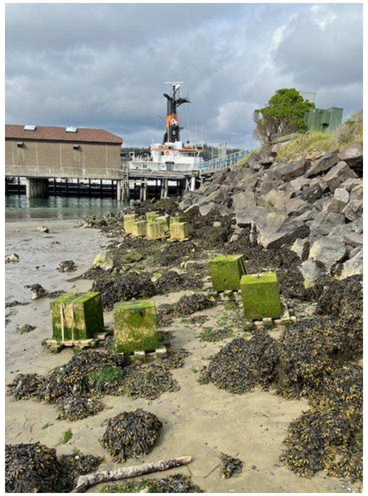
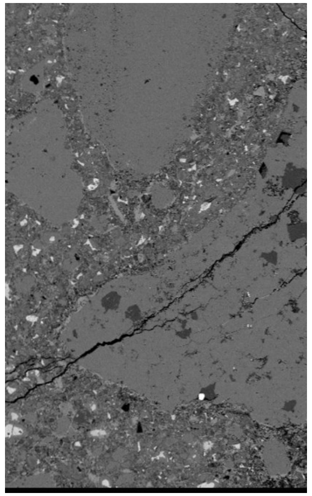
A New Approach to Preventing ASR: Alkali Sensitivity Evaluation





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On aggregate reactivity…

There is no ”inert aggregate”

only varying levels of “<u>ertness</u>”

– Paraphrased Quote from Bryant Mather, US Army Corps

Agenda

- Background
- Current FAA Approach for ASR
- Project Goals
- Proposed New Approach
- Brief: ACPTP 2021-1 Phase II

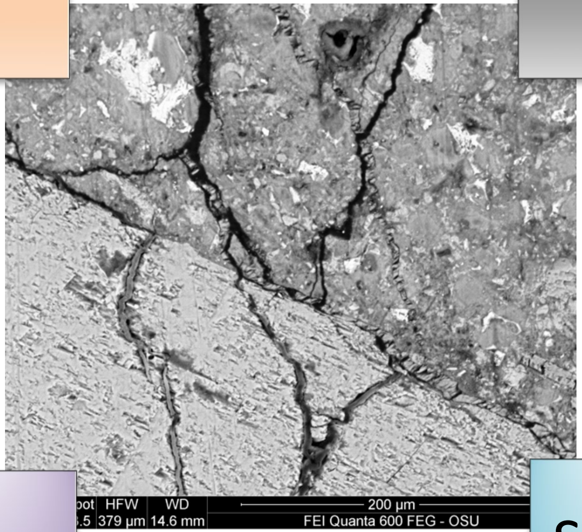
Alkali-silica reaction (ASR)

Calcium

- Cement
- Supplementary cementitious materials

Sufficient Alkali

- Cement
- Supplementary cementitious materials
- Aggregates
- External sources (deicers)
- Chemical admixtures



Reactive Silica

- Fine aggregates
- Coarse aggregates

Sufficient moisture

- Pore solution in concrete
- Concrete exposed to moist environment (RH $\geq$ 60%)

Prevention of ASR in Fresh Concrete

Most Supplementary Cementing Materials (SCMs) can be used to control ASR

- SCM composition (CaO, SiO_2, $\mathbf{Al_2O_3}$, Na_2O_e)
- Dosage rate
- Nature and level of aggregate reactivity
- Alkali content supplied by the portland cement, SCM, aggregates (and other sources also important)

Chemical Admixtures

- Lithium Nitrate
  - Dosage rate
  - Aggregate is responsive

Test Methods (1)

ASTM C1260/1567

Accelerated mortar bar test

25x25x285 mm
80^{o}C, 1N NaOH, 14 days

Fine aggregate or crushed coarse aggregate

AASHTO T 380

Miniature concrete prism test

50x50x285 mm
60^{o}C, 1N NaOH, 56-84 days

Coarse aggregate (maximum 12.5 mm)
Fine aggregate
Representative concrete mixture

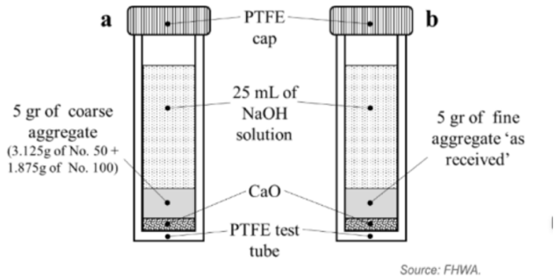
ASTM C 1293

Concrete prism test

75x75x285 mm
38^{o}C, 100% RH
1 year aggregate reactivity
2 years preventive options

Concrete mixture
Reactive coarse **<u>or</u>** reactive fine

Test Methods (2)



Configuration of the test tubes.

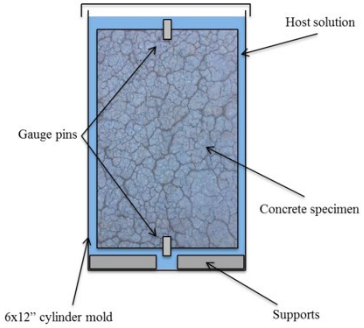
T-Fast

Solution Test

Solution Test
55 and 80^{o}C, 1N NaOH, 21 Days

Crushed coarse or fine aggregate*

**newest method, still under development*



UNBCCT

UNB Concrete Cylinder Test Method

~145 x 279 mm cylinder
60^{o}C, 1N NaOH, 1-2 years

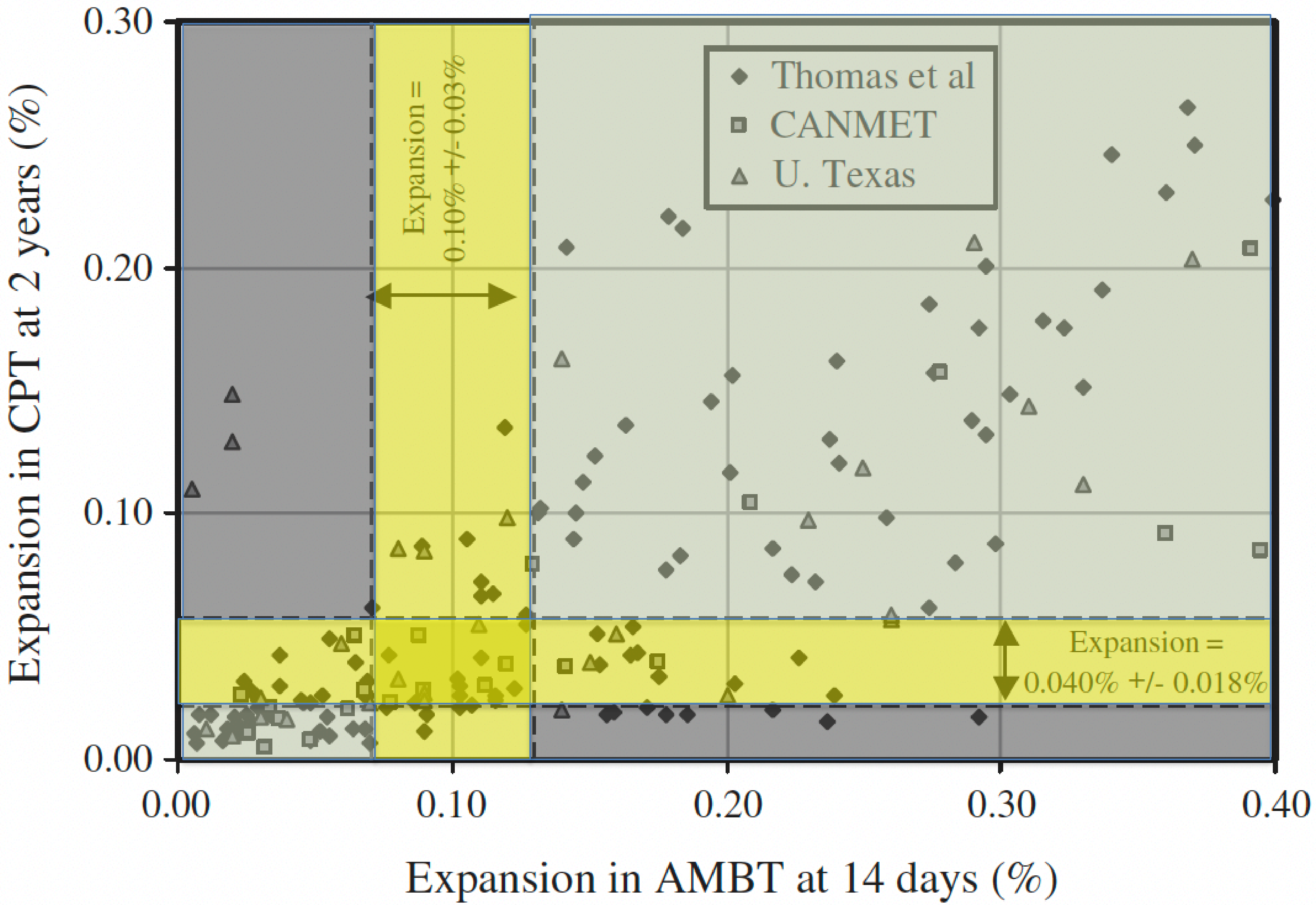
Job concrete mixture
Reactive coarse **or** reactive fine

Outdoor Exposure Blocks

381 mm cube
381 mm x 381 x 762 mm
Environmental Exposure
1 to 20+ years

Concrete mixture
Reactive coarse **or** reactive fine

Comparison between expansion at 2 years in CPT and expansion at 14 days in AMBT.



