20	18.00		-	
	4	100.40	202.54	3.614	2253		140.70	17.77		-	
28	1	100.55	202.10	3.625	2259	2260	171.08	21.54	21.61	26.507	26.258
	2	100.20	201.00	3.586	2263		172.65	21.89		26.491	
	3	100.05	200.75	3.564	2258		168.24	21.40		25.776	
60	1	100.50	201.00	3.604	2260	2268	223.30	28.15	28.17	27.341	27.418
	2	100.60	200.96	3.644	2281		224.10	28.19		27.393	
	3	100.60	200.90	3.615	2264		224.00	28.18		27.521	
90	1	100.00	199.22	3.555	2272	2272	240.23	30.59	30.57	28.358	28.442
	2	100.34	201.58	3.613	2267		243.37	30.78		28.144	
	3	100.42	200.28	3.612	2277		240.23	30.33		28.823	
180	1	100.90	203.10	3.673	2262	2277	271.60	33.97	33.34	-	-
	2	99.60	200.40	3.577	2291		255.60	32.81		-	
	3	100.80	203.00	3.692	2279		265.40	33.26		-	

Table C.21 Compressive strength and modulus of elasticity of 65RCF50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.18	200.30	3.551	2249	2250	125.40	15.91	15.87	-	-
	2	100.14	201.48	3.567	2248		125.10	15.88		-	
	3	100.60	200.94	3.597	2252		127.00	15.98		-	
	4	100.04	200.10	3.540	2251		123.60	15.72		-	
28	1	100.30	200.60	3.568	2251	2254	153.15	19.38	19.44	25.176	25.013
	2	100.65	202.20	3.626	2254		155.68	19.57		24.917	
	3	100.50	201.70	3.612	2257		158.25	19.95		24.945	
60	1	100.52	199.60	3.574	2256	2258	206.01	25.96	26.37	26.617	26.786
	2	99.90	200.80	3.550	2256		203.07	25.91		26.960	
	3	100.22	201.16	3.590	2262		214.84	27.23		26.782	
90	1	100.00	200.00	3.550	2260	2261	212.39	27.04	28.03	28.160	28.220
	2	100.54	200.40	3.598	2261		219.74	27.68		28.393	
	3	101.24	199.18	3.627	2262		236.42	29.37		28.107	
180	1	99.90	200.90	3.550	2254	2268	235.60	30.06	30.52	-	-
	2	99.80	201.00	3.596	2287		244.60	31.27		-	
	3	100.70	201.70	3.637	2264		240.70	30.22		-	

Table C.22 Compressive strength and modulus of elasticity of 65RCB20 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.10	200.10	3.570	2267	2258	156.50	19.89	19.49	-	-
	2	100.76	200.99	3.606	2250		155.80	19.54		-	
	3	100.30	200.20	3.558	2249		155.40	19.67		-	
	4	100.00	202.42	3.604	2267		148.30	18.88		-	
28	1	100.30	201.65	3.604	2262	2263	185.41	23.47	24.57	24.471	24.496
	2	100.10	203.00	3.620	2266		200.32	25.45		24.731	
	3	100.50	202.40	3.630	2261		196.69	24.79		24.287	
60	1	100.04	200.82	3.576	2265	2266	238.76	30.38	30.77	24.862	25.260
	2	100.14	201.20	3.586	2265		241.82	30.70		25.247	
	3	101.30	201.90	3.689	2267		251.82	31.25		25.672	
90	1	100.72	201.94	3.648	2267	2270	252.31	31.67	33.51	27.407	27.560
	2	99.92	200.74	3.571	2267		268.08	34.19		27.884	
	3	100.54	201.52	3.637	2273		275.25	34.67		27.389	
180	1	100.00	201.10	3.609	2285	2286	287.80	36.64	36.24	-	-
	2	99.40	202.00	3.589	2290		286.70	36.95		-	
	3	102.40	199.00	3.742	2283		289.40	35.14		-	

Table C.23 Compressive strength and modulus of elasticity of 65RCB35 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	100.16	200.12	3.539	2244	2241	129.80	16.47	16.58	-	-
	2	100.42	200.24	3.550	2238		130.70	16.50		-	
	3	99.62	201.62	3.527	2244		130.60	16.76		-	
	4	99.96	200.22	3.513	2236		104.70	13.34		-	
28	1	99.65	201.65	3.513	2234	2235	160.62	20.59	20.79	24.295	24.221
	2	101.00	200.50	3.588	2234		165.64	20.67		24.388	
	3	99.90	202.30	3.546	2236		165.33	21.09		23.981	
60	1	100.92	202.28	3.608	2230	2239	218.96	27.37	26.73	25.103	24.933
	2	100.20	200.92	3.568	2252		204.73	25.96		24.970	
	3	101.02	203.08	3.640	2236		215.33	26.87		24.725	
90	1	100.44	200.70	3.567	2243	2241	237.40	29.96	29.00	26.189	26.003
	2	99.84	199.22	3.493	2240		228.03	29.13		26.482	
	3	100.30	201.78	3.570	2239		220.64	27.92		25.339	
180	1	100.10	198.70	3.507	2243	2247	252.30	32.06	31.49	-	-
	2	100.20	200.50	3.549	2245		247.30	31.36		-	
	3	99.70	199.60	3.511	2253		242.30	31.04		-	

Table C.24 Compressive strength and modulus of elasticity of 65RCB50 concrete

Age (days)	Sample No.	Dia. (mm)	Height (mm)	Weight (kg)	Density (kg/m^3)		Load (kN)	Comp. Str. (MPa)		Modulus of Elasticity (GPa)	
7	1	99.98	200.00	3.485	2220	2221	117.20	14.93	15.05	-	-
	2	100.10	200.10	3.498	2221		119.50	15.18		-	
	3	99.99	201.00	3.505	2221		118.10	15.04		-	
28	1	100.25	201.80	3.542	2224	2222	147.70	18.71	18.64	23.300	22.581
	2	100.15	199.00	3.480	2220		146.10	18.55		22.481	
	3	99.90	198.55	3.458	2222		146.20	18.65		21.962	
60	1	100.10	201.00	3.527	2230	2228	192.77	24.50	24.14	23.567	23.778
	2	98.90	199.87	3.421	2228		186.67	24.30		24.142	
	3	99.98	200.10	3.498	2227		185.41	23.62		23.624	
90	1	100.50	200.00	3.545	2234	2232	210.42	26.53	25.95	24.565	24.608
	2	100.44	202.76	3.582	2230		203.18	25.64		25.284	
	3	100.60	201.58	3.575	2231		204.05	25.67		23.974	
180	1	100.00	200.40	3.524	2239	2231	215.70	27.46	27.71	-	-
	2	100.40	200.90	3.538	2224		216.40	27.33		-	
	3	100.40	201.20	3.553	2231		224.40	28.34		-	

APPENDIX D

Water Permeability

Water Permeability Calculation

The data in Table D.1 was used as an example to calculate the coefficient of water permeability of concrete. L_1 and L_2 are the length in meter of concrete samples 1 and 2, respectively and d_1 and d_2 are diameter in meter of samples 1 and 2, respectively.

L_1, L_2, d_1, and d_2 were obtained by measuring the tested sample. The cumulative time and cumulative depth of barometer were collected. Relationship between cumulative volume of passing water and cumulative time was plotted as shown in Fig. D.1 in order to obtain the flow rate of water (Q) passing through the sample as a slope from the graph of the relationship.

For Sample 1:

From Figure D.1, the flow rate or $Q_1 = 7.328\times10^{-12}$ m^3/s

And from Eq. (3.1); $K = \dfrac{\rho L g Q}{PA}$

$$K_1 = \frac{(1000\,kg/m^3)(4.18/100\,m)(9.81\,m/s^2)(7.328\times10^{-12}\,m^3/s)}{(500000\,N/m^2)(\frac{\pi(0.1001)^2}{4})} = 7.637\times10^{-13}\ m/s$$

For Sample 2:

From Figure D.1, the flow rate or $Q_1 = 6.423\times10^{-12}$ m^3/s

And from eq. 3.1; $K = \dfrac{\rho L g Q}{PA}$

$$K_2 = \frac{(1000\,kg/m^3)(4.22/100\,m)(9.81\,m/s^2)(6.423\times10^{-12}\,m^3/s)}{(500000\,N/m^2)(\frac{\pi(0.1001)^2}{4})} = 6.758\times10^{-13}\ m/s$$

$$\boxed{\therefore\ K_{av} = \frac{7.637\times10^{-13} + 6.758\times10^{-13}}{2} = 7.197\times10^{-13}\ m/s}$$

Table D.1 Water permeability at 28 days of 45CON concrete

Water permeability at 28 days of 45CON concrete				
L_1 = 4.18 cm		L_2 = 4.22 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
13,097	0.08	1.232E-07	0.12	1.847E-07
29,986	0.15	2.309E-07	0.24	3.695E-07
105,883	0.65	1.001E-06	0.37	5.696E-07
119,212	0.70	1.078E-06	0.42	6.465E-07
188,893	0.90	1.385E-06	0.64	9.852E-07
276,992	1.25	1.924E-06	0.92	1.416E-06
363,422	1.80	2.771E-06	1.52	2.340E-06
444,322	2.20	3.387E-06	1.92	2.956E-06
536,412	2.60	4.002E-06	2.27	3.494E-06

Q_1 = 7.328×10^{-12} m^3/s K_1 = 7.637×10^{-13} m/s

Q_2 = 6.423×10^{-12} m^3/s K_2 = 6.758×10^{-13} m/s

K_{av} = 7.197×10^{-13} m/s

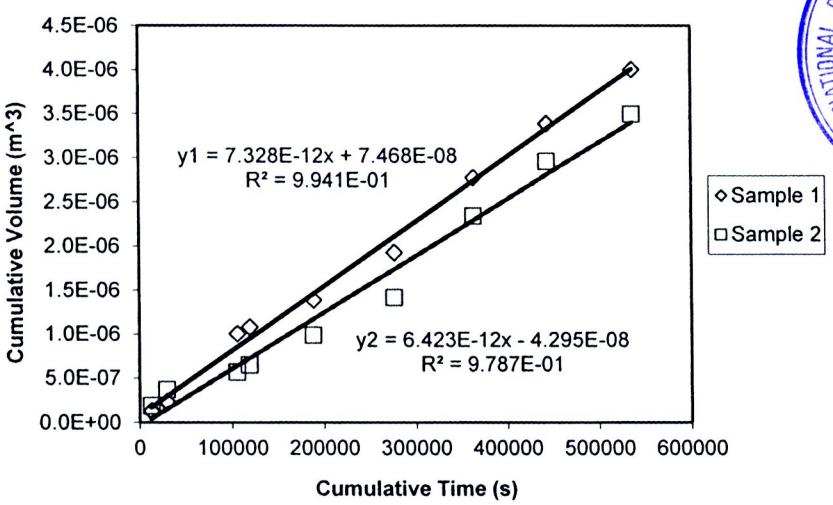

Figure D.1 Relationship between cumulative volume of passing water and cumulative time of 45CON concrete at 28 days

Table D.2 Water permeability at 90 days of 45CON concrete

Water permeability at 90 days of 45CON concrete			
L_1 = 4.36 cm		L_2 = 4.32 cm	
d_1 = 10.02 cm		d_2 = 10.02 cm	
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2	
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
64,820	0.05	7.697E-08	0.10	1.539E-07
87,430	0.20	3.079E-07	0.20	3.079E-07
168,900	0.35	5.388E-07	0.35	5.388E-07
242,100	0.35	5.388E-07	0.35	5.388E-07
258,500	0.55	8.467E-07	0.55	8.467E-07
408,350	0.55	8.467E-07	0.60	9.236E-07
430,690	0.90	1.385E-06	0.90	1.385E-06
518,565	0.85	1.308E-06	0.90	1.385E-06
608,100	1.10	1.693E-06	1.10	1.693E-06
690,930	1.25	1.924E-06	1.25	1.924E-06
781,710	1.40	2.155E-06	1.45	2.232E-06
1,039,060	1.85	2.848E-06	1.90	2.925E-06
1,122,050	1.90	2.925E-06	1.95	3.002E-06
1,211,810	2.10	3.233E-06	2.15	3.310E-06
1,370,460	2.20	3.387E-06	2.25	3.464E-06
1,646,280	2.55	3.925E-06	2.55	3.925E-06

Q_1 =	2.478×10^{-12}	m^3/s	K_1 =	2.688E-13	m/s
Q_2 =	2.504×10^{-12}	m^3/s	K_2 =	2.691E-13	m/s
			K_{av} =	**2.690E-13**	**m/s**

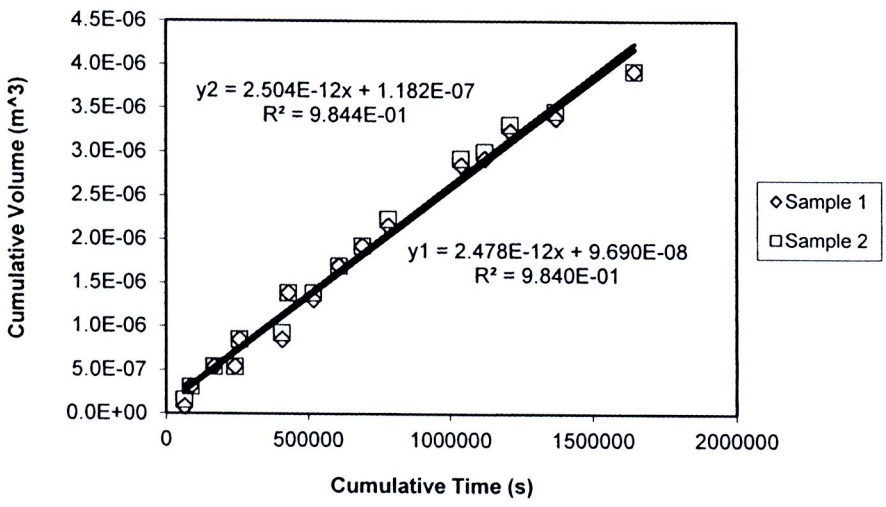

Figure D.2 Relationship between cumulative volume of passing water and cumulative time of 45CON concrete at 90 days

Table D.3 Water permeability at 28 days of 45RC concrete

Water permeability at 28 days of 45RC concrete				
L_1 = 4.25 cm		L_2 = 4.03 cm		
d_1 = 10.03 cm		d_2 = 10.01 cm		
A_1 = 0.00790 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
75,937	0.80	1.232E-06	3.00	4.618E-06
89,261	0.85	1.308E-06	4.85	7.466E-06
151,496	1.20	1.847E-06	5.20	8.005E-06
169,085	1.55	2.386E-06	5.45	8.390E-06
247,035	1.90	2.925E-06	5.65	8.697E-06
333,405	2.55	3.925E-06	6.20	9.544E-06
414,345	3.00	4.618E-06	6.45	9.929E-06
506,415	3.55	5.465E-06	6.65	1.024E-05
589,175	3.90	6.004E-06	7.20	1.108E-05
682,185	4.40	6.773E-06	7.60	1.170E-05

Q_1 = 9.308×10^{-12} m^3/s K_1 = 9.823E-13 m/s

Q_2 = 6.811×10^{-12} m^3/s K_2 = 6.843E-13 m/s

K_{av} = 8.333E-13 m/s

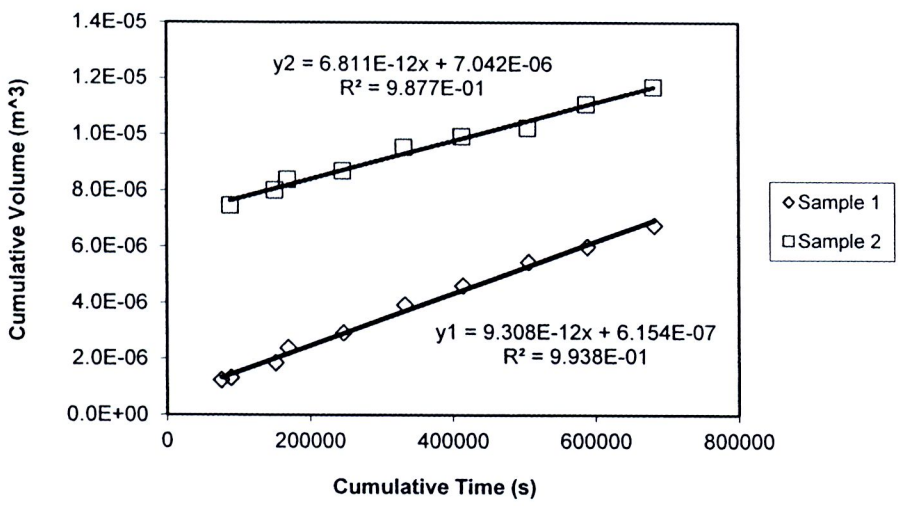

Figure D.3 Relationship between cumulative volume of passing water and cumulative time of 45RC concrete at 28 days

Table D.4 Water permeability at 90 days of 45RC concrete

Water permeability at 90 days of 45RC concrete			
L_1 = 4.36 cm		L_2 = 4.32 cm	
d_1 = 10.016 cm		d_2 = 10.016 cm	
A_1 = 0.00790 m^2		A_2 = 0.00787 m^2	
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
64,820	0.15	2.309E-07	0.15	2.309E-07
87,430	0.30	4.618E-07	0.30	4.618E-07
168,900	0.55	8.467E-07	0.55	8.467E-07
242,100	0.60	9.236E-07	0.60	9.236E-07
258,500	0.80	1.232E-06	0.80	1.232E-06
408,350	0.95	1.462E-06	1.00	1.539E-06
430,690	1.35	2.078E-06	1.30	2.001E-06
518,565	1.30	2.001E-06	1.35	2.078E-06
608,100	1.70	2.617E-06	1.70	2.617E-06
690,930	1.90	2.925E-06	1.85	2.848E-06
781,710	2.10	3.233E-06	2.10	3.233E-06
1,039,060	2.70	4.156E-06	2.70	4.156E-06
1,122,050	2.80	4.310E-06	2.80	4.310E-06
1,211,810	3.05	4.695E-06	3.05	4.695E-06
1,370,460	3.20	4.926E-06	3.20	4.926E-06
1,646,280	3.70	5.696E-06	3.70	5.696E-06

Q_1 = 3.390×10^{-12} m^3/s K_1 = 3.680E-13 m/s

Q_2 = 3.444×10^{-12} m^3/s K_2 = 3.705E-13 m/s

K_{av} = 3.693E-13 m/s

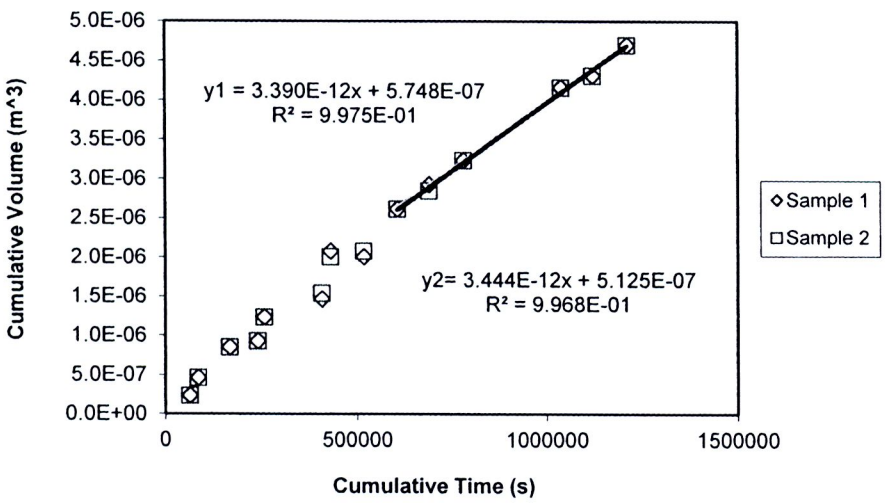

Figure D.4 Relationship between cumulative volume of passing water and cumulative time of 45RC concrete at 90 days

Table D.5 Water permeability at 28 days of 45RCF20 concrete

Water permeability at 28 days of 45RCF20 concrete				
L_1 = 4.35 cm		L_2 = 4.41 cm		
d_1 = 9.97 cm		d_2 = 9.97 cm		
A_1 = 0.00781 m^2		A_2 = 0.00781 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
77,550	0.15	2.309E-07	0.20	3.079E-07
177,510	0.30	4.618E-07	0.30	4.618E-07
347,940	0.50	7.697E-07	0.57	8.774E-07
440,280	0.55	8.467E-07	0.70	1.078E-06
524,490	0.65	1.001E-06	0.80	1.232E-06
609,990	0.75	1.155E-06	0.90	1.385E-06
941,130	1.10	1.693E-06	1.30	2.001E-06
1,044,420	1.25	1.924E-06	1.40	2.155E-06
1,133,790	1.40	2.155E-06	1.50	2.309E-06

Q_1 = 1.820×10^{-12} m^3/s K_1 = 1.990E-13 m/s

Q_2 = 1.786×10^{-12} m^3/s K_2 = 1.979E-13 m/s

K_{av} = 1.985E-13 m/s

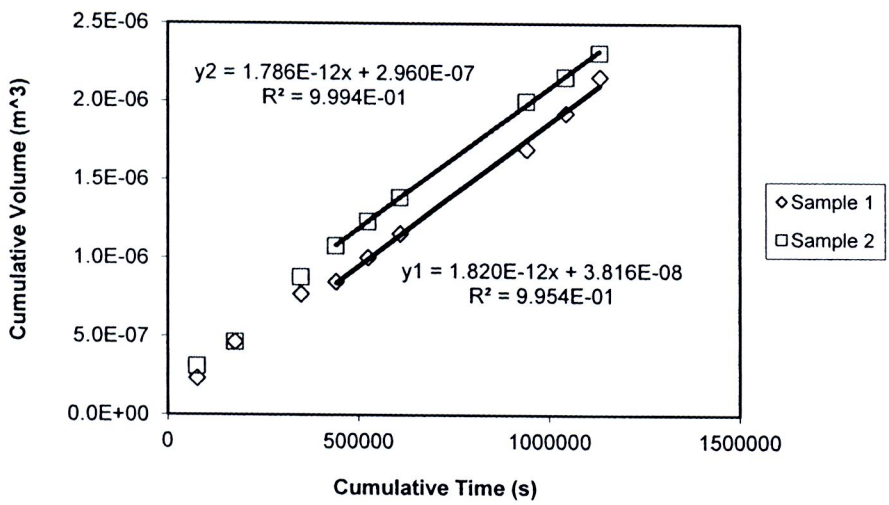

Figure D.5 Relationship between cumulative volume of passing water and cumulative time of 45RCF20 concrete at 28 days

Table D.6 Water permeability at 90 days of 45RCF20 concrete

Water permeability at 90 days of 45RCF20 concrete				
L_1 = 4.36 cm		L_2 = 4.32 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
87,875	0.10	1.539E-07	0.10	1.539E-07
177,410	0.20	3.079E-07	0.20	3.079E-07
260,240	0.30	4.618E-07	0.25	3.848E-07
351,020	0.35	5.388E-07	0.30	4.618E-07
608,370	0.50	7.697E-07	0.50	7.697E-07
691,360	0.60	9.236E-07	0.55	8.467E-07
781,120	0.65	1.001E-06	0.60	9.236E-07
939,770	0.80	1.232E-06	0.70	1.078E-06
1,198,970	1.00	1.539E-06	0.90	1.385E-06

Q_1 = 1.198×10^{-12} m^3/s K_1 = 1.301E-13 m/s

Q_2 = 1.073×10^{-12} m^3/s K_2 = 1.154E-13 m/s

K_{av} = 1.227E-13 m/s

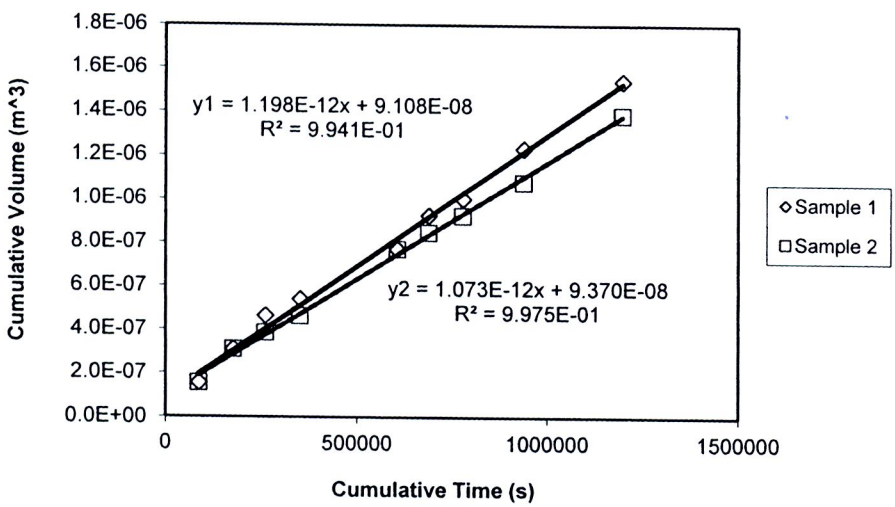

Figure D.6 Relationship between cumulative volume of passing water and cumulative time of 45RCF20 concrete at 90 days

Table D.7 Water permeability at 28 days of 45RCF35 concrete

Water permeability at 28 days of 45RCF35 concrete			
L_1 = 4.26 cm		L_2 = 4.35 cm	
d_1 = 9.99 cm		d_2 = 9.99 cm	
A_1 = 0.00785 m^2		A_2 = 0.00785 m^2	
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
77,570	0.15	2.309E-07	0.15	2.309E-07
177,530	0.25	3.848E-07	0.25	3.848E-07
347,960	0.47	7.235E-07	0.45	6.927E-07
440,300	0.60	9.236E-07	0.60	9.236E-07
524,495	0.70	1.078E-06	0.67	1.031E-06
610,040	0.75	1.155E-06	0.75	1.155E-06
941,120	1.15	1.770E-06	1.10	1.693E-06
1,044,410	1.25	1.924E-06	1.27	1.955E-06
1,133,840	1.35	2.078E-06	1.30	2.001E-06

Q_1 = 1.751×10^{-12} m^3/s K_1 = 1.867E-13 m/s

Q_2 = 1.712×10^{-12} m^3/s K_2 = 1.864E-13 m/s

K_{av} = 1.866E-13 m/s

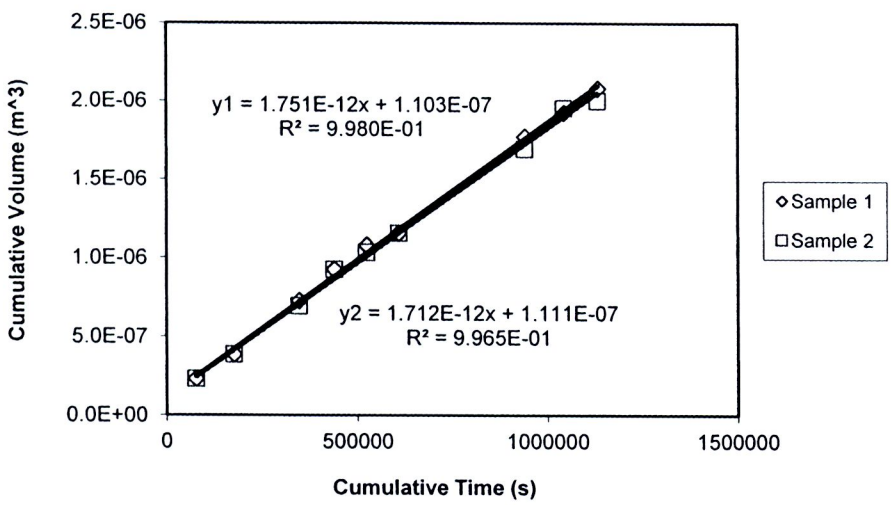

Figure D.7 Relationship between cumulative volume of passing water and cumulative time of 45RCF35 concrete at 28 days

Table D.8 Water permeability at 90 days of 45RCF35 concrete

Water permeability at 90 days of 45RCF35 concrete				
L_1 = 4.36 cm		L_2 = 4.32 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
87,875	0.10	1.539E-07	0.15	2.309E-07
177,410	0.20	3.079E-07	0.20	3.079E-07
260,240	0.25	3.848E-07	0.25	3.848E-07
351,020	0.30	4.618E-07	0.35	5.388E-07
608,370	0.50	7.697E-07	0.50	7.697E-07

Q_1 =	1.140×10^{-12}	m^3/s	K_1 =	1.190E-13	m/s
Q_2 =	1.065×10^{-12}	m^3/s	K_2 =	1.080E-13	m/s
			K_{av} =	**1.135E-13**	**m/s**

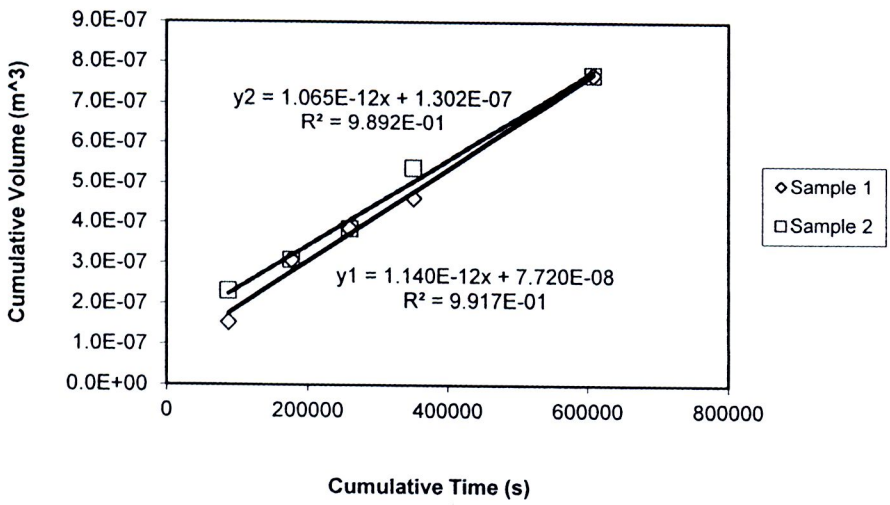

Figure D.8 Relationship between cumulative volume of passing water and cumulative time of 45RCF35 concrete at 90 days

