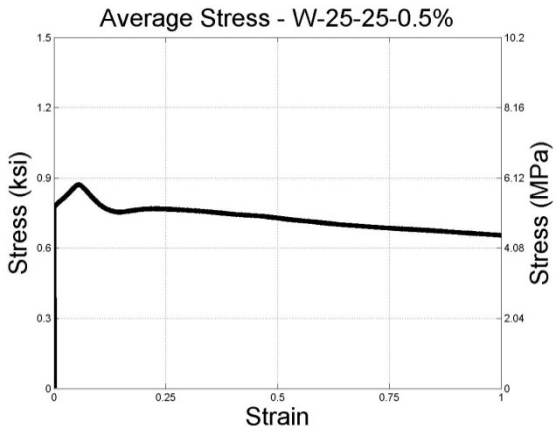
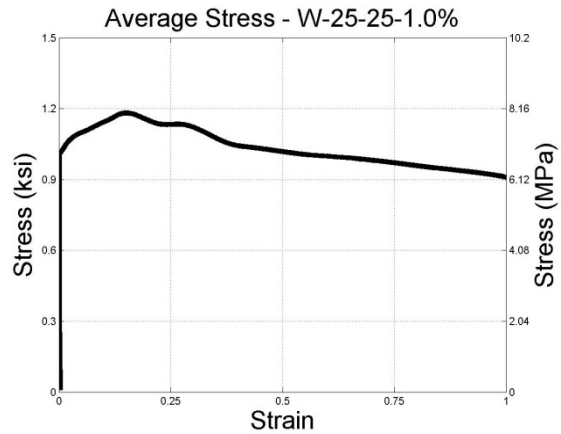
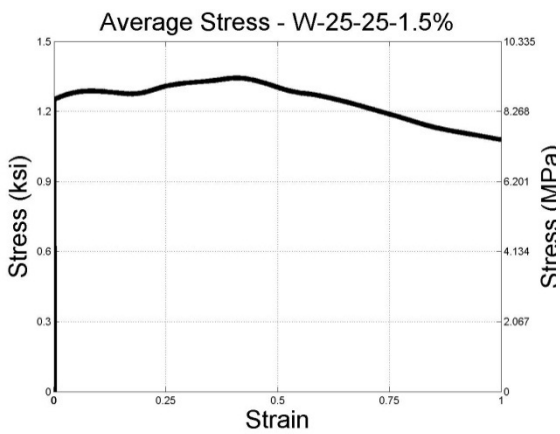
9. APPENDIX A – STRESS-STRAIN PLOTS FOR ALL UHPC MIXES

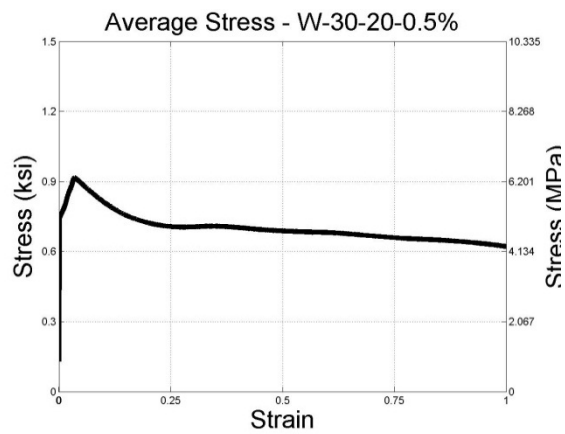
This appendix lists the stress-strain plots for all tensile tests conducted on UHPC coupons. For each set of tensile tests, at least 3 specimen tensile plots are averaged in order to produce a single tensile response curve. The plots are averaged at each point along the strain range. The result is then processed through a moving average filter to account for minute changes due to the sensitivity of the equipment. See Section 3.3.1 for further details.

