

APPENDIX D

MODULUS OF ELASTICITY AND POISSON'S RATIO DATA

Table D.1 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-1 Mixture @ 3-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	293.2449	37.3560	0.9963	14.9424	0.00005	0.0007839	0.00000	0.0000926
2	301.9972	38.4709	1.0356	15.3884	0.00005	0.0007870	0.00000	0.0000757

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	19002.725	0.1262	19.2386	0.1144
2	19474.627	0.1027		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $S_2 - S_1 / \epsilon_2 - \epsilon_1$

Poisson's Ratio (μ) = $\epsilon_{t2} - \epsilon_{t1} / \epsilon_2 - \epsilon_1$

Table D.2 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-1 Mixture @ 7-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	304.7681	38.8239	1.1465	15.5295	0.00005	0.0007791	0.0000012	0.0000649
2	316.3866	40.3040	1.0946	16.1216	0.00005	0.0007903	0.0000008	0.0000978

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	19727.060	0.0874	20.0128	0.1092
2	20298.527	0.1310		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.3 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-1 Mixture @ 28-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	330.5645	42.1101	1.2015	16.8440	0.00005	0.0007882	0.0000010	0.0001022
2	342.6218	43.6461	1.3252	17.4584	0.00005	0.0007964	0.0000002	0.0001090

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	21190.057	0.1371	21.4024	0.1414
2	21614.684	0.1458		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.4 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-2 Mixture @ 3-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	305.6635	38.9380	1.0089	15.5752	0.00005	0.0008075	0.0000001	0.0000840
2	314.9102	40.1159	1.1299	16.0464	0.00005	0.0007869	0.00000	0.0000996

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	19229.439	0.1108	19.7358	0.1230
2	20242.231	0.1352		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.5 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-2 Mixture @ 7-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	331.6540	42.2489	0.9236	16.8995	0.00005	0.0008102	0.0000007	0.0001090
2	338.5155	43.1230	1.3645	17.2492	0.00005	0.0007992	0.0000011	0.0001265

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	21015.391	0.1425	21.1088	0.1549
2	21202.216	0.1674		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.6 Modulus of Elasticity and Poisson's Ratio Measurements for SCGC-2 Mixture @ 28-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	364.9442	46.4897	1.6610	18.5959	0.00005	0.0008283	0.0000020	0.0001169
2	378.5439	48.2221	1.2761	19.2888	0.00005	0.0008358	0.0000016	0.0001013

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	21758.833	0.1476	22.3407	0.1372
2	22922.754	0.1269		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.7 Modulus of Elasticity and Poisson's Ratio Measurements for OPC Control Mixture @ 3-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	175.9892	22.4190	0.7711	8.9676	0.00005	0.0005459	0.0000002	0.0000921
2	198.0326	25.2271	0.9223	10.0908	0.00005	0.0005576	0.0000005	0.0000712

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	16528.534	0.1853	17.2955	0.1623
2	18062.451	0.1393		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.8 Modulus of Elasticity and Poisson's Ratio Measurements for OPC Control Mixture @ 7-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	242.3457	30.8721	0.9524	12.3488	0.00005	0.0005437	0.0000010	0.0000798
2	264.3881	33.6800	1.2561	13.4720	0.00005	0.0005518	0.0000007	0.0000675

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	23083.654	0.1596	23.7139	0.1463
2	24344.161	0.1331		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

Table D.9 Modulus of Elasticity and Poisson's Ratio Measurements for OPC Control Mixture @ 28-Days

Specimen	Load at Failure (kN)	Ultimate Stress (N/mm ²)	Stress (N/mm ²)		Longitudinal strain		Transverse strain	
			S ₁	S ₂	ε ₁	ε ₂	ε _{t1}	ε _{t2}
1	315.4604	40.1860	1.5834	16.0744	0.00005	0.0005678	0.0000014	0.0000853
2	322.6977	41.1079	1.7542	16.4432	0.00005	0.0005649	0.0000017	0.0000998

Specimen	Modulus of Elasticity (MPa)	Poisson's Ratio	Average	
			Modulus of Elasticity (GPa)	Poisson's Ratio
1	27985.709	0.1618	28.2568	0.1761
2	28527.869	0.1905		

Definitions and Calculations:

S₁ = Stress corresponding to a longitudinal strain of 0.000050

S₂ = Stress corresponding to 40% of the ultimate stress

ε₁ = Longitudinal strain at stress S₁

ε₂ = Longitudinal strain produced by stress S₂

ε_{t1} = average transverse strain at stress S₁

ε_{t2} = average transverse strain at stress S₂

Modulus of Elasticity (E) = $(S_2 - S_1) / (\epsilon_2 - \epsilon_1)$

Poisson's Ratio (μ) = $(\epsilon_{t2} - \epsilon_{t1}) / (\epsilon_2 - \epsilon_1)$

APPENDIX E

CREEP TEST DATA

Tables E.1 through E.3 contain all creep test data collected during this study. Each table contains the total strain, drying shrinkage strain, creep strain, compressive strength and applied load level for each mixture that is identified on the top line.