Table D.9 Water permeability at 28 days of 45RCF50 concrete

Water permeability at 28 days of 45RCF50 concrete				
L_1 = 4.33 cm		L_2 = - cm		
d_1 = 10.01 cm		d_2 = - cm		
A_1 = 0.00787 m^2				
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
84,200	0.15	2.309E-07		
169,680	0.25	3.848E-07		
500,830	0.60	9.236E-07		
604,140	0.75	1.155E-06		
693,475	0.87	1.339E-06		

Q_1 =	1.785×10^{-12}	m^3/s	K_1 =	1.927E-13	m/s
Q_2 =	-	m^3/s	K_2 =	-	m/s
			K_{av} =	**1.927E-13**	**m/s**

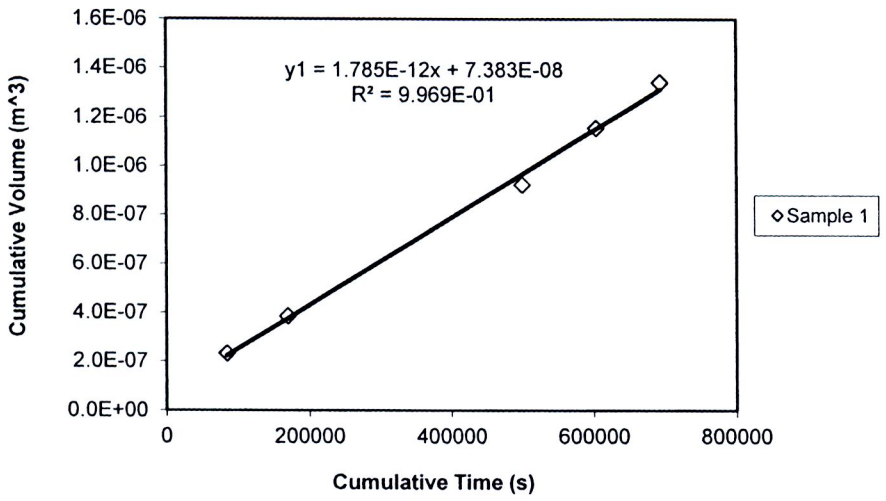

Figure D.9 Relationship between cumulative volume of passing water and cumulative time of 45RCF50 concrete at 28 days

Table D.10 Water permeability at 90 days of 45RCF50 concrete

Water permeability at 90 days of 45RCF50 concrete				
L_1 = 4.35 cm		L_2 = 4.41 cm		
d_1 = 9.97 cm		d_2 = 9.97 cm		
A_1 = 0.00783 m^2		A_2 = 0.00783 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
22,340	0.05	7.697E-08	0.05	7.697E-08
110,215	0.10	1.539E-07	0.10	1.539E-07
199,750	0.25	3.848E-07	0.25	3.848E-07
282,580	0.30	4.618E-07	0.30	4.618E-07
373,360	0.45	6.927E-07	0.35	5.388E-07
630,710	0.65	1.001E-06	0.60	9.236E-07
713,700	0.75	1.155E-06	0.70	1.078E-06
803,460	0.90	1.385E-06	0.83	1.278E-06

Q_1 = 1.632×10^{-12} m^3/s K_1 = 1.784E-13 m/s

Q_2 = 1.489×10^{-12} m^3/s K_2 = 1.650E-13 m/s

K_{av} = 1.717E-13 m/s

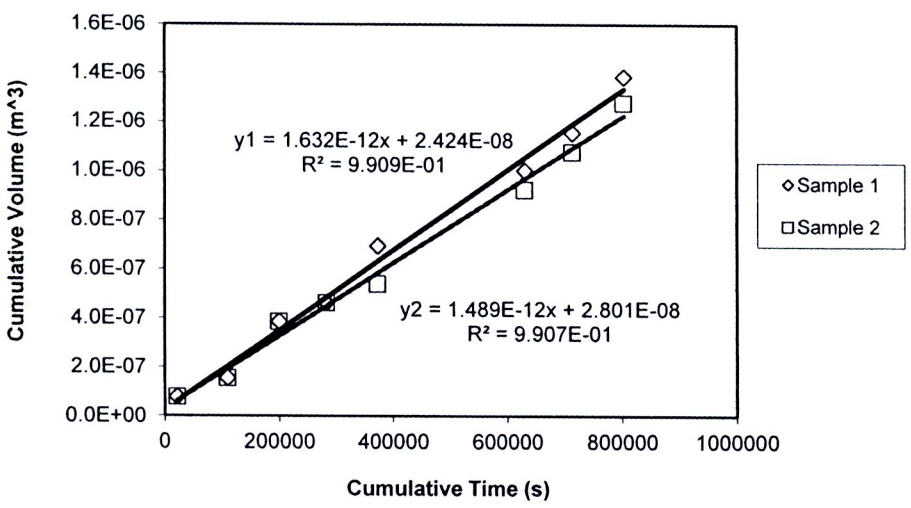

Figure D.10 Relationship between cumulative volume of passing water and cumulative time of 45RCF50 concrete at 90 days

Table D.11 Water permeability at 28 days of 45RCB20 concrete

Water permeability at 28 days of 45RCB20 concrete				
L_1 = 4.14 cm			L_2 = 4.26 cm	
d_1 = 9.98 cm			d_2 = 9.98 cm	
A_1 = 0.00784 m^2			A_2 = 0.00743 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
92,370	0.15	2.309E-07	0.10	1.539E-07
176,580	0.30	4.618E-07	0.25	3.848E-07
262,080	0.50	7.697E-07	0.35	5.388E-07
593,190	0.95	1.462E-06	0.70	1.078E-06
696,500	1.10	1.693E-06	0.85	1.308E-06
785,880	1.30	2.001E-06	1.00	1.539E-06

Q_1 = 2.435×10^{-12} m^3/s K_1 = 2.528E-13 m/s

Q_2 = 1.882×10^{-12} m^3/s K_2 = 2.011E-13 m/s

K_{av} = 2.270E-13 m/s

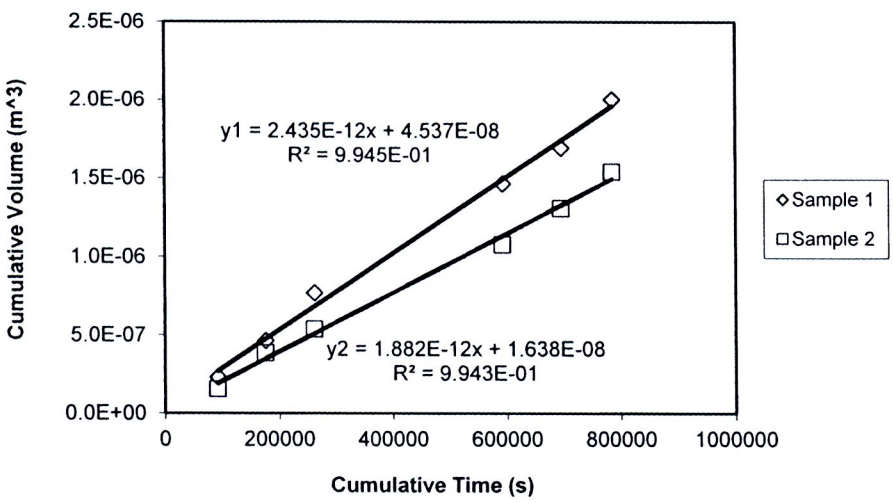

Figure D.11 Relationship between cumulative volume of passing water and cumulative time of 45RCB20 concrete at 28 days

Table D.12 Water permeability at 90 days of 45RCB20 concrete

Water permeability at 90 days of 45RCB20 concrete				
L_1 = 4.36 cm			L_2 = 4.32 cm	
d_1 = 10.02 cm			d_2 = 10.02 cm	
A_1 = 0.00788 m^2			A_2 = 0.00788 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
64,820	0.20	3.079E-07	0.25	3.848E-07
87,430	0.20	3.079E-07	0.30	4.618E-07
168,900	0.25	3.848E-07	0.35	5.388E-07
242,100	0.25	3.848E-07	0.40	6.158E-07
258,500	0.35	5.388E-07	0.45	6.927E-07
408,350	0.45	6.927E-07	0.65	1.001E-06
430,690	0.65	1.001E-06	0.65	1.001E-06
518,565	0.65	1.001E-06	0.75	1.155E-06
608,100	0.70	1.078E-06	0.85	1.308E-06
690,930	0.75	1.155E-06	0.95	1.462E-06
781,710	0.85	1.308E-06	1.05	1.616E-06
1,039,060	1.15	1.770E-06	1.35	2.078E-06
1,122,050	1.30	2.001E-06	1.45	2.232E-06
1,211,810	1.35	2.078E-06	1.55	2.386E-06
1,370,460	1.50	2.309E-06	1.65	2.540E-06
1,629,660	1.70	2.617E-06	2.00	3.079E-06

Q_1 = 1.563×10^{-12} m^3/s K_1 = 1.697E-13 m/s

Q_2 = 1.721×10^{-12} m^3/s K_2 = 1.851E-13 m/s

K_{av} = 1.774E-13 m/s

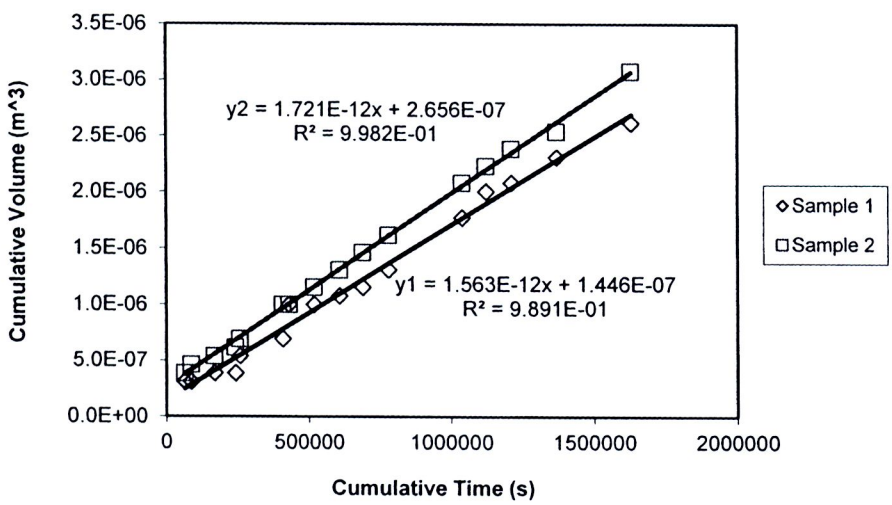

Figure D.12 Relationship between cumulative volume of passing water and cumulative time of 45RCB20 concrete at 90 days

Table D.13 Water permeability at 28 days of 45RCB35 concrete

Water permeability at 28 days of 45RCB35 concrete				
L_1 = 4.09 cm		L_2 = 4.21 cm		
d_1 = 9.99 cm		d_2 = 9.99 cm		
A_1 = 0.00784 m^2		A_2 = 0.00784 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
84,180	0.15	2.309E-07	0.15	2.309E-07
169,590	0.35	5.388E-07	0.40	6.158E-07
500,790	0.80	1.232E-06	0.95	1.462E-06
604,110	1.00	1.539E-06	1.20	1.847E-06
693,450	1.20	1.847E-06	1.40	2.155E-06

Q_1 = 2.506×10^{-12} m^3/s K_1 = 2.566E-13 m/s

Q_2 = 3.019×10^{-12} m^3/s K_2 = 3.181E-13 m/s

K_{av} = 2.873E-13 m/s

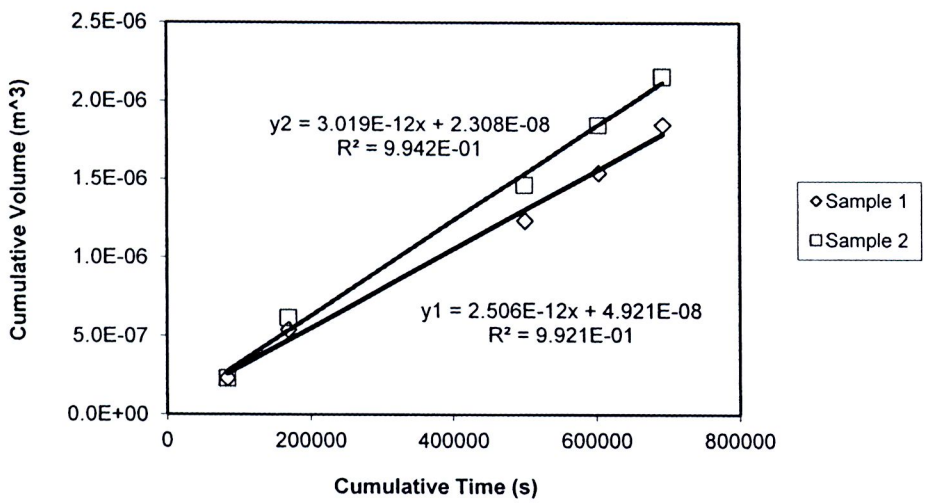

Figure D.13 Relationship between cumulative volume of passing water and cumulative time of 45RCB35 concrete at 28 days

Table D.14 Water permeability at 90 days of 45RCB35 concrete

Water permeability at 90 days of 45RCB35 concrete				
L_1 = 4.36 cm		L_2 = 4.32 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
64,820	0.05	7.697E-08	0.05	7.697E-08
87,430	0.05	7.697E-08	0.10	1.539E-07
168,900	0.10	1.539E-07	0.15	2.309E-07
242,100	0.20	3.079E-07	0.20	3.079E-07
258,500	0.25	3.848E-07	0.30	4.618E-07
408,350	0.40	6.158E-07	0.50	7.697E-07
430,690	0.40	6.158E-07	0.55	8.467E-07
518,565	0.50	7.697E-07	0.60	9.236E-07
608,100	0.60	9.236E-07	0.70	1.078E-06
690,930	0.70	1.078E-06	0.80	1.232E-06
781,710	0.85	1.308E-06	0.90	1.385E-06
1,039,060	1.10	1.693E-06	1.30	2.001E-06
1,122,050	1.20	1.847E-06	1.30	2.001E-06
1,211,810	1.30	2.001E-06	1.45	2.232E-06

Q_1 = 1.720×10^{-12} m^3/s K_1 = 1.867E-13 m/s

Q_2 = 1.882×10^{-12} m^3/s K_2 = 2.025E-13 m/s

K_{av} = 1.946E-13 m/s

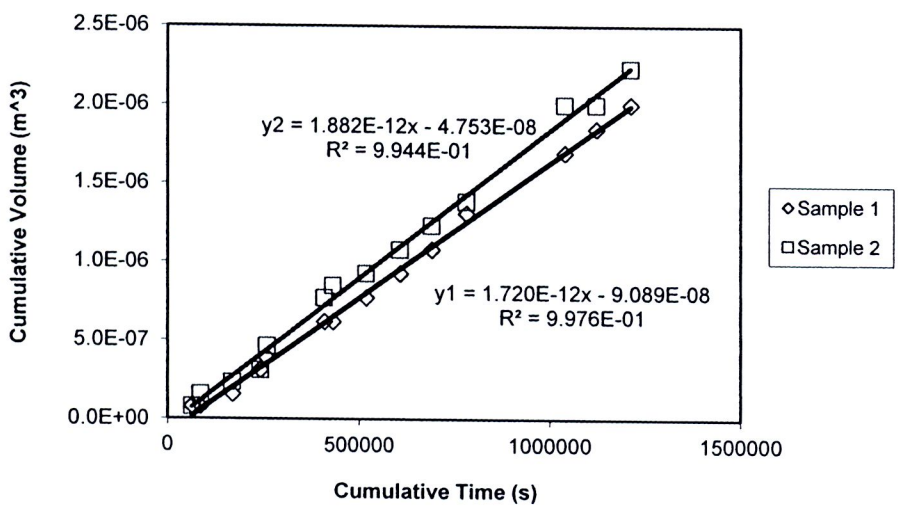

Figure D.14 Relationship between cumulative volume of passing water and cumulative time of 45RCB35 concrete at 90 days

Table D.15 Water permeability at 28 days of 45RCB50 concrete

Water permeability at 28 days of 45RCB50 concrete				
L_1 = 4.16 cm		L_2 = 4.20 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
7,960	0.15	2.309E-07	0.15	2.309E-07
16,880	0.30	4.618E-07	0.25	3.848E-07
75,680	0.50	7.697E-07	0.50	7.697E-07
88,790	0.65	1.001E-06	0.60	9.236E-07
102,260	0.80	1.232E-06	0.75	1.155E-06
163,880	1.00	1.539E-06	0.95	1.462E-06
172,540	1.10	1.693E-06	1.10	1.693E-06

Q_1 =	8.324×10^{-12}	m^3/s	K_1 =	8.633E-13	m/s
Q_2 =	8.284×10^{-12}	m^3/s	K_2 =	8.674E-13	m/s
			K_{av} =	**8.654E-13**	**m/s**

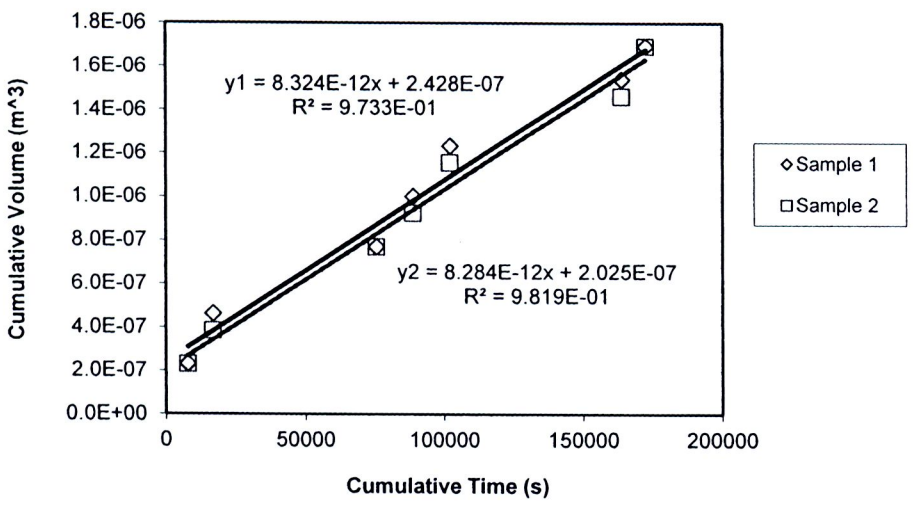

Figure D.15 Relationship between cumulative volume of passing water and cumulative time of 45RCB50 concrete at 28 days

Table D.16 Water permeability at 90 days of 45RCB50 concrete

Water permeability at 90 days of 45RCB50 concrete				
L_1 = 4.16 cm		L_2 = 4.20 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
64,820	0.35	5.388E-07	0.00	0.000E+00
87,430	0.75	6.927E-07	0.35	5.388E-07
168,900	1.30	1.001E-06	0.45	6.927E-07
242,100	1.75	1.462E-06	0.50	7.697E-07
258,500	1.95	1.770E-06	0.70	1.078E-06
408,350	2.90	1.924E-06	0.85	1.308E-06
430,690	3.35	2.232E-06	1.25	1.924E-06
518,565	3.75	2.694E-06	1.30	2.001E-06
608,100	4.50	2.925E-06	1.65	2.540E-06
690,930	5.15	3.310E-06	1.95	3.002E-06
781,710	5.75	3.618E-06	2.15	3.310E-06
1,039,060	6.75	4.849E-06	2.75	4.233E-06
1,122,050	7.75	5.311E-06	2.85	4.387E-06
1,211,810	8.20	5.619E-06	3.00	4.618E-06
1,370,460	9.00	6.234E-06	3.15	4.849E-06
1,629,480	10.35	7.466E-06	3.55	5.465E-06
1,733,760	10.95	7.928E-06	3.85	5.927E-06

Q_1 =	4.372×10^{-12}	m^3/s	K_1 =	4.534E-13	m/s
Q_2 =	2.322×10^{-12}	m^3/s	K_2 =	2.431E-13	m/s
			K_{av} =	**3.483E-13**	**m/s**

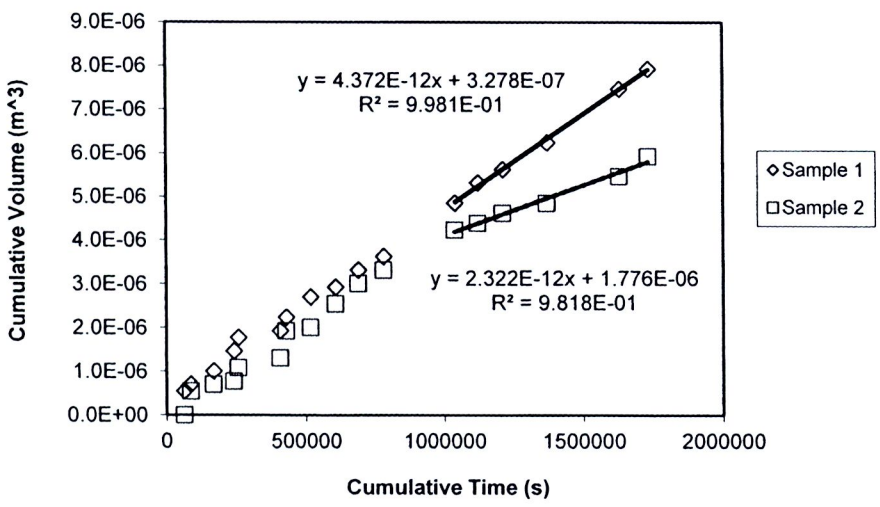

Figure D.16 Relationship between cumulative volume of passing water and cumulative time of 45RCB50 concrete at 90 days

Table D.17 Water permeability at 28 days of 55CON concrete

Water permeability at 28 days of 55CON concrete				
L_1 = 4.10 cm			L_2 = 4.30 cm	
d_1 = 10.01 cm			d_2 = 10.01 cm	
A_1 = 0.00787 m^2			A_2 = 0.00787 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
61,508	0.70	1.078E-06	0.80	1.232E-06
80,493	0.90	1.385E-06	1.00	1.539E-06
91,518	1.00	1.539E-06	1.10	1.693E-06
150,408	1.30	2.001E-06	1.40	2.155E-06
163,273	1.30	2.001E-06	1.40	2.155E-06
238,189	1.60	2.463E-06	2.10	3.233E-06
349,025	2.10	3.233E-06	2.60	4.002E-06
419,170	2.50	3.848E-06	3.10	4.772E-06
521,751	3.00	4.618E-06	3.90	6.004E-06
594,248	3.60	5.542E-06	4.20	6.465E-06
671,518	3.80	5.850E-06	4.50	6.927E-06
685,228	4.10	6.311E-06	4.60	7.081E-06
773,612	4.60	7.081E-06	5.30	8.159E-06
847,383	5.10	7.851E-06	5.70	8.774E-06
952,863	5.60	8.621E-06	6.10	9.390E-06
1,040,219	6.10	9.390E-06	6.60	1.016E-05

Q_1 =	8.347×10^{-12}	m^3/s	K_1 =	8.532E-13	m/s
Q_2 =	9.194×10^{-12}	m^3/s	K_2 =	9.856E-13	m/s
			K_{av} =	**9.194E-13**	**m/s**

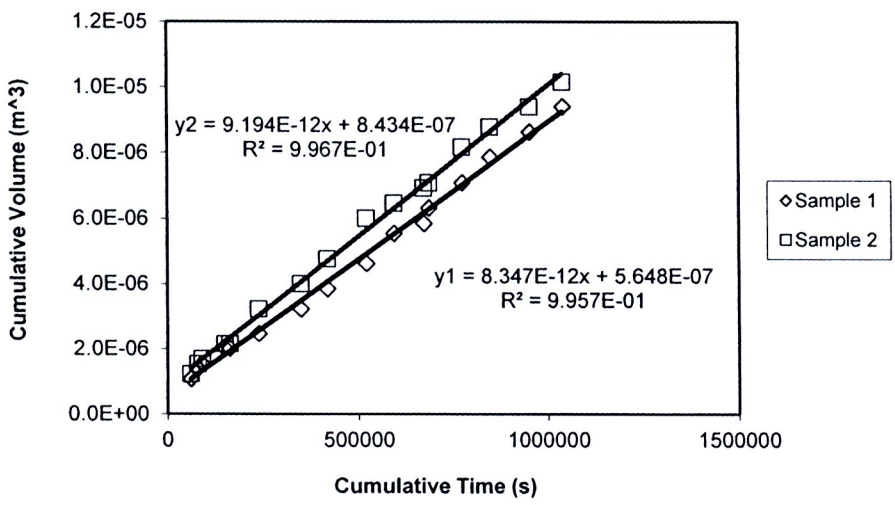

Figure D.17 Relationship between cumulative volume of passing water and cumulative time of 55CON concrete at 28 days

Table D.18 Water permeability at 90 days of 55CON concrete

Water permeability at 90 days of 55CON concrete				
L_1 = 4.16 cm		L_2 = 4.13 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
27,840	0.40	6.158E-07	1.25	1.924E-06
88,560	0.70	1.078E-06	1.55	2.386E-06
113,795	0.90	1.385E-06	1.70	2.617E-06
257,611	1.40	2.155E-06	2.15	3.310E-06
285,430	1.40	2.155E-06	2.45	3.771E-06
350,195	1.70	2.617E-06	2.65	4.079E-06
376,314	1.80	2.771E-06	2.95	4.541E-06
433,288	1.80	2.771E-06	3.05	4.695E-06
460,485	2.05	3.156E-06	3.35	5.157E-06
519,674	2.10	3.233E-06	3.35	5.157E-06
541,271	2.20	3.387E-06	3.60	5.542E-06
608,480	2.50	3.848E-06	3.70	5.696E-06
694,901	2.80	4.310E-06	3.95	6.081E-06
709,560	2.90	4.464E-06	4.05	6.234E-06
862,890	3.40	5.234E-06	4.35	6.696E-06
881,510	3.50	5.388E-06	4.65	7.158E-06

Q_1 =	5.317×10^{-12}	m^3/s	K_1 =	5.514E-13	m/s
Q_2 =	5.952×10^{-12}	m^3/s	K_2 =	6.128E-13	m/s
			K_{av} =	**5.821E-13**	**m/s**

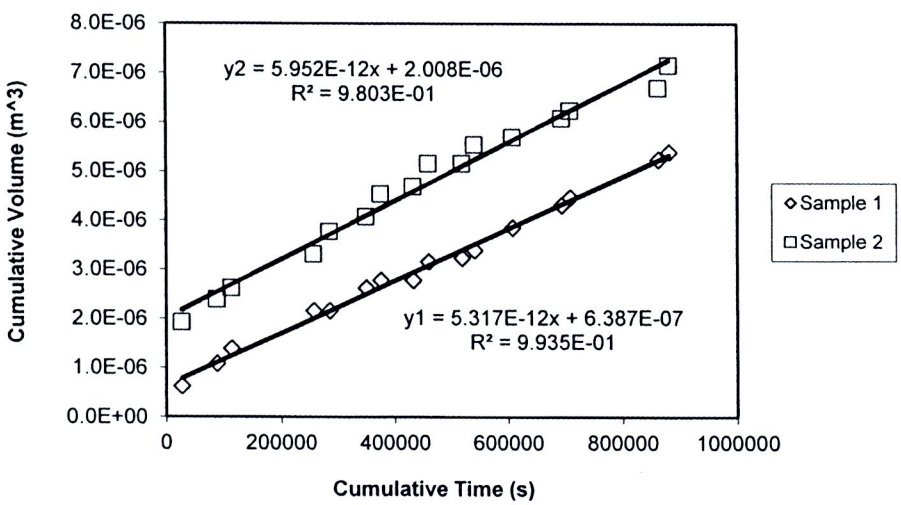

Figure D.18 Relationship between cumulative volume of passing water and cumulative time of 55CON concrete at 90 days

Table D.19 Water permeability at 28 days of 55RC concrete

Water permeability at 28 days of 55RC concrete				
L_1 = 4.25 cm		L_2 = 4.00 cm		
d_1 = 10.03 cm		d_2 = 10.03 cm		
A_1 = 0.00790 m^2		A_2 = 0.00790 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
18,985	0.40	6.158E-07	0.30	4.618E-07
30,010	0.70	1.078E-06	0.40	6.158E-07
88,900	1.70	2.617E-06	1.00	1.539E-06
101,765	1.90	2.925E-06	1.20	1.847E-06
176,681	3.20	4.926E-06	1.80	2.771E-06
287,517	5.10	7.851E-06	2.90	4.464E-06
357,662	6.30	9.698E-06	3.70	5.696E-06
460,243	8.10	1.247E-05	4.70	7.235E-06
532,740	9.30	1.432E-05	5.40	8.313E-06
610,010	10.40	1.601E-05	6.00	9.236E-06
623,720	10.70	1.647E-05	6.30	9.698E-06
712,104	12.00	1.847E-05	7.00	1.078E-05
785,875	12.70	1.955E-05	7.40	1.139E-05
891,355	14.10	2.171E-05	8.30	1.278E-05
978,711	15.30	2.355E-05	9.10	1.401E-05

