massDOT
Massachusetts Department of Transportation
Highway Division

# The Identification and Prevention of Alkali Silica Reactive (ASR) Aggregates

## 2017 Northeastern States' Materials Engineers Association (NESMEA) Annual Conference

**October 17-18 – Hartford, CT**

# John Grieco, PE

Director of Research & Materials

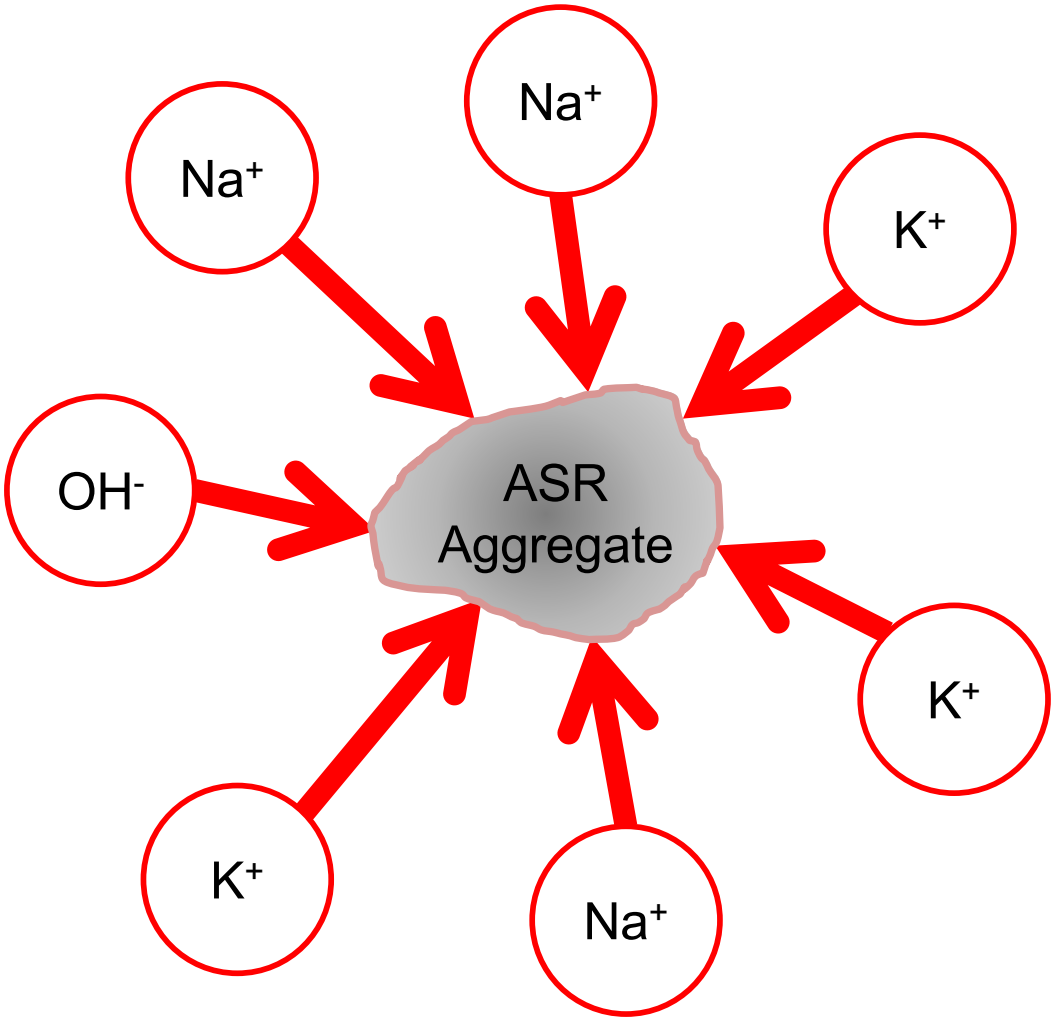
# Richard Mulcahy, EIT

Quality Assurance Section of Research & Materials

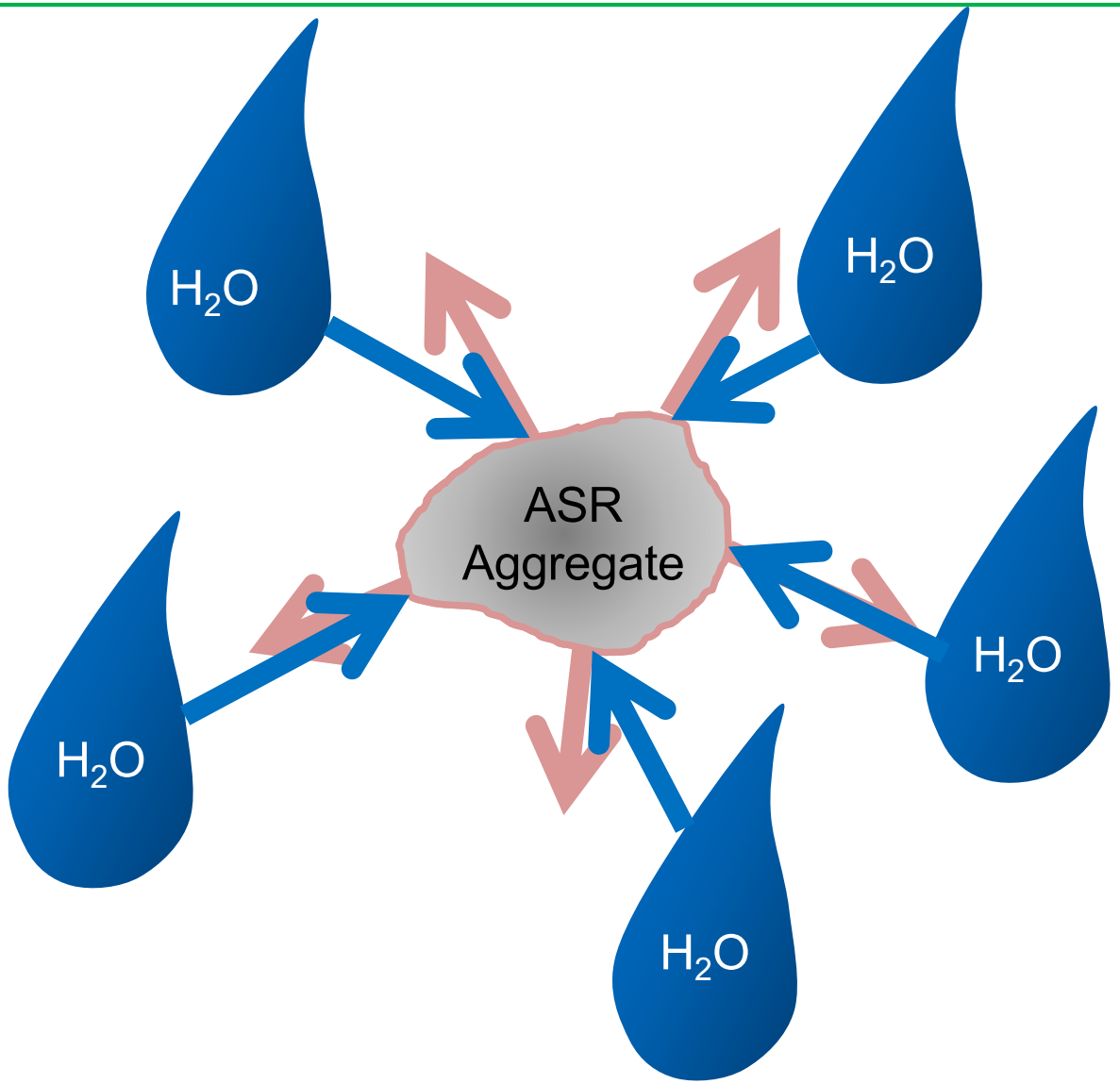
# What is Alkali Silica Reaction?

- **Definition**
  - A Process in which silica (found in aggregate) in the presence of moisture, is broken down by alkalis (sodium and potassium found in cement) and produces an expansive gel.
- **Three Step Process**
  - Alkali + Reactive Silica = Gel
  - Gel + Moisture = Gel Swelling Pressure
  - Gel Swelling Pressure > Concrete Tensile Strength = Concrete Cracking and Failure

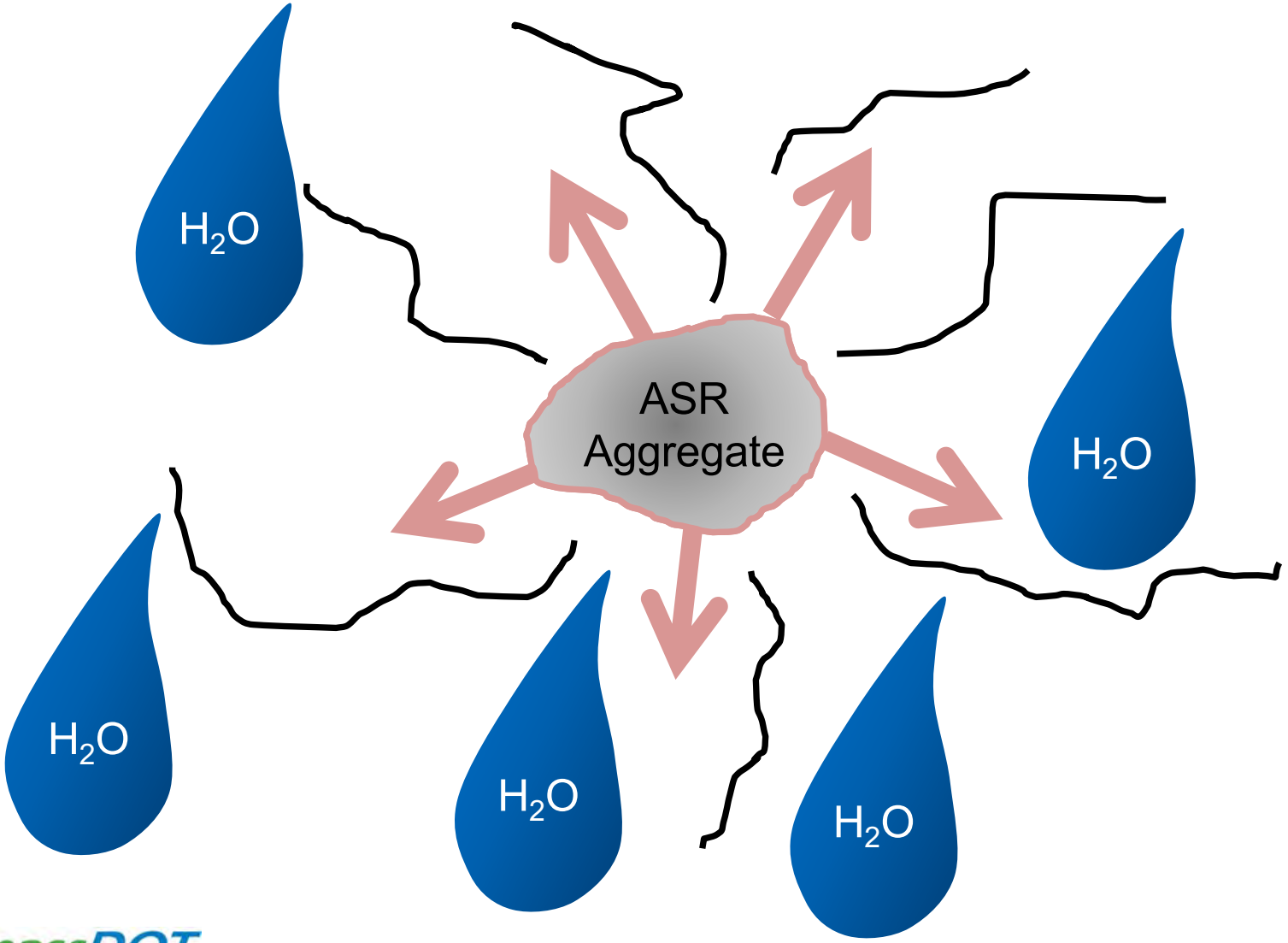
# Akali + Reactive Silica = Gel



# Gel + Moisture = Gel Swelling



# Gel Pressure > Tensile Strength



# MassDOT History with ASR

- **1996**
  - ASR found on Memorial Bridge in Springfield
  - FHWA advised MassDOT to test Aggregates for ASR
- **1998**
  - MassDOT requires producers to submit certified ASR Test Results Annually
    - "Modified" AASHTO T 303 Accelerated Mortar Bar Test (AMBT) results annually
    - ASTM C295 Petrographic Examination

# MassDOT History with ASR

- **2003**
  - MassDOT performs in-house ASR testing
    - Discrepancy between MassDOT and producer test results
    - Identified an aggregate source used by several producers which was “very highly reactive”
- **2008**
  - MassDOT begins proficiency testing of independent laboratories for “Modified” AASHTO T303 (AMBT).
  - Established a qualified list of approved testing laboratories based on their proficiency test performance.

