



SWIFT 2013 CONFERENCE and TRADE SHOW



ASR PREVENTION and REMEDICATION AT NORTHWEST ARKANSAS REGIONAL AIRPORT (XNA)

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BACKGROUND



US AIRPORTS WITH ASR

- Hartsfield-Jackson Atlanta International Airport
- Greenville-Spartanburg Airport, South Carolina
- Denver International Airport, Colorado
- Colorado Springs Airport, Colorado
- Idaho Falls Regional Airport, Idaho
- Memphis International Airport, Tennessee
- Regional Airports in Wyoming
- Northwest Arkansas Regional Airport



NORTHWEST ARKANSAS REGIONAL AIRPORT (XNA)

XNA



- 2nd Busiest AR Airport
 - 565,045 ENPLANEMENTS (2012)
- Wal-Mart, Tyson Foods, JB Hunt Transportation, & University of Arkansas
- ALLEGiant, AMERICAN AIRLINES, DELTA, US AIRWAYS, and UNITE AIRLINES
- Single Runway 16/34
- Opened on November 1, 1998



XNA

- 17/35 Alternate Landing Surface Opened July 31, 2012
- Runway 16/34 closed in 2012
- Cost:
 - \$38,531,000 for 17/35 Alternate Landing Surface
 - \$37,856,000 for 16/34 Runway
 - \$7 – 10,000,000 for Taxiway Bravo
- 16/34 to be Opened December 2013

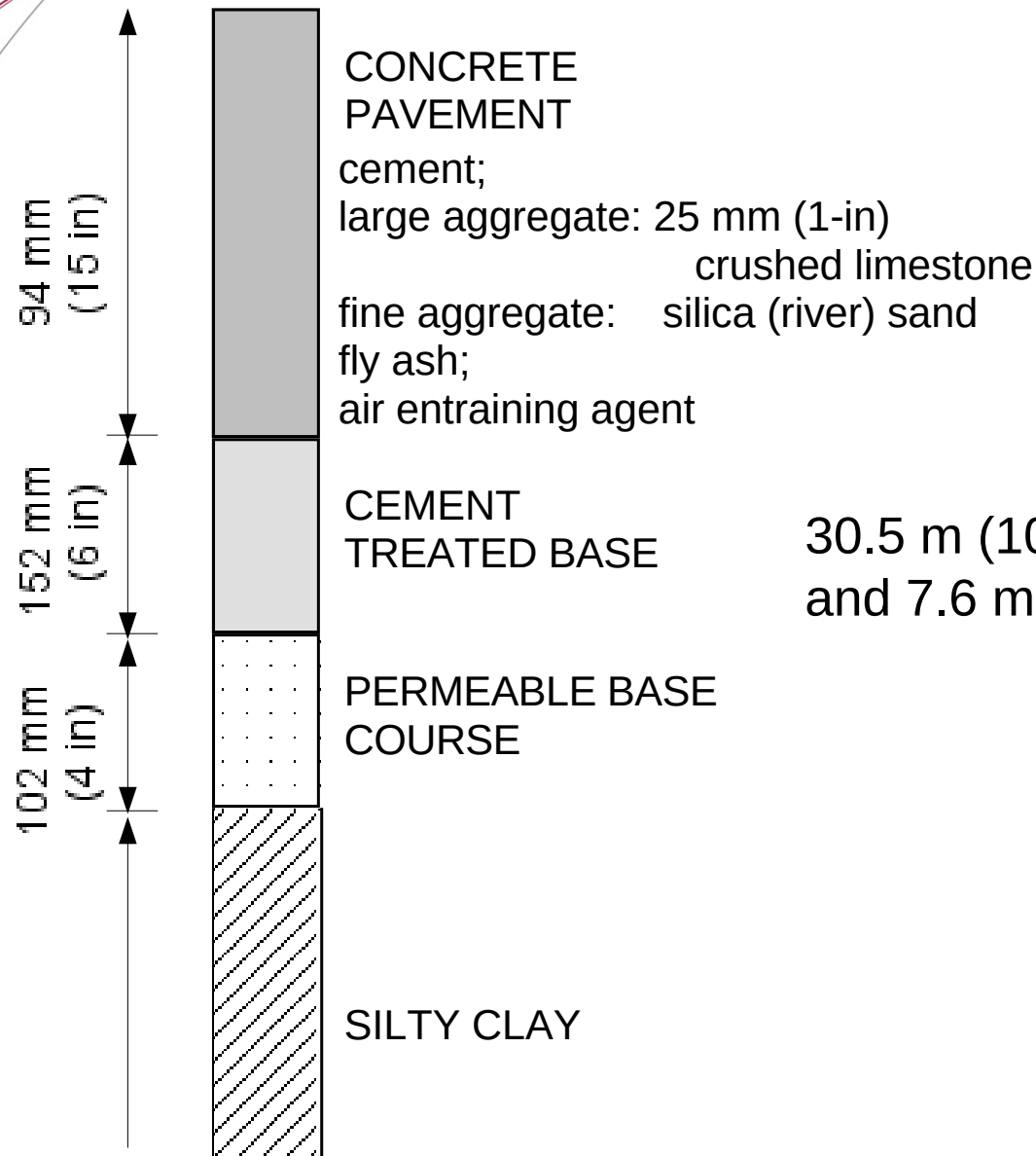


XNA (AERIAL VIEW)

ref: Google Earth



RUNWAY CROSS SECTION



30.5 m (100 ft) concrete pavement runway
and 7.6 m (25 ft) asphalt shoulders



ALKALI SILICA REACTION (ASR)

