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APPENDIX A

Setting Times of Concretes

Table A.1 Setting times of CR-FN(0.65) concrete

Sample: CR-FN(0.65)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
270	1	28	28	28
330	1	66	58	62
420	1/2	50	50	100
600	1/2	92	94	186
720	1/4	68	82	300
960	1/10	58	60	590
1080	1/20	40	36	760
1260	1/20	56	60	1160
1560	1/40	54	60	2280
1740	1/40	76	78	3080
2040	1/40	102	104	4120

Initial Setting Time	910 minutes	15:10 hr:min
Final Setting Time	1985 minutes	33:05 hr:min

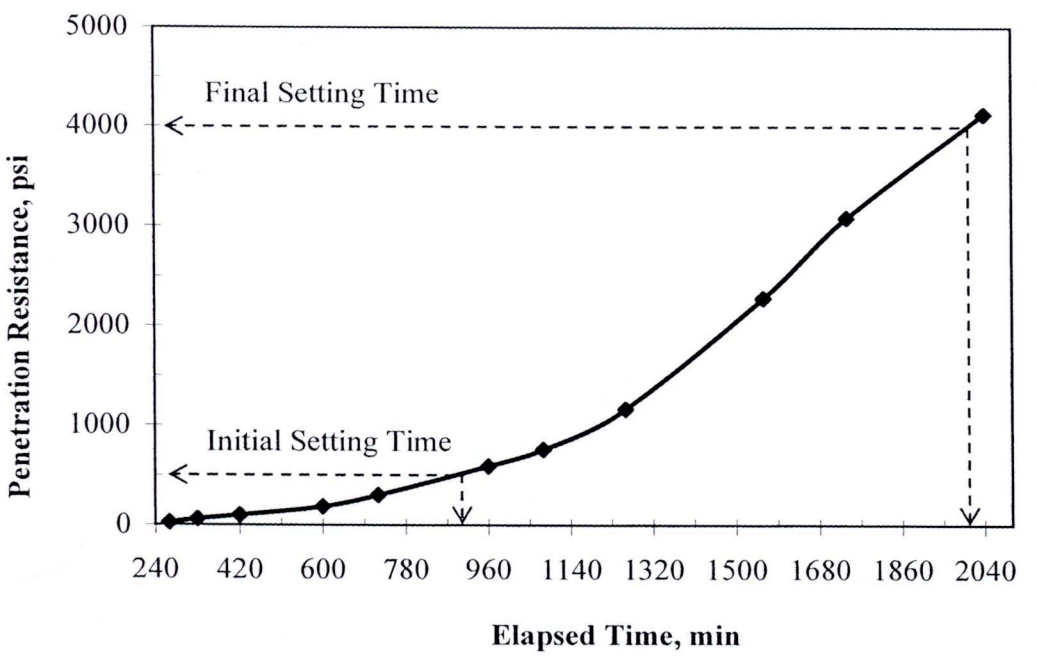


Table A.2 Setting times of CR-FN(0.65)10 concrete

Sample: CR-FN(0.65)10			Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)	Average Penetration Resistance (psi)
		Sample 1 / Sample 2	
160	1	48 / 50	49
215	1	84 / 106	95
275	1/2	104 / 102	206
335	1/4	80 / 66	292
395	1/10	52 / 50	510
455	1/10	80 / 64	720
515	1/10	84 / 80	820
575	1/20	70 / 48	1180
635	1/20	84 / 92	1760
695	1/40	60 / 58	2360
755	1/40	72 / 70	2840
815	1/40	94 / 80	3680
890	1/40	108 / 106	4360

Initial Setting Time	390 minutes	6:30 hr:min
Final Setting Time	850 minutes	14:10 hr:min

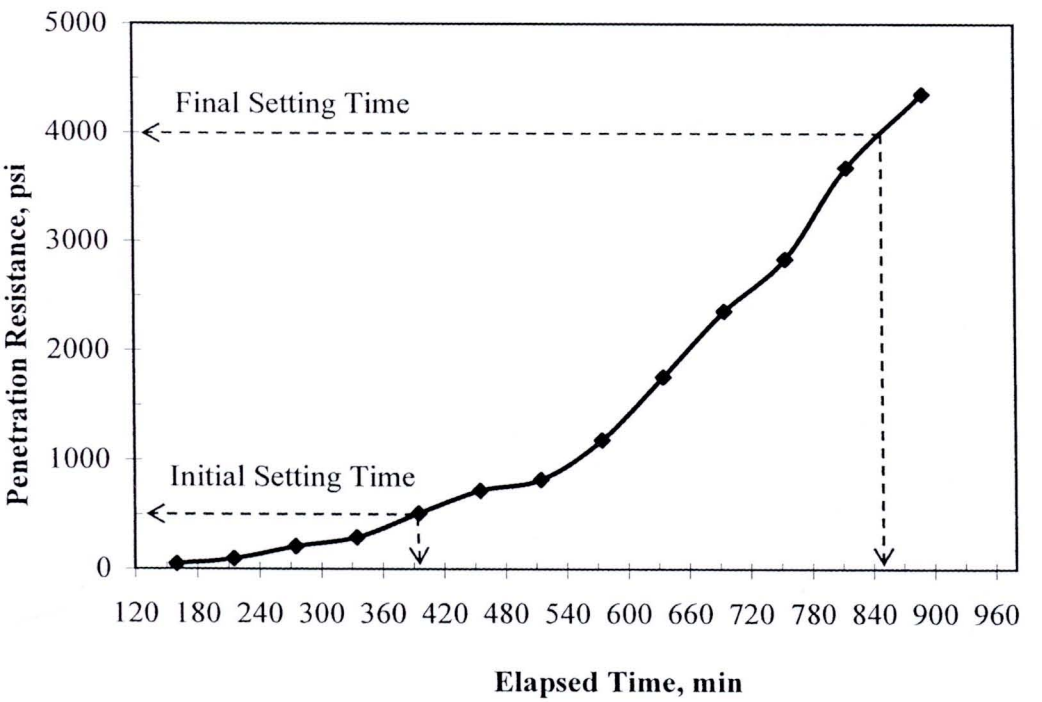


Table A.3 Setting times of NC(0.65) concrete

Sample: NC(0.65)			Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)	Average Penetration Resistance (psi)
		Sample 1 / Sample 2	
150	1/2	38 / 58	96
210	1/2	132 / 124	256
270	1/4	170 / 186	710
330	1/20	92 / 90	1820
390	1/40	96 / 102	3960
450	1/40	156 / 176	6640

Initial Setting Time	250 minutes	4:10 hr:min
Final Setting Time	390 minutes	6:30 hr:min

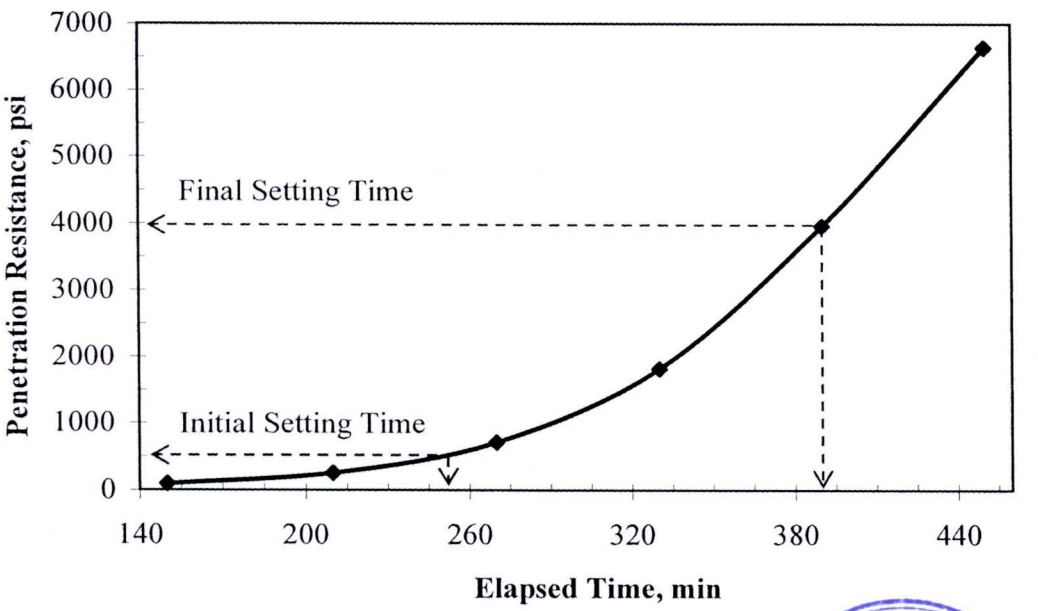


Table A.4 Setting times of CR-FM(0.45) concrete

Sample: CR-FM(0.45)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
445	1	88	94	91
610	1/2	178	146	324
700	1/4	134	130	528
790	1/10	136	116	1260
850	1/20	96	84	1800
1200	1/40	130	124	5080

Initial Setting Time	690 minutes	11:30 hr:min
Final Setting Time	1085 minutes	18:05 hr:min

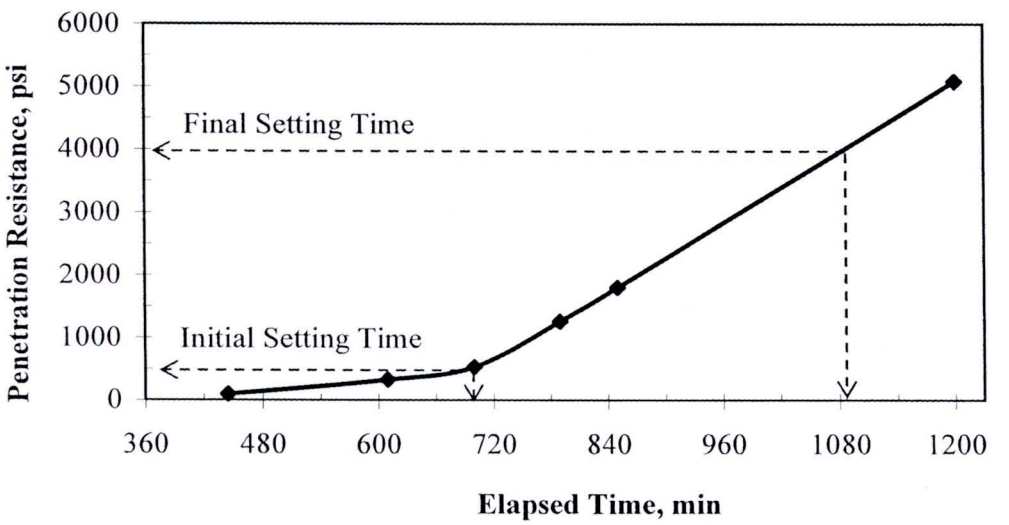


Table A.5 Setting times of CR-FM(0.45)10 concrete

Sample: CR-FM(0.45)10				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
235	1	40	56	48
295	1	110	136	123
355	1/2	112	184	296
415	1/4	114	152	532
475	1/10	104	112	1080
535	1/20	70	90	1600
595	1/40	92	64	3120
655	1/40	168	130	5960

Initial Setting Time	410 minutes	6:50 hr:min
Final Setting Time	615 minutes	10:15 hr:min

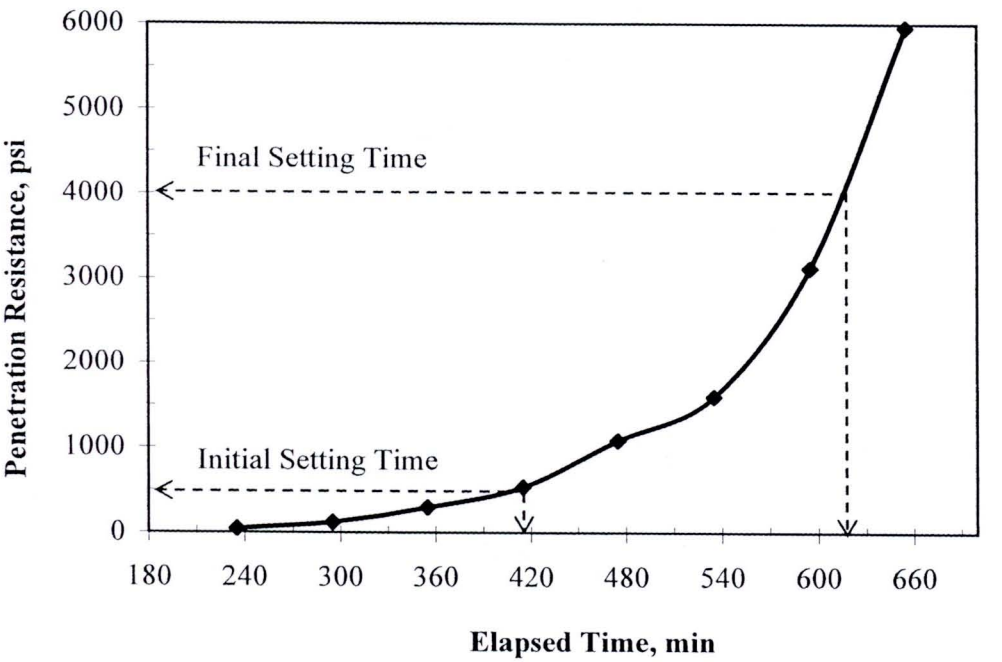


Table A.6 Setting times of CR-FN(0.45) concrete

Sample: CR-FN(0.45)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
270	1	45	44	45
580	1/4	80	76	312
985	1/10	128	80	1040
1210	1/20	104	84	1880
1420	1/40	70	66	2720
1605	1/40	92	82	3480
1845	1/40	110	106	4320

Initial Setting Time	700 minutes	11:40 hr:min
Final Setting Time	1750 minutes	29:10 hr:min

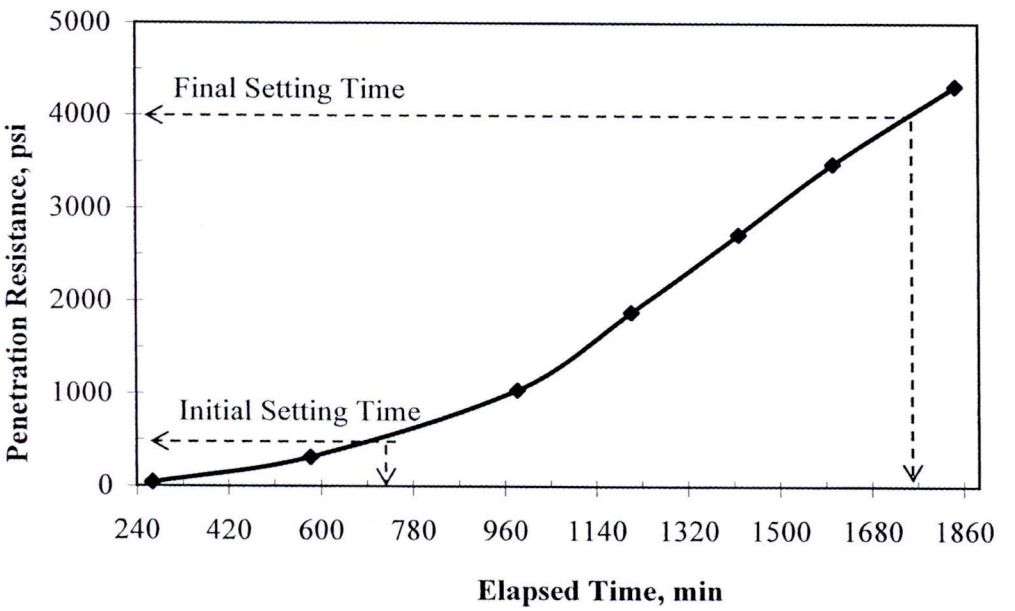


Table A.7 Setting times of CR-FN(0.45)10 concrete

Sample: CR-FN(0.45)10				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
145	1	96	114	105
205	1/2	146	168	314
265	1/4	140	146	572
325	1/10	76	106	910
385	1/20	66	70	1360
445	1/20	76	104	1800
505	1/40	64	76	2800
565	1/40	116	100	4320

Initial Setting Time	245 minutes	4:05 hr:min
Final Setting Time	550 minutes	9:10 hr:min

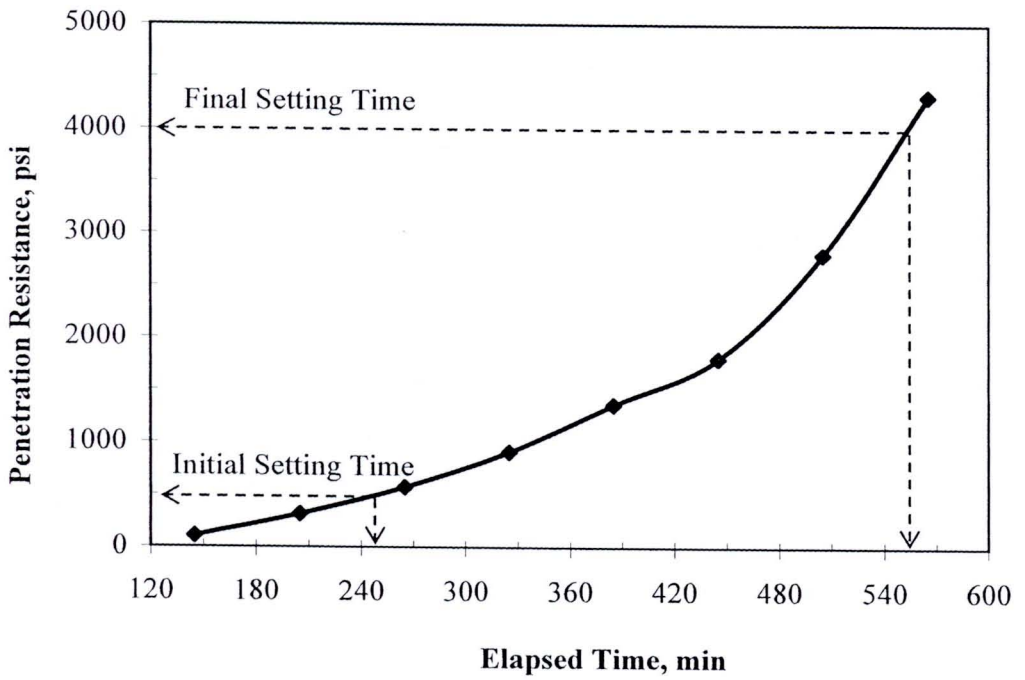


Table A.8 Setting times of CR-PA(0.45) concrete

Sample: CR-PA(0.45)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
560	1	50	60	55
770	1/2	94	60	154
1010	1/4	120	138	516
1250	1/10	136	144	1400
1400	1/20	112	122	2340
1580	1/40	108	112	4400

Initial Setting Time	995 minutes	16:35 hr:min
Final Setting Time	1550 minutes	25:50 hr:min

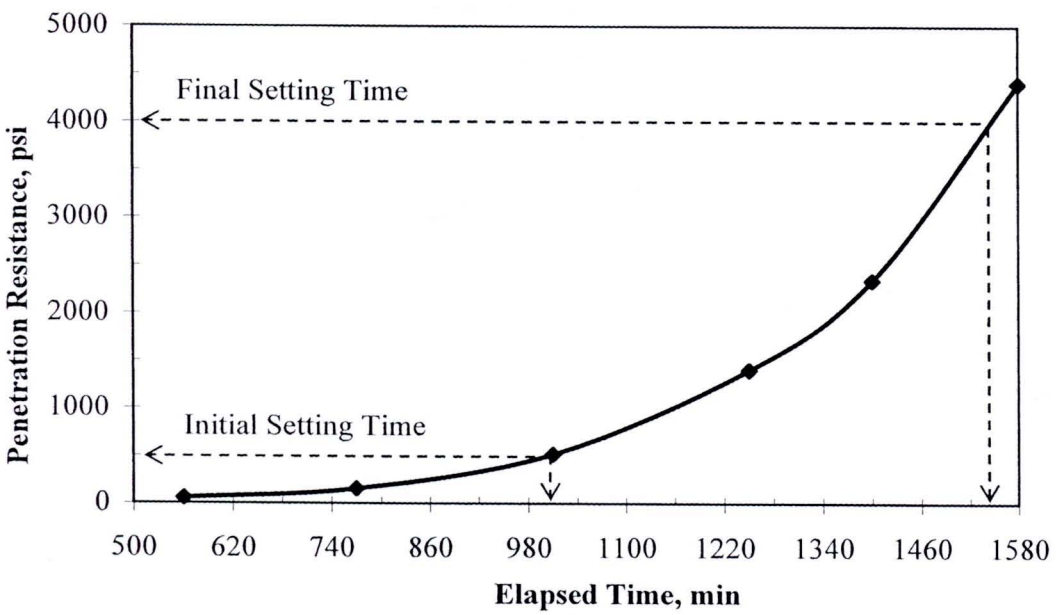


Table A.9 Setting times of CR-PA(0.45)10 concrete

Sample: CR-PA(0.45)10				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
205	1	100	86	93
325	1/2	114	108	222
445	1/4	140	122	524
565	1/10	106	86	960
645	1/20	84	50	1340
735	1/20	90	100	1900
805	1/40	60	70	2600
835	1/40	66	84	3000
900	1/40	120	130	5000

Initial Setting Time	445 minutes	7:25 hr:min
Final Setting Time	860 minutes	14:20 hr:min

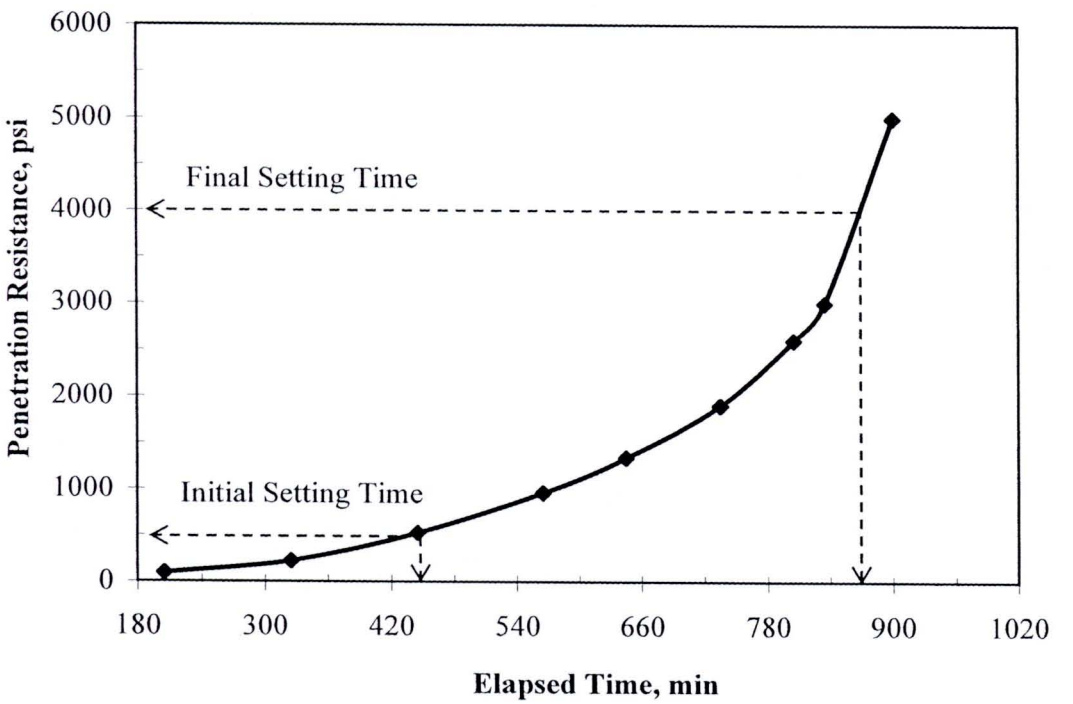


Table A.10 Setting times of CR-RA(0.45) concrete

Sample: CR-RA(0.45)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
625	1	76	74	75
705	1/2	72	74	146
1110	1/10	40	38	390
1335	1/10	50	56	530
1545	1/20	32	34	660
1725	1/20	38	38	760
2145	1/40	32	32	1280
2565	1/40	54	52	2120
2925	1/40	70	74	2880
3225	1/40	84	86	3400
3330	1/40	92	90	3640
3585	1/40	100	102	4040

Initial Setting Time	1300 minutes	21:40 hr:min
Final Setting Time	3550 minutes	59:10 hr:min