# MassDOT History with ASR

## 2008

- Identified 40 construction projects completed between 7 and 12 years ago that used the “very highly reactive” aggregate identified in 2003
- Developed research program to analyze concrete structures on the 40 projects, determine risk assessment and future management of the structures.


# ASR Effected Precast Barrier

Contract 95505: Somerset-Fall River-Westport-Dartmouth, I-195 East, Precast Barrier At Highland Ave. Bridge


# ASR Effected Sign Foundation

Contract 95559: Raynham-Taunton-Norton-Mansfield-Wrentham Sign Foundations, South Bound Exit 8 Route 138 1 Mile Advance Sign Foundation-Gauge Point Measurement


# ASR Effected Sign Foundation

Contract 98106:  Bridgewater-Raynham-Taunton-Berkley-Freetown, Exit 14B Route 24 South Bound


# ASR Effected Culvert

Contract 96527: Somerset, Route 138 at Read Street, Precast Culvert South Side Riverside Avenue


# ASR Effected Parapet Wall

Contract 97343: Middleborough, Miller Street / I-495 South Bound Bottom of Parapet Wall on Outside of Bridge Approximately 12’ Left of the Southwest Corner of the Bridge

# MassDOT History with ASR

- **2009**
  - MassDOT begins ASTM C1293 Concrete Prism Test (CPT) of a Canadian aggregate source known to be historically highly reactive
- **2011**
  - MassDOT is approached by the FHWA to build a long-term ASR Exposure Site
- **2012**
  - MassDOT and FHWA break ground on ASR Exposure site on June 6, 2012

# MassDOT History with ASR

- **2016**
  - MassDOT begins experimenting with AASHTO TP 110 Mini Concrete Prism Test (MCPT)
- **2017**
  - MassDOT begins ASTM C1293 (CPT) on all MassDOT approved aggregate sources
  - 5 year anniversary of the long-term ASR exposure site study

# MassDOT Future with ASR

- **2018**
  - MassDOT will perform AASHTO TP 110 (MCPT) on all MassDOT aggregates
  - MassDOT will utilize CCRL Proficiency Program for Independent Laboratory pre-qualification
- **2022**
  - 10 year anniversary of the long-term ASR exposure site study
    - Determine if field results correlate with lab tests
    - Prescribe treatments

# “Screening” for ASR

*Report on Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction*

U.S.Department of Transportation
Federal Highway Administration

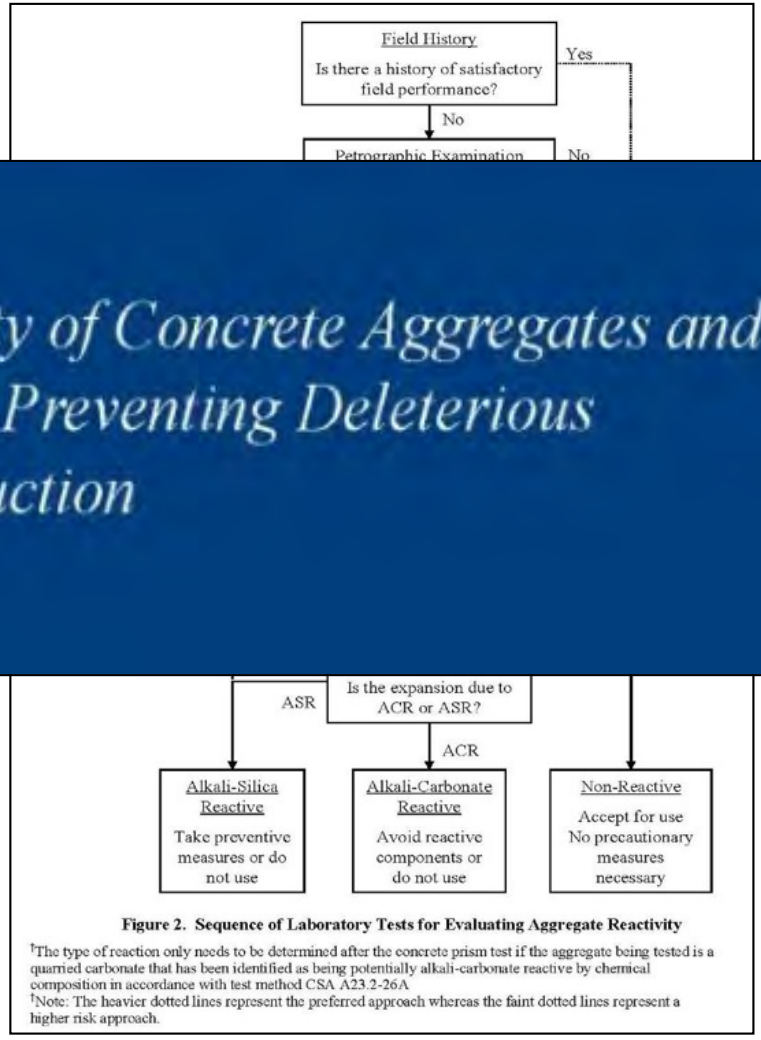


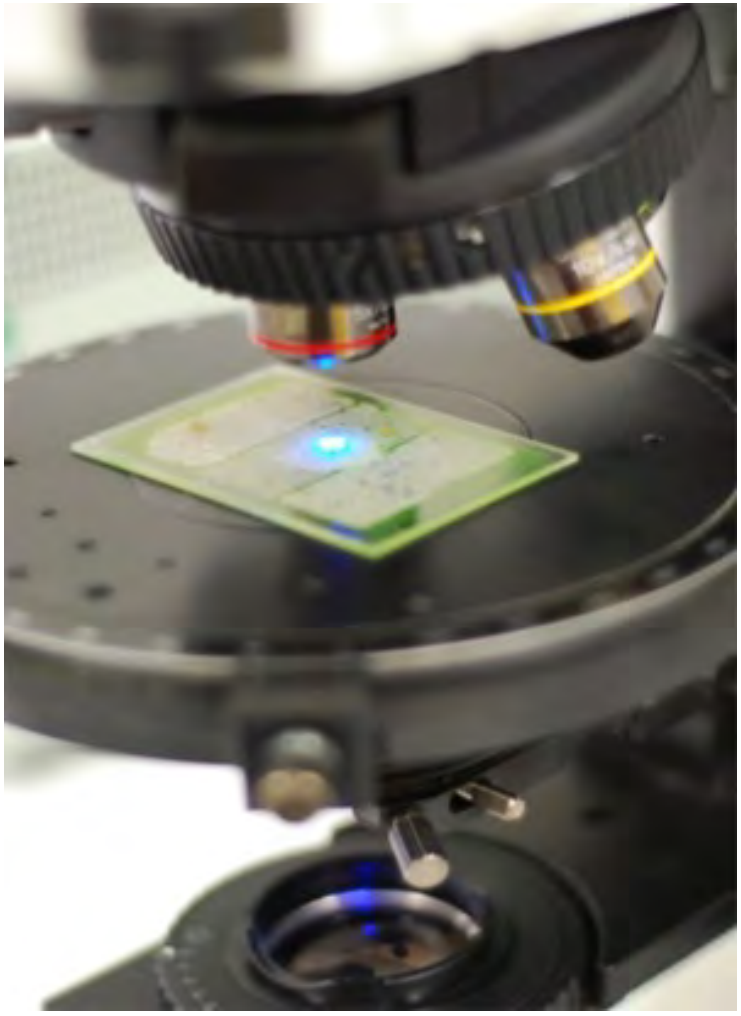

**Figure 2. Sequence of Laboratory Tests for Evaluating Aggregate Reactivity**

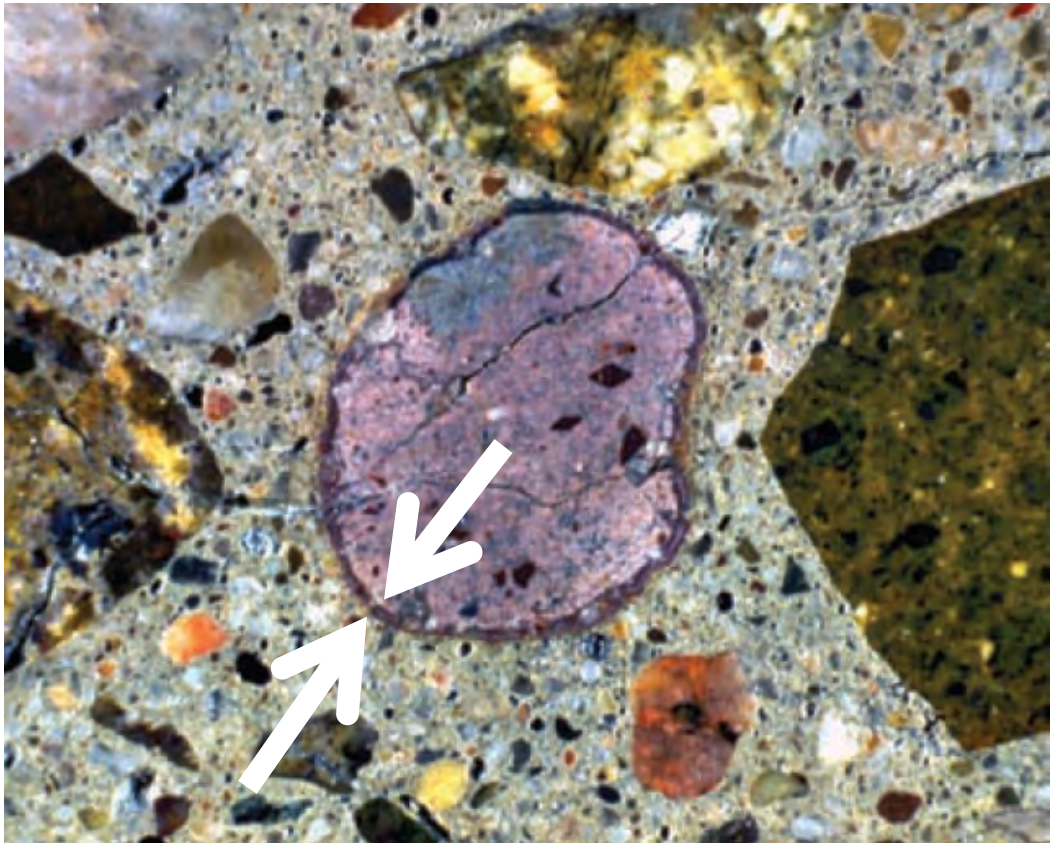
†The type of reaction only needs to be determined after the concrete prism test if the aggregate being tested is a quarried carbonate that has been identified as being potentially alkali-carbonate reactive by chemical composition in accordance with test method CSA A23.2-26A
‡Note: The heavier dotted lines represent the preferred approach whereas the faint dotted lines represent a higher risk approach.

# "Screening" for ASR

- **ASTM C295**
  - Petrographic Examination
- **AASHTO T 303**
  - Accelerated Mortar Bar Test (14 days)
- **AASHTO TP 110**
  - Mini Concrete Prism Test (56 to 84 days)
- **ASTM C 1293**
  - Concrete Prism Test (1 to 2 years)
- **Long-Term Exposure Site (10 to 20 years)**

# ASTM C295 Petrography





ASR is identified by the dark areas around the aggregate. This specimen shows ASR gel cracks extending from the aggregate into the surrounding paste.