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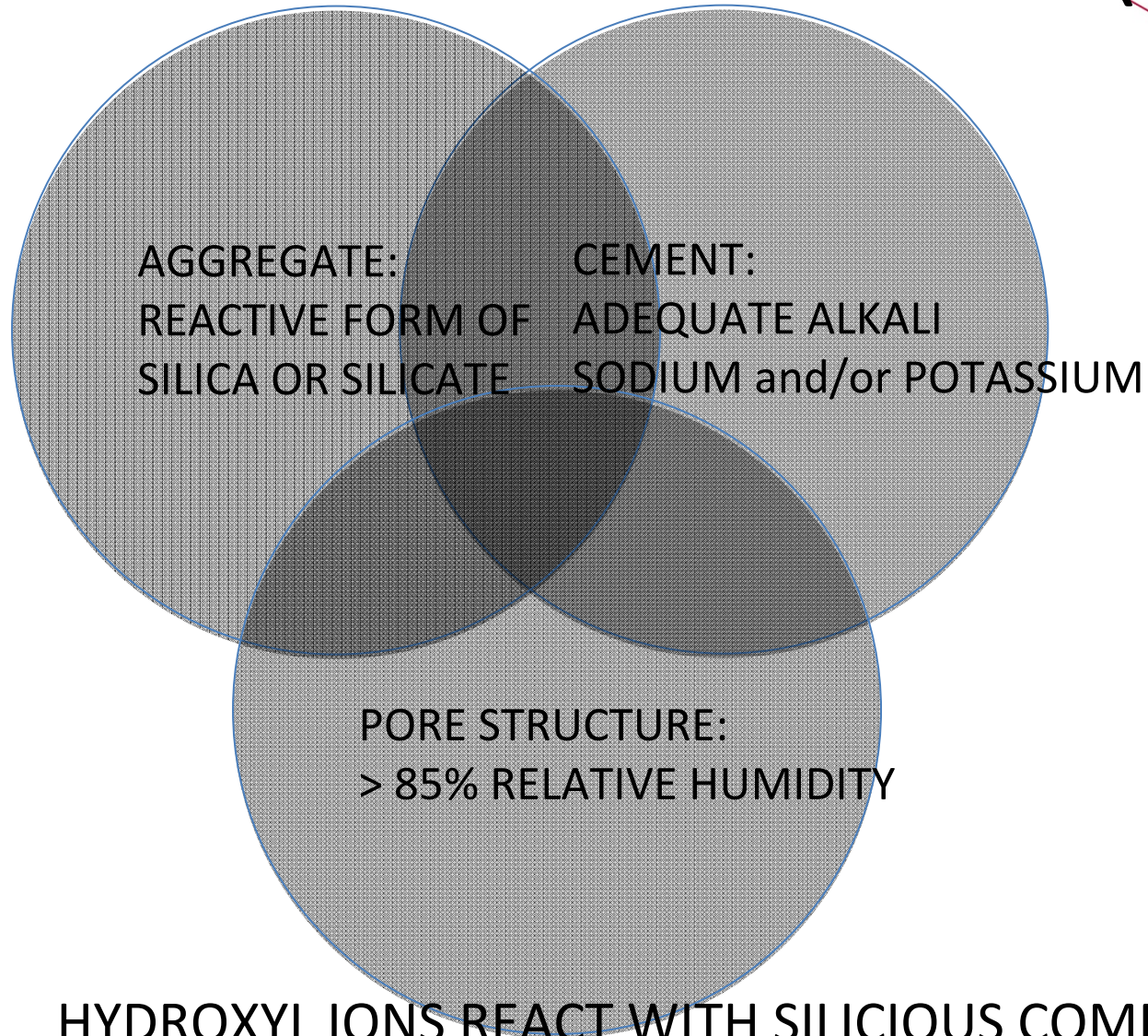


AGGREGATE:
REACTIVE FORM OF
SILICA OR SILICATE

CEMENT:
ADEQUATE ALKALI ($>.6\%$)
SODIUM and/or POTASSIUM

PORE STRUCTURE:
 $> 85\%$ RELATIVE HUMIDITY

ALKALI SILICA REACTION (ASR)



HYDROXYL IONS REACT WITH SILICIOUS COMPONENTS >>
HYGROSCOPIC ALKALI-SILICA GEL

AMBIENT CONDITIONS (AC 150/5380-8A; TTI)



- INTENSIFIES

- RAINFALL > 1016 mm, 40-in
(1170 mm, 46-in avg. annual)
- RELATIVE HUMIDITY > 80%
(avg. annual 77%)
- FREEZE-THAW CYCLES >
20 cycles/year (60 cycles/year)
- DE-ICING SALTS (alkali bearing)
Sodium Formate Granules
- DYNAMIC LOADS

- INHIBITORS

- FLY ASH
- BLAST SLAG



ASR DETECTION

- VISUAL DETECTION (PRELIMINARY)
 - PAVEMENT DISTRESS (CRACKING)
 - PAVEMENT STRUCTURE CONDITION
 - JOINT CLOSURE
 - HEAVING
 - RELATIVE JOINT MOVEMENT IN ADJACENT SLAB PANELS
- LABORATORY TESTING (CONFIRM)
 - PETROGRAPHIC ANALYSIS



RIGID PAVEMENT DESIGN

- FAA Advisory Circular 150/5370-10F;
Standards for Specifying Construction of
Airports
 - Item P-501 Portland Cement Concrete Pavement
 - 1998: Allowed for Class C or Class F Fly Ash
 - 2011: Class F Fly Ash or N (Natural Pozzolan)
(Class C with innocuous aggregates, no airfield pavement
de-icers, approval from the engineer and FAA)



ALKALI SILICA REACTION @ NORTHWEST ARKANSAS REGIONAL AIRPORT



TAXIWAY (PAVEMENT-SHOULDER BOUNDARY)



ASR DISTRESS



SURFACE CRACKING

JOINT ALIGNMENT

JOINT CLOSURE





JOINT ALIGNMENT





FAA SITE VISIT

- April 9, 2008
- Expansive growth due to Alkali-Silica Reactivity (ASR)
- ASR distress will accelerate
- 5-7 years additional service
- Deicing chemicals (sodium formate pellets) not related to the primary distress
- Reconstruction of Runway 16-34 and Taxiway A