Thomas, M., Fournier, B., Folliard, K., Ideker J., and Shehata, M., ”Test Methods for Evaluating Preventive Measures for Controlling Expansion due to Alkali-silica Reaction in Concrete,” *Cement and Concrete Research*, V 36, 2006, pp. 1842-1856

Current FAA approach in 10H

ASTM C1260: coarse and fine aggregates evaluated separately

- Expansion < 0.10% at 28 days

ASTM C1567: combined aggregates and/or SCMs, job mixture modifications, lithium (CRD C662)

- Expansion < 0.10% at 28 days

Challenge: current approach is time consuming, fly ash availability, slag availability/high dosage levels, lithium nitrate availability

Positive: current approach “seems” to be working to prevent ASR in airfield pavements

Sources:
ACPTP RFP 2021-1 https://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5370-10H.pdf

ASTM C1778-23, AASHTO R80, CSA A23.2-27A

EB 106

TABLE 4 Determining Level of Prevention

Level of ASR Risk (Table 2)	Classification of Structure (Table 3)			
	Class SC1	Class SC2	Class SC3	Class SC4
Risk Level 1	V	V	V	V
Risk Level 2	V	V	W	X
Risk Level 3	V	W	X	Y
Risk Level 4	W	X	Y	Z
Risk Level 5	X	Y	Z	ZZ
Risk Level 6	Y	Z	ZZ	A

[A] It may not be permitted to construct a Class SC4 structure (see Table 3) if the risk of ASR is Level 6. Measures should be taken to reduce the level of risk in these circumstances **(9)**.

TABLE 5 Maximum Alkali Loadings to Provide Various Levels of Prevention

Prevention Level	Maximum Alkali Loading of Concrete	
	kg/m^3	lb/yd^3
V	No Limit	
W	3.0	5.0
X	2.4	4.0
Y	1.8	3.0
Z^A	Table 8	
ZZ^A		

[A] SCMs may be used in Prevention Levels Z and ZZ.

g of Concrete Mixture

ıggregate to be used in P-501, *Cement Concrete* *or Miscellaneous Structures*, is potentially reactive, as ;0 test and as outlined in paragraphs 4.5 and 4.6, limit the ıixture to be less than or equal to 3.0 lb/yd^3 (1.8 kg/m^3).

ling of Concrete Mixture.

lb/yd^3) = portland cement fraction content (lb/yd^3) × ‹ 1/100. **Note:** In concrete that includes supplementary ; alkali content of the portland cement fraction of the led in the calculations of alkali loading.

te mix containing 575 lbs/yd^3 of ASTM C595 *Type IL* and cement, 15% limestone. If the equivalent alkali component is 0.63% Na_2Oeq, the alkali loading of

) = 3.1 lbs/yd^3. (**Note:** In this case the mix designer must ;e a different cement to get the alkali loading below 3.0 lb/cy.)

ACPTP 2021-1 Project Objectives

1. Identifying and assessing approaches for mitigation of ASR in mixtures with reactive aggregates that do **not include the use of fly ash or slag cement;**
2. Identifying and assessing methods or protocols to assess mitigation plans for a given aggregate source; and
3. Reviewing and recommending protocols and practices adopted by other agencies for **prequalifying aggregates**, and to develop mitigation guidance based on the reactivity of a given aggregate source.

Research Team Questions

- How do we reduce ambiguity?
- How do we develop a faster method that is reliable, and still appropriate/conservative (airfield pavements)?
- How do we bring more science into our approach and reduce empiricism and engineering judgement?

Research Team

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Modified Current Approach

- Current typical ASR minimization
- AMBT (C1567) is 28 days
- Proposed - MCPT is 56 days (agg) or 84 days (preventive)

Option 1: Performance Testing Approach for Minimizing Risk of Alkali-silica Reaction

Aggregate Reactivity Check
Does ASTM C1260 benchmark against AASHTO T380?

Yes

Preventive Measure Quantification
Use preventive measure quantity to meet:

ASTM C 1567 expansion at 28 days < 0.10%
-or-
AASHTO T380 at 84 days < 0.020%

No/Unknown

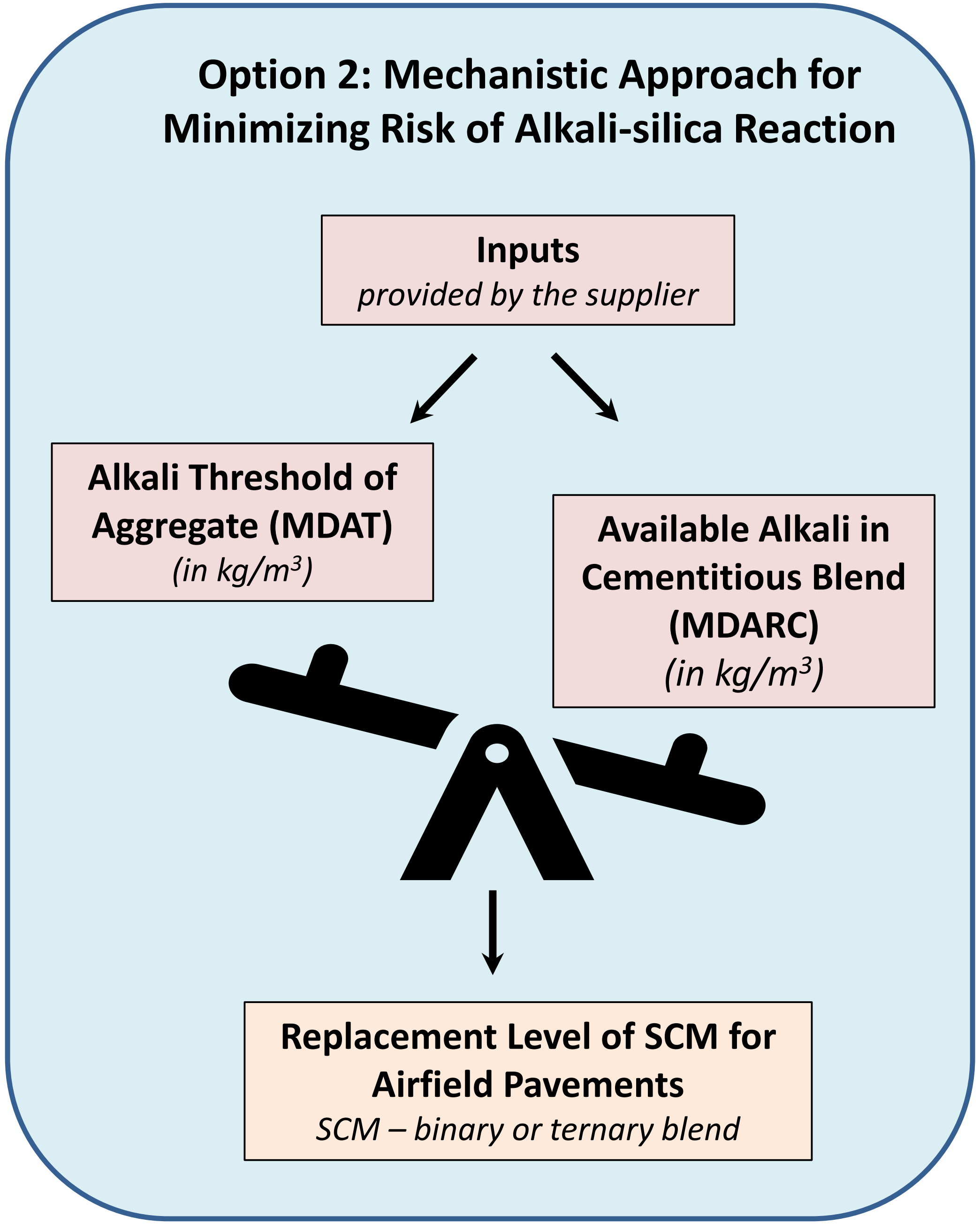
Preventive Measure Quantification
Use preventive measure quantity to meet:

AASHTO T380 expansion at 84 days < 0.020%

Proposed Approach

- **<u>Prescriptive modeling approach is "1" day</u>**
  - *Data is provided by supplier*
  - *Aggregate supplier*
  - *Ready-mix producer/Cementitious materials supplier*

Unique: will form a **<u>generalized</u>** and **<u>rapid</u>** approach for extension to a wide range of SCMs, verified on a subset of SCMs in this research



Aggregates – Fine

Fine or coarse		Source	Mineralogy	AMBT (%)	CPT (%)	MCPT (%)	Reactivity (C1778)
F	F1	El Paso, Texas	Natural sand with Mixed quartz/chert/ feldspar	0.64	0.59	0.640	R3
F	F7	Robstown, Texas	Natural sand with wide variety of rock types including abundant microcrystalline quartz in form of chert and calcedony	0.29	0.21	0.382	R2
F	F17	Klamath Falls, Oregon	Natural sand comprised of volcanic rocks - primarily basaltic andesite, andesite and tuff	0.49	NA	0.550	R3
F	F18	Bishop, California	Natural sand comprised of quartzite and rhyolite with lesser amounts of granite	0.60	NA	0.340	R3