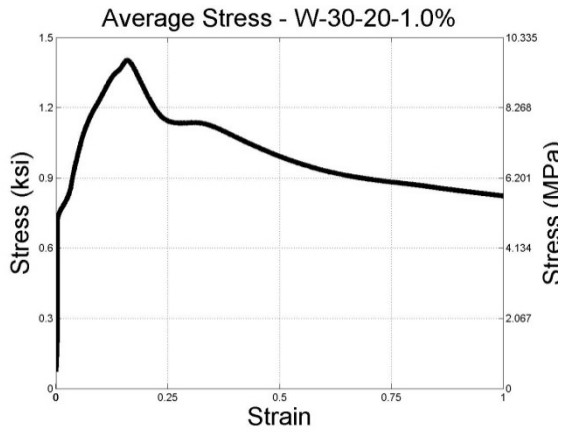
9.1. WHITE CEMENT MIXES

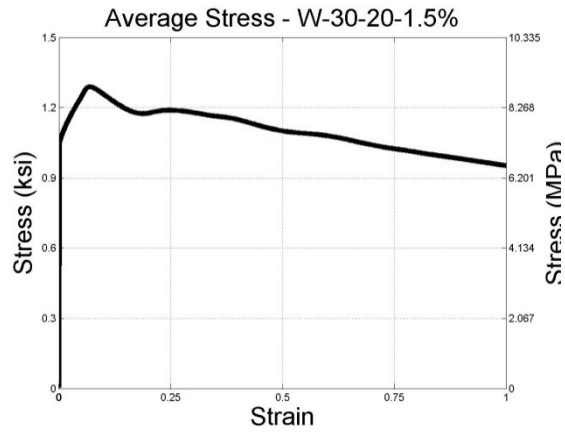


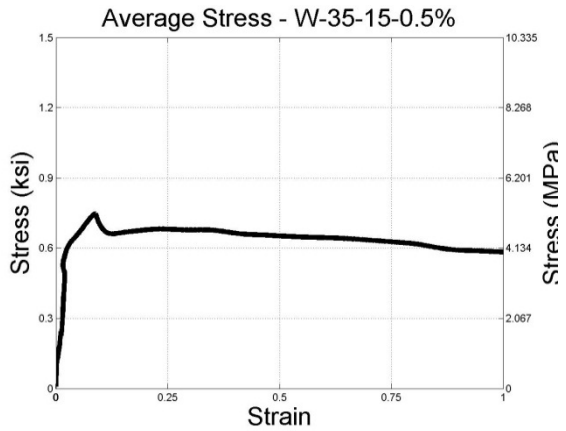


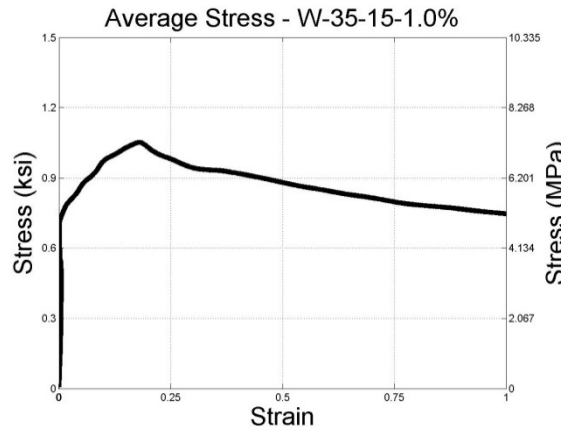


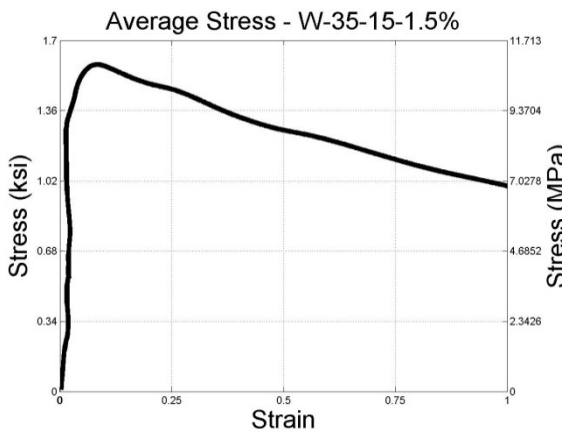


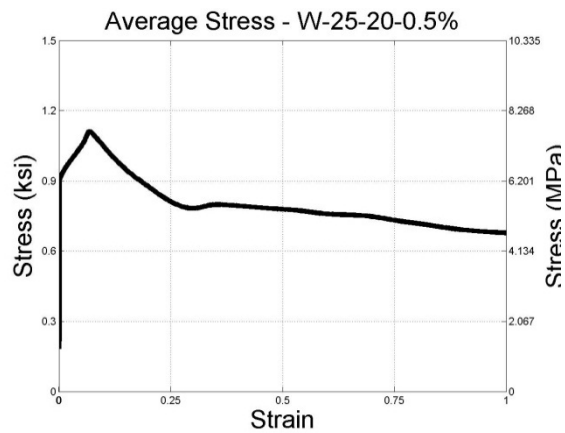

Average Stress - W-30-20-1.0%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