RUNWAY RECONSTRUCTION





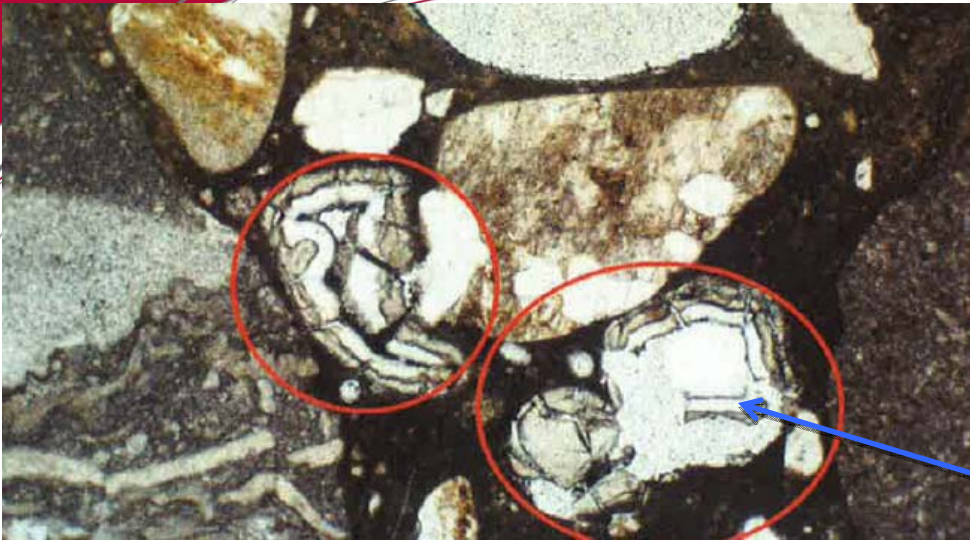
PETROGRAPHIC ANALYSIS

- 5 REPRESENTATIVE BORINGS WITHIN THE RUNWAY PAVEMENT
- ASR TESTING: MINOR TO MODERATE LEVELS

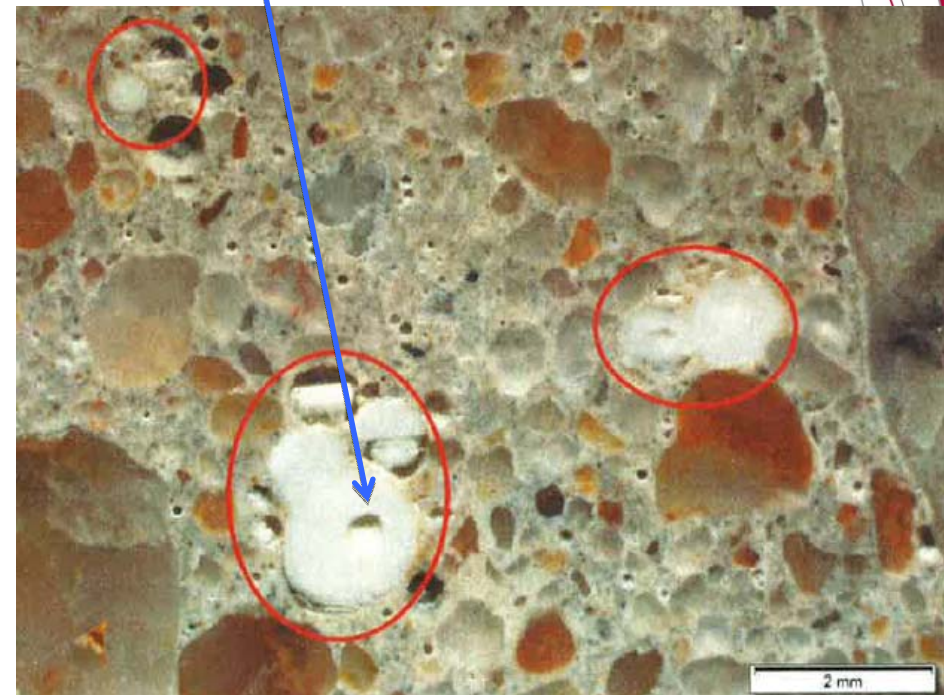
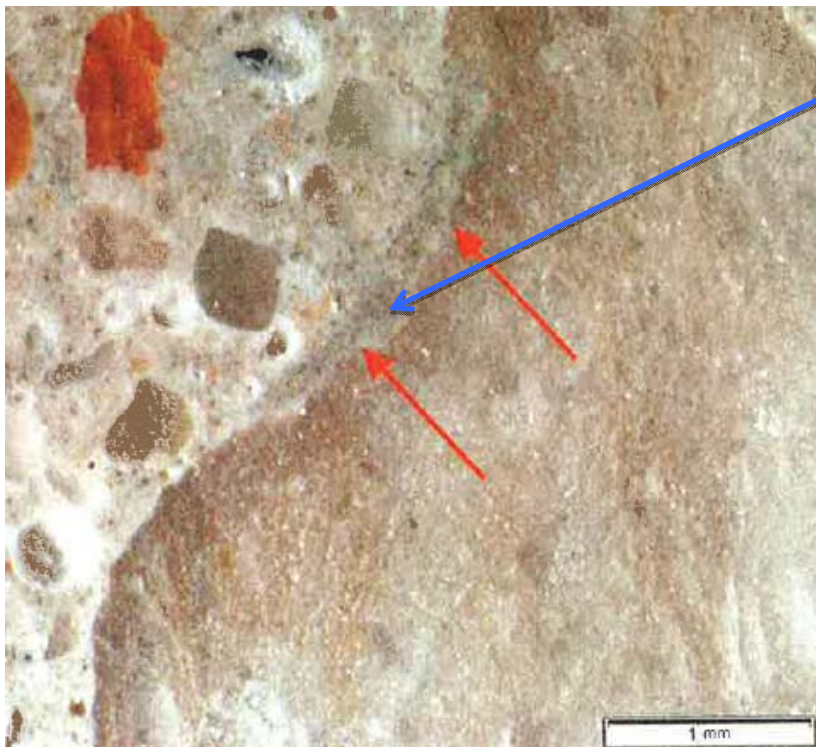


PETROGRAPHIC ANALYSIS

(plane polarized light)