Aggregates – Coarse

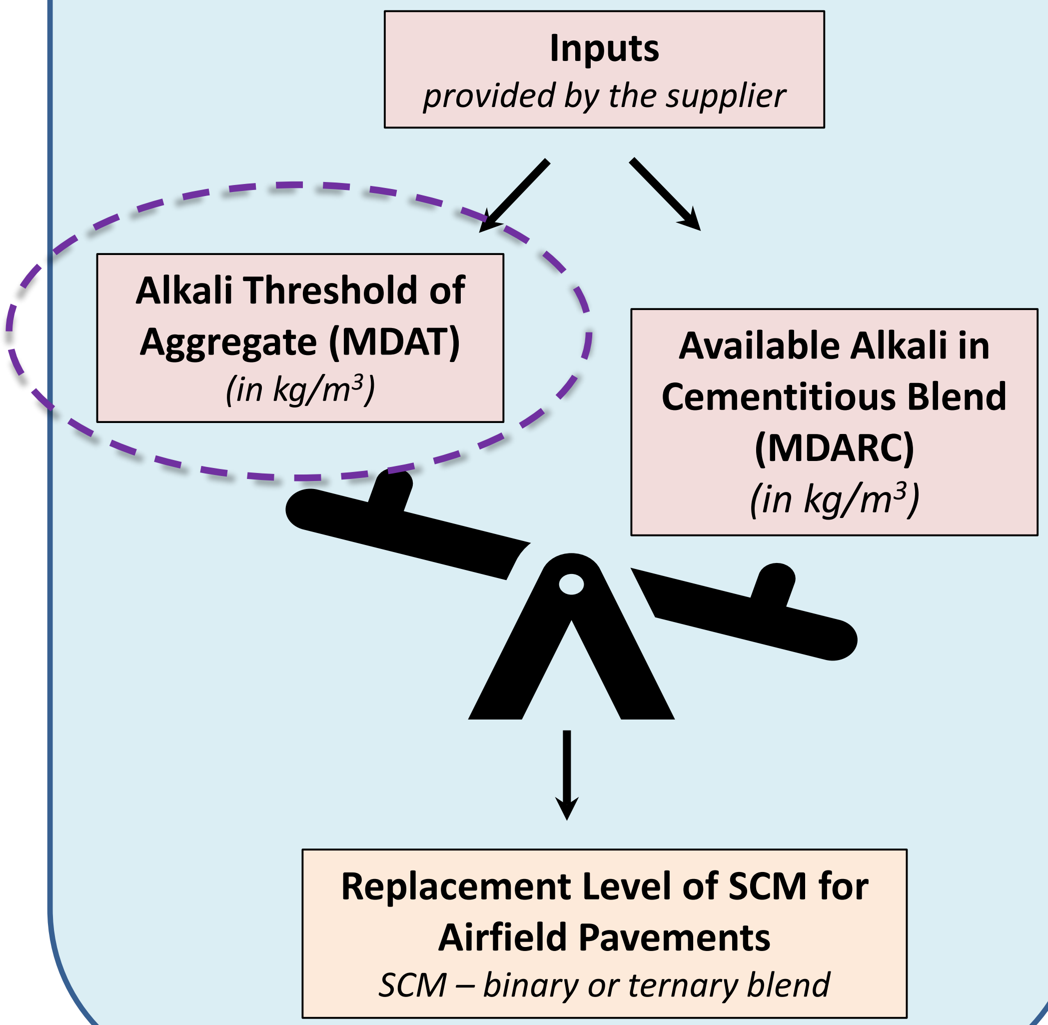
Fine or coarse		Source	Mineralogy	AMBT (%)	CPT (%)	MCPT (%)	Reactivity (C1778)
C	C7	Ontario, Canada	Siliceous limestone	0.37	0.20	0.121	R2
C	C8	Ontario, Canada	Natural gravel comprised predominately of fine-grained sedimentary rocks including greywacke and argillite	0.31	0.14	0.200	R1
C	C10	New Mexico	Natural gravel comprised of rhyolitic volcanic rock with quartz and granite	0.82	0.16	0.169	R3
C	C14	Cheyenne, Wyoming	Granite and quartzite gravel	0.23	0.09	0.053	R1
C	C16	Virginia	Granitic Gneiss	0.06	0.05	NA	R1
C	C21	New Brunswick, Canada	Natural greywacke gravel	0.57	0.21	0.300	R3
C	C22	North Carolina	Crushed Phyllite, schist	0.27	0.12	0.075	R1
C	C23	Pennsylvania	Crushed siltstone/phyllite and gneiss	0.15	NA	NA	R1

Proposed Approach

- **<u>Prescriptive modeling approach is "1" day</u>**
  - *Data is provided by supplier*
  - *Aggregate supplier*
  - *Ready-mix producer*

Unique: will form a **<u>generalized</u>** and **<u>rapid</u>** approach for extension to a wide range of SCMs, verified on a subset of SCMs in this research

Option 2: Mechanistic Approach for Minimizing Risk of Alkali-silica Reaction



Inspiration - Data Summary from Hobbs, 1988

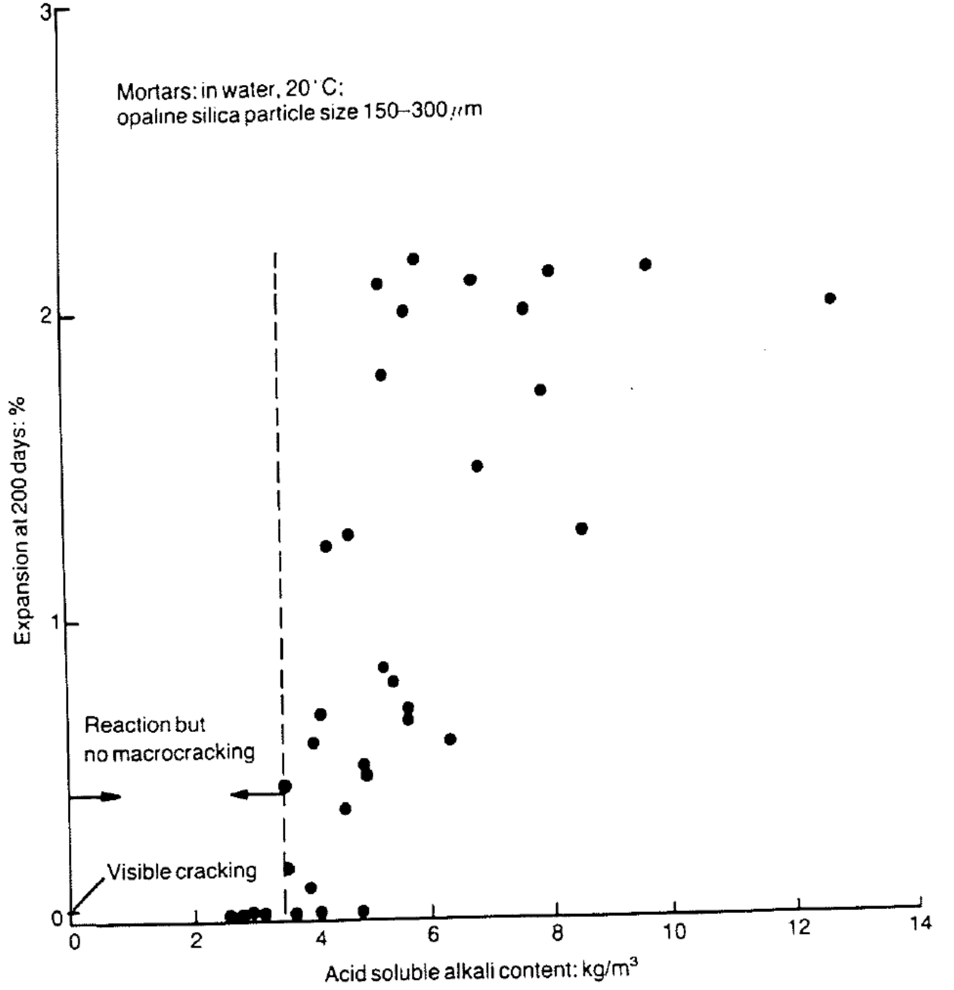
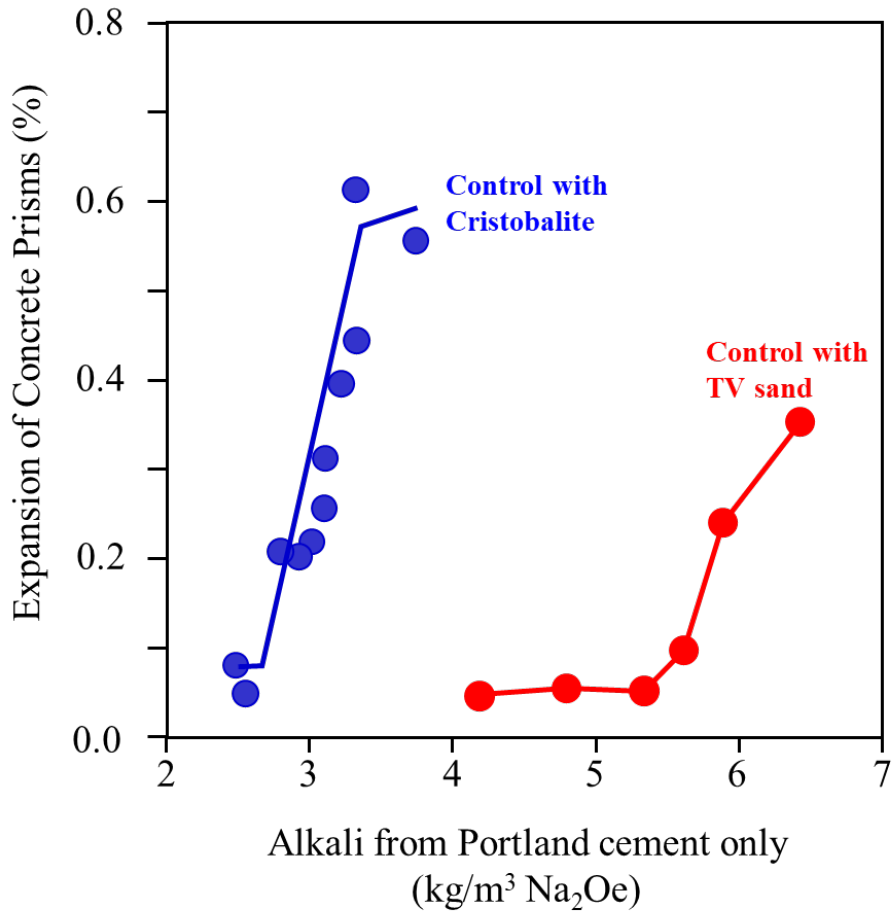


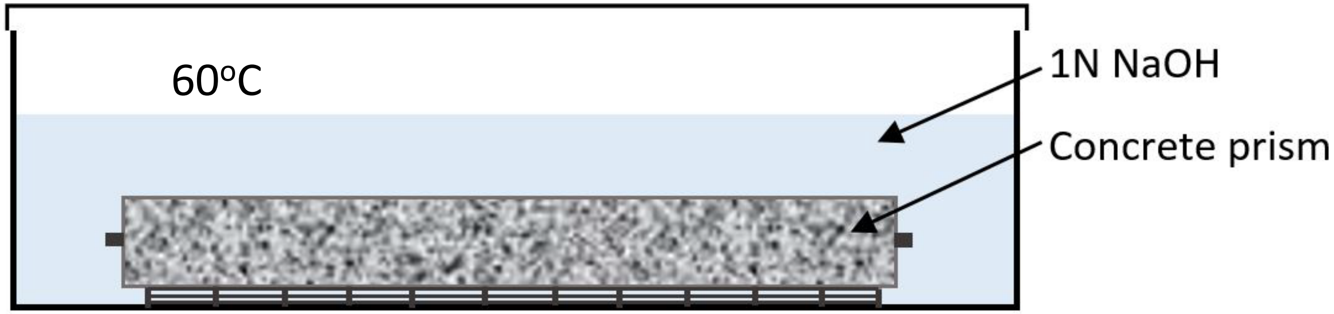
Fig. 2.5. Variation of expansion at 200 days with acid soluble alkali content of mortars



Source: Thomas, M.D.A., Blackwell, B.Q. and Nixon, P.J., "Estimating the Alkali Contribution from Fly Ash to Expansion due to Alkali-Aggregate Reaction in Concrete, *Magazine of Concrete Research*, Dec. 1996, V 48 [177], pp. 251-264.