# AASHTO T 303 (AMBT)

- **Duration**
  - 14 days
- **Specimen Size**
  - 1 x 1 x 10”

# AASHTO T 303 (AMBT)

| Reactivity | 14-Day Expansion in AMBT, % | Expected Signs of ASR distress in the Field |
|---|---|---|
| Nonreactive | ≤0.1 | N/A |
| Moderately Reactive | >0.1, ≤0.30 | >5 years, <10 years |
| Highly Reactive | >0.30, ≤0.45 | <5 years |
| Very highly Reactive | >0.45 | <5 years |

# AASHTO TP 110 (MCPT)

- **Duration**
  - 56 to 84 days (depends on rate of reactivity)
- **Specimen Size**
  - 2 x 2 x 10”

# AASHTO TP 110 (MCPT)

| Reactivity | 56-Day Expansion in MCPT, % | Average 2-Week Rate of Expansion from 8 to 12 Weeks | Expected Signs of ASR distress in the Field |
|---|---|---|---|
| Nonreactive | ≤0.03 | N/A | N/A |
| Nonreactive | >0.03, ≤0.04 | ≤0.01 per 2 weeks | N/A |
| Low/slow Reactive | >0.03, ≤0.04 | >0.01 per 2 weeks | >10 years |
| Moderately Reactive | >0.04, ≤0.12 | N/A | >5 years, <10 years |
| Highly Reactive | >0.12, ≤0.24 | N/A | <5 years |
| Very highly Reactive | >0.24 | N/A | <5 years |

# AASHTO TP 110 (MCPT)

| Efficiency of Mitigation | 56-Day Expansion in MCPT, % |
|---|---|
| Effective | ≤0.020 |
| Uncertain | >0.020, ≤0.025 |
| Not Effective | >0.025 |

# ASTM C 1293 (CPT)

- **Duration**
  - 1 to 2 years (depends on use of mitigation)
- **Specimen Size**
  - 3 x 3 x 10”

# ASTM C 1293 (CPT)

| Reactivity | 1-Year Expansion in CPT, % | Expected Signs of ASR distress in the Field |
|---|---|---|
| Nonreactive | ≤0.04 | N/A |
| Moderately Reactive | >0.04, ≤0.12 | >5 years, <10 years |
| Highly Reactive | >0.12, ≤0.24 | <5 years |
| Very highly Reactive | >0.24 | <5 years |

# Long-Term Exposure Site

- **Duration**
  - 10 to 20 year study on the “efficacy” of the trialed “Treatments”
- **Specimen Size**
  - 15 x 15 x 28”
- **Specimens**
  - 73 Blocks

# Long-Term Exposure Site

| Reactivity | 10 to 20 year Expansion (%) | Expected Signs of ASR distress in the Field |
|---|---|---|
| Nonreactive | ≤0.04 | N/A |
| Moderately Reactive | >0.04, ≤0.12 | >5 years, <10 years |
| Highly Reactive | >0.12, ≤0.24 | <5 years |
| Very highly Reactive | >0.24 | <5 years |

# “Candidates” for Prevention

# “Candidates” for Prevention

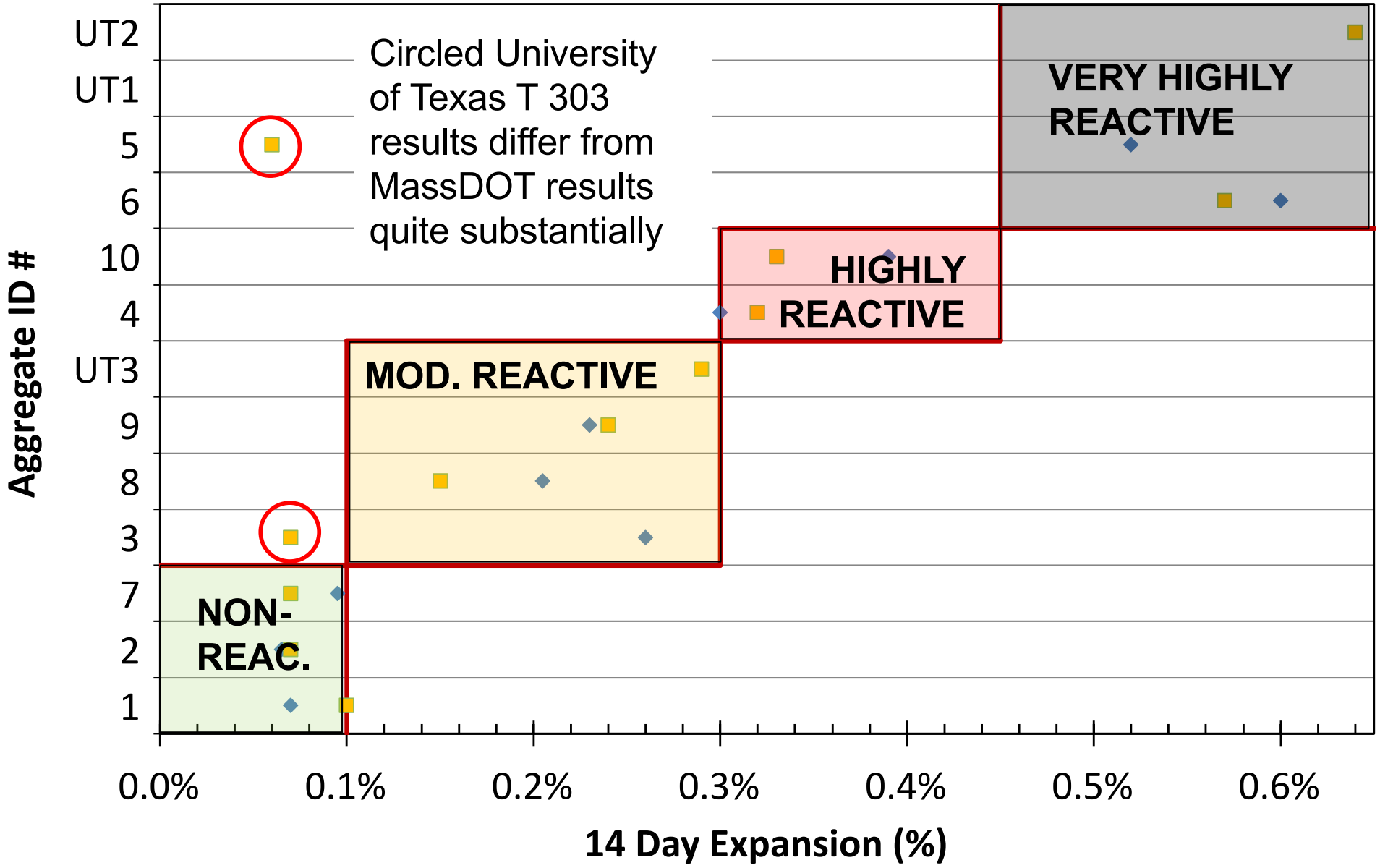
| Coarse Aggregate | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reactivity Class | AMBT Range | Agg. ID | Mineralogy | AMBT (14 days) | | CPT (360 days) | |
| | | | | Mass DOT | U of Texas | Mass DOT | U of Texas |
| Nonreactive | <0.10 | 1 | Diorite (mainly); granitic & volcanic (traces) | 0.05 - 0.09 | 0.095 | 0.03 | 0.024 |
| | | 2 | Mixed Diorite/gneiss/granite/schist | 0.04 - 0.09 | 0.066 | 0.06 | 0.074 |
| Moderately Reactive | 0.10 - 0.29 | 3 | Pinkish meta-granite | 0.20 - 0.32 | 0.072 | 0.1 | 0.054 |
| Highly Reactive | 0.30 - 0.45 | 4 | Mixed gneiss/granitic | 0.30 - 0.30 | 0.324 | 0.22 | 0.155 |
| Very Highly Reactive | >0.45 | 5 | Mixed gneiss/schist/quartzite | 0.50 - 0.54 | 0.063 | 0.09 | 0.077 |
| | | 6 | Greywacke/sandstone | 0.58 - 0.62 | 0.573 | 0.27 | 0.158 |
| | | UT1 | Rhyolitic volcanic rocks with quartz and granite | - | 0.82 | - | 0.159 |

# “Candidates” for Prevention

| Fine Aggregate | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reactivity Class | AMBT Range | Agg. ID | Mineralogy | AMBT (14 days) | | CPT (360 days) | |
| | | | | Mass DOT | U of Texas | Mass DOT | U of Texas |
| Nonreactive | <0.10 | 7 | Mixed gneiss/quartzite/quartz/ feldspar sand | 0.09 - 0.10 | 0.066 | 0.06 | 0.024 |
| Moderately Reactive | 0.10 - 0.29 | 8 | Mixed quartzite/gneiss/quartz/ feldspar sand | 0.20 - 0.21 | 0.147 | 0.05 | 0.07 |
| | | 9 | Mixed gneiss/quartzite/quartz/ feldspar sand | 0.20 - 0.26 | 0.239 | 0.05 | 0.028 |
| Highly Reactive | 0.30 - 0.45 | 10 | Mixed gneiss/schist/quartzite/ quartz/feldspar sand | 0.38 - 0.40 | 0.327 | 0.06 | 0.051 |
| Very Highly Reactive | >0.45 | UT2 | Mixed quartz/chert/feldspar sand | - | 0.64 | - | 0.582 |
| | | UT3 | Mixed quartz/chert sand | - | 0.29 | | 0.27 |

# Do Lab Test Methods Correlate?

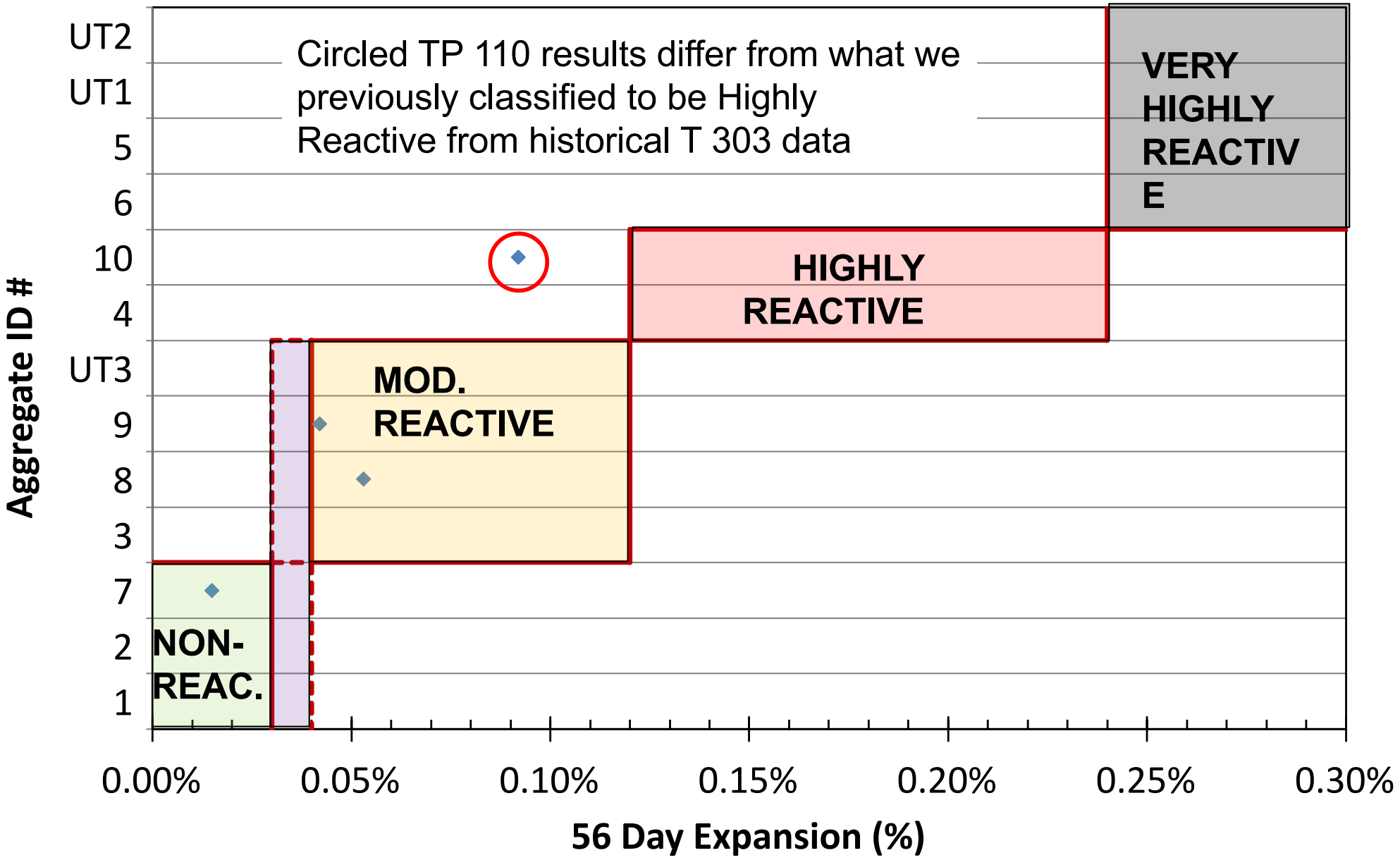
# AASHTO T 303 (AMBT) 14 Day Expansion (%) for *100% Cement*