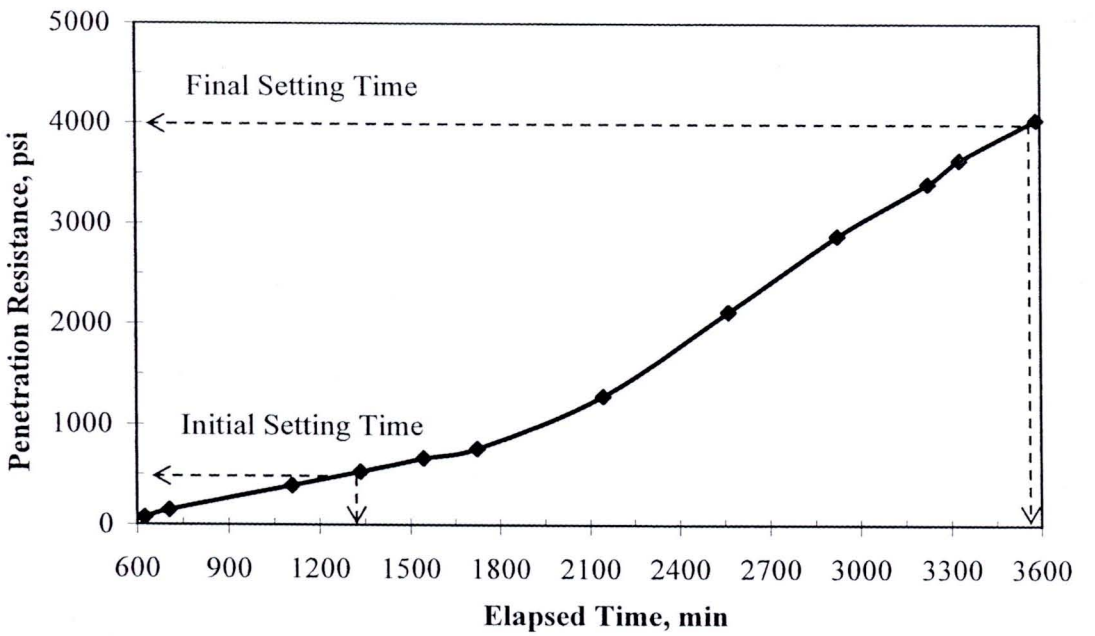


Table A.11 Setting times of CR-RA(0.45)10 concrete

Sample: CR-RA(0.45)10				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
165	1	124	124	124
285	1/2	164	192	356
345	1/4	126	144	540
405	1/10	88	92	900
600	1/20	108	106	2140
675	1/40	56	80	2720
855	1/40	86	104	3800
915	1/40	106	108	4280

Initial Setting Time	340 minutes	5:40 hr:min
Final Setting Time	880 minutes	14:40 hr:min

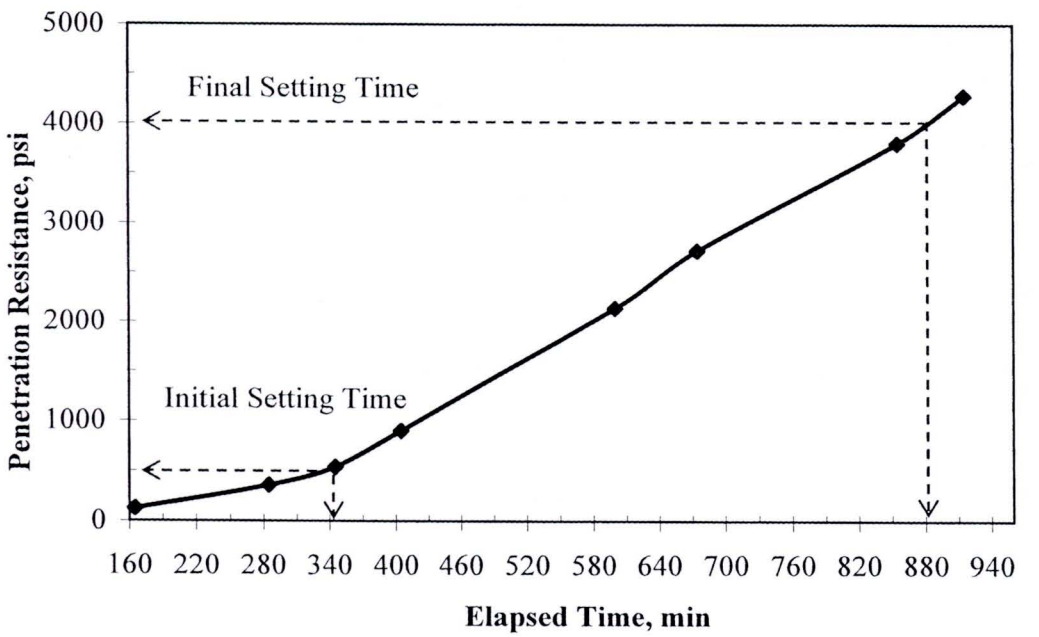


Table A.12 Setting times of NC(0.45) concrete

Sample: NC(0.45)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1.	Sample 2.	
145	1	30	30	30
175	1	70	60	65
220	1/2	190	190	380
250	1/4	160	160	640
265	1/10	82	90	860
290	1/20	80	56	1360
320	1/40	80	70	3000
350	1/40	96	116	4240

Initial Setting Time	235 minutes	3:55 hr:min
Final Setting Time	345 minutes	5:45 hr:min

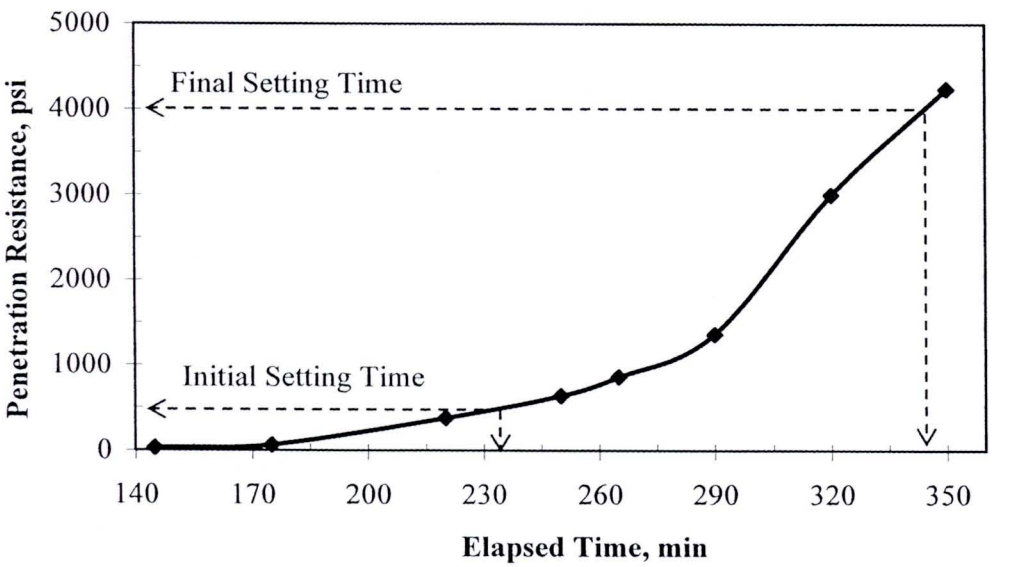


Table A.13 Setting times of CR-FM(0.25) concrete

Sample: CR-FM(0.25)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
160	1	96	168	132
210	1/2	140	86	226
280	1/4	170	90	520
330	1/10	118	140	1290
390	1/20	134	168	3020
450	1/40	112	110	4440

Initial Setting Time	275 minutes	4:35 hr:min
Final Setting Time	430 minutes	7:10 hr:min

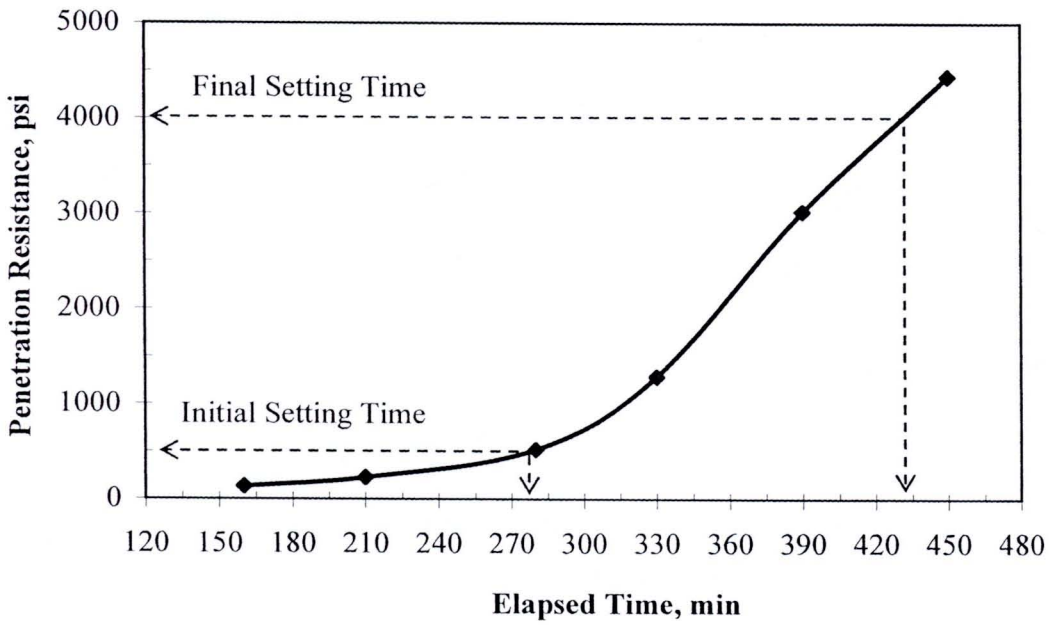


Table A.14 Setting times of CR-FM(0.25)10 concrete

Sample: CR-FM(0.25)10				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
120	1	38	40	39
150	1/2	154	144	298
190	1/4	142	166	616
230	1/10	128	130	1290
270	1/20	122	122	2440
340	1/40	130	138	5360
Initial Setting Time		175 minutes		2:55 hr:min
Final Setting Time		310 minutes		5:10 hr:min

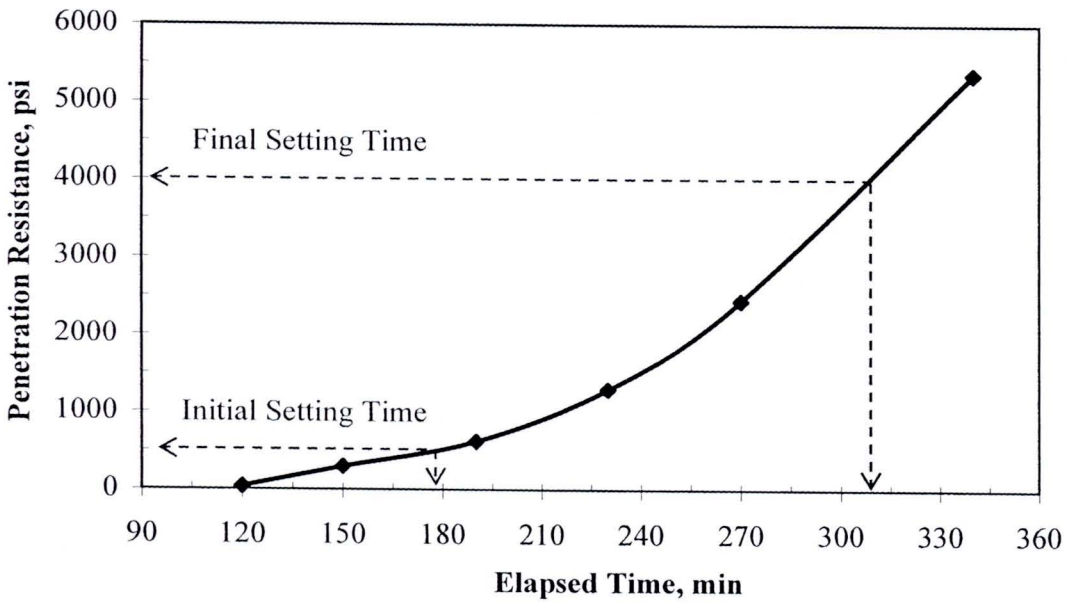
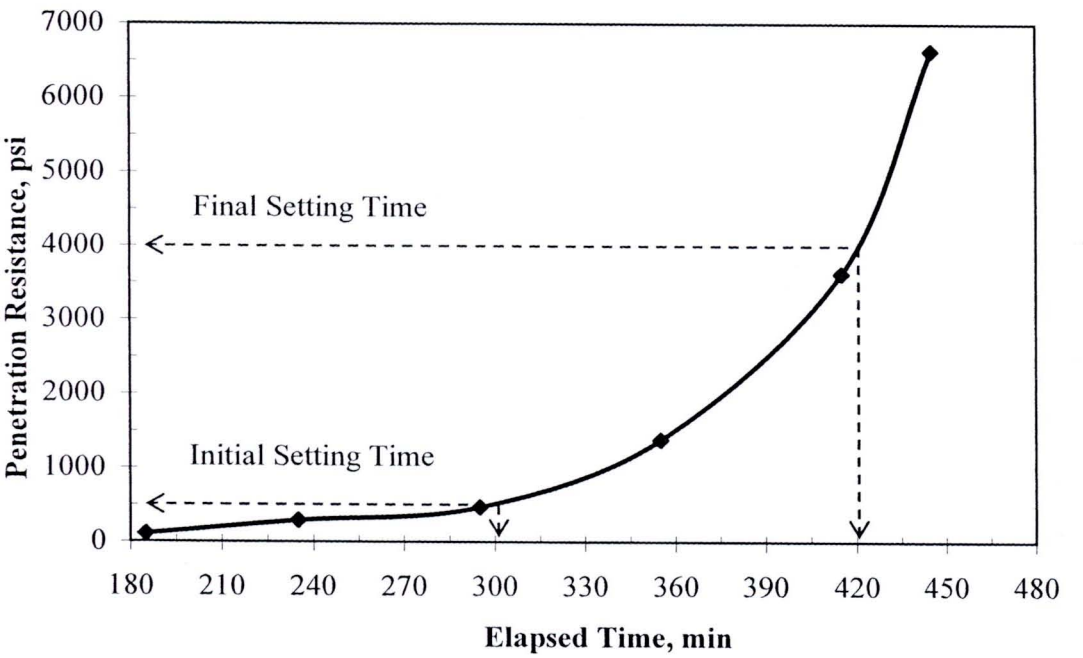


Table A.15 Setting times of NC(0.25) concrete

Sample: NC(0.25)				Temperature 24°C
Elapsed Time (min)	Needle Area (in^2)	Load (pounds)		Average Penetration Resistance (psi)
		Sample 1	Sample 2	
185	1	110	108	109
235	1/2	112	180	292
295	1/4	130	106	472
355	1/10	132	144	1380
415	1/20	190	172	3620
445	1/40	156	176	6640

Initial Setting Time	300 minutes	5:00 hr:min
Final Setting Time	420 minutes	7:00 hr:min



APPENDIX B

Heat Evolution of Fresh Concretes

Table B.1 Heat evolution of fresh concretes

Time (Hours)	Temperature (Degree Celsius)					
	CR-FM(0.25)		CR-FM(0.25)10		NC(0.25)	
	Actual	Rise	Actual	Rise	Actual	Rise
0	30	1	30	1	29	0
1	31	2	31	2	30	1
2	33	4	32	3	31	2
3	34	5	33	4	31	2
4	35	6	34	5	32	3
5	35	6	35	6	33	4
6	36	7	35	6	33	4
7	36	7	36	7	34	5
8	36	7	37	8	35	6
9	37	8	37	8	38	9
10	37	8	38	9	44	15
11	38	9	39	10	53	24
12	38	9	40	11	61	32
14	39	10	42	13	68	39
16	40	11	43	14	70	41
18	40	11	43	14	71	42
20	40	11	44	15	70	41
22	40	11	44	15	69	40
24	40	11	44	15	67	38
28	39	10	44	15	63	34
32	39	10	44	15	60	31
36	39	10	44	15	57	28
40	38	9	43	14	55	26
44	38	9	42	13	52	23
48	38	9	42	13	50	21
54	37	8	40	11	47	18
60	37	8	39	10	45	16
66	36	7	38	9	42	13
72	36	7	37	8	41	12
84	35	6	35	6	38	9
96	34	5	34	5	36	7
108	33	4	33	4	35	6
120	33	4	32	3	34	5
132	32	3	32	3	33	4
144	32	3	31	2	32	3
156	31	2	31	2	32	3
168	31	2	31	2	31	2

Note: Temperature of Environment is 29 Degree Celsius

APPENDIX C

Compressive Strength of Concretes

Table C.1 Compressive strengths of CR-FN(0.65) concrete

Concrete : CR-FN(0.65) (W/B = 0.65)									Slump = 85 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.00	20.17	3.66	2,312	2,319	6.58	8.38	8.36
	2	9.99	20.20	3.71	2,344		6.14	7.84	
	3	10.08	20.26	3.72	2,302		7.06	8.85	
28	1	10.05	20.40	3.78	2,337	2,332	8.39	10.58	10.42
	2	9.94	20.40	3.75	2,370		7.78	10.03	
	3	10.05	20.12	3.65	2,288		8.44	10.64	
60	1	9.97	20.17	3.75	2,383	2,379	11.16	14.30	13.55
	2	10.00	20.39	3.79	2,368		10.14	12.92	
	3	9.96	20.18	3.75	2,386		10.45	13.42	
90	1	10.00	20.30	3.70	2,322	2,342	10.81	13.76	13.73
	2	10.01	20.55	3.83	2,369		10.75	13.67	
	3	10.00	20.47	3.75	2,334		10.81	13.76	
180	1	10.06	20.38	3.76	2,322	2,333	11.62	14.63	14.22
	2	10.18	20.27	3.82	2,317		11.11	13.66	
	3	9.97	20.04	3.69	2,360		11.21	14.37	

Table C.2 Compressive strengths of CR-FN(0.65)10 concrete

Concrete : CR-FN(0.65)10 (W/B = 0.65)									Slump = 70 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.00	20.03	3.70	2,351	2,357	8.62	10.98	10.40
	2	10.02	20.03	3.70	2,344		8.11	10.29	
	3	9.96	20.03	3.71	2,376		7.73	9.93	
28	1	9.94	20.25	3.75	2,386	2,363	12.94	16.68	15.30
	2	10.02	20.27	3.77	2,362		11.54	14.64	
	3	10.02	20.80	3.84	2,341		11.49	14.58	
60	1	10.04	20.23	3.71	2,315	2,324	17.14	21.66	22.54
	2	10.04	20.78	3.85	2,338		18.67	23.59	
	3	9.98	20.46	3.71	2,319		17.49	22.37	
90	1	10.06	20.53	3.77	2,311	2,328	19.13	24.08	24.63
	2	10.09	20.46	3.80	2,322		19.21	24.04	
	3	9.95	20.57	3.76	2,352		20.04	25.79	
180	1	9.96	20.37	3.82	2,408	2,372	20.50	26.32	25.90
	2	10.04	20.34	3.81	2,367		19.63	24.81	
	3	10.00	20.35	3.74	2,341		20.85	26.56	

Table C.3 Compressive strengths of NC(0.65) concrete

Concrete : NC(0.65) (W/B = 0.65)									Slump = 70 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.05	19.60	3.71	2,387	2,317	18.37	23.17	23.54
	2	9.90	20.20	3.72	2,394		18.74	24.35	
	3	10.40	20.30	3.74	2,170		19.60	23.08	
28	1	9.97	20.08	3.70	2,361	2,372	25.06	32.11	31.92
	2	9.97	20.09	3.73	2,379		24.45	31.34	
	3	10.02	20.25	3.79	2,375		25.47	32.32	
60	1	10.03	20.05	3.70	2,337	2,364	29.11	36.87	36.21
	2	9.95	20.13	3.73	2,384		26.34	33.89	
	3	9.95	20.25	3.73	2,370		29.44	37.88	
90	1	10.00	20.23	3.70	2,330	2,327	28.07	35.76	37.45
	2	10.00	20.17	3.70	2,337		29.98	38.19	
	3	10.04	20.20	3.70	2,315		30.38	38.39	
180	1	10.05	19.96	3.68	2,325	2,329	30.54	38.52	38.94
	2	10.09	20.14	3.76	2,336		32.58	40.76	
	3	10.07	20.10	3.72	2,325		29.89	37.55	

Table C.4 Compressive strengths of CR-FM(0.45) concrete

Concrete : CR-FM(0.45) (W/B = 0.45)									Slump = 100 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	9.98	20.39	3.73	2,338	2,327	6.14	7.85	7.28
	2	10.04	20.32	3.72	2,310		5.71	7.22	
	3	9.97	20.34	3.70	2,331		5.27	6.76	
28	1	10.00	20.17	3.71	2,345	2,324	10.11	12.87	12.54
	2	10.20	20.22	3.72	2,254		9.60	11.75	
	3	9.96	20.04	3.70	2,373		10.12	13.00	
60	1	10.02	20.15	3.72	2,341	2,342	12.51	15.88	16.35
	2	10.04	20.32	3.72	2,312		13.07	16.52	
	3	9.97	20.33	3.76	2,371		13.00	16.66	
90	1	9.91	20.12	3.68	2,371	2,365	15.15	19.65	19.87
	2	10.00	20.40	3.78	2,359		15.65	19.93	
	3	9.99	20.45	3.76	2,346		15.68	20.01	
180	1	9.99	20.13	3.80	2,410	2,405	17.21	21.96	22.52
	2	9.95	20.53	3.83	2,400		17.33	22.30	
	3	10.01	20.26	3.79	2,378		18.33	23.30	

Table C.5 Compressive strengths of CR-FM(0.45)10 concrete

Concrete : CR-FM(0.45)10 (W/B = 0.45)									Slump = 90 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.00	20.50	3.78	2,351	2,341	9.51	12.11	11.66
	2	10.10	20.40	3.81	2,335		8.67	10.83	
	3	10.06	20.50	3.81	2,337		9.57	12.05	
28	1	10.00	20.25	3.90	2,455	2,402	13.72	17.48	17.59
	2	9.97	20.44	3.80	2,381		13.73	17.59	
	3	9.94	20.11	3.70	2,370		13.73	17.70	
60	1	10.12	20.27	3.82	2,345	2,360	18.95	23.58	24.59
	2	10.00	20.48	3.82	2,375		20.50	26.11	
	3	10.03	20.57	3.83	2,359		19.02	24.09	
90	1	9.96	20.44	3.82	2,398	2,358	22.44	28.81	28.23
	2	9.96	20.46	3.75	2,350		22.11	28.39	
	3	10.13	20.31	3.81	2,326		22.14	27.49	
180	1	9.93	20.54	3.85	2,422	2,407	22.46	29.01	29.22
	2	10.06	20.37	3.89	2,404		24.44	30.77	
	3	10.01	20.48	3.86	2,396		21.94	27.89	

Table C.6 Compressive strengths of CR-FN(0.45) concrete

Concrete : CR-FN(0.45) (W/B = 0.45)									Slump = 65 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.14	20.22	3.75	2,298	2,278	8.87	10.99	10.95
	2	9.99	20.39	3.71	2,323		8.51	10.86	
	3	10.30	20.73	3.82	2,213		9.17	11.01	
28	1	10.04	20.22	3.67	2,294	2,313	24.11	30.47	29.01
	2	9.99	20.04	3.69	2,350		22.60	28.85	
	3	9.99	19.98	3.59	2,293		21.71	27.71	
60	1	9.97	20.14	3.65	2,323	2,335	26.35	33.77	32.31
	2	9.99	20.17	3.69	2,335		24.72	31.55	
	3	9.94	20.38	3.71	2,347		24.52	31.61	
90	1	9.97	19.77	3.56	2,308	2,308	27.49	35.23	34.25
	2	9.94	20.44	3.69	2,328		26.07	33.61	
	3	10.04	20.10	3.64	2,289		26.83	33.91	
180	1	10.06	20.58	3.76	2,300	2,291	28.10	35.38	35.01
	2	10.11	20.62	3.76	2,273		27.49	34.26	
	3	10.01	20.62	3.73	2,300		27.85	35.41	