Q_1 = 2.432×10^{-12} m^3/s K_1 = 1.507E-12 m/s

Q_2 = 1.428×10^{-12} m^3/s K_2 = 1.418E-12 m/s

K_{av} = 1.463E-12 m/s

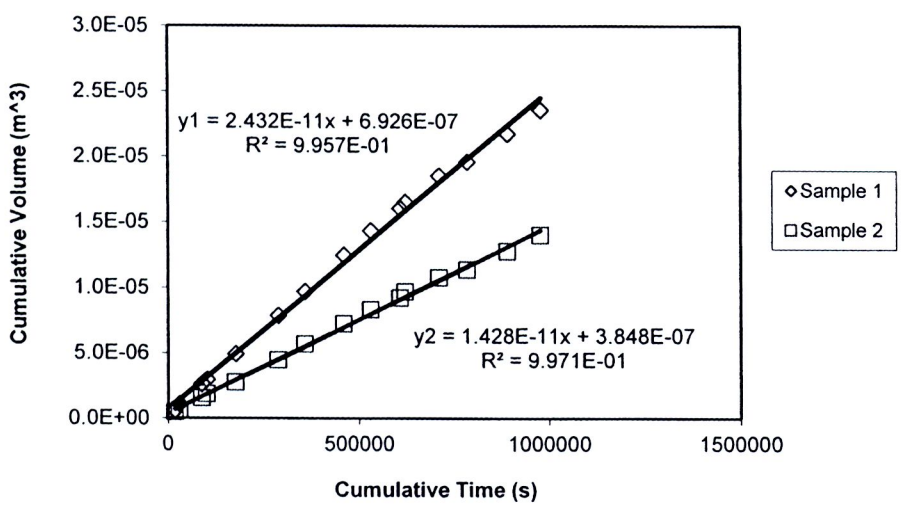

Figure D.19 Relationship between cumulative volume of passing water and cumulative time of 55RC concrete at 28 days

Table D.20 Water permeability at 90 days of 55RC concrete

Water permeability at 90 days of 55RC concrete				
L_1 = 4.10 cm			L_2 = 4.10 cm	
d_1 = 10.04 cm			d_2 = 10.04 cm	
A_1 = 0.00792 m^2			A_2 = 0.00792 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
27,840	3.00	4.618E-06	2.00	3.079E-06
88,560	3.30	5.080E-06	2.50	3.848E-06
113,795	3.40	5.234E-06	2.80	4.310E-06
257,611	4.10	6.311E-06	3.60	5.542E-06
285,430	4.40	6.773E-06	3.70	5.696E-06
350,195	4.80	7.389E-06	4.10	6.311E-06
376,314	5.00	7.697E-06	4.30	6.619E-06
433,288	5.25	8.082E-06	4.55	7.004E-06
460,485	5.40	8.313E-06	4.70	7.235E-06
519,674	5.80	8.928E-06	4.90	7.543E-06
541,271	5.90	9.082E-06	5.10	7.851E-06
608,480	6.20	9.544E-06	5.40	8.313E-06
694,901	6.40	9.852E-06	5.90	9.082E-06
709,560	6.60	1.016E-05	6.00	9.236E-06
862,890	7.50	1.155E-05	6.90	1.062E-05
881,510	7.60	1.170E-05	7.00	1.078E-05

Q_1 = 8.306×10^{-12} m^3/s K_1 = 8.443E-13 m/s

Q_2 = 8.623×10^{-12} m^3/s K_2 = 8.765E-13 m/s

K_{av} = 8.604E-13 m/s

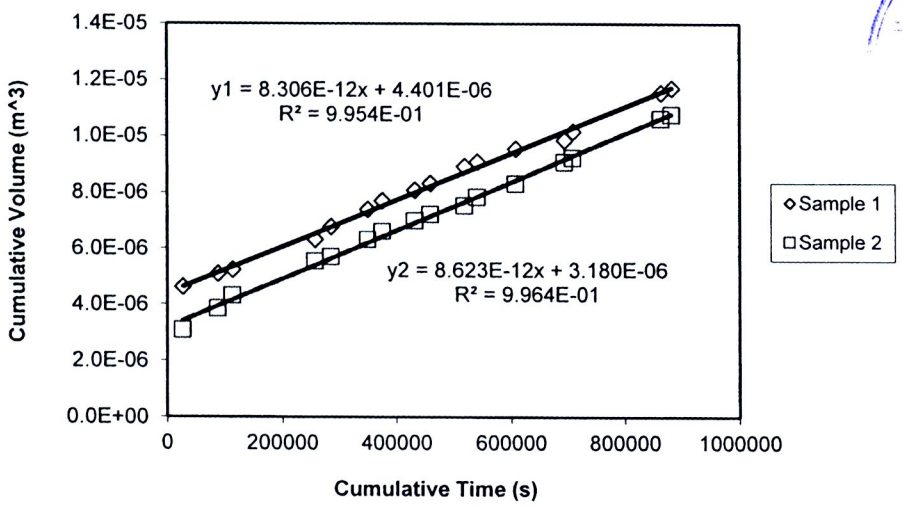

Figure D.20 Relationship between cumulative volume of passing water and cumulative time of 55RC concrete at 90 days

Table D.21 Water permeability at 28 days of 55RCF20 concrete

Water permeability at 28 days of 55RCF20 concrete			
L_1 = 4.36 cm		L_2 = 4.32 cm	
d_1 = 10.00 cm		d_2 = 10.00 cm	
A_1 = 0.00785 m^2		A_2 = 0.00785 m^2	
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
62,044	0.10	1.835E-07	2.00	3.670E-06
92,036	0.20	3.670E-07	2.20	4.037E-06
152,109	0.30	5.505E-07	2.30	4.220E-06
238,785	0.40	7.340E-07	2.50	4.587E-06
349,561	0.60	1.101E-06	2.70	4.954E-06
419,406	0.80	1.468E-06	2.80	5.138E-06
521,987	1.00	1.835E-06	2.90	5.321E-06
594,484	1.20	2.202E-06	3.10	5.688E-06
671,754	1.30	2.385E-06	3.20	5.872E-06
685,464	1.40	2.569E-06	3.30	6.055E-06
773,848	1.60	2.936E-06	3.50	6.422E-06
847,619	1.80	3.303E-06	3.70	6.789E-06
953,099	2.00	3.670E-06	3.80	6.973E-06
1,040,455	2.20	4.037E-06	4.00	7.340E-06

Q_1 = 3.941×10^{-12} m^3/s K_1 = 4.292E-13 m/s

Q_2 = 3.555×10^{-12} m^3/s K_2 = 3.836E-13 m/s

K_{av} = 4.064E-13 m/s

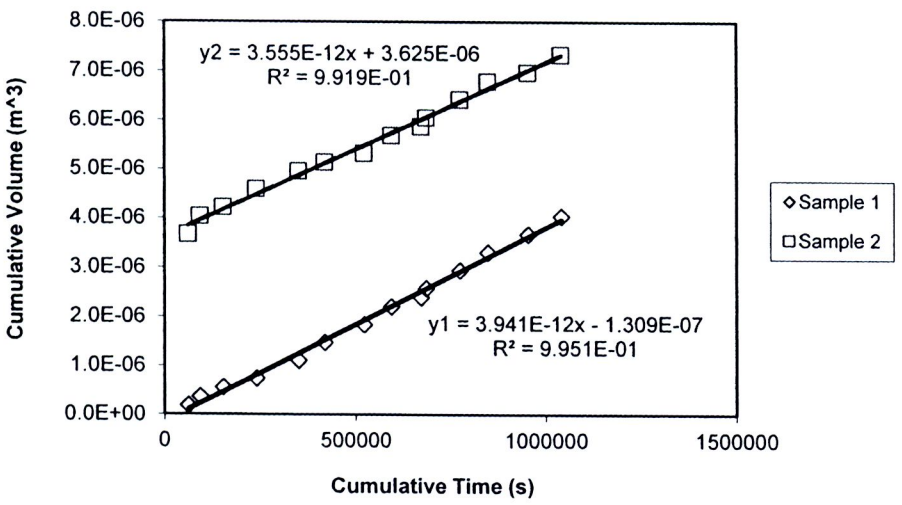

Figure D.21 Relationship between cumulative volume of passing water and cumulative time of 55RCF20 concrete at 28 days

Table D.22 Water permeability at 90 days of 55RCF20 concrete

Water permeability at 90 days of 55RCF20 concrete				
L_1 = 4.20 cm		L_2 = 4.00 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
68,516	3.10	4.772E-06	1.60	2.463E-06
173,135	3.30	5.080E-06	1.90	2.925E-06
258,300	3.50	5.388E-06	2.10	3.233E-06
342,300	3.60	5.542E-06	2.30	3.541E-06
601,193	3.90	6.004E-06	2.60	4.002E-06
685,090	4.10	6.311E-06	2.90	4.464E-06
773,079	4.30	6.619E-06	3.00	4.618E-06
1,205,976	5.00	7.697E-06	3.60	5.542E-06

Q_1 = 2.503×10^{-12} m^3/s K_1 = 2.606E-13 m/s

Q_2 = 2.653×10^{-12} m^3/s K_2 = 2.630E-13 m/s

K_{av} = 2.618E-13 m/s

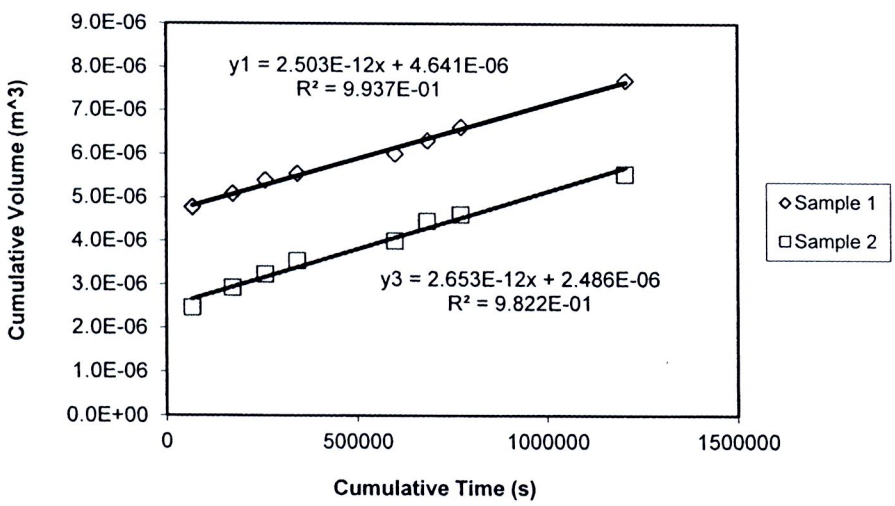

Figure D.22 Relationship between cumulative volume of passing water and cumulative time of 55RCF20 concrete at 90 days

Table D.23 Water permeability at 28 days of 55RCF35 concrete

Water permeability at 28 days of 55RCF35 concrete				
L_1 = 4.30 cm			L_2 = 4.32 cm	
d_1 = 10.09 cm			d_2 = 10.09 cm	
A_1 = 0.00800 m^2			A_2 = 0.00800 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
61,508	0.60	9.236E-07	0.50	7.697E-07
80,493	0.70	1.078E-06	0.60	9.236E-07
91,518	0.70	1.078E-06	0.70	1.078E-06
150,408	0.90	1.385E-06	0.80	1.232E-06
238,189	0.90	1.385E-06	0.80	1.232E-06
349,025	1.10	1.693E-06	0.95	1.462E-06
419,170	1.20	1.847E-06	1.10	1.693E-06
521,751	1.50	2.309E-06	1.30	2.001E-06
594,248	1.55	2.386E-06	1.40	2.155E-06
671,518	1.55	2.386E-06	1.40	2.155E-06
685,228	1.70	2.617E-06	1.60	2.463E-06
773,612	1.80	2.771E-06	1.70	2.617E-06
847,383	1.70	2.617E-06	1.50	2.309E-06
952,863	1.90	2.925E-06	1.70	2.617E-06
1,040,219	2.10	3.233E-06	1.90	2.925E-06

Q_1 = 2.239×10^{-12} m^3/s K_1 = 2.362E-13 m/s

Q_2 = 2.053×10^{-12} m^3/s K_2 = 2.176E-13 m/s

K_{av} = 2.269E-13 m/s

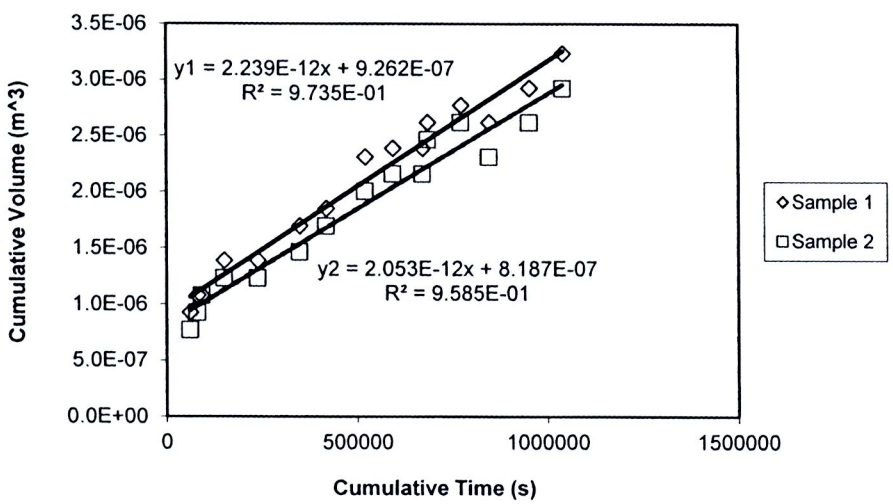

Figure D.23 Relationship between cumulative volume of passing water and cumulative time of 55RCF35 concrete at 28 days

Table D.24 Water permeability at 90 days of 55RCF35 concrete

Water permeability at 90 days of 55RCF35 concrete				
L_1 = 4.01 cm		L_2 = 4.00 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
68,516	1.00	1.539E-06	1.80	2.771E-06
173,135	1.20	1.847E-06	1.90	2.925E-06
258,300	1.30	2.001E-06	2.00	3.079E-06
342,300	1.40	2.155E-06	2.10	3.233E-06
601,193	1.80	2.771E-06	2.50	3.848E-06
685,090	1.90	2.925E-06	2.60	4.002E-06
773,079	2.00	3.079E-06	2.80	4.310E-06
1,205,976	2.60	4.002E-06	3.30	5.080E-06

Q_1 =	2.140×10^{-12}	m^3/s	K_1 =	2.174E-13	m/s
Q_2 =	2.111×10^{-12}	m^3/s	K_2 =	2.093E-13	m/s
			K_{av} =	**2.134E-13**	**m/s**

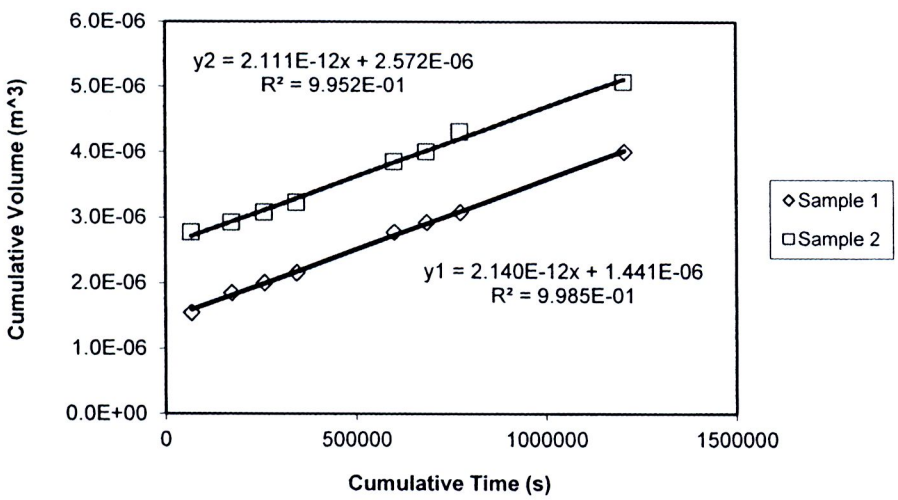

Figure D.24 Relationship between cumulative volume of passing water and cumulative time of 55RCF35 concrete at 90 days

Table D.25 Water permeability at 28 days of 55RCF50 concrete

Water permeability at 28 days of 55RCF50 concrete				
L_1 = 4.40 cm		L_2 = 4.20 cm		
d_1 = 9.99 cm		d_2 = 9.99 cm		
A_1 = 0.00784 m^2		A_2 = 0.00784 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (sec)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
58,890	1.20	2.202E-06	0.10	1.835E-07
146,671	1.30	2.385E-06	0.20	3.670E-07
257,507	1.40	2.569E-06	0.30	5.505E-07
327,652	1.45	2.661E-06	0.40	7.340E-07
430,233	1.60	2.936E-06	0.50	9.175E-07
502,730	1.70	3.119E-06	0.60	1.101E-06
580,000	1.80	3.303E-06	0.65	1.193E-06
593,710	1.80	3.303E-06	0.70	1.284E-06
682,094	1.90	3.486E-06	0.80	1.468E-06
755,865	2.00	3.670E-06	0.90	1.651E-06
861,345	2.10	3.853E-06	1.00	1.835E-06
948,701	2.10	3.853E-06	1.10	2.018E-06

Q_1 = 2.013×10^{-12} m^3/s K_1 = 2.217E-13 m/s

Q_2 = 2.079×10^{-12} m^3/s K_2 = 2.186E-13 m/s

K_{av} = 2.201E-13 m/s

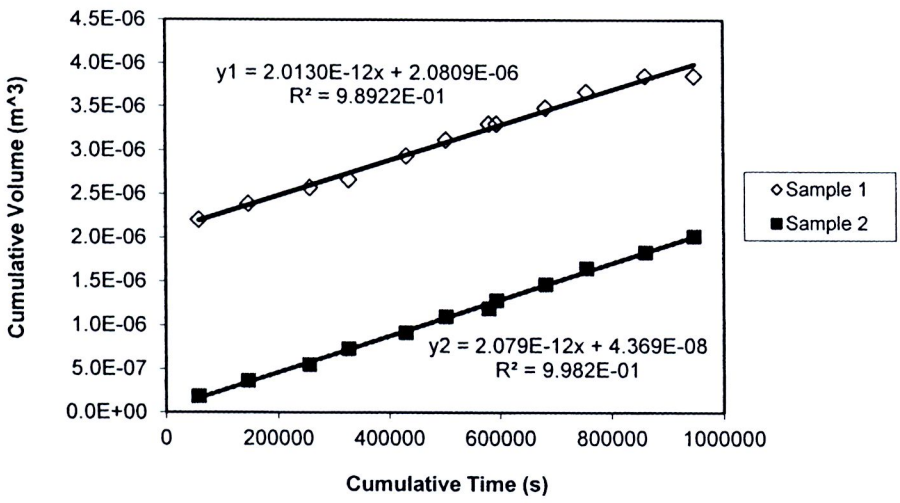

Figure D.25 Relationship between cumulative volume of passing water and cumulative time of 55RCF50 concrete at 28 days

Table D.26 Water permeability at 90 days of 55RCF50 concrete

Water permeability at 90 days of 55RCF50 concrete				
L_1 = 4.06 cm		L_2 = 4.05 cm		
d_1 = 10.03 cm		d_2 = 10.03 cm		
A_1 = 0.00790 m^2		A_2 = 0.00790 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
68,516	1.40	2.155E-06	2.10	3.233E-06
173,135	1.50	2.309E-06	2.30	3.541E-06
258,300	1.70	2.617E-06	2.40	3.695E-06
342,300	1.80	2.771E-06	2.60	4.002E-06
601,193	2.10	3.233E-06	2.90	4.464E-06
685,090	2.20	3.387E-06	3.00	4.618E-06
773,079	2.30	3.541E-06	3.20	4.926E-06
1,205,976	2.90	4.464E-06	3.70	5.696E-06

Q_1 = 2.004×10^{-12} m^3/s K_1 = 2.020E-13 m/s

Q_2 = 2.153×10^{-12} m^3/s K_2 = 2.165E-13 m/s

K_{av} = 2.020E-13 m/s

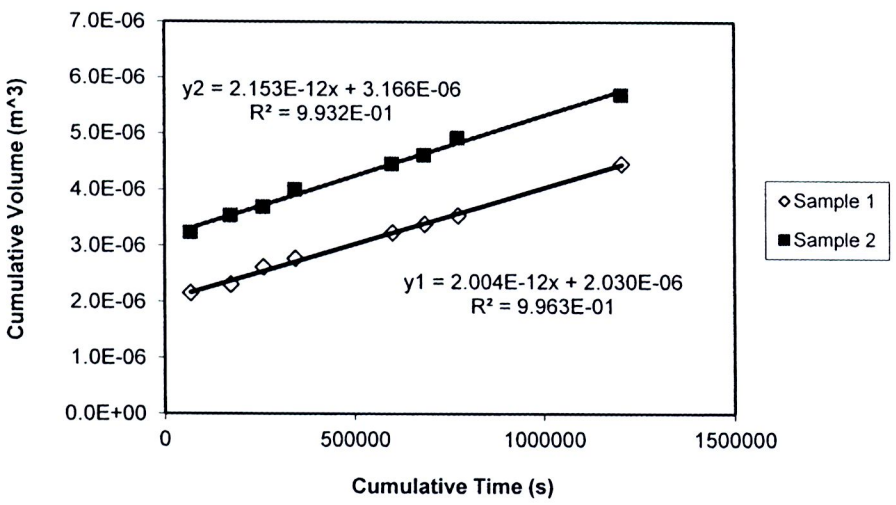

Figure D.26 Relationship between cumulative volume of passing water and cumulative time of 55RCF50 concrete at 90 days

Table D.27 Water permeability at 28 days of 55RCB20 concrete

Water permeability at 28 days of 55RCB20 concrete				
L_1 = 4.10 cm		L_2 = 4.20 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
62,044	0.80	1.468E-06	0.30	5.505E-07
81,124	0.85	1.560E-06	0.35	6.422E-07
92,036	0.85	1.560E-06	0.40	7.340E-07
152,109	0.90	1.651E-06	0.50	9.175E-07
238,785	1.10	2.018E-06	0.70	1.284E-06
349,561	1.30	2.385E-06	0.90	1.651E-06
419,406	1.40	2.569E-06	1.00	1.835E-06
521,987	1.70	3.119E-06	1.20	2.202E-06
594,484	1.90	3.486E-06	1.40	2.569E-06
671,754	2.00	3.670E-06	1.45	2.661E-06
685,464	2.00	3.670E-06	1.50	2.752E-06
773,848	2.20	4.037E-06	1.70	3.119E-06
847,619	2.30	4.220E-06	1.90	3.486E-06
953,099	2.60	4.771E-06	2.10	3.853E-06
1,040,455	2.80	5.138E-06	2.30	4.220E-06

Q_1 =	3.733×10^{-12}	m^3/s	K_1 =	3.811E-13	m/s
Q_2 =	3.639×10^{-12}	m^3/s	K_2 =	3.806E-13	m/s
			K_{av} =	**3.809E-13**	**m/s**

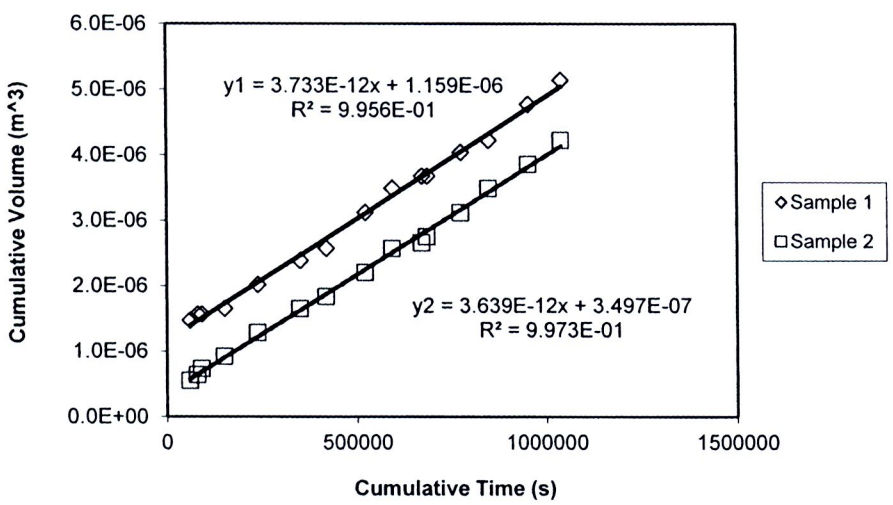

Figure D.27 Relationship between cumulative volume of passing water and cumulative time of 55RCB20 concrete at 28 days

Table D.28 Water permeability at 90 days of 55RCB20 concrete

Water permeability at 90 days of 55RCB20 concrete				
L_1 = 4.04 cm		L_2 = 4.03 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
68,516	2.70	4.156E-06	1.80	2.771E-06
173,135	2.90	4.464E-06	2.00	3.079E-06
258,300	3.00	4.618E-06	2.20	3.387E-06
342,300	3.10	4.772E-06	2.30	3.541E-06
601,193	3.60	5.542E-06	2.70	4.156E-06
685,090	3.70	5.696E-06	2.80	4.310E-06
773,079	3.90	6.004E-06	3.00	4.618E-06
1,205,976	4.70	7.235E-06	3.80	5.850E-06

Q_1 = 2.690×10^{-12} m^3/s K_1 = 2.693E-13 m/s

Q_2 = 2.624×10^{-12} m^3/s K_2 = 2.621E-13 m/s

K_{av} = 2.657E-13 m/s

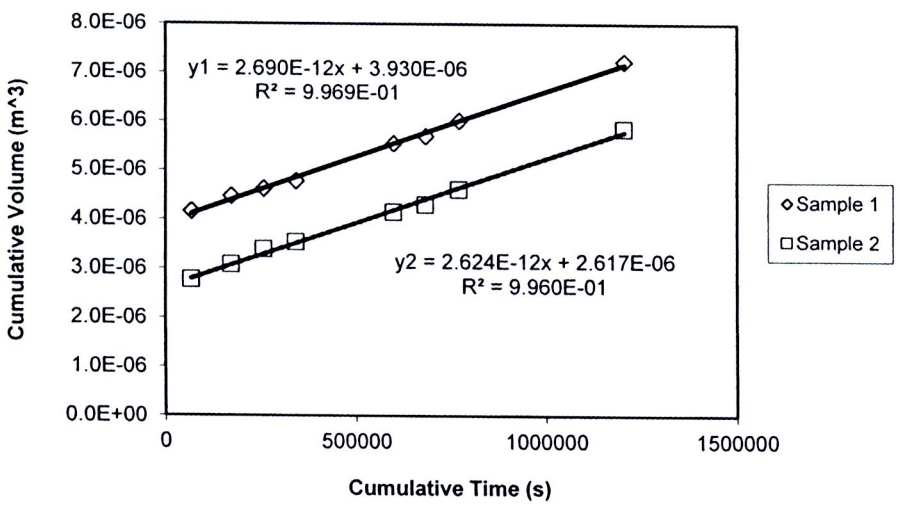

Figure D.28 Relationship between cumulative volume of passing water and cumulative time of 55RCB20 concrete at 90 days

Table D.29 Water permeability at 28 days of 55RCB35 concrete

Water permeability at 28 days of 55RCB35 concrete			
L_1 = 4.30 cm		L_2 = 4.30 cm	
d_1 = 9.95 cm		d_2 = 9.95 cm	
A_1 = 0.00778 m^2		A_2 = 0.00778 m^2	
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
62,044	0.60	9.236E-07	0.70	1.078E-06
81,124	0.70	1.078E-06	0.80	1.232E-06
92,036	0.70	1.078E-06	0.80	1.232E-06
152,109	0.80	1.232E-06	0.90	1.385E-06
238,785	0.90	1.385E-06	1.00	1.539E-06
349,561	1.05	1.616E-06	1.10	1.693E-06
419,406	1.20	1.847E-06	1.30	2.001E-06
521,987	1.30	2.001E-06	1.50	2.309E-06
594,484	1.40	2.155E-06	1.60	2.463E-06
671,754	1.50	2.309E-06	1.70	2.617E-06
685,464	1.60	2.463E-06	1.80	2.771E-06
773,848	1.70	2.617E-06	1.90	2.925E-06
847,619	1.85	2.848E-06	2.10	3.233E-06
953,099	2.05	3.156E-06	2.20	3.387E-06
1,040,455	2.20	3.387E-06	2.30	3.541E-06

Q_1 =	2.385×10^{-12}	m^3/s	K_1 =	2.588E-13	m/s
Q_2 =	2.545×10^{-12}	m^3/s	K_2 =	2.761E-13	m/s
			K_{av} =	**2.675E-13**	**m/s**