massDOT Massachusetts Department of Transportation Highway Division

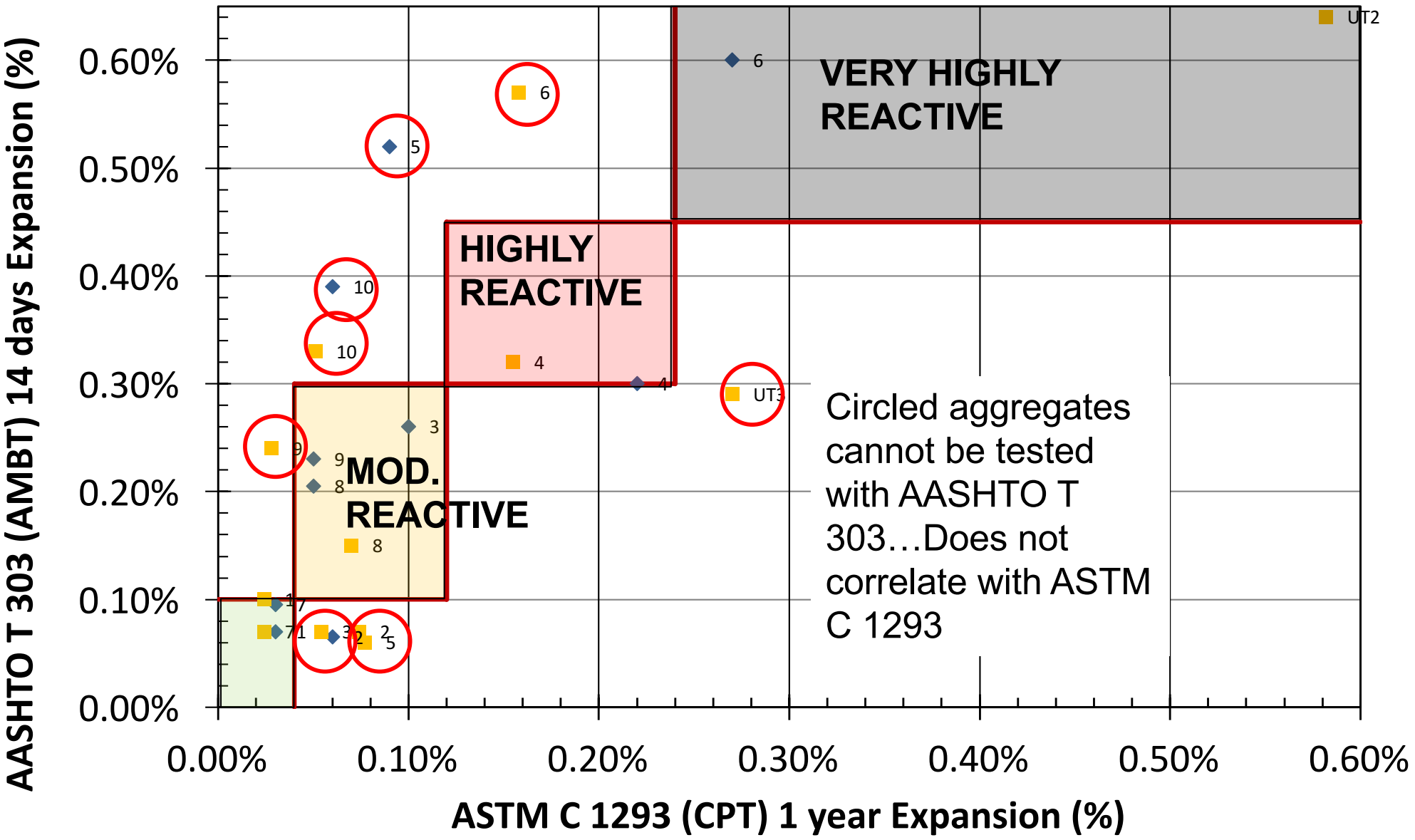
MASSDOT AASHTO T 303 TEXAS AASHTO T 303 Reactivity Limits

# AASHTO TP 110 (MCPT) 56 Day Expansion (%) for *100% Cement*

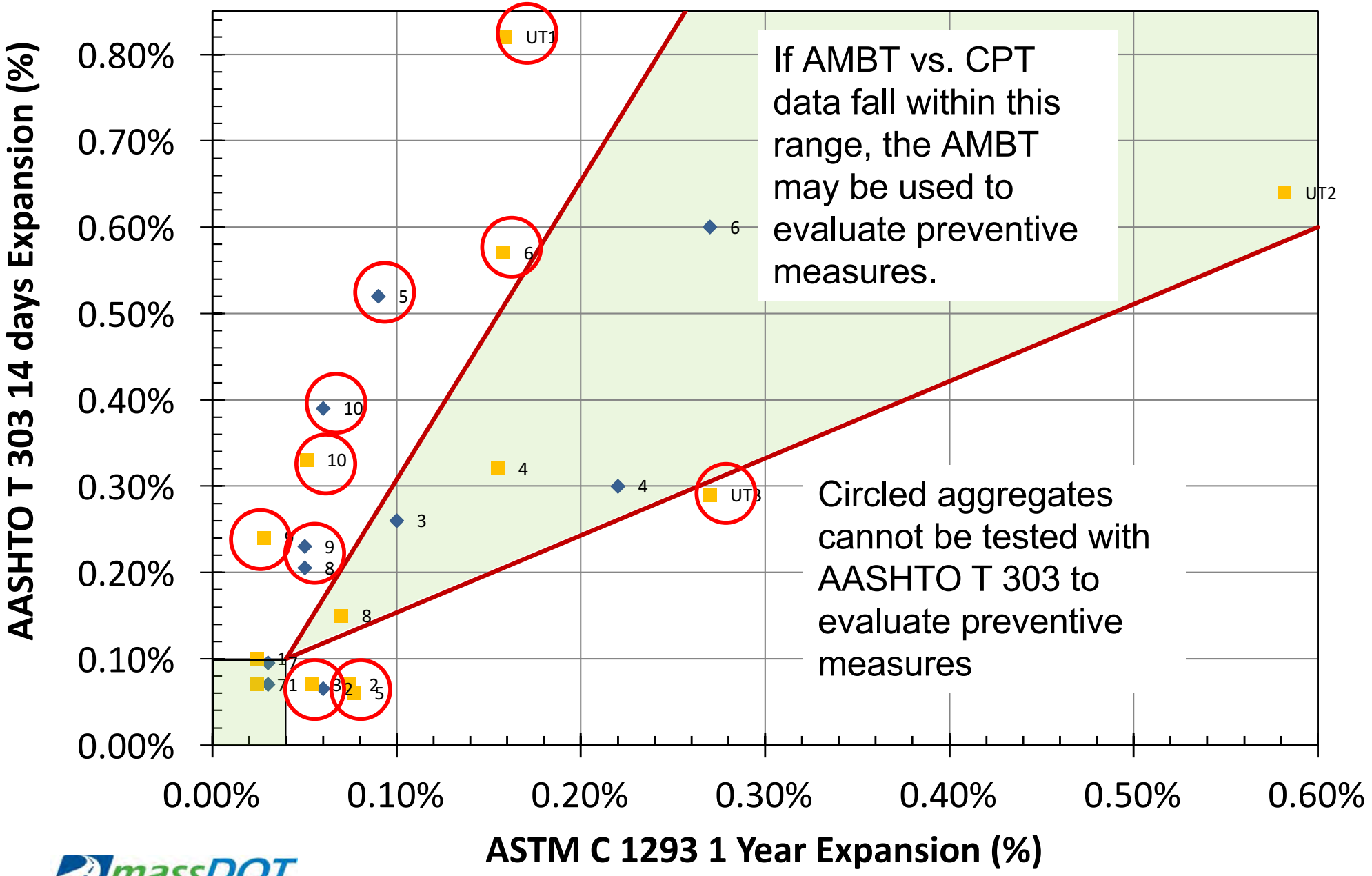


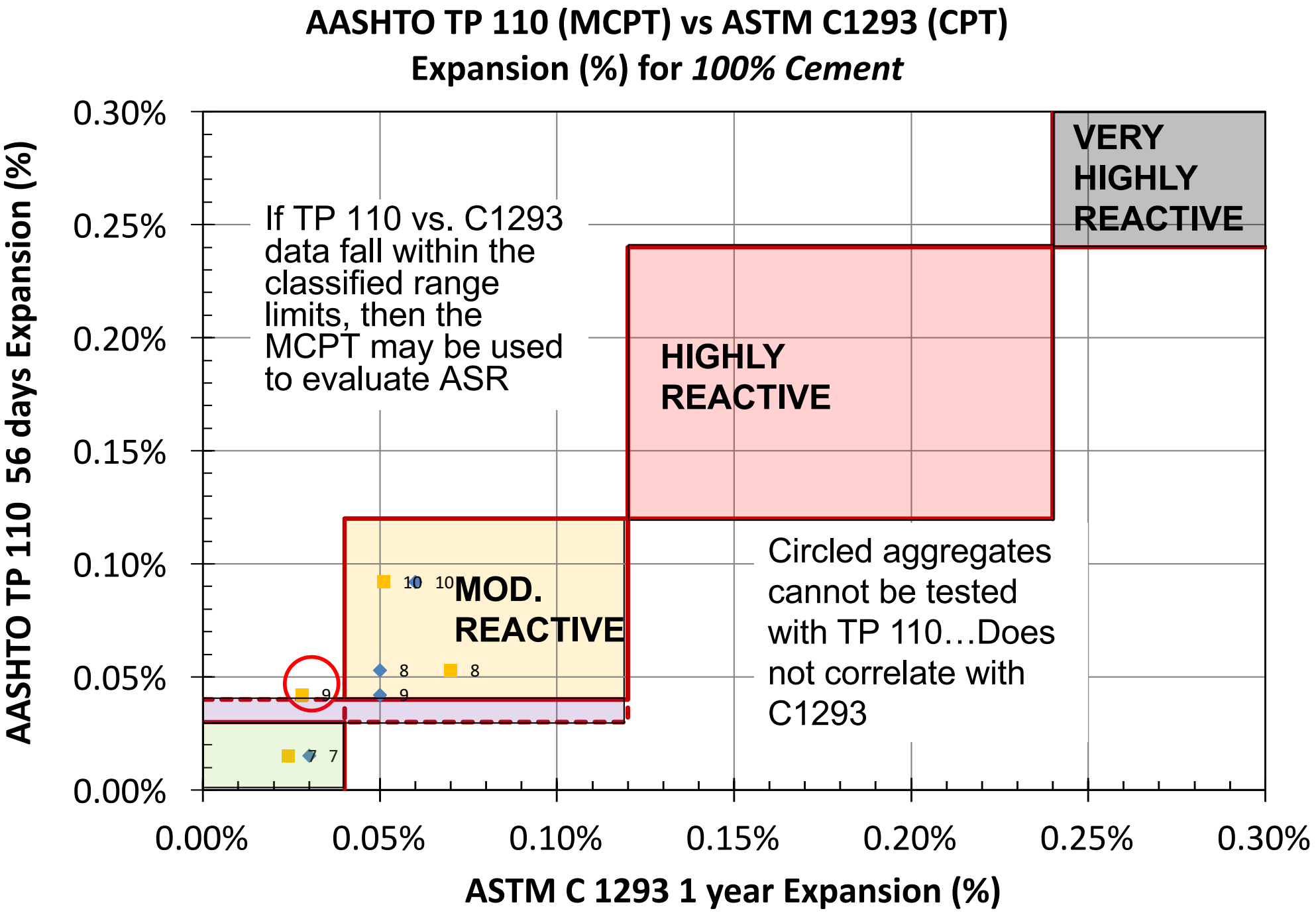

MASSDOT AASHTO TP 110 (56 DAY)

Reactivity Limits


AASHTO T 303 (AMBT) vs ASTM C1293 (CPT)
Expansion (%) for 100% Cement
AASHTO T 303 (AMBT) 14 days Expansion (%)
0.00%
0.10%
0.20%
0.30%
0.40%
0.50%
0.60%
ASTM C 1293 (CPT) 1 year Expansion (%)
VERY HIGHLY REACTIVE
HIGHLY REACTIVE
MOD. REACTIVE
Circled aggregates cannot be tested with AASHTO T 303…Does not correlate with ASTM C 1293
MassDOT
U of Texas
Reactivity Limits

# AASHTO PP 65 AMBT vs ASTM C1293 (CPT)
## Expansion (%) for *100% Cement*




AASHTO TP 110 (MCPT) vs ASTM C1293 (CPT)
Expansion (%) for 100% Cement
AASHTO TP 110 56 days Expansion (%)
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
If TP 110 vs. C1293 data fall within the classified range limits, then the MCPT may be used to evaluate ASR
VERY HIGHLY REACTIVE
HIGHLY REACTIVE
MOD. REACTIVE
Circled aggregates cannot be tested with TP 110…Does not correlate with C1293
10
10
8
8
9
9
7
7
0.00%
0.05%
0.10%
0.15%
0.20%
0.25%
0.30%
ASTM C 1293 1 year Expansion (%)
MassDOT
U of Texas
Reactivity Limits