Table C.7 Compressive strengths of CR-FN(0.45)10 concrete

Concrete : CR-FN(0.45)10 (W/B = 0.45)									Slump = 90 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.00	20.07	3.66	2,321	2,322	15.78	20.10	17.34
	2	10.03	20.54	3.75	2,311		12.27	15.54	
	3	9.95	20.30	3.68	2,334		12.74	16.39	
28	1	9.98	20.10	3.66	2,326	2,322	24.57	31.42	31.52
	2	9.97	20.14	3.65	2,321		24.36	31.22	
	3	9.99	20.08	3.65	2,319		25.01	31.92	
60	1	10.06	20.41	3.72	2,292	2,295	28.21	35.51	36.47
	2	10.00	20.52	3.72	2,309		29.07	37.03	
	3	10.13	20.49	3.77	2,284		29.70	36.87	
90	1	10.07	20.44	3.75	2,305	2,305	29.87	37.52	38.54
	2	9.99	20.13	3.65	2,313		29.56	37.73	
	3	10.00	20.24	3.65	2,296		31.68	40.36	
180	1	9.90	20.12	3.79	2,448	2,382	33.19	43.14	42.66
	2	9.97	20.40	3.77	2,368		32.26	41.35	
	3	10.03	20.27	3.73	2,330		34.34	43.49	

Table C.8 Compressive strengths of CR-PA(0.45) concrete

Concrete : CR-PA(0.45) (W/B = 0.45)									Slump = 80 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.07	20.12	3.63	2,266	2,274	5.86	7.36	6.82
	2	10.00	20.34	3.66	2,293		5.89	7.50	
	3	10.05	20.40	3.66	2,263		4.44	5.60	
28	1	10.08	20.23	3.66	2,265	2,264	9.74	12.22	12.47
	2	10.07	20.06	3.63	2,270		10.26	12.89	
	3	10.09	20.15	3.63	2,255		9.84	12.31	
60	1	10.02	20.19	3.67	2,305	2,287	11.78	14.94	14.90
	2	10.10	20.50	3.72	2,267		11.78	14.71	
	3	10.01	20.29	3.65	2,289		11.84	15.06	
90	1	10.00	20.00	3.59	2,285	2,291	12.95	16.49	16.06
	2	9.98	20.29	3.66	2,304		12.51	16.00	
	3	10.00	20.40	3.66	2,284		12.33	15.70	
180	1	10.00	20.30	3.71	2,328	2,346	16.20	20.64	18.87
	2	9.97	20.20	3.70	2,347		14.16	18.15	
	3	9.97	20.18	3.72	2,362		13.92	17.84	

Table C.9 Compressive strengths of CR-PA(0.45)10 concrete

Concrete : CR-PA(0.45)10 (W/B = 0.45)									Slump = 85 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	9.97	20.06	3.58	2,287	2,318	10.27	13.16	13.43
	2	9.97	19.04	3.56	2,395		10.12	12.97	
	3	9.96	19.96	3.53	2,271		11.03	14.16	
28	1	9.90	20.02	3.61	2,344	2,316	15.98	20.77	20.66
	2	10.00	20.07	3.62	2,295		15.85	20.19	
	3	10.00	19.96	3.62	2,307		16.49	21.01	
60	1	9.97	19.85	3.52	2,270	2,299	17.11	21.92	22.36
	2	9.95	19.93	3.62	2,335		17.84	22.95	
	3	10.00	20.03	3.60	2,291		17.43	22.20	
90	1	10.00	20.01	3.65	2,323	2,319	19.41	24.72	24.10
	2	10.15	19.80	3.74	2,335		19.10	23.62	
	3	9.99	20.07	3.62	2,299		18.78	23.97	
180	1	9.99	20.05	3.70	2,356	2,340	22.41	28.60	27.91
	2	10.01	20.37	3.73	2,328		21.08	26.80	
	3	9.97	20.35	3.71	2,336		22.11	28.34	

Table C.10 Compressive strengths of CR-RA(0.45) concrete

Concrete : CR-RA(0.45) (W/B = 0.45)									Slump = 75 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.06	20.49	3.66	2,248	2,293	3.82	4.81	4.84
	2	9.92	20.40	3.63	2,303		3.72	4.82	
	3	9.98	20.29	3.69	2,326		3.82	4.89	
28	1	10.03	20.07	3.69	2,328	2,308	8.99	11.38	11.50
	2	9.91	20.45	3.63	2,302		9.02	11.70	
	3	9.94	20.25	3.60	2,292		8.85	11.41	
60	1	9.98	20.18	3.59	2,275	2,259	9.17	11.73	11.58
	2	10.23	20.10	3.70	2,241		9.33	11.35	
	3	10.04	20.58	3.68	2,260		9.23	11.66	
90	1	9.92	20.19	3.62	2,321	2,304	9.58	12.40	12.52
	2	10.00	20.19	3.61	2,278		10.24	13.05	
	3	9.92	20.08	3.59	2,314		9.35	12.10	
180	1	10.01	19.90	3.58	2,287	2,280	10.36	13.17	14.07
	2	10.01	20.40	3.64	2,268		11.72	14.90	
	3	9.96	20.17	3.59	2,286		11.01	14.14	

Table C.11 Compressive strengths of CR-RA(0.45)10 concrete

Concrete : CR-RA(0.45)10 (W/B = 0.45)									Slump = 70 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	9.97	20.31	3.63	2,288	2,297	6.80	8.71	9.18
	2	9.91	20.27	3.65	2,333		6.63	8.60	
	3	10.05	20.62	3.71	2,269		8.12	10.24	
28	1	10.03	20.64	3.69	2,261	2,266	15.24	19.30	19.38
	2	10.03	20.35	3.66	2,276		15.73	19.92	
	3	9.97	20.31	3.58	2,262		14.76	18.91	
60	1	10.00	20.17	3.61	2,279	2,284	21.13	26.91	26.78
	2	10.16	20.48	3.69	2,225		21.01	25.93	
	3	10.03	20.80	3.86	2,348		21.72	27.51	
90	1	9.97	20.48	3.72	2,326	2,301	22.54	28.89	28.63
	2	9.94	20.54	3.67	2,303		22.64	29.19	
	3	10.00	20.25	3.61	2,273		21.83	27.81	
180	1	10.02	20.66	3.64	2,235	2,288	27.24	34.56	32.51
	2	9.95	20.42	3.66	2,306		24.89	32.03	
	3	9.96	20.47	3.70	2,321		24.10	30.94	

Table C.12 Compressive strengths of NC(0.45) concrete

Concrete : NC(0.45) (W/B = 0.45)									Slump = 90 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.03	20.45	3.92	2,426	2,456	25.79	32.66	29.91
	2	9.97	20.20	3.88	2,459		23.85	30.57	
	3	9.95	20.36	3.93	2,482		20.59	26.50	
28	1	10.00	20.44	3.87	2,410	2,411	39.41	50.20	50.03
	2	9.97	20.50	3.88	2,423		38.90	49.85	
	3	10.07	20.35	3.89	2,401		39.83	50.03	
60	1	10.11	20.26	3.90	2,399	2,420	42.56	53.04	52.55
	2	9.96	20.45	3.89	2,443		41.30	53.04	
	3	10.01	20.56	3.91	2,418		40.57	51.58	
90	1	9.94	20.55	3.87	2,427	2,397	43.58	56.19	53.78
	2	10.30	20.41	3.99	2,350		42.83	51.43	
	3	10.04	20.45	3.91	2,414		42.51	53.72	
180	1	10.02	20.32	3.86	2,409	2,427	43.58	55.29	54.53
	2	9.98	20.39	3.90	2,446		42.83	54.78	
	3	10.06	20.39	3.88	2,398		42.51	53.51	

Table C.13 Compressive strengths of CR-FM(0.25) concrete

Concrete : CR-FM(0.25) (W/B = 0.25)									Slump = 185 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.00	20.15	3.74	2,361	2,357	16.41	20.90	21.95
	2	10.02	20.33	3.78	2,360		17.20	21.82	
	3	10.07	20.00	3.74	2,349		18.40	23.11	
28	1	9.96	20.42	3.78	2,380	2,354	27.79	35.69	33.51
	2	9.99	20.46	3.74	2,333		25.87	33.02	
	3	10.04	20.61	3.83	2,348		25.18	31.82	
60	1	9.99	20.36	3.74	2,343	2,383	35.80	45.70	45.99
	2	10.00	20.44	3.82	2,379		35.40	45.10	
	3	9.90	20.60	3.85	2,426		36.30	47.18	
90	1	10.03	20.07	3.81	2,406	2,385	40.30	51.03	51.17
	2	10.03	20.18	3.78	2,371		39.70	50.27	
	3	9.99	20.29	3.78	2,378		40.90	52.21	
180	1	9.97	20.40	3.91	2,456	2,443	45.00	57.67	56.06
	2	9.96	20.34	3.83	2,418		44.50	57.14	
	3	9.94	20.33	3.87	2,454		41.40	53.38	

Table C.14 Compressive strengths of CR-FM(0.25)10 concrete

Concrete : CR-FM(0.25)10 (W/B = 0.25)									Slump = 185 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	9.97	20.13	3.82	2,432	2,416	20.62	26.42	25.88
	2	10.07	20.35	3.89	2,398		19.68	24.72	
	3	9.97	20.16	3.80	2,417		20.67	26.49	
28	1	10.01	20.04	3.84	2,434	2,432	33.12	42.10	42.31
	2	9.99	20.22	3.82	2,413		34.13	43.56	
	3	9.95	20.27	3.86	2,448		32.08	41.28	
60	1	9.96	20.02	3.91	2,509	2,465	46.98	60.33	57.04
	2	10.16	20.09	3.96	2,435		44.41	54.80	
	3	9.94	20.17	3.84	2,451		43.42	55.98	
90	1	10.05	20.52	3.90	2,394	2,454	48.89	61.66	65.50
	2	9.92	20.00	3.80	2,460		52.00	67.31	
	3	10.00	20.19	3.98	2,508		53.00	67.52	
180	1	9.94	20.10	3.87	2,482	2,452	54.54	70.31	72.38
	2	9.93	20.20	3.87	2,475		54.74	70.72	
	3	9.93	20.95	3.89	2,399		58.92	76.12	

Table C.15 Compressive strengths of NC(0.25) concrete

Concrete : NC(0.25) (W/B = 0.25)									Slump = 195 mm
Age (Days)	Sample	Diameter (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)	
7	1	10.11	20.10	4.04	2,503	2,498	40.63	50.64	51.94
	2	10.01	19.95	3.90	2,482		42.08	53.49	
	3	10.00	19.94	3.93	2,510		40.57	51.68	
28	1	10.08	20.30	4.03	2,488	2,487	60.10	75.35	72.55
	2	10.05	19.86	3.93	2,496		56.20	70.88	
	3	10.10	20.11	3.99	2,476		57.20	71.43	
60	1	9.97	20.07	3.98	2,538	2,522	58.30	74.72	81.76
	2	9.96	20.14	3.95	2,520		60.00	77.05	
	3	10.00	20.04	3.94	2,507		73.40	93.50	
90	1	9.95	19.89	3.97	2,566	2,561	66.00	84.92	88.40
	2	9.93	19.79	3.93	2,565		65.00	83.97	
	3	9.96	20.00	3.97	2,552		75.00	96.31	
180	1	9.91	20.22	4.00	2,566	2,558	73.39	95.20	99.53
	2	9.92	20.20	3.98	2,551		77.17	99.89	
	3	9.95	20.12	4.00	2,558		80.43	103.49	

APPENDIX D

Modulus of Elasticity of Concretes

Table D.1 Modulus of elasticity of concretes at 28 days

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp.Strength (MPa)		Modulus of Elasticity (GPa)	
CR-FN(0.65)	1	10.1	20.40	3.78	2337	2332	8.4	10.58	10.42	18.33	18.59
	2	9.9	20.40	3.75	2370		7.8	10.03		18.79	
	3	10.1	20.12	3.65	2288		8.4	10.64		18.64	
CR-FN(0.65)10	1	9.9	20.25	3.75	2386	2363	12.9	16.68	15.30	19.67	19.18
	2	10.0	20.27	3.77	2362		11.5	14.64		17.18	
	3	10.0	20.80	3.84	2341		11.5	14.58		20.69	
NC(0.65)	1	10.0	20.08	3.70	2361	2372	25.1	32.11	31.92	29.42	28.29
	2	10.0	20.09	3.73	2379		24.5	31.34		28.17	
	3	10.0	20.25	3.79	2375		25.5	32.32		27.26	
CR-FM(0.45)	1	10.0	20.17	3.71	2345	2324	10.1	12.87	12.54	18.31	17.27
	2	10.2	20.22	3.72	2254		9.6	11.75		16.47	
	3	10.0	20.04	3.70	2373		10.1	13.00		17.03	
CR-FM(0.45)10	1	10.0	20.25	3.90	2455	2402	13.7	17.48	17.59	18.83	20.16
	2	10.0	20.44	3.80	2381		13.7	17.59		21.28	
	3	9.9	20.11	3.70	2370		13.7	17.70		20.36	
CR-FN(0.45)	1	10.0	20.22	3.67	2294	2313	24.1	30.47	29.01	27.89	27.94
	2	10.0	20.04	3.69	2350		22.6	28.85		27.48	
	3	10.0	19.98	3.59	2293		21.7	27.71		28.45	
CR-FN(0.45)10	1	10.0	20.10	3.66	2326	2322	24.6	31.42	31.52	27.18	28.84
	2	10.0	20.14	3.65	2321		24.4	31.22		30.47	
	3	10.0	20.08	3.65	2319		25.0	31.92		28.86	
CR-PA(0.45)	1	10.1	20.23	3.66	2265	2264	9.7	12.22	12.47	10.27	11.16
	2	10.1	20.06	3.63	2270		10.3	12.89		11.01	
	3	10.1	20.15	3.63	2255		9.8	12.31		12.19	
CR-PA(0.45)10	1	9.9	20.02	3.61	2344	2316	16.0	20.77	20.66	20.51	21.53
	2	10.0	20.07	3.62	2295		15.9	20.19		21.16	
	3	10.0	19.96	3.62	2307		16.5	21.01		22.93	
CR-RA(0.45)	1	10.0	20.07	3.69	2328	2308	9.0	11.38	11.50	15.29	14.77
	2	9.9	20.45	3.63	2302		9.0	11.70		14.51	
	3	9.9	20.25	3.60	2292		8.8	11.41		14.51	

Table D.1 Modulus of elasticity of concretes at 28 days (Continued)

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)		Modulus of Elasticity (GPa)	
CR-RA(0.45)10	1	10.0	20.64	3.69	2261	2266	15.2	19.30	19.38	20.50	20.25
	2	10.0	20.35	3.66	2276		15.7	19.92		20.76	
	3	10.0	20.31	3.58	2262		14.8	18.91		19.49	
NC(0.45)	1	10.0	20.44	3.87	2410	2411	39.4	50.20	50.03	32.55	31.91
	2	10.0	20.50	3.88	2423		38.9	49.85		32.35	
	3	10.1	20.35	3.89	2401		39.8	50.03		30.83	
CR-FM(0.25)	1	10.0	20.42	3.78	2380	2354	27.8	35.69	33.51	25.66	24.89
	2	10.0	20.46	3.74	2333		25.9	33.02		24.89	
	3	10.0	20.61	3.83	2348		25.2	31.82		24.11	
CR-FM(0.25)10	1	10.0	20.04	3.84	2434	2432	33.1	42.10	42.31	29.51	29.78
	2	10.0	20.22	3.82	2413		34.1	43.56		30.14	
	3	10.0	20.27	3.86	2448		32.1	41.28		29.70	
NC(0.25)	1	10.1	20.30	4.03	2488	2487	60.1	75.35	72.55	33.89	34.32
	2	10.1	19.86	3.93	2496		56.2	70.88		34.95	
	3	10.1	20.11	3.99	2476		57.2	71.43		34.12	

Table D.2 Modulus of elasticity of concretes at 90 days

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)		Modulus of Elasticity (GPa)	
CR-FN(0.65)	1	10.0	20.30	3.70	2322	2342	10.8	13.76	13.73	22.02	21.95
	2	10.0	20.55	3.83	2369		10.8	13.67		21.95	
	3	10.0	20.47	3.75	2334		10.8	13.76		21.88	
CR-FN(0.65)10	1	10.1	20.53	3.77	2311	2328	19.1	24.08	24.63	24.62	21.33
	2	10.1	20.46	3.80	2322		19.2	24.04		18.98	
	3	10.0	20.57	3.76	2352		20.0	25.79		20.39	
NC(0.65)	1	10.0	20.23	3.70	2330	2327	28.1	35.76	37.45	36.07	35.48
	2	10.0	20.17	3.70	2337		30.0	38.19		35.85	
	3	10.0	20.20	3.70	2315		30.4	38.39		34.53	
CR-FM(0.45)	1	9.9	20.12	3.68	2371	2365	15.2	19.65	19.87	20.74	20.92
	2	10.0	20.40	3.78	2359		15.6	19.93		20.66	
	3	10.0	20.45	3.76	2346		15.7	20.01		21.36	
CR-FM(0.45)10	1	10.0	20.44	3.82	2398	2358	22.4	28.81	28.23	25.24	25.50
	2	10.0	20.46	3.75	2350		22.1	28.39		25.75	
	3	10.1	20.31	3.81	2326		22.1	27.49		25.52	
CR-FN(0.45)	1	10.0	19.77	3.56	2308	2308	27.5	35.23	34.25	34.65	33.64
	2	9.9	20.44	3.69	2328		26.1	33.61		31.54	
	3	10.0	20.10	3.64	2289		26.8	33.91		34.72	
CR-FN(0.45)10	1	10.1	20.44	3.75	2305	2305	29.9	37.52	38.54	35.35	36.16
	2	10.0	20.13	3.65	2313		29.6	37.73		36.33	
	3	10.0	20.24	3.65	2296		31.7	40.36		36.79	
CR-PA(0.45)	1	10.0	20.00	3.59	2285	2291	12.9	16.49	16.06	17.39	15.25
	2	10.0	20.29	3.66	2304		12.5	16.00		14.90	
	3	10.0	20.40	3.66	2284		12.3	15.70		13.45	
CR-PA(0.45)10	1	10.0	20.01	3.65	2323	2319	19.4	24.72	24.10	29.01	28.95
	2	10.2	19.80	3.74	2335		19.1	23.62		28.99	
	3	10.0	20.07	3.62	2299		18.8	23.97		28.85	
CR-RA(0.45)	1	9.9	20.19	3.62	2321	2304	9.6	12.40	12.52	15.11	15.14
	2	10.0	20.19	3.61	2278		10.2	13.05		15.24	
	3	9.9	20.08	3.59	2314		9.3	12.10		15.06	

Table D.2 Modulus of elasticity of concretes at 90 days (Continued)

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Comp. Strength (MPa)		Modulus of Elasticity (GPa)	
CR-RA(0.45)10	1	10.0	20.48	3.72	2326	2301	22.5	28.89	28.63	23.77	23.42
	2	9.9	20.54	3.67	2303		22.6	29.19		24.44	
	3	10.0	20.25	3.61	2273		21.8	27.81		22.04	
NC(0.45)	1	9.9	20.55	3.87	2427	2397	43.6	56.19	53.78	33.34	35.29
	2	10.3	20.41	3.99	2350		42.8	51.43		35.43	
	3	10.0	20.45	3.91	2414		42.5	53.72		37.10	
CR-FM(0.25)	1	10.0	20.07	3.81	2406	2385	40.3	51.03	51.17	29.52	29.23
	2	10.0	20.18	3.78	2371		39.7	50.27		28.86	
	3	10.0	20.29	3.78	2378		40.9	52.21		29.30	
CR-FM(0.25)10	1	10.1	20.52	3.90	2394	2454	48.9	61.66	65.50	32.54	33.24
	2	9.9	20.00	3.80	2460		52.0	67.31		34.14	
	3	10.0	20.19	3.98	2508		53.0	67.52		33.04	
NC(0.25)	1	10.0	19.89	3.97	2566	2561	66.0	84.92	88.40	41.04	40.72
	2	9.9	19.79	3.93	2565		65.0	83.97		40.85	
	3	10.0	20.00	3.97	2552		75.0	96.31		40.28	

APPENDIX E

Splitting Tensile Strength of Concretes

Table E.1 Splitting tensile strength of concretes at 28 days

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Ten. Strength (MPa)	
CR-FN(0.65)	1	9.94	20.20	3.77	2406	2358	5.28	1.67	1.65
	2	9.96	20.29	3.66	2316		4.93	1.55	
	3	9.98	20.06	3.69	2353		5.43	1.73	
CR-FN(0.65)10	1	10.02	20.85	3.80	2309	2349	8.60	2.62	2.04
	2	9.94	20.31	3.75	2379		6.54	2.06	
	3	10.00	20.28	3.75	2358		4.56	1.43	
NC(0.65)	1	10.05	20.47	3.80	2341	2373	11.67	3.61	3.60
	2	10.02	20.18	3.80	2389		11.56	3.64	
	3	10.05	20.16	3.82	2390		11.34	3.56	
CR-FM(0.45)	1	10.00	20.38	3.72	2325	2343	6.11	1.91	2.01
	2	10.03	20.47	3.78	2335		5.58	1.73	
	3	9.99	20.21	3.75	2370		7.59	2.39	
CR-FM(0.45)10	1	9.96	20.40	3.79	2383	2382	5.59	1.75	2.15
	2	10.19	20.36	3.97	2391		8.11	2.49	
	3	10.04	20.37	3.83	2373		7.06	2.20	
CR-FN(0.45)	1	10.01	20.39	3.68	2295	2330	10.95	3.41	3.50
	2	10.07	20.07	3.74	2341		11.18	3.52	
	3	9.93	19.98	3.64	2354		11.09	3.56	
CR-FN(0.45)10	1	10.02	20.25	3.73	2335	2322	9.99	3.13	3.55
	2	10.01	20.19	3.68	2319		12.56	3.96	
	3	10.01	20.13	3.66	2312		11.23	3.55	
CR-PA(0.45)	1	10.09	20.20	3.62	2242	2298	4.63	1.45	1.37
	2	10.06	20.26	3.65	2266		3.98	1.24	
	3	10.01	20.35	3.82	2386		4.55	1.42	
CR-PA(0.45)10	1	10.01	20.18	3.65	2302	2315	7.59	2.39	2.41
	2	9.94	20.02	3.60	2315		7.62	2.44	
	3	10.00	20.16	3.69	2329		7.59	2.40	
CR-RA(0.45)	1	9.97	20.10	3.58	2283	2240	4.63	1.47	1.44
	2	10.19	20.14	3.67	2236		4.52	1.40	
	3	10.13	20.40	3.62	2203		4.67	1.44	

Table E.1 Splitting tensile strength of concretes at 28 days (Continued)

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Ten. Strength (MPa)	
CR-RA(0.45)10	1	10.01	20.70	3.68	2263	2277	8.62	2.65	2.50
	2	10.02	20.56	3.72	2296		7.59	2.35	
	3	10.00	20.73	3.70	2271		8.12	2.49	
NC(0.45)	1	10.20	20.37	3.96	2379	2384	17.13	5.25	5.03
	2	10.05	20.56	3.92	2407		16.40	5.05	
	3	10.10	20.46	3.88	2366		15.54	4.79	
CR-FM(0.25)	1	9.96	20.60	3.82	2380	2399	9.65	2.99	3.16
	2	9.97	20.53	3.92	2445		12.20	3.79	
	3	10.00	20.37	3.79	2371		8.60	2.69	
CR-FM(0.25)10	1	9.96	20.20	3.82	2428	2427	16.79	5.31	4.80
	2	10.00	20.36	3.87	2423		13.75	4.30	
	3	10.00	20.26	3.86	2430		15.26	4.80	
NC(0.25)	1	10.04	20.00	3.98	2514	2546	22.91	7.26	7.23
	2	9.94	20.46	4.18	2637		23.41	7.33	
	3	10.04	20.06	3.95	2486		22.41	7.08	