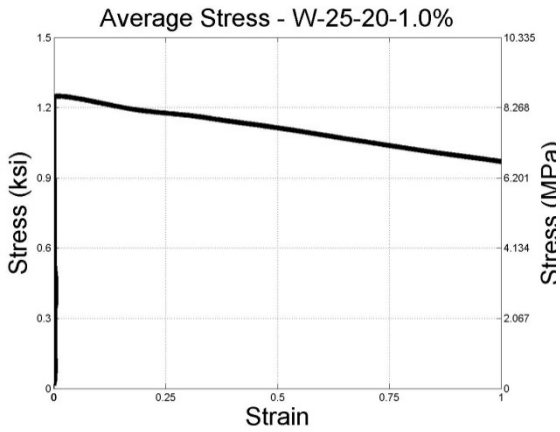

Average Stress - W-30-20-1.5%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

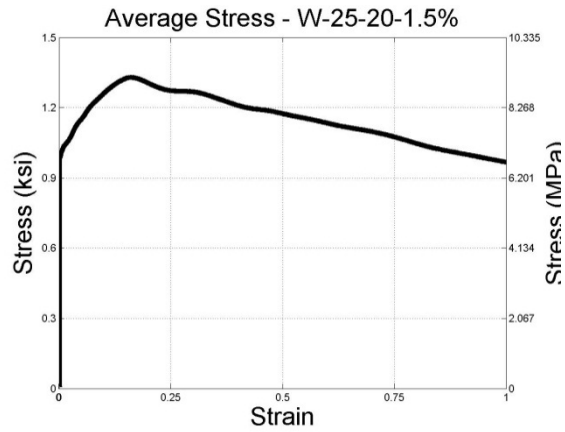

Average Stress - W-35-15-0.5%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

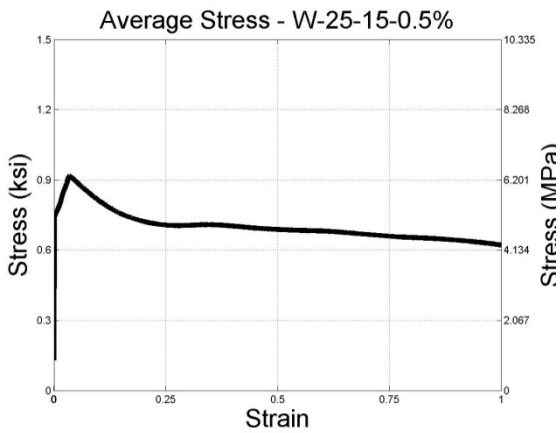

Average Stress - W-35-15-1.0%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

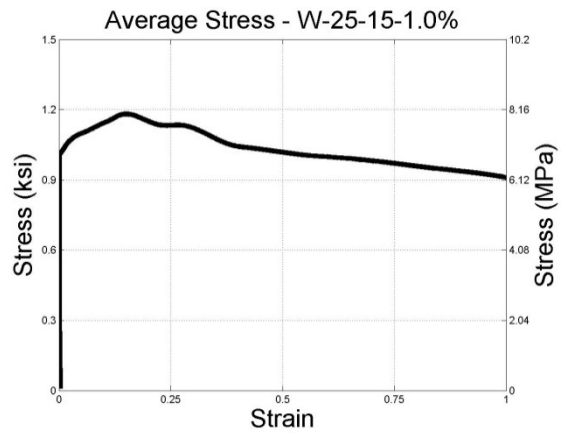

Average Stress - W-35-15-1.5%
Stress (ksi)
Stress (MPa)
Strain
1.7
1.36
1.02
0.68
0.34
0
11.713
9.3704
7.0278
4.6852
2.3426
0
0.25
0.5
0.75
1