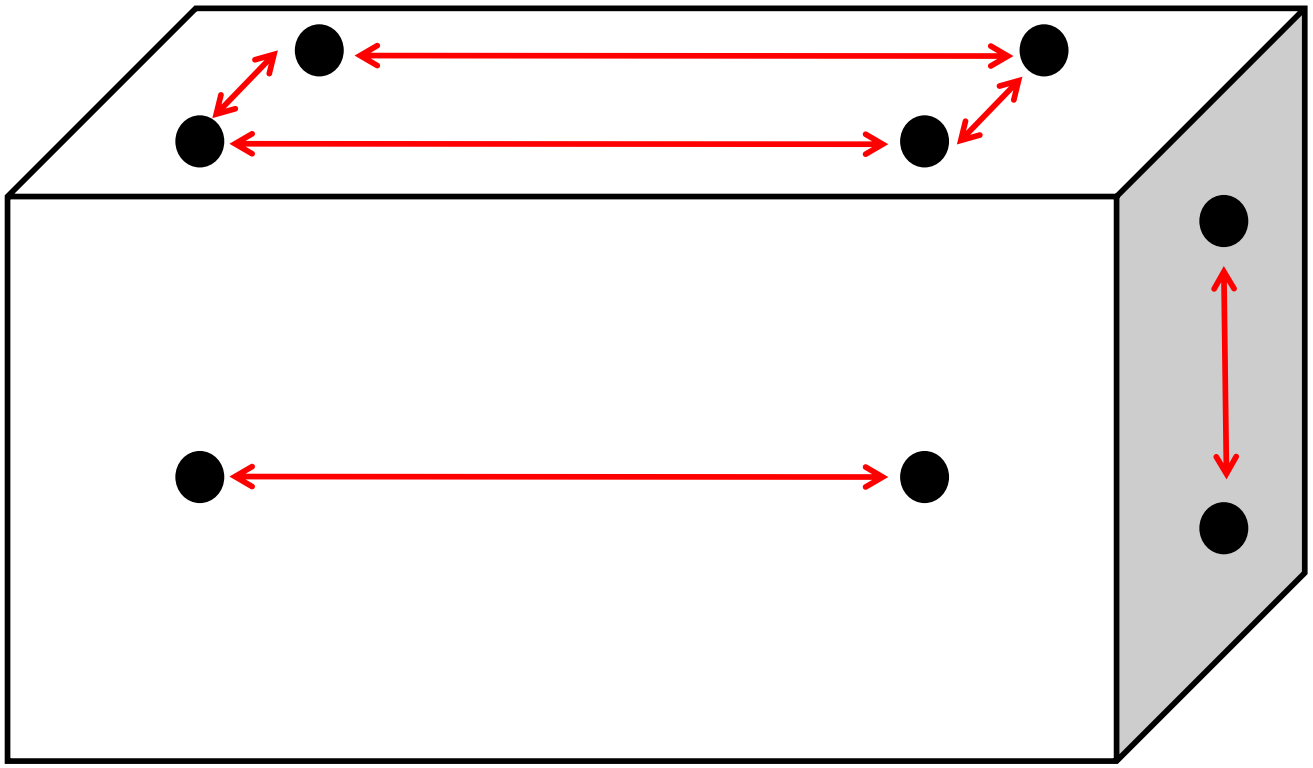
# “Clinical” Trials (Exposure Site)

# “Clinical” Trials (Exposure Site)

- **Duration**
  - 10 to 20 year study on the “efficacy” of the trialed “Treatments”
- **Specimen Size**
  - 15 x 15 x 28”
- **Specimens**
  - 73 Blocks

# “Clinical” Trials (Exposure Site)

# Gauge Measurement Locations



# “Clinical” Trials (Exposure Site)

- Simulate
- Correlate
- Prescribe


# “Placebo”

- **33 “Placebo” (Control) Blocks**
  - No preventative measures
  - 10 local aggregates at 3 levels of alkalinity of Portland Cement
    - 0.66, 0.88, and 1.10% Na2Oe
  - 3 non-local aggregates (Texas) at 1.10% $Na_2Oe$

# "Placebo"

| AGG REACTIVITY | BLOCK | AGG | $Na_2Oe$ | CEM | FA | SLAG | SF | LITHIUM |
|---|---|---|---|---|---|---|---|---|
| Nonreactive | 50 | 1 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 26 | 2 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 39 | 7 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 51 | 1 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 27 | 2 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 40 | 7 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 28 | 2 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 41 | 7 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| Moderately Reactive | 1 | 3 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 42 | 8 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 11 | 9 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 2 | 3 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 43 | 8 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 12 | 9 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 3 | 3 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 44 | 8 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 13 | 9 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 14 | 9 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 49 | UT3 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| Highly Reactive | 45 | 4 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 29 | 10 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 46 | 4 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 30 | 10 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 47 | 4 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 31 | 10 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| Very Highly Reactive | 52 | 6 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 16 | 6 | 0.66% | 100% | 0% | 0% | 0% | 0% |
| | 53 | 6 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 17 | 6 | 0.88% | 100% | 0% | 0% | 0% | 0% |
| | 54 | 6 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 18 | 6 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 15 | UT1 | 1.10% | 100% | 0% | 0% | 0% | 0% |
| | 48 | UT2 | 1.10% | 100% | 0% | 0% | 0% | 0% |

# Preventative “Treatments”

# Preventative “Treatments”

- **ASR only occurs if ALL THREE Conditions are met! Eliminate One!**

# Preventative “Treatments”

- Nonreactive Aggregate
- Fly Ash
- Slag
- Silica Fume
- Lithium
- Low Alkali Cement

# Preventative "Treatments"

- **40 "Treatment" (Preventative Measure) Blocks**
  - 4 of the most reactive local "Candidates" (Aggregates) chosen
  - 2 levels of alkalinity of Portland Cement
    - 0.88 and 1.11% $Na_2Oe$
  - 7 preventative measures
    - 20% Class F fly ash
    - 30% Class F fly ash
    - 35% slag
    - 50% slag
    - 4% silica fume + 15% fly ash
    - 4% silica fume + 20% slag
    - 100% standard dose of lithium nitrate (0.55 gal of 30% lithium nitrate per pound of $Na_2Oe$)

# Preventative "Treatments"

| MODERATELY REACTIVE AGGREGATE | | | | | | | |
|---|---|---|---|---|---|---|---|
| BLOCK | AGG | $Na_2Oe$ | CEM | FA | SLAG | SF | LITHIUM |
| 72 | 3 | 0.88% | 65% | 0% | 35% | 0% | 0% |
| 73 | 3 | 0.88% | 50% | 0% | 50% | 0% | 0% |
| 70 | 3 | 0.88% | 80% | 20% | 0% | 0% | 0% |
| 71 | 3 | 0.88% | 70% | 30% | 0% | 0% | 0% |
| 10 | 3 | 1.10% | 100% | 0% | 0% | 0% | 100% |
| 9 | 3 | 1.10% | 76% | 0% | 20% | 4% | 0% |
| 6 | 3 | 1.10% | 65% | 0% | 35% | 0% | 0% |
| 7 | 3 | 1.10% | 50% | 0% | 50% | 0% | 0% |
| 8 | 3 | 1.10% | 81% | 15% | 0% | 4% | 0% |
| 4 | 3 | 1.10% | 80% | 20% | 0% | 0% | 0% |
| 5 | 3 | 1.10% | 70% | 30% | 0% | 0% | 0% |

# Preventative "Treatments"

| HIGHLY REACTIVE AGGREGATE | | | | | | | |
|---|---|---|---|---|---|---|---|
| BLOCK | AGG | $Na_2Oe$ | CEM | FA | SLAG | SF | LITHIUM |
| 38 | 10 | 1.10% | 100% | 0% | 0% | 0% | 100% |
| 35 | 10 | 1.10% | 65% | 0% | 35% | 0% | 0% |
| 32 | 10 | 1.10% | 50% | 0% | 50% | 0% | 0% |
| 36 | 10 | 1.10% | 81% | 15% | 0% | 4% | 0% |
| 33 | 10 | 1.10% | 80% | 20% | 0% | 0% | 0% |
| 37 | 10 | 1.10% | 76% | 20% | 0% | 4% | 0% |
| 34 | 10 | 1.10% | 70% | 30% | 0% | 0% | 0% |

# Preventative "Treatments"

| VERY HIGHLY REACTIVE | | | | | | | |
|---|---|---|---|---|---|---|---|
| BLOCK | AGG | $Na_2Oe$ | CEM | FA | SLAG | SF | LITHIUM |
| 64 | 6 | 0.88% | 65% | 0% | 35% | 0% | 0% |
| 68 | 5 | 0.88% | 65% | 0% | 35% | 0% | 0% |
| 65 | 6 | 0.88% | 50% | 0% | 50% | 0% | 0% |
| 69 | 5 | 0.88% | 50% | 0% | 50% | 0% | 0% |
| 62 | 6 | 0.88% | 80% | 20% | 0% | 0% | 0% |
| 66 | 5 | 0.88% | 80% | 20% | 0% | 0% | 0% |
| 63 | 6 | 0.88% | 70% | 30% | 0% | 0% | 0% |
| 67 | 5 | 0.88% | 70% | 30% | 0% | 0% | 0% |
| 61 | 6 | 1.10% | 100% | 0% | 0% | 0% | 100% |
| 25 | 5 | 1.10% | 100% | 0% | 0% | 0% | 100% |
| 24 | 5 | 1.10% | 76% | 0% | 20% | 4% | 0% |
| 57 | 6 | 1.10% | 65% | 0% | 35% | 0% | 0% |
| 21 | 5 | 1.10% | 65% | 0% | 35% | 0% | 0% |
| 58 | 6 | 1.10% | 50% | 0% | 50% | 0% | 0% |
| 22 | 5 | 1.10% | 50% | 0% | 50% | 0% | 0% |
| 59 | 6 | 1.10% | 81% | 15% | 0% | 4% | 0% |
| 23 | 5 | 1.10% | 81% | 15% | 0% | 4% | 0% |
| 55 | 6 | 1.10% | 80% | 20% | 0% | 0% | 0% |
| 19 | 5 | 1.10% | 80% | 20% | 0% | 0% | 0% |
| 60 | 6 | 1.10% | 76% | 20% | 0% | 4% | 0% |
| 56 | 6 | 1.10% | 70% | 30% | 0% | 0% | 0% |
| 20 | 5 | 1.10% | 70% | 30% | 0% | 0% | 0% |

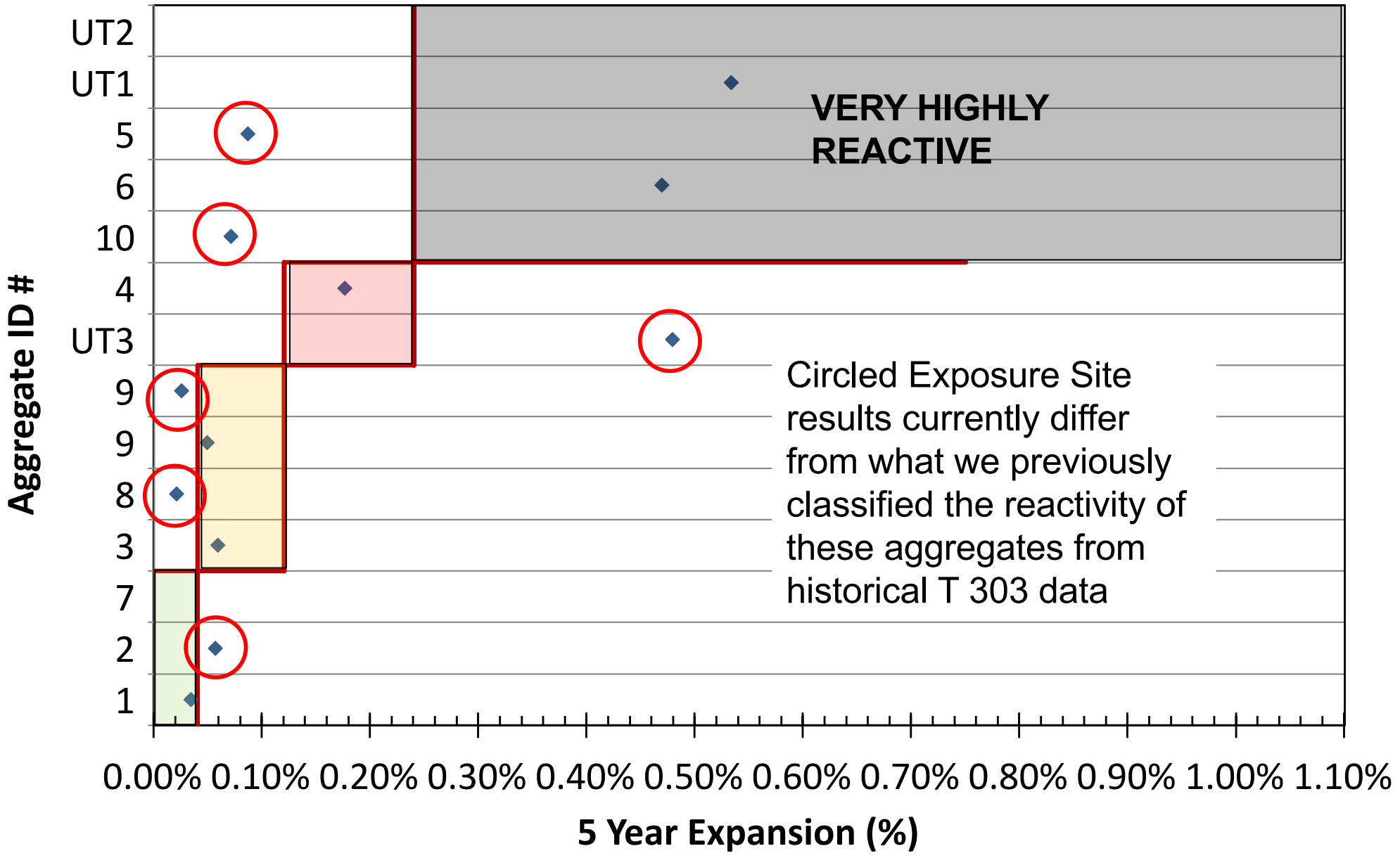
massDOT Massachusetts Department of Transportation Highway Division