Hobbs, D.W., Alkali-silica reaction in concrete, Thomas Telford, London, 1988, 184 pp.

Miniature-Concrete Prism Test (MCPT) AASHTO T380



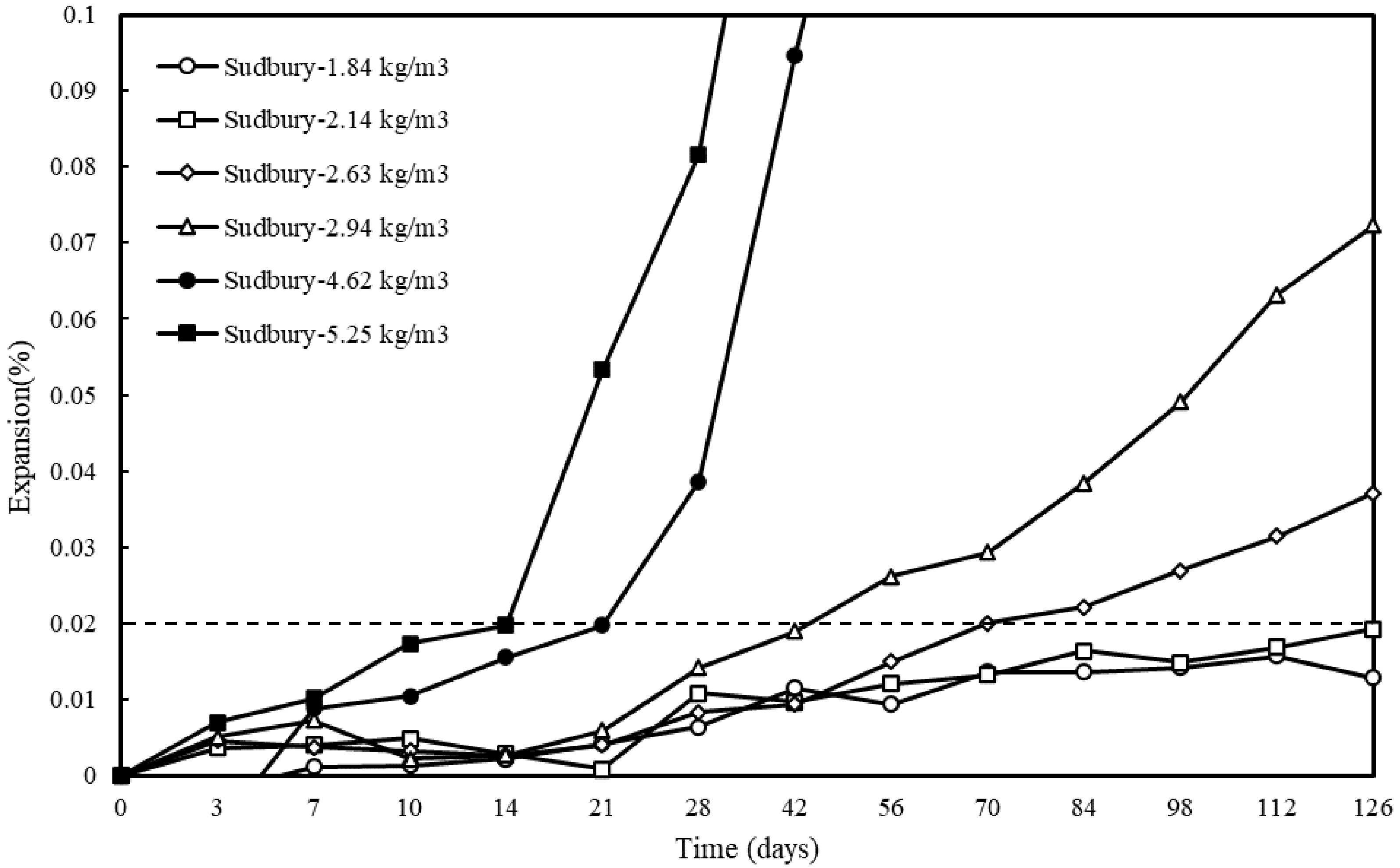
Modified AASHTO T380 – For Alkali Sensitivity

- Different alkali loadings are obtained by blending high- and low-alkali cements.
- The soaking solution alkalinity is matched with that of pore solution using [OH-] = 0.7 * Na_2O_{eq}
- Soaking solution is made using KOH and NaOH. K/Na depends on the composition of the cement.
- Other MCPT parameters remain unchanged.
- The timeframe of the test has been extended to test the expansion behavior of low-alkali mixes.

Standard AASHTO T380

- 50 x 50 x 285 mm bars
- w/cm = 0.45
- 60°C
- *immersed in 1N NaOH solution*
- 56 to 84 days

Alkali threshold testing using AASHTO T380



AASHTO T 380

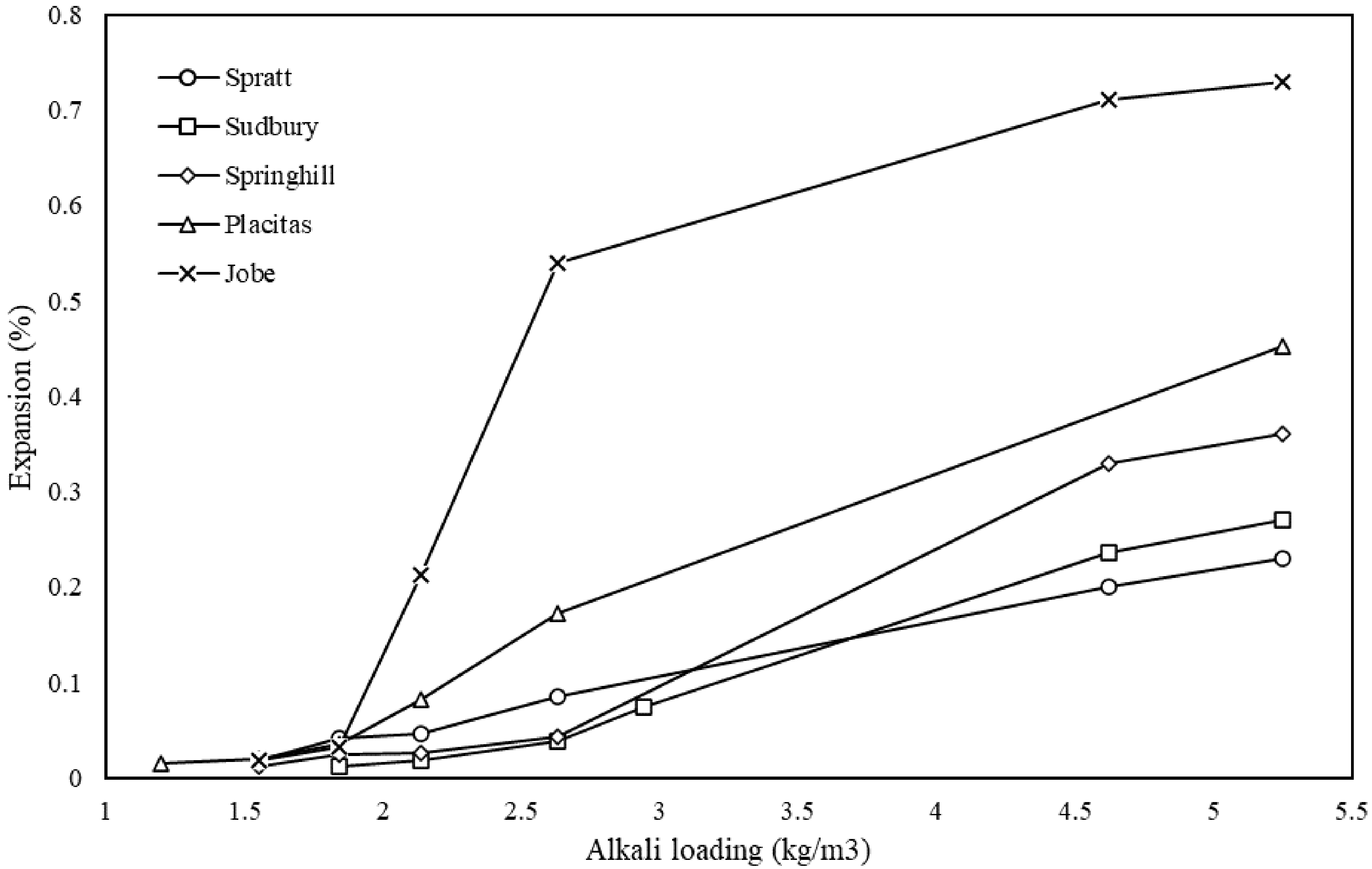
Miniature concrete prism test

50x50x285 mm
60°C
Alkali content varies,
matched soak solution to
OPC (or PLC)

Varying aggregate reactivities

Ideker, J.H., Drimalas, T., Folliard, K.J., Ghanizadeh, A., Parashar, A., Chopperla, K.S.T., Snyder, A., and Thomas, M.D.A., Preventing Alkali-Silica Reaction in Concrete, Keynote Lecture, ibausil, Weimar, Germany, September 13, 2023, *Proceedings in Civil Engineering*, 10.1002/cepa.2935