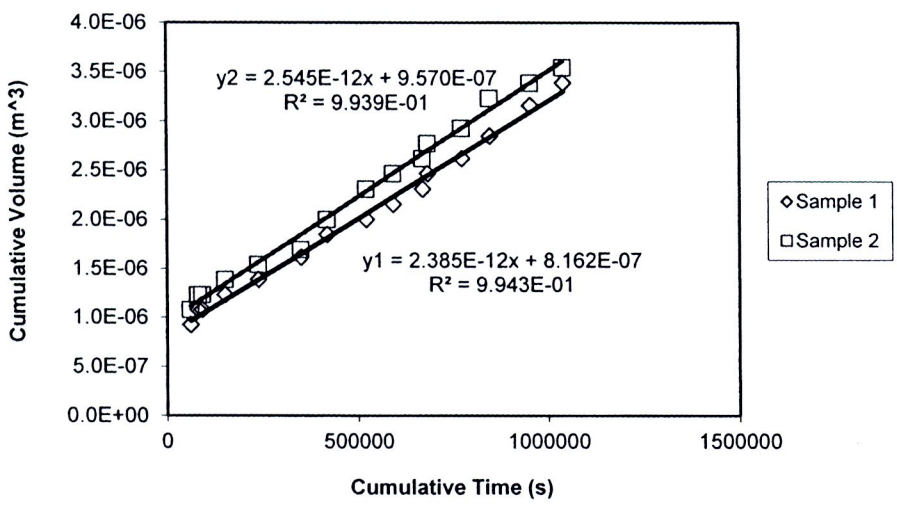

Figure D.29 Relationship between cumulative volume of passing water and cumulative time of 55RCB35 concrete at 28 days

Table D.30 Water permeability at 90 days of 55RCB35 concrete

Water permeability at 90 days of 55RCB35 concrete				
L_1 = 4.10 cm		L_2 = 4.03 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
253,697	2.25	4.129E-06	0.20	3.670E-07
340,186	2.35	4.312E-06	0.30	5.505E-07
601,183	2.75	5.046E-06	0.60	1.101E-06
864,007	3.00	5.505E-06	0.90	1.651E-06
932,523	3.05	5.597E-06	1.00	1.835E-06
1,037,142	3.25	5.964E-06	1.10	2.018E-06
1,122,307	3.35	6.147E-06	1.30	2.385E-06
1,206,307	3.55	6.514E-06	1.40	2.569E-06
1,465,200	3.75	6.881E-06	1.70	3.119E-06
1,549,097	3.95	7.248E-06	1.90	3.486E-06
1,637,086	4.05	7.431E-06	1.90	3.486E-06
2,069,983	4.55	8.349E-06	2.50	4.587E-06

Q_1 = 2.349×10^{-12} m^3/s K_1 = 2.401E-13 m/s

Q_2 = 2.348×10^{-12} m^3/s K_2 = 2.359E-13 m/s

K_{av} = 2.380E-13 m/s

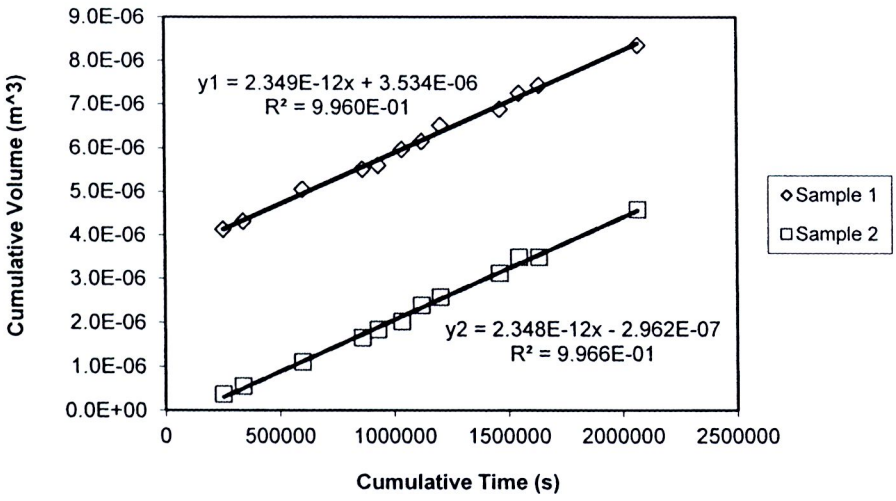

Figure D.30 Relationship between cumulative volume of passing water and cumulative time of 55RCB35 concrete at 90 days

Table D.31 Water permeability at 28 days of 55RCB50 concrete

Water permeability at 28 days of 55RCB50 concrete			
L_1 = 4.40 cm		L_2 = 4.20 cm	
d_1 = 10.02 cm		d_2 = 10.02 cm	
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2	
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
81,222	1.20	1.847E-06	0.80	1.232E-06
91,864	1.30	2.001E-06	0.90	1.385E-06
152,109	1.40	2.155E-06	1.00	1.539E-06
238,785	1.50	2.309E-06	1.10	1.693E-06
349,561	1.70	2.617E-06	1.30	2.001E-06
419,406	1.80	2.771E-06	1.40	2.155E-06
521,987	2.00	3.079E-06	1.50	2.309E-06
594,484	2.10	3.233E-06	1.60	2.463E-06
671,754	2.20	3.387E-06	1.70	2.617E-06
685,464	2.30	3.541E-06	1.80	2.771E-06
773,848	2.40	3.695E-06	1.90	2.925E-06
847,619	2.50	3.848E-06	2.10	3.233E-06
953,099	2.70	4.156E-06	2.30	3.541E-06
1,040,455	2.90	4.464E-06	2.40	3.695E-06

Q_1 = 2.586×10^{-12} m^3/s K_1 = 2.831E-13 m/s

Q_2 = 2.456×10^{-12} m^3/s K_2 = 2.567E-13 m/s

K_{av} = 2.699E-13 m/s

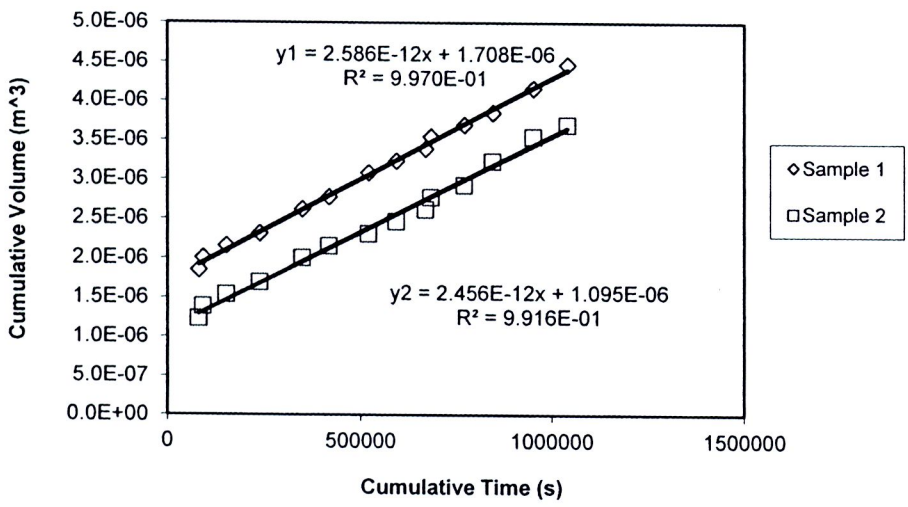

Figure D.31 Relationship between cumulative volume of passing water and cumulative time of 55RCB50 concrete at 28 days

Table D.32 Water permeability at 90 days of 55RCB50 concrete

Water permeability at 90 days of 55RCB50 concrete				
L_1 = 4.16 cm		L_2 = 4.20 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00788 m^2		A_2 = 0.00788 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
253,697	1.15	1.770E-06	1.60	2.463E-06
340,186	1.15	1.770E-06	1.80	2.771E-06
601,183	1.65	2.540E-06	2.30	3.541E-06
864,007	2.05	3.156E-06	2.80	4.310E-06
932,523	2.25	3.464E-06	2.90	4.464E-06
1,037,142	2.35	3.618E-06	3.00	4.618E-06
1,122,307	2.55	3.925E-06	3.10	4.772E-06
1,206,307	2.65	4.079E-06	3.40	5.234E-06
1,465,200	3.05	4.695E-06	3.60	5.542E-06
1,549,097	3.15	4.849E-06	3.80	5.850E-06
1,637,086	3.35	5.157E-06	4.00	6.158E-06
2,069,983	3.95	6.081E-06	4.80	7.389E-06

Q_1 = 2.457×10^{-12} m^3/s K_1 = 2.543E-13 m/s

Q_2 = 2.607×10^{-12} m^3/s K_2 = 2.724E-13 m/s

K_{av} = 2.634E-13 m/s

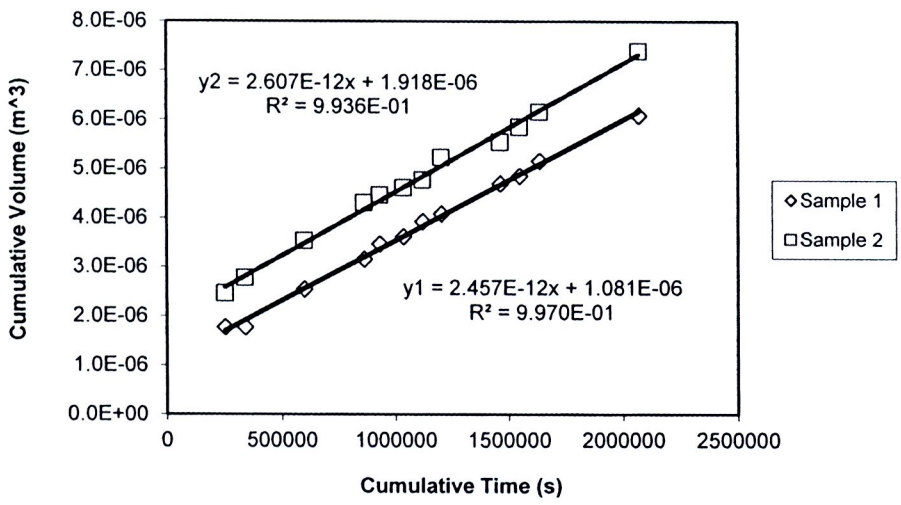

Figure D.32 Relationship between cumulative volume of passing water and cumulative time of 55RCB50 concrete at 90 days

Table D.33 Water permeability at 28 days of 65CON concrete

Water permeability at 28 days of 65CON concrete				
L_1 = 4.06 cm		L_2 = 4.03 cm		
d_1 = 9.99 cm		d_2 = 9.99 cm		
A_1 = 0.00784 m^2		A_2 = 0.00784 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	0.10	1.835E-07	0.70	1.284E-06
5,400	0.10	1.835E-07	0.80	1.468E-06
10,800	0.20	3.670E-07	0.90	1.651E-06
17,100	0.20	3.670E-07	1.00	1.835E-06
19,800	0.40	7.340E-07	1.10	2.018E-06
25,200	0.50	9.175E-07	1.20	2.202E-06
35,100	0.60	1.101E-06	1.30	2.385E-06
88,200	1.10	2.018E-06	1.70	3.119E-06
93,300	1.10	2.018E-06	1.75	3.211E-06
100,500	1.20	2.202E-06	1.90	3.486E-06
112,500	1.30	2.385E-06	1.90	3.486E-06
175,200	1.80	3.303E-06	2.30	4.220E-06
181,200	1.80	3.303E-06	2.40	4.404E-06
193,200	1.80	3.303E-06	2.55	4.679E-06
260,400	2.30	4.220E-06	3.00	5.505E-06
280,800	2.40	4.404E-06	3.20	5.872E-06

Q_1 = 1.261×10^{-11} m^3/s K_1 = 1.283E-12 m/s

Q_2 = 1.375×10^{-11} m^3/s K_2 = 1.388E-12 m/s

K_{av} = 1.335E-12 m/s

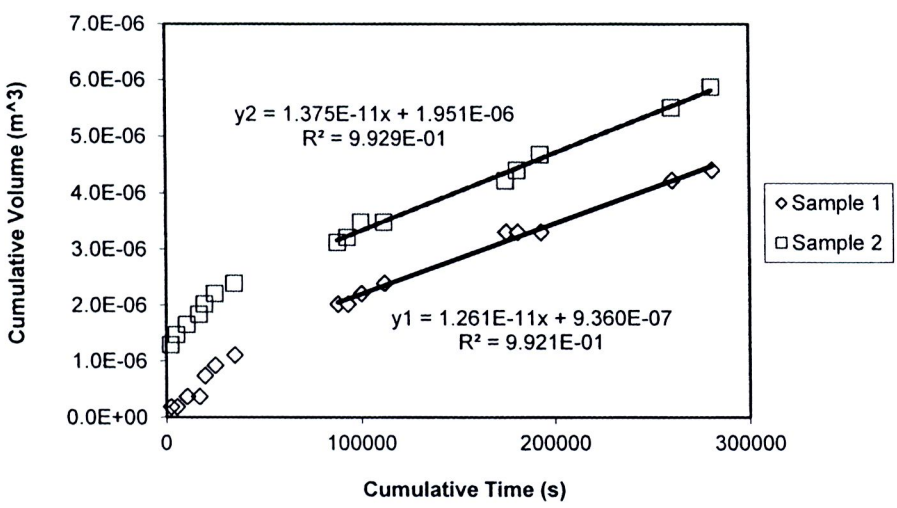

Figure D.33 Relationship between cumulative volume of passing water and cumulative time of 65CON concrete at 28 days

Table D.34 Water permeability at 90 days of 65CON concrete

Water permeability at 90 days of 65CON concrete				
L_1 = 4.05 cm		L_2 = 4.05 cm		
d_1 = 10.00 cm		d_2 = 10.00 cm		
A_1 = 0.00785 m^2		A_2 = 0.00785 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
25,235	0.55	8.467E-07	0.60	9.236E-07
169,051	1.60	2.463E-06	1.60	2.463E-06
196,870	2.00	3.079E-06	2.10	3.233E-06
261,635	2.30	3.541E-06	2.35	3.618E-06
287,754	2.60	4.002E-06	2.70	4.156E-06
344,728	2.85	4.387E-06	2.85	4.387E-06
371,925	3.20	4.926E-06	3.20	4.926E-06
431,114	3.30	5.080E-06	3.30	5.080E-06
452,711	3.60	5.542E-06	3.60	5.542E-06
519,920	3.80	5.850E-06	3.80	5.850E-06
606,341	4.29	6.604E-06	4.19	6.450E-06
621,000	4.35	6.696E-06	4.25	6.542E-06
774,330	4.90	7.543E-06	4.75	7.312E-06
792,950	5.25	8.082E-06	5.15	7.928E-06

Q_1	=	8.015×10^{-12}	m^3/s	K_1 =	8.109E-13	m/s
Q_2	=	7.419×10^{-12}	m^3/s	K_2 =	7.506E-13	m/s
				K_{av} =	**7.808E-13**	**m/s**

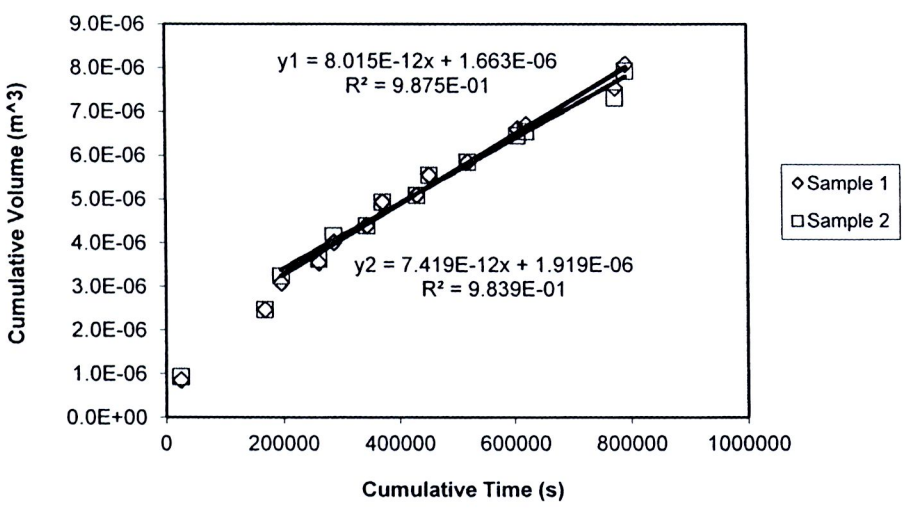

Figure D.34 Relationship between cumulative volume of passing water and cumulative time of 65CON concrete at 90 days

Table D.35 Water permeability at 28 days of 65RC concrete

Water permeability at 28 days of 65RC concrete				
L_1 = 4.01 cm			L_2 = 4.00 cm	
d_1 = 10.01 cm			d_2 = 10.01 cm	
A_1 = 0.00787 m^2			A_2 = 0.00787 m^2	
Vol. of tube = 1.8349 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	2.90	5.321E-06	0.60	1.101E-06
5,400	3.10	5.688E-06	0.80	1.468E-06
10,800	3.30	6.055E-06	1.10	2.018E-06
17,100	3.80	6.973E-06	1.60	2.936E-06
19,800	4.10	7.523E-06	2.00	3.670E-06
25,200	4.20	7.707E-06	2.30	4.220E-06
35,100	4.50	8.257E-06	2.50	4.587E-06
88,200	5.70	1.046E-05	4.50	8.257E-06
93,300	6.00	1.101E-05	5.50	1.009E-05
100,500	6.70	1.229E-05	5.80	1.064E-05
112,500	7.20	1.321E-05	6.00	1.101E-05
175,200	9.10	1.670E-05	9.50	1.743E-05
181,200	9.70	1.780E-05	10.50	1.927E-05
193,200	10.20	1.872E-05	10.80	1.982E-05
260,400	12.30	2.257E-05	13.50	2.477E-05
280,800	12.70	2.330E-05	15.50	2.844E-05

Q_1 = 6.616×10^{-11} m^3/s K_1 = 6.763E-12 m/s

Q_2 = 9.797×10^{-11} m^3/s K_2 = 9.770E-12 m/s

K_{av} = 8.266E-12 m/s

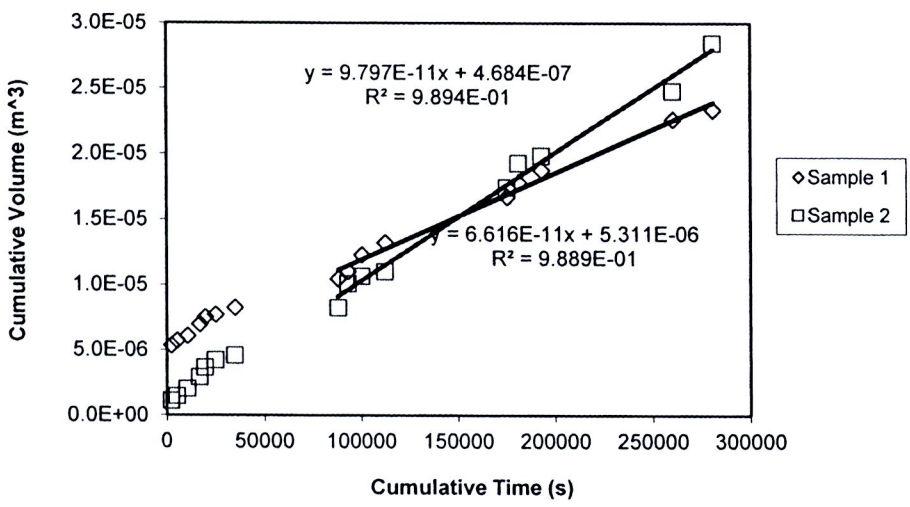

Figure D.35 Relationship between cumulative volume of passing water and cumulative time of 65RC concrete at 28 days

Table D.36 Water permeability at 90 days of 65RC concrete

Water permeability at 90 days of 65RC concrete				
L_1 = 4.01 cm		L_2 = 4.01 cm		
d_1 = 10.03 cm		d_2 = 10.03 cm		
A_1 = 0.00790 m^2		A_2 = 0.00790 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
143,816	2.65	4.863E-06	2.25	4.129E-06
171,635	3.30	6.055E-06	2.85	5.230E-06
236,400	4.20	7.707E-06	3.55	6.514E-06
262,519	4.70	8.624E-06	4.05	7.431E-06
319,493	5.35	9.817E-06	4.60	8.441E-06
346,690	5.95	1.092E-05	5.10	9.358E-06
405,879	6.45	1.184E-05	5.50	1.009E-05
427,476	6.90	1.266E-05	5.85	1.073E-05
494,685	7.55	1.385E-05	6.35	1.165E-05
581,106	8.50	1.560E-05	7.15	1.312E-05
595,765	8.70	1.596E-05	7.35	1.349E-05
749,095	10.20	1.872E-05	8.45	1.551E-05
767,715	10.65	1.954E-05	8.90	1.633E-05

Q_1 = 2.247×10^{-11} m^3/s K_1 = 2.288E-12 m/s

Q_2 = 1.847×10^{-11} m^3/s K_2 = 1.880E-12 m/s

K_{av} = 2.084E-12 m/s

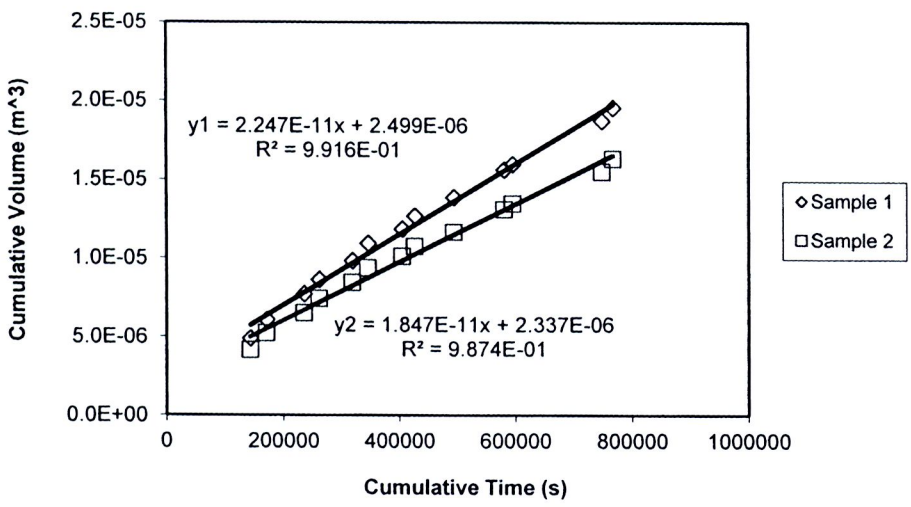

Figure D.36 Relationship between cumulative volume of passing water and cumulative time of 65RC concrete at 90 days

Table D.37 Water permeability at 28 days of 65RCF20 concrete

Water permeability at 28 days of 65RCF20 concrete				
L_1 = 4.01 cm		L_2 = 4.01 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	0.20	3.670E-07	1.10	2.018E-06
5,400	0.20	3.670E-07	1.00	1.835E-06
10,800	0.30	5.505E-07	1.10	2.018E-06
17,100	0.40	7.340E-07	1.20	2.202E-06
19,800	0.40	7.340E-07	1.20	2.202E-06
25,200	0.50	9.175E-07	1.20	2.202E-06
35,100	0.50	9.175E-07	1.30	2.385E-06
88,200	1.10	1.101E-06	1.40	2.569E-06
93,300	1.20	1.284E-06	1.40	2.569E-06
100,500	1.25	1.376E-06	1.50	2.752E-06
112,500	1.30	1.468E-06	1.60	2.936E-06
175,200	1.50	1.835E-06	1.70	3.119E-06
181,200	1.60	2.018E-06	1.80	3.303E-06
193,200	1.60	2.018E-06	1.90	3.486E-06
260,400	1.80	2.385E-06	2.00	3.670E-06
280,800	1.90	2.569E-06	2.10	3.853E-06

Q_1 = 6.975×10^{-12} m^3/s K_1 = 7.090E-13 m/s

Q_2 = 6.387×10^{-12} m^3/s K_2 = 6.490E-13 m/s

K_{av} = 6.790E-13 m/s

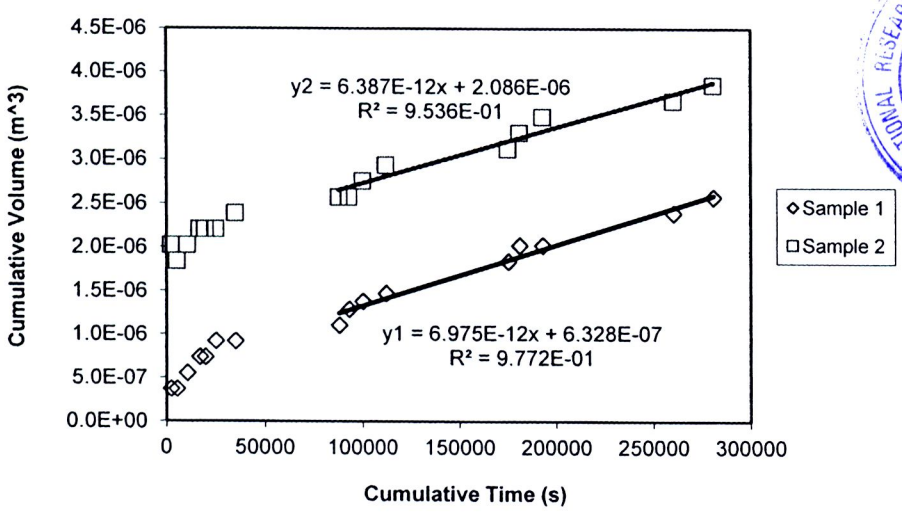

Figure D.37 Relationship between cumulative volume of passing water and cumulative time of 65RCF20 concrete at 28 days

Table D.38 Water permeability at 90 days of 65RCF20 concrete

Water permeability at 90 days of 65RCF20 concrete				
L_1 = 4.11 cm			L_2 = 4.00 cm	
d_1 = 10.04 cm			d_2 = 10.04 cm	
A_1 = 0.00792 m^2			A_2 = 0.00792 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
85,440	2.70	4.156E-06	0.55	8.467E-07
172,560	2.90	4.464E-06	0.95	1.462E-06
261,395	3.30	5.080E-06	1.25	1.924E-06
348,811	3.70	5.696E-06	1.60	2.463E-06
694,630	5.10	7.851E-06	2.75	4.233E-06
778,895	5.40	8.313E-06	2.95	4.541E-06
867,395	5.80	8.928E-06	3.20	4.926E-06
957,088	6.40	9.852E-06	3.40	5.234E-06
1,210,785	7.50	1.155E-05	4.30	6.619E-06
1,297,274	8.00	1.232E-05	4.50	6.927E-06

Q_1 =	6.732×10^{-12}	m^3/s	K_1 =	6.860E-13	m/s
Q_2 =	4.934×10^{-12}	m^3/s	K_2 =	4.891E-13	m/s
			K_{av} =	**5.875E-13**	**m/s**

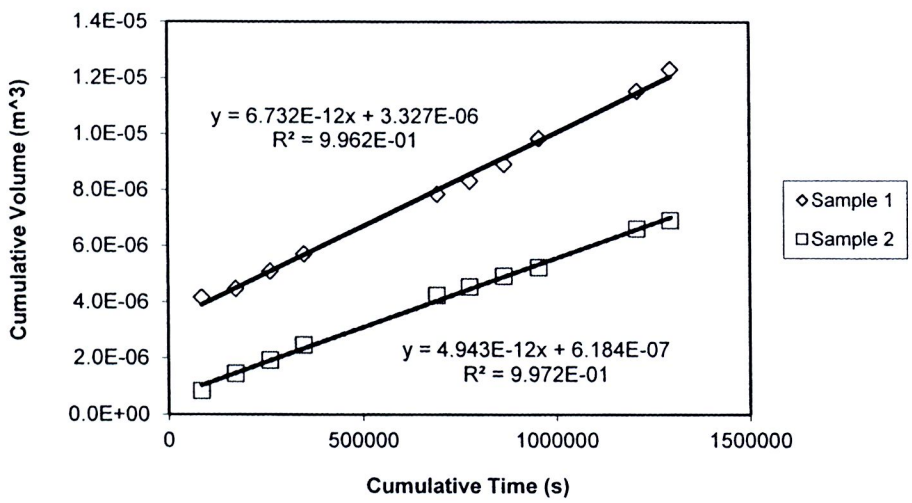

Figure D.38 Relationship between cumulative volume of passing water and cumulative time of 65RCF20 concrete at 90 days

Table D.39 Water permeability at 28 days of 65RCF35 concrete

Water permeability at 28 days of 65RCF35 concrete			
L_1 = 4.02 cm		L_2 = 4.01 cm	
d_1 = 10.01 cm		d_2 = 10.01 cm	
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2	
Vol. of tube = 1.8349 cc./cm		P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
7,200	0.20	3.670E-07	0.20	3.670E-07
14,400	0.30	5.505E-07	0.20	3.670E-07
79,200	0.50	9.175E-07	0.40	7.340E-07
86,400	0.50	9.175E-07	0.40	7.340E-07
94,200	0.55	1.009E-06	0.50	9.175E-07
246,600	0.90	1.651E-06	0.90	1.651E-06
255,600	0.90	1.651E-06	0.90	1.651E-06
266,400	0.90	1.651E-06	0.90	1.651E-06
331,200	1.00	1.835E-06	1.00	1.835E-06
337,800	1.00	1.835E-06	1.00	1.835E-06
345,600	1.00	1.835E-06	1.00	1.835E-06
364,200	1.10	2.018E-06	1.00	1.835E-06
412,200	1.20	2.202E-06	1.10	2.018E-06
439,200	1.40	2.569E-06	1.30	2.385E-06

Q_1 =	4.264×10^{-12}	m^3/s	K_1 =	4.465E-13	m/s
Q_2 =	4.314×10^{-12}	m^3/s	K_2 =	4.410E-13	m/s
			K_{av} =	**4.437E-13**	**m/s**

