



# **Evaluation of ASR Potential for Aggregate Sources in Arkansas**

**Materials Division Chemistry Lab**



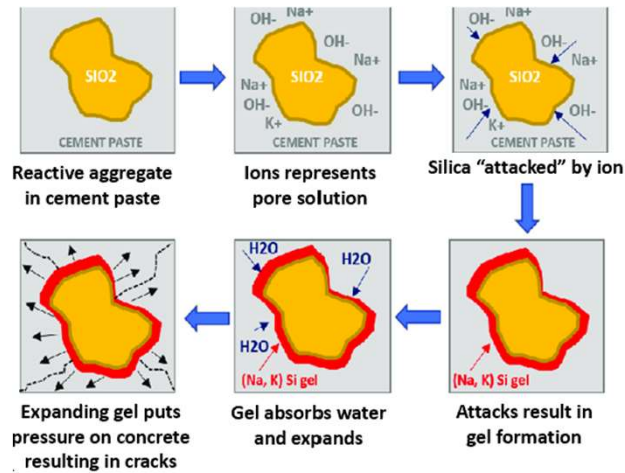
Hi everyone, my name is Jacie Jordan.

I am a chemist at ARDOT within the Materials Division.

I began working as an intern in May of 2024 and my first week working I spent at the TRC conference last year. It is very full circle that now a year and a half later I am one of the ones presenting and I am beyond excited to share the research that my fellow chemists and I have been working on since then.

The research project has been over the evaluation of ASR potential for aggregate sources in Arkansas.

# What is ASR?



ASR -> Alkali-Silica Reaction

Basically, this reaction is between the alkalis which are these ions within the cement paste that react with high silica aggregates. When this reaction occurs, a white/clear gel begins to form around the aggregate and gets larger overtime with the exposure of water. Eventually, the expansion will cause cracks within the concrete destroying the structural integrity.

# Northwest AR Airport

Arkansas Democrat  Gazette

## Concrete cracking is linked to alkali

Projects in state not holding up



## \$76.4 Million Repair



Most serious cases we are knowledgeable of occurred between 1990-2000 time period, and as a result of changes at one of our leading cement plants resulting in extremely high alkali cements.

Here is a great example, the Northwest Arkansas Airport

Placed in 1997-1998 -> 2002 signs of failure already being seen

2014 -> determined it had to be replaced

2015 -> 76.4 million repair

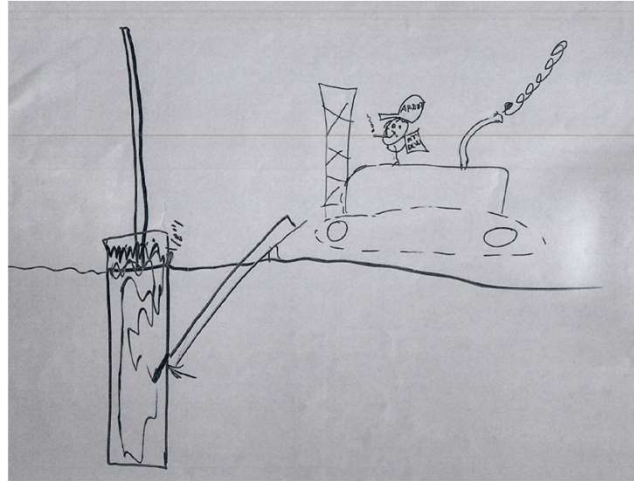
ARDOT was made more aware as years progressed of cement looking like this picture in the bottom left that was laid during this time period.

## Field Examples In Arkansas



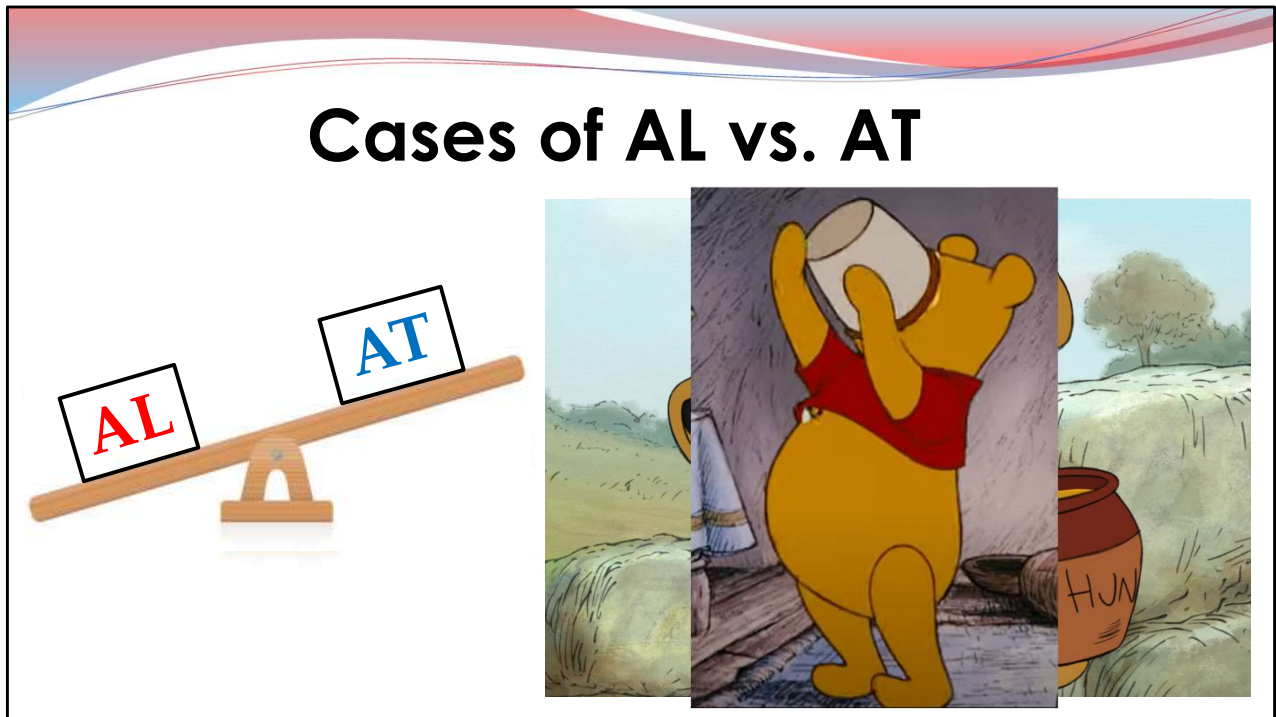
This summer, the Materials division was made aware of this high massed light foundation -> In Little Rock, AR near our building. (University Avenue). Whenever I went out to the field to look at the foundation myself, I could break it off with my pen I had with me.

## Field Examples In Arkansas



This was Paul's expert plan he personally drew for the drill team to show how they were going to find out how deep the damage went. Results of this showed sound concrete at 12 feet of depth not exposed to water which does indicate ASR occurred.