Alkali threshold testing using AASHTO T380



Ghanizadeh et al., unpublished results

AASHTO T 380

Miniature concrete prism test

50x50x285 mm
60°C
Alkali content varies,
matched to OPC (or PLC)

Five different well known
reactive aggregates

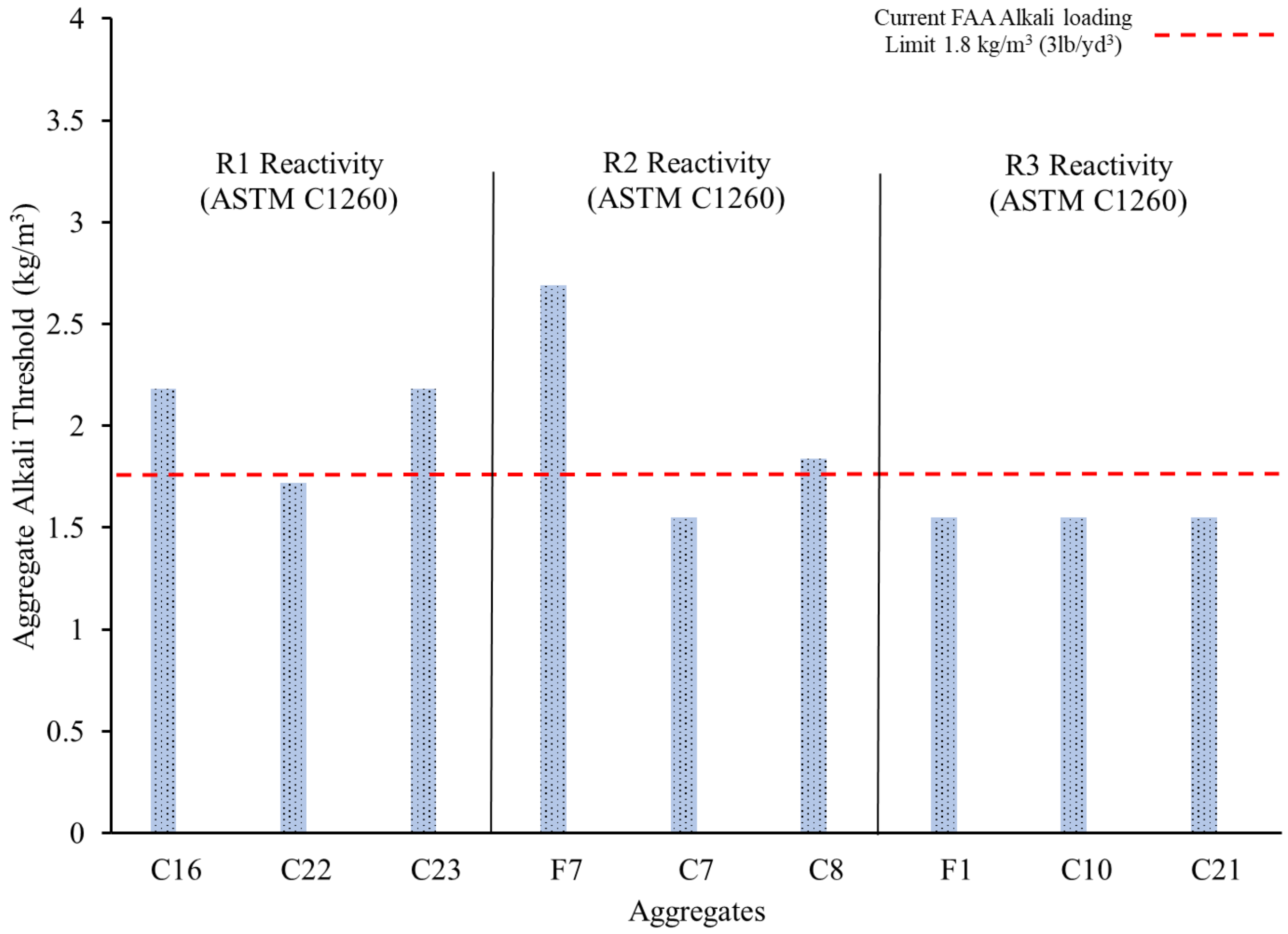
Fine Aggregate Reactivity Summary

	AMBT (%)	CPT (%)	MCPT (%)	C1260 (%) 14D	C1260 (%) 28D	C1293 (%) 365D*	T380 MCPT (%) 56D*	TP 144 Reactivity (ACPTP)	C1778 Reactivity (14D C1260)	C1778 Reactivity (28D C1260)	C1778 Reactivity (365D CPT)	Alkali Threshold kg/m3
F1	0.64	0.59	0.640	0.72	0.85	0.59	0.640	MR/HR	R3	R3	R3	1.5
F7	0.29	0.21	0.382	0.33	0.41	0.21	0.382	MR/HR	R2	R2	R2	2.7
F17	0.49	NA	0.550	0.49	0.92	-	0.550	MR/HR	R3	R3	-	~2.5-3
F18	0.60	NA	0.340	0.60	0.65	0.52 (252 D)	0.340	MR	R3	R3	R3	Ongoing

Coarse Aggregate Reactivity Summary

	AMBT (%)	CPT (%)	MCPT (%)	C1260 (%) 14D	C1260 (%) 28D	C1293 (%) 365D*	T380 MCPT (%) 56D*	TP 144 Reactivity (ACPTP)	TP 144 Reactivity (NCHRP 1083) 2022	C1778 Reactivity (14D C1260)	C1778 Reactivit y (28D C1260)	C1778 Reactivity (365D CPT)	Alkali Threshold kg/m3
C7	0.37	0.20	0.121	0.37	0.67	0.20	0.121	HR	HR	R2	R3	R2	1.5
C8	0.31	0.14	0.200	0.31	0.47	0.14	0.200	HR	MR	R2	R3	R2	1.8
C10	0.82	0.16	0.169	0.82	1.09	0.16	0.169	HR	HR	R3	R3	R2	1.5
C14	0.23	0.09	0.053	0.21	0.28	0.09	0.053	HR	MR/HR	R1	R1	R1	*
C16	0.06	0.05	NA	0.06	0.14	0.05	NA	NR/SR*	NR/SR	R0	R1	R1	2.2
C21	0.57	0.21	0.300	0.57	0.77	0.21	0.300	HR	HR	R3	R3	R2	1.5
C22	0.27	0.12	0.075	0.28	0.38	0.12	0.075	MR/HR	MR	R1	R2	R2	1.7
C23	0.15	NA	NA	0.15	0.24	0.04*	0.072*	MR	NR/SR	R1	R1	R1	2.3

Coarse aggregate alkali threshold results summary



What about the Supplementary Cementitious Materials?

Proposed Approach

- <u>**Prescriptive modeling approach is "1" day**</u>
  - *Data is provided by supplier*
  - *Aggregate supplier*
  - *Ready-mix producer*

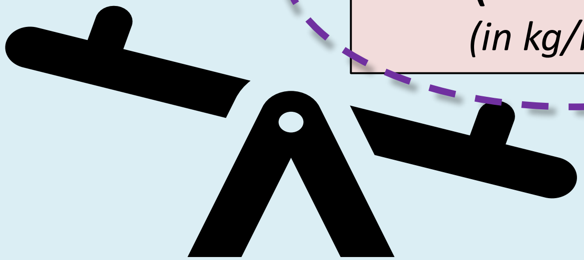
Unique: will form a <u>**generalized**</u> and <u>**rapid**</u> approach for extension to a wide range of SCMs, verified on a subset of SCMs in this research

Option 2: Mechanistic Approach for Minimizing Risk of Alkali-silica Reaction

Inputs
provided by the supplier

Alkali Threshold of Aggregate (MDAT)
(in kg/m³)

Available Alkali in Cementitious Blend (MDARC)
(in kg/m³)



Replacement Level of SCM for Airfield Pavements
SCM – binary or ternary blend

Cements

%	CM1	CM2	CM4	CML1	CML2	CML3
Na_2O	0.14	0.32	0.31	0.17	0.08	0.24
MgO	2.42	3.21	2.61	0.61	2.19	2.46
Al_2O_3	4.62	6.33	4.37	4.42	3.83	3.86
SiO_2	18.22	19.63	18.24	17.53	17.59	18.04
P_2O_5	0.05	0.25	0.24	0.03	0.04	0.21
SO_3	2.5	4.26	3.68	2.83	2.42	3.55
Cl	0.02	0	0	0.01	0	0.01
K_2O	0.55	1.23	0.71	0.28	0.5	0.86
CaO	62.59	59.25	63.25	64.01	63.82	62.77
TiO_2	0.27	0.2	0.31	0.26	0.22	0.22
Mn_2O_3	0.16	0.08	0.06	0.03	0.06	0.05
Fe_2O_3	3.75	2.04	3.09	3.01	3.46	2.71
ZnO	0.04	0.04	0.02	0.05	0.01	0.02
LoI	4.68	3.16	3.1	6.77	5.78	5
Na_2Oe	0.5	1.13	0.78	0.35	0.41	0.8