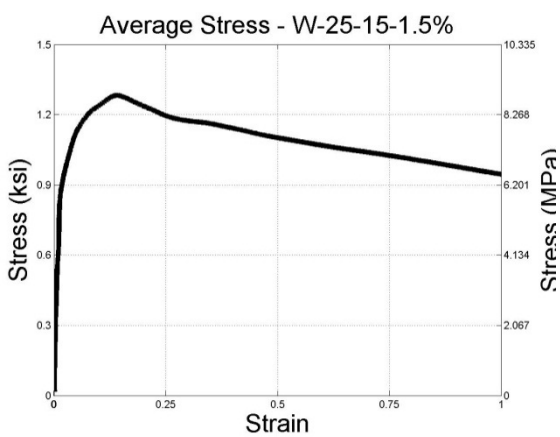

Average Stress - W-25-20-0.5%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

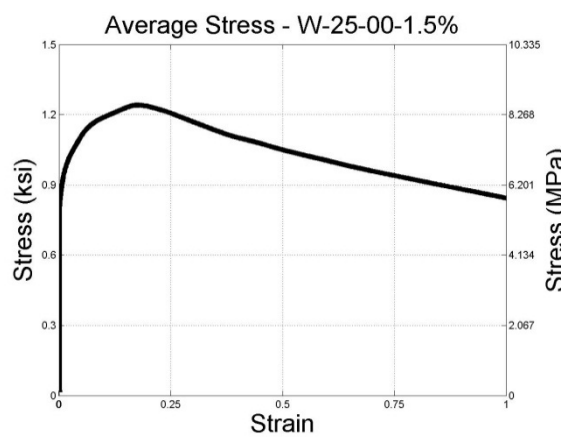

Average Stress - W-25-20-1.0%
Stress (ksi)
Stress (MPa)
Strain


Average Stress - W-25-20-1.5%
Stress (ksi)
Stress (MPa)
Strain

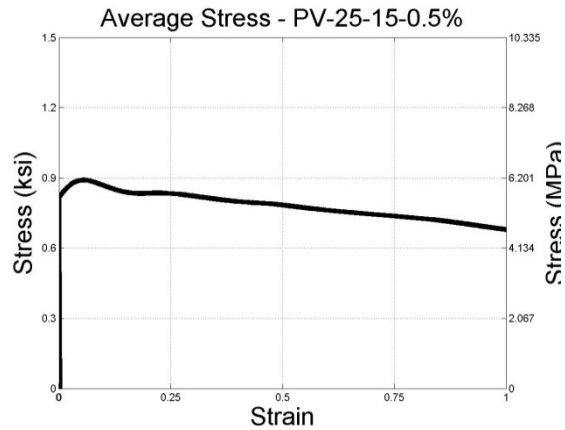

Average Stress - W-25-15-0.5%
Stress (ksi)
Stress (MPa)
Strain

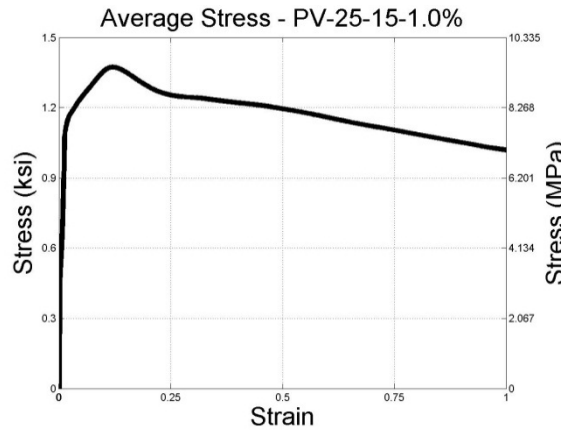

Average Stress - W-25-15-1.0%
Stress (ksi)
Stress (MPa)
Strain

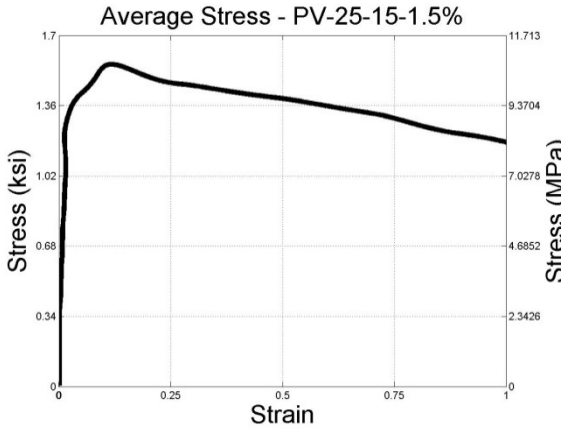

Average Stress - W-25-15-1.5%
Stress (ksi)
Stress (MPa)
Strain

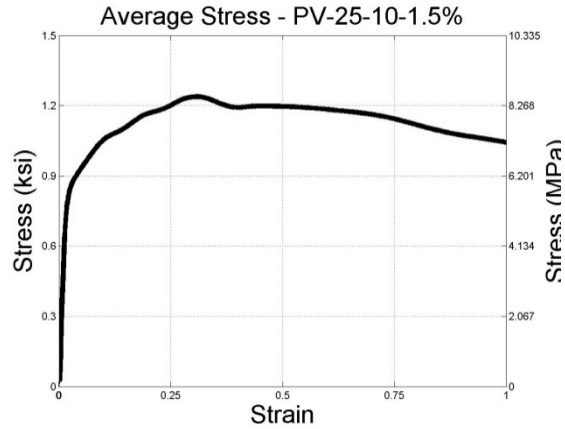

Average Stress - W-25-00-1.5%
Stress (ksi)
Stress (MPa)
Strain

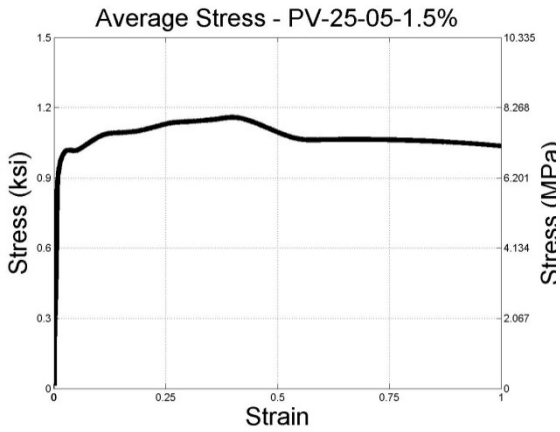