## Cases of AL vs. AT



Most aggregates have a potential to form ASR, the question is how high is that potential?

Alkali loading -> Alkali content in the cement itself & the amount of cement planning on being used (KNOWN for mix design)

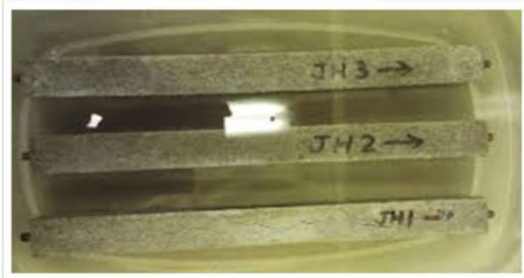
Alkali Threshold -> Unknown threshold that we have been attempting to determine for years. It's a measure of how much alkalinity exposure it can withstand before ASR occurs.

Talk about Pooh bear

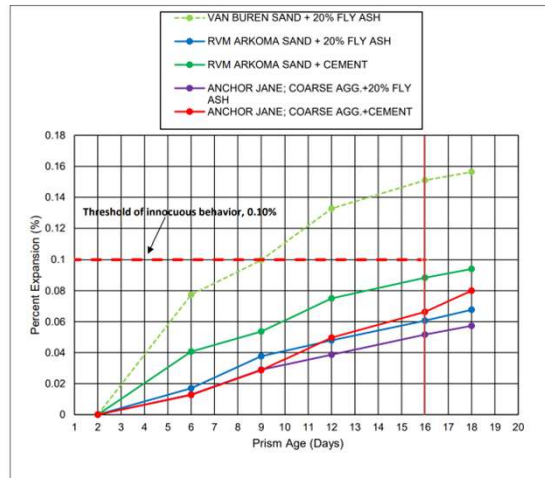
The first image is representative of the alkali loading being the honey pot & the threshold is Pooh bears stomach. Next image everything is good. Then bam! Past your threshold no more room in his stomach.

# Previous/Current ASR Testing

- ASTM C1260 (Mortar Bars) & AASHTO T380 (Concrete Prism Test)
- Assumes 11 lbs Na<sub>2</sub>Oeq/yd<sup>3</sup> of alkali loading (C1260)
- FHWA claims ASTM C1260 misclassifies more than 30% of reactive aggregates as nonreactive



Purdue University: Mortar Bars

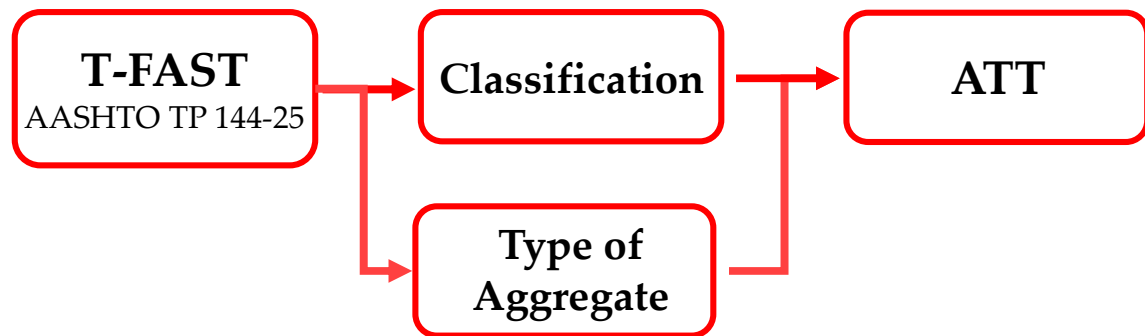


Geotechnical & Testing Services; May-June 2024

Currently, our test to evaluate mix designs is C1260, mortar bars. These bars consist of the cement and aggregates planning on being used. 3 bars are made and placed in approximately 6 L of heavily concentrated sodium hydroxide solution over 16 days. Some cons with this test is that it requires continuous measurements to be taken throughout those 16 days, requires a lot of sodium hydroxide to be used, and can classify up to 30% of bars as nonreactive when they are actually reactive.

The other test that is commonly recommended by other states is the T380 test also known as the concrete prism test. This test is much more accurate; however, the test can take up to 1-3 years before seeing usable results.

# New Testing Methods



With ASR being a major focus of research in the past 20 years, the FHWA association has been attempting to come up with better testing methods. They produced T-FAST (Turner-Fairbank Aggregate Susceptibility Test) This test classifies aggregate individually as a reactivity class ranging from nonreactive up to highly reactive along with identifying the type of aggregate. ATT (Alkali-Threshold Test) is the following test that can identify what the threshold of an individual aggregate/combinations of aggregate are capable of alkali content wise up until ASR is guaranteed to form.

## Counting Label & Store Aggregates

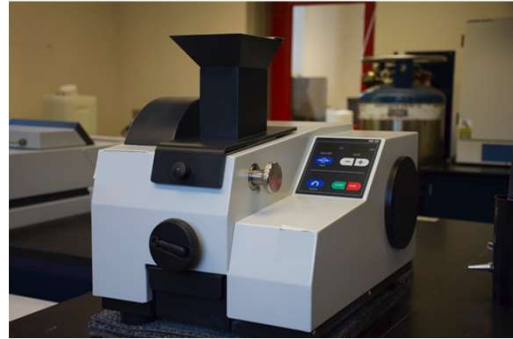


Beginning stage of T-FAST:

- Acquired 50 lbs of coarse & fine aggregates from variety of concrete mix plants.
- Quarted/split down aggregate to 600 g of representative sample size
- Used crusher to get No. 50 & No. 100 size of coarse aggregate
- Washed off dust/fines and dried in oven for 24 hours
- Labeled and store for further usage

# Preparation Stage

- 600 grams of a representative sample of coarse or fine aggregate obtained in accordance with R90 and reduced in accordance with R76.
- Jaw crusher was used to reduce the size of coarse aggregate through a No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100 sieves.
- Retained a minimum 90 grams of No. 50 and 60 grams of No. 100 of the coarse sample.
- Each fraction was washed with deionized water and allowed to dry according to T 255 at  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).
- The aggregate was then stored in an air-tight bag until used.

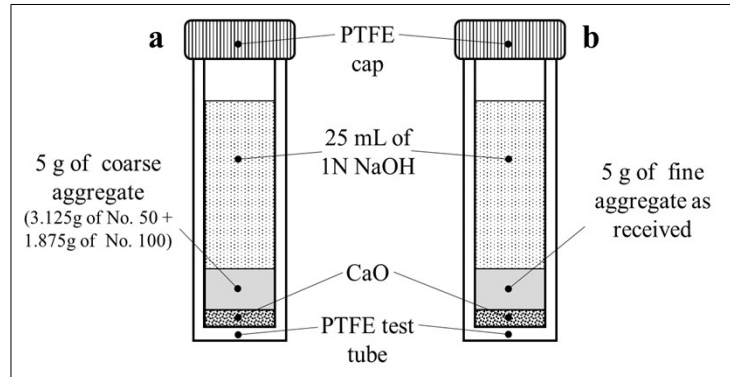


**Retsch Jaw Crusher BB 50**

This is a general summary of how T-FAST preparation is done & the image on the right is the desktop jawcrusher used to get it down to size.