XRF of Traditional SCMs

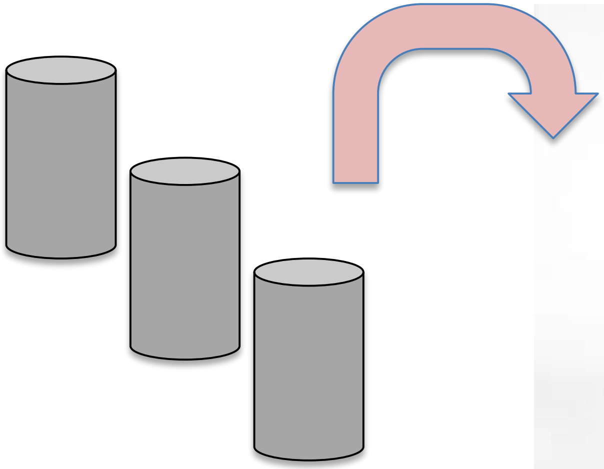
%	FA1	FA2	FA3	FA4	SC1	SC2	MK	SFU1	SFD1
Na_2O	0.59	3.6	1.43	1.14	0.27	0.26	0.26	0.17	0.17
MgO	0.71	5.26	5.12	2.03	10.79	4.95	0.11	0.31	0.33
Al_2O_3	21.23	17.12	19.03	20.38	10.1	13.64	44.69	0.67	0.65
SiO_2	41.61	48.26	38.38	55.56	34.62	32.28	51.25	94.32	93.92
P_2O_5	0.07	0.23	0.86	0.2	0	0	0.09	0.05	0.07
SO_3	1.14	0.78	1.02	0.11	2.13	3.35	0.06	0.06	0.07
Cl	0.01	0	0	0.01	0.01	0	0.01	0.01	0.01
K_2O	1.5	1.74	0.65	2.37	0.31	0.21	0.16	0.47	0.58
CaO	6.03	14.3	25.45	2.78	38.34	43.28	0.17	0.61	0.92
TiO_2	1.01	1.05	1.47	0.93	0.36	0.73	1.7	0.01	0.02
Mn_2O_3	0.03	0.09	0.03	0.06	0.23	0.24	0	0.09	0.05
Fe_2O_3	20.91	6.3	5.79	6.46	1.43	1.07	0.55	0.84	0.17
ZnO	0.01	0.02	0.02	0.01	0	0	0.01	0.05	0.15
LoI	5.12	1.23	0.76	-	1.42	3.43	0.92	2.33	2.88
Na_2Oe	1.58	4.74	1.86	2.7	0.47	0.4	0.37	0.48	0.55

XRF of Select Alternative SCMs

%	NP1	NP2	NP3	NP5	NP6	RA1	BLA1	ASCM1
Na_2O	3.63	2.92	2.69	3.82	2.4	0.32	1.51	0.19
MgO	0.18	0.96	0.12	0.09	2.4	0.84	3.18	1.54
Al_2O_3	13.22	13.16	11.77	13.48	15.98	26.28	21.02	3.53
SiO_2	69.72	69.6	72.21	72.68	55.98	48.55	46.27	31.71
P_2O_5	0.01	0.01	0.02	0.01	0.15	0.31	0.73	0.06
SO_3	0.1	0.08	0.07	0.07	0.09	0.16	0.91	0.78
Cl	0.01	0.01	0.01	0.02	0.01	0.01	0	0
K_2O	4.68	4.29	6.02	4.83	1.38	2.3	1.21	0.51
CaO	1.2	1.78	0.76	0.98	5.65	2.67	15.71	37.9
TiO_2	0.09	0.15	0.2	0.06	0.79	1.4	1.32	0.2
Mn_2O_3	0.27	0.08	0.05	0.08	0.12	0.05	0.05	0.04
Fe_2O_3	0.88	1.61	2.02	1.32	6.7	13.89	7.28	1.78
ZnO	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01
LoI	6.01	5.35	4.04	2.56	8.34	3.19	0.78	21.75
Na_2Oe	6.71	5.74	6.65	7	3.31	1.84	2.31	0.53

Method of Determining Alkalies Releasable by Cementitious (MDARC)

Similar to ASTM C311



PC+SCM paste samples are made with w/b=0.5

Sealed cured

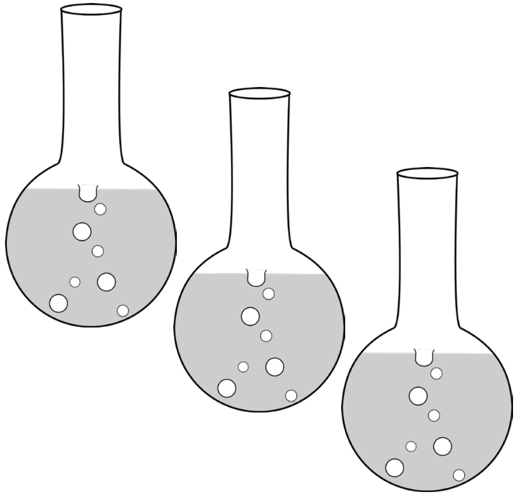
38 C
28 days

Pastes are finally ground

Leaching solution has an alkalinity of 0.2 mol/L

2 grams FGP mixed with 20 g solution

Agitated for 3 days



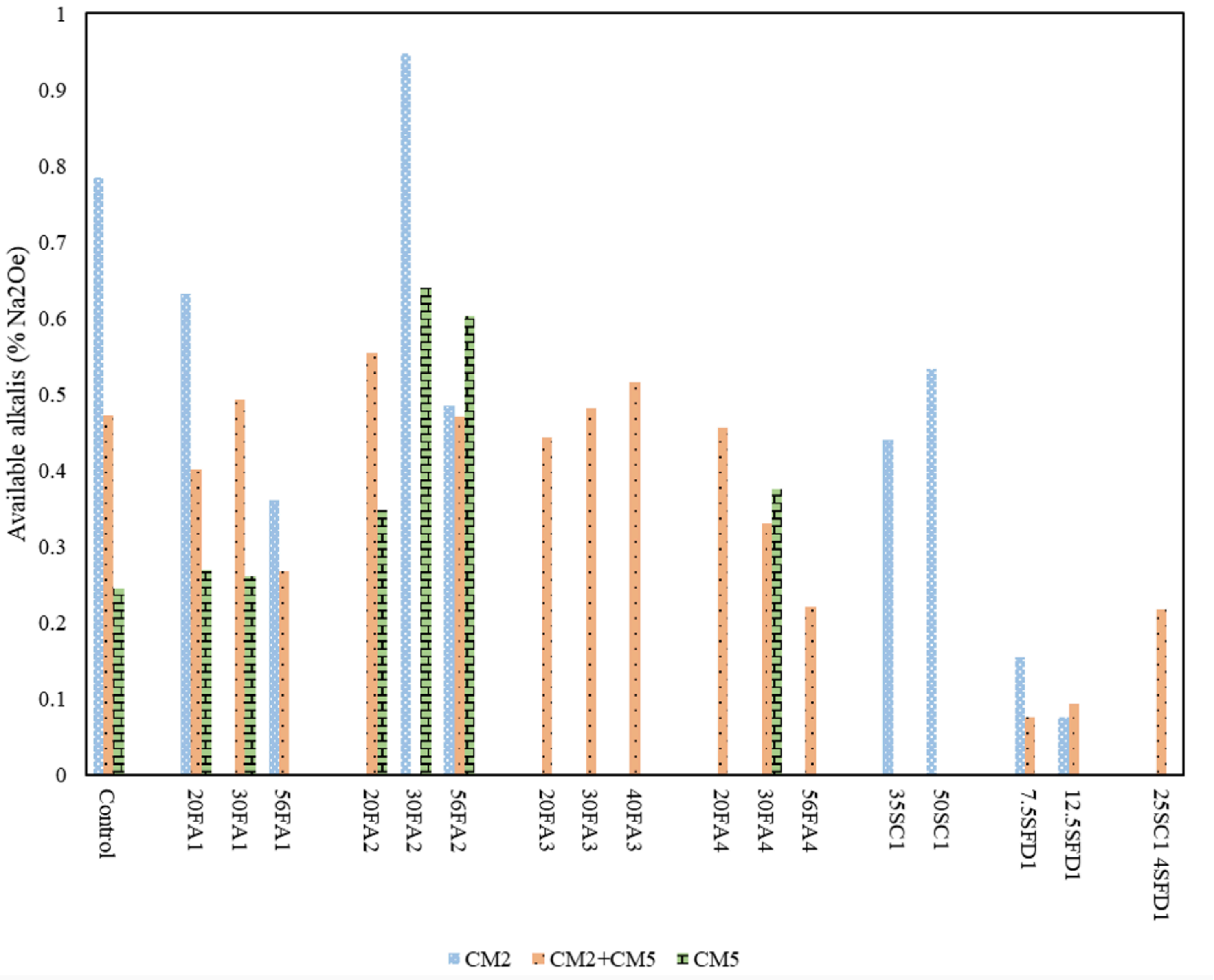
Analyzed using ICP-OES

Could be flame photometer (Na, K)