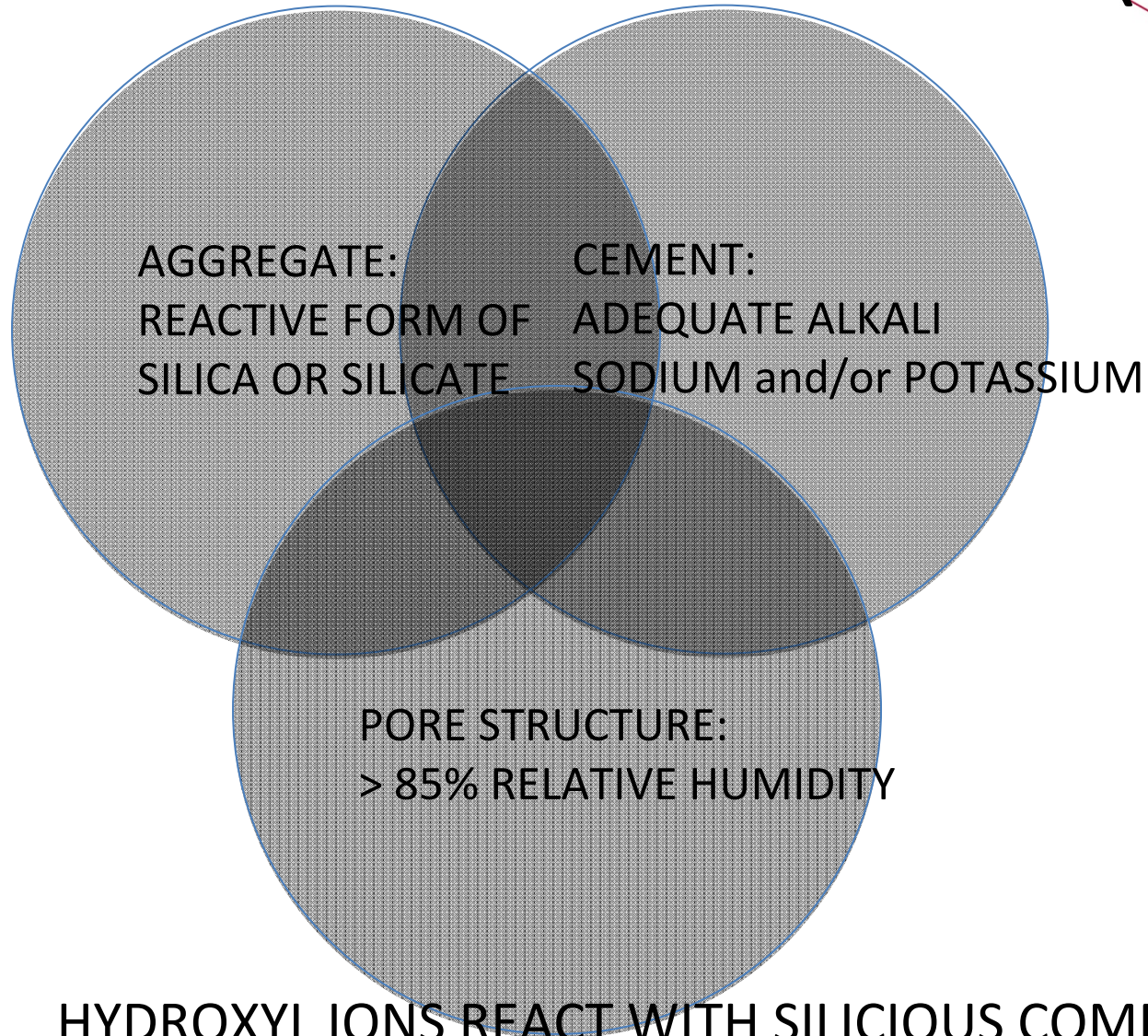
AIR VOID





ASR PREVENTION / MITIGATION

ALKALI SILICA REACTION (ASR)



HYDROXYL IONS REACT WITH SILICIOUS COMPONENTS >>
HYGROSCOPIC ALKALI-SILICA GEL



PREVENTING ASR IN NEW MIXES

- NON-REACTIVE AGGREGATE
- LOW ALKALI CEMENT
- FLY ASH / BLAST FURNACE SLAG (retards reaction, Class F better than Class C)
- LITHIUM NITRATE (prevents gel from expanding)
- SILICA FUME



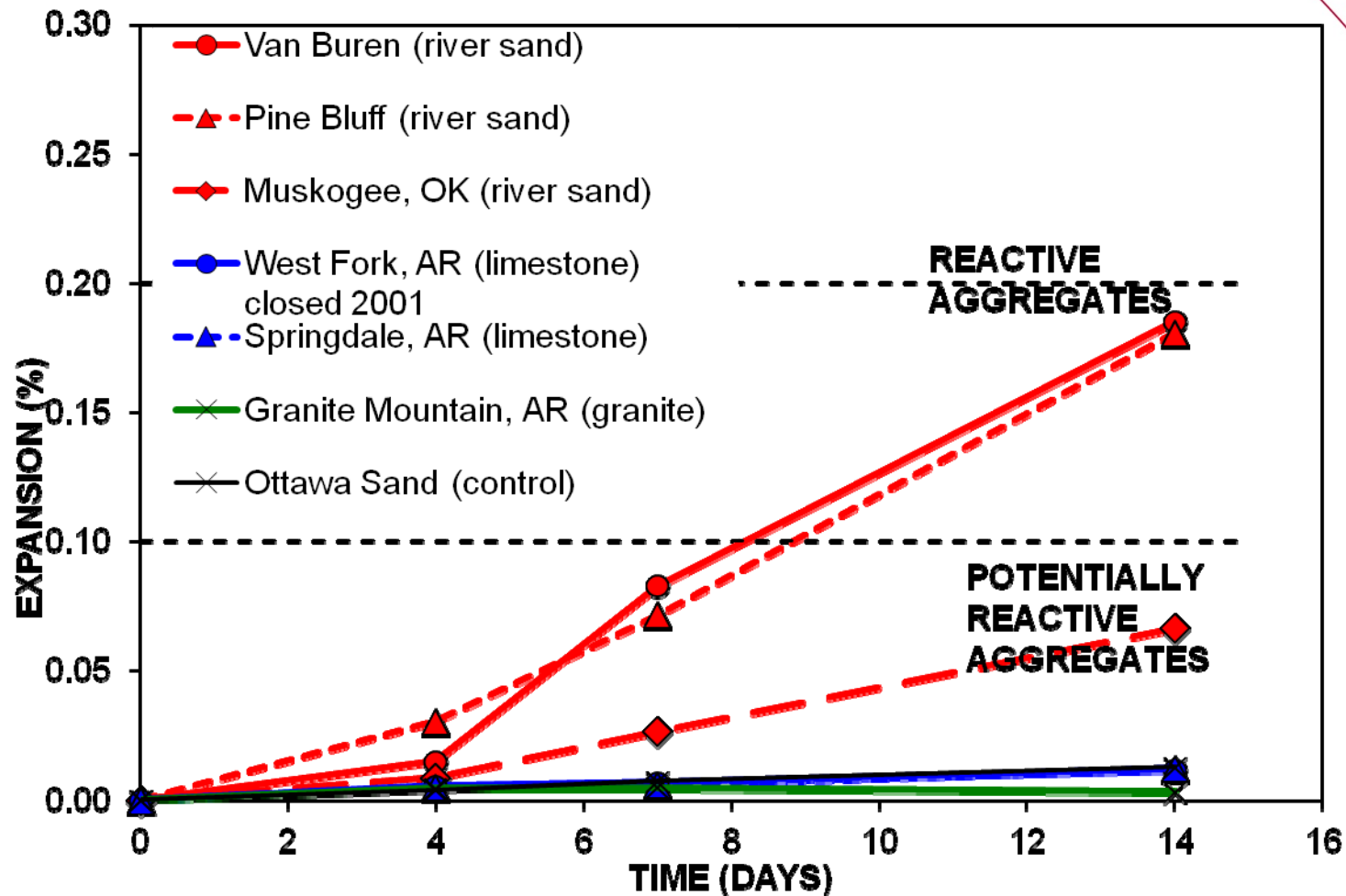
AGGREGATE TESTING

- ACCELERATED MORTAR BAR TEST (ASTM C1260)
- CONCRETE PRISM TEST (ASTM C1293)