# Test Tube Preparation

- Baked calcium oxide and 1 N NaOH reagents
- Dependent on coarse or fine aggregate being analyzed for makeup of tubes
- No disruption of layers
- Place in oven for 21 days



Schematic of test tubes using  
(a) coarse and (b) fine aggregates

Make sure to have reagents ready

CaO gets up to 950 C for an hour & 1 N NaOH maximum you need is 500 mL for one sample.

Tube preparation differs between coarse and fine aggregates

## Step 1: Backfill Core



Fine on the left coarse on the right

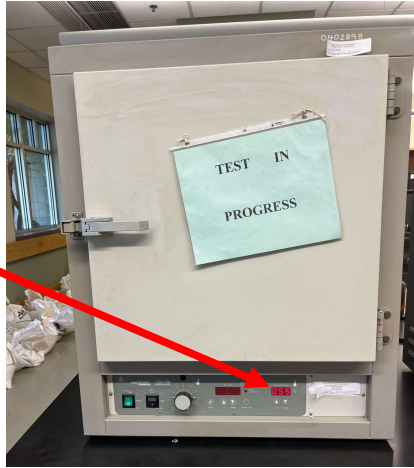
# Test Conditions to Evaluate Reactivity

- Each aggregate sample gets 12 test tubes total.
- Varying CaO & temperatures to simulate natural environment.

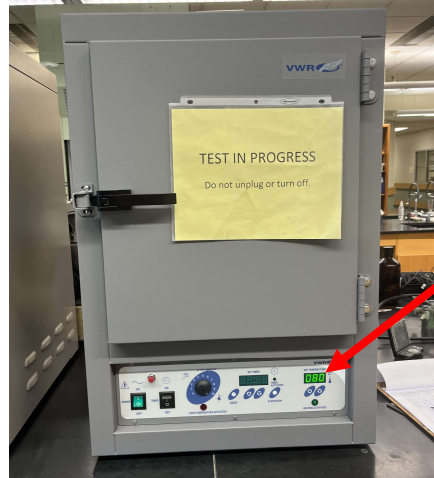
Condition	Calcium Oxide (g)	Temperature (°C)
1	0.13	55
2	0.25	55
3	0.34	55
4	0.25	80

Each aggregate sample gets 12 test tubes, three tubes per condition. The variation of calcium oxide is due to some places receiving more precipitation than others which does affect the calcium oxide. The temperature variation can also affect the formation of ASR and as we all know, Arkansas temperature varies quite a bit.

# Ovens used for T-FAST



Conditions 1-3  
@ 55°C



Condition 4  
@ 80°C

# Ovens used for T-FAST



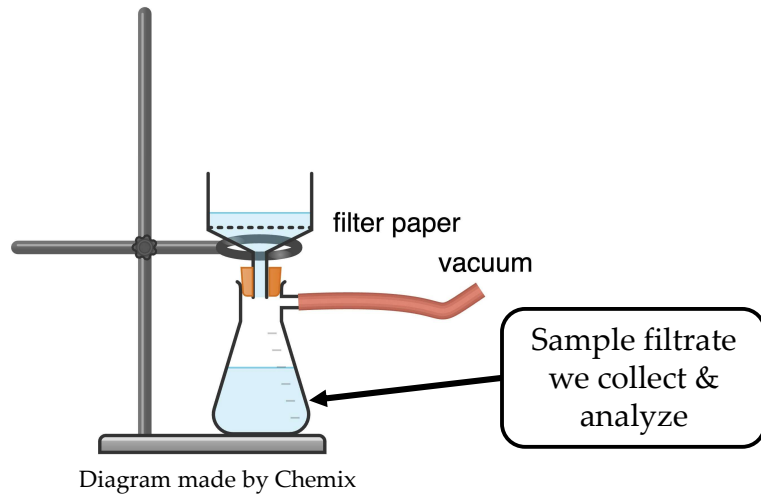
Conditions 1-3  
@ 55°C



Condition 4  
@ 80°C

# Filtration Process

Wait 21 Days



Glass microfiber filter paper

Collect the filtrate and put it into plastic tubes until we are ready to analyze the solutions.

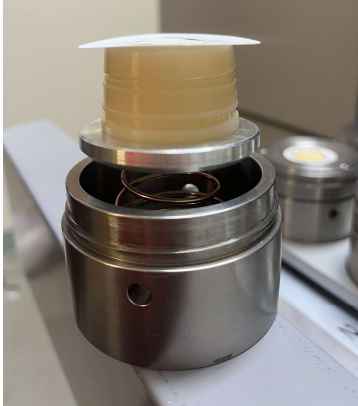
# Membrane Analysis

- Within 12 hours of filtering, analysis must be performed.
- Using a micropipette, 100  $\mu\text{L}$  of sample is placed in the center of the membrane.
- Placed in oven at 40 °C for  $15 \pm 5$  minutes until membrane is dry.
- Move membranes into cannisters for x-ray analysis.



Point out ring on top due to oven blowing & cool to room temp after

# WD-XRF Analysis



Takes an average of  
1 ½ - 2 ½ hours to  
complete with  
checks included!

The x-ray that we use is a wave-dispersive x-ray fluorescence instrument. When analyzing the solution, we tell the instrument to ignore the composition of the membrane, sample holder, metal ring and cannister. This on average takes an hour and a half to 2 and a half hours.

# T-FAST Classification

$$RI = \frac{[Si]}{[Al] + [Ca]}$$

where:

RI = Reactivity Index

Si = Concentration of silicon (mM)

Al = Concentration of aluminum (mM)

Ca = Concentration of calcium (mM)

	RI ≤ 0.45 for three conditions	RI ≤ 2	Non-reactive
	0.45 < RI ≤ 2 for one condition	2 < RI ≤ 100	Slow reactive
Coarse	0.45 < RI ≤ 2 for at least two conditions	2 < RI ≤ 100	Moderately reactive
	RI > 2 for at least one condition	100 < RI ≤ 1000	Highly reactive
	RI > 2 for at least one condition	RI > 1000	Very highly reactive
	RI ≤ 1 for three conditions	RI ≤ 10	Non-reactive
	1 < RI ≤ 10 for one condition	10 < RI ≤ 150	Slow reactive
Fine	1 < RI ≤ 10 for at least two conditions	10 < RI ≤ 150	Moderately reactive
	RI > 10 for at least one condition	150 < RI ≤ 1000	Highly reactive
	RI > 10 for at least one condition	RI > 1000	Very highly reactive

After the x-ray gives us the results, we can then calculate the Reactivity Index -> Arbitrary number that gives an indication of reactivity classification for coarse or fine depending on what we are analyzing.