Table E.1 Creep strain Measurements for SCGC-1 Mixture

Mixture ID				SCGC-1			
7 th Day compressive strength (MPa)				39.84			
Applied load (MPa)				15.94			
Elastic strain ($\mu\epsilon$)				798			
Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
0	0.0000	00	0.1620	798	00	00	00
0.0833	0.0015	7	0.1660	818	13	0.0163	0.8156
0.25	0.0020	10	0.1730	852	44	0.0551	2.7603
1	0.0040	20	0.1825	899	81	0.1015	5.0816
2	0.0055	27	0.1880	926	101	0.1266	6.3363
3	0.0075	37	0.1960	966	131	0.1642	8.2183
4	0.0090	44	0.2040	1005	163	0.2043	10.2258
5	0.0115	57	0.2105	1037	182	0.2281	11.4178
6	0.0125	62	0.2135	1052	192	0.2406	12.0451
7	0.0140	69	0.2200	1084	217	0.2719	13.6135
14	0.0180	89	0.2330	1148	261	0.3271	16.3739
21	0.0205	101	0.2425	1195	296	0.3709	18.5696

Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
28	0.0220	108	0.2540	1251	345	0.4323	21.6437
42	0.0255	126	0.2630	1296	372	0.4662	23.3375
56	0.0265	131	0.2680	1320	391	0.4899	24.5295
70	0.0285	140	0.2745	1352	414	0.5188	25.9724
84	0.0310	153	0.2820	1389	438	0.5488	27.4780
112	0.0345	170	0.2860	1409	441	0.5526	27.6662
140	0.0335	165	0.2950	1453	490	0.6140	30.7403
168	0.0370	182	0.2990	1473	493	0.6178	30.9285
196	0.0380	187	0.3015	1485	500	0.6266	31.3676
224	0.0400	197	0.3090	1522	527	0.6604	33.0615
252	0.0390	192	0.3125	1539	549	0.6880	34.4416
280	0.0405	200	0.3110	1532	534	0.6692	33.5006
308	0.0425	209	0.3155	1554	547	0.6855	34.3162
336	0.0410	202	0.3145	1549	549	0.6880	34.4416
364	0.0420	207	0.3175	1564	559	0.7005	35.0690

Table E.2 Creep strain Measurements for SCGC-2 Mixture

Mixture ID				SCGC-2			
7 th Day compressive strength (MPa)				42.98			
Applied load (MPa)				17.19			
Elastic strain ($\mu\epsilon$)				850			
Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
0	0.0000	00	0.1725	850	00	00	00
0.0833	0.0010	5	0.1780	877	22	0.0259	1.2798
0.25	0.0015	7	0.1845	909	52	0.0612	3.0250
1	0.0030	15	0.1920	946	81	0.0953	4.7120
2	0.0045	22	0.1980	975	103	0.1212	5.9918
3	0.0060	30	0.2050	1010	130	0.1529	7.5625
4	0.0080	39	0.2115	1042	153	0.1800	8.9005
5	0.0095	47	0.2155	1062	165	0.1941	9.5986
6	0.0110	54	0.2200	1084	180	0.2118	10.4712
7	0.0120	59	0.2255	1111	202	0.2376	11.7510
14	0.0145	71	0.2370	1167	246	0.2894	14.3106
21	0.0160	79	0.2460	1212	283	0.3329	16.4631
28	0.0180	89	0.2555	1259	320	0.3765	18.6155
42	0.0220	108	0.2650	1305	347	0.4082	20.1861
56	0.0240	118	0.2695	1328	360	0.4235	20.9424
70	0.0265	131	0.2750	1355	374	0.4400	21.7568
84	0.0275	135	0.2840	1399	414	0.4871	24.0838
112	0.0300	148	0.2955	1456	458	0.5388	26.6434
140	0.0315	155	0.2980	1468	463	0.5447	26.9343
168	0.0320	158	0.3075	1515	507	0.5965	29.4939

Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
196	0.0335	165	0.3095	1525	510	0.6000	29.6684
224	0.0325	160	0.3155	1554	544	0.6400	31.6463
252	0.0340	167	0.3190	1571	554	0.6518	32.2280
280	0.0330	163	0.3185	1569	556	0.6542	32.3444
308	0.0350	172	0.3225	1589	567	0.6671	32.9843
336	0.0365	180	0.3235	1594	564	0.6635	32.8098
364	0.0355	175	0.3260	1606	581	0.6835	33.7987