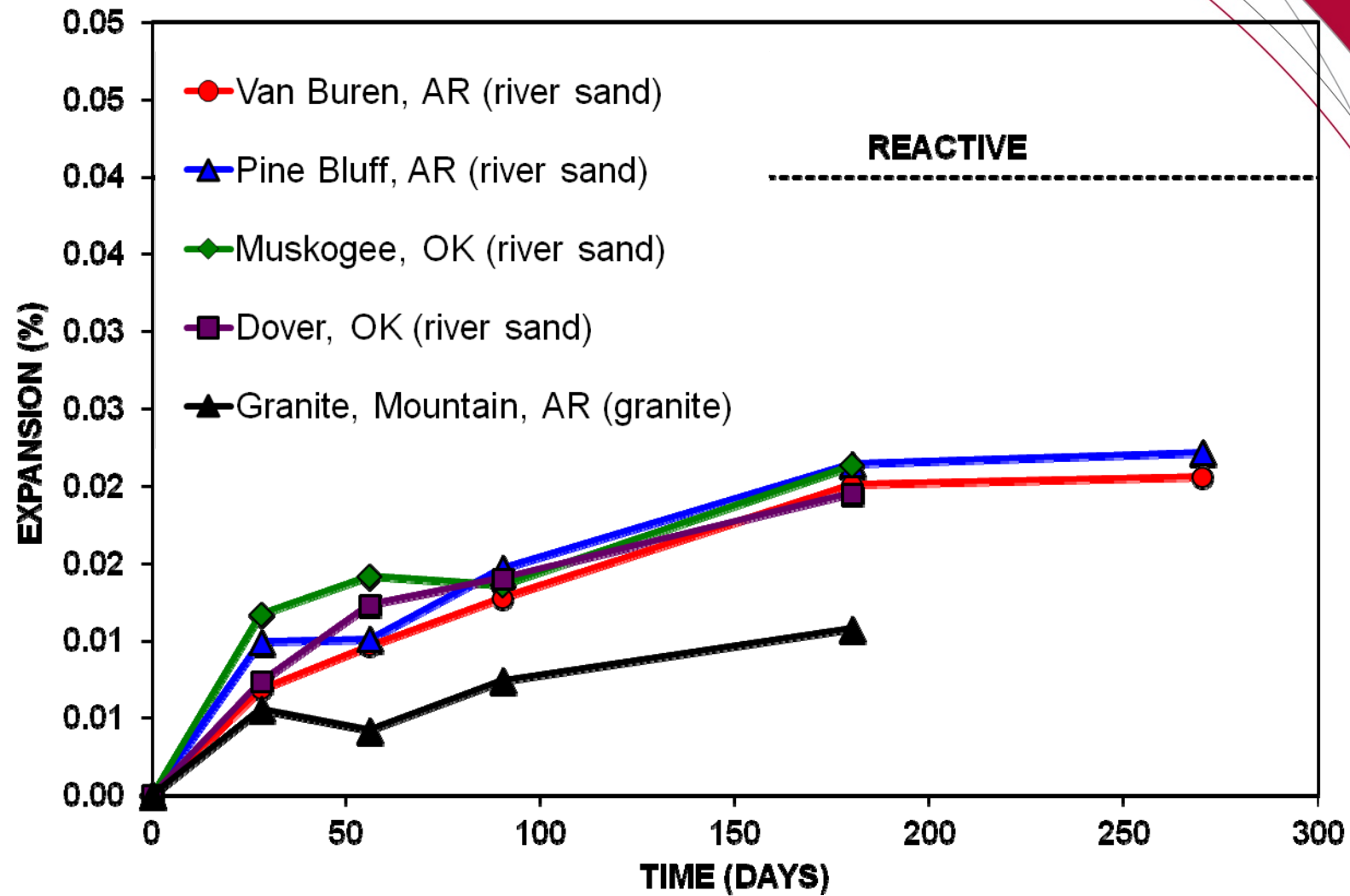
ASTM C1260



(ACCELERATED MORTAR BAR TEST) 3 SPECIMENS / BATCH, 2 BATCHES



ASTM C1293 (CONCRETE PRISM TEST), 3 SPECIMENS / BATCH, 2 BATCHES



REMEDIATION APPROACH



AGGREGATE:
REACTIVE FORM OF
SILICA OR SILICATE

CEMENT:
ADEQUATE ALKALI
SODIUM and/or POTASSIUM

PORE STRUCTURE:
> 85% RELATIVE HUMIDITY

MITIGATING ASR IN EXISTING PAVEMENTS



- LITHIUM NITRATE
 - SPRAY
 - PONDING
 - VACUUM
- ELASTOMERIC COATING
- LINSEED OIL
- SILANE COATING



TEST SETUP



TEST LAYOUT

381 mm x 381 mm x 1524 mm (15 in X 15 in x 60 in)

1T
CONTROL

9T
LINSEED OIL

8T

6T

2T
CONTROL

11T
ELASTOMERIC

10T

7T

4T
SILANE

3T

5T
SILANE

NOT
TREATED

381 mm x 381 mm x 762 mm (15 in X 15 in x 30 in)

TEST SETUP (SECTIONS FROM TWY E & C)



381 mm x 381 mm x 762 mm (15" x 15" x 30")