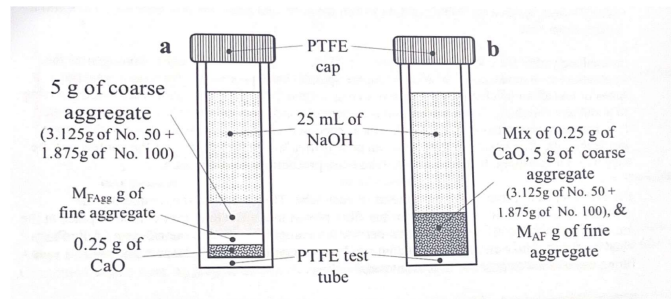
# Type A or B aggregate?

- Mainly important for coarse aggregates
  - Carbonate minerals (dolomites, limestones, etc.) are typically type B -> Low Aluminium
  - ATT preparation differs between Type A and B

Al in Cond. 2 is > 0.2 mM → Type A

Al in Cond. 2 is ≤ 0.2 mM → Type B

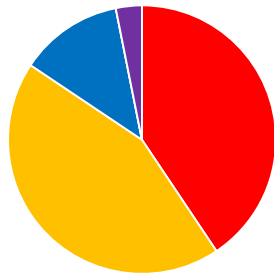
$$RI = \frac{[Si]}{[Ca] + [Al]}$$



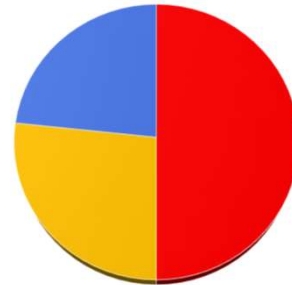
More information that we get out of the T-FAST results is the information of if it is a type A or B aggregate. Carbonate minerals with low aluminium are labeled as Type B which is important for the ATT process which we will get into in a bit.

# Results of Fine Aggregates:

## ARDOT



## Turner-Fairbank



■ HR ■ MR/HR ■ MR ■ SR ■ NR/SR ■ NR

■ HR ■ MR/HR ■ MR

93% Correlation

### ARDOT:

HR 13 MR/HR 14 MR 4 SR 0 NR/SR 1 NR 0

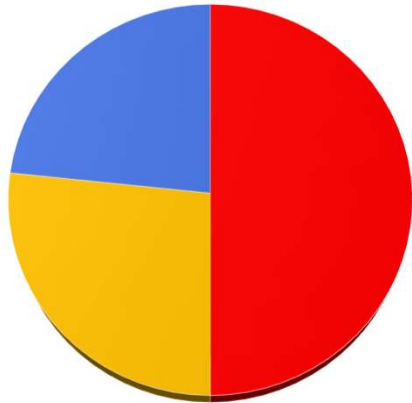
TOTAL SAMPLES TESTED: 32

### TF:

HR 15 MR/HR 8 MR 7

TOTAL SAMPLES TESTED: 30

# Results of Fine Aggregates: Turner-Fairbank Data



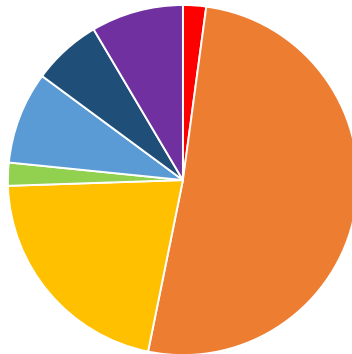
■ HR ■ MR/HR ■ MR

HR	15
MR/HR	8
MR	7
SR	0
NR/SR	0
NR	0
<b>TOTAL SAMPLES TESTED:</b>	<b>30</b>

**\*93% Correlation with ArDOT**

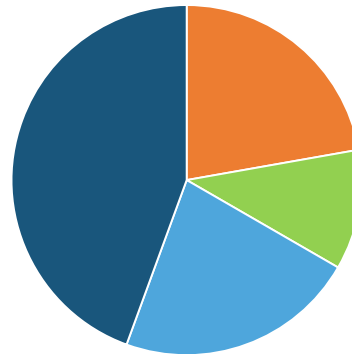
# Results of Coarse Aggregates:

## ARDOT



■ VHR ■ HR ■ MR/HR ■ MR ■ SR ■ NR/SR ■ NR

## Turner-Fairbank



■ HR ■ MR ■ SR ■ NR

**ARDOT did 47 samples, Turner-Fairbank completed 9 samples so far.**

**ARDOT:**

**VHR 1 HR 24 MR/HR 10 MR 1 SR 4 NR/SR 3 NR 4 WINTER 2**

**TOTAL NOT INCLUDING WINTER**

**47**

**TF:**

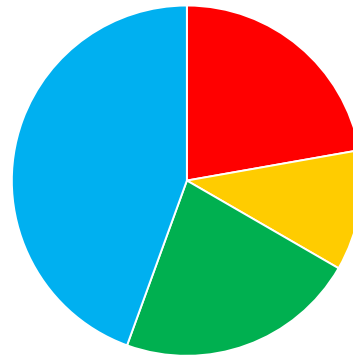
**HR 2 MR 1 SR 2 NR 4**

**TOTAL CURRENTLY**

**9**

# Results of Coarse Aggregates: Turner-Fairbank Data

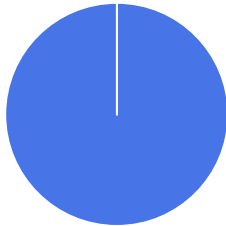
HR	2
MR	1
SR	2
NR	4
<b>TOTAL CURRENTLY</b>	<b>9</b>



■ HR ■ MR ■ SR ■ NR

# T-FAST: Completion Progress

Total Overall



■ Completed ■ Remaining

**Overall: 100.0% completed (77/77)**

**Fine: 100.0% completed**

**Coarse: 100.0% completed**

Fine Aggregate



■ Remaining ■ Completed

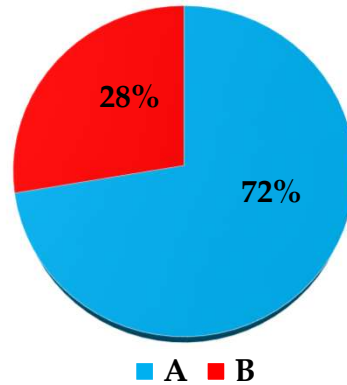
Coarse Aggregate



■ Remaining ■ Completed

As of now, we have completed T-FAST classification on all 77 aggregates across the state.

