

## **Appendix G: Laboratory Test Method Results with Standard Deviations**

*Appendix G of NCHRP Research Report 1083: Alkali-Silica Reactivity Potential and Mitigation: Test Methods and State of Practice (NCHRP Project 10-103)*

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**Table G1: Expansion results for each aggregate.**

Aggregate	ASTM C1260 14-Day Expansion (%)	AASHTO T 380 56-Day Expansion (%)	ASTM C1293 (%)	AAR-13 (%)
CA1	0.16 (0.003)	0.072 (0.004)	0.040 (0.008)	0.091 (0.001)
CA2	0.22 (0.006)	0.053 (0.004)	0.078 (0.001)	0.066 (0.014)
CA3	0.28 (0.020)	0.077 (0.001)	0.122 (0.001)	0.123 (0.001)
CA4	0.06 (0.001)	0.068 (0.001)	0.048 (0.001)	0.071 (0.004)
RAT1	0.18 (0.071)	0.126 (0.014)	0.040 (0.001)	0.090 (0.001)
RAT2	0.32 (0.042)	0.356 (0.040)	0.198 (0.002)	0.193 (0.002)
RAC1	0.58 (0.006)	0.304 (0.032)	0.217	
RAC2	0.32 (0.012)	0.255 (0.021)	0.196	
RAO1	0.81 (0.043)	0.586 (0.020)		
RAO2	0.61 (0.001)	0.553 (0.004)		

**Table G2: Comparison of test methods for aggregate CA1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix Design	ASTM C1567 14D (%)	ASTM C1567 28D (%)	ASTM C1293 (%)	AAR-13 (%)	AASHTO T 380-56d (%)	AASHTO T 380-84d (%)
CA1	Control	0.16 (0.003)	0.24 (0.003)	0.040 (0.008)	0.091 (0.001)	0.072 (0.004)	0.099 (0.003)
	35% FA3	0.09 (0.002)	0.15 (0.003)	0.003 (0.001)	0.001 (0.001)	0.025 (0.001)	0.031 (0.001)
	35% SC1	0.08 (0.012)	0.14 (0.021)	0.004 (0.008)	0.005 (0.007)	0.077 (0.006)	0.092 (0.005)
	50% SC1					0.019 (0.001)	0.023 (0.001)
	5% MK	0.11 (0.003)	0.27 (0.004)				
	10% MK	0.03* (0.001)		0.005* (0.001)	0.009* (0.001)	0.023 (0.005)	0.037 (0.001)
	20% FA3+5%SF	0.04 (0.001)	0.12 (0.002)			0.027 (0.005)	0.034 (0.003)
	35% FA3+5%SF	0.03 (0.001)	0.06 (0.001)	0.003 (0.002)	0.011 (0.013)		
	20% FA1+75%Li			0.005 (0.001)	0.014 (0.001)	0.015 (0.001)	0.023 (0.001)

\*These mixtures contain 7.5MK

**Table G3: UNBCCT data for CA1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix design	UNBCCT at 3 months	UNBCCT at 6 months	UNBCCT at 9 months	UNBCCT at 12 months	SD at 12 months
CA1	2.8 Ctrl	0.021	0.054	0.097	0.116	0.014
	2.8 35% FA3	0.012	0.026	0.031	0.032	0.004
	2.8 35% SC1	-0.004	-0.002	0.000	0.004	0.012
	6.4 Ctrl	0.049	0.113	0.172	0.192	0.016
	6.4 35% FA3	0.006	0.008	0.011	0.014	0.004
	6.4 35% SC1	-0.003	0.000	0.001	0.005	0.019