Table E.2 Splitting tensile strength of concretes at 90 days

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Ten. Strength (MPa)	
CR-FN(0.65)	1	10.03	20.03	3.69	2333	2332	6.88	2.18	2.12
	2	10.10	20.33	3.76	2310		6.63	2.05	
	3	10.01	20.19	3.74	2355		6.73	2.12	
CR-FN(0.65)10	1	10.12	20.22	3.86	2375	2353	9.13	2.84	2.63
	2	10.06	20.20	3.71	2310		8.61	2.70	
	3	9.93	20.74	3.81	2373		7.62	2.36	
NC(0.65)	1	10.02	20.17	3.88	2441	2407	15.93	5.02	5.16
	2	10.05	20.17	3.79	2370		16.29	5.12	
	3	10.03	20.02	3.81	2410		16.86	5.35	
CR-FM(0.45)	1	10.04	20.12	3.71	2328	2356	5.87	1.85	2.28
	2	9.95	20.38	3.76	2373		9.14	2.87	
	3	9.94	20.04	3.68	2367		6.63	2.12	
CR-FM(0.45)10	1	10.02	20.22	3.73	2341	2325	7.98	2.51	2.45
	2	10.03	20.19	3.74	2343		8.15	2.56	
	3	10.06	20.41	3.72	2292		7.36	2.28	
CR-FN(0.45)	1	9.96	20.07	3.63	2323	2460	12.54	3.99	4.15
	2	9.14	20.12	3.64	2759		12.68	4.39	
	3	9.99	20.15	3.63	2299		12.90	4.08	
CR-FN(0.45)10	1	10.04	20.20	3.68	2300	2301	13.81	4.33	4.30
	2	10.05	20.47	3.74	2302		13.83	4.28	
	3	10.05	20.29	3.70	2302		13.72	4.28	
CR-PA(0.45)	1	10.00	20.28	3.63	2281	2290	5.31	1.67	1.61
	2	10.13	20.34	3.72	2269		5.02	1.55	
	3	9.97	20.07	3.63	2318		5.06	1.61	
CR-PA(0.45)10	1	9.95	20.08	3.70	2370	2352	10.37	3.30	3.27
	2	9.98	20.00	3.67	2350		10.33	3.29	
	3	10.01	20.15	3.70	2336		10.17	3.21	
CR-RA(0.45)	1	10.02	20.35	3.64	2270	2270	5.10	1.59	1.61
	2	9.99	20.16	3.58	2267		5.12	1.62	
	3	9.92	20.37	3.58	2275		5.15	1.62	

Table E.2 Splitting tensile strength of concretes at 90 days (Continued)

Concrete	Sample	Dia. (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)		Load (ton)	Ten. Strength (MPa)	
CR-RA(0.45)10	1	10.00	20.60	3.76	2327	2327	9.64	2.98	3.10
	2	9.97	20.53	3.74	2337		9.63	2.99	
	3	9.93	20.54	3.68	2317		10.65	3.32	
NC(0.45)	1	10.07	20.30	3.88	2402	2414	17.74	5.52	5.67
	2	10.00	20.58	3.94	2437		18.04	5.58	
	3	10.02	20.08	3.80	2403		18.71	5.92	
CR-FM(0.25)	1	10.12	20.32	3.83	2345	2344	10.18	3.15	3.61
	2	10.06	20.52	3.83	2351		13.15	4.05	
	3	10.06	20.38	3.79	2338		11.65	3.62	
CR-FM(0.25)10	1	9.97	20.23	3.86	2448	2456	16.35	5.16	5.25
	2	9.94	20.13	3.84	2459		17.59	5.60	
	3	9.95	19.94	3.81	2461		15.52	4.98	
NC(0.25)	1	9.96	19.92	3.95	2548	2530	22.57	7.24	7.94
	2	10.00	19.75	3.93	2537		26.91	8.67	
	3	10.00	20.15	3.96	2505		25.00	7.90	

APPENDIX F

Water Permeability of Concretes

Table F.1 Water permeability of CR-FM(0.45) concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
29/4/09	8:30:00			41.2	40.5						
29/4/09	10:30:00	7,200	7,200	40.1	39.3	1.1	1.2	1.69E-06	1.85E-06	1.69E-06	1.85E-06
29/4/09	15:00:00	16,200	23,400	39.0	38.3	1.1	1.0	1.69E-06	1.54E-06	3.39E-06	3.39E-06
29/4/09	20:00:00	18,000	41,400	37.9	37.3	1.1	1.0	1.69E-06	1.54E-06	5.08E-06	4.93E-06
30/4/09	8:15:00	44,100	85,500	35.6	35.8	2.3	1.5	3.54E-06	2.31E-06	8.62E-06	7.24E-06
30/4/09	19:45:00	41,400	126,900	33.3	34.6	2.3	1.2	3.54E-06	1.85E-06	1.22E-05	9.08E-06
1/5/09	8:25:00	45,600	172,500	30.7	33.5	2.6	1.1	4.00E-06	1.69E-06	1.62E-05	1.08E-05
1/5/09	19:45:00	40,800	213,300	28.3		2.4		3.69E-06		1.99E-05	
2/5/09	10:00:00	51,300	264,600	25.5	31.8	2.8	1.7	4.31E-06	2.62E-06	2.42E-05	1.34E-05
4/5/09	8:15:00	166,500	431,100	16.3	29.3	9.2	2.5	1.42E-05	3.85E-06	3.83E-05	1.72E-05
5/5/09	10:00:00	92,700	523,800	11.2	28.1	5.1	1.2	7.85E-06	1.85E-06	4.62E-05	1.91E-05
5/5/09	18:45:00	31,500	555,300	9.4		1.8		2.77E-06		4.90E-05	
6/5/09	9:30:00	53,100	608,400	6.4	27.3	3.0	0.8	4.62E-06	1.23E-06	5.36E-05	2.03E-05
6/5/09	19:15:00	35,100	643,500	4.5		1.9		2.92E-06		5.65E-05	
7/5/09	8:15:00	46,800	690,300	1.9	26.6	2.6	0.7	4.00E-06	1.08E-06	6.05E-05	2.14E-05
15/5/09	19:00:00				21.3		5.3		8.16E-06		
19/5/09	19:00:00	345,600	1,035,900		20.2		1.1		1.69E-06		2.31E-05
22/5/09	20:25:00	264,300	1,300,200		19.5		0.7		1.08E-06		2.42E-05
26/5/09	10:30:00	309,900	1,610,100		18.5		1.0		1.54E-06		2.57E-05
28/5/09	16:00:00	192,600	1,802,700		18.0		0.5		7.70E-07		2.65E-05
31/5/09	18:30:00	268,200	2,070,900		17.4		0.6		9.24E-07		2.74E-05
1/6/09	19:00:00	88,200	2,159,100		17.2		0.2		3.08E-07		2.77E-05
2/6/09	19:00:00	86,400	2,245,500		16.9		0.3		4.62E-07		2.82E-05
4/6/09	18:45:00	171,900	2,417,400		16.5		0.4		6.16E-07		2.88E-05
5/6/09	18:45:00	86,400	2,503,800		16.3		0.2		3.08E-07		2.91E-05

Table F.1 Water permeability of CR-FM(0.45) concrete at 28 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
9/6/09	19:00:00	346,500	2,850,300		15.4		0.9		1.39E-06		3.05E-05
10/6/09	19:00:00	86,400	2,936,700		15.2		0.2		3.08E-07		3.08E-05
15/6/09	9:00:00	396,000	3,332,700		14.6		0.6		9.24E-07		3.17E-05

Dia.1	=	0.099	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	8.57E-11	m^3/sec	Q_2	=	3.85E-12	m^3/sec				
K_1	=	9.13E-12	m/sec	K_2	=	4.02E-13	m/sec	**K_{avg}**	**=**	**4.77E-12**	**m/sec**

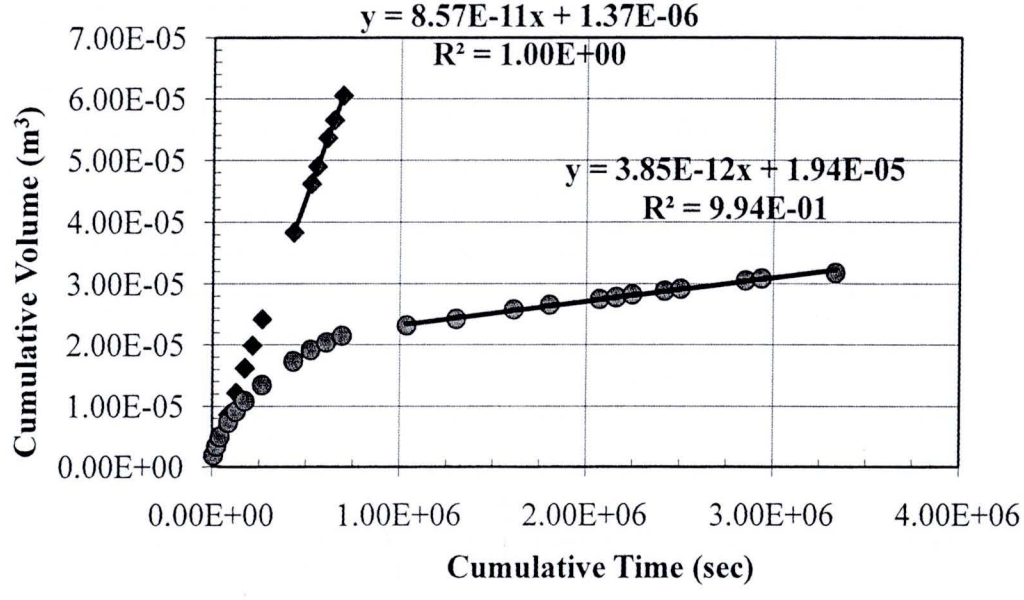


Table F.2 Water permeability of CR-FM(0.45) concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
1/7/09	11:00:00			41.4							
1/7/09	12:00:00	3,600	3,600	41.0		0.4		6.16E-07		6.16E-07	
1/7/09	13:00:00	3,600	7,200	40.8		0.2		3.08E-07		9.24E-07	
1/7/09	17:00:00	14,400	21,600	40.4		0.4		6.16E-07		1.54E-06	
1/7/09	19:15:00	8,100	29,700	40.4		0.0		0.00E+00		1.54E-06	
2/7/09	7:30:00	44,100	73,800	39.9		0.5		7.70E-07		2.31E-06	
2/7/09	18:30:00	39,600	113,400	39.3		0.6		9.24E-07		3.23E-06	
3/7/09	8:15:00	49,500	162,900	38.7		0.6		9.24E-07		4.16E-06	
3/7/09	18:00:00	35,100	198,000	38.0		0.7		1.08E-06		5.23E-06	
6/7/09	20:00:00	266,400	464,400	34.8		3.2		4.93E-06		1.02E-05	
8/7/09	18:00:00	165,600	630,000	32.5	39.3	2.3		3.54E-06		1.37E-05	
9/7/09	18:45:00	89,100	719,100	31.4	37.0	1.1	2.3	1.69E-06	3.54E-06	1.54E-05	3.54E-06
10/7/09	18:15:00	84,600	803,700	30.4	35.0	1.0	2.0	1.54E-06	3.08E-06	1.69E-05	6.62E-06
13/7/09	8:30:00	224,100	1,027,800	28.0	30.2	2.4	4.8	3.69E-06	7.39E-06	2.06E-05	1.40E-05
14/7/09	8:30:00	86,400	1,114,200	26.9	28.2	1.1	2.0	1.69E-06	3.08E-06	2.23E-05	1.71E-05
15/7/09	19:00:00	124,200	1,238,400	25.4	25.5	1.5	2.7	2.31E-06	4.16E-06	2.46E-05	2.12E-05
16/7/09	19:00:00	86,400	1,324,800	24.6	24.1	0.8	1.4	1.23E-06	2.16E-06	2.59E-05	2.34E-05
19/7/09	10:30:00	228,600	1,553,400	22.2	19.9	2.4	4.2	3.69E-06	6.47E-06	2.96E-05	2.99E-05
20/7/09	19:00:00	117,000	1,670,400	21.0	17.8	1.2	2.1	1.85E-06	3.23E-06	3.14E-05	3.31E-05
21/7/09	18:30:00	84,600	1,755,000	20.2	16.3	0.8	1.5	1.23E-06	2.31E-06	3.26E-05	3.54E-05
23/7/09	8:30:00	136,800	1,891,800	18.8	13.9	1.4	2.4	2.16E-06	3.69E-06	3.48E-05	3.91E-05
24/7/09	9:00:00	88,200	1,980,000	17.9	12.4	0.9	1.5	1.39E-06	2.31E-06	3.62E-05	4.14E-05
25/7/09	11:45:00	96,300	2,076,300	17.0	10.1	0.9	2.3	1.39E-06	3.54E-06	3.76E-05	4.50E-05

Table F.2 Water permeability of CR-FM(0.45) concrete at 90 days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	1.57E-11	m^3/sec	Q_2	=	2.82E-11	m^3/sec				
K_1	=	1.60E-12	m/sec	K_2	=	2.93E-12	m/sec	**K_{avg}**	**=**	**2.26E-12**	**m/sec**

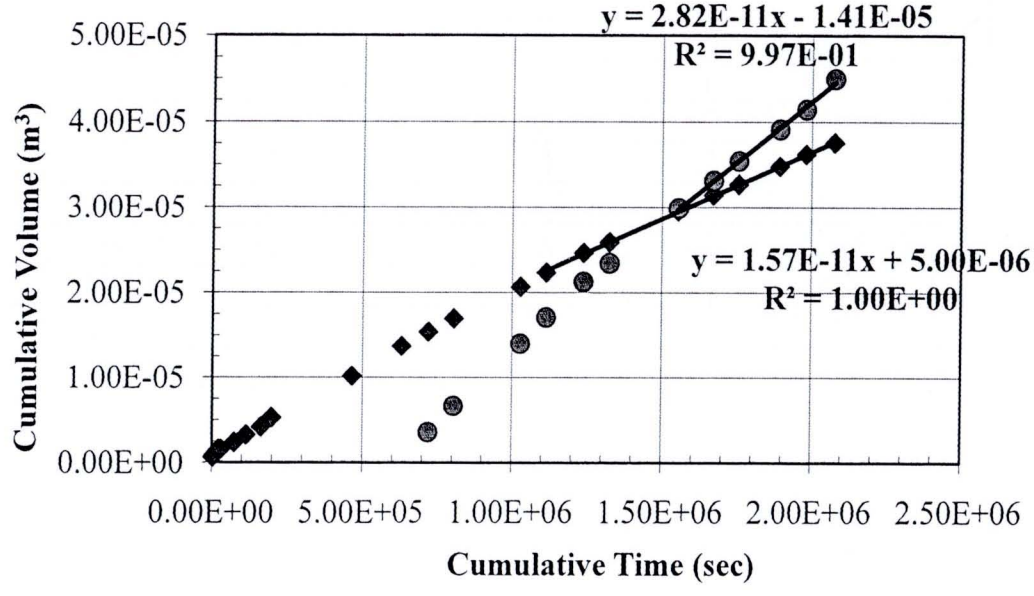


Table F.3 Water permeability of CR-FM(0.45)10 concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
10/4/09	8:00:00			39.5	38.7						
11/4/09	10:00:00	93,600	93,600	36.6	24.2	2.9	14.5	4.46E-06	2.23E-05	4.46E-06	2.23E-05
12/4/09	11:00:00	90,000	183,600	35.5	18.3	1.1	5.9	1.69E-06	9.08E-06	6.16E-06	3.14E-05
13/4/09	16:45:00	107,100	290,700	35.0	14.0	0.5	4.3	7.70E-07	6.62E-06	6.93E-06	3.80E-05
14/4/09	14:35:00	78,600	369,300	34.6	10.4	0.4	3.6	6.16E-07	5.54E-06	7.54E-06	4.36E-05
15/4/09	17:00:00	95,100	464,400	34.3	7.4	0.3	3.0	4.62E-07	4.62E-06	8.00E-06	4.82E-05
16/4/09	19:15:00	94,500	558,900	33.9	4.7	0.4	2.7	6.16E-07	4.16E-06	8.62E-06	5.23E-05
17/4/09	8:35:00	48,000	606,900	33.7	3.5	0.2	1.2	3.08E-07	1.85E-06	8.93E-06	5.42E-05
17/4/09	22:00:00	48,300	655,200	33.5	2.5	0.2	1.0	3.08E-07	1.54E-06	9.24E-06	5.57E-05
18/4/09	15:30:00	63,000	718,200	32.9	1.4	0.6	1.1	9.24E-07	1.69E-06	1.02E-05	5.74E-05
20/4/09	8:30:00	147,600	865,800	31.3		1.6		2.46E-06		1.26E-05	
21/4/09	10:00:00	91,800	957,600	29.7		1.6		2.46E-06		1.51E-05	
22/4/09	10:00:00	86,400	1,044,000	27.5		2.2		3.39E-06		1.85E-05	
23/4/09	10:00:00	86,400	1,130,400	26.4		1.1		1.69E-06		2.02E-05	
24/4/09	13:00:00	97,200	1,227,600	23.1		3.3		5.08E-06		2.52E-05	
25/4/09	13:00:00	86,400	1,314,000	21.6		1.5		2.31E-06		2.76E-05	

Table F.3 Water permeability of CR-FM(0.45)10 concrete at 28 days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.099	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	3.66E-11	m^3/sec	Q_2	=	3.41E-11	m^3/sec				
K_1	=	3.83E-12	m/sec	K_2	=	3.66E-12	m/sec	**K_{avg}**	**=**	**3.74E-12**	**m/sec**

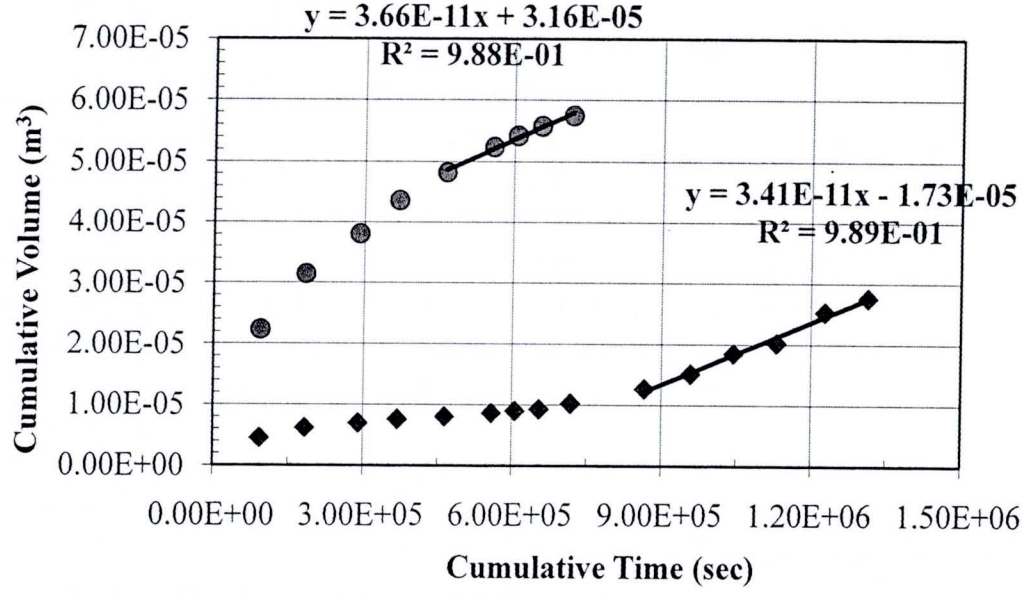


Table F.4 Water permeability of CR-FM(0.45)10 concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
18/6/09	19:10:00			39.6							
19/6/09	8:45:00	48,900	48,900	39.5		0.1		1.54E-07		1.54E-07	
19/6/09	19:00:00	36,900	85,800	39.4		0.1		1.54E-07		3.08E-07	
22/6/09	8:30:00	221,400	307,200	38.9		0.5		7.70E-07		1.08E-06	
22/6/09	19:00:00	37,800	345,000	38.7		0.2		3.08E-07		1.39E-06	
23/6/09	8:15:00	47,700	392,700	38.7		0.0		0.00E+00		1.39E-06	
23/6/09	19:00:00	38,700	431,400	38.4		0.3		4.62E-07		1.85E-06	
24/6/09	8:30:00				38.5						
25/6/09	19:30:00	126,000	126,000		38.3		0.2		3.08E-07		3.08E-07
29/6/09	9:30:00	309,600	435,600		37.8		0.5		7.70E-07		1.08E-06
2/7/09	18:30:00	291,600	727,200		37.4		0.4		6.16E-07		1.69E-06
8/7/09	18:00:00	516,600	1,243,800		36.5		0.9		1.39E-06		3.08E-06
10/7/09	18:15:00	173,700	1,417,500		36.2		0.3		4.62E-07		3.54E-06
14/7/09	8:30:00	310,500	1,728,000		35.8		0.4		6.16E-07		4.16E-06
19/7/09	10:30:00	439,200	2,167,200		35.3		0.5		7.70E-07		4.93E-06
23/7/09	8:30:00	338,400	2,505,600		34.7		0.6		9.24E-07		5.85E-06
29/7/09	9:45:00	522,900	3,028,500		34.0		0.7		1.08E-06		6.93E-06
30/7/09	8:00:00	80,100	3,108,600		33.9		0.1		1.54E-07		7.08E-06
31/7/09	18:30:00	124,200	3,232,800		33.7		0.2		3.08E-07		7.39E-06
3/8/09	18:45:00	260,100	3,492,900		33.3		0.4		6.16E-07		8.00E-06
5/8/09	18:15:00	171,000	3,663,900		33.2		0.1		1.54E-07		8.16E-06
7/8/09	18:45:00	174,600	3,838,500		33.0		0.2		3.08E-07		8.47E-06
10/8/09	18:30:00	258,300	4,096,800		32.5		0.5		7.70E-07		9.24E-06
13/8/09	18:30:00	259,200	4,356,000		32.3		0.2		3.08E-07		9.54E-06
17/8/09	18:30:00	345,600	4,701,600		32.0		0.3		4.62E-07		1.00E-05

Table F.4 Water permeability of CR-FM(0.45)10 concrete at 90 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
20/8/09	12:30:00	237,600	4,939,200		31.8		0.2		3.08E-07		1.03E-05
24/8/09	19:20:00	370,200	5,309,400		31.3		0.5		7.70E-07		1.11E-05
31/8/09	18:20:00	601,200	5,910,600		30.5		0.8		1.23E-06		1.23E-05

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.040	m	g	=	9.81	m/sec^2
Q_1	=	4.05E-12	m^3/sec	Q_2	=	1.81E-12	m^3/sec				
K_1	=	4.20E-13	m/sec	K_2	=	1.82E-13	m/sec	**K_{avg}**	**=**	**3.01E-13**	**m/sec**

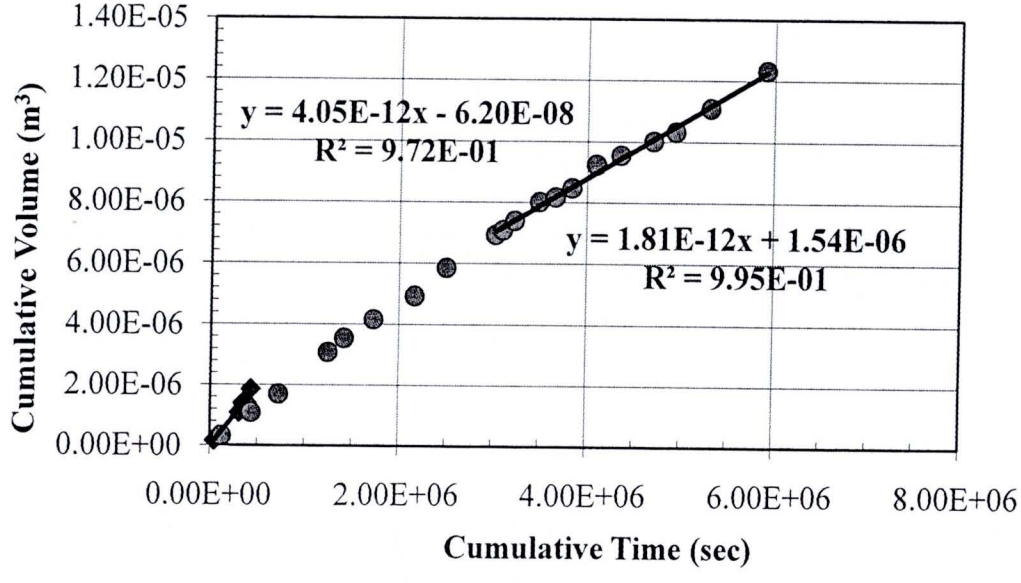


Table F.5 Water permeability of CR-FN(0.45) concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
24/6/08	11:55:00			34.40	34.50						
24/6/08	15:00:00	11,100	11,100	31.90	32.00	2.5	2.5	3.85E-06	3.85E-06	3.85E-06	3.85E-06
25/6/08	9:05:00	65,100	76,200	26.50	26.70	5.4	5.3	8.31E-06	8.16E-06	1.22E-05	1.20E-05
25/6/08	12:00:00	10,500	86,700	26.00	26.20	0.5	0.5	7.70E-07	7.70E-07	1.29E-05	1.28E-05
25/6/08	13:20:00	4,800	91,500	25.30	25.50	0.7	0.7	1.08E-06	1.08E-06	1.40E-05	1.39E-05
25/6/08	17:15:00	14,100	105,600	24.70	25.00	0.6	0.5	9.24E-07	7.70E-07	1.49E-05	1.46E-05
26/6/08	7:55:00	52,800	158,400	23.80	24.00	0.9	1.0	1.39E-06	1.54E-06	1.63E-05	1.62E-05
26/6/08	12:00:00	14,700	173,100	23.70	23.70	0.1	0.3	1.54E-07	4.62E-07	1.65E-05	1.66E-05
26/6/08	17:20:00	19,200	192,300	23.40	23.40	0.3	0.3	4.62E-07	4.62E-07	1.69E-05	1.71E-05
27/6/08	7:45:00	51,900	244,200	23.00	23.00	0.4	0.4	6.16E-07	6.16E-07	1.75E-05	1.77E-05
27/6/08	7:55:00	600	244,800	23.00	23.00	0.0	0.0	0.00E+00	0.00E+00	1.75E-05	1.77E-05
27/6/08	12:00:00	14,700	259,500	22.90	22.90	0.1	0.1	1.54E-07	1.54E-07	1.77E-05	1.79E-05
27/6/08	17:20:00	19,200	278,700	22.90	22.90	0.0	0.0	0.00E+00	0.00E+00	1.77E-05	1.79E-05
28/6/08	7:45:00	51,900	330,600	22.70	22.70	0.2	0.2	3.08E-07	3.08E-07	1.80E-05	1.82E-05
28/6/08	12:45:00	18,000	348,600	22.60	22.60	0.1	0.1	1.54E-07	1.54E-07	1.82E-05	1.83E-05
28/6/08	18:30:00	20,700	369,300	22.50	22.50	0.1	0.1	1.54E-07	1.54E-07	1.83E-05	1.85E-05
29/6/08	9:00:00	52,200	421,500	22.30	22.30	0.2	0.2	3.08E-07	3.08E-07	1.86E-05	1.88E-05
29/6/08	11:40:00	9,600	431,100	22.20	22.20	0.1	0.1	1.54E-07	1.54E-07	1.88E-05	1.89E-05
29/6/08	16:20:00	16,800	447,900	22.20	22.20	0.0	0.0	0.00E+00	0.00E+00	1.88E-05	1.89E-05