## Results of Coarse Aggregates: ARDOT Data

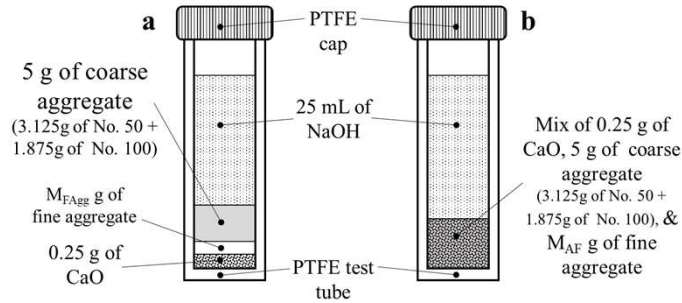


Out of the 47  
aggregates analyzed:

Type A: 34  
Type B: 13

The results showed we had 34 type A and 13 type B coarse aggregates. Fine aggregates are always assumed to be type A. We did have the most carbonate minerals out of all the states Turner-Fairbank have collaborated with which is pretty interesting.

# Alkali-Threshold Test



Schematic of ATT tubes: Type A or B

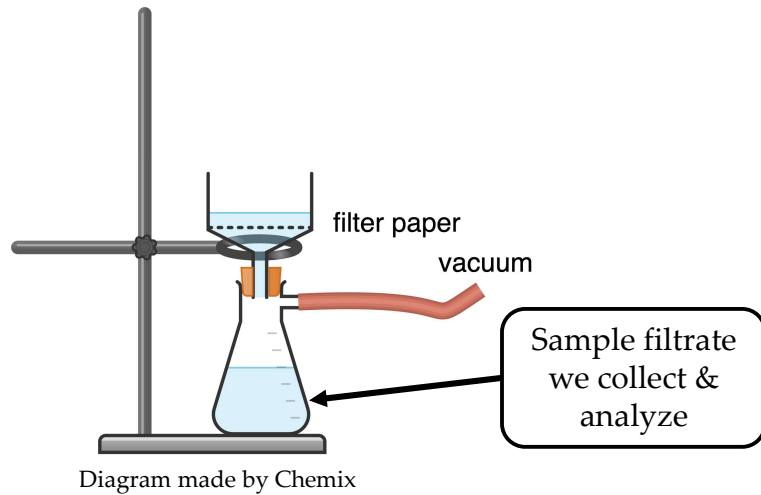


Slow / Moderately Reactive	Highly / Very High Reactive
6.51 kg/m <sup>3</sup>	3.57 kg/m <sup>3</sup>
5.25 kg/m <sup>3</sup>	2.73 kg/m <sup>3</sup>
4.41 kg/m <sup>3</sup>	1.89 kg/m <sup>3</sup>
3.57 kg/m <sup>3</sup>	1.47 kg/m <sup>3</sup>
2.73 kg/m <sup>3</sup>	1.05 kg/m <sup>3</sup>
1.89 kg/m <sup>3</sup>	0.84 kg/m <sup>3</sup>

Type A or B -> A means we keep the layers, and B is we mix the layers  
 If performing combination of aggregates, follow this schematic of test tube prep.  
 Main difference is now that our NaOH solution concentrations varies depending on our T-FAST classification. This is representative of our Alkali loading changing.

# Filtration Process

Wait 21 Days



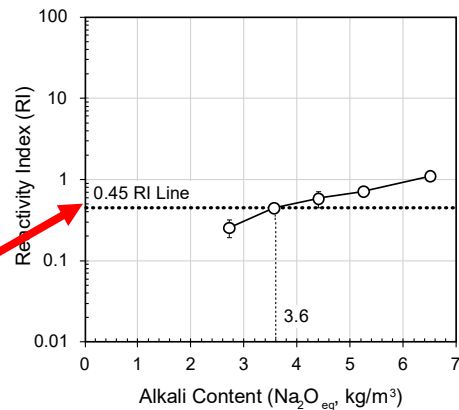
Glass microfiber filter paper

Collect the filtrate and put it into plastic tubes until we are ready to analyze the solutions.

# Alkali-Threshold Test

**TYPE A:**

$$RI = \frac{[Si]}{[Al] + [Ca]}$$



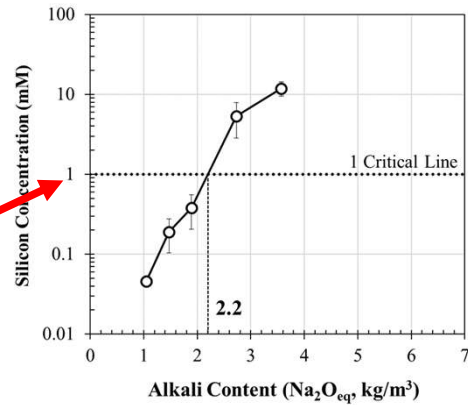
Example of Type A aggregate & fine aggregate

Once the results from the x-ray are obtained, the RI can be calculated. If the reactivity index passes the critical line of 0.45, that is where the maximum alkali content the aggregate is capable of withstanding before ASR is guaranteed to form. After 0.45, there isn't a question that we have gone past our threshold and it's only a matter of time until we are able to tell physically. In this example, the Alkali Threshold was established to be 3.6 kg/m<sup>3</sup>.

# Alkali-Threshold Test

## TYPE B:

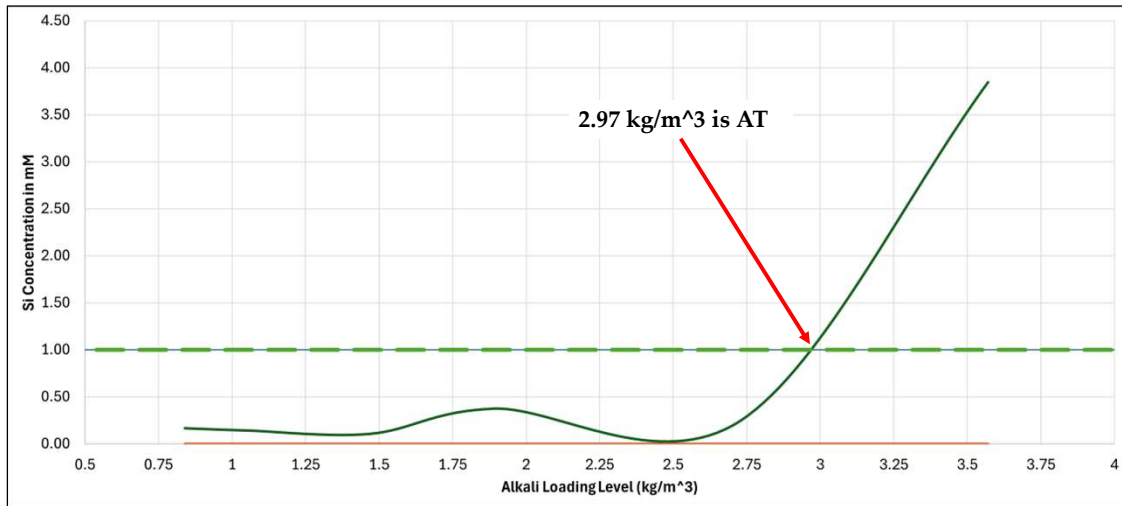
ONLY graph the Si (mM) on y-axis to establish threshold



Example of Type B aggregate & fine aggregate

For type B, we only look at the Silicon concentration since the aluminum concentration is so low. Same idea as the previous slide with the critical line being at 1 mM of silicon before ASR will form.