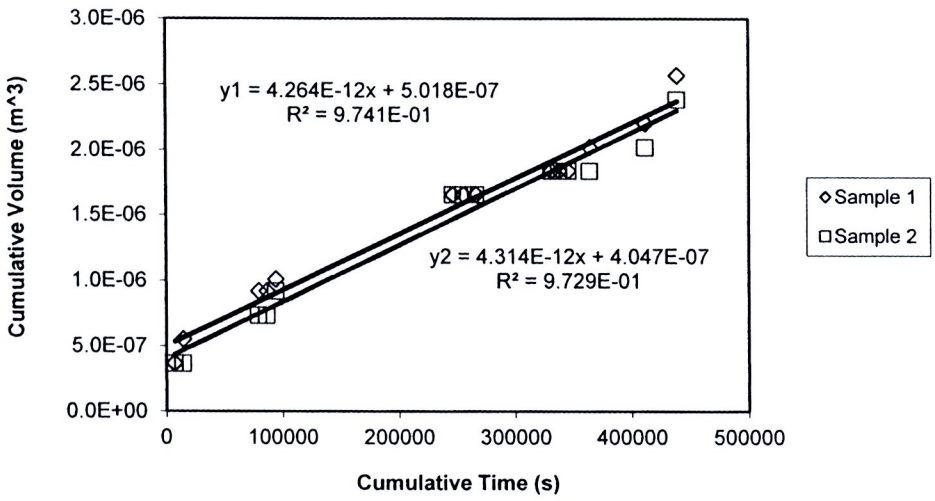

Figure D.39 Relationship between cumulative volume of passing water and cumulative time of 65RCF35 concrete at 28 days

Table D.40 Water permeability at 90 days of 65RCF35 concrete

Water permeability at 90 days of 65RCF35 concrete				
L_1 = 4.13 cm		L_2 = 4.07 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
87,416	7.15	1.101E-05	9.70	1.493E-05
433,235	7.95	1.224E-05	10.60	1.632E-05
517,500	8.35	1.285E-05	10.70	1.647E-05
606,000	8.35	1.285E-05	11.10	1.709E-05
695,693	8.90	1.370E-05	11.60	1.786E-05
949,390	9.65	1.486E-05	12.10	1.863E-05
1,035,879	10.05	1.547E-05	12.60	1.940E-05
1,296,876	10.65	1.639E-05	13.30	2.047E-05
1,559,700	11.45	1.763E-05	13.80	2.124E-05
1,628,216	11.55	1.778E-05	14.10	2.171E-05
1,732,835	11.75	1.809E-05	14.20	2.186E-05
1,818,000	11.95	1.840E-05	14.40	2.217E-05
1,902,000	12.15	1.870E-05	14.60	2.247E-05
2,160,893	12.55	1.932E-05	15.10	2.324E-05
2,244,790	12.95	1.993E-05	15.30	2.355E-05
2,332,779	12.95	1.993E-05	15.60	2.401E-05
2,765,676	13.95	2.147E-05	16.60	2.555E-05

Q_1 = 4.029×10^{-12} m^3/s K_1 = 4.148E-13 m/s

Q_2 = 3.989×10^{-12} m^3/s K_2 = 4.048E-13 m/s

K_{av} = 4.098E-13 m/s

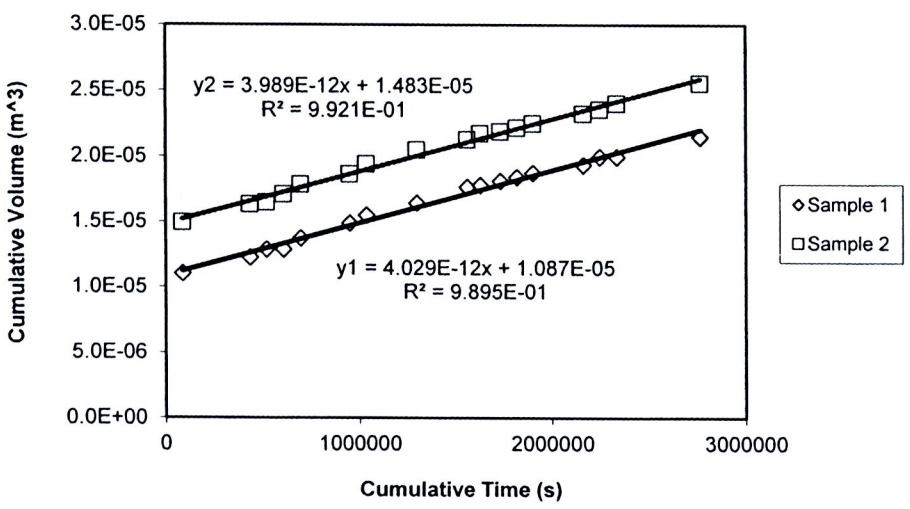

Figure D.40 Relationship between cumulative volume of passing water and cumulative time of 65RCF35 concrete at 90 days

Table D.41 Water permeability at 28 days of 65RCF50 concrete

Water permeability at 28 days of 65RCF50 concrete				
L_1 = 4.01 cm		L_2 = 4.01 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	0.60	9.236E-07	0.20	3.079E-07
5,400	0.60	9.236E-07	0.20	3.079E-07
10,800	0.65	1.001E-06	0.25	3.848E-07
17,100	0.70	1.078E-06	0.30	4.618E-07
19,800	0.70	1.078E-06	0.30	4.618E-07
25,200	0.80	1.232E-06	0.35	5.388E-07
35,100	0.80	1.232E-06	0.40	6.158E-07
88,200	0.95	1.462E-06	0.50	7.697E-07
93,300	0.95	1.462E-06	0.50	7.697E-07
100,500	1.00	1.539E-06	0.55	8.467E-07
112,500	1.05	1.616E-06	0.55	8.467E-07
175,200	1.20	1.847E-06	0.70	1.078E-06
181,200	1.20	1.847E-06	0.70	1.078E-06
193,200	1.25	1.924E-06	0.70	1.078E-06
260,400	1.45	2.232E-06	0.85	1.308E-06
280,800	1.50	2.309E-06	0.90	1.385E-06

Q_1 = 4.360×10^{-12} m^3/s K_1 = 4.432E-13 m/s

Q_2 = 3.133×10^{-12} m^3/s K_2 = 3.185E-13 m/s

K_{av} = 3.808E-13 m/s

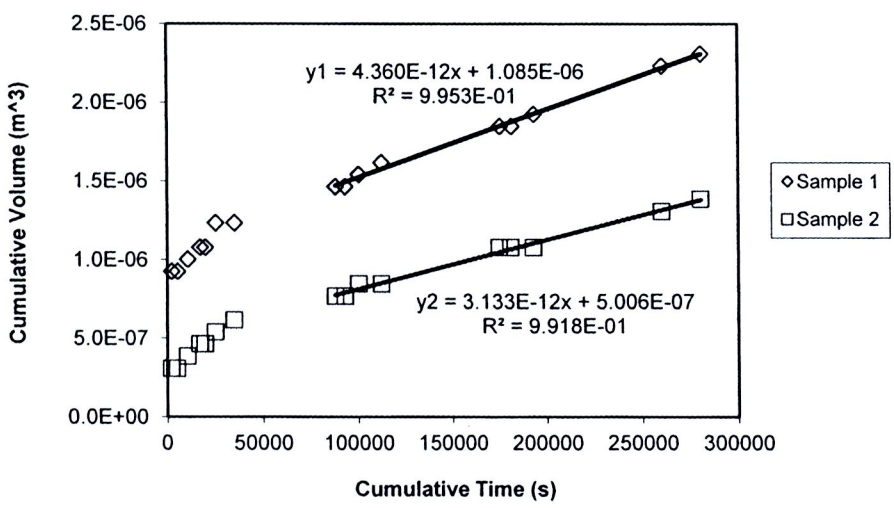

Figure D.41 Relationship between cumulative volume of passing water and cumulative time of 65RCF50 concrete at 28 days

Table D.42 Water permeability at 90 days of 65RCF50 concrete

Water permeability at 90 days of 65RCF50 concrete				
L_1 = 4.10 cm		L_2 = 4.12 cm		
d_1 = 10.02 cm		d_2 = 10.02 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
345,819	3.70	5.696E-06	1.65	2.540E-06
430,084	4.00	6.158E-06	1.90	2.925E-06
518,584	4.20	6.465E-06	2.15	3.310E-06
608,277	4.50	6.927E-06	2.35	3.618E-06
861,974	5.20	8.005E-06	2.85	4.387E-06
948,463	5.50	8.467E-06	3.05	4.695E-06
1,209,460	6.00	9.236E-06	3.75	5.773E-06
1,472,284	6.60	1.016E-05	4.15	6.388E-06
1,540,800	6.85	1.054E-05	4.35	6.696E-06
1,645,419	7.10	1.093E-05	4.75	7.312E-06
1,730,584	7.40	1.139E-05	4.95	7.620E-06
1,814,584	7.60	1.170E-05	5.05	7.774E-06
2,073,477	8.20	1.262E-05	5.35	8.236E-06
2,157,374	8.25	1.270E-05	5.55	8.544E-06
2,245,363	8.40	1.293E-05	5.75	8.851E-06
2,678,260	9.70	1.493E-05	6.65	1.024E-05

Q_1 = 3.855×10^{-12} m^3/s K_1 = 3.933E-13 m/s

Q_2 = 3.286×10^{-12} m^3/s K_2 = 3.367E-13 m/s

K_{av} = 3.650E-13 m/s

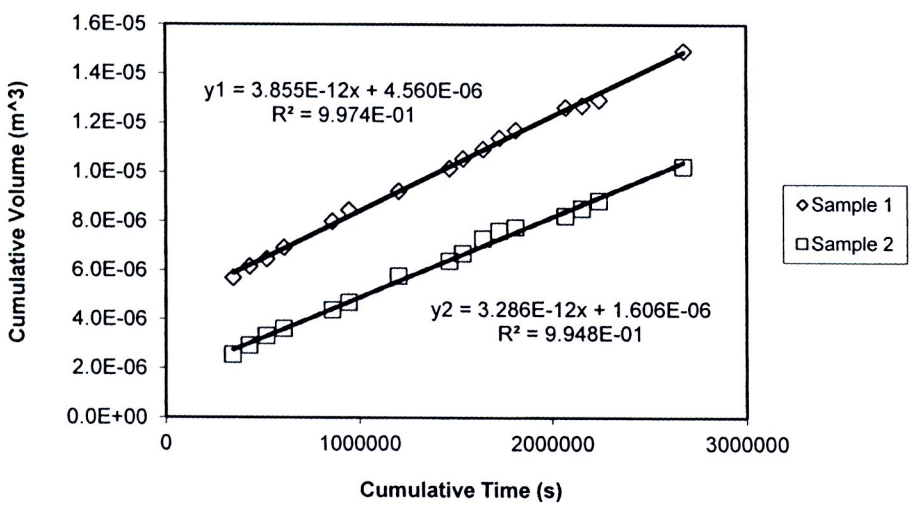

Figure D.42 Relationship between cumulative volume of passing water and cumulative time of 65RCF50 concrete at 90 days

Table D.43 Water permeability at 28 days of 65RCB20 concrete

Water permeability at 28 days of 65RCB20 concrete				
L_1 = 4.20 cm		L_2 = 4.10 cm		
d_1 = 10.01 cm		d_2 = 10.01 cm		
A_1 = 0.00787 m^2		A_2 = 0.00787 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	0.90	1.385E-06	1.40	2.155E-06
5,400	1.00	1.539E-06	1.40	2.155E-06
10,800	1.10	1.693E-06	1.45	2.232E-06
17,100	1.10	1.693E-06	1.45	2.232E-06
19,800	1.10	1.693E-06	1.50	2.309E-06
25,200	1.20	1.847E-06	1.50	2.309E-06
35,100	1.20	1.847E-06	1.60	2.463E-06
88,200	1.40	2.155E-06	1.80	2.771E-06
93,300	1.45	2.232E-06	1.80	2.771E-06
100,500	1.45	2.232E-06	1.90	2.925E-06
112,500	1.60	2.463E-06	1.95	3.002E-06
175,200	1.85	2.848E-06	2.30	3.541E-06
181,200	1.90	2.925E-06	2.30	3.541E-06
193,200	1.90	2.925E-06	2.30	3.541E-06
260,400	2.20	3.387E-06	2.70	4.156E-06
280,800	2.30	3.541E-06	2.80	4.310E-06

Q_1 = 7.023×10^{-12} m^3/s K_1 = 7.354E-13 m/s

Q_2 = 7.933×10^{-12} m^3/s K_2 = 8.109E-13 m/s

K_{av} = 7.731E-13 m/s

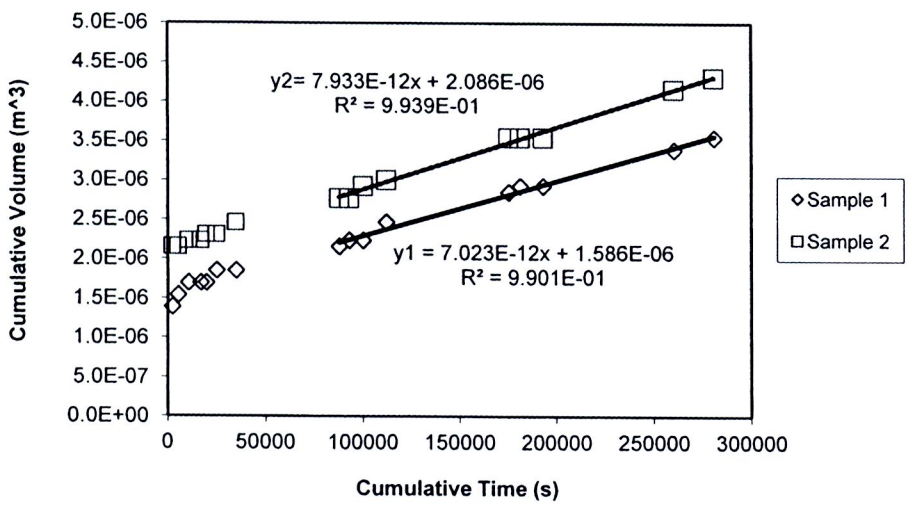

Figure D.43 Relationship between cumulative volume of passing water and cumulative time of 65RCB20 concrete at 28 days

Table D.44 Water permeability at 90 days of 65RCB20 concrete

Water permeability at 90 days of 65RCB20 concrete				
L_1 = 4.01 cm		L_2 = 4.10 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
85,440	2.70	4.156E-06	1.00	1.539E-06
172,560	3.00	4.618E-06	1.25	1.924E-06
261,395	3.50	5.388E-06	1.70	2.617E-06
348,811	4.00	6.158E-06	1.95	3.002E-06
694,630	5.60	8.621E-06	2.85	4.387E-06
778,895	5.90	9.082E-06	3.10	4.772E-06
867,395	6.30	9.698E-06	3.50	5.388E-06
957,088	6.70	1.031E-05	3.80	5.850E-06
1,210,785	7.50	1.155E-05	4.45	6.850E-06
1,297,274	8.00	1.232E-05	4.65	7.158E-06
1,558,271	9.00	1.385E-05	5.45	8.390E-06
1,809,380	10.00	1.539E-05	6.25	9.621E-06

Q_1 = 6.539×10^{-12} m^3/s K_1 = 6.647E-13 m/s

Q_2 = 4.612×10^{-12} m^3/s K_2 = 4.688E-13 m/s

K_{av} = 5.667E-13 m/s

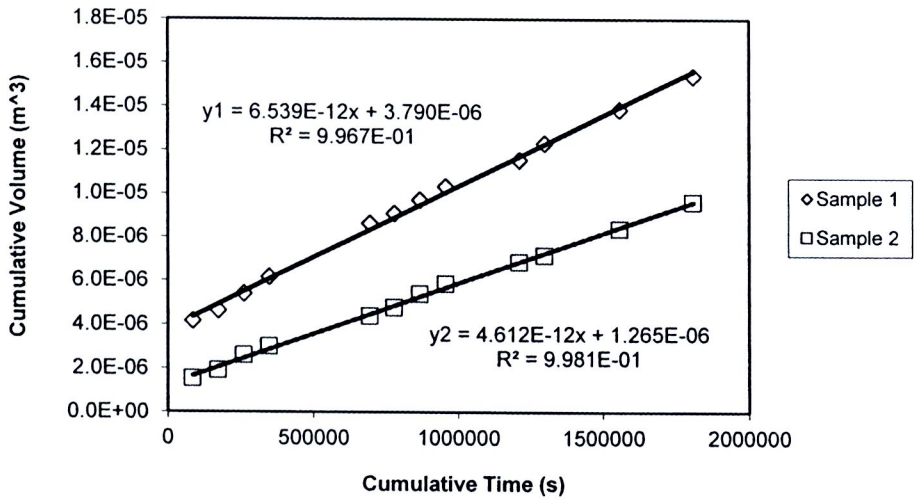

Figure D.44 Relationship between cumulative volume of passing water and cumulative time of 65RCB20 concrete at 90 days

Table D.45 Water permeability at 28 days of 65RCB35 concrete

Water permeability at 28 days of 65RCB35 concrete				
L_1 = 4.15 cm		L_2 = 4.10 cm		
d_1 = 10.03 cm		d_2 = 10.03 cm		
A_1 = 0.00790 m^2		A_2 = 0.00790 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,700	0.20	3.079E-07	0.20	3.079E-07
8,100	0.30	4.618E-07	0.30	4.618E-07
18,000	0.30	4.618E-07	0.30	4.618E-07
71,100	0.50	7.697E-07	0.50	7.697E-07
76,200	0.50	7.697E-07	0.50	7.697E-07
83,400	0.50	7.697E-07	0.60	9.236E-07
95,400	0.50	7.697E-07	0.60	9.236E-07
158,100	0.70	1.078E-06	0.80	1.232E-06
164,100	0.70	1.078E-06	0.80	1.232E-06
176,100	0.70	1.078E-06	0.80	1.232E-06
243,300	0.90	1.385E-06	1.00	1.539E-06
263,700	1.00	1.539E-06	1.10	1.693E-06

Q_1 = 3.954×10^{-12} m^3/s K_1 = 4.075E-13 m/s

Q_2 = 4.504×10^{-12} m^3/s K_2 = 4.586E-13 m/s

K_{av} = 4.330E-13 m/s

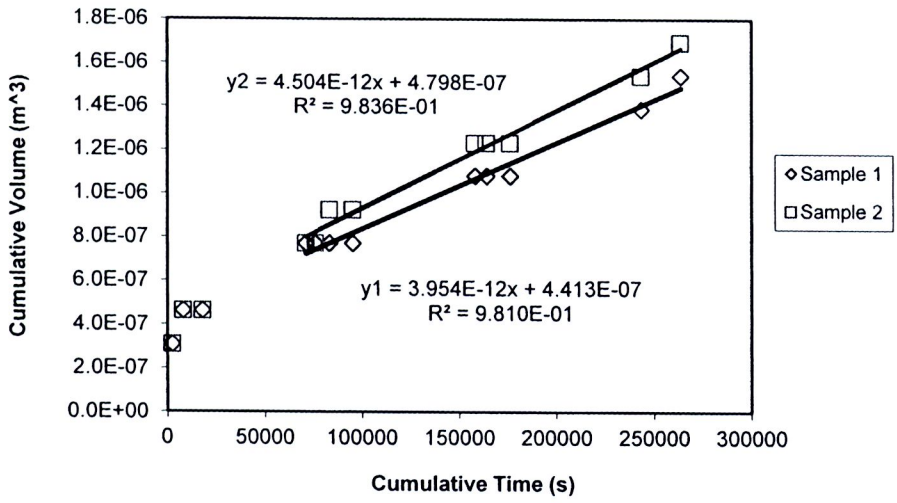

Figure D.45 Relationship between cumulative volume of passing water and cumulative time of 65RCB35 concrete at 28 days

Table D.46 Water permeability at 90 days of 65RCB35 concrete

Water permeability at 90 days of 65RCB35 concrete				
L_1 = 4.10 cm		L_2 = 4.05 cm		
d_1 = 10.04 cm		d_2 = 10.04 cm		
A_1 = 0.00792 m^2		A_2 = 0.00792 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
85,440	2.60	4.002E-06	1.20	1.847E-06
172,560	3.05	4.695E-06	1.60	2.463E-06
261,395	3.25	5.003E-06	2.00	3.079E-06
348,811	3.50	5.388E-06	2.20	3.387E-06
694,630	4.35	6.696E-06	2.90	4.464E-06
778,895	4.70	7.235E-06	3.10	4.772E-06
867,395	5.05	7.774E-06	3.50	5.388E-06
957,088	5.20	8.005E-06	3.85	5.927E-06
1,210,785	5.80	8.928E-06	4.50	6.927E-06
1,558,271	6.90	1.062E-05	5.25	8.082E-06

Q_1 = 4.345×10^{-12} m^3/s K_1 = 4.415E-13 m/s

Q_2 = 4.146×10^{-12} m^3/s K_2 = 4.161E-13 m/s

K_{av} = 4.288E-13 m/s

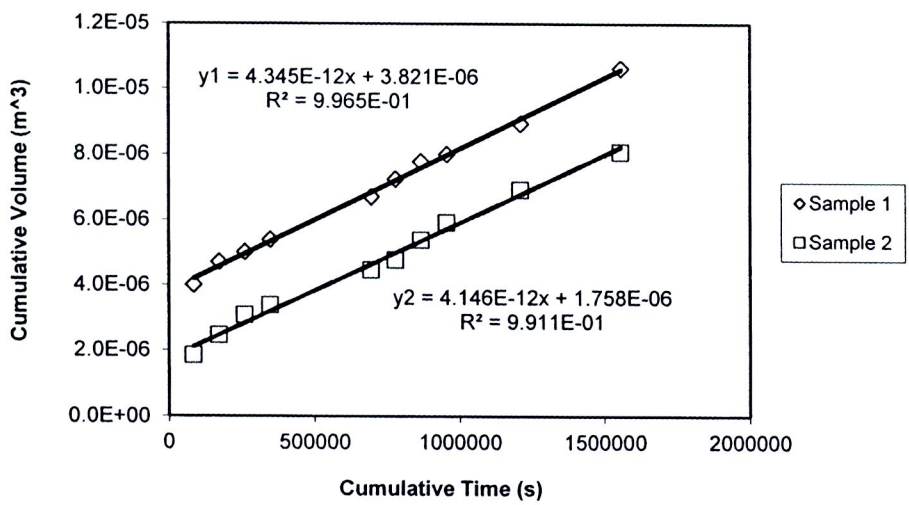

Figure D.46 Relationship between cumulative volume of passing water and cumulative time of 65RCB35 concrete at 90 days

Table D.47 Water permeability at 28 days of 65RCB50 concrete

Water permeability at 28 days of 65RCB50 concrete				
L_1 = 4.15 cm			L_2 = 4.10 cm	
d_1 = 10.01 cm			d_2 = 10.01cm	
A_1 = 0.00787 m^2			A_2 = 0.00787 m^2	
Vol. of tube = 1.5394 cc./cm			P = 500,000 N/m^2	
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
2,400	0.25	3.848E-07	0.30	4.618E-07
5,400	0.25	3.848E-07	0.30	4.618E-07
10,800	0.25	3.848E-07	0.35	5.388E-07
17,100	0.30	4.618E-07	0.40	6.158E-07
19,800	0.30	4.618E-07	0.40	6.158E-07
25,200	0.30	4.618E-07	0.40	6.158E-07
35,100	0.35	5.388E-07	0.45	6.927E-07
88,200	0.50	7.697E-07	0.60	9.236E-07
93,300	0.50	7.697E-07	0.65	1.001E-06
100,500	0.55	8.467E-07	0.65	1.001E-06
112,500	0.55	8.467E-07	0.70	1.078E-06
175,200	0.80	1.232E-06	0.90	1.385E-06
181,200	0.80	1.232E-06	0.90	1.385E-06
193,200	0.80	1.232E-06	0.95	1.462E-06
280,800	1.20	1.847E-06	1.20	1.847E-06

Q_1	=	5.018×10^{-12} m^3/s	K_1	=	5.129E-13	m/s
Q_2	=	4.957×10^{-12} m^3/s	K_2	=	5.141E-13	m/s
			K_{av}	**=**	**5.135E-13**	**m/s**

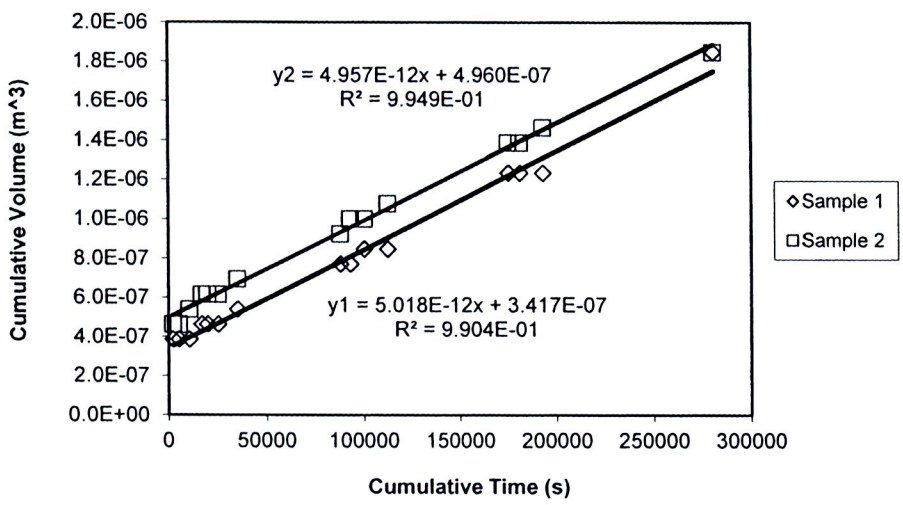

Figure D.47 Relationship between cumulative volume of passing water and cumulative time of 65RCB50 concrete at 28 days

Table D.48 Water permeability at 90 days of 65RCB50 concrete

Water permeability at 90 days of 65RCB50 concrete				
L_1 = 4.11 cm		L_2 = 4.13 cm		
d_1 = 10.03 cm		d_2 = 10.03 cm		
A_1 = 0.00790 m^2		A_2 = 0.00790 m^2		
Vol. of tube = 1.5394 cc./cm		P = 500,000 N/m^2		
Cum. Time (s)	Sample 1		Sample 2	
	Cum. H (cm)	Cum. Vol. (m^3)	Cum. H (cm)	Cum. Vol. (m^3)
85,440	2.50	3.848E-06	1.40	2.155E-06
172,560	2.80	4.310E-06	1.50	2.309E-06
261,395	3.00	4.618E-06	2.00	3.079E-06
348,811	3.50	5.388E-06	2.20	3.387E-06
694,630	4.20	6.465E-06	3.00	4.618E-06
778,895	4.50	6.927E-06	3.50	5.388E-06
865,295	5.00	7.697E-06	3.70	5.696E-06
957,088	5.20	8.005E-06	4.00	6.158E-06
1,210,785	6.00	9.236E-06	5.00	7.697E-06
1,297,274	6.30	9.698E-06	5.20	8.005E-06
1,558,271	7.00	1.078E-05	6.00	9.236E-06
1,809,380	7.50	1.155E-05	6.50	1.001E-05

Q_1 = 4.591×10^{-12} m^3/s K_1 = 4.686E-13 m/s

Q_2 = 4.757×10^{-12} m^3/s K_2 = 4.879E-13 m/s

K_{av} = 4.782E-13 m/s

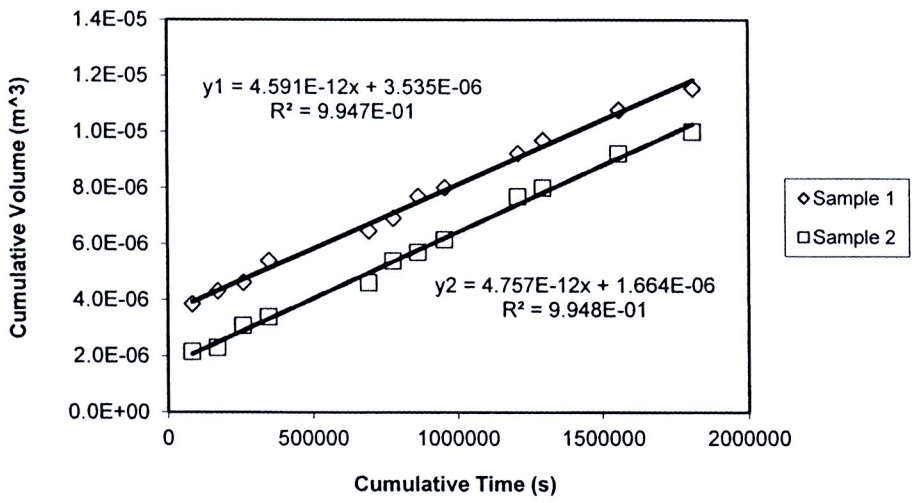

Figure D.48 Relationship between cumulative volume of passing water and cumulative time of 65RCB50 concrete at 90 days

APPENDIX E

Chloride Penetration Depth

Table E.1 Chloride penetration depths of concretes with W/B ratio of 0.45

Immersed Time (months)	Chloride Penetration Depth (mm)															
	45CON		45RC		45RCF20		45RCF35		45RCF50		45RCB20		45RCB35		45RCB50	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
3	15	14	20	19	10	9	6	8	8	7	7	7	6	6	7	5
	15	15	20	19	9	10	8	9	8	9	7	7	6	7	6	6
	14	14	19	18	10	11	9	12	8	7	5	7	7	6	5	6
	16	14	17	18	11	10	9	10	8	8	6	5	6	5	6	6
	14	14	18	17	10	10	8	9	9	8	7	6	6	6	6	7
	14.5		**18.5**		**10.0**		**8.8**		**8.0**		**6.4**		**6.1**		**6.0**	
6	28	25	30	30	15	15	10	13	10	10	14	13	14	11	7	8
	23	22	30	27	17	17	11	11	7	9	11	10	14	11	7	7
	25	25	32	30	15	18	14	11	10	7	9	10	16	12	6	6
	23	20	30	29	17	17	8	11	7	9	11	12	14	14	9	7
	22	20	30	27	18	14	7	11	9	8	12	13	13	12	7	6
	23.3		**29.5**		**16.3**		**10.7**		**8.6**		**11.5**		**10.0**		**7.0**	
9	30	31	40	42	21	22	14	15	10	11	13	12	10	11	7	7
	30	30	38	41	22	21	14	15	10	11	14	13	10	10	8	7
	32	30	39	39	20	23	13	14	11	9	13	13	9	12	9	6
	31	29	39	42	19	22	13	15	10	10	13	11	9	10	8	6
	32	30	38	42	19	21	13	14	9	9	14	12	9	10	8	6
	30.5		**40.0**		**21.0**		**14.0**		**10.0**		**12.8**		**10.0**		**7.2**	
12	30	35	41	43	23	25	15	16	12	10	14	12	12	11	8	7
	31	33	43	45	24	26	16	16	12	12	12	12	11	11	8	8
	31	34	44	45	25	25	17	16	10	11	15	13	11	11	7	9
	30	34	42	43	23	25	18	15	11	11	13	15	10	10	9	8
	32	35	43	44	23	24	16	15	10	11	12	14	10	11	8	8
	32.5		**43.3**		**24.3**		**16.0**		**11.0**		**13.2**		**10.8**		**8.0**	
18	33	35	41	45	25	27	19	17	12	14	16	18	15	14	12	11
	37	35	45	45	27	26	19	18	12	13	17	19	14	13	10	11
	35	36	48	46	26	25	18	19	13	13	18	20	14	13	10	11
	35	34	48	47	25	26	16	16	12	13	19	19	14	15	11	10
	35	35	46	45	25	24	17	19	13	14	16	18	14	16	11	11
	35.0		**45.6**		**25.6**		**17.8**		**12.9**		**18.0**		**14.2**		**10.8**	

Note: The bold characters are average values.