# “Clinical” Trials: Day 1828 (5 yr)

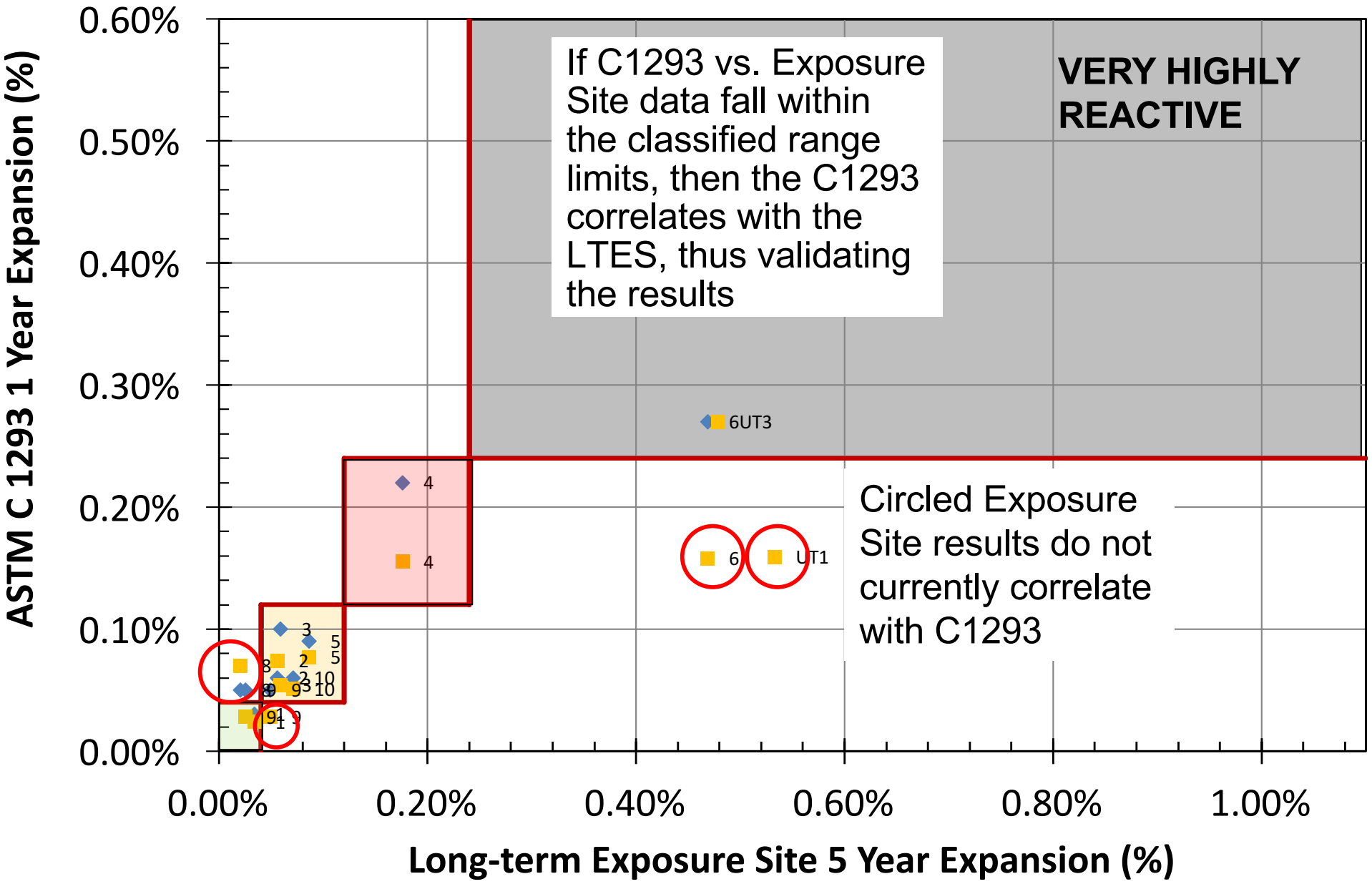
- **Which “Patients” really need preventative “treatment”?**
  - “Patients” that exhibit expansions >0.04 are considered to need preventative “treatment”

# Long-term Exposure Site Expansion (%) for *1.10% $Na_2Oe$*; 100% Cement*

Note* Aggregate 1 was tested using 0.88% $Na_2Oe$; Aggregate 9 is being tested twice

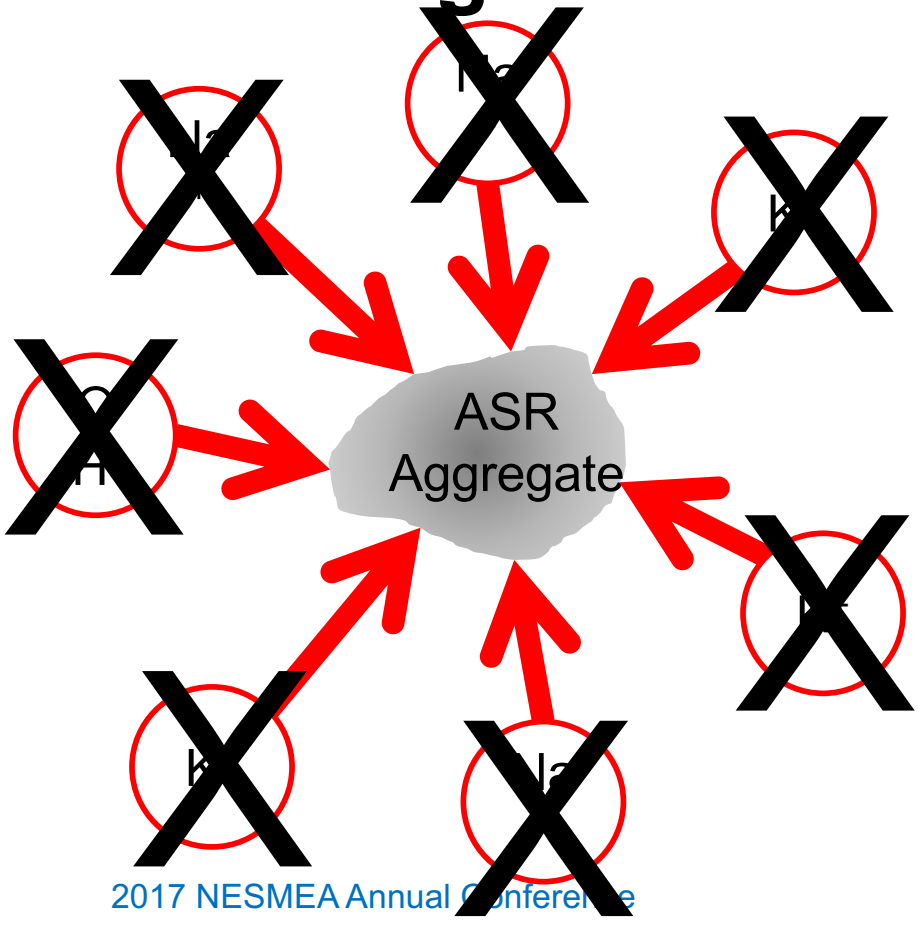


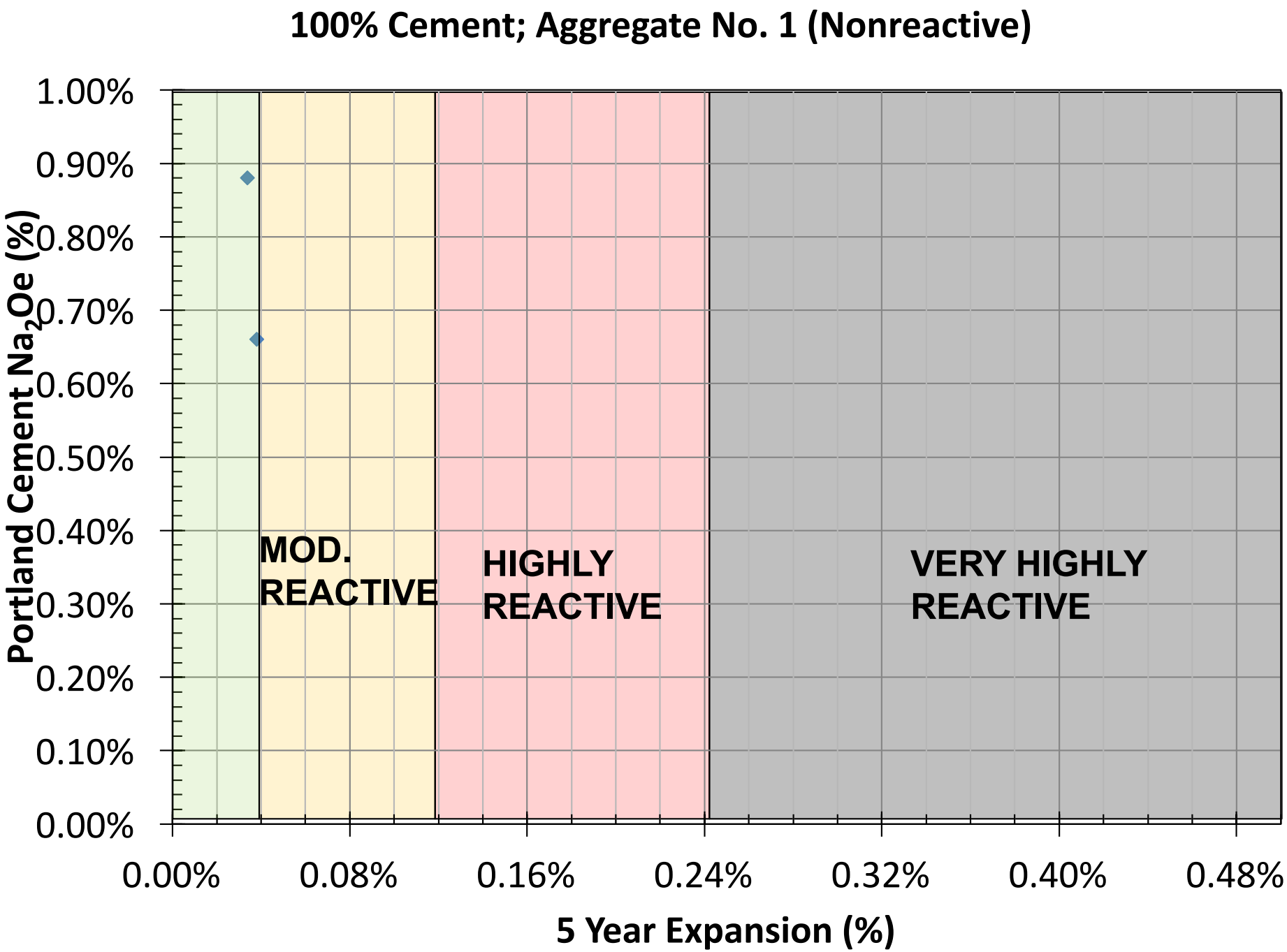
# ASTM C1293 (1 Year) vs Long-term Exposure Site (5 Year)
## Expansion (%) for *100% Cement*