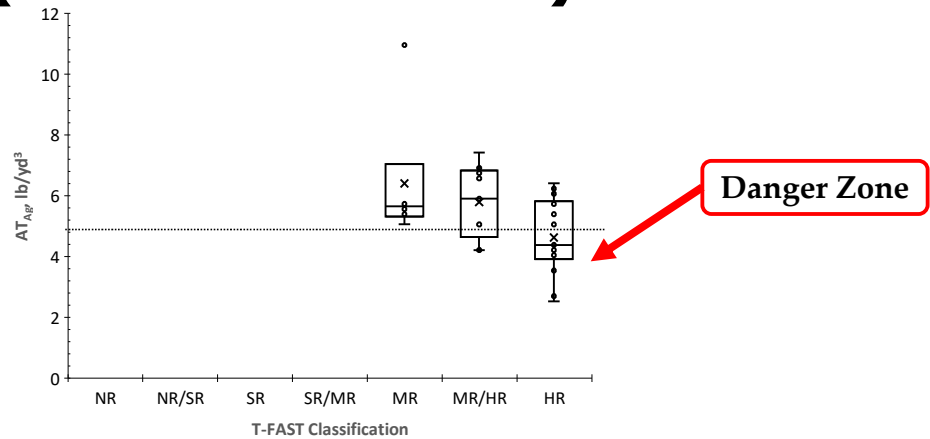
## Example of ATT Result (ARDOT)



This is an example of ATT that we have performed and as you can see, it definitely exceeded the threshold so we are to definitively say that past 2.97 kg/m<sup>3</sup> of alkali content, ASR will form.

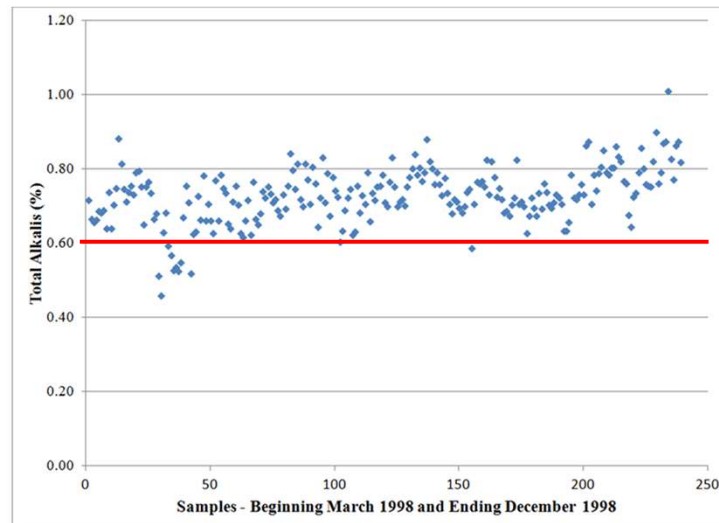
# Fine ATT Individual Results (Turner-Fairbank)

10/28 under  
5 lbs/yd<sup>3</sup>  
requirement  
\*4 of those from  
same aggregate  
source



Turner-Fairbank did ATT on some of the fine aggregates we sent them, and they determined that only 10 of the 28 were flagged for being potentially dangerous. I have to the side an important note that four of those samples were from the same quarry, just sampled from different concrete mix plants.

## What is next?



Further analysis of concrete placed during the mid to late 1990s shows that that the alkali content well exceeds the 0.60% recommended content now recommended by several states.

We know what we did wrong in the past, what about our current mix designs?

# What is next?

Order of Mix Designs to be tested	Coarse Aggregate Source	Coarse Lab Number Identification	Fine Aggregate Source	Fine Lab Number Identification	Number of Active Mix Designs with Combination
#1	Hunt Rodgers - Sonora	20250513	River Valley Materials- Arkoma	20240191	6
#2	Hunt Rodgers - Sonora	20250513	APAC Central/Arkhol Division - Van Buren	20240209	10
#3	Anchor Stone- Jane MO	20240188	APAC Central/Arkhol Division - Van Buren	20240209	10
#4	APAC Central- Hindsville Quarry	20240180	APAC Central/Arkhol Division - Van Buren	20240209	23
#5	APAC Central Inc. - Valley Springs	20240130	APAC Central/Arkhol Division - Van Buren	20240209	32
#6	APAC Central - Preston Quarry	20240172	APAC Central/Arkhol Division - Van Buren	20240209	54
#7	Rogers Group, Inc. - El Paso Quarry	20240185	Jeffery Sand Co. - North Little Rock	20240203	37
#8	Blue Bayou Sand & Gravel	20240139	Blue Bayou Sand & Gravel	20240208	15
#9	Duffield Quarry- Gum Log	20240186	Big River Materials- Russellville, AR	20240217	11
#10	Johnsville Sand & Gravel	20240127	Johnsville Sand & Gravel	20240192	5
#11	Rogers Group, Inc. - El Paso Quarry	20240185	Jeffery Sand Co. - North Little Rock	20240203	37
#12	Granite Mountain Quarries - Sweet Home	20240125	Jeffery Sand Co. - North Little Rock	20240203	30
#13	Granite Mountain Quarries - Sweet Home	20240125	Pine Bluff Sand & Gravel	20240190	28
#14	Capital Quarries- Pocahantas	20250338	Capital Sand Co. - Harrisburg South	20250339	17
#15	Capital Quarries- Pocahantas	20250338	Hedger Aggregates - Jonesboro	20240205	5
#16	Rock Island Sand & Gravel	20250384	Rock Island Sand & Gravel	20250965	9
#17	White River Materials Inc. - Cord	20240134	Capital Sand Co. - Harrisburg South	20250339	5
#18	B & B - Bearden	20250385	B & B - Bearden	20240525	7
#19	B & B - Bearden	20240526	B & B - Bearden	20240525	5

346

Listed out all of our top mix design aggregate combinations that we use and run ATT on them.

Evaluate combinations of coarse & fine aggregates to learn AT.