Table F.5 Water permeability of CR-FN(0.45) concrete at 28 days (Continued)

Dia.1	=	0.101	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	6.24E-12	m^3/sec	Q_2	=	6.24E-12	m^3/sec				
K_1	=	6.47E-13	m/sec	K_2	=	6.53E-13	m/sec	**K_{avg}**	**=**	**6.50E-13**	**m/sec**

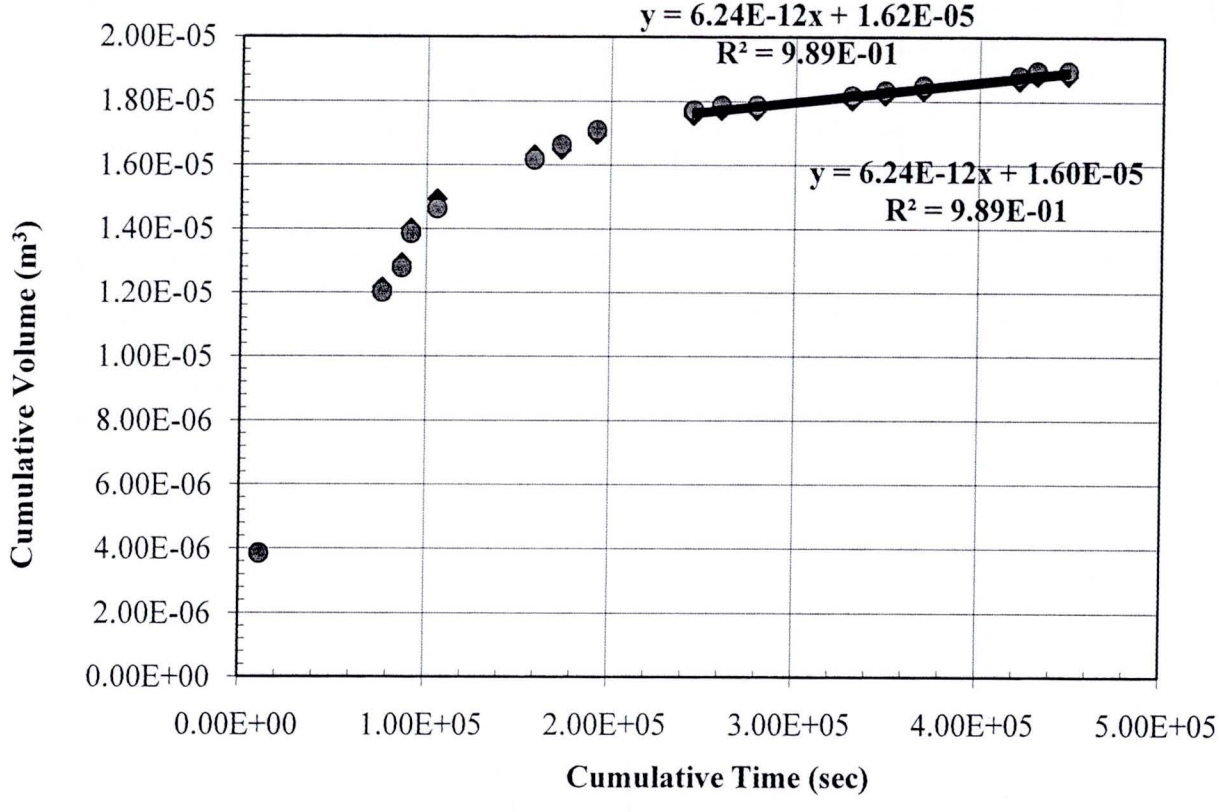


Table F.6 Water permeability of CR-FN(0.45) concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
8/9/08	8:15:00			34.9	34.9						
8/9/08	11:40:00	12,300	12,300	34.0	33.8	0.9	1.1	1.39E-06	1.69E-06	1.39E-06	1.69E-06
8/9/08	15:25:00	13,500	25,800	33.3	33.0	0.7	0.8	1.08E-06	1.23E-06	2.46E-06	2.92E-06
9/9/08	8:00:00	59,700	85,500	31.0	31.0	2.3	2.0	3.54E-06	3.08E-06	6.00E-06	6.00E-06
9/9/08	12:45:00	17,100	102,600	30.4	30.4	0.6	0.6	9.24E-07	9.24E-07	6.93E-06	6.93E-06
9/9/08	19:30:00	24,300	126,900	29.3	29.3	1.1	1.1	1.69E-06	1.69E-06	8.62E-06	8.62E-06
10/9/08	9:20:00	49,800	176,700	26.6	27.0	2.7	2.3	4.16E-06	3.54E-06	1.28E-05	1.22E-05
10/9/08	12:00:00	9,600	186,300	26.3	26.5	0.3	0.5	4.62E-07	7.70E-07	1.32E-05	1.29E-05
10/9/08	15:30:00	12,600	198,900	25.8	26.0	0.5	0.5	7.70E-07	7.70E-07	1.40E-05	1.37E-05
11/9/08	16:00:00	88,200	287,100	22.2	22.9	3.6	3.1	5.54E-06	4.77E-06	1.96E-05	1.85E-05
12/9/08	14:00:00	79,200	366,300	21.8	22.7	0.4	0.2	6.16E-07	3.08E-07	2.02E-05	1.88E-05
15/9/08	10:00:00	244,800	611,100	21.1	22.2	0.7	0.5	1.08E-06	7.70E-07	2.12E-05	1.96E-05
15/9/08	14:25:00	15,900	627,000	21.1	22.1	0.0	0.1	0.00E+00	1.54E-07	2.12E-05	1.97E-05
22/9/08	9:30:00	587,100	1,214,100	20.2	21.0	0.9	1.1	1.39E-06	1.69E-06	2.26E-05	2.14E-05

Table F.6 Water permeability of CR-FN(0.45) concrete at 90 days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.043	m	L_2	=	0.043	m	g	=	9.81	m/sec^2
Q_1	=	3.15E-12	m^3/sec	Q_2	=	3.13E-12	m^3/sec				
K_1	=	3.38E-13	m/sec	K_2	=	3.35E-13	m/sec	**K_{avg}**	**=**	**3.36E-13**	**m/sec**

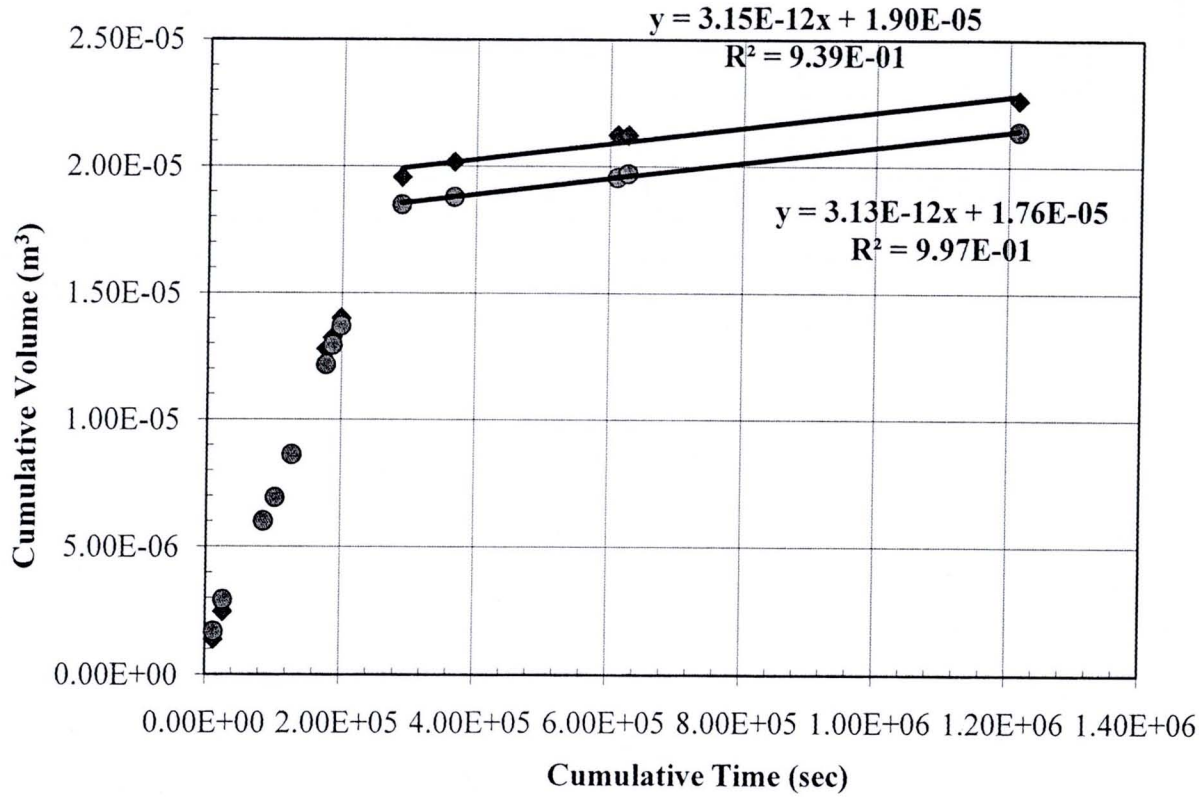


Table F.7 Water permeability of CR-FN(0.45)10 concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
14/11/09	17:30:00			39.9	40.0						
15/11/09	17:45:00	87,300	87,300	37.4	39.8	2.5	0.2	3.85E-06	3.08E-07	3.85E-06	3.08E-07
16/11/09	17:15:00	84,600	171,900	36.1	39.8	1.3	0.0	2.00E-06	7.70E-08	5.85E-06	3.85E-07
17/11/09	17:00:00	85,500	257,400	34.8	39.6	1.4	0.2	2.08E-06	3.08E-07	7.93E-06	6.93E-07
18/11/09	18:40:00	92,400	349,800	33.7	39.5	1.1	0.1	1.62E-06	1.54E-07	9.54E-06	8.47E-07
20/11/09	18:00:00	170,400	520,200	32.2	39.2	1.5	0.3	2.31E-06	3.85E-07	1.19E-05	1.23E-06
21/11/09	17:15:00	83,700	603,900	31.4	39.0	0.8	0.2	1.23E-06	3.08E-07	1.31E-05	1.54E-06
22/11/09	17:15:00	86,400	690,300	31.0	38.9	0.4	0.1	6.16E-07	1.54E-07	1.37E-05	1.69E-06
23/11/09	17:15:00	86,400	776,700	30.5	38.8	0.5	0.1	7.70E-07	1.54E-07	1.45E-05	1.85E-06
24/11/09	17:25:00	87,000	863,700	30.2	38.8	0.3	0.0	4.62E-07	0.00E+00	1.49E-05	1.85E-06
25/11/09	17:15:00	85,800	949,500	29.8	38.7	0.4	0.1	6.16E-07	1.54E-07	1.55E-05	2.00E-06
26/11/09	17:55:00	88,800	1,038,300	29.5	38.6	0.4	0.1	5.39E-07	1.54E-07	1.61E-05	2.16E-06
27/11/09	17:05:00	83,400	1,121,700	29.1	38.5	0.3	0.1	5.39E-07	1.54E-07	1.66E-05	2.31E-06
28/11/09	19:55:00	96,600	1,218,300	28.7	38.4	0.4	0.1	6.16E-07	1.54E-07	1.72E-05	2.46E-06
29/11/09	19:02:00	83,220	1,301,520	28.2	38.3	0.5	0.1	7.70E-07	1.54E-07	1.80E-05	2.62E-06
30/11/09	18:05:00	82,980	1,384,500	28.1	38.2	0.1	0.1	1.54E-07	1.54E-07	1.82E-05	2.77E-06
1/12/09	18:00:00	86,100	1,470,600	28.0	38.2	0.1	0.0	1.54E-07	0.00E+00	1.83E-05	2.77E-06
2/12/09	19:00:00	90,000	1,560,600	27.7	38.1	0.3	0.2	4.62E-07	2.31E-07	1.88E-05	3.00E-06
3/12/09	18:30:00	84,600	1,645,200	27.5	38.0	0.2	0.0	3.08E-07	7.70E-08	1.91E-05	3.08E-06
4/12/09	16:30:00	79,200	1,724,400	27.3	37.9	0.2	0.1	3.08E-07	1.54E-07	1.94E-05	3.23E-06
5/12/09	17:05:00	88,500	1,812,900	27.2	37.8	0.1	0.1	1.54E-07	1.54E-07	1.96E-05	3.39E-06
6/12/09	18:50:00	92,700	1,905,600	27.0	37.8	0.2	0.0	3.08E-07	7.70E-08	1.99E-05	3.46E-06
7/12/09	16:45:00	78,900	1,984,500	26.9	37.7	0.1	0.0	1.54E-07	7.70E-08	2.00E-05	3.54E-06
8/12/09	17:15:00	88,200	2,072,700		37.6		0.1		1.54E-07		3.69E-06
9/12/09	17:25:00	87,000	2,159,700		37.6		0.0		0.00E+00		3.69E-06

Table F.7 Water permeability of CR-FN(0.45)10 concrete at 28 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
10/12/09	17:00:00	84,900	2,244,600		37.5		0.1		1.54E-07		3.85E-06
11/12/09	17:15:00	87,300	2,331,900		37.3		0.2		3.08E-07		4.16E-06
12/12/09	18:25:00	90,600	2,422,500		37.15		0.1		2.31E-07		4.39E-06

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	3.22E-12	m^3/sec	Q_2	=	1.57E-12	m^3/sec				
K_1	=	3.29E-13	m/sec	K_2	=	1.61E-13	m/sec	**K_{avg}**	**=**	**2.45E-13**	**m/sec**

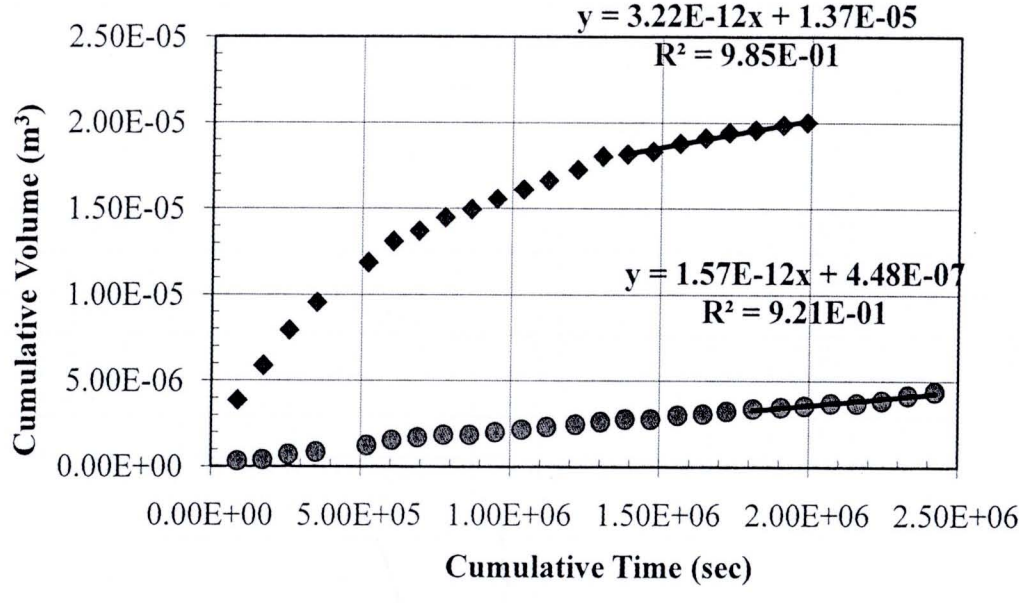


Table F.8 Water permeability of CR-FN(0.45)10 concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
15/6/09	10:00:00			40.5							
17/6/09	8:00:00	165,600	165,600	39.0		1.5		2.31E-06		2.31E-06	
19/6/09	8:45:00	175,500	341,100	38.7		0.3		4.62E-07		2.77E-06	
22/6/09	19:00:00	296,100	637,200	37.8	40.0	0.9		1.39E-06		4.16E-06	
24/6/09	8:30:00	135,000	772,200	37.5	39.7	0.3	0.3	4.62E-07	4.62E-07	4.62E-06	4.62E-07
26/6/09	19:00:00	210,600	982,800	37.2	39.6	0.3	0.1	4.62E-07	1.54E-07	5.08E-06	6.16E-07
30/6/09	18:00:00	342,000	1,324,800	36.5	39.1	0.7	0.5	1.08E-06	7.70E-07	6.16E-06	1.39E-06
6/7/09	20:00:00	525,600	1,850,400	36.0	38.9	0.5	0.2	7.70E-07	3.08E-07	6.93E-06	1.69E-06
9/7/09	18:45:00	254,700	2,105,100	35.3	38.3	0.7	0.6	1.08E-06	9.24E-07	8.00E-06	2.62E-06
13/7/09	8:30:00	308,700	2,413,800	35.0	38.1	0.3	0.2	4.62E-07	3.08E-07	8.47E-06	2.92E-06
15/7/09	19:00:00	210,600	2,624,400	34.4	37.5	0.6	0.6	9.24E-07	9.24E-07	9.39E-06	3.85E-06
19/7/09	10:30:00	315,000	2,939,400	34.3	37.5	0.1	0.0	1.54E-07	0.00E+00	9.54E-06	3.85E-06
21/7/09	18:30:00	201,600	3,141,000	34.0	37.3	0.3	0.2	4.62E-07	3.08E-07	1.00E-05	4.16E-06
24/7/09	9:00:00	225,000	3,366,000	33.6	36.9	0.4	0.4	6.16E-07	6.16E-07	1.06E-05	4.77E-06
27/7/09	7:30:00	253,800	3,619,800	33.3	36.7	0.3	0.2	4.62E-07	3.08E-07	1.11E-05	5.08E-06
29/7/09	9:45:00	180,900	3,800,700	33.2	36.6	0.1	0.1	1.54E-07	1.54E-07	1.12E-05	5.23E-06
30/7/09	8:00:00	80,100	3,880,800	33.1	36.5	0.1	0.1	1.54E-07	1.54E-07	1.14E-05	5.39E-06
31/7/09	18:30:00	124,200	4,005,000	33	36.4	0.1	0.1	1.54E-07	1.54E-07	1.15E-05	5.54E-06
3/8/09	18:45:00	260,100	4,265,100	32.5	36.0	0.5	0.4	7.70E-07	6.16E-07	1.23E-05	6.16E-06
5/8/09	18:15:00	171,000	4,436,100	32.5	36.0	0.0	0.0	0.00E+00	0.00E+00	1.23E-05	6.16E-06
7/8/09	18:45:00	174,600	4,610,700	32.4	35.9	0.1	0.1	1.54E-07	1.54E-07	1.25E-05	6.31E-06
10/8/09	18:30:00	258,300	4,869,000	32.0	35.5	0.4	0.4	6.16E-07	6.16E-07	1.31E-05	6.93E-06
13/8/09	18:30:00	259,200	5,128,200	31.7	35.3	0.3	0.2	4.62E-07	3.08E-07	1.35E-05	7.24E-06
17/8/09	18:30:00	345,600	5,473,800	31.5	35.2	0.2	0.1	3.08E-07	1.54E-07	1.39E-05	7.39E-06
20/8/09	12:30:00	237,600	5,711,400	31.4	35.0	0.1	0.2	1.54E-07	3.08E-07	1.40E-05	7.70E-06

Table F.8 Water permeability of CR-FN(0.45)10 concrete at 90 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
24/8/09	19:20:00	370,200	6,081,600		34.8		0.2		3.08E-07		8.00E-06
31/8/09	18:20:00	601,200	6,682,800		34.1		0.7		1.08E-06		9.08E-06
5/9/09	12:15:00	410,100	7,092,900		34.1		0.0		0.00E+00		9.08E-06

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	1.51E-12	m^3/sec	Q_2	=	1.21E-12	m^3/sec				
K_1	=	1.57E-13	m/sec	K_2	=	1.23E-13	m/sec	**K_{avg}**	**=**	**1.40E-13**	**m/sec**

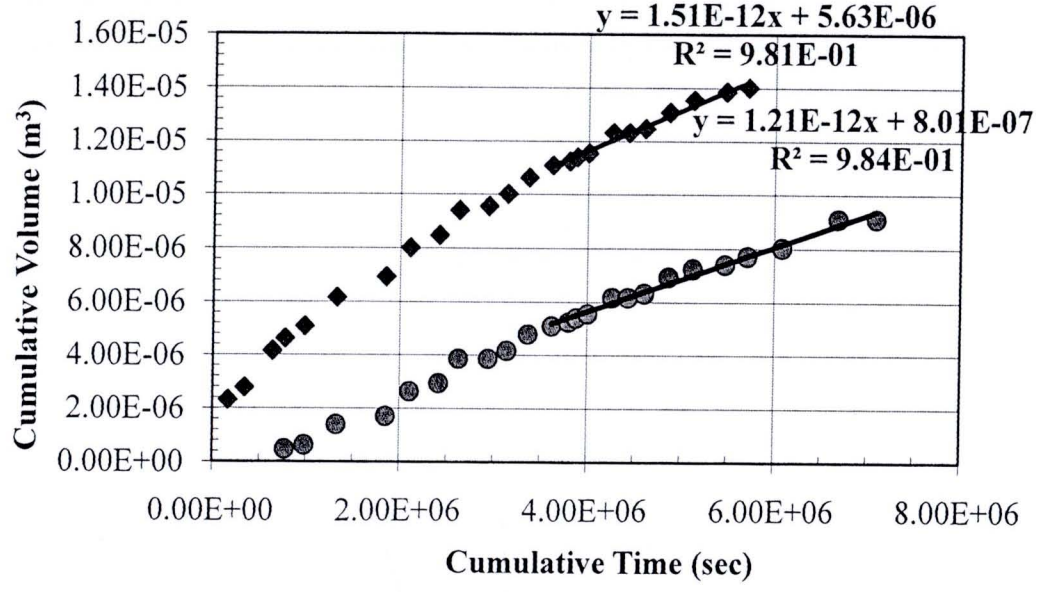


Table F.9 Water permeability of CR-PA(0.45) concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
16/5/09	10:30:00			39.8	39.5						
16/5/09	13:20:00	10,200	10,200	37.1	37.0	2.7	2.5	4.16E-06	3.85E-06	4.16E-06	3.85E-06
16/5/09	17:20:00	14,400	24,600	34.4	34.2	2.7	2.8	4.16E-06	4.31E-06	8.31E-06	8.16E-06
18/5/09	8:20:00	140,400	165,000	20.9	18.9	13.5	15.3	2.08E-05	2.36E-05	2.91E-05	3.17E-05
18/5/09	20:00:00	42,000	207,000	17.4	15.8	3.5	3.1	5.39E-06	4.77E-06	3.45E-05	3.65E-05
19/5/09	15:15:00	69,300	276,300	11.3	11.3	6.1	4.5	9.39E-06	6.93E-06	4.39E-05	4.34E-05
19/5/09	19:00:00	13,500	289,800	10.1	10.5	1.2	0.8	1.85E-06	1.23E-06	4.57E-05	4.46E-05
20/5/09	9:40:00	52,800	342,600	6.1	7.1	4.0	3.4	6.16E-06	5.23E-06	5.19E-05	4.99E-05
20/5/09	16:45:00	25,500	368,100	3.5	5.3	2.6	1.8	4.00E-06	2.77E-06	5.59E-05	5.26E-05
21/5/09	8:30:00	56,700	424,800		2.7		2.6		4.00E-06		5.66E-05
21/5/09	18:30:00	36,000	460,800		0.8		1.9		2.92E-06		5.96E-05