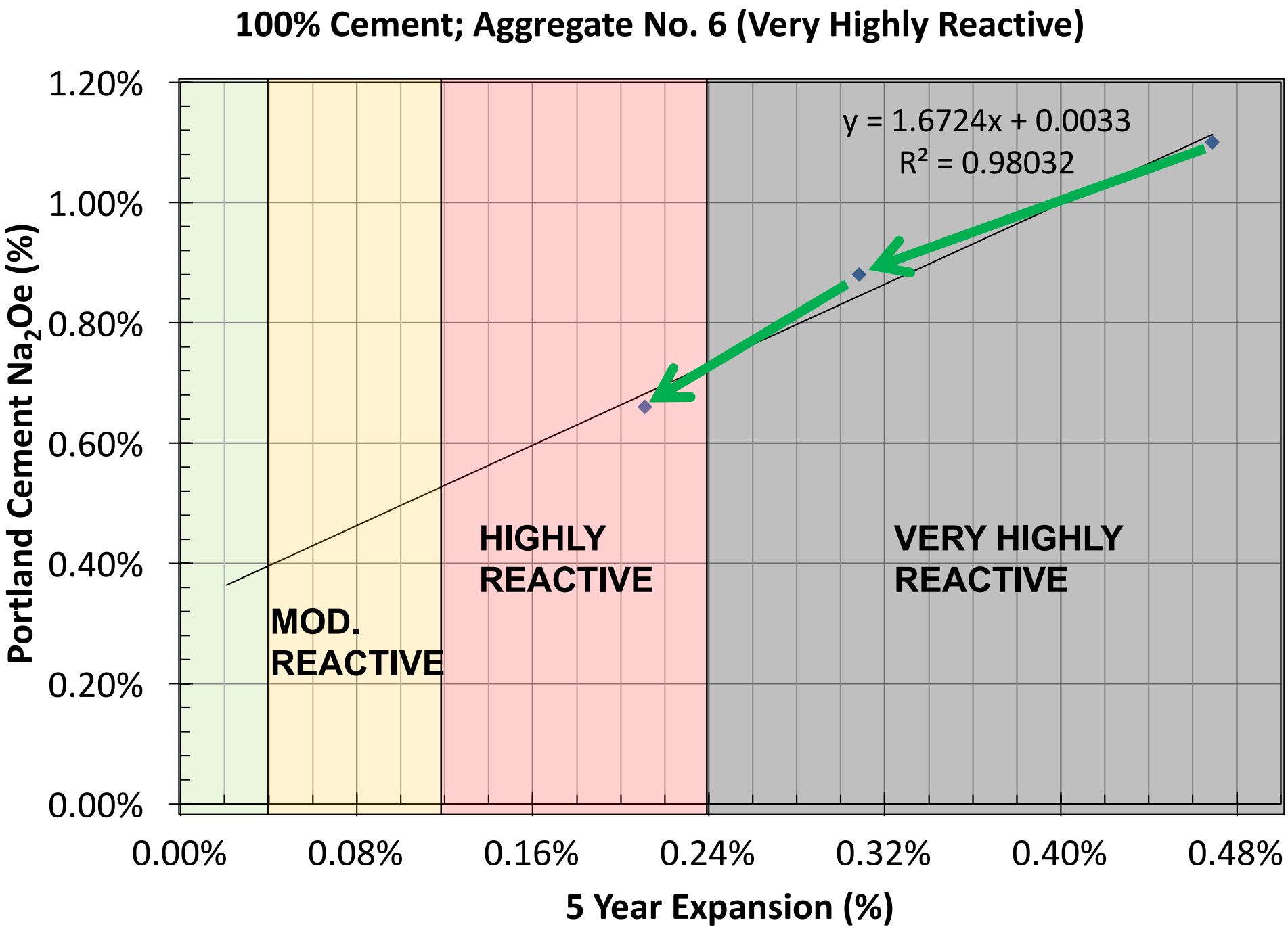


# “Clinical” Trials: Day 1828 (5 yr)

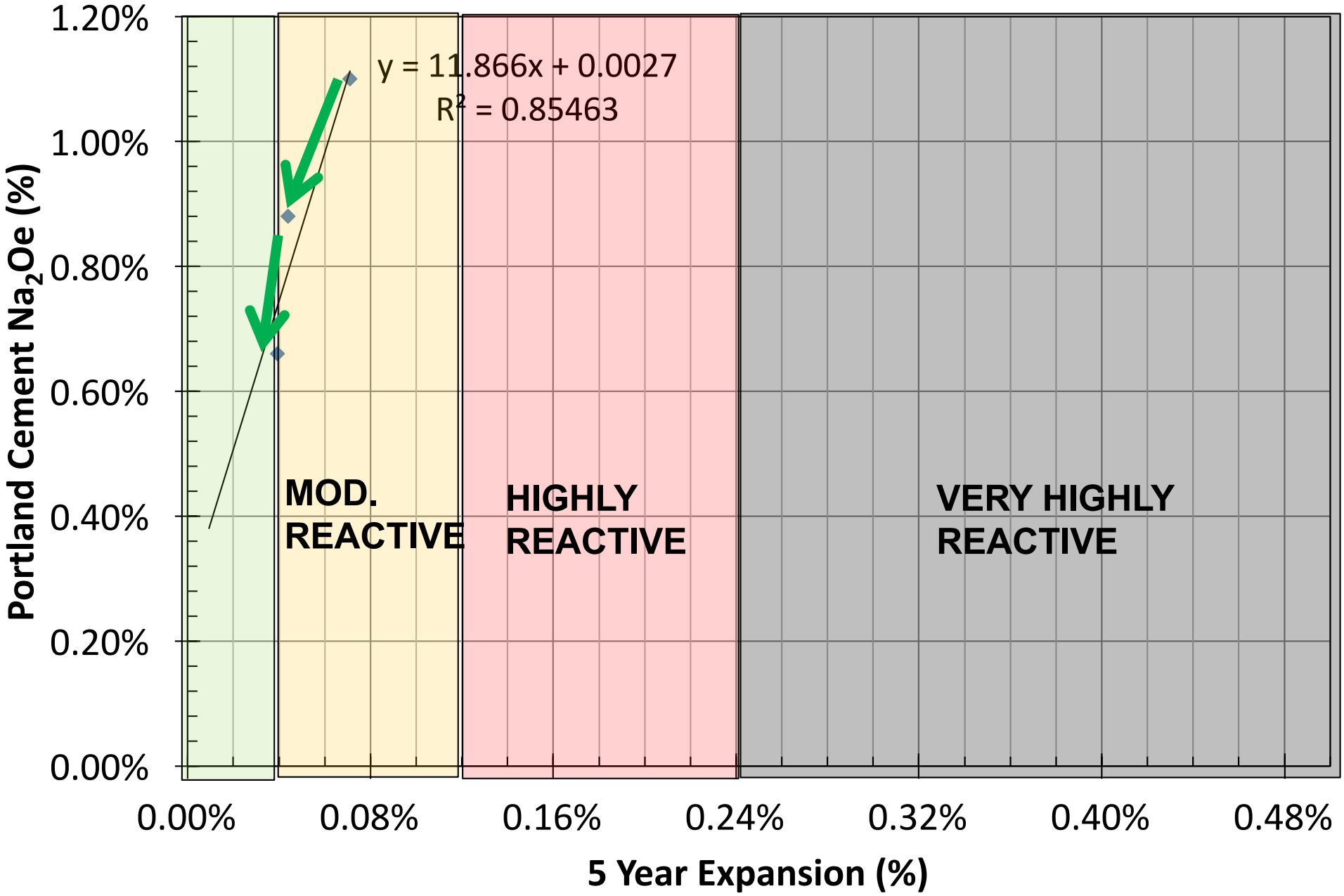
- How well are the Low Alkali “treatments” working?




100% Cement; Aggregate No. 1 (Nonreactive)
1.00%
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Portland Cement Na2Oe (%)
MOD. REACTIVE
HIGHLY REACTIVE
VERY HIGHLY REACTIVE
0.00%
0.08%
0.16%
0.24%
0.32%
0.40%
0.48%
5 Year Expansion (%)
Non-Reactive Aggregate No. 1


100% Cement; Aggregate No. 6 (Very Highly Reactive)
y = 1.6724x + 0.0033
R² = 0.98032
MOD. REACTIVE
HIGHLY REACTIVE
VERY HIGHLY REACTIVE
Portland Cement Na2Oe (%)
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
0.00%
0.08%
0.16%
0.24%
0.32%
0.40%
0.48%
5 Year Expansion (%)
Very Highly Reactive Aggregate No. 6
Linear Trendline

# 100% Cement; Aggregate No. 10 (Highly Reactive)



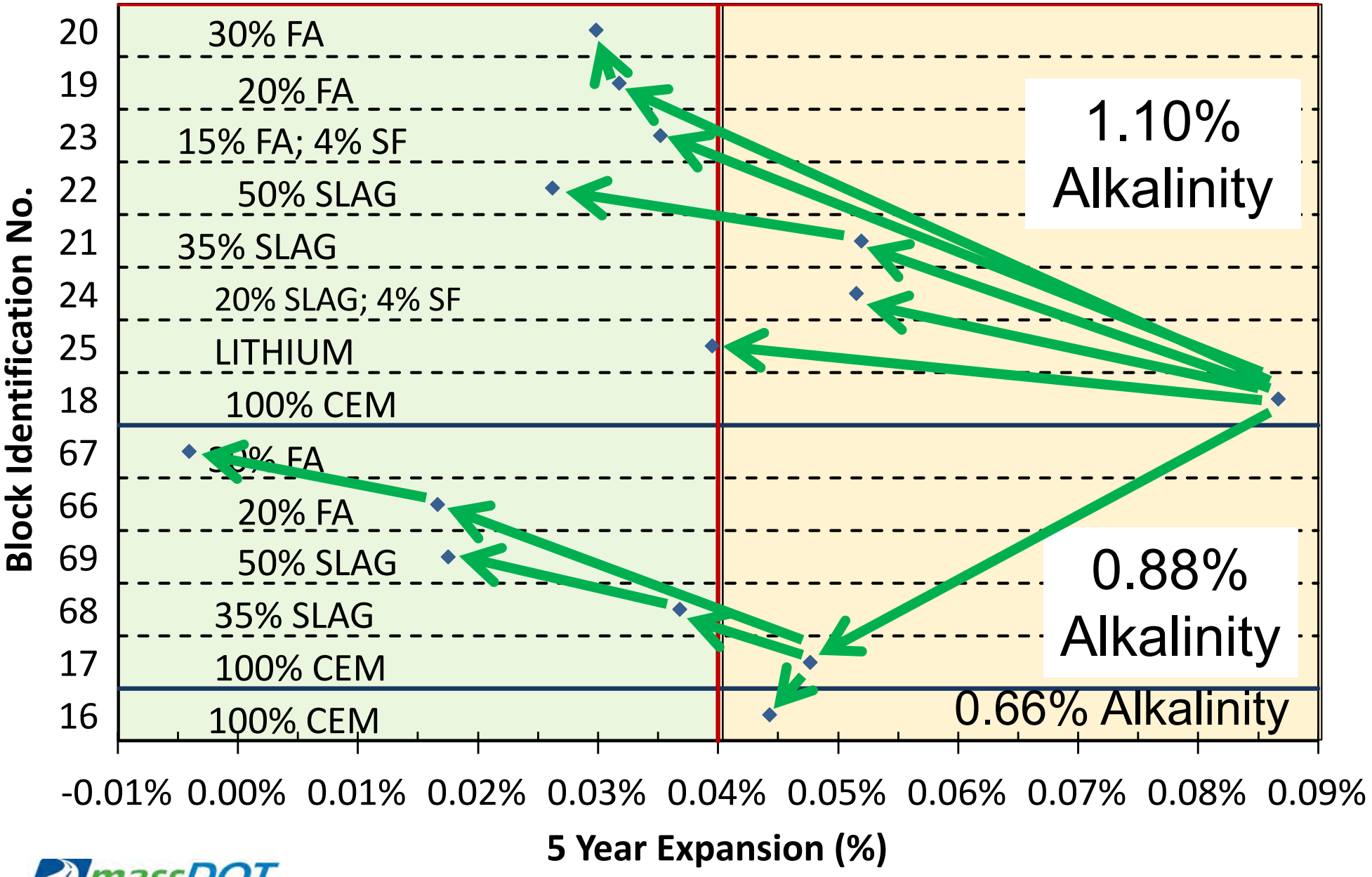

massDOT Massachusetts Department of Transportation Highway Division

◆ Highly Reactive Aggregate No. 10 —— Linear Trendline

# “Clinical” Trials: Day 1828 (5 yr)

- **How well are the Mitigation “treatments” working?**
  - Fly Ash
  - Slag
  - Silica Fume
  - Lithium