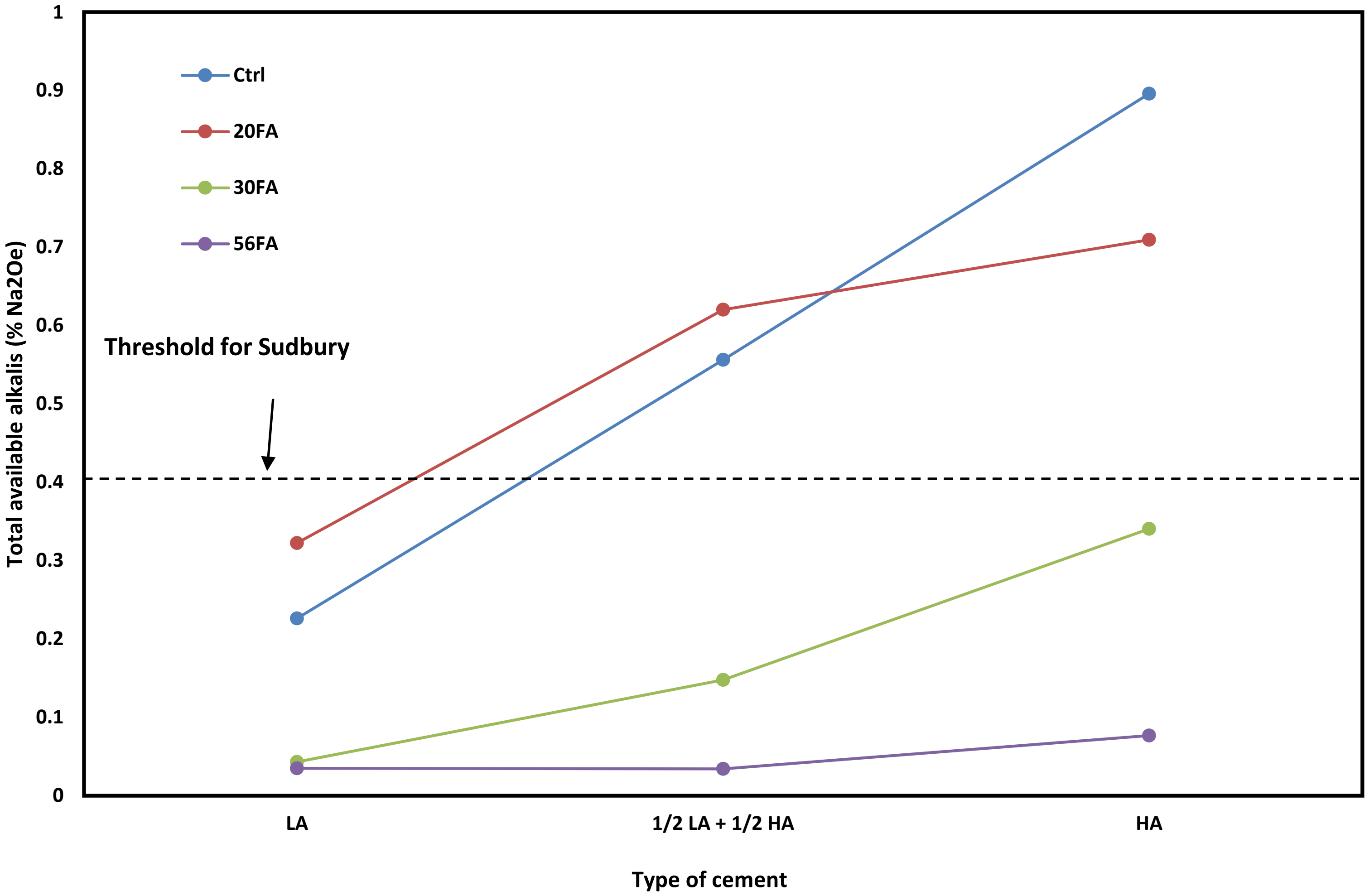
Images from VWR and Agilent Technologies

Results for a range of Traditional SCMs

MDARC



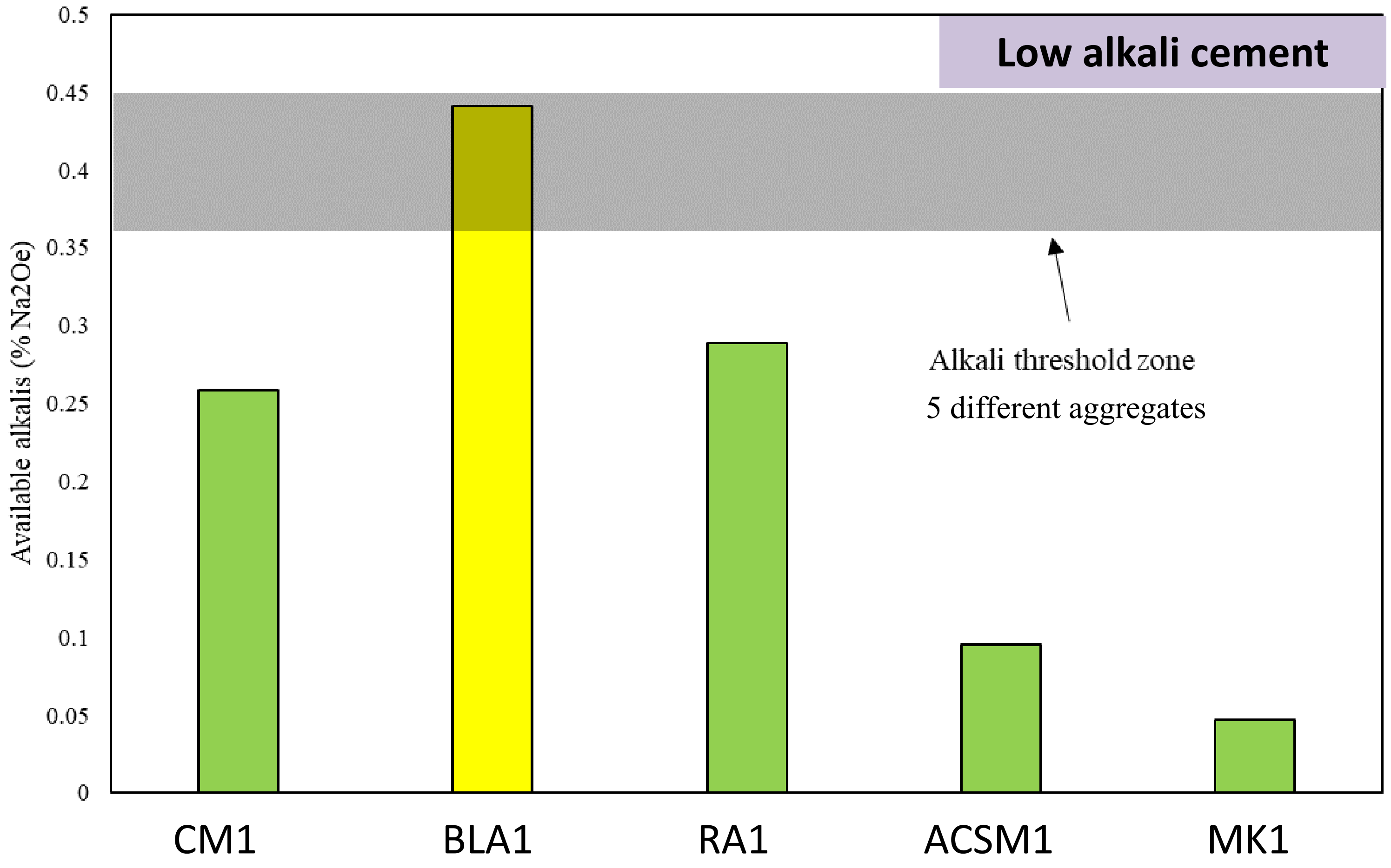
MDARC



Ghanizadeh and Thomas, ICCC, 2023

Results for Select ASCMs

Alkali Leaching Test



Proposed Approach

How does this all come together?

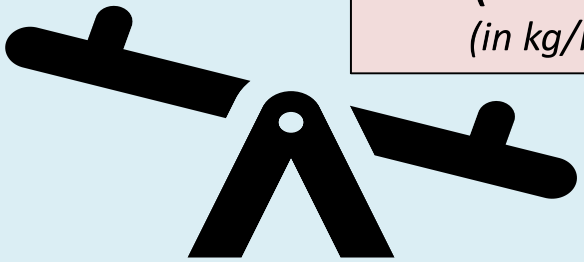
Unique: will form a **generalized** and **rapid** approach for extension to a wide range of SCMs, verified on a subset of SCMs in this research

Option 2: Mechanistic Approach for Minimizing Risk of Alkali-silica Reaction

Inputs
provided by the supplier

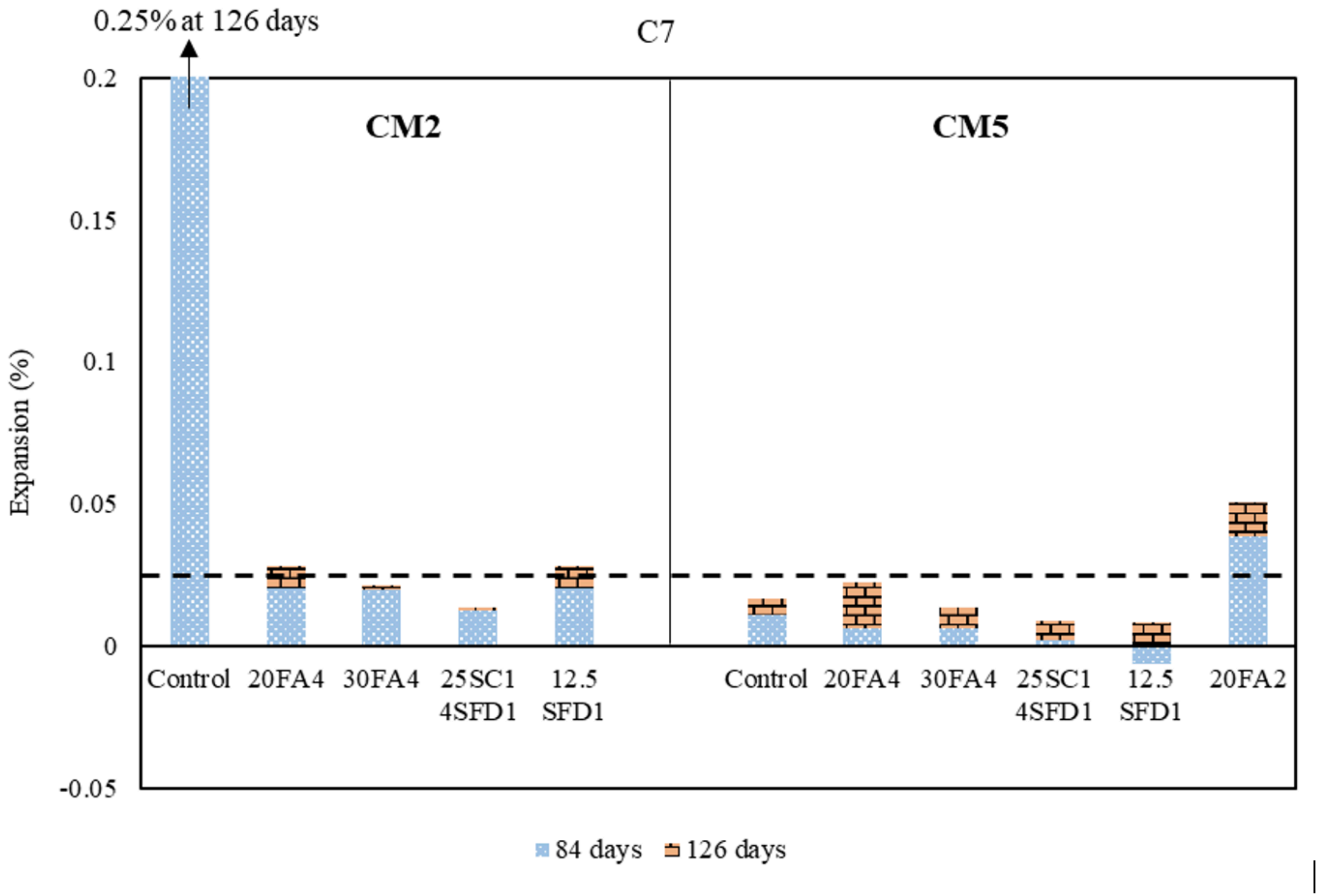
Alkali Threshold of Aggregate (MDAT)
(in kg/m^3)