**Table G4: Comparison of test methods for aggregate CA2. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix Design	ASTM C1567 14D (%)	ASTM C1567 28D (%)	ASTM C1293 (%)	AAR-13 (%)	AASHTO T 380-56d (%)	AASHTO T 380-84d (%)
CA2	Control	0.22 (0.006)	0.30 (0.006)	0.07 (0.001)	0.094 (0.014)	0.053 (0.004)	0.073 (0.004)
	20% FA1	0.15 (0.006)	0.23 (0.012)	0.026 (0.001)	0.029 (0.005)	0.068 (0.007)	0.068 (0.001)
	25% FA1	0.08 (0.006)	0.16 (0.003)	0.022 (0.001)	0.022 (0.001)	0.013 (0.001)	0.020 (0.001)
	35% FA1					0.009 (0.002)	0.016 (0.001)
	15% FA2	0.23 (0.060)		0.065 (0.002)	0.071 (0.003)	0.043 (0.001)	0.061 (0.001)
	25% RA	0.06 (0.005)	0.13 (0.006)	0.032 (0.001)	0.022 (0.001)	0.011 (0.001)	0.012 (0.005)
	25% BA	0.10 (0.004)	0.18 (0.005)			0.025 (0.001)	0.027 (0.001)
	35% BA	0.04 (0.002)	0.07 (0.002)	0.016 (0.001)	0.021 (0.001)	0.021 (0.001)	0.024 (0.001)
	25% SC1	0.14 (0.030)		0.034 (0.003)	0.052 (0.002)	0.048 (0.001)	0.063 (0.002)
	15% NP1	0.06 (0.009)	0.14 (0.022)	0.022 (0.002)	0.042 (0.003)	0.019 (0.002)	0.020 (0.001)

**Table G5: UNBCCT data for CA2. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mixture design	UNBCCT at 3 months (%)	UNBCCT at 6 months (%)	UNBCCT at 9 months (%)	UNBCCT at 12 months (%)	SD at 12 months
CA2	3.5 Ctrl	0.020	0.040	0.064	0.083	0.017
	3.5 25% FA1	0.004	0.006	0.011	0.013	0.003
	3.5 35% BA	0.008	0.008	0.007	0.009	0.001

	6.4 Ctrl	0.094	0.157	0.191	0.205	0.016
	6.4 25% FA1	-0.002	-0.003	0.001	0.002	0.007
	6.4 35% BA	0.001	-0.002	0.004	0.007	0.003

**Table G6: Comparison of test methods for aggregate CA3. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mixture Design	ASTM C1567 14D (%)	ASTM C1567 28D (%)	ASTM C1293 (%)	AAR-13 (%)	AASHTO T 380 56 Day (%)	AASHTO T 380 84 Day (%)
CA3	Control	0.28 (0.020)		0.122 (0.001)	0.157 (0.001)	0.077 (0.001)	0.095
	25% FA1	0.10 (0.003)		0.038 (0.005)	0.035 (0.004)	0.024 (0.001)	0.032
	25% FA2	0.16 (0.012)		0.050 (0.003)	0.059 (0.001)	0.042 (0.003)	0.054
	35% SC2	0.17 (0.040)		0.048 (0.002)	0.056 (0.002)	0.040 (0.002)	0.058
	10% MK	0.07 (0.009)	0.09 (0.011)			0.024 (0.005)	0.032 (0.007)
	35% FA3 5% SF	0.04 (0.043)	0.06 (0.040)	0.007 (0.003)	0.002 (0.001)	0.007 (0.001)	.009
	10% NP1	0.18 (0.011)					
	15% NP1	0.06 (0.001)	0.14 (0.008)				

**Table G3: UNBCCT data for CA3 Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mixture design	UNBCCT at 3 months (%)	UNBCCT at 6 months (%)	UNBCCT at 9 months (%)	UNBCCT at 12 months (%)	SD at 12 months
CA3	2.8 Control*	0.087	0.147	0.190	0.200	0.014
	2.8 25% FA2	0.032	0.047	0.087	0.093	0.011
	2.8 35% SC2	0.026	0.038	0.070	0.074	0.007
	2.8 35% FA3 5% SF	0.022	0.039	0.043	0.049	0.005
	2.8 25% FA1	-0.003	0.013	0.007	0.022	0.001
	3.5 Control	0.086	0.177	0.236	0.267	0.004
	3.5 25% FA2	0.020	0.060	0.078	0.101	0.011
	3.5 35% SC2	0.018	0.022	0.036	0.044	0.002
	3.5 10% MK	-0.001	0.000	0.022	0.022	0.000
	3.5 35% FA3 5% SF	0.017	0.038	0.051	0.055	0.012
	6.4 Control	0.142	0.200	0.233	0.252	0.028
	6.4 25% FA1	0.011	0.017	0.001	0.029	