9.2. PORTLAND TYPE V CEMENT MIXES

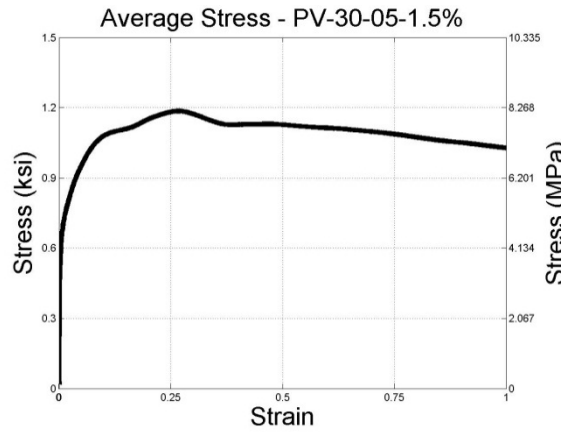


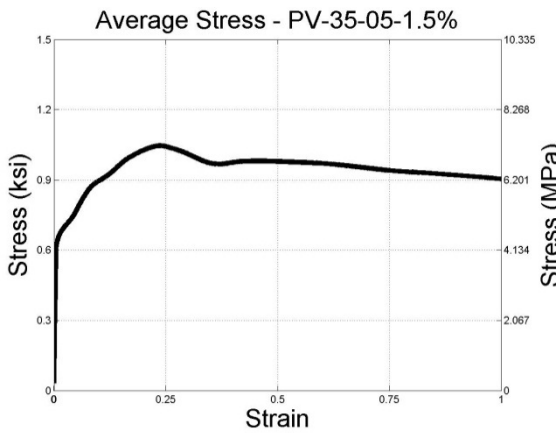


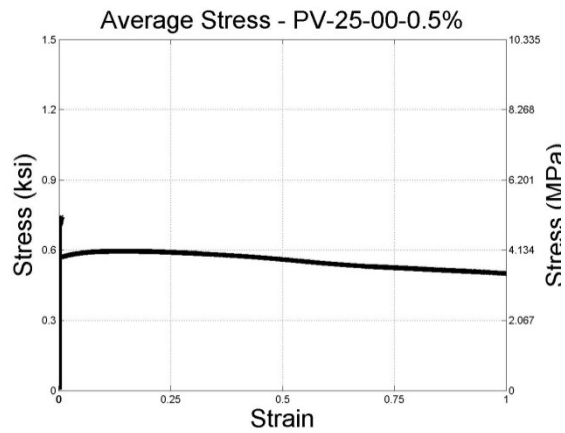


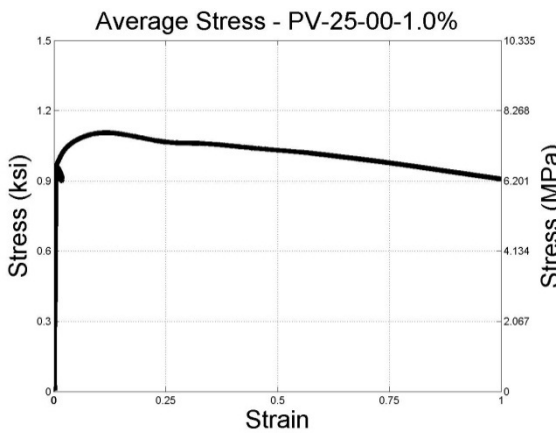


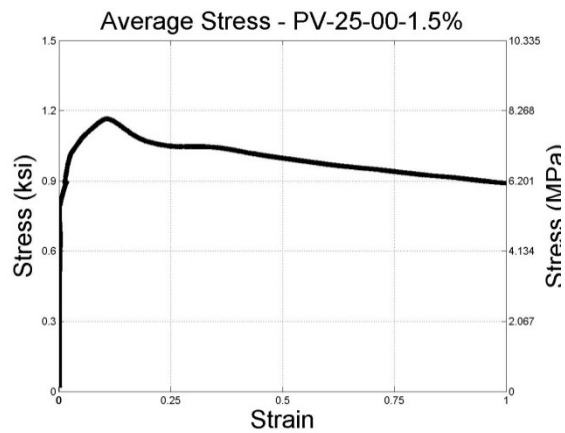

Average Stress - PV-25-05-1.5%
Stress (ksi)
Stress (MPa)
Strain

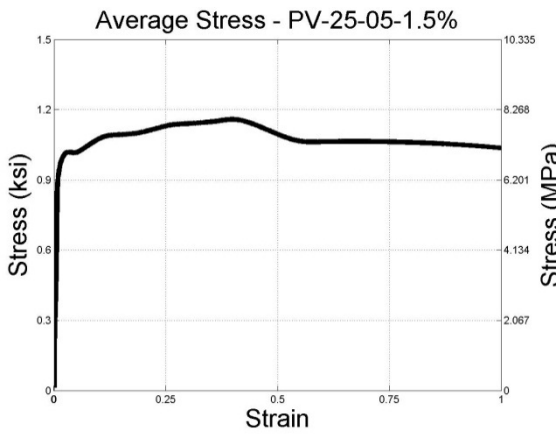

Average Stress - PV-30-05-1.5%
Stress (ksi)
Stress (MPa)
Strain

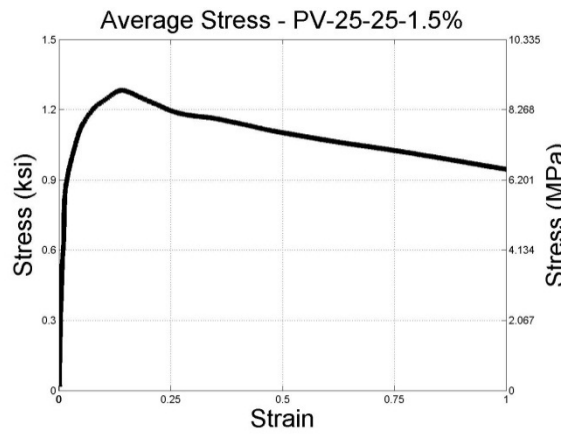

Average Stress - PV-35-05-1.5%
Stress (ksi)
Stress (MPa)
Strain


Average Stress - PV-25-00-0.5%
Stress (ksi)
Stress (MPa)
Strain

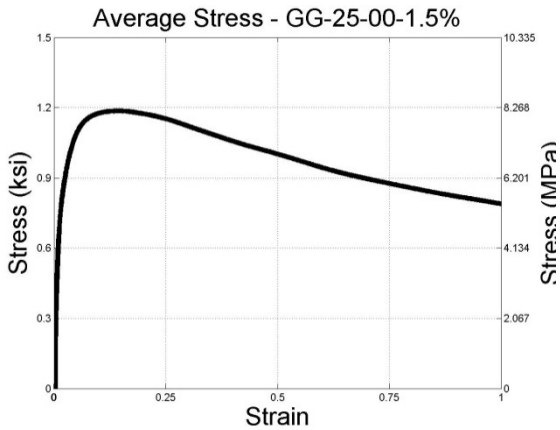

Average Stress - PV-25-00-1.0%
Stress (ksi)
Stress (MPa)
Strain

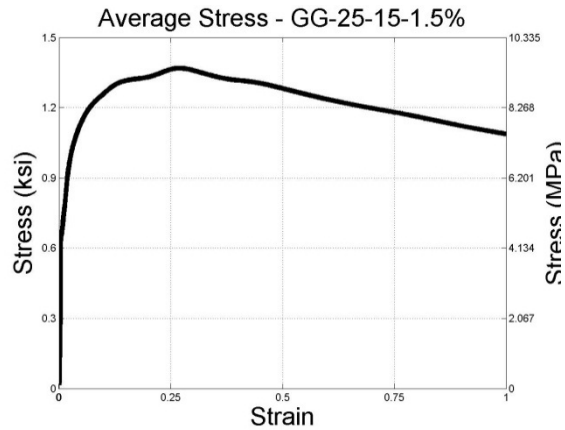