# What is next?

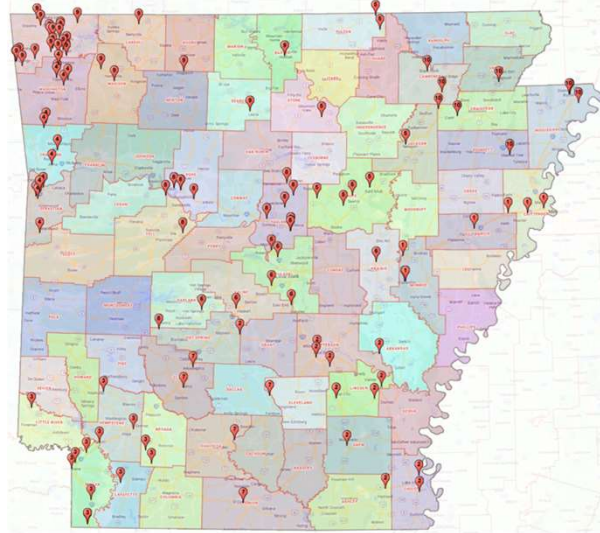
Cement Type	Cement Source	Alkali Loading (lbs)		
		5.5 Sacks of Cement (517 lbs.)	6 Sacks of Cement (564 lbs)	6.5 Sacks of Cement (611 lbs.)
Type I/L	Argos Cement USA - Calera	2.24	2.44	2.64
Type III	Ash Grove Cement Company - Chanute	2.82	3.07	3.33
Type I/L	Ash Grove Cement Company - Chanute	2.76	3.01	3.26
Type I/II	Ash Grove Cement Company - Foreman	2.71	2.96	3.21
Type I/L	Ash Grove Cement Company - Foreman	2.48	2.71	2.93
Type I/L	Ash Grove Cement Company - Midlothian	2.69	2.93	3.18
Type I/II	Atlantic Sunshine, LLC - Ha Nam	2.48	2.71	2.93
Type I/L	Buzzi Unicem USA, Inc. - Cape Girardeau	2.62	2.86	3.10
Type I/L	Buzzi Unicem USA, Inc. - Festus	2.02	2.20	2.38
Type I/L	Buzzi Unicem USA, Inc. - Pryor	2.82	3.08	3.34
Type I/L	Central Plains Cement Company - Tulsa	2.79	3.05	3.30
Type I/L	Continental Cement Company - Buffalo	2.66	2.90	3.15
Type I/L	Continental Cement Company - Hannibal	2.60	2.84	3.08
Type I/L	Continental Cement Company - Medcem	1.78	1.95	2.11
Type I/L	Holcim (US) Inc. - Ada	3.70	4.03	4.37
Type I/L	Holcim (US) Inc. - Bloomsdale	2.77	3.02	3.27
Type I/L	Holcim (US) Inc. - Grand Chain	2.59	2.82	3.06
Type I/II	Martin Marietta Materials, Inc. - Midlothian	2.86	3.12	3.38
Type III	Martin Marietta Materials, Inc. - Midlothian	2.91	3.17	3.44
Type I/L	Monarch Cement Company - Humboldt	2.95	3.21	3.48
Type I/II	Ozinga Cement - Nghe An Province	2.86	3.12	3.38

Once AT established for mix design, it is possible to identify what the cement loading is and begin advising contractors to use a different cement source if they are working with highly reactive aggregate.

It also allows for the evaluation at the mix design phased to see if mitigation may be required.

Mitigation could be to lower cement alkali content, SCMs, or to choose dif aggregates completely.

## What is next?



After ATT results, best test is field performance. We ID these locations that have mix designs that were placed 10 to 15 yrs ago using cements similar to what we have today -> Petrographic analysis conformation -> Eliminate concern for certain locations and allow us to concentrate our resources on the known problematic regions. Potentially with ATT data and field observations combined, can then build a better plan on future projects.

## Good News

- Going to be published with FHWA journal articles
- Developed analysis method using WD-XRF (membrane method)
- Successfully completed T-FAST on all state aggregates
- Leading against other states in this process



The good news is that we are going to be published a lot in the future with FHWA journal articles. Our lab was the first to get conclusive x-ray results using T-FAST and showed great correlation to FHWA that uses a completely different analysis method. We are much more advance than other states in our process of dealing with ASR and hope to continue to advance.

## Bad News

- X-ray was installed in 2007
  - 18 yrs old
- ATT reads much lower conc. than T-FAST
  - No longer can determine 50-300 ppm
  - On pause until further notice



The bad news is our x-ray is extremely old. For context, I was in pre-k as you can see on the right when the instrument was installed. The x-ray has reached the point that at the low concentrations required by ATT, it can no longer read accurately. Until we get a new system, currently ATT is at a standstill.



**Thanks for listening!**  
**Questions?**

# Field Evaluations & ATT Results

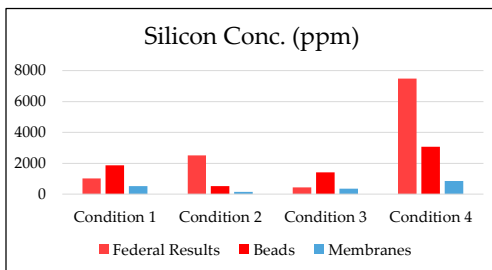
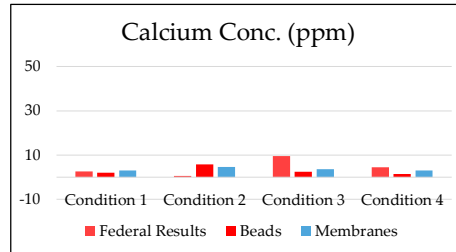
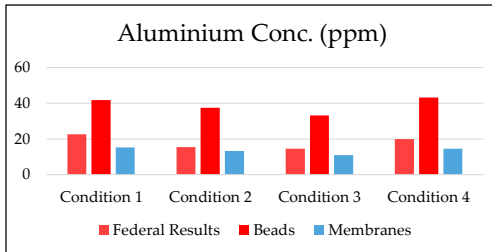
Order of Mix Designs to be tested	Coarse Aggregate Source	Coarse Lab Number Identification	Fine Aggregate Source	Fine Lab Number Identification	Number of Active Mix Designs with Combination
#1	Hunt Rodgers - Sonora	20250513	River Valley Materials- Arkoma	20240191	6
#2	Hunt Rodgers - Sonora	20250513	APAC Central/Arkhol Division - Van Buren	20240209	10
#3	Anchor Stone- Jane MO	20240188	APAC Central/Arkhol Division - Van Buren	20240209	10
#4	APAC Central- Hindsville Quarry	20240180	APAC Central/Arkhol Division - Van Buren	20240209	23
#5	APAC Central Inc. - Valley Springs	20240130	APAC Central/Arkhol Division - Van Buren	20240209	32
#6	APAC Central - Preston Quarry	20240172	APAC Central/Arkhol Division - Van Buren	20240209	54
#7	Rogers Group, Inc. - El Paso Quarry	20240185	Jeffery Sand Co. - North Little Rock	20240203	37
#8	Blue Bayou Sand & Gravel	20240139	Blue Bayou Sand & Gravel	20240208	15
#9	Duffield Quarry- Gum Log	20240186	Big River Materials- Russellville, AR	20240217	11
#10	Johnsville Sand & Gravel	20240127	Johnsville Sand & Gravel	20240192	5
#11	Rogers Group, Inc. - El Paso Quarry	20240185	Jeffery Sand Co. - North Little Rock	20240203	37
#12	Granite Mountain Quarries - Sweet Home	20240125	Jeffery Sand Co. - North Little Rock	20240203	30
#13	Granite Mountain Quarries - Sweet Home	20240125	Pine Bluff Sand & Gravel	20240190	28
#14	Capital Quarries- Pocahantas	20250338	Capital Sand Co. - Harrisburg South	20250339	17
#15	Capital Quarries- Pocahantas	20250338	Hedger Aggregates - Jonesboro	20240205	5
#16	Rock Island Sand & Gravel	20250384	Rock Island Sand & Gravel	20250965	9
#17	White River Materials Inc. - Cord	20240134	Capital Sand Co. - Harrisburg South	20250339	5
#18	B & B - Bearden	20250385	B & B - Bearden	20240525	7
#19	B & B - Bearden	20240526	B & B - Bearden	20240525	5