	6.4 25% FA2	0.068	0.101	0.115	0.125	0.004
	6.4 35% SC2	0.065	0.077	0.087	0.088	0.011
	6.4 35% FA3 5% SF	0.041	0.050	0.066	0.069	0.019
	6.4 10% MK	0.022	0.022	0.050	0.054	0.001

**Table G8: Comparison of test methods for aggregate CA4. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mixture Design	ASTM C1567-14d (%)	ASTM C1567-28d (%)	ASTM C1293 (%)	AAR-13 (%)	AASHTO T 380 56 Day (%)	AASHTO T 380 84 Day (%)
CA4	Control	0.07 (0.001)	0.14 (0.002)	0.072 (0.001)	0.071 (0.003)	0.068 (0.001)	0.087 (0.001)
	20% FA1			0.012 (0.001)	0.017 (0.001)	0.035 (0.001)	0.042 (0.001)
	35% FA3	0.06 (0.002)	0.10 (0.000)	0.021 (0.001)	0.021 (0.001)	0.040 (0.002)	0.045 (0.002)
	15% NP1	0.03 (0.003)	0.07 (0.001)	0.018 (0.001)	0.018 (0.001)	0.021 (0.002)	0.034 (0.001)
	15% NP2	0.06 (0.006)	0.13 (0.009)	0.032 (0.002)	0.007 (0.001)	0.028 (0.002)	0.042 (0.004)
	20% RA	0.05 (0.003)	0.10 (0.002)	0.015 (0.001)	0.000 (0.001)	0.012 (0.001)	0.030 (0.001)
	20% BA	0.09 (0.004)	0.15 (0.004)	0.012 (0.001)	0.022 (0.001)	0.027 (0.003)	0.041 (0.002)

**Table G3: UNBCCT data for CA4. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mixture design	UNBCCT at 3 months	UNBCCT at 6 months	UNBCCT at 9 months	UNBCCT at 12 months	SD at 12 months
CA4	2.8 Ctrl	0.050	0.112	0.166	0.201	0.012
	2.8 35% FA3	0.010	0.020	0.028	0.030	0.009
	2.8 15% NP1	0.010	0.013	0.028	0.039	0.009
	2.8 15% NP2	-0.002	0.013	0.012	0.010	0.004
	2.8 20% FA1	0.015	0.018	0.023	0.037	0.015
	2.8 20% RA	0.013	0.021	0.022	0.029	0.021
	2.8 20% BA	0.012	0.025	0.035	0.057	0.007
	6.4 Ctrl	0.042	0.162	0.270	0.459	0.043

**Table G10: Comparison of test methods for aggregate RAT1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix Design	ASTM C1567 14D (%)	ASTM C1567 28D (%)	AAR-13 (%)	AASHTO T 380-56d (%)	AASHTO T 380-84d (%)
RAT1	Control	0.18 (0.017)	0.28 (.033)	0.19 (0.001)	0.126 (0.014)	0.213 (0.021)
	25% FA1	0.02 (.003)	0.04 (.018)	0.027 (0.001)	0.009 (0.001)	0.019 (0.005)
	35% FA1				0.004 (0.003)	0.019 (0.002)
	35% FA2	0.04 (0.011)	0.05 (0.018)	0.035 (0.001)	0.020 (0.001)	0.05 (0.018)
	10% MK	0.04 (0.013)	0.01 (0.001)	0.022* (0.004)	0.009 (0.004)	0.009 (0.004)