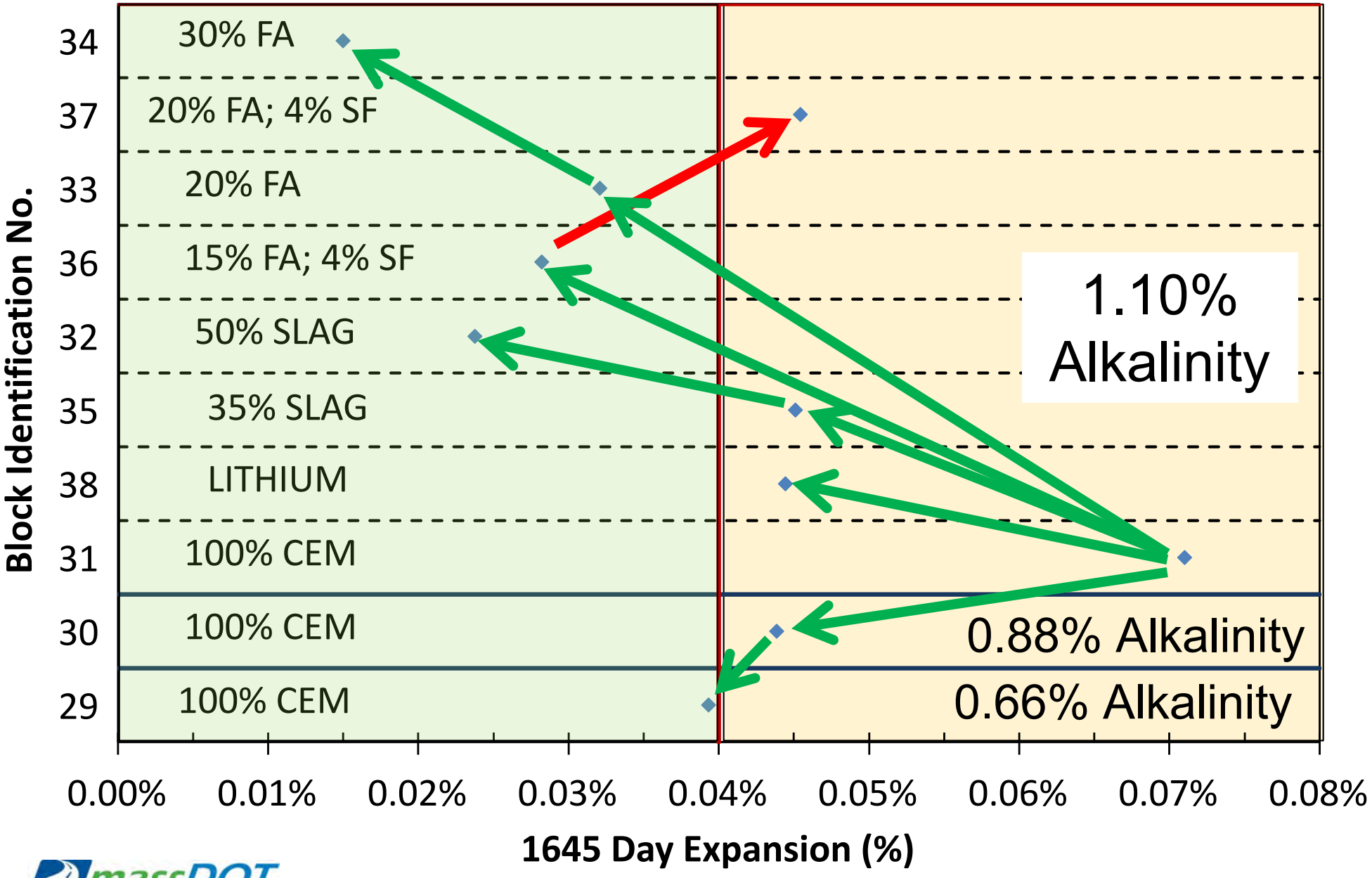
# Long-term Exposure Site Expansion (%) for Aggregate No. 5 (Very Highly Reactive)




massDOT Massachusetts Department of Transportation Highway Division

◆ Very Highly Reactive Aggregate No. 5 — ASTM C1293 Reactivity Limit

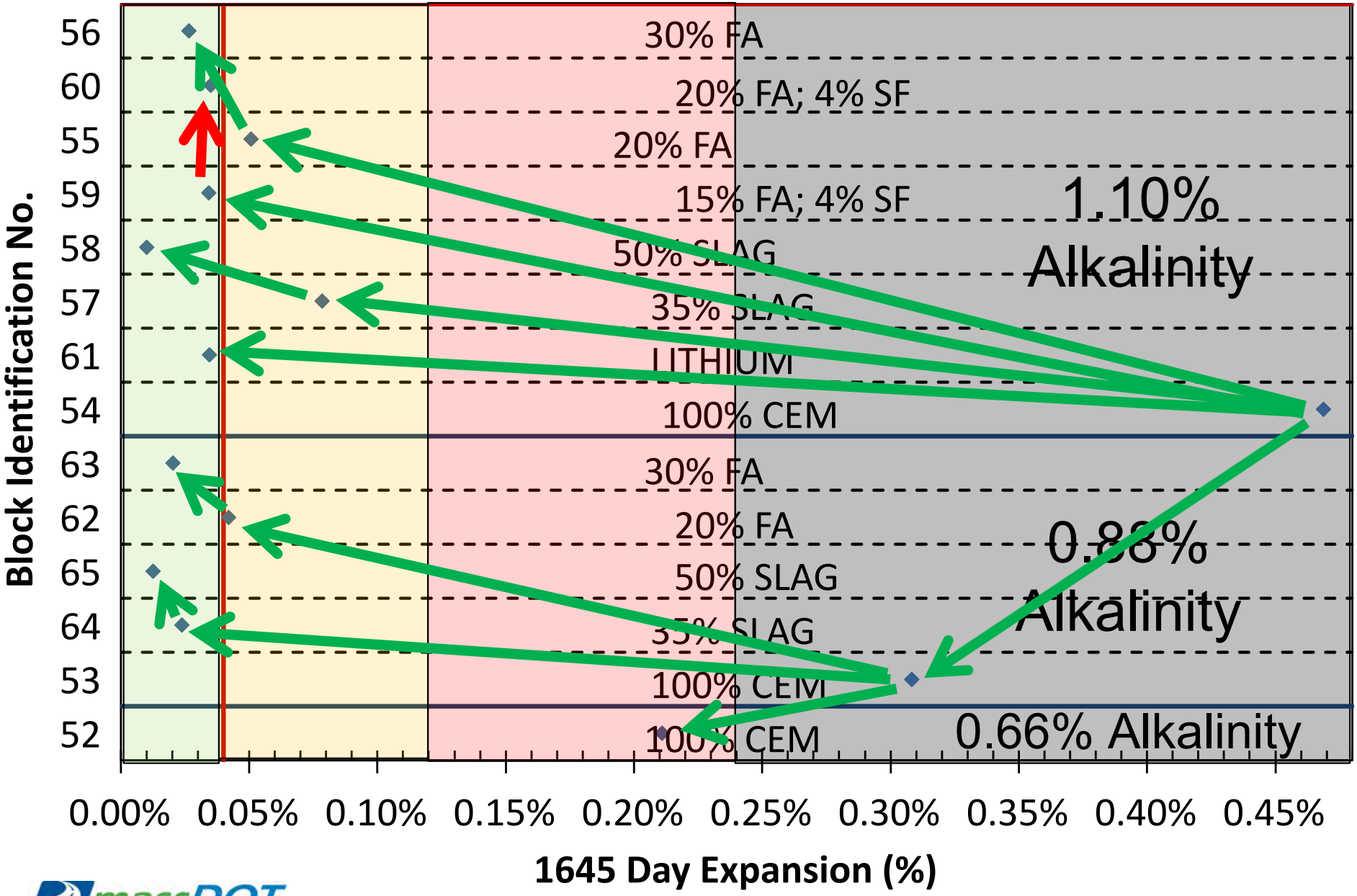
# Long-term Exposure Site Expansion (%) for Aggregate No. 10 (Highly Reactive)




massDOT Massachusetts Department of Transportation Highway Division

◆ Very Highly Reactive Aggregate No. 6 — ASTM C1293 Reactivity Limit

# Long-term Exposure Site Expansion (%) for Aggregate No. 6 (Very Highly Reactive)

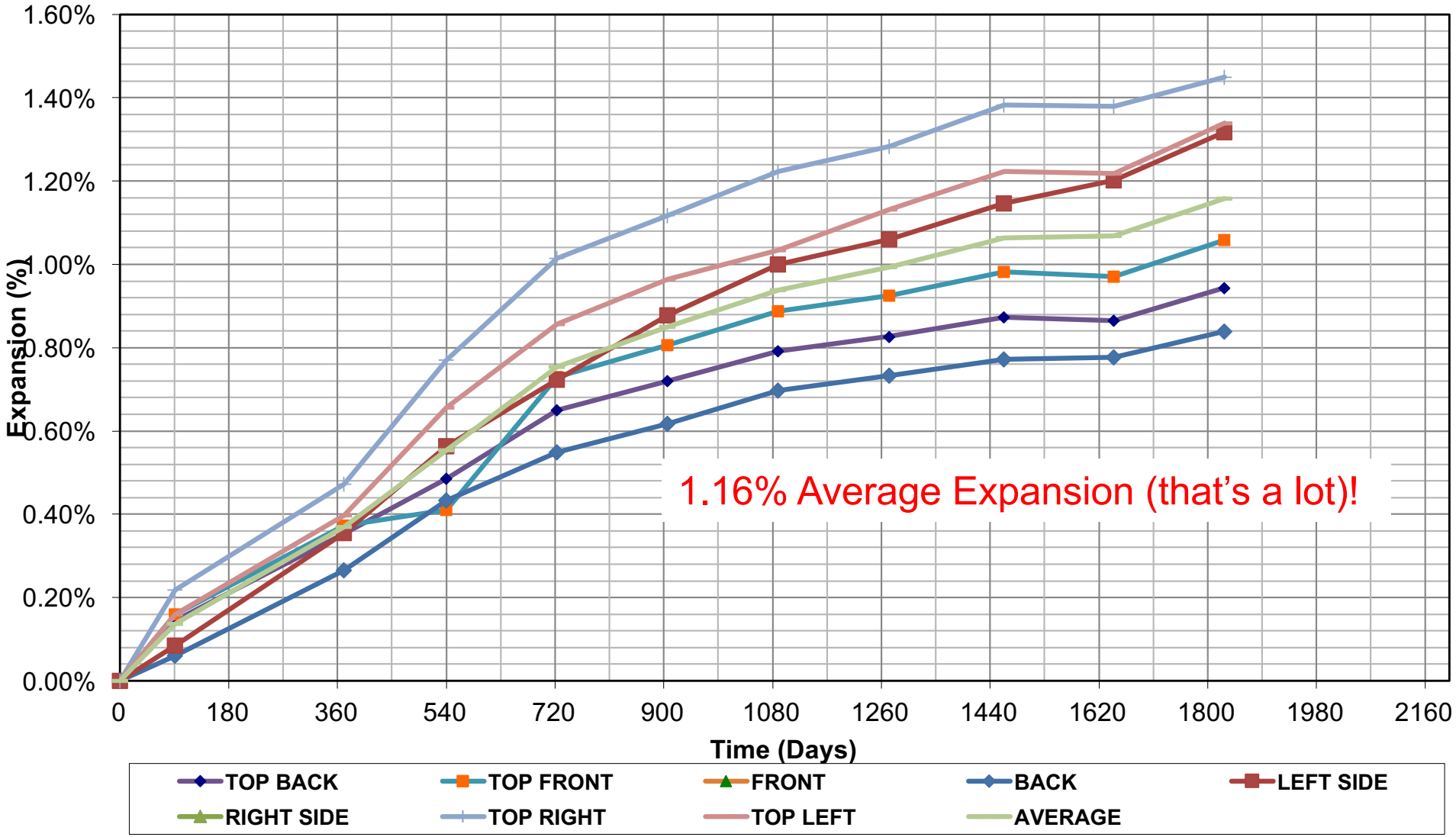



massDOT Massachusetts Department of Transportation Highway Division

◆ Very Highly Reactive Aggregate No. 6 — ASTM C1293 Reactivity Limit

# Patient: UT 2 (Jobe, TX), No. 48

# Patient: UT 2 (Jobe, TX), No. 48



# MassDOT Moving Forward

- Evaluate Exposure Site (10 to 20 yrs)
- Establish Trends
- Correlate Field Performance with Lab Tests
- Verify Aggregate Reactivity
- Decrease ASR Lab Test Frequency
- Implement AASHTO TP 110 (56 – 84 Days) and ASTM C 1293 (1 – 2 Years)
- Identify appropriate preventative "Treatment" to MassDOT aggregates to slow down or eliminate ASR

# Conclusion

- Eliminate only ONE of the three conditions to eliminate ASR all together
- “Screen” “Patients” for ASR using various laboratory test methods
- “Prescribe” the proper “treatment” and “dosage” of “medicine” to the “Patients”
- Remember! Different “Patients” may react drastically dissimilar to the same “medicine”!
- Identify Nonreactive / reactive aggregates with confidence
- Correlate aggregates with appropriate lab tests

# Conclusion

- There is no Silver Bullet


# Questions and Comments