Table E.3 Creep strain Measurements for OPC Control Mixture

Mixture ID				OPC Control Mixture			
7 th Day compressive strength (MPa)				31.77			
Applied load (MPa)				12.71			
Elastic strain ($\mu\epsilon$)				532			
Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
0	00	00	0.1080	532	00	00	00
0.0833	0.0035	17	0.1245	613	54	0.1015	4.2486
0.25	0.0085	42	0.1385	682	98	0.1842	7.7105
1	0.0155	76	0.1550	764	146	0.2744	11.4870
2	0.0220	108	0.1705	840	190	0.3571	14.9488
3	0.0260	128	0.1790	882	212	0.3985	16.6798
4	0.0305	150	0.1880	926	234	0.4398	18.4107
5	0.0340	167	0.1960	966	262	0.4925	20.6137
6	0.0370	182	0.2080	1025	306	0.5752	24.0755
7	0.0420	207	0.2170	1069	320	0.6015	25.1770
14	0.0485	239	0.2335	1150	369	0.6936	29.0322
21	0.0535	264	0.2455	1209	409	0.7688	32.1794
28	0.0570	281	0.2525	1244	426	0.8007	33.5169
42	0.0630	310	0.2635	1298	451	0.8477	35.4839
56	0.0675	333	0.2710	1335	466	0.8759	36.6640
70	0.0715	352	0.2780	1369	480	0.9022	37.7655
84	0.0750	369	0.2895	1426	515	0.9680	40.5193
112	0.0790	389	0.3020	1488	552	1.0376	43.4304
140	0.0845	416	0.3070	1512	551	1.0357	43.3517
168	0.0865	426	0.3175	1564	596	1.1203	46.8922

Age (days)	Average Shrinkage (mm)	Shrinkage strain ($\mu\epsilon$)	Total creep (mm)	Total creep strain ($\mu\epsilon$)	Creep strain ($\mu\epsilon$)	Creep coefficient	Specific creep ($\mu\epsilon$)/MPa
196	0.0915	451	0.3165	1559	576	1.0827	45.3186
224	0.0920	453	0.3290	1621	623	1.1710	49.0165
252	0.0945	466	0.3390	1670	663	1.2462	52.1636
280	0.0985	485	0.3395	1672	655	1.2312	51.5342
308	0.0970	478	0.3485	1717	705	1.3252	55.4681
336	0.0990	488	0.3510	1729	707	1.3289	55.6255
364	0.1005	495	0.3595	1771	744	1.3985	58.5365

APPENDIX F

DRYING SHRINKAGE TEST DATA

Table F.1 Drying Shrinkage Measurements for SCGC-1 Mixture

Time (Days)	Average Observed Reading (mm)	Drying Shrinkage Strain ($\mu\epsilon$)
0	00	00
1	0.0014	5
2	0.0025	9
3	0.0031	11
4	0.0043	15
5	0.0062	22
6	0.0077	27
7	0.0096	34
14	0.0114	40
21	0.0148	52
28	0.0168	59
42	0.0180	63
56	0.0206	72
70	0.0236	83
84	0.0242	85
112	0.0288	101
140	0.0320	112
168	0.0345	121
196	0.0365	128
224	0.0396	139
252	0.0399	140
280	0.0422	148
308	0.0436	153
336	0.0447	157
364	0.0453	159

Table F.2 Drying Shrinkage Measurements for SCGC-2 Mixture

Time (Days)	Average Observed Reading (mm)	Drying Shrinkage Strain ($\mu\epsilon$)
0	00	00
1	0.0008	3
2	0.0020	7
3	0.0028	10
4	0.0040	14
5	0.0052	18
6	0.0063	22
7	0.0080	28
14	0.0105	37
21	0.0128	45
28	0.0150	53
42	0.0168	59
56	0.0188	66
70	0.0205	72
84	0.0225	79
112	0.0260	91
140	0.0294	103
168	0.0305	107
196	0.0334	117
224	0.0365	128
252	0.0370	130
280	0.0382	134
308	0.0399	140
336	0.0394	138
364	0.0402	141

Table F.3 Drying Shrinkage Measurements for OPC Control Mixture

Time (Days)	Average Observed Reading (mm)	Drying Shrinkage Strain ($\mu\epsilon$)
0	00	00
1	0.0110	39
2	0.0180	63
3	0.0236	83
4	0.0282	99
5	0.0342	120
6	0.0390	137
7	0.0456	160
14	0.0550	193
21	0.0627	220
28	0.0698	245
42	0.0784	275
56	0.0812	285
70	0.0898	315
84	0.0969	340
112	0.1040	365
140	0.1068	375
168	0.1134	398
196	0.1177	413
224	0.1192	418
252	0.1254	440
280	0.1282	450
308	0.1325	465
336	0.1310	460
364	0.1328	466