Silane

Linseed
Elastomer
Not
Treated

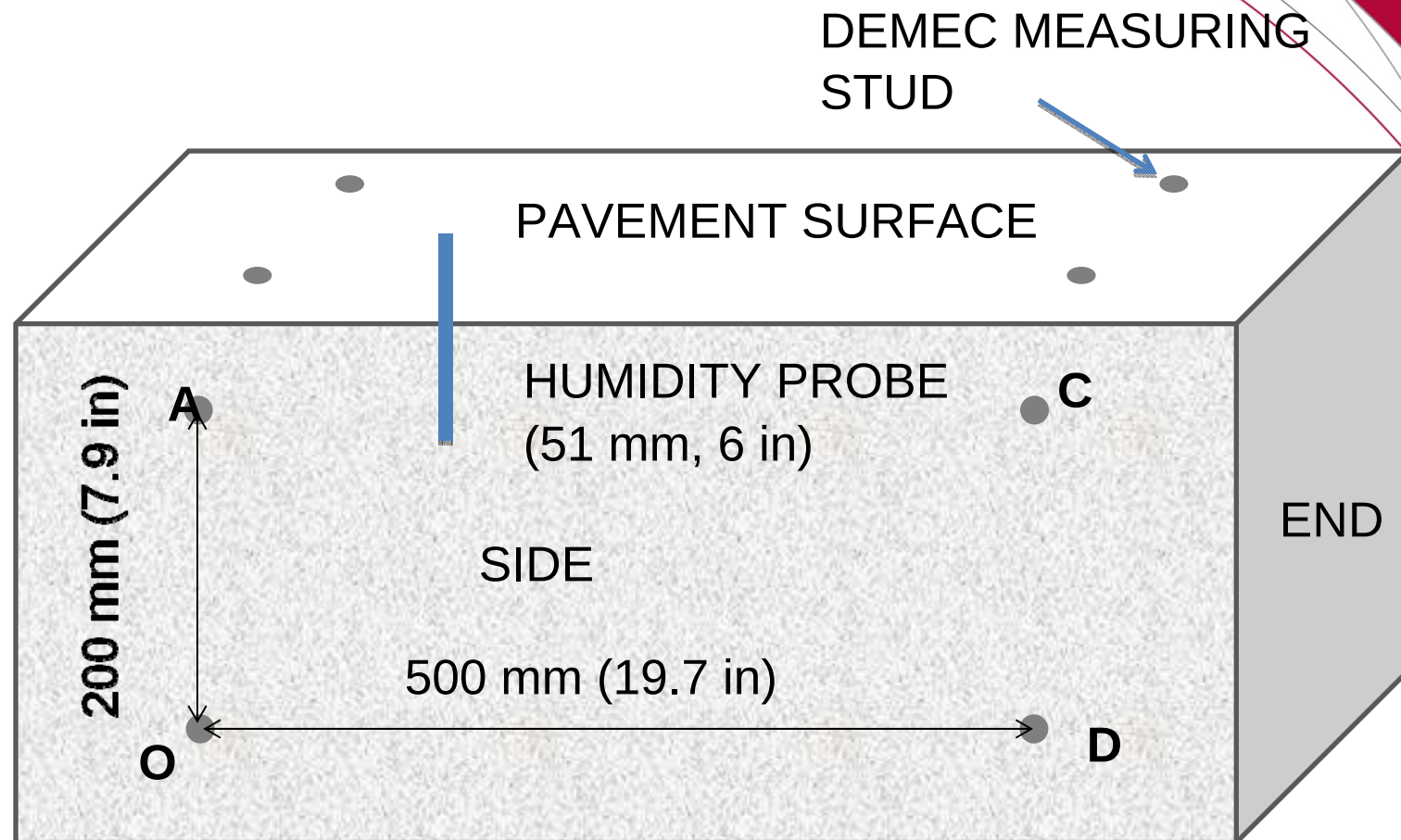
TEST COATINGS (VAPOR BARRIERS)