Average Stress - PV-25-00-1.5%
Stress (ksi)
Stress (MPa)
Strain

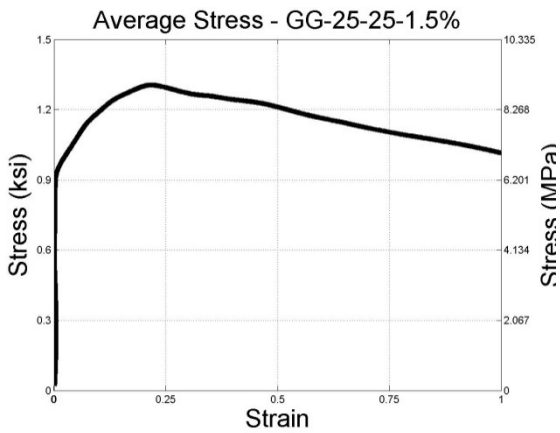

Average Stress - PV-25-05-1.5%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1


Average Stress - PV-25-25-1.5%
Stress (ksi)
Stress (MPa)
Strain
1.5
1.2
0.9
0.6
0.3
0
10.335
8.268
6.201
4.134
2.067
0
0.25
0.5
0.75
1

9.3. GGBS/PORTLAND TYPE I CEMENT MIXES







10. APPENDIX B – RESULTS OF FREEZE-THAW TESTING – RILEM

This appendix lists the raw results from the freeze-thaw testing outlined in section 4.3.1. For each specimen, the internal damage as measured by the relative dynamic modulus; moisture uptake and salt scaling are listed.

W-25-25-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 1	UHPC 1	UHPC 1		UHPC 1	UHPC 1	UHPC 1		UHPC 1	UHPC 1	UHPC 1
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
10	81.4	67.3	74.4		100	100	100		0.23	0.24	0.23
18	112.3	89.0	100.6		100	100	100		0.25	0.27	0.26
23	161.8	122.6	142.2		100	99	99.5		0.29	0.30	0.30
45	177.3	137.1	157.2		100	99	99.5		0.31	0.30	0.30
61	194.8	157.5	176.2		100	99	99.5		0.32	0.32	0.32

W-25-15-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 2	UHPC 2	UHPC 2		UHPC 2	UHPC 2	UHPC 2		UHPC 2	UHPC 2	UHPC 2
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	16.4	6.6	11.5		100	100	100		0.18	0.20	0.19
26	24.3	10.7	17.5		100	100	100		0.20	0.23	0.21
40	32.9	24.8	28.8		100	100	100		0.20	0.25	0.22
52	43.1	35.5	39.3		100	100	100		0.24	0.27	0.25
68	49.3	52.1	50.7		100	100	100		0.24	0.27	0.26