Table F.9 Water permeability of CR-PA(0.45) concrete at 28 days (Continued)

Dia.1	=	0.102	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	1.31E-10	m^3/sec	Q_2	=	9.43E-11	m^3/sec				
K_1	=	1.29E-11	m/sec	K_2	=	9.88E-12	m/sec	**K_{avg}**	**=**	**1.14E-11**	**m/sec**

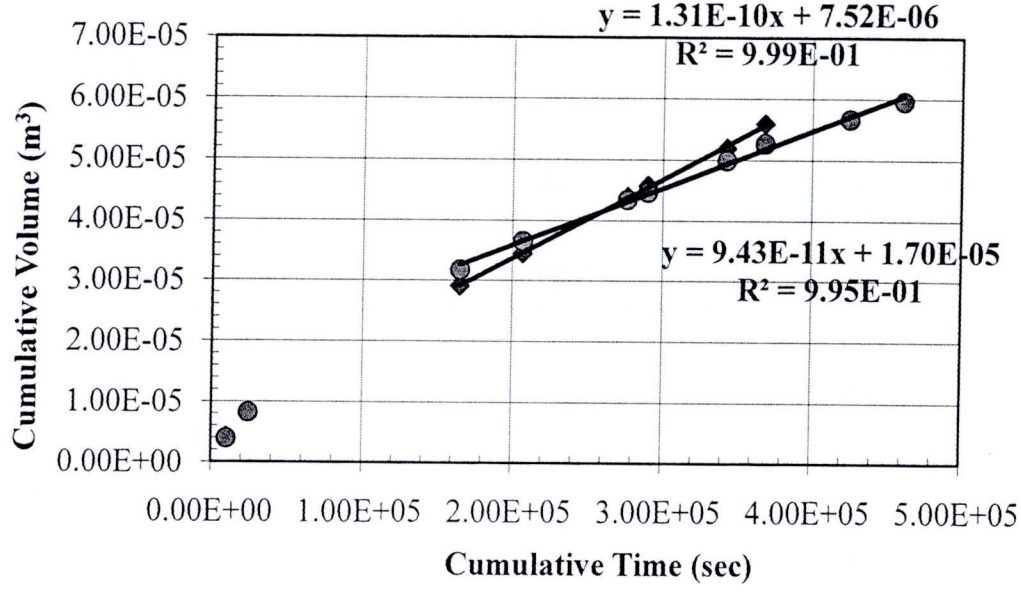
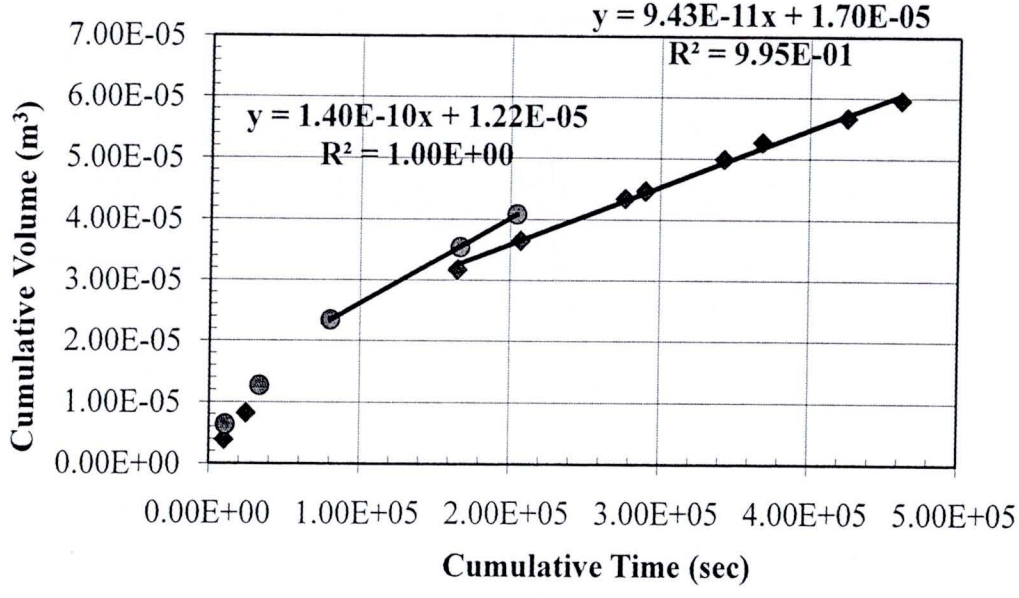


Table F.10 Water permeability of CR-PA(0.45) concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
16/5/09	10:30:00			39.5							
16/5/09	13:20:00	10,200	10,200	37.0		2.5		3.85E-06		3.85E-06	
16/5/09	17:20:00	14,400	24,600	34.2		2.8		4.31E-06		8.16E-06	
18/5/09	8:20:00	140,400	165,000	18.9		15.3		2.36E-05		3.17E-05	
18/5/09	20:00:00	42,000	207,000	15.8		3.1		4.77E-06		3.65E-05	
19/5/09	15:15:00	69,300	276,300	11.3		4.5		6.93E-06		4.34E-05	
19/5/09	19:00:00	13,500	289,800	10.5		0.8		1.23E-06		4.46E-05	
20/5/09	9:40:00	52,800	342,600	7.1		3.4		5.23E-06		4.99E-05	
20/5/09	16:45:00	25,500	368,100	5.3		1.8		2.77E-06		5.26E-05	
21/5/09	8:30:00	56,700	424,800	2.7		2.6		4.00E-06		5.66E-05	
21/5/09	18:30:00	36,000	460,800	0.8		1.9		2.92E-06		5.96E-05	
29/7/09	9:45:00				41.3						
29/7/09	12:45:00	10,800	10,800		37.2		4.1		6.31E-06		6.31E-06
29/7/09	19:00:00	22,500	33,300		33.1		4.1		6.31E-06		1.26E-05
30/7/09	8:00:00	46,800	80,100		26.1		7.0		1.08E-05		2.34E-05
31/7/09	8:00:00	86,400	166,500		18.3		7.8		1.20E-05		3.54E-05
31/7/09	18:30:00	37,800	204,300		14.8		3.5		5.39E-06		4.08E-05

Table F.10 Water permeability of CR-PA(0.45) concrete at 90 days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.043	m	g	=	9.81	m/sec^2
Q_1	=	9.43E-11	m^3/sec	Q_2	=	1.40E-10	m^3/sec				
K_1	=	9.88E-12	m/sec	K_2	=	1.50E-11	m/sec	**K_{avg}**	**=**	**9.88E-12**	**m/sec**



Note: This means, it is not included for analysis.

Table F.11 Water permeability of CR-PA(0.45)10 concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
11/2/10	17:00:00			40.2	40.0						
12/2/10	17:30:00	88,200	88,200	37.2	37.0	3.0	3.0	4.62E-06	4.62E-06	4.62E-06	4.62E-06
13/2/10	17:05:00	84,900	173,100	36.2	36.0	1.0	1.1	1.54E-06	1.62E-06	6.16E-06	6.23E-06
14/2/10	17:05:00	86,400	259,500	35.5	35.1	0.8	0.9	1.15E-06	1.31E-06	7.31E-06	7.54E-06
15/2/10	17:05:00	86,400	345,900	34.8	34.2	0.7	0.9	1.00E-06	1.39E-06	8.31E-06	8.93E-06
17/2/10	17:15:00	173,400	519,300	33.8	32.7	1.0	1.6	1.54E-06	2.39E-06	9.85E-06	1.13E-05
18/2/10	17:10:00	86,100	605,400	33.2	31.9	0.6	0.8	9.24E-07	1.23E-06	1.08E-05	1.25E-05
19/2/10	17:15:00	86,700	692,100	32.8	31.2	0.5	0.7	6.93E-07	1.08E-06	1.15E-05	1.36E-05
20/2/10	17:20:00	86,700	778,800	32.3	30.4	0.5	0.8	7.70E-07	1.15E-06	1.22E-05	1.48E-05
21/2/10	17:45:00	87,900	866,700	31.8	29.7	0.4	0.8	6.93E-07	1.15E-06	1.29E-05	1.59E-05
22/2/10	17:10:00	84,300	951,000	31.3	29.0	0.6	0.6	8.47E-07	1.00E-06	1.38E-05	1.69E-05
23/2/10	17:30:00	87,600	1,038,600	30.8	28.3	0.4	0.7	6.93E-07	1.08E-06	1.45E-05	1.80E-05
24/2/10	17:00:00	84,600	1,123,200	30.4	27.7	0.4	0.7	6.93E-07	1.00E-06	1.52E-05	1.90E-05
25/2/10	17:15:00	87,300	1,210,500	29.9	27.2	0.5	0.4	6.93E-07	6.93E-07	1.59E-05	1.97E-05
26/2/10	17:25:00	87,000	1,297,500	29.5	26.8	0.4	0.4	6.16E-07	6.93E-07	1.65E-05	2.04E-05
27/2/10	17:30:00	86,700	1,384,200	29.1	26.3	0.4	0.5	6.93E-07	7.70E-07	1.72E-05	2.12E-05
28/2/10	17:30:00	86,400	1,470,600	28.7	25.9	0.4	0.4	6.16E-07	5.39E-07	1.78E-05	2.17E-05
1/3/10	17:30:00	86,400	1,557,000	28.2	25.5	0.4	0.4	6.93E-07	6.16E-07	1.85E-05	2.23E-05
2/3/10	17:40:00	87,000	1,644,000	27.9	25.1	0.3	0.4	5.39E-07	6.93E-07	1.90E-05	2.30E-05
3/3/10	17:35:00	86,100	1,730,100	27.5	24.7	0.4	0.4	6.16E-07	5.39E-07	1.96E-05	2.36E-05
4/3/10	17:35:00	86,400	1,816,500	27.1	24.3	0.3	0.4	5.39E-07	6.16E-07	2.02E-05	2.42E-05
5/3/10	17:40:00	86,700	1,903,200	26.8	24.0	0.3	0.4	4.62E-07	5.39E-07	2.06E-05	2.47E-05
6/3/10	17:40:00	86,400	1,989,600	26.5	23.5	0.3	0.4	4.62E-07	6.93E-07	2.11E-05	2.54E-05
7/3/10	17:35:00	86,100	2,075,700	26.0	23.2	0.5	0.4	7.70E-07	5.39E-07	2.19E-05	2.59E-05
8/3/10	17:40:00	86,700	2,162,400	25.8	22.8	0.2	0.3	3.08E-07	5.39E-07	2.22E-05	2.65E-05

Table F.11 Water permeability of CR-PA(0.45)10 concrete at 28 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
9/3/10	17:40:00	86,400	2,248,800	25.6	22.5	0.2	0.4	3.08E-07	5.39E-07	2.25E-05	2.70E-05
10/3/10	17:55:00	87,300	2,336,100	25.3	22.1	0.4	0.4	5.39E-07	6.16E-07	2.30E-05	2.76E-05
11/3/10	17:55:00	86,400	2,422,500	25.0	21.8	0.3	0.3	3.85E-07	3.85E-07	2.34E-05	2.80E-05

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	5.47E-12	m^3/sec	Q_2	=	6.46E-12	m^3/sec				
K_1	=	5.80E-13	m/sec	K_2	=	6.74E-13	m/sec	**K_{avg}**	**=**	**6.27E-13**	**m/sec**

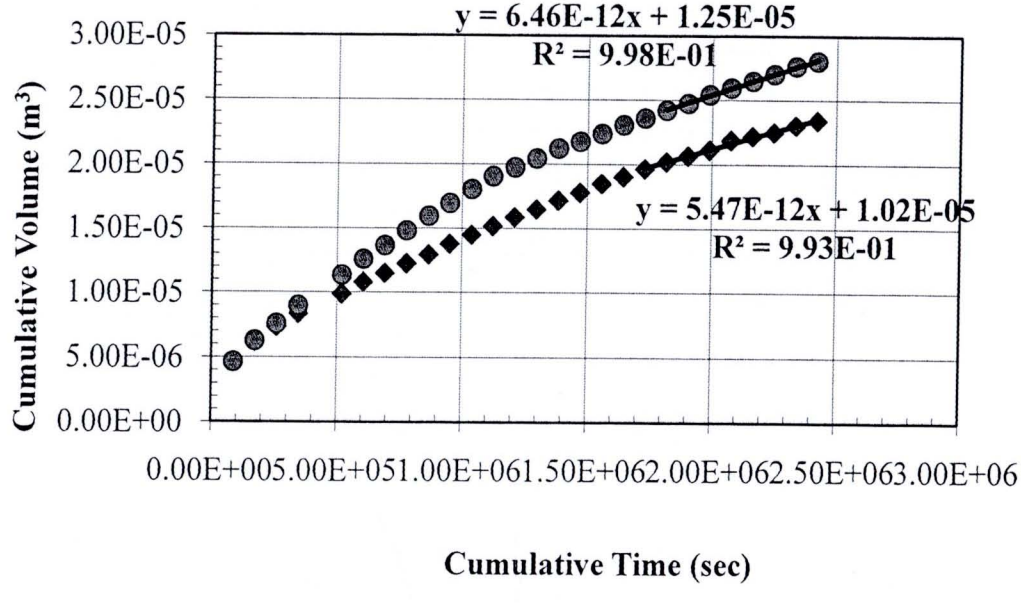


Table F.12 Water permeability of CR-PA(0.45)10 concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
11/4/10	15:00:00			41.2	41.1						
13/4/10	15:10:00	173,400	173,400	40.1	39.7	1.1	1.4	1.69E-06	2.16E-06	1.69E-06	2.16E-06
15/4/10	15:10:00	172,800	346,200	39.3	38.8	0.9	0.9	1.31E-06	1.39E-06	3.00E-06	3.54E-06
17/4/10	15:00:00	172,200	518,400	38.7	38.1	0.5	0.7	8.47E-07	1.08E-06	3.85E-06	4.62E-06
19/4/10	15:15:00	173,700	692,100	38.3	37.5	0.4	0.6	6.16E-07	9.24E-07	4.46E-06	5.54E-06
20/4/10	17:45:00	95,400	787,500	37.9	37.0	0.4	0.5	6.16E-07	7.70E-07	5.08E-06	6.31E-06
21/4/10	15:30:00	78,300	865,800	37.4	36.6	0.5	0.4	7.70E-07	6.16E-07	5.85E-06	6.93E-06
22/4/10	15:35:00	86,700	952,500	37.1	36.3	0.3	0.3	4.62E-07	4.62E-07	6.31E-06	7.39E-06
23/4/10	15:30:00	86,100	1,038,600	36.9	36.1	0.2	0.3	3.08E-07	3.85E-07	6.62E-06	7.77E-06
24/4/10	15:40:00	87,000	1,125,600	36.7	35.9	0.2	0.1	3.08E-07	2.31E-07	6.93E-06	8.00E-06
25/4/10	17:05:00	91,500	1,217,100	36.5	35.6	0.2	0.3	3.08E-07	4.62E-07	7.24E-06	8.47E-06
26/4/10	15:30:00	80,700	1,297,800	36.3	35.4	0.2	0.2	3.08E-07	3.08E-07	7.54E-06	8.77E-06
27/4/10	15:30:00	86,400	1,384,200	36.2	35.2	0.1	0.2	2.31E-07	3.08E-07	7.77E-06	9.08E-06
28/4/10	15:45:00	87,300	1,471,500	36.0	35.1	0.1	0.2	2.31E-07	2.31E-07	8.00E-06	9.31E-06
29/4/10	16:15:00	88,200	1,559,700	35.8	34.9	0.3	0.2	3.85E-07	3.08E-07	8.39E-06	9.62E-06
30/4/10	15:30:00	83,700	1,643,400	35.5	34.5	0.3	0.4	3.85E-07	5.39E-07	8.77E-06	1.02E-05
1/5/10	16:00:00	88,200	1,731,600	35.3	34.4	0.2	0.1	3.08E-07	1.54E-07	9.08E-06	1.03E-05
2/5/10	15:00:00	82,800	1,814,400	35.2	34.3	0.1	0.1	2.31E-07	2.31E-07	9.31E-06	1.05E-05
4/5/10	15:20:00	174,000	1,988,400	34.9	33.9	0.3	0.4	4.62E-07	6.16E-07	9.78E-06	1.12E-05
5/5/10	15:10:00	85,800	2,074,200	34.6	33.6	0.3	0.3	3.85E-07	3.85E-07	1.02E-05	1.15E-05
6/5/10	16:25:00	90,900	2,165,100	34.4	33.4	0.3	0.3	3.85E-07	3.85E-07	1.05E-05	1.19E-05
7/5/10	15:25:00	82,800	2,247,900	34.2	33.0	0.1	0.4	2.31E-07	5.39E-07	1.08E-05	1.25E-05
8/5/10	15:40:00	87,300	2,335,200	34.1	32.8	0.2	0.3	2.31E-07	3.85E-07	1.10E-05	1.29E-05
9/5/10	10:30:00	67,800	2,403,000	33.8	32.5	0.3	0.3	4.62E-07	3.85E-07	1.15E-05	1.32E-05
10/5/10	15:05:00	102,900	2,505,900	33.4	32.3	0.4	0.2	5.39E-07	3.08E-07	1.20E-05	1.35E-05

Table F.12 Water permeability of CR-PA(0.45)10 concrete at 90 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
11/5/10	10:30:00	69,900	2,575,800	33.2	32.1	0.2	0.2	3.08E-07	3.08E-07	1.23E-05	1.39E-05
12/5/10	18:50:00	116,400	2,692,200	32.9	32.0	0.3	0.2	4.62E-07	2.31E-07	1.28E-05	1.41E-05
14/5/10	14:45:00	158,100	2,850,300	32.5	31.6	0.4	0.3	6.93E-07	5.39E-07	1.35E-05	1.46E-05

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	4.36E-12	m^3/sec	Q_2	=	3.80E-12	m^3/sec				
K_1	=	4.53E-13	m/sec	K_2	=	3.87E-13	m/sec	**K_{avg}**	**=**	**4.20E-13**	**m/sec**

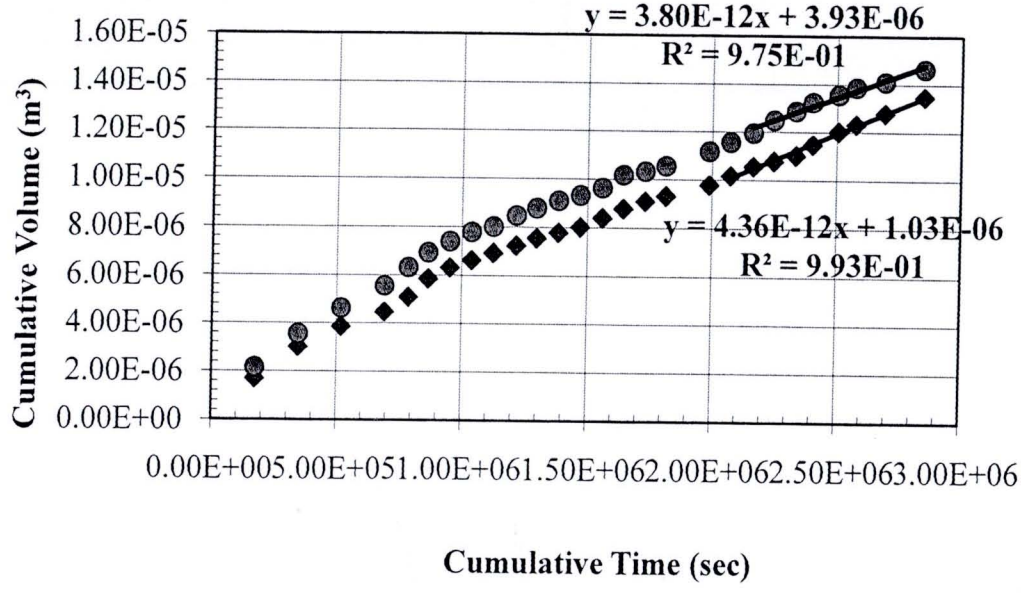


Table F.13 Water permeability of CR-RA(0.45) concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
27/6/08	16:40:00			42.5	42.5						
27/6/08	16:42:00	120	120	41.5	41.5	1.0	1.0	1.54E-06	1.54E-06	1.54E-06	1.54E-06
27/6/08	16:45:00	180	300	40.8	40.8	0.7	0.7	1.08E-06	1.08E-06	2.62E-06	2.62E-06
27/6/08	16:47:00	120	420	39.4	39.4	1.4	1.4	2.16E-06	2.16E-06	4.77E-06	4.77E-06
27/6/08	16:49:00	120	540	39.0	39.0	0.4	0.4	6.16E-07	6.16E-07	5.39E-06	5.39E-06
27/6/08	17:10:00	1,260	1,800	38.9	38.9	0.1	0.1	1.54E-07	1.54E-07	5.54E-06	5.54E-06
27/6/08	17:26:00	960	2,760	38.8	38.8	0.1	0.1	1.54E-07	1.54E-07	5.70E-06	5.70E-06
27/6/08	19:00:00	5,640	8,400	35.4	35.4	3.5	3.5	5.31E-06	5.31E-06	1.10E-05	1.10E-05
28/6/08	6:39:00	41,940	50,340	13.1	13.1	22.3	22.3	3.43E-05	3.43E-05	4.53E-05	4.53E-05
28/6/08	7:41:00	3,720	54,060	11.2	11.2	1.9	1.9	2.92E-06	2.92E-06	4.82E-05	4.82E-05
28/6/08	9:00:00	4,740	58,800	8.4	8.4	2.8	2.8	4.31E-06	4.31E-06	5.25E-05	5.25E-05
28/6/08	12:00:00	10,800	69,600	3.7	3.7	4.7	4.7	7.24E-06	7.24E-06	5.97E-05	5.97E-05

Table F.13 Water permeability of CR-RA(0.45) concrete at 28 days (Continued)

Dia.1	=	0.101	m	Dia.2	=	0.101	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	8.15E-10	m^3/sec	Q_2	=	8.15E-10	m^3/sec				
K_1	=	8.25E-11	m/sec	K_2	=	8.13E-11	m/sec	**K_{avg}**	**=**	**8.19E-11**	**m/sec**