- SILANE
- LINSEED OIL
- ELASTOMERIC COATING

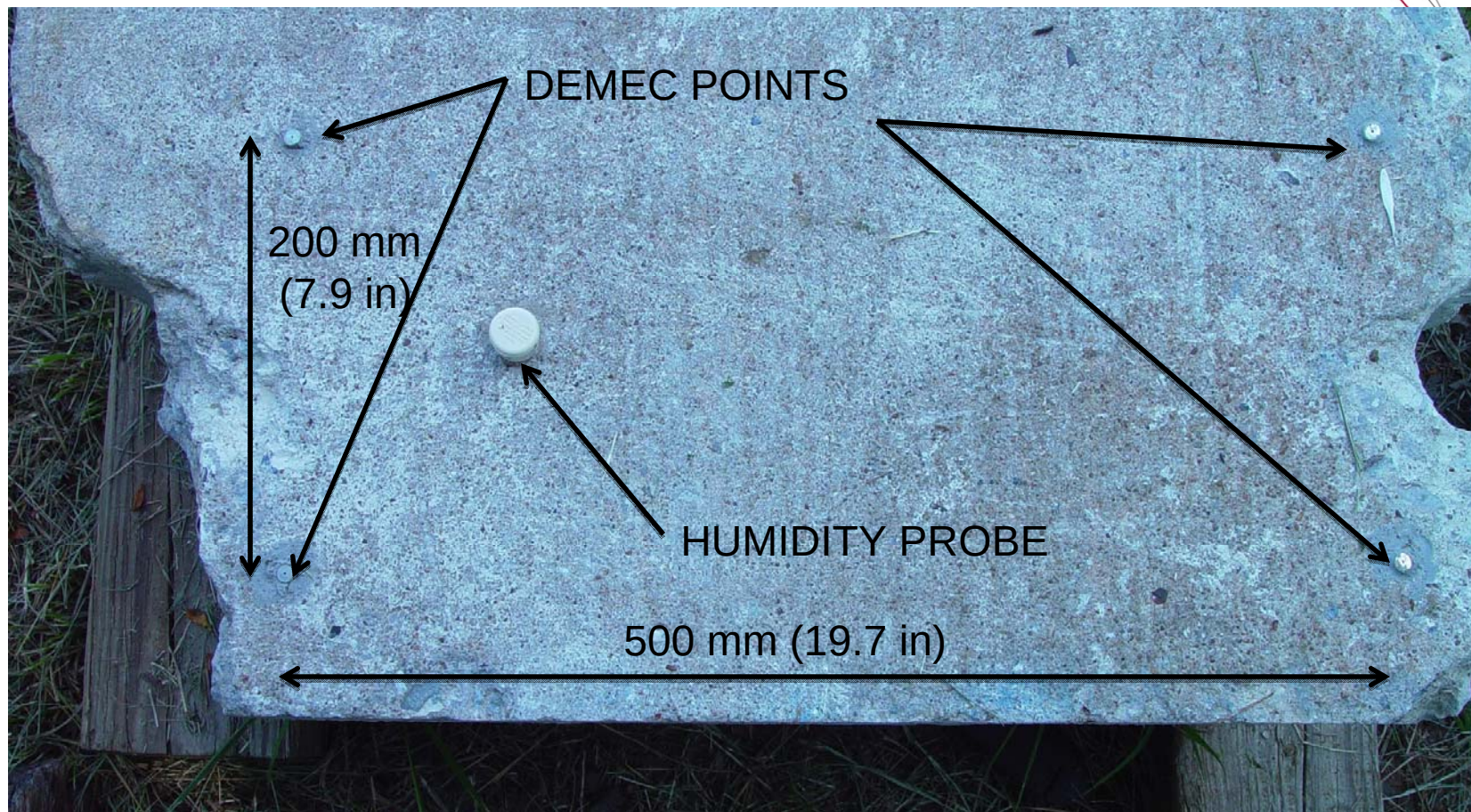


RUNWAY SECTION TEST SAMPLES





TEST MEASUREMENTS





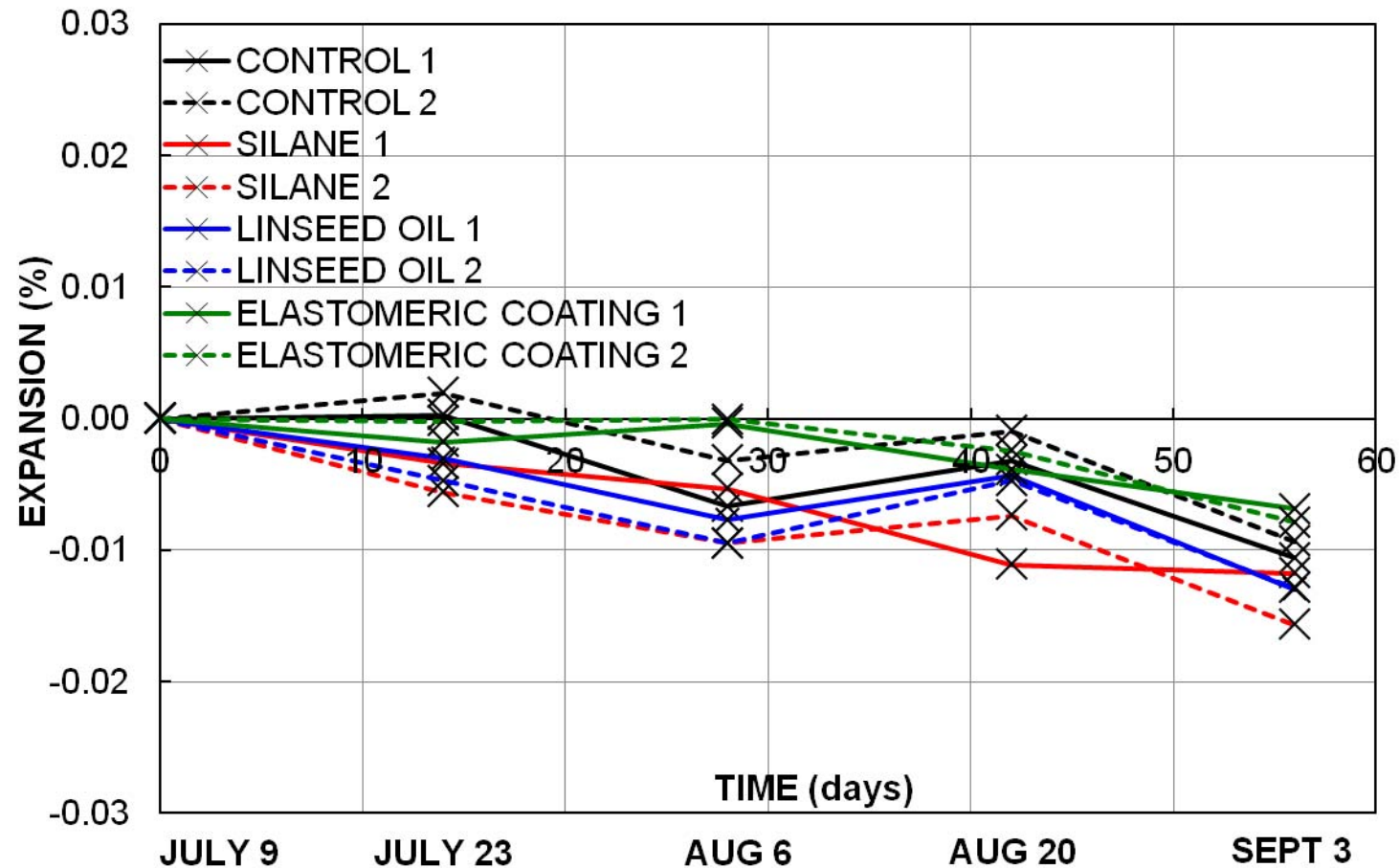
DEMEC STRAIN GAUGE MEASURING