W-25-00-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 3	UHPC 3	UHPC 3		UHPC 3	UHPC 3	UHPC 3		UHPC 3	UHPC 3	UHPC 3
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	9.9	6.0	8.0		100	100	100		0.18	0.18	0.22
26	22.3	9.4	15.9		100	100	100		0.20	0.20	0.23
40	30.6	17.5	24.0		100	100	100		0.20	0.21	0.25
52	42.1	25.5	33.8		100	100	100		0.24	0.25	0.26
68	51.2	35.6	43.4		100	100	100		0.24	0.26	0.28

PV-25-25-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 4	UHPC 4	UHPC 4	UHPC 4	UHPC 4	UHPC 4	UHPC 4		UHPC 4	UHPC 4	UHPC 4
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	13.6	10.7	12.2		100	100	100		0.18	0.18	0.17
26	18.7	14.0	16.4		100	100	100		0.20	0.20	0.17
40	27.3	25.6	26.5		100	100	100		0.20	0.21	0.19
52	33.8	32.2	33.0		100	100	100		0.24	0.24	0.22
68	47.4	40.5	43.9		100	100	100		0.24	0.25	0.22

PV-25-15-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 5	UHPC 5	UHPC 5		UHPC 5	UHPC 5	UHPC 5		UHPC 5	UHPC 5	UHPC 5
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	1.5	6.7	4.1		100	100	100		0.13	0.10	0.12
26	12.3	14.2	13.3		100	100	100		0.16	0.14	0.15
40	22.3	22.5	22.4		100	100	100		0.18	0.15	0.17
52	35.4	32.2	33.8		100	100	100		0.22	0.19	0.20
68	50.8	45.0	47.9		100	100	100		0.22	0.19	0.21

PV-25-00-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 6	UHPC 6	UHPC 6		UHPC 6	UHPC 6	UHPC 6		UHPC 6	UHPC 6	UHPC 6
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	26.6	20.3	23.4		100	100	100		0.10	0.10	0.10
30	50.6	42.2	46.4		100	100	100		0.13	0.13	0.13
42	75.4	64.9	70.2		100	100	100		0.14	0.15	0.15
56	85.7	70.6	78.2		100	100	100		0.16	0.15	0.16

GG-25-25-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 8	UHPC 8	UHPC 8		UHPC 8	UHPC 8	UHPC 8		UHPC 8	UHPC 8	UHPC 8
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	15.4	4.4	9.9		100	100	100		0.18	0.20	0.19
26	26.3	9.8	18.0		100	100	100		0.23	0.22	0.23
40	40.8	24.0	32.4		100	100	100		0.25	0.25	0.25
52	50.8	36.5	43.6		100	100	100		0.30	0.29	0.29
68	69.8	56.1	63.0		100	100	100		0.32	0.30	0.31

GG-25-15-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 7	UHPC 7	UHPC 7		UHPC 7	UHPC 7	UHPC 7		UHPC 7	UHPC 7	UHPC 7
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
14	10.8	5.4	8.1		100	100	100		0.18	0.15	0.17
26	24.3	15.4	19.8		100	100	100		0.24	0.19	0.22
40	33.2	23.6	28.4		100	100	100		0.28	0.23	0.26
52	44.0	29.0	36.5		100	100	100		0.34	0.25	0.30
68	61.1	41.7	51.4		100	100	100		0.36	0.27	0.31

GG-25-00-1.5											
	Salt scaling, g/m^2 concrete				Internal damage by RDM, %				Moisture uptake, %		
F-T cycle	UHPC 9	UHPC 9	UHPC 9		UHPC 9	UHPC 9	UHPC 9		UHPC 9	UHPC 9	UHPC 9
0	0.0	0.0	0.0		100	100	100		0.00	0.00	0.00
10	23.9	29.9	26.9		100	100	100		0.18	0.16	0.17
24	43.9	46.3	45.1		100	100	100		0.21	0.19	0.20
40	64.6	69.1	66.9		100	100	100		0.24	0.21	0.23
52	83.1	94.0	88.6		100	100	100		0.25	0.23	0.24
66	90.0	100.4	95.2		100	100	100		0.25	0.23	0.24