\*This mixture contains 7.5% MK

**Table G11: Comparison of test methods for aggregate RAT1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM**

Aggregate	Mixture Design	ASTM C1567 (%)	ASTM C1567 28 Day (%)	ASTM C1293 (%)	AAR-13 (%)	AASHTO T 380-56d (%)	AASHTO T 380-84d (%)
RAT2	Control	0.33 (0.042)		0.210 (0.002)	0.190 (0.002)	0.360 (0.04)	0.440 (0.051)
	20% FA1	0.11 (0.011)	0.18 (0.020)	0.007 (0.001)	0.030 (0.001)	0.072 (0.002)	0.110 (0.003)
	35% FA1	0.00 (0.001)	0.01 (0.001)	-0.038 (0.003)	0.006 (0.004)	0.017 (0.001)	0.028 (0.001)
	35% FA3	0.04 (0.003)	0.09 (0.008)	0.008 (0.001)	0.006 (0.001)	0.053 (0.001)	0.080 (0.001)
	35% SC1	0.07 (0.001)	0.13 (0.005)	-0.010 (0.003)	0.018 (0.002)	0.029 (0.001)	0.054 (0.001)
	35% SC2	0.10 (.011)	0.17 (.012)	0.026 (0.001)	0.021 (0.001)	0.043 (0.002)	0.075 (.003)
	10% NP1	0.12 (0.001)	0.19 (0.002)	0.096 (0.002)	0.151 (0.001)	0.156 (0.002)	0.203 (0.002)
	10% NP2	0.18 (0.001)			0.185 (0.001)	0.103 (0.002)	0.149 (0.003)
	10% MK	0.12 (0.002)		0.017 (0.001)	0.021 (0.001)	0.020 (0.001)	0.030 (0.001)
	7.5% SF	0.22 (0.002)		0.002 (0.001)	0.002 (0.001)	0.330 (0.008)	0.430 (0.009)

**Table G12: Comparison of test methods for aggregate RAO1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM**

Aggregate	Mixture Design	ASTM C1567 14-Day Expansion (%)	MCPT 56-Day Expansion (%)	MCPT 84-Day Expansion (%)
RAO1	Control	0.81 (0.043)	0.588 (0.020)	0.0705 (0.026)
	25% FA1	0.100 (0.002)	0.067 (0.001)	0.107 (0.002)
	35% FA1	0.026 (0.003)	0.023 (0.002)	0.041 (0.008)
	35% FA2	0.025 (0.001)	0.065 (0.004)	0.107 (0.006)
	65% SC1	0.013 (0.002)	0.021 (0.002)	0.026 (0.003)
	7.5% MK	0.034 (0.007)	0.078 (0.005)	0.124 (0.008)

**Table G13: Comparison of test methods for aggregate RAO2. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM**

Aggregate	Mix Design	ASTM C1260 14-Day Expansion (%)	MCPT 56-Day Expansion (%)	MCPT 84-Day Expansion (%)
RAO2	Control	0.61 (0.001)	0.553 (0.004)	0.705 (0.001)
	25% FA1	0.028 (0.003)	0.045 (0.002)	0.086 (0.003)
	35% FA1	0.03 (0.002)	0.036 (0.004)	0.072 (0.005)
	35% FA3	0.03 (0.001)	0.073 (0.007)	0.124 (0.008)
	35% RA	0.05 (0.001)	0.017 (0.002)	0.029 (0.003)
	35% BA	0.03 (0.001)	0.031 (0.002)	0.06 (0.007)
	50% SC1	0.023 (0.002)	0.019 (0.001)	0.049 (0.004)
	65% SC1	0.012 (0.002)	0.009 (0.002)	0.012 (0.001)
	50% SC2	0.025 (0.002)	0.023 (0.003)	0.039 (0.006)
	20% NP1	0.03 (0.001)	0.030 (0.004)	0.071 (0.010)
	20% NP2	0.03 (0.001)	0.045 (0.004)	0.094 (0.002)
	9.5% SF	0.034 (0.003)	0.097 (0.004)	0.167 (0.005)
	7.5% MK	0.04 (0.002)	0.056 (0.009)	0.125 (0.006)
	10% MK	0.03 (0.001)	0.028 (0.002)	0.074 (0.001)

**Table G14: UNBCCT data for RAC1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix design	UNBCCT at 3 months	UNBCCT at 6 months	UNBCCT at 9 months	UNBCCT at 12 months	SD At 12 months
RAC1	3.1 Control	0.0580	0.109	0.143	0.223	0.009
	3.1 35% FA2	-0.005	0.018	0.040	0.060	0.031
	3.1 25% FA1	0.000	0.007	0.013	0.033	0.005