Table E.2 Chloride penetration depths of concretes with W/B ratio of 0.55

Immersed Time (months)	Chloride Penetration Depth (mm)															
	55CON		55RC		55RCF20		55RCF35		55RCF50		55RCB20		55RCB35		55RCB50	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
3	18	20	27	20	10	10	10	10	12	10	12	7	6	7	8	8
	18	20	25	20	13	13	11	9	10	9	11	7	6	7	8	7
	22	15	23	16	13	11	12	10	12	9	13	9	8	7	7	6
	20	18	19	18	14	12	10	9	10	8	10	8	6	7	5	6
	20	20	18	17	11	13	9	11	9	8	10	10	10	8	6	6
	18.6		**20.3**		**12.0**		**10.1**		**9.7**		**9.7**		**7.2**		**6.6**	
6	32	30	43	46	20	17	12	12	11	10	13	14	10	12	7	6
	28	32	44	47	20	16	10	11	10	10	13	12	12	11	7	7
	29	31	43	45	21	14	9	11	9	9	14	13	13	11	8	6
	30	28	42	41	20	15	15	14	12	9	11	13	13	12	9	8
	30	30	40	39	18	13	14	11	11	9	14	13	10	12	10	8
	30.0		**43.0**		**17.4**		**11.9**		**10.0**		**13.0**		**11.6**		**7.6**	
9	44	45	51	52	27	25	17	17	13	11	15	16	15	11	10	8
	44	46	50	53	25	25	17	16	11	12	13	16	15	12	11	6
	43	46	49	52	26	24	18	16	12	11	15	15	15	12	10	6
	43	45	50	54	25	23	17	17	11	10	13	16	14	10	8	7
	43	46	50	54	26	24	18	17	12	11	14	17	13	11	9	7
	44.5		**51.5**		**25.0**		**17.0**		**11.4**		**15.0**		**12.8**		**8.2**	
12	49	48	55	56	26	28	15	18	11	15	14	19	14	14	9	13
	49	49	54	57	27	27	18	18	11	14	15	18	15	15	8	12
	47	47	59	56	27	27	16	19	11	14	14	17	14	15	10	12
	46	47	55	56	27	26	16	19	12	15	17	19	14	16	9	12
	48	48	58	56	27	26	17	19	12	15	16	19	15	15	8	12
	47.8		**56.2**		**26.8**		**17.5**		**13.0**		**16.8**		**14.7**		**10.5**	
18	52	51	60	58	30	31	19	18	13	15	22	20	18	20	12	11
	53	52	60	60	30	29	19	19	14	14	21	22	18	18	11	10
	50	52	59	61	30	29	18	18	14	13	23	24	19	17	11	11
	51	50	60	61	29	28	16	17	13	14	23	22	18	17	11	12
	50	51	60	59	28	30	17	17	14	13	21	22	17	18	11	12
	51.2		**59.8**		**29.4**		**17.8**		**13.7**		**22.0**		**18.0**		**11.2**	

Note: The bold characters are average values.

Table E.3 Chloride penetration depths of concretes with W/B ratio of 0.65

Immersed Time (months)	Chloride Penetration Depth (mm)															
	65CON		65RC		65RCF20		65RCF35		65RCF50		65RCB20		65RCB35		65RCB50	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
3	22	23	35	30	20	17	12	12	12	13	17	15	11	14	8	8
	23	21	35	30	17	16	13	12	12	12	13	14	13	13	9	8
	23	23	35	30	20	17	13	10	13	14	14	15	11	15	7	7
	24	23	30	30	13	15	10	10	12	14	14	14	12	15	8	7
	22	21	30	32	14	15	12	11	13	15	15	14	12	15	9	9
	22.5		**31.7**		**16.4**		**11.5**		**13.0**		**14.5**		**13.1**		**8.0**	
6	35	30	43	43	16	18	18	13	25	16	18	17	18	17	11	12
	31	31	45	45	19	17	16	10	10	10	15	15	13	16	12	10
	32	32	48	44	20	18	20	12	12	13	18	15	11	17	10	10
	34	32	47	43	18	18	15	12	12	10	18	17	10	15	10	13
	33	30	45	45	17	19	18	16	20	13	15	17	10	14	12	10
	32.0		**44.8**		**18.0**		**15.0**		**14.1**		**16.5**		**14.1**		**11.0**	
9	49	50	64	67	25	26	18	18	14	16	18	19	12	15	11	12
	48	50	64	68	25	26	18	17	14	15	18	20	13	16	12	12
	47	51	65	68	26	25	18	19	16	15	19	18	14	17	10	11
	47	50	66	66	27	26	17	18	15	14	20	19	15	15	11	11
	48	50	65	67	26	26	17	18	15	14	19	18	14	14	11	12
	49.0		**66.0**		**25.8**		**17.8**		**14.8**		**18.8**		**14.5**		**11.3**	
12	51	52	70	72	30	28	17	19	15	15	20	21	16	16	12	12
	52	53	69	71	30	30	18	19	14	15	20	20	16	16	11	12
	51	53	68	70	30	31	16	18	14	16	20	21	15	16	11	13
	52	52	68	71	29	30	16	19	15	16	21	20	17	17	13	12
	52	52	70	71	29	29	18	20	15	15	20	20	18	17	13	11
	52.0		**70.0**		**29.6**		**18.0**		**15.0**		**20.3**		**16.4**		**12.0**	
18	60	59	76	74	34	33	18	20	17	16	26	27	20	21	12	15
	62	58	77	75	34	35	20	21	15	17	28	27	20	20	12	14
	62	59	75	73	32	34	18	19	14	17	29	28	20	20	14	13
	61	59	75	74	32	32	19	19	15	18	26	26	21	19	15	12
	61	59	76	75	32	30	20	21	15	20	25	26	22	22	15	13
	60.0		**75.0**		**32.8**		**19.5**		**16.4**		**26.8**		**20.5**		**14.0**	

Note: The bold characters are average values.

APPENDIX F

Total and Free Chloride Contents

Example for determination of total chloride content at 12 months of 45CON at layer 2 (15 mm from surface of sample)

Molarity of standard NaCl

The 0.0585 grams of NaCl was dissolved in 100 mL of deionize (DI) water.

Molecular mass of NaCl = 58.5 g/mol (Na = 23 g, Cl = 35.5 g)

Therefore,

$$[NaCl] = \frac{g}{M_w} \times \frac{1000\,g/L}{V\ of\ DI\ water}$$

$$= \frac{0.0583\,g}{58.5\,g/mole} \times \frac{1000\,g/L}{100\,g}$$

$$= 9.966\times10^{-3}\ or\ 0.009966\ mole/L$$

Standardization of $AgNO_3$

Average volume of $AgNO_3$ = 10.75 mL

Average volume of $AgNO_3$ for blank = 0.80 mL

From equation : $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

$$\therefore \frac{n\cdot NaCl}{n\cdot AgNO_3} = 1$$

$$n\cdot NaCl = n\cdot AgNO_3$$

thus,

$$M_1V_1 = M_2V_2$$

$$0.009966\ mole/L \times 10\ mL = M_2 \times (10.75\text{-}0.80)\ mL$$

$$M_2 = 0.0100161\ mole/L \text{ (Concentration of } AgNO_3\text{)}$$

Determination of total chloride in solution which was extracted from sample powder by nitric acid

Weight of sample powder = 10 g

Volume of solution was used for titration = 10 mL (after diluting to 10 times)

Average titration volume of $AgNO_3$ = 2.45 mL

From equation : $Cl^- + AgNO_3 \rightarrow AgCl + NO_3^-$

$$\therefore \frac{n\cdot Cl^-}{n\cdot AgCl} = 1$$

$$n\cdot Cl^- = n\cdot AgCl$$

thus,

$$M_1V_1 = M_2V_2$$

$$M_1(10\text{ mL}) = 0.0100161\times(2.45\text{-}0.80)$$

$$M_1 = 0.00165265\ mole/L$$

$$\therefore \text{Concentration of } Cl^- = (10\times0.00165265\ mole/L)\times35.5\ g/mole \times \frac{100\%}{1000\,g/L}$$

$$= 0.058669\%$$

P = Weight of binder / Total weight of mixture = 424/2361 = 17.958%

$$\therefore \text{Concentration of } Cl^- = 0.058669\% \times \frac{100\%}{P}$$

$$= 0.3267\% \text{ (by weight of binder)}$$

Note: Determination of the free chloride content is the same procedure except the solution used. It was obtained from extracting the same sample powder by distrilled water.

Table F.1 Total chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45CON	12	5	10	0.0583	10.75	0.80	2.75	0.0693	0.3861
		15	10	0.0583	10.75	0.80	2.45	0.0587	0.3267
		25	10	0.0583	10.75	0.80	1.85	0.0373	0.2079
		35	10	0.0583	10.75	0.80	1.65	0.0302	0.1683
	18	5	10	0.0586	10.95	0.75	2.95	0.0767	0.4271
		15	10	0.0586	10.95	0.75	2.70	0.0680	0.3786
		25	10	0.0586	10.95	0.75	2.30	0.0540	0.3009
		35	10	0.0586	10.95	0.75	2.15	0.0488	0.2718
		45	10	0.0586	10.95	0.75	1.90	0.0401	0.2232
45RC	12	5	10	0.0583	10.75	0.80	3.30	0.0889	0.4788
		15	10	0.0583	10.75	0.80	3.00	0.0782	0.4214
		25	10	0.0583	10.75	0.80	2.85	0.0729	0.3926
		35	10	0.0583	10.75	0.80	1.80	0.0356	0.1915
		45	10	0.0583	10.75	0.80	1.75	0.0338	0.1820
	18	5	10	0.0586	10.95	0.75	3.45	0.0941	0.5071
		15	10	0.0586	10.95	0.75	2.95	0.0767	0.4132
		25	10	0.0586	10.95	0.75	2.85	0.0732	0.3944
		35	10	0.0586	10.95	0.75	2.40	0.0575	0.3099
		45	10	0.0586	10.95	0.75	2.00	0.0436	0.2348
		55	10	0.0586	10.95	0.75	1.85	0.0383	0.2066

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.1 Total chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCF20	12	5	10	0.0583	10.75	0.80	3.75	0.1049	0.5591
		15	10	0.0583	10.75	0.80	2.35	0.0551	0.2938
		25	10	0.0583	10.75	0.80	1.90	0.0391	0.2085
		35	10	0.0583	10.75	0.80	1.55	0.0267	0.1421
	18	5	10	0.0586	10.95	0.75	3.15	0.0837	0.4460
		15	10	0.0586	10.95	0.75	2.35	0.0558	0.2973
		25	10	0.0586	10.95	0.75	2.10	0.0471	0.2509
		35	10	0.0586	10.95	0.75	2.00	0.0436	0.2323
45RCF35	12	5	10	0.0583	10.75	0.8	3.40	0.0924	0.4893
		15	10	0.0583	10.75	0.8	2.45	0.0587	0.3105
		25	10	0.0583	10.75	0.8	1.85	0.0373	0.1976
		35	10	0.0583	10.75	0.8	1.45	0.0231	0.1223
	18	5	10	0.0586	10.95	0.75	2.80	0.0715	0.3782
		15	10	0.0586	10.95	0.75	2.25	0.0523	0.2768
		25	10	0.0586	10.95	0.75	2.10	0.0471	0.2491
		35	10	0.0586	10.95	0.75	1.75	0.0349	0.1845
45RCF50	12	5	10	0.0583	10.75	0.80	3.15	0.0836	0.4393
		15	10	0.0583	10.75	0.80	2.30	0.0533	0.2804
		25	10	0.0583	10.75	0.80	1.65	0.0302	0.1589
		35	10	0.0583	10.75	0.80	1.35	0.0196	0.1028

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.1 Total chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCF50	18	5	10	0.0586	10.95	0.75	2.35	0.0558	0.2932
		15	10	0.0586	10.95	0.75	2.00	0.0436	0.2291
		25	10	0.0586	10.95	0.75	1.75	0.0349	0.1833
		35	10	0.0586	10.95	0.75	1.60	0.0296	0.1558
45RCB20	12	5	10	0.0583	10.75	0.80	3.15	0.0836	0.4446
		15	10	0.0583	10.75	0.80	2.15	0.0480	0.2554
		25	10	0.0583	10.75	0.80	1.75	0.0338	0.1797
		35	10	0.0583	10.75	0.80	1.55	0.0267	0.1419
	18	5	10	0.0583	10.80	0.85	3.40	0.0907	0.4824
		15	10	0.0583	10.80	0.85	2.35	0.0533	0.2838
		25	10	0.0583	10.80	0.85	2.10	0.0444	0.2365
		35	10	0.0583	10.80	0.85	1.95	0.0391	0.2081
45RCB35	12	5	10	0.0583	10.75	0.80	3.00	0.0782	0.4116
		15	10	0.0583	10.75	0.80	1.95	0.0409	0.2152
		25	10	0.0583	10.75	0.80	1.8	0.0356	0.1871
		35	10	0.0583	10.75	0.80	1.5	0.0249	0.1310
	18	5	10	0.0588	10.80	0.85	3.55	0.0968	0.5095
		15	10	0.0588	10.80	0.85	2.30	0.0520	0.2736
		25	10	0.0588	10.80	0.85	1.95	0.0394	0.2076
		35	10	0.0588	10.80	0.85	1.80	0.0341	0.1793

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.1 Total chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCB50	12	5	10	0.0583	10.75	0.80	2.90	0.0747	0.3883
		15	10	0.0583	10.75	0.80	1.90	0.0391	0.2034
		25	10	0.0583	10.75	0.80	1.70	0.0320	0.1664
		35	10	0.0583	10.75	0.80	1.35	0.0196	0.1017
	18	5	10	0.0588	10.80	0.85	3.05	0.0789	0.4103
		15	10	0.0588	10.80	0.85	2.05	0.0430	0.2238
		25	10	0.0588	10.80	0.85	1.90	0.0376	0.1958
		35	10	0.0588	10.80	0.85	1.65	0.0287	0.1492

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.2 Total chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55CON	12	5	10	0.0586	10.75	0.80	3.00	0.0786	0.5295
		15	10	0.0586	10.75	0.80	2.7	0.0679	0.4573
		25	10	0.0586	10.75	0.80	2.35	0.0554	0.3730
		35	10	0.0586	10.75	0.80	2.05	0.0447	0.3008
		45	10	0.0586	10.75	0.80	2.00	0.0429	0.2888
		55	10	0.0586	10.75	0.80	1.80	0.0357	0.2407
	18	5	10	0.0588	10.80	0.85	3.15	0.0825	0.5554
		15	10	0.0588	10.80	0.85	2.85	0.0717	0.4830
		25	10	0.0588	10.80	0.85	2.30	0.0520	0.3502
		35	10	0.0588	10.80	0.85	2.15	0.0466	0.3140
		45	10	0.0588	10.80	0.85	2.10	0.0448	0.3019
		55	10	0.0588	10.80	0.85	2.00	0.0412	0.2777
55RC	12	5	10	0.0586	10.75	0.80	3.30	0.0893	0.5777
		15	10	0.0586	10.75	0.80	2.95	0.0768	0.4968
		25	10	0.0586	10.75	0.80	2.50	0.0608	0.3928
		35	10	0.0586	10.75	0.80	2.40	0.0572	0.3697
		45	10	0.0586	10.75	0.80	2.05	0.0447	0.2888
		55	10	0.0586	10.75	0.80	1.90	0.0393	0.2542

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.2 Total chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RC	18	5	10	0.0588	10.80	0.85	3.50	0.0950	0.6144
		15	10	0.0588	10.80	0.85	3.05	0.0789	0.5101
		25	10	0.0588	10.80	0.85	2.80	0.0699	0.4521
		35	10	0.0588	10.80	0.85	2.35	0.0538	0.3478
		45	10	0.0588	10.80	0.85	2.30	0.0520	0.3362
		55	10	0.0588	10.80	0.85	2.20	0.0484	0.3130
55RCF20	12	5	10	0.0586	10.75	0.80	3.10	0.0822	0.5277
		15	10	0.0586	10.75	0.80	2.45	0.0590	0.3786
		25	10	0.0586	10.75	0.80	2.20	0.0500	0.3212
		35	10	0.0586	10.75	0.80	1.80	0.0357	0.2294
	18	5	10	0.0588	10.80	0.85	3.60	0.0986	0.6331
		15	10	0.0588	10.80	0.85	2.55	0.0610	0.3914
		25	10	0.0588	10.75	0.85	2.25	0.0504	0.3239
		35	10	0.0588	10.80	0.85	2.10	0.0448	0.2878
		45	10	0.0588	10.80	0.85	1.90	0.0376	0.2417
55RCF35	12	5	10	0.0586	10.75	0.80	3.4	0.0929	0.5931
		15	10	0.0586	10.75	0.80	2.3	0.0536	0.3422
		25	10	0.0586	10.75	0.80	1.95	0.0411	0.2623
		35	10	0.0586	10.75	0.80	1.7	0.0322	0.2053

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.2 Total chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCF35	18	5	10	0.0588	10.8	0.85	3.35	0.0896	0.5722
		15	10	0.0588	10.8	0.85	2.45	0.0574	0.3662
		25	10	0.0588	10.8	0.85	2.10	0.0448	0.2861
		35	10	0.0588	10.8	0.85	1.95	0.0394	0.2518
		45	10	0.0588	10.8	0.85	1.80	0.0341	0.2174
55RCF50	12	5	10	0.0586	10.75	0.80	2.90	0.0750	0.4763
		15	10	0.0586	10.75	0.80	2.20	0.0500	0.3175
		25	10	0.0586	10.75	0.80	1.85	0.0375	0.2381
		35	10	0.0586	10.75	0.80	1.70	0.0322	0.2041
	18	5	10	0.0588	10.80	0.85	3.05	0.0789	0.5006
		15	10	0.0588	10.80	0.85	2.25	0.0502	0.3186
		25	10	0.0588	10.80	0.85	1.95	0.0394	0.2503
		35	10	0.0588	10.80	0.85	1.85	0.0359	0.2276
		45	10	0.0588	10.80	0.85	1.70	0.0305	0.1934
55RCB20	12	5	10	0.0586	10.75	0.80	3.20	0.0858	0.5494
		15	10	0.0586	10.75	0.80	2.35	0.0554	0.3548
		25	10	0.0586	10.75	0.80	2.15	0.0482	0.3091
		35	10	0.0586	10.75	0.80	1.80	0.0357	0.2289

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.2 Total chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCB20	18	5	10	0.0588	10.80	0.85	3.30	0.0879	0.5628
		15	10	0.0588	10.80	0.85	2.55	0.0610	0.3905
		25	10	0.0588	10.80	0.85	2.30	0.0520	0.3331
		35	10	0.0588	10.80	0.85	2.00	0.0412	0.2642
		45	10	0.0588	10.80	0.85	1.85	0.0359	0.2297
55RCB35	12	5	10	0.0583	10.75	0.80	3.00	0.0782	0.4973
		15	10	0.0583	10.75	0.80	2.20	0.0498	0.3164
		25	10	0.0583	10.75	0.80	2.05	0.0444	0.2825
		35	10	0.0583	10.75	0.80	1.75	0.0338	0.2147
	18	5	10	0.0588	10.80	0.85	3.40	0.0914	0.5813
		15	10	0.0588	10.80	0.85	2.45	0.0574	0.3648
		25	10	0.0588	10.80	0.85	2.15	0.0466	0.2964
		35	10	0.0588	10.80	0.85	1.90	0.0376	0.2394
		45	10	0.0588	10.80	0.85	1.80	0.0341	0.2166
55RCB50	12	5	10	0.0583	10.75	0.80	3.10	0.0818	0.5152
		15	10	0.0583	10.75	0.80	2.15	0.0480	0.3024
		25	10	0.0583	10.75	0.80	2.00	0.0427	0.2688
		35	10	0.0583	10.75	0.80	1.80	0.0356	0.2240

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.2 Total chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCB50	18	5	10	0.0588	10.80	0.85	3.35	0.0896	0.5648
		15	10	0.0588	10.80	0.85	2.25	0.0502	0.3163
		25	10	0.0588	10.80	0.85	2.10	0.0448	0.2824
		35	10	0.0588	10.80	0.85	1.90	0.0376	0.2372
		45	10	0.0588	10.80	0.85	1.80	0.0341	0.2146

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.3 Total chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65CON	12	5	10	0.0586	10.75	0.80	2.95	0.0768	0.6095
		15	10	0.0586	10.75	0.80	2.65	0.0661	0.5245
		25	10	0.0586	10.75	0.80	2.20	0.0500	0.3969
		35	10	0.0586	10.75	0.80	2.15	0.0482	0.3827
		45	10	0.0586	10.75	0.80	1.90	0.0393	0.3118
		55	10	0.0586	10.75	0.80	1.85	0.0375	0.2977
	18	5	10	0.0588	10.95	0.85	3.35	0.0883	0.7006
		15	10	0.0588	10.95	0.85	3.00	0.0759	0.6025
		25	10	0.0588	10.95	0.85	2.75	0.0671	0.5324
		35	10	0.0588	10.95	0.85	2.40	0.0548	0.4344
		45	10	0.0588	10.95	0.85	2.15	0.0459	0.3643
		55	10	0.0588	10.95	0.85	2.05	0.0424	0.3363
65RC	12	5	10	0.0589	10.95	0.90	3.30	0.0854	0.6522
		15	10	0.0589	10.95	0.90	2.95	0.0729	0.5571
		25	10	0.0589	10.95	0.90	2.55	0.0587	0.4484
		35	10	0.0589	10.95	0.90	2.45	0.0551	0.4212
		45	10	0.0589	10.95	0.90	2.15	0.0444	0.3397
		55	10	0.0589	10.95	0.90	2.10	0.0427	0.3261
		65	10	0.0589	10.95	0.90	1.95	0.0373	0.2853

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.3 Total chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RC	18	5	10	0.0587	11.00	0.95	3.35	0.0851	0.6500
		15	10	0.0587	11.00	0.95	3.25	0.0815	0.6229
		25	10	0.0587	11.00	0.95	3.05	0.0744	0.5687
		35	10	0.0587	11.00	0.95	2.65	0.0602	0.4604
		45	10	0.0587	11.00	0.95	2.55	0.0567	0.4333
		55	10	0.0587	11.00	0.95	2.35	0.0496	0.3791
		65	10	0.0587	11.00	0.95	2.20	0.0443	0.3385
65RCF20	12	5	10	0.0586	10.75	0.80	3.15	0.0840	0.6377
		15	10	0.0586	10.75	0.80	2.70	0.0679	0.5156
		25	10	0.0586	10.75	0.80	2.20	0.0500	0.3799
		35	10	0.0589	10.95	0.80	2.05	0.0440	0.3342
		45	10	0.0589	10.95	0.80	1.85	0.0370	0.2808
	18	5	10	0.0588	10.95	0.85	3.75	0.1024	0.7780
		15	10	0.0588	10.95	0.85	2.70	0.0654	0.4963
		25	10	0.0588	10.95	0.85	2.20	0.0477	0.3621
		35	10	0.0588	10.95	0.85	2.05	0.0424	0.3219
		45	10	0.0588	10.95	0.85	1.95	0.0389	0.2951

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.3 Total chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCF35	12	5	10	0.0586	10.75	0.80	3.55	0.0983	0.7426
		15	10	0.0586	10.75	0.80	2.65	0.0661	0.4996
		25	10	0.0586	10.75	0.80	2.15	0.0482	0.3646
		35	10	0.0586	10.75	0.80	2.00	0.0429	0.3240
		45	10	0.0586	10.75	0.80	1.80	0.0357	0.2700
	18	5	10	0.0588	10.95	0.85	3.70	0.1007	0.7608
		15	10	0.0588	10.95	0.85	2.55	0.0600	0.4538
		25	10	0.0588	10.95	0.85	2.00	0.0406	0.3070
		35	10	0.0588	10.95	0.85	1.85	0.0353	0.2669
		45	10	0.0588	10.95	0.85	1.80	0.0336	0.2536
65RCF50	12	5	10	0.0589	10.95	0.90	3.60	0.0960	0.7223
		15	10	0.0589	10.95	0.90	2.60	0.0605	0.4548
		25	10	0.0589	10.95	0.90	2.05	0.0409	0.3076
		35	10	0.0589	10.95	0.90	1.95	0.0373	0.2809
		45	10	0.0589	10.95	0.90	1.80	0.0320	0.2408
	18	5	10	0.0587	11.00	0.95	3.80	0.1010	0.7598
		15	10	0.0587	11.00	0.95	2.45	0.0532	0.3999
		25	10	0.0587	11.00	0.95	2.05	0.0390	0.2933
		35	10	0.0587	11.00	0.95	1.85	0.0319	0.2400
		45	10	0.0587	11.00	0.95	1.80	0.0301	0.2266

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.3 Total chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCB20	12	5	10	0.0589	10.95	0.90	3.85	0.1049	0.7952
		15	10	0.0589	10.95	0.90	2.70	0.0640	0.4852
		25	10	0.0589	10.95	0.90	2.10	0.0427	0.3235
		35	10	0.0589	10.95	0.90	2.00	0.0391	0.2965
		45	10	0.0589	10.95	0.90	1.90	0.0356	0.2696
	18	5	10	0.0587	11.00	0.95	3.55	0.0922	0.6985
		15	10	0.0587	11.00	0.95	2.55	0.0567	0.4298
		25	10	0.0587	11.00	0.95	2.15	0.0425	0.3224
		35	10	0.0587	11.00	0.95	2.10	0.0408	0.3090
		45	10	0.0587	11.00	0.95	2.00	0.0372	0.2821
65RCB35	12	5	10	0.0589	10.95	0.90	3.15	0.0800	0.6027
		15	10	0.0589	10.95	0.90	2.65	0.0622	0.4688
		25	10	0.0589	10.95	0.90	2.15	0.0444	0.3348
		35	10	0.0589	10.95	0.90	1.90	0.0356	0.2679
		45	10	0.0589	10.95	0.90	1.85	0.0338	0.2545
	18	5	10	0.0587	11.00	0.95	3.75	0.0992	0.7475
		15	10	0.0587	11.00	0.95	2.25	0.0461	0.3471
		25	10	0.0587	11.00	0.95	2.05	0.0390	0.2937
		35	10	0.0587	11.00	0.95	2.00	0.0372	0.2803
		45	10	0.0587	11.00	0.95	1.90	0.0337	0.2536

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.3 Total chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Total Chloride Content (%)	Total Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCB50	12	5	10	0.0586	10.75	0.80	3.20	0.0858	0.6411
		15	10	0.0586	10.75	0.80	2.50	0.0608	0.4541
		25	10	0.0586	10.75	0.80	1.85	0.0375	0.2805
		35	10	0.0586	10.75	0.80	1.80	0.0357	0.2671
		45	10	0.0586	10.75	0.80	1.70	0.0322	0.2404
	18	5	10	0.0587	11.00	0.95	3.40	0.0868	0.6491
		15	10	0.0587	11.00	0.95	2.35	0.0496	0.3709
		25	10	0.0587	11.00	0.95	2.00	0.0372	0.2782
		35	10	0.0587	11.00	0.95	1.90	0.0337	0.2517
		45	10	0.0587	11.00	0.95	1.85	0.0319	0.2384