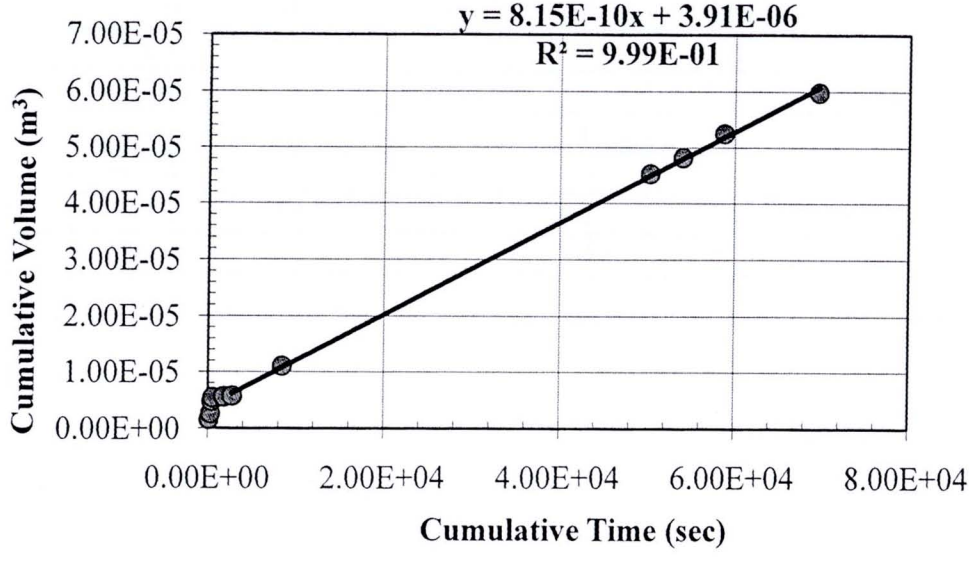


Table F.14 Water permeability of CR-RA(0.45) concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
22/9/08	15:30:00			44.0	44.0						
22/9/08	15:32:00	120	120	43.2	43.0	0.8	1.0	1.23E-06	1.54E-06	1.23E-06	1.54E-06
22/9/08	15:35:00	180	300	42.6	42.8	0.6	0.2	9.24E-07	3.08E-07	2.16E-06	1.85E-06
22/9/08	15:37:00	120	420	41.4	42.4	1.2	0.4	1.85E-06	6.16E-07	4.00E-06	2.46E-06
22/9/08	15:39:00	120	540	40.0	42.0	1.4	0.4	2.16E-06	6.16E-07	6.16E-06	3.08E-06
22/9/08	16:00:00	1,260	1,800	39.6	39.0	0.4	3.0	6.16E-07	4.62E-06	6.77E-06	7.70E-06
22/9/08	16:16:00	960	2,760	38.6	38.0	1.0	1.0	1.54E-06	1.54E-06	8.31E-06	9.24E-06
22/9/08	17:50:00	5,640	8,400	37.2	37.1	1.4	0.9	2.16E-06	1.39E-06	1.05E-05	1.06E-05
23/9/08	5:29:00	41,940	50,340	19.3	19.4	17.9	17.7	2.76E-05	2.72E-05	3.80E-05	3.79E-05
23/9/08	6:30:00	3,660	54,000	18.1	18.8	1.2	0.6	1.85E-06	9.24E-07	3.99E-05	3.88E-05
23/9/08	8:00:00	5,400	59,400	16.8	17.0	1.3	1.8	2.00E-06	2.77E-06	4.19E-05	4.16E-05

Table F.14 Water permeability of CR-RA(0.45) concrete at 90 days (Continued)

Dia.1	=	0.101	m	Dia.2	=	0.101	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	6.22E-10	m^3/sec	Q_2	=	5.98E-10	m^3/sec				
K_1	=	6.45E-11	m/sec	K_2	=	6.20E-11	m/sec	**K_{avg}**	**=**	**6.32E-11**	**m/sec**

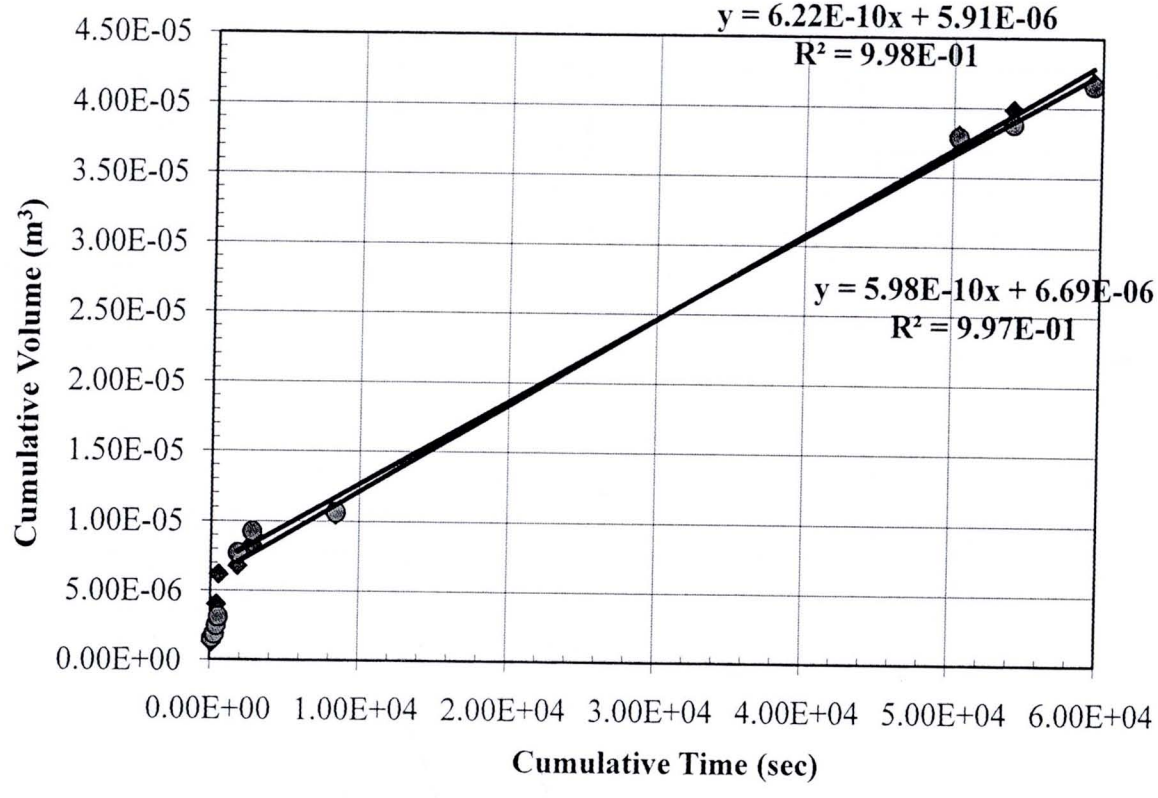


Table F.15 Water permeability of CR-RA(0.45)10 concrete at 28 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
1/7/09	11:00:00			41.5							
1/7/09	12:00:00	3,600	3,600	41.2		0.3		4.62E-07		4.62E-07	
1/7/09	13:00:00	3,600	7,200	41.0		0.2		3.08E-07		7.70E-07	
1/7/09	17:00:00	14,400	21,600	40.7		0.3		4.62E-07		1.23E-06	
1/7/09	19:15:00	8,100	29,700	40.7		0.0		0.00E+00		1.23E-06	
2/7/09	18:30:00	83,700	113,400	40.2		0.5		7.70E-07		2.00E-06	
3/7/09	18:00:00	84,600	198,000	39.7		0.5		7.70E-07		2.77E-06	
8/7/09	18:00:00	432,000	630,000	37.8		1.9		2.92E-06		5.70E-06	
10/7/09	18:15:00	173,700	803,700	37.3		0.5		7.70E-07		6.47E-06	
14/7/09	8:30:00	310,500	1,114,200	36.5		0.8		1.23E-06		7.70E-06	
16/7/09	19:00:00	210,600	1,324,800	35.9		0.6		9.24E-07		8.62E-06	
20/7/09	19:00:00	345,600	1,670,400	35.3		0.6		9.24E-07		9.54E-06	
23/7/09	8:30:00	221,400	1,891,800	34.8		0.5		7.70E-07		1.03E-05	
24/7/09	9:00:00	88,200	1,980,000	34.6		0.2		3.08E-07		1.06E-05	
27/7/09	7:30:00	253,800	2,233,800	34.2		0.4		6.16E-07		1.12E-05	
29/7/09	9:45:00	180,900	2,414,700	34.0	41.3	0.2		3.08E-07		1.15E-05	
30/7/09	8:00:00	80,100	2,494,800	33.8	40.7	0.2	0.6	3.08E-07	9.24E-07	1.19E-05	9.24E-07
31/7/09	18:30:00	124,200	2,619,000	33.7	40.7	0.1	0.0	1.54E-07	0.00E+00	1.20E-05	9.24E-07
3/8/09	18:45:00	260,100	2,879,100	33.2	40.3	0.5	0.4	7.70E-07	6.16E-07	1.28E-05	1.54E-06
5/8/09	18:15:00	171,000	3,050,100	33.1	40.3	0.1	0.0	1.54E-07	0.00E+00	1.29E-05	1.54E-06
7/8/09	18:45:00	174,600	3,224,700	33.0	40.2	0.1	0.1	1.54E-07	1.54E-07	1.31E-05	1.69E-06
10/8/09	18:30:00	258,300	3,483,000	32.4	39.8	0.6	0.4	9.24E-07	6.16E-07	1.40E-05	2.31E-06
13/8/09	18:30:00	259,200	3,742,200	32.2	39.6	0.2	0.2	3.08E-07	3.08E-07	1.43E-05	2.62E-06
17/8/09	18:30:00	345,600	4,087,800	31.9	39.4	0.3	0.2	4.62E-07	3.08E-07	1.48E-05	2.92E-06
20/8/09	12:30:00	237,600	4,325,400	31.7	39.3	0.2	0.1	3.08E-07	1.54E-07	1.51E-05	3.08E-06

Table F.15 Water permeability of CR-RA(0.45)10 concrete at 28 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
24/8/09	19:20:00	370,200	4,695,600	31.4	39.0	0.3	0.3	4.62E-07	4.62E-07	1.55E-05	3.54E-06
31/8/09	18:20:00	601,200	5,296,800	30.4	38.4	1.0	0.6	1.54E-06	9.24E-07	1.71E-05	4.46E-06
5/9/09	12:15:00	410,100	5,706,900	30.2	38.4	0.2	0.0	3.08E-07	0.00E+00	1.74E-05	4.46E-06

Dia.1	=	0.100	m	Dia.2	=	0.099	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	1.69E-12	m^3/sec	Q_2	=	1.04E-12	m^3/sec				
K_1	=	1.74E-13	m/sec	K_2	=	1.08E-13	m/sec	**K_{avg}**	**=**	**1.41E-13**	**m/sec**

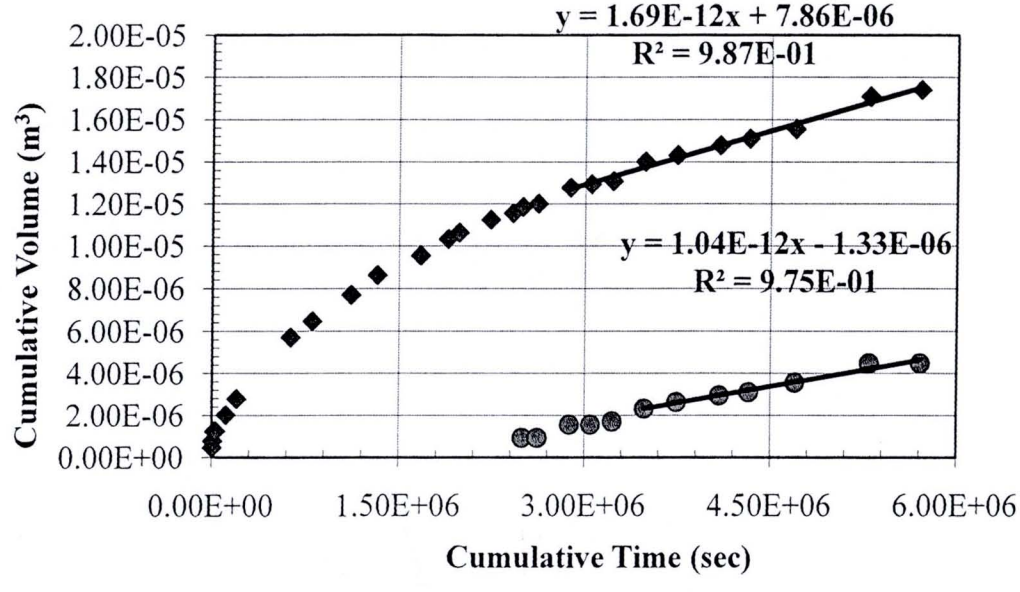


Table F.16 Water permeability of CR-RA(0.45)10 concrete at 90 Days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
29/4/09	8:30:00			40.5	39.7						
30/4/09	8:15:00	85,500	85,500	39.3	38.3	1.2	1.4	1.85E-06	2.16E-06	1.85E-06	2.16E-06
2/5/09	10:00:00	179,100	264,600	38.8	37.5	0.5	0.8	7.70E-07	1.23E-06	2.62E-06	3.39E-06
5/5/09	10:00:00	259,200	523,800	38.5	37.1	0.3	0.4	4.62E-07	6.16E-07	3.08E-06	4.00E-06
7/5/09	8:15:00	166,500	690,300	38.4	36.9	0.1	0.2	1.54E-07	3.08E-07	3.23E-06	4.31E-06
9/5/09	17:30:00	206,100	896,400	38.1	36.6	0.3	0.3	4.62E-07	4.62E-07	3.69E-06	4.77E-06
11/5/09	15:30:00	165,600	1,062,000	38.0	36.4	0.1	0.2	1.54E-07	3.08E-07	3.85E-06	5.08E-06
15/5/09	19:00:00	358,200	1,420,200	37.5	35.8	0.5	0.6	7.70E-07	9.24E-07	4.62E-06	6.00E-06
19/5/09	19:00:00	345,600	1,765,800	37.2	35.5	0.3	0.3	4.62E-07	4.62E-07	5.08E-06	6.47E-06
22/5/09	20:25:00	264,300	2,030,100	37.2	35.5	0.0	0.0	0.00E+00	0.00E+00	5.08E-06	6.47E-06
26/5/09	10:30:00	309,900	2,340,000	36.9	35.2	0.3	0.3	4.62E-07	4.62E-07	5.54E-06	6.93E-06
28/5/09	16:00:00	192,600	2,532,600	36.8	35.0	0.1	0.2	1.54E-07	3.08E-07	5.70E-06	7.24E-06
31/5/09	18:30:00	268,200	2,800,800	36.7	34.8	0.1	0.2	1.54E-07	3.08E-07	5.85E-06	7.54E-06
1/6/09	19:00:00	88,200	2,889,000	36.6	34.8	0.1	0.0	1.54E-07	0.00E+00	6.00E-06	7.54E-06
2/6/09	19:00:00	86,400	2,975,400	36.5	34.7	0.1	0.1	1.54E-07	1.54E-07	6.16E-06	7.70E-06
4/6/09	18:45:00	171,900	3,147,300	36.4	34.5	0.1	0.2	1.54E-07	3.08E-07	6.31E-06	8.00E-06
5/6/09	18:45:00	86,400	3,233,700	36.3	34.5	0.1	0.0	1.54E-07	0.00E+00	6.47E-06	8.00E-06
9/6/09	19:00:00	346,500	3,580,200	35.9	34.1	0.4	0.4	6.16E-07	6.16E-07	7.08E-06	8.62E-06
10/6/09	19:00:00	86,400	3,666,600	35.8	33.9	0.1	0.2	1.54E-07	3.08E-07	7.24E-06	8.93E-06
15/6/09	9:00:00	396,000	4,062,600	35.7	33.8	0.1	0.1	1.54E-07	1.54E-07	7.39E-06	9.08E-06
17/6/09	19:30:00	210,600	4,273,200	35.5	33.7	0.2	0.1	3.08E-07	1.54E-07	7.70E-06	9.24E-06
18/6/09	19:10:00	85,200	4,358,400	35.5	33.7	0.0	0.0	0.00E+00	0.00E+00	7.70E-06	9.24E-06
22/6/09	19:00:00	345,000	4,703,400	35.3	33.4	0.2	0.3	3.08E-07	4.62E-07	8.00E-06	9.70E-06
23/6/09	19:00:00	86,400	4,789,800	35.2	33.3	0.1	0.1	1.54E-07	1.54E-07	8.16E-06	9.85E-06
25/6/09	19:30:00	174,600	4,964,400	35.2	33.3	0.0	0.0	0.00E+00	0.00E+00	8.16E-06	9.85E-06

Table F.16 Water permeability of CR-RA(0.45)10 concrete at 90 days (Continued)

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
26/6/09	19:00:00	84,600	5,049,000	35.2	33.3	0.0	0.0	0.00E+00	0.00E+00	8.16E-06	9.85E-06
29/6/09	9:30:00	225,000	5,274,000	35.2	33.3	0.0	0.0	0.00E+00	0.00E+00	8.16E-06	9.85E-06
30/6/09	18:00:00	117,000	5,391,000	35.0	33.1	0.2	0.2	3.08E-07	3.08E-07	8.47E-06	1.02E-05

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.041	m	L_2	=	0.042	m	g	=	9.81	m/sec^2
Q_1	=	9.72E-13	m^3/sec	Q_2	=	9.13E-13	m^3/sec				
K_1	=	1.00E-13	m/sec	K_2	=	9.65E-14	m/sec	**K_{avg}**	**=**	**9.84E-14**	**m/sec**

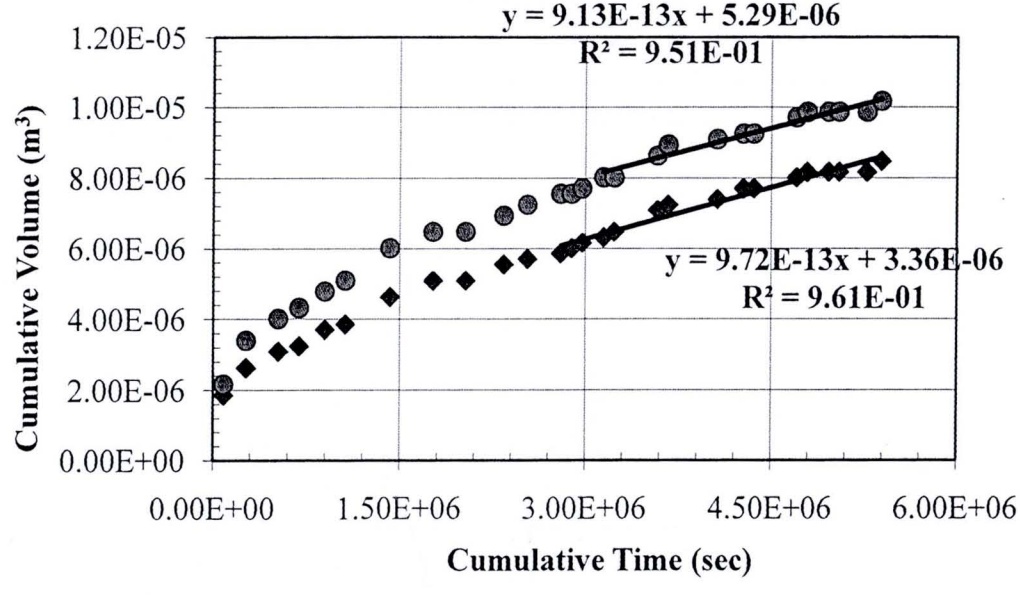


Table F.17 Water permeability of NC(0.65) concrete at 28 Days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
6/5/08	9:25:00			37.0							
6/5/08	16:24:00	25,140	25,140	34.8		2.2		3.39E-06		3.39E-06	
7/5/08	7:00:00	52,560	77,700	33.2		1.6		2.46E-06		5.85E-06	
7/5/08	16:50:00	35,400	113,100	32.3		0.9		1.39E-06		7.24E-06	
8/5/08	7:50:00	54,000	167,100	31.1		1.2		1.85E-06		9.08E-06	
8/5/08	18:30:00	38,400	205,500	30.4		0.7		1.08E-06		1.02E-05	
9/5/08	8:31:00	50,460	255,960	28.6		1.8		2.77E-06		1.29E-05	
12/5/08	8:10:00	257,940	513,900	25.4		3.2		4.93E-06		1.79E-05	
17/5/08	10:30:00	440,400	954,300	20.7		4.7		7.24E-06		2.51E-05	
18/5/08	10:12:00	85,320	1,039,620	19.8		0.9		1.39E-06		2.65E-05	
10/10/06	15:30:00				37.3						
10/10/06	19:30:00	14,400	14,400		34.3		3.0		4.62E-06		4.62E-06
11/10/06	9:45:00	51,300	65,700		32.5		1.8		2.85E-06		7.47E-06
11/10/06	13:45:00	14,400	80,100		32.1		0.4		5.39E-07		8.00E-06
11/10/06	17:45:00	14,400	94,500		31.9		0.3		3.85E-07		8.39E-06
11/10/06	21:45:00	14,400	108,900		31.7		0.2		3.08E-07		8.70E-06
12/10/06	10:30:00	45,900	154,800		31.1		0.5		8.47E-07		9.54E-06
12/10/06	16:54:00	23,040	177,840		30.9		0.3		3.85E-07		9.93E-06
12/10/06	21:46:00	17,520	195,360		30.7		0.2		3.08E-07		1.02E-05
13/10/06	9:45:00	43,140	238,500		30.1		0.5		8.47E-07		1.11E-05
13/10/06	15:20:00	20,100	258,600		29.7		0.4		6.16E-07		1.17E-05
13/10/06	18:15:00	10,500	269,100		29.4		0.3		4.62E-07		1.22E-05
14/10/06	16:58:00	81,780	350,880		28.6		0.8		1.23E-06		1.34E-05
15/10/06	12:12:00	69,240	420,120		28.5		0.1		1.54E-07		1.35E-05
16/10/06	13:57:00	92,700	512,820		27.6		0.9		1.39E-06		1.49E-05

Table F.17 Water permeability of NC(0.65) concrete at 28 days (Continued)

Dia.1	=	0.093	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.043	m	L_2	=	0.040	m	g	=	9.81	m/sec^2
Q_1	=	1.85E-11	m^3/sec	Q_2	=	1.51E-11	m^3/sec				
K_1	=	2.27E-12	m/sec	K_2	=	1.52E-12	m/sec	**K_{avg}**	**=**	**1.89E-12**	**m/sec**

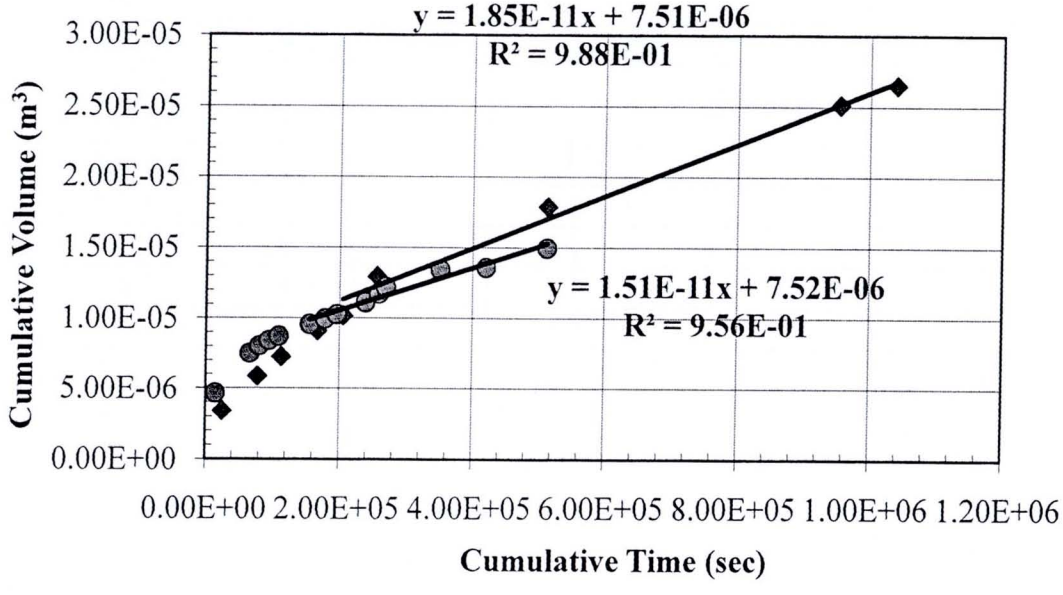


Table F.18 Water permeability of NC(0.65) concrete at 90 days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
24/12/06	18:08:00			29.7							
25/12/06	11:09:00	61,260	61,260	29.4		0.3		4.62E-07		4.62E-07	
25/12/06	15:45:00	16,560	77,820	29.4		0.0		0.00E+00		4.62E-07	
25/12/06	20:57:00	18,720	96,540	29.3		0.1		1.54E-07		6.16E-07	
26/12/06	11:49:00	53,520	150,060	29.0		0.3		3.85E-07		1.00E-06	
26/12/06	15:58:00	14,940	165,000	29.0		0.0		0.00E+00		1.00E-06	
26/12/06	22:21:00	22,980	187,980	28.9		0.1		1.54E-07		1.15E-06	
27/12/06	1:56:00	12,900	200,880	28.9		0.0		7.70E-08		1.23E-06	
27/12/06	5:12:00	11,760	212,640	28.7		0.2		2.31E-07		1.46E-06	
27/12/06	20:00:00	53,280	265,920	28.7		0.1		7.70E-08		1.54E-06	
28/12/06	10:34:00	52,440	318,360	28.5		0.2		3.08E-07		1.85E-06	
23/12/06	23:26:00				30.0						
24/12/06	18:08:00	67,320	67,320		29.7		0.3		4.62E-07		4.62E-07
25/12/06	11:09:00	61,260	128,580		29.4		0.3		4.62E-07		9.24E-07
25/12/06	15:45:00	16,560	145,140		29.4		0.0		0.00E+00		9.24E-07
25/12/06	20:57:00	18,720	163,860		29.3		0.1		1.54E-07		1.08E-06
26/12/06	11:49:00	53,520	217,380		29.0		0.3		3.85E-07		1.46E-06
26/12/06	15:58:00	14,940	232,320		29.0		0.0		0.00E+00		1.46E-06
26/12/06	22:21:00	22,980	255,300		28.9		0.1		1.54E-07		1.62E-06
27/12/06	1:56:00	12,900	268,200		28.9		0.0		7.70E-08		1.69E-06
27/12/06	5:12:00	11,760	279,960		28.7		0.2		2.31E-07		1.92E-06
27/12/06	20:00:00	53,280	333,240		28.7		0.1		7.70E-08		2.00E-06