	3.1 35% FA1	0.000	0.006	0.010	0.028	0.006
	4.0 Control	0.060	0.107	0.154	0.224	0.002
	4.0 35% FA2	0.004	0.032	0.073	0.092	0.005
	4.0 25% FA1	0.008	0.014	0.022	0.060	0.007
	4.0 35% FA1	0.000	0.007	0.013	0.063	0.006
	5.3 Control	0.150	0.226	0.330	0.372	0.001
	5.3 35% FA2	0.038	0.070	0.113	0.156	0.012
	5.3 25% FA1	0.008	0.018	0.020	0.033	0.014
	5.3 35% FA1	0.012	0.020	0.024	0.030	0.006

**Table G15: UNBCCT data for RAC1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix design	UNBCCT at 3 months	UNBCCT at 6 months	UNBCCT at 9 months	UNBCCT at 12 months	SD at 12 months
RAC2	3.5 Control	0.068	0.110	0.150	0.176	0.031
	3.5 35% SC1	0.036	0.043	0.048	0.049	0.009
	3.5 50% SC1	0.015	0.016	0.018	0.019	0.005
	3.5 35% SC2	0.004	0.008	0.018	0.020	0.004
	3.5 20% NP1	0.004	0.014	0.020	0.034	0.009
	3.5 20% NP2	-0.008	-0.001	0.022	0.036	0.006
	3.5 40% FA3	0.014	0.031	0.034	0.036	0.011
	3.5 7.2% SF	0.002	0.021	0.039	0.038	0.011
	6.4 Control	0.126	0.172	0.202	0.259	0.036
	6.4 20% FA1	0.010	0.019	0.020	0.028	
	6.4 35% SC1	0.058	0.086	0.088	0.091	0.006
	6.4 50% SC1	0.040	0.041	0.067	0.080	0.006
	6.4 35% SC2	0.059	0.072	0.084	0.085	0.015
	6.4 20% NP1	0.015	0.028	0.034	0.041	0.011
	6.4 20% NP2	0.008	0.018	0.028	0.034	0.006
	6.4 40% FA3	0.005	0.030	0.037	0.045	0.013
	6.4 7.2% SF	-0.017	0.012	0.035	0.039	0.016

**Table G16: ASTM C1567 data for RAC1. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM.**

Aggregate	Mix Design	ASTM C1260 14-Day Expansion (%)	ASTM C1567 28-Day Expansion (%)
RAC1	Control	0.58 (0.012)	0.77 (0.016)
	25% FA1	0.089(0.009)	0.16 (0.016)
	35% FA1	0.04 (0.002)	0.06 (0.003)
	35% FA2	0.08 (0.004)	0.13 (0.005)
	45% FA3	0.06 (0.009)	0.11 (0.009)
	40% FA3	0.11 (0.007)	0.16 (0.006)
	7.5 MK	0.14 (0.005)	0.24 (0.008)
	10% MK	0.10 (0.005)	0.19 (0.003)
	12.5% MK	0.07 (0.005)	0.13 (0.003)

**Table G17 ASTM C1567 data for RAC2. Text in red with gray shading indicates a value exceeding the current expansion limit that would require retesting with a higher replacement level of SCM**

Aggregate	Mix Design	ASTM C1260 14-Day Expansion (%)	ASTM C1567 28-Day Expansion (%)
RAC2	Control	0.31 (0.006)	0.44 (0.007)
	35% FA3	0.12 (0.007)	0.18 (0.009)
	40% FA3	0.07 (0.002)	0.10 (0.002)
	50% FA3	0.04 (0.004)	0.07 (0.005)
	20% NP1	0.04 (0.009)	0.09 (0.007)
	20% NP2	0.07 (0.007)	0.09 (0.008)
	7.5 MK	0.11 (0.007)	0.15 (0.008)
	10% MK	0.06 (0.003)	0.12 (0.003)
	7.2% SF	0.20 (0.008)	0.33 (0.000)
	20% FA1	0.15 (0.006)	0.23 (0.007)
	35% FA1	0.05 (0.002)	0.08 (0.001)
	50% SC1	0.05 (0.006)	0.08 (0.004)