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.4 Free chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45CON	12	5	10	0.0587	11.00	0.95	1.80	0.0301	0.1678
		15	10	0.0587	11.00	0.95	1.45	0.0177	0.0987
		25	10	0.0587	11.00	0.95	1.00	0.0018	0.0099
		35	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0588	10.00	0.85	2.00	0.0448	0.2497
		15	10	0.0588	10.00	0.85	1.50	0.0253	0.1411
		25	10	0.0588	10.00	0.85	1.25	0.0156	0.0868
		35	10	0.0588	10.00	0.85	1.10	0.0097	0.0543
		45	10	0.0588	10.00	0.85	1.00	0.0058	0.0326
45RC	12	5	10	0.0587	11.00	0.95	2.00	0.0372	0.2005
		15	10	0.0587	11.00	0.95	1.50	0.0195	0.1050
		25	10	0.0583	11.00	0.95	1.15	0.0070	0.0379
		35	10	0.0583	11.00	0.95	1.00	0.0018	0.0095
		45	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0588	10.80	0.85	2.05	0.0430	0.2318
		15	10	0.0588	10.80	0.85	1.60	0.0269	0.1449
		25	10	0.0588	10.80	0.85	1.40	0.0197	0.1062
		35	10	0.0588	10.80	0.85	1.25	0.0143	0.0773
		45	10	0.0588	10.80	0.85	1.15	0.0108	0.0579
		55	10	0.0588	10.80	0.85	1.00	0.0054	0.0290

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.4 Free chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCF20	12	5	10	0.0587	11.00	0.95	1.90	0.0337	0.1795
		15	10	0.0587	11.00	0.95	1.25	0.0106	0.0567
		25	10	0.0587	11.00	0.95	1.00	0.0018	0.0094
		35	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0588	10.80	0.85	1.85	0.0359	0.1911
		15	10	0.0588	10.80	0.85	1.10	0.0090	0.0478
		25	10	0.0588	10.80	0.85	0.90	0.0018	0.0096
		35	10	0.0588	10.80	0.85	0.85	0.0000	0.0000
45RCF35	12	5	10	0.0587	11.00	0.95	2.00	0.0372	0.1970
		15	10	0.0587	11.00	0.95	1.10	0.0053	0.0281
		25	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
		35	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0588	10.80	0.85	1.95	0.0394	0.2088
		15	10	0.0588	10.80	0.85	1.00	0.0054	0.0285
		25	10	0.0588	10.80	0.85	0.90	0.0018	0.0095
		35	10	0.0588	10.80	0.85	0.85	0.0000	0.0000
45RCF50	12	5	10	0.0588	10.90	0.85	1.80	0.0337	0.1773
		15	10	0.0588	10.90	0.85	0.90	0.0018	0.0093
		25	10	0.0588	10.90	0.85	0.85	0.0000	0.0000
		35	10	0.0588	10.90	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.4 Free chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCF50	18	5	10	0.0588	10.80	0.85	1.85	0.0359	0.1885
		15	10	0.0588	10.80	0.85	0.95	0.0036	0.0188
		25	10	0.0588	10.80	0.85	0.85	0.0000	0.0000
		35	10	0.0588	10.80	0.85	0.85	0.0000	0.0000
45RCB20	12	5	10	0.0587	11.00	0.95	2.35	0.0496	0.2640
		15	10	0.0587	11.00	0.95	1.20	0.0089	0.0471
		25	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
		35	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0586	10.75	0.85	1.85	0.0359	0.1911
		15	10	0.0586	10.75	0.85	1.30	0.0162	0.0860
		25	10	0.0586	10.75	0.85	1.00	0.0054	0.0287
		35	10	0.0586	10.75	0.85	0.90	0.0018	0.0096
45RCB35	12	5	10	0.0587	11.00	0.95	2.30	0.0478	0.2518
		15	10	0.0587	11.00	0.95	1.10	0.0053	0.0280
		25	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
		35	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0586	10.75	0.85	1.90	0.0377	0.1984
		15	10	0.0586	10.75	0.85	1.20	0.0126	0.0662
		25	10	0.0586	10.75	0.85	0.95	0.0036	0.0189
		35	10	0.0586	10.75	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.4 Free chloride content of concrete with W/B ratio of 0.45 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
45RCB50	12	5	10	0.0587	11.00	0.95	2.25	0.0461	0.2396
		15	10	0.0588	10.90	0.95	1.00	0.0018	0.0093
		25	10	0.0588	10.90	0.95	0.95	0.0000	0.0000
		35	10	0.0588	10.90	0.95	0.95	0.0000	0.0000
	18	5	10	0.0586	10.75	0.85	1.75	0.0323	0.1681
		15	10	0.0586	10.75	0.85	1.05	0.0072	0.0374
		25	10	0.0586	10.75	0.85	0.85	0.0000	0.0000
		35	10	0.0586	10.75	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.5 Free chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55CON	12	5	10	0.0587	11.00	0.95	1.95	0.0354	0.2387
		15	10	0.0587	11.00	0.95	1.55	0.0213	0.1432
		25	10	0.0587	11.00	0.95	1.20	0.0089	0.0597
		35	10	0.0587	11.00	0.95	1.05	0.0035	0.0239
		45	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
		55	10	0.0587	11.00	0.95	0.95	0.0000	0.0000
	18	5	10	0.0586	10.75	0.85	2.00	0.0413	0.2782
		15	10	0.0586	10.75	0.85	1.65	0.0287	0.1935
		25	10	0.0586	10.75	0.85	1.35	0.0180	0.1209
		35	10	0.0586	10.75	0.85	1.15	0.0108	0.0726
		45	10	0.0586	10.75	0.85	1.00	0.0054	0.0363
		55	10	0.0586	10.75	0.85	0.95	0.0036	0.0242
55RC	12	5	10	0.0588	10.90	0.85	2.00	0.0408	0.2640
		15	10	0.0588	10.90	0.85	1.60	0.0266	0.1722
		25	10	0.0588	10.90	0.85	1.20	0.0124	0.0803
		35	10	0.0588	10.90	0.85	1.05	0.0071	0.0459
		45	10	0.0588	10.90	0.85	0.90	0.0018	0.0115
		55	10	0.0588	10.90	0.85	0.90	0.0018	0.0115

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.5 Free chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RC	18	5	10	0.0586	10.75	0.85	2.00	0.0413	0.2671
		15	10	0.0586	10.75	0.85	1.75	0.0323	^.2090
		25	10	0.0586	10.75	0.85	1.45	0.0216	0.1393
		35	10	0.0586	10.75	0.85	1.20	0.0126	0.0813
		45	10	0.0586	10.75	0.85	1.05	0.0072	0.0464
		55	10	0.0586	10.75	0.85	0.95	0.0036	0.0232
55RCF20	12	5	10	0.0589	10.95	0.80	1.75	0.0334	0.2148
		15	10	0.0589	10.95	0.80	1.25	0.0158	0.1017
		25	10	0.0589	10.95	0.80	1.00	0.0070	0.0452
		35	10	0.0589	10.95	0.80	0.85	0.0018	0.0113
	18	5	10	0.0586	10.75	0.85	1.80	0.0341	0.2191
		15	10	0.0586	10.75	0.85	1.40	0.0198	0.1268
		25	10	0.0586	10.75	0.85	1.20	0.0126	0.0807
		35	10	0.0586	10.75	0.85	1.05	0.0072	0.0461
		45	10	0.0586	10.75	0.85	0.90	0.0018	0.0115
55RCF35	12	5	10	0.0589	10.95	0.80	1.40	0.0211	0.1349
		15	10	0.0589	10.95	0.80	1.15	0.0123	0.0787
		25	10	0.0589	10.90	0.85	1.00	0.0053	0.0340
		35	10	0.0589	10.90	0.85	0.90	0.0018	0.0114
		45	10	0.0589	10.90	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.5 Free chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCF35	18	5	10	0.0586	10.75	0.85	1.80	0.0341	0.2178
		15	10	0.0586	10.75	0.85	1.35	0.0180	0.1146
		25	10	0.0586	10.75		1.20	0.0126	0.0802
		35	10	0.0586	10.75	0.85	1.00	0.0054	0.0344
		45	10	0.0586	10.75	0.85	0.90	0.0018	0.0115
55RCF50	12	5	10	0.0588	10.90	0.80	1.50	0.0247	0.1569
		15	10	0.0588	10.90	0.80	1.10	0.0106	0.0672
		25	10	0.0588	10.90	0.80	0.90	0.0035	0.0224
		35	10	0.0588	10.90	0.80	0.80	0.0000	0.0000
	18	5	10	0.0586	10.75	0.85	1.60	0.0269	0.1710
		15	10	0.0586	10.75	0.85	1.20	0.0126	0.0798
		25	10	0.0586	10.75	0.85	1.00	0.0054	0.0342
		35	10	0.0586	10.75	0.85	0.90	0.0018	0.0114
		45	10	0.0586	10.75	0.85	0.85	0.0000	0.0000
55RCB20	12	5	10	0.0588	10.90	0.85	1.90	0.0373	0.2388
		15	10	0.0588	10.90	0.85	1.25	0.0142	0.0910
		25	10	0.0588	10.90	0.85	1.00	0.0053	0.0341
		35	10	0.0588	10.90	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.5 Free chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCB20	18	5	10	0.0586	10.75	0.85	1.95	0.0395	0.2531
		15	10	0.0586	10.75	0.85	1.25	0.0144	0.0920
		25	10	0.0586	10.75	0.85	1.10	0.0090	0.0575
		35	10	0.0586	10.75	0.85	0.95	0.0036	0.0230
		45	10	0.0586	10.75	0.85	0.90	0.0018	0.0115
55RCB35	12	5	10	0.0588	10.90	0.85	1.80	0.0337	0.2144
		15	10	0.0588	10.90	0.85	1.20	0.0124	0.0790
		25	10	0.0588	10.90	0.85	0.95	0.0036	0.0226
		35	10	0.0588	10.90	0.85	0.90	0.0018	0.0113
	18	5	10	0.0586	10.75	0.85	1.95	0.0395	0.2512
		15	10	0.0586	10.75	0.85	1.20	0.0126	0.0799
		25	10	0.0586	10.75	0.85	1.00	0.0054	0.0342
		35	10	0.0586	10.75	0.85	0.95	0.0036	0.0228
		45	10	0.0586	10.75	0.85	0.85	0.0000	0.0000
55RCB50	12	5	10	0.0588	10.90	0.85	1.75	0.0320	0.2013
		15	10	0.0588	10.90	0.85	1.10	0.0089	0.0559
		25	10	0.0588	10.90	0.85	0.90	0.0018	0.0112
		35	10	0.0588	10.90	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.5 Free chloride content of concrete with W/B ratio of 0.55 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
55RCB50	18	5	10	0.0586	10.75	0.85	1.85	0.0359	0.2263
		15	10	0.0586	10.75	0.85	1.15	0.0108	0.0679
		25	10	0.0586	10.75	0.85	0.95	0.0036	0.0226
		35	10	0.0586	10.75	0.85	0.90	0.0018	0.0113
		45	10	0.0586	10.75	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.6 Free chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65CON	12	5	10	0.0589	10.95	0.80	2.35	0.0546	0.4330
		15	[illegible] 0.05	0.0589	10.95	0.80	1.70	0.0317	0.2514
		25	10	0.0589	10.95	0.80	1.30	0.0176	0.1397
		35	10	0.0589	10.95	0.80	1.10	0.0106	0.0838
		45	10	0.0589	10.95	0.80	0.90	0.0035	0.0279
		55	10	0.0589	10.95	0.80	0.85	0.0018	0.0140
	18	5	10	0.0585	10.75	0.90	2.45	0.0559	0.4431
		15	10	0.0585	10.75	0.90	1.90	0.0360	0.2859
		25	10	0.0585	10.75	0.90	1.50	0.0216	0.1715
		35	10	0.0585	10.75	0.90	1.30	0.0144	0.1144
		45	10	0.0585	10.75	0.90	1.10	0.0072	0.0572
		55	10	0.0585	10.75	0.90	0.95	0.0018	0.0143
65RC	12	5	10	0.0589	10.95	0.80	2.50	0.0599	0.4574
		15	10	0.0589	10.95	0.80	1.95	0.0405	0.3094
		25	10	0.0589	10.95	0.80	1.55	0.0264	0.2018
		35	10	0.0589	10.95	0.80	1.25	0.0158	0.1211
		45	10	0.0589	10.95	0.80	1.15	0.0123	0.0942
		55	10	0.0589	10.95	0.80	1.00	0.0070	0.0538
		65	10	0.0589	10.95	0.80	0.95	0.0053	0.0404

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.6 Free chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RC	18	5	10	0.0588	10.95	0.85	2.70	0.0654	0.4994
		15	10	0.0588	10.95	0.85	2.15	0.0459	0.3509
		25	10	0.0588	10.95	0.85	1.80	0.0336	0.2564
		35	10	0.0588	10.95	0.85	1.45	0.0212	0.1620
		45	10	0.0588	10.95	0.85	1.30	0.0159	0.1215
		55	10	0.0588	10.95	0.85	1.15	0.0106	0.0810
		65	10	0.0588	10.95	0.85	0.95	0.0035	0.0270
65RCF20	12	5	10	0.0589	10.95	0.80	2.25	0.0511	0.3877
		15	10	0.0589	10.95	0.80	1.45	0.0229	0.1738
		25	10	0.0589	10.95	0.80	1.05	0.0088	0.0668
		35	10	0.0589	10.95	0.80	0.90	0.0035	0.0267
		45	10	0.0589	10.95	0.80	0.80	0.0000	0.0000
	18	5	10	0.0585	10.75	0.90	2.40	0.0541	0.4105
		15	10	0.0585	10.75	0.90	1.65	0.0270	0.2052
		25	10	0.0585	10.75	0.90	1.35	0.0162	0.1231
		35	10	0.0585	10.75	0.90	1.05	0.0054	0.0410
		45	10	0.0585	10.75	0.90	0.95	0.0018	0.0137

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.6 Free chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCF35	12	5	10	0.0589	10.95	0.80	2.00	0.0422	0.3193
		15	10	0.0589	10.95	0.80	1.35	0.0194	0.1463
		25	10	[illegible]	10.95	0.80	0.95	0.0053	0.0399
		35	10	0.0589	10.95	0.80	0.85	0.0018	0.0133
		45	10	0.0589	10.95	0.80	0.80	0.0000	0.0000
	18	5	10	0.0585	10.75	0.90	2.35	0.0522	0.3949
		15	10	0.0585	10.75	0.90	1.55	0.0234	0.1770
		25	10	0.0585	10.75	0.90	1.20	0.0108	0.0817
		35	10	0.0585	10.75	0.90	1.00	0.0036	0.0272
		45	10	0.0585	10.75	0.90	0.95	0.0018	0.0136
65RCF50	12	5	10	0.0589	10.95	0.80	2.05	0.0440	0.3311
		15	10	0.0589	10.95	0.80	1.20	0.0141	0.1060
		25	10	0.0589	10.95	0.80	0.95	0.0053	0.0397
		35	10	0.0589	10.95	0.80	0.85	0.0018	0.0132
		45	10	0.0589	10.95	0.80	0.80	0.0000	0.0000
	18	5	10	0.0588	10.95	0.85	2.30	0.0512	0.3853
		15	10	0.0588	10.95	0.85	1.40	0.0194	0.1462
		25	10	0.0588	10.95	0.85	1.05	0.0071	0.0531
		35	10	0.0588	10.95	0.85	0.90	0.0018	0.0138
		45	10	0.0588	10.95	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.6 Free chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCB20	12	5	10	0.0589	10.95	0.80	2.05	0.0440	0.3336
		15	10	0.0589	10.95	0.80	1.35	0.0194	0.1468
		25	10	0.0589	10.95	0.80	1.00	0.0070	0.0534
		35	10	0.0589	10.95	0.80	0.90	0.0035	0.0267
		45	10	0.0589	10.95	0.80	0.85	0.0018	0.0133
	18	5	10	0.0588	10.95	0.85	2.15	0.0459	0.3481
		15	10	0.0588	10.95	0.85	1.50	0.0230	0.1740
		25	10	0.0588	10.95	0.85	1.05	0.0071	0.0536
		35	10	0.0588	10.95	0.85	0.95	0.0035	0.0268
		45	10	0.0588	10.95	0.85	0.85	0.0000	0.0000
65RCB35	12	5	10	0.0589	10.95	0.80	2.00	0.0422	0.3183
		15	10	0.0589	10.95	0.80	1.25	0.0158	0.1193
		25	10	0.0589	10.95	0.80	0.95	0.0053	0.0398
		35	10	0.0589	10.95	0.80	0.85	0.0018	0.0133
		45	10	0.0589	10.95	0.80	0.80	0.0000	0.0000
	18	5	10	0.0588	10.95	0.85	2.05	0.0424	0.3193
		15	10	0.0588	10.95	0.85	1.35	0.0177	0.1330
		25	10	0.0588	10.95	0.85	1.00	0.0053	0.0399
		35	10	0.0588	10.95	0.85	0.95	0.0035	0.0266
		45	10	0.0588	10.95	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

Table F.6 Free chloride content of concrete with W/B ratio of 0.65 immersed in 3% NaCl solution (Cont.)

Sample	Immersed Time (months)	Average Distance from Surface (mm)	Weight of Sample Powder (g)	Weight of NaCl (g)	Average Volume of $AgNO_3$			Free Chloride Content (%)	Free Chloride by Weight of Binder (%)
					Standardization (mL)	Blank (mL)	Titration Sample Solution (mL)		
65RCB50	12	5	10	0.0588	10.90	0.85	2.05	0.0426	0.3184
		15	10	0.0588	10.90	0.85	1.15	0.0106	0.0796
		25	10	0.0588	10.90	0.85	0.95	0.0036	0.0265
		35	10	0.0588	10.90	0.85	0.90	0.0018	0.0133
		45	10	0.0588	10.90	0.85	0.85	0.0000	0.0000
	18	5	10	0.0588	10.95	0.85	2.00	0.0406	0.3037
		15	10	0.0588	10.95	0.85	1.30	0.0159	0.1188
		25	10	0.0588	10.95	0.85	0.95	0.0035	0.0264
		35	10	0.0588	10.95	0.85	0.85	0.0000	0.0000
		45	10	0.0588	10.95	0.85	0.85	0.0000	0.0000

Note : The concentration of all samples was diluted 10 times from original concentration before titration

APPENDIX G

Expansion

Table G.1 Expansion of 65CON concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.01890	9.99449	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.01925	9.99519	0.00035	0.00070	0.00349	0.00700	0.00525
2	10.01965	9.99549	0.00075	0.00100	0.00749	0.01001	0.00875
3	10.02015	9.99589	0.00125	0.00140	0.01248	0.01401	0.01324
4	10.02035	9.99594	0.00145	0.00145	0.01447	0.01451	0.01449
5	10.02085	9.99649	0.00195	0.00200	0.01946	0.02001	0.01974
6	10.02165	9.99709	0.00275	0.00260	0.02745	0.02601	0.02673
7	10.02185	9.99719	0.00295	0.00270	0.02944	0.02701	0.02823
8	10.02225	9.99764	0.00335	0.00315	0.03344	0.03152	0.03248
9	10.02235	9.99769	0.00345	0.00320	0.03443	0.03202	0.03323
10	10.02265	9.99819	0.00375	0.00370	0.03743	0.03702	0.03722
11	10.02270	9.99829	0.00380	0.00380	0.03793	0.03802	0.03797
12	10.02305	9.99869	0.00415	0.00420	0.04142	0.04202	0.04172
13	10.02305	9.99879	0.00415	0.00430	0.04142	0.04302	0.04222
14	10.02335	9.99914	0.00445	0.00465	0.04442	0.04653	0.04547
15	10.02405	9.99979	0.00515	0.00530	0.05140	0.05303	0.05222
16	10.02415	9.99989	0.00525	0.00540	0.05240	0.05403	0.05322
17	10.02445	10.00029	0.00555	0.00580	0.05540	0.05803	0.05671
18	10.02475	10.00074	0.00585	0.00625	0.05839	0.06253	0.06046
19	10.02520	10.00129	0.00630	0.00680	0.06288	0.06804	0.06546
20	10.02505	10.00139	0.00615	0.00690	0.06138	0.06904	0.06521
21	10.02565	10.00189	0.00675	0.00740	0.06737	0.07404	0.07071
22	10.02530	10.00164	0.00640	0.00715	0.06388	0.07154	0.06771
23	10.02530	10.00224	0.00640	0.00775	0.06388	0.07754	0.07071
24	10.02585	10.00279	0.00695	0.00830	0.06937	0.08305	0.07621

Table G.2 Expansion of 65RC concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.97953	10.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.98003	10.00040	0.00050	0.00040	0.00501	0.00400	0.00451
2	9.98048	10.00100	0.00095	0.00100	0.00952	0.01000	0.00976
3	9.98093	10.00115	0.00140	0.00115	0.01403	0.01150	0.01276
4	9.98188	10.00065	0.00235	0.00065	0.02355	0.00650	0.01502
5	9.98188	10.00200	0.00235	0.00200	0.02355	0.02000	0.02177
6	9.98233	10.00270	0.00280	0.00270	0.02806	0.02700	0.02753
7	9.98253	10.00320	0.00300	0.00320	0.03006	0.03200	0.03103
8	9.98293	10.00340	0.00340	0.00340	0.03407	0.03400	0.03403
9	9.98303	10.00340	0.00350	0.00340	0.03507	0.03400	0.03454
10	9.98333	10.00370	0.00380	0.00370	0.03808	0.03700	0.03754
11	9.98353	10.00420	0.00400	0.00420	0.04008	0.04200	0.04104
12	9.98393	10.00440	0.00440	0.00440	0.04409	0.04400	0.04405
13	9.98473	10.00525	0.00520	0.00525	0.05211	0.05250	0.05230
14	9.98488	10.00540	0.00535	0.00540	0.05361	0.05400	0.05380
15	9.98628	10.00580	0.00675	0.00580	0.06764	0.05800	0.06282
16	9.98663	10.00650	0.00710	0.00650	0.07115	0.06500	0.06807
17	9.98693	10.00680	0.00740	0.00680	0.07415	0.06800	0.07108
18	9.98773	10.00730	0.00820	0.00730	0.08217	0.07300	0.07758
19	9.98798	10.00770	0.00845	0.00770	0.08467	0.07700	0.08084
20	9.98853	10.00815	0.00900	0.00815	0.09018	0.08150	0.08584
21	9.98878	10.00865	0.00925	0.00865	0.09269	0.08650	0.08959
22	9.98903	10.00830	0.00950	0.00830	0.09519	0.08300	0.08910
23	9.98883	10.00895	0.00930	0.00895	0.09319	0.08950	0.09135
24	9.99013	10.00940	0.01060	0.00940	0.10622	0.09400	0.10011

Table G.3 Expansion of 65RCF20 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.97717	10.03937	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.97822	10.03937	0.00105	0.00000	0.01052	0.00000	0.00526
2	9.97802	10.04027	0.00085	0.00090	0.00852	0.00896	0.00874
3	9.97827	10.04037	0.00110	0.00100	0.01103	0.00996	0.01049
4	9.97852	10.04082	0.00135	0.00145	0.01353	0.01444	0.01399
5	9.97922	10.04077	0.00205	0.00140	0.02055	0.01395	0.01725
6	9.97952	10.04192	0.00235	0.00255	0.02355	0.02540	0.02448
7	9.97977	10.04227	0.00260	0.00290	0.02606	0.02889	0.02747
8	9.98022	10.04247	0.00305	0.00310	0.03057	0.03088	0.03072
9	9.98042	10.04267	0.00325	0.00330	0.03257	0.03287	0.03272
10	9.98057	10.04252	0.00340	0.00315	0.03408	0.03138	0.03273
11	9.98032	10.04297	0.00315	0.00360	0.03157	0.03586	0.03372
12	9.98102	10.04327	0.00385	0.00390	0.03859	0.03885	0.03872
13	9.98092	10.04337	0.00375	0.00400	0.03759	0.03984	0.03871
14	9.98092	10.04317	0.00375	0.00380	0.03759	0.03785	0.03772
15	9.98102	10.04317	0.00385	0.00380	0.03859	0.03785	0.03822
16	9.98112	10.04322	0.00395	0.00385	0.03959	0.03835	0.03897
17	9.98152	10.04337	0.00435	0.00400	0.04360	0.03984	0.04172
18	9.98142	10.04347	0.00425	0.00410	0.04260	0.04084	0.04172
19	9.98152	10.04337	0.00435	0.00400	0.04360	0.03984	0.04172
20	9.98137	10.04362	0.00420	0.00425	0.04210	0.04233	0.04221
21	9.98152	10.04377	0.00435	0.00440	0.04360	0.04383	0.04371
22	9.98172	10.04397	0.00455	0.00460	0.04560	0.04582	0.04571
23	9.98192	10.04417	0.00475	0.00480	0.04761	0.04781	0.04771
24	9.98222	10.04447	0.00505	0.00510	0.05062	0.05080	0.05071

Table G.4 Expansion of 65RCF35 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.00157	10.06693	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.00192	10.06743	0.00035	0.00050	0.00350	0.00497	0.00423
2	10.00232	10.06763	0.00075	0.00070	0.00750	0.00695	0.00723
3	10.00252	10.06803	0.00095	0.00110	0.00950	0.01093	0.01021
4	10.00272	10.06818	0.00115	0.00125	0.01150	0.01242	0.01196
5	10.00287	10.06863	0.00130	0.00170	0.01300	0.01689	0.01494
6	10.00357	10.06888	0.00200	0.00195	0.02000	0.01937	0.01968
7	10.00387	10.06923	0.00230	0.00230	0.02300	0.02285	0.02292
8	10.00427	10.06963	0.00270	0.00270	0.02700	0.02682	0.02691
9	10.00452	10.07003	0.00295	0.00310	0.02950	0.03079	0.03014
10	10.00467	10.07003	0.00310	0.00310	0.03100	0.03079	0.03089
11	10.00477	10.07023	0.00320	0.00330	0.03199	0.03278	0.03239
12	10.00492	10.07033	0.00335	0.00340	0.03349	0.03377	0.03363
13	10.00487	10.07043	0.00330	0.00350	0.03299	0.03477	0.03388
14	10.00507	10.07038	0.00350	0.00345	0.03499	0.03427	0.03463
15	10.00507	10.07043	0.00350	0.00350	0.03499	0.03477	0.03488
16	10.00517	10.07058	0.00360	0.00365	0.03599	0.03626	0.03613
17	10.00537	10.07033	0.00380	0.00340	0.03799	0.03377	0.03588
18	10.00527	10.07053	0.00370	0.00360	0.03699	0.03576	0.03638
19	10.00527	10.07053	0.00370	0.00360	0.03699	0.03576	0.03638
20	10.00537	10.07063	0.00380	0.00370	0.03799	0.03675	0.03737
21	10.00527	10.07063	0.00370	0.00370	0.03699	0.03675	0.03687
22	10.00537	10.07123	0.00380	0.00430	0.03799	0.04271	0.04035
23	10.00577	10.07113	0.00420	0.00420	0.04199	0.04172	0.04186
24	10.00587	10.07133	0.00430	0.00440	0.04299	0.04371	0.04335

Table G.5 Expansion of 65RCF50 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.08189	10.02047	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.08234	10.02072	0.00045	0.00025	0.00446	0.00249	0.00348
2	10.08249	10.02092	0.00060	0.00045	0.00595	0.00449	0.00522
3	10.08294	10.02122	0.00105	0.00075	0.01041	0.00748	0.00895
4	10.08304	10.02147	0.00115	0.00100	0.01141	0.00998	0.01069
5	10.08324	10.02162	0.00135	0.00115	0.01339	0.01148	0.01243
6	10.08379	10.02222	0.00190	0.00175	0.01885	0.01746	0.01815
7	10.08409	10.02252	0.00220	0.00205	0.02182	0.02046	0.02114
8	10.08429	10.02307	0.00240	0.00260	0.02381	0.02595	0.02488
9	10.08469	10.02312	0.00280	0.00265	0.02777	0.02645	0.02711
10	10.08464	10.02327	0.00275	0.00280	0.02728	0.02794	0.02761
11	10.08479	10.02352	0.00290	0.00305	0.02876	0.03044	0.02960
12	10.08469	10.02357	0.00280	0.00310	0.02777	0.03094	0.02935
13	10.08469	10.02367	0.00280	0.00320	0.02777	0.03193	0.02985
14	10.08479	10.02357	0.00290	0.00310	0.02876	0.03094	0.02985
15	10.08484	10.02382	0.00295	0.00335	0.02926	0.03343	0.03135
16	10.08489	10.02387	0.00300	0.00340	0.02976	0.03393	0.03184
17	10.08504	10.02362	0.00315	0.00315	0.03124	0.03144	0.03134
18	10.08519	10.02367	0.00330	0.00320	0.03273	0.03193	0.03233
19	10.08519	10.02357	0.00330	0.00310	0.03273	0.03094	0.03183
20	10.08524	10.02362	0.00335	0.00315	0.03323	0.03144	0.03233
21	10.08539	10.02377	0.00350	0.00330	0.03472	0.03293	0.03382
22	10.08539	10.02377	0.00350	0.00330	0.03472	0.03293	0.03382
23	10.08554	10.02392	0.00365	0.00345	0.03620	0.03443	0.03532
24	10.08599	10.02392	0.00410	0.00345	0.04067	0.03443	0.03755