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# Comparison of Data to Federal Highway

Lab ID 20240190: Fine Aggregate from Pine Bluff Sand & Gravel

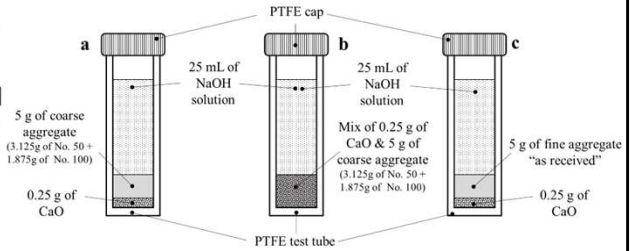


When comparing fine aggregate results, ArDOT & TFHRC show a correlation of 93% for fine aggregates

# Determining Alkali Threshold Cont.

**Table 1**—Alkali Loadings to Determine the Alkali Threshold of Aggregates  
(Coarse, Fine, or a Combination of Both as in the Concrete Mix Proportions)

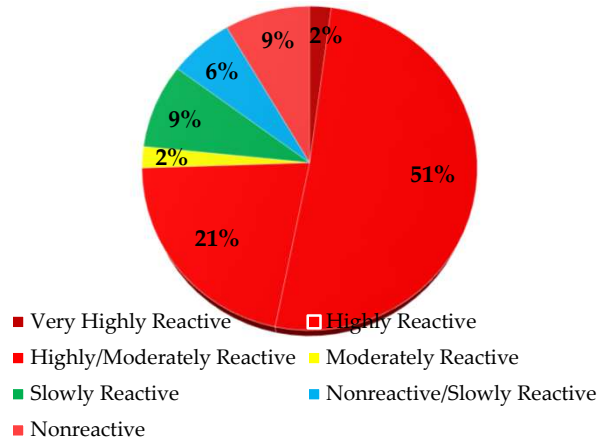
T-FAST Classification	Alkali Loading Level	Alkali Loading ( $\text{Na}_2\text{O}_{\text{eq}}$ kg/m <sup>3</sup> )	NaOH, g in 100 -mL of DI Water	
Slow Reactive/ Moderately Reactive	1	6.51	4.44	
	2	5.25	3.58	
	3	4.41	3.01	
	4	3.57	2.44	
	5	2.73	1.86	
	Highly Reactive/ Very Highly Reactive	1	3.57	2.44
		2	2.73	1.86
	3	1.89	1.29	
	4	1.47	1.00	
	5	1.05	0.72	



Make up ATT tubes depending on results from T-FAST

- Type A => Layers kept
- Type B => Thoroughly mix layers

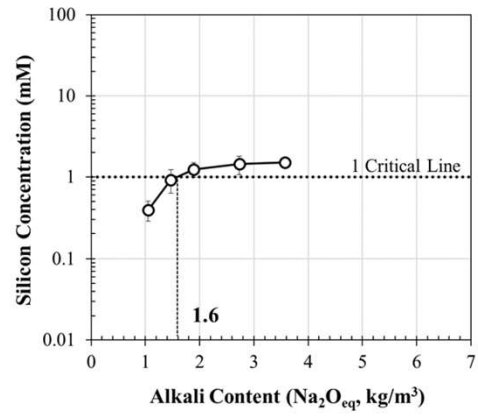
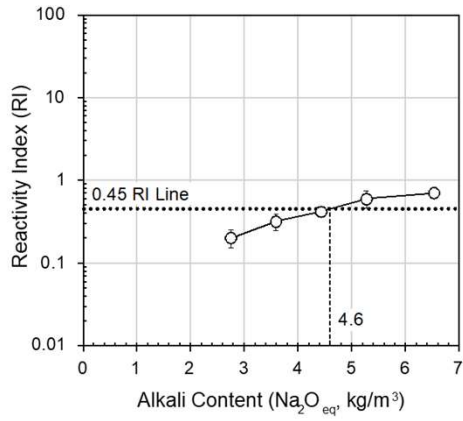
# Results of Coarse Aggregates: ArDOT Data



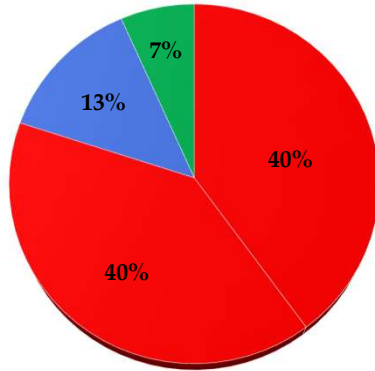
Out of the 47 aggregates analyzed:

- 1 VHR
- 24 HR
- 10 HR/MR
- 1 MR
- 4 SR
- 3 SR/NR
- 4 NR

# Determining Alkali Threshold Cont



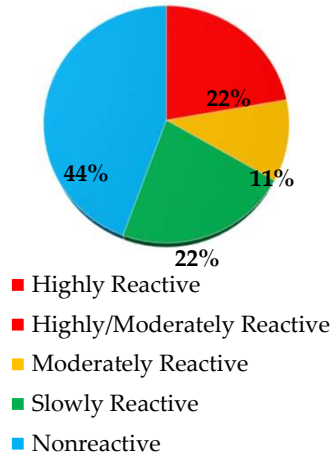
# Results of Fine Aggregates: ArDOT Data



- Highly Reactive
- Highly/Moderately Reactive
- Moderately Reactive
- Nonreactive/Slowly Reactive

Out of the 30 aggregates analyzed:  
12 HR  
12 HR/MR  
4 MR  
2 NR/SR <- Repeating Low Si

# Results of Coarse Aggregates: TFHRC Data



Out of the 9 aggregates analyzed:

2 HR  
1 MR  
2 SR  
4 NR

\*Will be updated once more results with FHWA is shared

\*\*So far, 89% correlation with ArDOT