Table F.18 Water permeability of NC(0.65) concrete at 90 days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.040	m	L_2	=	0.041	m	g	=	9.81	m/sec^2
Q_1	=	5.65E-12	m^3/sec	Q_2	=	6.02E-12	m^3/sec				
K_1	=	5.62E-13	m/sec	K_2	=	6.08E-13	m/sec	**K_{avg}**	**=**	**5.85E-13**	**m/sec**

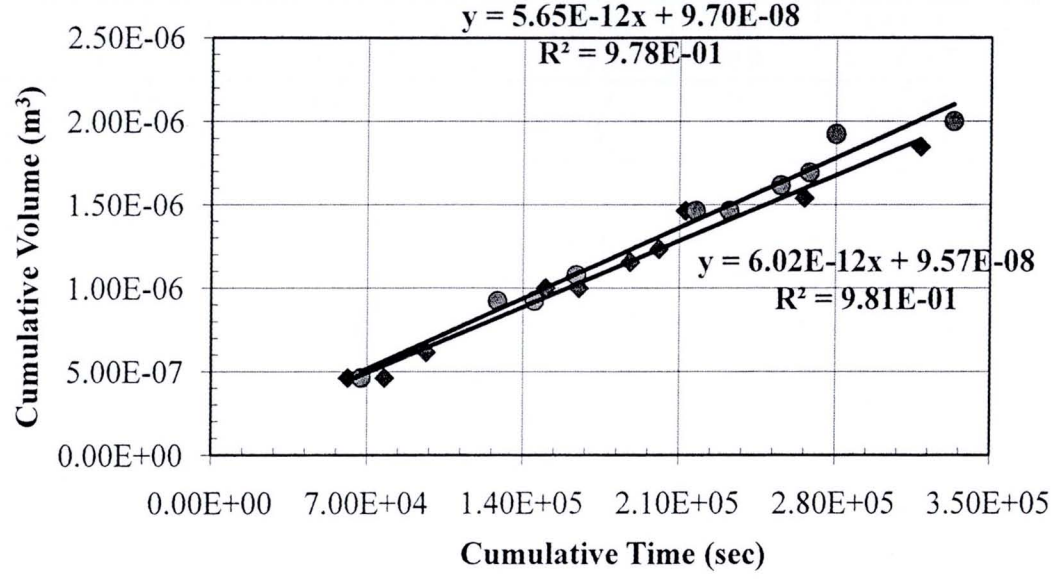


Table F.19 Water Permeability of NC(0.45) Concrete at 28 Days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
24/6/2008	11:55:00			32.60	33.4						
24/6/2008	15:00:00	11,100	11,100	31.90	32.7	0.7	0.7	1.08E-06	1.08E-06	1.08E-06	1.08E-06
25/6/2008	9:05:00	65,100	76,200	30.10	31.2	1.8	1.5	2.77E-06	2.31E-06	3.85E-06	3.39E-06
25/6/2008	12:00:00	10,500	86,700	29.90	31.0	0.2	0.2	3.08E-07	3.08E-07	4.16E-06	3.69E-06
25/6/2008	13:20:00	4,800	91,500	29.70	30.9	0.2	0.1	3.08E-07	1.54E-07	4.46E-06	3.85E-06
25/6/2008	17:15:00	14,100	105,600	29.40	30.6	0.3	0.3	4.62E-07	4.62E-07	4.93E-06	4.31E-06
26/6/2008	7:55:00	52,800	158,400	28.60	30.1	0.8	0.5	1.23E-06	7.70E-07	6.16E-06	5.08E-06
26/6/2008	12:00:00	14,700	173,100	28.60	30.0	0.0	0.1	0.00E+00	1.54E-07	6.16E-06	5.23E-06
26/6/2008	17:20:00	19,200	192,300	28.40	29.9	0.2	0.1	3.08E-07	1.54E-07	6.47E-06	5.39E-06
27/6/2008	7:45:00	51,900	244,200	28.30	29.8	0.1	0.1	1.54E-07	1.54E-07	6.62E-06	5.54E-06
27/6/2008	12:45:00	18,000	262,200	28.30	29.7	0.0	0.1	0.00E+00	1.54E-07	6.62E-06	5.70E-06
27/6/2008	18:30:00	20,700	282,900	28.30	29.6	0.0	0.1	0.00E+00	1.54E-07	6.62E-06	5.85E-06
28/6/2008	9:00:00	52,200	335,100	28.20	29.4	0.1	0.2	1.54E-07	3.08E-07	6.77E-06	6.16E-06
28/6/2008	12:45:00	13,500	348,600		29.4		0.0		0.00E+00		6.16E-06

Table F.19 Water Permeability of NC(0.45) Concrete at 28 Days (Continued)

Dia.1	=	0.100	m	Dia.2	=	0.099	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.043	m	g	=	9.81	m/sec^2
Q_1	=	5.59E-12	m^3/sec	Q_2	=	3.50E-12	m^3/sec				
K_1	=	5.84E-13	m/sec	K_2	=	3.80E-13	m/sec	**K_{avg}**	**=**	**4.82E-13**	**m/sec**

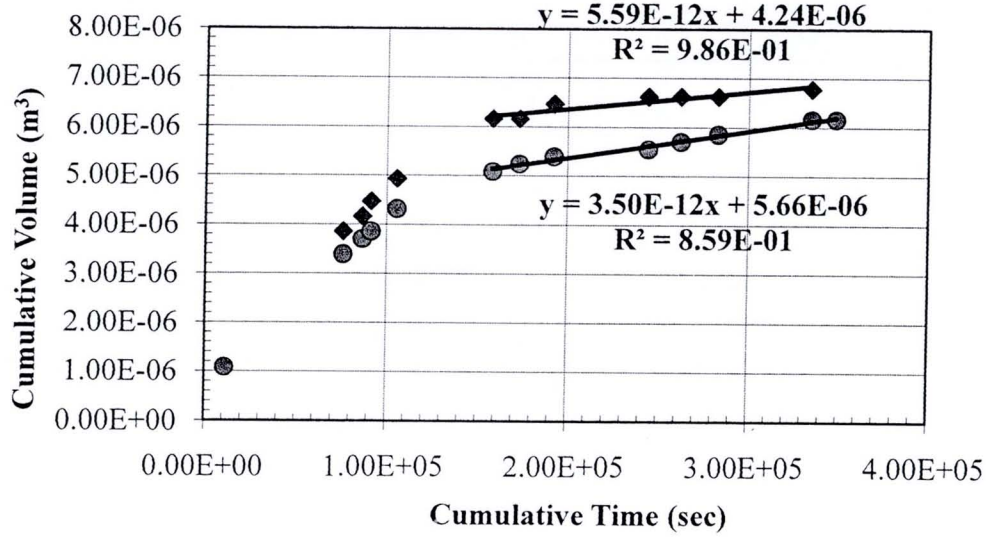
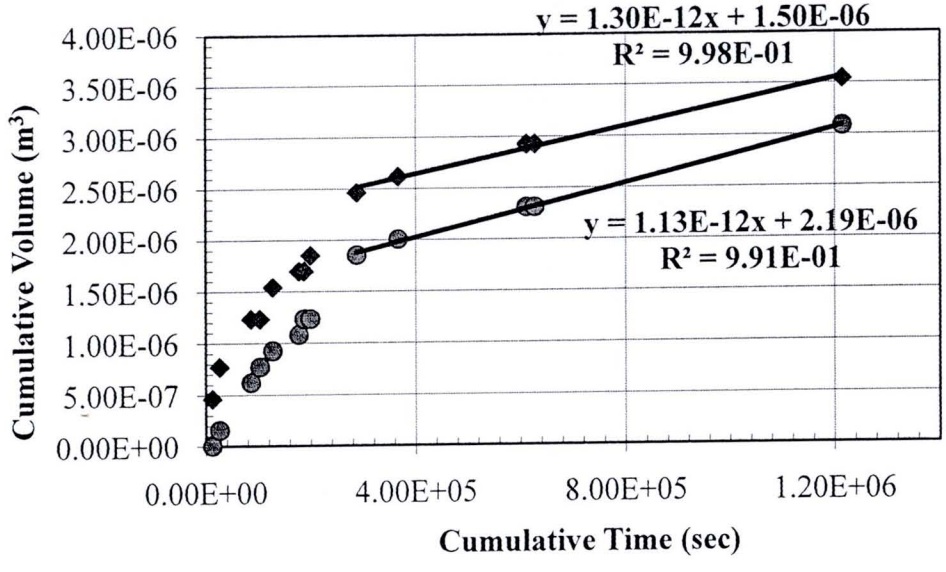


Table F.20 Water Permeability of NC(0.45) Concrete at 90 Days

Date	Reading Time	Time Different (sec)	Cumulative Time (sec)	Water Level (cm)		Different Level (cm)		Volume (cm^3)		Cum. Volume (cm^3)	
				Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
8/9/2008	8:15:00			38.00	37.30						
8/9/2008	11:40:00	12,300	12,300	37.70	37.30	0.3	0.0	4.62E-07	0.00E+00	4.62E-07	0.00E+00
8/9/2008	15:25:00	13,500	25,800	37.50	37.20	0.2	0.1	3.08E-07	1.54E-07	7.70E-07	1.54E-07
9/9/2008	8:00:00	59,700	85,500	37.20	36.90	0.3	0.3	4.62E-07	4.62E-07	1.23E-06	6.16E-07
9/9/2008	12:45:00	17,100	102,600	37.20	36.80	0.0	0.1	0.00E+00	1.54E-07	1.23E-06	7.70E-07
9/9/2008	19:30:00	24,300	126,900	37.00	36.70	0.2	0.1	3.08E-07	1.54E-07	1.54E-06	9.24E-07
#######	9:20:00	49,800	176,700	36.90	36.60	0.1	0.1	1.54E-07	1.54E-07	1.69E-06	1.08E-06
#######	12:00:00	9,600	186,300	36.90	36.50	0.0	0.1	0.00E+00	1.54E-07	1.69E-06	1.23E-06
#######	15:30:00	12,600	198,900	36.80	36.50	0.1	0.0	1.54E-07	0.00E+00	1.85E-06	1.23E-06
#######	16:00:00	88,200	287,100	36.40	36.10	0.4	0.4	6.16E-07	6.16E-07	2.46E-06	1.85E-06
#######	14:00:00	79,200	366,300	36.30	36.00	0.1	0.1	1.54E-07	1.54E-07	2.62E-06	2.00E-06
#######	10:00:00	244,800	611,100	36.10	35.80	0.2	0.2	3.08E-07	3.08E-07	2.92E-06	2.31E-06
#######	14:25:00	15,900	627,000	36.10	35.80	0.0	0.0	0.00E+00	0.00E+00	2.92E-06	2.31E-06
#######	9:30:00	587,100	1,214,100	35.70	35.30	0.4	0.5	6.16E-07	7.70E-07	3.54E-06	3.08E-06

Table F.20 Water Permeability of NC(0.45) Concrete at 90 Days (Continued)

Dia.1	=	0.101	m	Dia.2	=	0.100	m	P	=	500,000	N/m^2
L_1	=	0.042	m	L_2	=	0.043	m	g	=	9.81	m/sec^2
Q_1	=	1.30E-12	m^3/sec	Q_2	=	1.13E-12	m^3/sec				
K_1	=	1.34E-13	m/sec	K_2	=	1.19E-13	m/sec	**K_{avg}**	**=**	**1.27E-13**	**m/sec**



APPENDIX G

Compressive Strength and Water Absorption of Concrete Bricks

Table G.1 Compressive strengths of CR-FM concrete brick

Age (Days)	Sample	Width (cm)	Length (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)	Load (ton)	Comp. Strength (MPa)	
3	1	9.9	20.1	10.0	4.593	2293	28.00	13.74	12.61
	2	10.1	20.2	10.2	4.939	2389	26.00	12.52	
	3	10.1	20.1	10.0	4.691	2310	24.00	11.58	
7	1	10.0	20.1	10.1	4.776	2349	39.00	19.01	17.99
	2	10.1	20.0	10.0	4.807	2371	38.00	18.39	
	3	10.1	20.0	10.2	4.763	2317	34.00	16.57	
28	1	10.1	20.2	10.4	4.799	2272	57.00	27.45	26.53
	2	10.1	20.4	10.2	4.803	2282	55.00	26.20	
	3	10.1	20.2	10.1	4.746	2303	54.00	25.94	
60	1	10.1	20.2	10.5	4.811	2265	69.00	33.36	32.26
	2	10.1	20.4	10.4	4.773	2247	69.00	32.95	
	3	10.2	20.5	10.8	4.867	2155	65.00	30.46	
90	1	10.1	20.5	10.0	4.775	2303	70.00	33.08	33.85
	2	10.2	20.2	10.4	4.799	2232	71.00	33.69	
	3	10.1	20.0	10.2	4.764	2314	72.00	34.79	

Table G.2 Compressive strengths of CR-FN concrete brick

Age (Days)	Sample	Width (cm)	Length (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)	Load (ton)	Comp. Strength (MPa)	
3	1	10.2	20.1	10.4	4.531	2125	21.36	10.21	10.12
	2	10.3	20.2	10.2	4.519	2129	22.32	10.52	
	3	10.1	20.5	10.2	4.521	2141	20.38	9.64	
7	1	10.2	20.4	10.5	4.637	2122	35.38	16.66	15.82
	2	10.5	20.3	10.3	4.642	2114	33.76	15.52	
	3	10.5	20.2	10.4	4.643	2105	33.06	15.27	
28	1	10.1	20.2	10.3	4.675	2216	42.29	20.23	20.47
	2	10.1	20.2	10.3	4.670	2216	42.99	20.59	
	3	10.1	20.2	10.3	4.654	2210	42.97	20.60	
60	1	10.2	20.2	11.0	4.675	2063	51.26	24.38	24.46
	2	10.2	20.1	10.7	4.628	2110	51.59	24.66	
	3	10.2	20.5	10.5	4.668	2126	51.91	24.33	
90	1	10.2	20.2	10.4	4.571	2126	60.68	28.79	29.82
	2	10.1	20.5	10.4	4.590	2148	61.61	29.25	
	3	10.2	20.1	10.5	4.530	2108	65.58	31.41	

Table G.3 Compressive strengths of CR-PA concrete brick

Age (Days)	Sample	Width (cm)	Length (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)	Load (ton)	Comp. Strength (MPa)	
3	1	10.0	20.1	10.3	4.625	2230	32.00	15.52	15.50
	2	10.0	20.1	10.5	4.649	2202	33.00	16.01	
	3	10.1	20.2	10.3	4.658	2228	31.00	14.96	
7	1	10.1	20.5	10.2	4.723	2240	42.00	19.87	19.15
	2	10.2	20.2	10.5	4.694	2181	38.00	18.10	
	3	10.0	20.1	10.1	4.694	2309	40.00	19.47	
28	1	10.1	20.1	10.4	4.711	2226	61.00	29.43	27.39
	2	10.1	20.2	10.6	4.734	2195	51.00	24.47	
	3	10.2	20.1	10.5	4.735	2198	59.00	28.26	
60	1	10.1	20.2	10.2	4.688	2258	62.00	29.91	30.02
	2	10.1	20.6	10.6	4.807	2175	62.00	29.25	
	3	10.1	20.5	10.4	4.696	2191	65.00	30.90	
90	1	10.1	20.5	10.0	4.696	2285	72.00	34.33	32.60
	2	10.1	20.3	10.4	4.939	2329	64.00	30.64	
	3	10.1	20.2	10.4	4.950	2336	68.00	32.83	

Table G.4 Compressive strengths of CR-RA concrete brick

Age (Days)	Sample	Width (cm)	Length (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)	Load (ton)	Comp. Strength (MPa)	
3	1	10.2	20.2	10.4	4.455	2082	17.09	8.12	8.08
	2	10.3	20.2	10.0	4.393	2116	17.06	8.05	
	3	10.4	20.7	10.3	4.462	2027	17.69	8.09	
7	1	10.3	20.3	10.3	4.412	2053	17.79	8.32	8.48
	2	10.2	20.5	10.4	4.457	2046	18.35	8.56	
	3	10.4	20.5	10.4	4.507	2044	18.53	8.57	
28	1	10.1	20.3	10.3	4.478	2126	19.08	9.11	9.32
	2	10.2	20.3	10.3	4.487	2128	21.15	10.07	
	3	10.1	20.3	10.2	4.546	2164	18.40	8.77	
60	1	10.4	20.2	10.2	4.565	2126	22.94	10.72	11.14
	2	10.2	20.2	10.2	4.531	2168	26.10	12.48	
	3	10.4	20.7	9.9	4.454	2089	22.53	10.22	
90	1	10.1	20.3	10.6	4.440	2038	30.61	14.59	13.67
	2	10.1	20.5	10.2	4.458	2108	28.51	13.47	
	3	10.2	20.2	10.3	4.506	2127	27.17	12.95	

Table G.5 Compressive strengths of NB concrete brick

Age (Days)	Sample	Width (cm)	Length (cm)	Height (cm)	Weight (kg)	Density (kg/m^3)	Load (ton)	Comp. Strength (MPa)	
3	1	10.1	20.3	10.8	4.915	2220	57.61	27.54	27.29
	2	10.2	20.5	10.9	4.939	2167	57.98	27.17	
	3	10.3	20.3	9.9	5.053	2441	57.94	27.16	
7	1	10.3	20.2	10.3	5.176	2415	60.24	28.38	28.51
	2	10.2	20.2	9.9	5.087	2494	60.69	28.87	
	3	10.2	20.2	10.3	5.163	2433	59.45	28.28	
28	1	10.3	20.3	10.3	5.192	2411	66.38	31.11	31.61
	2	10.0	20.2	10.3	5.128	2465	67.16	32.58	
	3	10.1	20.2	10.1	5.146	2497	64.80	31.13	
60	1	10.1	20.2	10.9	5.099	2293	75.32	36.18	35.30
	2	10.3	20.4	10.0	5.175	2463	73.25	34.16	
	3	10.2	20.5	10.8	5.067	2244	75.88	35.56	
90	1	10.4	20.3	10.1	4.989	2352	75.00	35.00	35.88
	2	10.1	20.4	11.0	4.939	2171	77.00	36.62	
	3	10.1	20.2	10.1	4.950	2402	75.00	36.03	

Table G.6 Water absorption of concrete bricks

Mixes	Sample	W/B	Dry Weight (kg)	Wet Weight (kg)	Apsorption (kg)	Total Volume (m^3)	Oven-Dry Weight / Volume (kg/m^3)	Average (kg/m^3)	Absorption / Volume (kg/m^3)	Average (kg/m^3)	Water Absorption (%)
CR-FM	1	0.5	4.752	4.819	0.067	0.00208	2282	2256	32.18	32.57	1.44
	2		4.714	4.779	0.065	0.00211	2235		30.82		
	3		4.732	4.805	0.073	0.00210	2249		34.70		
CR-FN	1	0.5	4.515	4.650	0.135	0.00215	2100	2102	62.79	64.98	3.09
	2		4.542	4.692	0.150	0.00214	2126		70.22		
	3		4.465	4.598	0.133	0.00215	2079		61.92		
CR-PA	1	0.5	4.581	4.756	0.175	0.00213	2152	2155	82.20	80.45	3.73
	2		4.577	4.760	0.183	0.00213	2148		85.88		
	3		4.552	4.706	0.154	0.00210	2166		73.26		
CR-RA	1	0.5	4.352	4.574	0.222	0.00218	1998	2014	101.93	105.48	5.24
	2		4.342	4.568	0.226	0.00212	2053		106.86		
	3		4.215	4.443	0.228	0.00212	1990		107.65		
NB	1	0.5	4.689	4.768	0.079	0.00208	2254	2310	37.98	41.66	1.80
	2		4.999	5.107	0.108	0.00211	2369		51.18		
	3		4.892	4.968	0.076	0.00212	2305		35.82		

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1992 – 1998	High School from Wat Rajabopit School (RB 107), Bangkok, Thailand
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RESEARCH EXPERTISE

PATENT Cementitious Material for Producing Concrete which had High Strength, Low Heat Evolution, and High Durability (Application Patent No.1001000385)

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EMPLOYMENT RECORD

2005 – 2007	Structural Engineer, K.C.S. and Associates Co., Ltd., Bangkok, Thailand
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มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี

ข้อตกลงว่าด้วยการโอนสิทธิในทรัพย์สินทางปัญญาของนักศึกษาระดับบัณฑิตศึกษา

วันที่ 25 เดือน พฤศจิกายน พ.ศ. 2554

ข้าพเจ้า (นาย/~~นาง/นางสาว~~) **ณัฐพงศ์ มกระธัช** รหัสประจำตัว **49500101** เป็นนักศึกษาของมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ระดับ ❍ ประกาศนียบัตรบัณฑิต ❍ ปริญญาโท ⓥ ปริญญาเอก หลักสูตร **วิศวกรรมศาสตรปรัชญาดุษฎีบัณฑิต** สาขาวิชา **วิศวกรรมโยธา** คณะ **วิศวกรรมศาสตร์** อยู่บ้านเลขที่ **710/155** หมู่ **-** ตรอก/ซอย **ริมคลองชักพระ** ถนน **วัดแก้ว-ฉิมพลี** ตำบล/แขวง **คลองชักพระ** อำเภอ/เขต **ตลิ่งชัน** จังหวัด **กรุงเทพมหานคร** รหัสไปรษณีย์ **10170** เป็น "ผู้โอน" ขอโอนสิทธิในทรัพย์สินทางปัญญาให้ไว้กับมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี โดยมี **รศ.ดร.ปิยะบุตร วานิชพงษ์พันธุ์** ตำแหน่ง **รองคณบดีฝ่ายวิชาการ** คณะวิศวกรรมศาสตร์ เป็นตัวแทน "ผู้รับโอน" สิทธิในทรัพย์สินทางปัญญาและมีข้อตกลงดังนี้

1. ข้าพเจ้าได้จัดทำวิทยานิพนธ์เรื่อง **การพัฒนาส่วนผสมของกากแคลเซียมคาร์ไบด์และวัสดุปอซโซลานเป็นวัสดุประสานในคอนกรีต** ซึ่งอยู่ในความควบคุมของ **ศ.ดร.ชัย จาตุรพิทักษ์กุล** อาจารย์ที่ปรึกษาตามพระราชบัญญัติลิขสิทธิ์ 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 และมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีมีสิทธิในทรัพย์สินทางปัญญานั้นพร้อมกับได้รับชำระค่าตอบแทนการอนุญาตให้ใช้สิทธิดังกล่าว รวมถึงการจัดสรรผลประโยชน์อันพึง

เกิดขึ้นจากส่วนใดส่วนหนึ่งหรือทั้งหมดของวิทยานิพนธ์ในอนาคต โดยให้เป็นไปตามระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วย การบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538

6. ในกรณีที่มีผลประโยชน์เกิดขึ้นจากวิทยานิพนธ์หรืองานทรัพย์สินทางปัญญาอื่นที่ข้าพเจ้าทำขึ้นโดยมีมหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีเป็นเจ้าของ ข้าพเจ้าจะมีสิทธิได้รับการจัดสรรผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญาดังกล่าวตามอัตราที่กำหนดไว้ในระเบียบสถาบันเทคโนโลยีพระจอมเกล้าธนบุรี ว่าด้วย การบริหารผลประโยชน์อันเกิดจากทรัพย์สินทางปัญญา พ.ศ. 2538

ลงชื่อ.....ผู้โอนสิทธิ

(นายณัฐพงศ์ มกระธัช)

ลงชื่อ.....ผู้รับโอนสิทธิ

(รศ.ดร.ปิยะบุตร วานิชพงษ์พันธุ์)

รองคณบดีฝ่ายวิชาการ ปฏิบัติการแทนคณบดี

ลงชื่อ.....พยาน

(ศ.ดร.ชัย จาตุรพิทักษ์กุล)

ลงชื่อ.....พยาน

(รศ.เอนก ศิริพานิชกร)