Table G.6 Expansion of 65RCB20 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.98425	10.04567	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.98480	10.04612	0.00055	0.00045	0.00551	0.00448	0.00499
2	9.98495	10.04642	0.00070	0.00075	0.00701	0.00747	0.00724
3	9.98525	10.04677	0.00100	0.00110	0.01002	0.01095	0.01048
4	9.98555	10.04722	0.00130	0.00155	0.01302	0.01543	0.01423
5	9.98615	10.04757	0.00190	0.00190	0.01903	0.01891	0.01897
6	9.98680	10.04817	0.00255	0.00250	0.02554	0.02489	0.02521
7	9.98710	10.04847	0.00285	0.00280	0.02854	0.02787	0.02821
8	9.98735	10.04857	0.00310	0.00290	0.03105	0.02887	0.02996
9	9.98720	10.04887	0.00295	0.00320	0.02955	0.03185	0.03070
10	9.98735	10.04902	0.00310	0.00335	0.03105	0.03335	0.03220
11	9.98790	10.04937	0.00365	0.00370	0.03656	0.03683	0.03669
12	9.98830	10.04897	0.00405	0.00330	0.04056	0.03285	0.03671
13	9.98865	10.04927	0.00440	0.00360	0.04407	0.03584	0.03995
14	9.98790	10.05027	0.00365	0.00460	0.03656	0.04579	0.04117
15	9.98860	10.05007	0.00435	0.00440	0.04357	0.04380	0.04368
16	9.98865	10.05007	0.00440	0.00440	0.04407	0.04380	0.04393
17	9.98870	10.05017	0.00445	0.00450	0.04457	0.04480	0.04468
18	9.98880	10.05027	0.00455	0.00460	0.04557	0.04579	0.04568
19	9.98870	10.05027	0.00445	0.00460	0.04457	0.04579	0.04518
20	9.98890	10.05107	0.00465	0.00540	0.04657	0.05375	0.05016
21	9.98890	10.05167	0.00465	0.00600	0.04657	0.05973	0.05315
22	9.98910	10.05177	0.00485	0.00610	0.04858	0.06072	0.05465
23	9.98900	10.05177	0.00475	0.00610	0.04757	0.06072	0.05415
24	9.98800	10.05397	0.00375	0.00830	0.03756	0.08262	0.06009

Table G.7 Expansion of 65RCB35 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.06299	10.04252	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.06344	10.04297	0.00045	0.00045	0.00447	0.00448	0.00448
2	10.06379	10.04327	0.00080	0.00075	0.00795	0.00747	0.00771
3	10.06399	10.04362	0.00100	0.00110	0.00994	0.01095	0.01045
4	10.06424	10.04387	0.00125	0.00135	0.01242	0.01344	0.01293
5	10.06469	10.04417	0.00170	0.00165	0.01689	0.01643	0.01666
6	10.06524	10.04467	0.00225	0.00215	0.02236	0.02141	0.02188
7	10.06574	10.04522	0.00275	0.00270	0.02733	0.02689	0.02711
8	10.06594	10.04537	0.00295	0.00285	0.02932	0.02838	0.02885
9	10.06599	10.04547	0.00300	0.00295	0.02981	0.02938	0.02959
10	10.06604	10.04562	0.00305	0.00310	0.03031	0.03087	0.03059
11	10.06664	10.04622	0.00365	0.00370	0.03627	0.03684	0.03656
12	10.06669	10.04637	0.00370	0.00385	0.03677	0.03834	0.03755
13	10.06699	10.04612	0.00400	0.00360	0.03975	0.03585	0.03780
14	10.06694	10.04662	0.00395	0.00410	0.03925	0.04083	0.04004
15	10.06709	10.04652	0.00410	0.00400	0.04074	0.03983	0.04029
16	10.06719	10.04662	0.00420	0.00410	0.04174	0.04083	0.04128
17	10.06729	10.04657	0.00430	0.00405	0.04273	0.04033	0.04153
18	10.06739	10.04672	0.00440	0.00420	0.04372	0.04182	0.04277
19	10.06729	10.04672	0.00430	0.00420	0.04273	0.04182	0.04228
20	10.06729	10.04687	0.00430	0.00435	0.04273	0.04332	0.04302
21	10.06734	10.04707	0.00435	0.00455	0.04323	0.04531	0.04427
22	10.06749	10.04722	0.00450	0.00470	0.04472	0.04680	0.04576
23	10.06759	10.04737	0.00460	0.00485	0.04571	0.04829	0.04700
24	10.06789	10.04757	0.00490	0.00505	0.04869	0.05029	0.04949

Table G.8 Expansion of 65RCB50 concrete immersed in 5% $MgSO_4$ solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.94094	9.97874	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.94119	9.97904	0.00025	0.00030	0.00251	0.00301	0.00276
2	9.94139	9.97934	0.00045	0.00060	0.00453	0.00601	0.00527
3	9.94184	9.97969	0.00090	0.00095	0.00905	0.00952	0.00929
4	9.94204	9.97979	0.00110	0.00105	0.01107	0.01052	0.01079
5	9.94234	9.98014	0.00140	0.00140	0.01408	0.01403	0.01406
6	9.94284	9.98049	0.00190	0.00175	0.01911	0.01754	0.01833
7	9.94359	9.98124	0.00265	0.00250	0.02666	0.02505	0.02586
8	9.94369	9.98154	0.00275	0.00280	0.02766	0.02806	0.02786
9	9.94369	9.98154	0.00275	0.00280	0.02766	0.02806	0.02786
10	9.94399	9.98169	0.00305	0.00295	0.03068	0.02956	0.03012
11	9.94419	9.98194	0.00325	0.00320	0.03269	0.03207	0.03238
12	9.94434	9.98214	0.00340	0.00340	0.03420	0.03407	0.03414
13	9.94429	9.98224	0.00335	0.00350	0.03370	0.03507	0.03439
14	9.94449	9.98234	0.00355	0.00360	0.03571	0.03608	0.03589
15	9.94454	9.98209	0.00360	0.00335	0.03621	0.03357	0.03489
16	9.94469	9.98224	0.00375	0.00350	0.03772	0.03507	0.03640
17	9.94464	9.98219	0.00370	0.00345	0.03722	0.03457	0.03590
18	9.94489	9.98234	0.00395	0.00360	0.03973	0.03608	0.03791
19	9.94474	9.98244	0.00380	0.00370	0.03823	0.03708	0.03765
20	9.94484	9.98244	0.00390	0.00370	0.03923	0.03708	0.03816
21	9.94499	9.98244	0.00405	0.00370	0.04074	0.03708	0.03891
22	9.94509	9.98259	0.00415	0.00385	0.04175	0.03858	0.04016
23	9.94519	9.98264	0.00425	0.00390	0.04275	0.03908	0.04092
24	9.94869	9.98034	0.00775	0.00160	0.07796	0.01603	0.04700

Table G.9 Expansion of 65CON concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.99449	9.96614	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.99549	9.96714	0.00100	0.00100	0.01001	0.01003	0.01002
2	9.99639	9.96794	0.00190	0.00180	0.01901	0.01806	0.01854
3	9.99679	9.96834	0.00230	0.00220	0.02301	0.02207	0.02254
4	9.99694	9.96859	0.00245	0.00245	0.02451	0.02458	0.02455
5	9.99759	9.96934	0.00310	0.00320	0.03102	0.03211	0.03156
6	9.99789	9.97034	0.00340	0.00420	0.03402	0.04214	0.03808
7	9.99809	9.97054	0.00360	0.00440	0.03602	0.04415	0.04008
8	9.99839	9.97004	0.00390	0.00390	0.03902	0.03913	0.03908
9	9.99879	9.97044	0.00430	0.00430	0.04302	0.04315	0.04308
10	9.99889	9.97069	0.00440	0.00455	0.04402	0.04565	0.04484
11	9.99929	9.97084	0.00480	0.00470	0.04803	0.04716	0.04759
12	9.99949	9.97104	0.00500	0.00490	0.05003	0.04917	0.04960
13	9.99969	9.97124	0.00520	0.00510	0.05203	0.05117	0.05160
14	9.99999	9.97154	0.00550	0.00540	0.05503	0.05418	0.05461
15	10.00049	9.97204	0.00600	0.00590	0.06003	0.05920	0.05962
16	10.00079	9.97234	0.00630	0.00620	0.06303	0.06221	0.06262
17	10.00124	9.97279	0.00675	0.00665	0.06754	0.06673	0.06713
18	10.00179	9.97334	0.00730	0.00720	0.07304	0.07224	0.07264
19	10.00209	9.97364	0.00760	0.00750	0.07604	0.07525	0.07565
20	10.00224	9.97374	0.00775	0.00760	0.07754	0.07626	0.07690
21	10.00289	9.97439	0.00840	0.00825	0.08405	0.08278	0.08341
22	10.00329	9.97489	0.00880	0.00875	0.08805	0.08780	0.08792
23	10.00384	9.97529	0.00935	0.00915	0.09355	0.09181	0.09268
24	10.00469	9.97574	0.01020	0.00960	0.10206	0.09633	0.09919

Table G.10 Expansion of 65RC concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.99921	10.07008	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.00021	10.07118	0.00100	0.00110	0.01000	0.01092	0.01046
2	10.00121	10.07228	0.00200	0.00220	0.02000	0.02185	0.02092
3	10.00181	10.07288	0.00260	0.00280	0.02600	0.02781	0.02690
4	10.00236	10.07333	0.00315	0.00325	0.03150	0.03227	0.03189
5	10.00311	10.07398	0.00390	0.00390	0.03900	0.03873	0.03887
6	10.00360	10.07447	0.00439	0.00439	0.04390	0.04359	0.04375
7	10.00381	10.07473	0.00460	0.00465	0.04600	0.04618	0.04609
8	10.00401	10.07498	0.00480	0.00490	0.04800	0.04866	0.04833
9	10.00441	10.07528	0.00520	0.00520	0.05200	0.05164	0.05182
10	10.00441	10.07538	0.00520	0.00530	0.05200	0.05263	0.05232
11	10.00466	10.07563	0.00545	0.00555	0.05450	0.05511	0.05481
12	10.00501	10.07598	0.00580	0.00590	0.05800	0.05859	0.05830
13	10.00526	10.07618	0.00605	0.00610	0.06050	0.06058	0.06054
14	10.00571	10.07658	0.00650	0.00650	0.06501	0.06455	0.06478
15	10.00621	10.07718	0.00700	0.00710	0.07001	0.07051	0.07026
16	10.00639	10.07726	0.00718	0.00718	0.07181	0.07130	0.07155
17	10.00711	10.07788	0.00790	0.00780	0.07901	0.07746	0.07823
18	10.00851	10.07698	0.00930	0.00690	0.09301	0.06852	0.08076
19	10.00921	10.07738	0.01000	0.00730	0.10001	0.07249	0.08625
20	10.00961	10.07768	0.01040	0.00760	0.10401	0.07547	0.08974
21	10.00851	10.07948	0.00930	0.00940	0.09301	0.09335	0.09318
22	10.00916	10.07985	0.00995	0.00976	0.09951	0.09697	0.09824
23	10.00951	10.08048	0.01030	0.01040	0.10301	0.10328	0.10314
24	10.00981	10.08078	0.01060	0.01070	0.10601	0.10626	0.10613

Table G.11 Expansion of 65RCF20 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.94094	9.92362	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.94144	9.92422	0.00050	0.00060	0.00503	0.00605	0.00554
2	9.94194	9.92482	0.00100	0.00120	0.01006	0.01209	0.01108
3	9.94239	9.92512	0.00145	0.00150	0.01459	0.01512	0.01485
4	9.94349	9.92567	0.00255	0.00205	0.02565	0.02066	0.02315
5	9.94354	9.92592	0.00260	0.00230	0.02615	0.02318	0.02467
6	9.94424	9.92672	0.00330	0.00310	0.03320	0.03124	0.03222
7	9.94444	9.92702	0.00350	0.00340	0.03521	0.03426	0.03473
8	9.94489	9.92757	0.00395	0.00395	0.03973	0.03980	0.03977
9	9.94489	9.92747	0.00395	0.00385	0.03973	0.03880	0.03927
10	9.94524	9.92792	0.00430	0.00430	0.04326	0.04333	0.04329
11	9.94544	9.92812	0.00450	0.00450	0.04527	0.04535	0.04531
12	9.94539	9.92807	0.00445	0.00445	0.04476	0.04484	0.04480
13	9.94579	9.92837	0.00485	0.00475	0.04879	0.04787	0.04833
14	9.94584	9.92842	0.00490	0.00480	0.04929	0.04837	0.04883
15	9.94574	9.92837	0.00480	0.00475	0.04829	0.04787	0.04808
16	9.94589	9.92857	0.00495	0.00495	0.04979	0.04988	0.04984
17	9.94619	9.92877	0.00525	0.00515	0.05281	0.05190	0.05235
18	9.94604	9.92872	0.00510	0.00510	0.05130	0.05139	0.05135
19	9.94624	9.92897	0.00530	0.00535	0.05331	0.05391	0.05361
20	9.94639	9.92912	0.00545	0.00550	0.05482	0.05542	0.05512
21	9.94674	9.92952	0.00580	0.00590	0.05834	0.05945	0.05890
22	9.94684	9.92962	0.00590	0.00600	0.05935	0.06046	0.05991
23	9.94689	9.92967	0.00595	0.00605	0.05985	0.06097	0.06041
24	9.94714	9.92992	0.00620	0.00630	0.06237	0.06348	0.06293

Table G.12 Expansion of 65RCF35 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.00551	10.02205	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.00601	10.02275	0.00050	0.00070	0.00500	0.00698	0.00599
2	10.00646	10.02305	0.00095	0.00100	0.00949	0.00998	0.00974
3	10.00691	10.02355	0.00140	0.00150	0.01399	0.01497	0.01448
4	10.00726	10.02380	0.00175	0.00175	0.01749	0.01746	0.01748
5	10.00781	10.02445	0.00230	0.00240	0.02299	0.02395	0.02347
6	10.00801	10.02455	0.00250	0.00250	0.02499	0.02494	0.02497
7	10.00861	10.02515	0.00310	0.00310	0.03098	0.03093	0.03096
8	10.00901	10.02555	0.00350	0.00350	0.03498	0.03492	0.03495
9	10.00931	10.02595	0.00380	0.00390	0.03798	0.03891	0.03845
10	10.00961	10.02615	0.00410	0.00410	0.04098	0.04091	0.04094
11	10.00971	10.02625	0.00420	0.00420	0.04198	0.04191	0.04194
12	10.00991	10.02635	0.00440	0.00430	0.04398	0.04291	0.04344
13	10.01011	10.02670	0.00460	0.00465	0.04597	0.04640	0.04619
14	10.01001	10.02655	0.00450	0.00450	0.04498	0.04490	0.04494
15	10.01021	10.02675	0.00470	0.00470	0.04697	0.04690	0.04694
16	10.01001	10.02665	0.00450	0.00460	0.04498	0.04590	0.04544
17	10.01031	10.02685	0.00480	0.00480	0.04797	0.04789	0.04793
18	10.01051	10.02705	0.00500	0.00500	0.04997	0.04989	0.04993
19	10.01061	10.02705	0.00510	0.00500	0.05097	0.04989	0.05043
20	10.01061	10.02715	0.00510	0.00510	0.05097	0.05089	0.05093
21	10.01081	10.02745	0.00530	0.00540	0.05297	0.05388	0.05343
22	10.01091	10.02755	0.00540	0.00550	0.05397	0.05488	0.05442
23	10.01086	10.02750	0.00535	0.00545	0.05347	0.05438	0.05393
24	10.01131	10.02785	0.00580	0.00580	0.05797	0.05787	0.05792

Table G.13 Expansion of 65RCF50 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	9.95433	9.96614	0.00000	0.00000	0.00000	0.00000	0.00000
1	9.95468	9.96654	0.00035	0.00040	0.00352	0.00401	0.00376
2	9.95493	9.96694	0.00060	0.00080	0.00603	0.00803	0.00703
3	9.95533	9.96714	0.00100	0.00100	0.01005	0.01003	0.01004
4	9.95548	9.96729	0.00115	0.00115	0.01155	0.01154	0.01155
5	9.95633	9.96834	0.00200	0.00220	0.02009	0.02207	0.02108
6	9.95658	9.96859	0.00225	0.00245	0.02260	0.02458	0.02359
7	9.95678	9.96879	0.00245	0.00265	0.02461	0.02659	0.02560
8	9.95738	9.96929	0.00305	0.00315	0.03064	0.03161	0.03112
9	9.95763	9.96944	0.00330	0.00330	0.03315	0.03311	0.03313
10	9.95788	9.96969	0.00355	0.00355	0.03566	0.03562	0.03564
11	9.95793	9.96974	0.00360	0.00360	0.03617	0.03612	0.03614
12	9.95813	9.96994	0.00380	0.00380	0.03817	0.03813	0.03815
13	9.95823	9.97004	0.00390	0.00390	0.03918	0.03913	0.03916
14	9.95843	9.97024	0.00410	0.00410	0.04119	0.04114	0.04116
15	9.95843	9.97034	0.00410	0.00420	0.04119	0.04214	0.04167
16	9.95858	9.97039	0.00425	0.00425	0.04269	0.04264	0.04267
17	9.95883	9.97054	0.00450	0.00440	0.04521	0.04415	0.04468
18	9.95903	9.97084	0.00470	0.00470	0.04722	0.04716	0.04719
19	9.95913	9.97089	0.00480	0.00475	0.04822	0.04766	0.04794
20	9.95923	9.97104	0.00490	0.00490	0.04922	0.04917	0.04920
21	9.95933	9.97114	0.00500	0.00500	0.05023	0.05017	0.05020
22	9.95943	9.97119	0.00510	0.00505	0.05123	0.05067	0.05095
23	9.95953	9.97124	0.00520	0.00510	0.05224	0.05117	0.05171
24	9.95973	9.97184	0.00540	0.00570	0.05425	0.05719	0.05572

Table G.14 Expansion of 65RCB20 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.11417	9.98504	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.11467	9.98554	0.00050	0.00050	0.00494	0.00501	0.00498
2	10.11547	9.98624	0.00130	0.00120	0.01285	0.01202	0.01244
3	10.11572	9.98654	0.00155	0.00150	0.01533	0.01502	0.01517
4	10.11622	9.98709	0.00205	0.00205	0.02027	0.02053	0.02040
5	10.11707	9.98774	0.00290	0.00270	0.02867	0.02704	0.02786
6	10.11727	9.98804	0.00310	0.00300	0.03065	0.03004	0.03035
7	10.11742	9.98829	0.00325	0.00325	0.03213	0.03255	0.03234
8	10.11772	9.98854	0.00355	0.00350	0.03510	0.03505	0.03508
9	10.11787	9.98864	0.00370	0.00360	0.03658	0.03605	0.03632
10	10.11817	9.98894	0.00400	0.00390	0.03955	0.03906	0.03930
11	10.11847	9.98924	0.00430	0.00420	0.04251	0.04206	0.04229
12	10.11857	9.98934	0.00440	0.00430	0.04350	0.04306	0.04328
13	10.11897	9.98974	0.00480	0.00470	0.04746	0.04707	0.04726
14	10.11917	9.98989	0.00500	0.00485	0.04944	0.04857	0.04900
15	10.11912	9.98994	0.00495	0.00490	0.04894	0.04907	0.04901
16	10.11932	9.99004	0.00515	0.00500	0.05092	0.05007	0.05050
17	10.11947	9.99024	0.00530	0.00520	0.05240	0.05208	0.05224
18	10.11967	9.99044	0.00550	0.00540	0.05438	0.05408	0.05423
19	10.12012	9.99089	0.00595	0.00585	0.05883	0.05859	0.05871
20	10.12037	9.99114	0.00620	0.00610	0.06130	0.06109	0.06120
21	10.12067	9.99144	0.00650	0.00640	0.06427	0.06410	0.06418
22	10.12097	9.99174	0.00680	0.00670	0.06723	0.06710	0.06717
23	10.12132	9.99209	0.00715	0.00705	0.07069	0.07061	0.07065
24	10.12147	9.99224	0.00730		0.07218	0.07211	0.07214

Table G.15 Expansion of 65RCB35 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.03307	10.03937	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.03387	10.04017	0.00080	0.00080	0.00797	0.00797	0.00797
2	10.03417	10.04037	0.00110	0.00100	0.01096	0.00996	0.01046
3	10.03477	10.04107	0.00170	0.00170	0.01694	0.01693	0.01694
4	10.03502	10.04142	0.00195	0.00205	0.01944	0.02042	0.01993
5	10.03537	10.04157	0.00230	0.00220	0.02292	0.02191	0.02242
6	10.03557	10.04187	0.00250	0.00250	0.02492	0.02490	0.02491
7	10.03607	10.04227	0.00300	0.00290	0.02990	0.02889	0.02939
8	10.03627	10.04257	0.00320	0.00320	0.03189	0.03187	0.03188
9	10.03662	10.04292	0.00355	0.00355	0.03538	0.03536	0.03537
10	10.03687	10.04337	0.00380	0.00400	0.03787	0.03984	0.03886
11	10.03697	10.04347	0.00390	0.00410	0.03887	0.04084	0.03986
12	10.03727	10.04367	0.00420	0.00430	0.04186	0.04283	0.04235
13	10.03747	10.04387	0.00440	0.00450	0.04385	0.04482	0.04434
14	10.03762	10.04407	0.00455	0.00470	0.04535	0.04682	0.04608
15	10.03757	10.04397	0.00450	0.00460	0.04485	0.04582	0.04534
16	10.03773	10.04413	0.00465	0.00475	0.04640	0.04736	0.04688
17	10.03787	10.04417	0.00480	0.00480	0.04784	0.04781	0.04783
18	10.03797	10.04427	0.00490	0.00490	0.04884	0.04881	0.04882
19	10.03837	10.04467	0.00530	0.00530	0.05283	0.05279	0.05281
20	10.03852	10.04482	0.00545	0.00545	0.05432	0.05429	0.05430
21	10.03867	10.04497	0.00560	0.00560	0.05582	0.05578	0.05580
22	10.03887	10.04517	0.00580	0.00580	0.05781	0.05777	0.05779
23	10.03902	10.04542	0.00595	0.00605	0.05930	0.06026	0.05978
24	10.03937	10.04567	0.00630	0.00630	0.06279	0.06275	0.06277

Table G.16 Expansion of 65RCB50 concrete immersed in 5% Na_2SO_4 solution

Immersed Time (months)	Length (in)		Diff. Length (in)		Expansion (%)		Average (%)
	No.1	No.2	No.1	No.2	No.1	No.2	
0	10.00866	10.07480	0.00000	0.00000	0.00000	0.00000	0.00000
1	10.00916	10.07530	0.00050	0.00050	0.00500	0.00496	0.00498
2	10.00946	10.07560	0.00080	0.00080	0.00799	0.00794	0.00797
3	10.00976	10.07590	0.00110	0.00110	0.01099	0.01092	0.01095
4	10.01021	10.07635	0.00155	0.00155	0.01549	0.01538	0.01544
5	10.01076	10.07685	0.00210	0.00205	0.02098	0.02035	0.02066
6	10.01086	10.07700	0.00220	0.00220	0.02198	0.02184	0.02191
7	10.01121	10.07745	0.00255	0.00265	0.02548	0.02630	0.02589
8	10.01146	10.07770	0.00280	0.00290	0.02798	0.02878	0.02838
9	10.01176	10.07790	0.00310	0.00310	0.03097	0.03077	0.03087
10	10.01191	10.07805	0.00325	0.00325	0.03247	0.03226	0.03237
11	10.01236	10.07850	0.00370	0.00370	0.03697	0.03673	0.03685
12	10.01251	10.07870	0.00385	0.00390	0.03847	0.03871	0.03859
13	10.01266	10.07890	0.00400	0.00410	0.03997	0.04070	0.04033
14	10.01276	10.07900	0.00410	0.00420	0.04096	0.04169	0.04133
15	10.01296	10.07910	0.00430	0.00430	0.04296	0.04268	0.04282
16	10.01301	10.07915	0.00435	0.00435	0.04346	0.04318	0.04332
17	10.01326	10.07940	0.00460	0.00460	0.04596	0.04566	0.04581
18	10.01336	10.07960	0.00470	0.00480	0.04696	0.04764	0.04730
19	10.01356	10.07970	0.00490	0.00490	0.04896	0.04864	0.04880
20	10.01376	10.08000	0.00510	0.00520	0.05096	0.05161	0.05128
21	10.01406	10.08030	0.00540	0.00550	0.05395	0.05459	0.05427
22	10.01416	10.08040	0.00550	0.00560	0.05495	0.05558	0.05527
23	10.01456	10.08050	0.00590	0.00570	0.05895	0.05658	0.05776
24	10.01466	10.08090	0.00600	0.00610	0.05995	0.06055	0.06025

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มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ข้อตกลงว่าด้วยการโอนสิทธิในทรัพย์สินทางปัญญาของนักศึกษาระดับบัณฑิตศึกษา

วันที่.....19.....เดือน....มิถุนายน.... พ.ศ....2555....

ข้าพเจ้า (นาย/~~นาง/นางสาว~~).....**รัฐพล สมนา**.....รหัสประจำตัว...**49500103**.....
เป็นนักศึกษาของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี
ระดับ ❍ ประกาศนียบัตรบัณฑิต ❍ ปริญญาโท ∅ ปริญญาเอก
หลักสูตร....**ปรัชญาดุษฎีบัณฑิต**..... สาขาวิชา....**วิศวกรรมโยธา**.....คณะ.....**วิศวกรรมศาสตร์**.....
อยู่บ้านเลขที่..**457**..หมู่.....**2**.....ตรอก/ซอย.....-.....ถนน.....-.....ตำบล/แขวง.....**บ้านเกาะ**...
อำเภอ/เขต....**เมือง**.....จังหวัด....**นครราชสีมา**.....รหัสไปรษณีย์.....**30000**.....
เป็น "ผู้โอน"ขอโอนสิทธิในทรัพย์สินทางปัญญาให้ไว้กับมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี โดยมี **รศ.ดร.สักกมน เทพหัสดิน ณ อยุธยา** ตำแหน่ง **รองคณบดีฝ่ายวิจัยและวิชาการ** คณะวิศวกรรมศาสตร์ เป็นตัวแทน "ผู้รับโอน" สิทธิในทรัพย์สินทางปัญญาและมีข้อตกลงดังนี้

1. ข้าพเจ้าได้จัดทำวิทยานิพนธ์เรื่อง....**การใช้เถ้าถ่านหินบดละเอียดที่เผาด้วยระบบฟลูอิดไดซ์เบดและเถ้าชานอ้อยบดละเอียดเพื่อปรับปรุงคุณสมบัติของคอนกรีตที่ใช้มวลรวมจากการย่อยเศษคอนกรีต** ซึ่งอยู่ในความควบคุมของ.....**ศ.ดร.ชัย จาตุรพิทักษ์กุล**.....อาจารย์ที่ปรึกษา และ/หรือ .....-.....อาจารย์ที่ปรึกษาร่วม ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 และถือว่าเป็นส่วนหนึ่งของการศึกษาตามหลักสูตรของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

2. ข้าพเจ้าตกลงโอนลิขสิทธิ์จากผลงานทั้งหมดที่เกิดขึ้นจากการสร้างสรรค์ของข้าพเจ้าในวิทยานิพนธ์ให้กับมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ตลอดอายุแห่งการคุ้มครองลิขสิทธิ์ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 ตั้งแต่วันที่ได้รับอนุมัติโครงร่างวิทยานิพนธ์จากมหาวิทยาลัย

3. ในกรณีที่ข้าพเจ้าประสงค์จะนำวิทยานิพนธ์ไปใช้ในการเผยแพร่ในสื่อใดๆ ก็ตาม ข้าพเจ้าจะต้องระบุว่าวิทยานิพนธ์เป็นผลงานของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีทุกครั้งที่มีการเผยแพร่

4. ในกรณีที่ข้าพเจ้าประสงค์จะนำวิทยานิพนธ์ไปเผยแพร่ หรือให้ผู้อื่นทำซ้ำหรือดัดแปลงหรือเผยแพร่ต่อสาธารณชนหรือกระทำการอื่นใด ตามพระราชบัญญัติลิขสิทธิ์ พ.ศ. 2537 โดยมีค่าตอบแทนในเชิงธุรกิจ ข้าพเจ้าจะกระทำได้เมื่อได้รับความยินยอมเป็นลายลักษณ์อักษรจากมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีก่อน

5. ในกรณีที่ข้าพเจ้าประสงค์จะนำข้อมูลจากวิทยานิพนธ์ไปประดิษฐ์หรือพัฒนาต่อยอดเป็นสิ่งประดิษฐ์หรืองานทรัพย์สินทางปัญญาประเภทอื่น ภายในระยะเวลาสิบ (10) ปีนับจากวันลงนามในข้อตกลงฉบับนี้ ข้าพเจ้าจะกระทำได้เมื่อได้รับความยินยอมเป็นลายลักษณ์อักษรจากมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี และมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีมีสิทธิในทรัพย์สินทางปัญญานั้น พร้อมกับได้รับชำระค่าตอบแทนการอนุญาตให้ใช้สิทธิดังกล่าว รวมถึงการจัดสรรผลประโยชน์อันพึงเกิดขึ้นจากส่วนใดส่วนหนึ่งหรือ

ทั้งหมดของวิทยานิพนธ์ในอนาคต โดยให้เป็นไปตามระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วย การบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538

6. ในกรณีที่มีผลประโยชน์เกิดขึ้นจากวิทยานิพนธ์หรืองานทรัพย์สินทางปัญญาอื่นที่ข้าพเจ้าทำขึ้นโดยมีมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีเป็นเจ้าของ ข้าพเจ้าจะมีสิทธิได้รับการจัดสรรผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญาดังกล่าวตามอัตราที่กำหนดไว้ในระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วย การบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538

ลงชื่อ.....ผู้โอนลิขสิทธิ์
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นักศึกษา

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