Available Alkali in Cementitious Blend (MDARC)
(in kg/m^3)

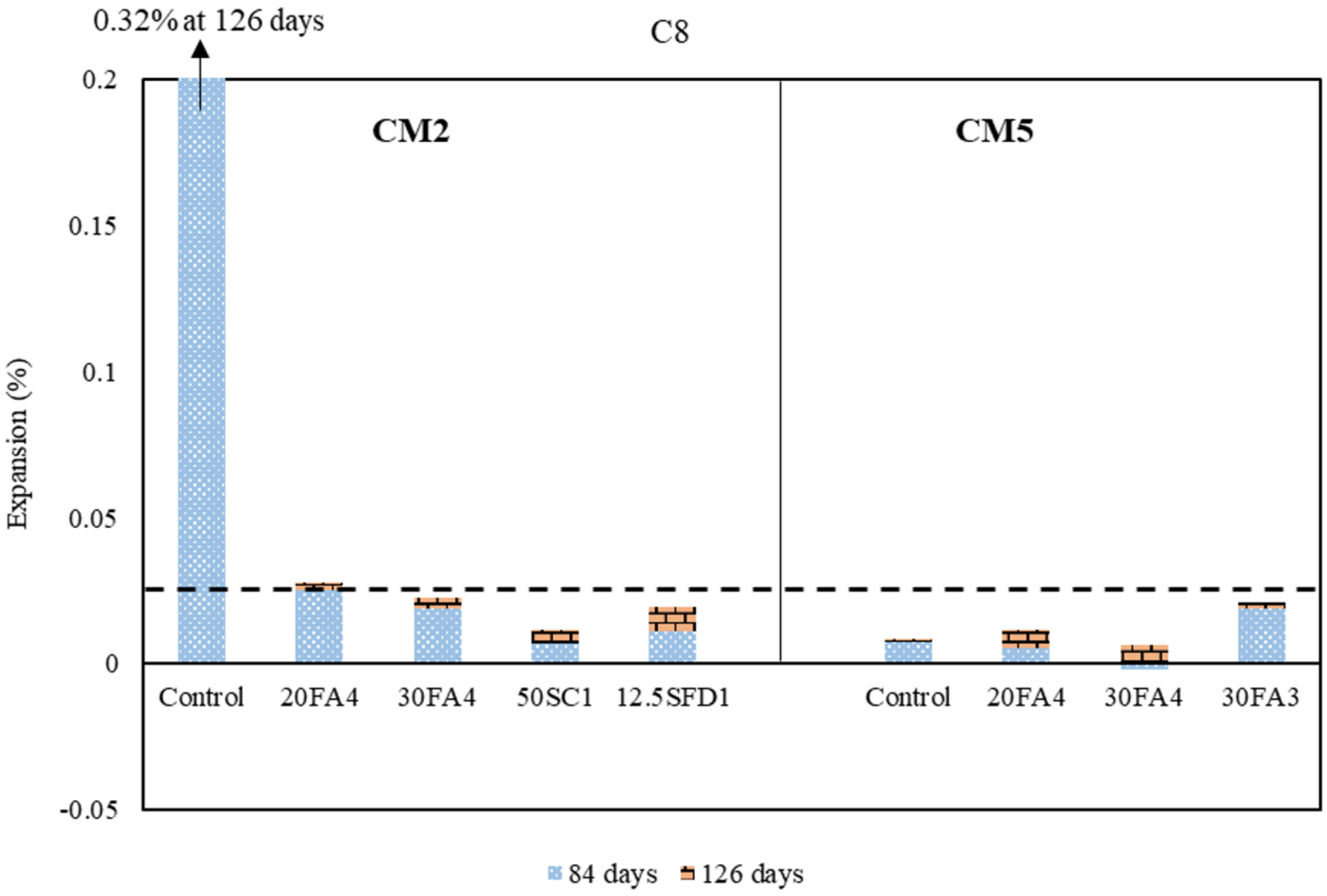


Replacement Level of SCM for Airfield Pavements
SCM – binary or ternary blend

Verification Results with C7 (Spratt)



Verification Results with C8 (Sudbury)



Proposed Approach

- Current approach is 28 days
- MCPT is 56 (84) days
- **Prescriptive modeling approach is “1” day**
  - *Data is provided by supplier*

Option 1: Performance Testing Approach for Minimizing Risk of Alkali-silica Reaction

Aggregate Reactivity Check
Does ASTM C1260 benchmark against AASHTO T380?

Yes

Preventive Measure Quantification
Use preventive measure quantity to meet:

ASTM C 1567 expansion at 28 days < 0.10%
-or-
AASHTO T380 at 84 days < 0.020%

No/Unknown

Preventive Measure Quantification
Use preventive measure quantity to meet:

AASHTO T380 expansion at 84 days < 0.020%

Unique: will form a **generalized** and **rapid** approach for extension to a wide range of SCMs, verified on a subset of SCMs in this research

Option 2: Mechanistic Approach for Minimizing Risk of Alkali-silica Reaction

Inputs
provided by the supplier

Alkali Threshold of Aggregate (MDAT)
(in kg/m³)

Available Alkali in Cementitious Blend (MDARC)
(in kg/m³)

Replacement Level of SCM for Airfield Pavements
SCM – binary or ternary blend

Unique: allows performance testing, **similar to current approach**, provides verification that aggregate reactivity/prevention is characterized properly

Findings to Date

- Developed an approach for evaluating alkali sensitivity of aggregates - MDAT
- Developed a test method for assessing alkali availability in a cementitious blend - MDARC
- Propose additional verification work for the approach and evaluate all project materials
- The new approach represents a rapid approach that could be required as part of prequalification of material.

What might this look like in 10J?

Will could stay:

- Option: ASTM C1567 – 28-day 0.10% expansion limit
  - Positive: Generally, works well with alternative SCMs
  - Exception: SCMs that contribute appreciable alkalies
  - Concern: chemical admixtures

What will be added:

- Option: Alkali sensitivity of aggregates and alkali contribution from the cementitious blend (MDAT/MDARC)
- Prequalification of aggregates required from the suppliers
- Prequalification of cementitious blend (PLC+SCM)
  - Would allow mixture design Decision on Day 1
- Chemical admixtures - TBD

ACPTP 2021-1 Phase II

Phase II Timeline and Funding Proposal

- **Title: Phase II Mitigating Potential Alkali-Silica Reaction Expansion in Airfield Pavements**
- Performance Period: 36 months (September 16, 2024-September 15, 2027)
- Performing Organizations: Oregon State University (Prime), PI Jason H. Ideker; The University of Texas at Austin, Co-PIs Kevin J. Folliard, Thano Drimalas; The University of New Brunswick, Co-PI Ashlee Hossack; *Pennsylvania State University, Co-PI Farshad Rajabipour*; RJ Lee Group, Consultant April Snyder

Overview

1. Add two new outdoor exposure sites
   - Pennsylvania State University
     - Site location committed
   - Minnesota DOT
     - Site location to be confirmed
2. Add new exposure blocks to existing university sites
3. Expand the laboratory testing program

Additional Laboratory Work

- Petrographic assessment of new aggregate sources investigated.
- Alkali release and availability assessment from aggregates and recycled concrete aggregate (RCA) and inclusion in the prescriptive modeling approach currently under developing in Phase I
- Alkali release and availability from limestone portion of portland limestone
- Alkali release and availability from new SCMs
- Alkali sensitivity assessment of new aggregates and RCA
- Verification of prescriptive modeling approach developed in Phase I using AASHTO T380, ASTM C1567 and T-Fast for new aggregates and RCA included in the project.

Blocks

- Pennsylvania State Univ. (Newly Constructed site as part of this project) – 192*
- Univ. Of Texas (ship to Minnesota DOT, new site) - 12
- Oregon State Univ. (Corvallis, Oregon) – 20*
- Oregon State Univ. (Newport, Oregon) – 6
- Oregon State Univ. (ship to University of Hawaii, Manoa, Hawaii) - 6
- Univ. of Texas (Austin, Texas) – 20*
- Univ. of Texas (Port Aransas, Texas) - 6
- Univ. of New Brunswick (Treat Island, Eastport, Maine) - 12
- Univ. of New Brunswick (Fredericton, New Brunswick) – 20*
- Univ. of New Brunswick (Lawrence, Massachusetts) – 6

A New Approach to Preventing ASR: Alkali Sensitivity Evaluation

Thank you!

Questions?

Jason H. Ideker, FACI

Professor in Civil and Construction Engineering

Presentation to NC²

8 April 2025

POSTED ON JUNE 16, 2021 IN / GOVERNMENT AFFAIRS, NEWSLETTER

FAA ACPTP Issues RFP for ASR Research

Research Sponsors

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FAA ACPTP Issues RFP for ASR Research

ACPTP
Airport Concrete Pavement Technology Program

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NATIONAL ACADEMIES *Sciences Engineering Medicine*

NCHRP

Thank you!

Questions?

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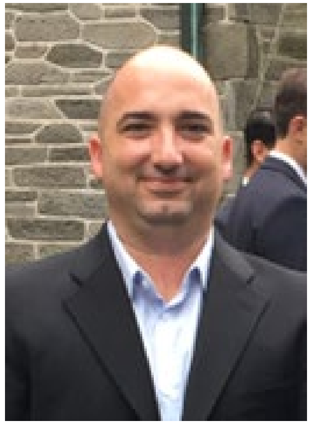

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