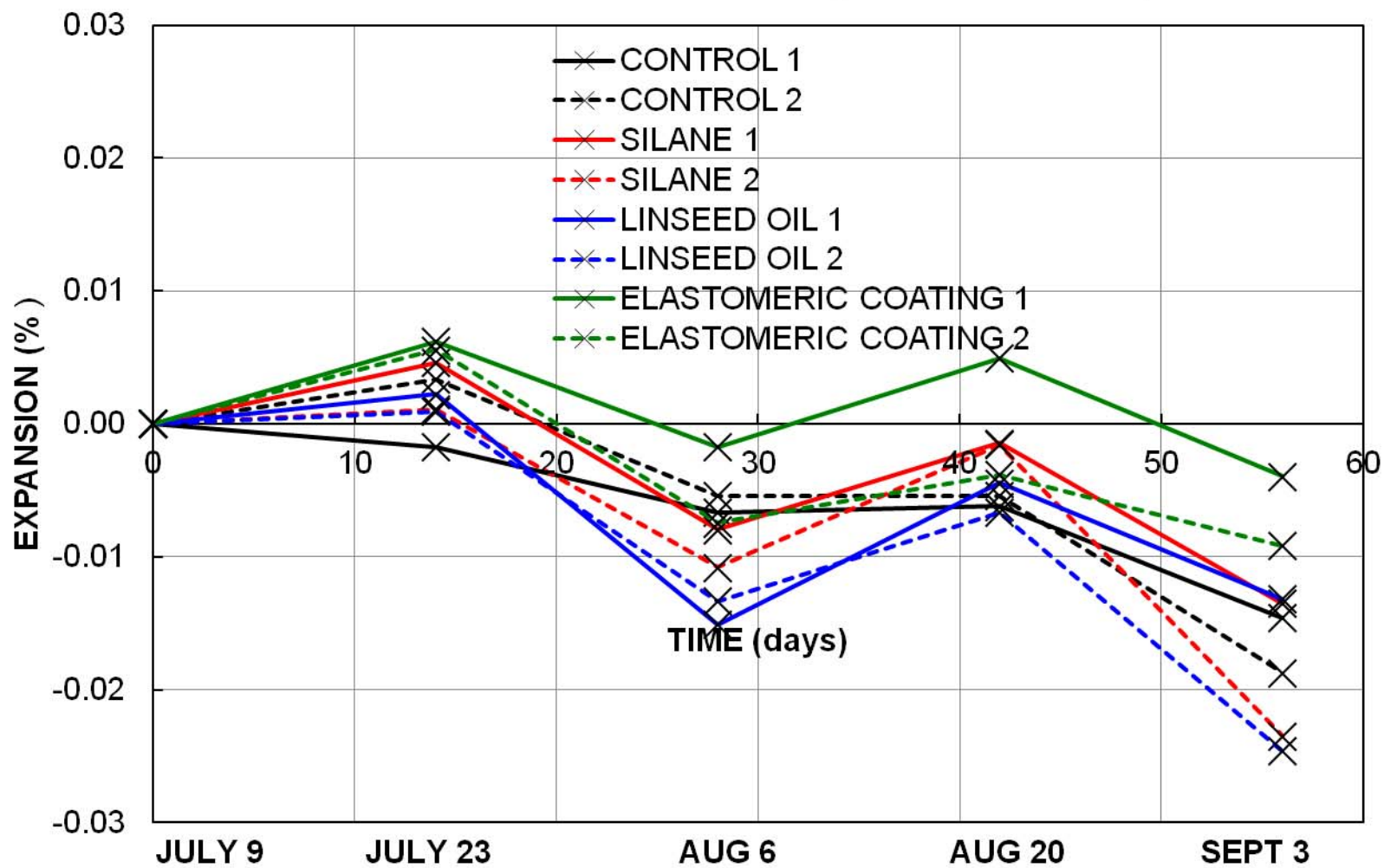
EXPANSION (TOP SURFACE)

LONGITUDINAL EXPANSION (TOP SURFACE)



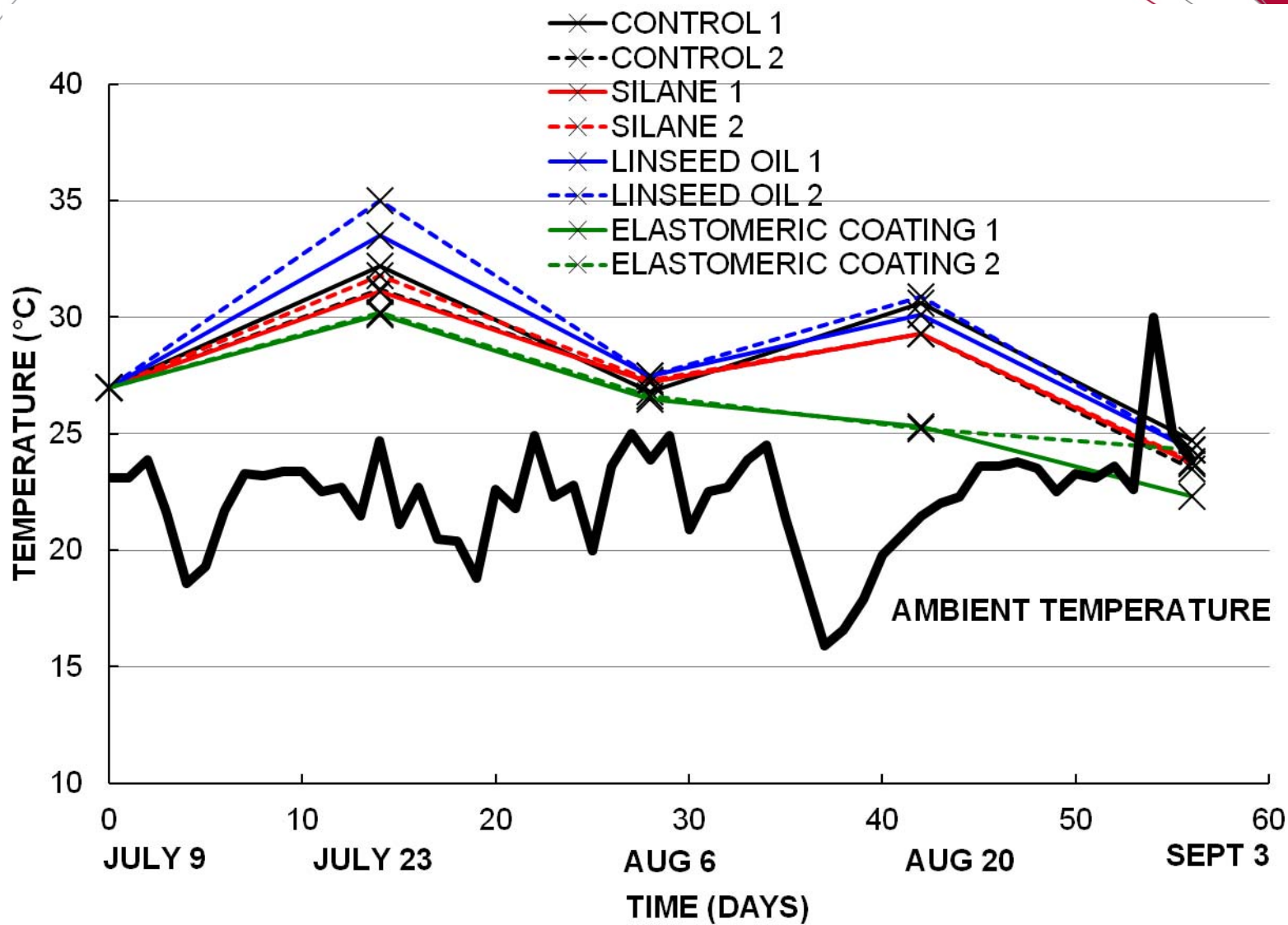


HORIZONTAL EXPANSION (TOP SURFACE)



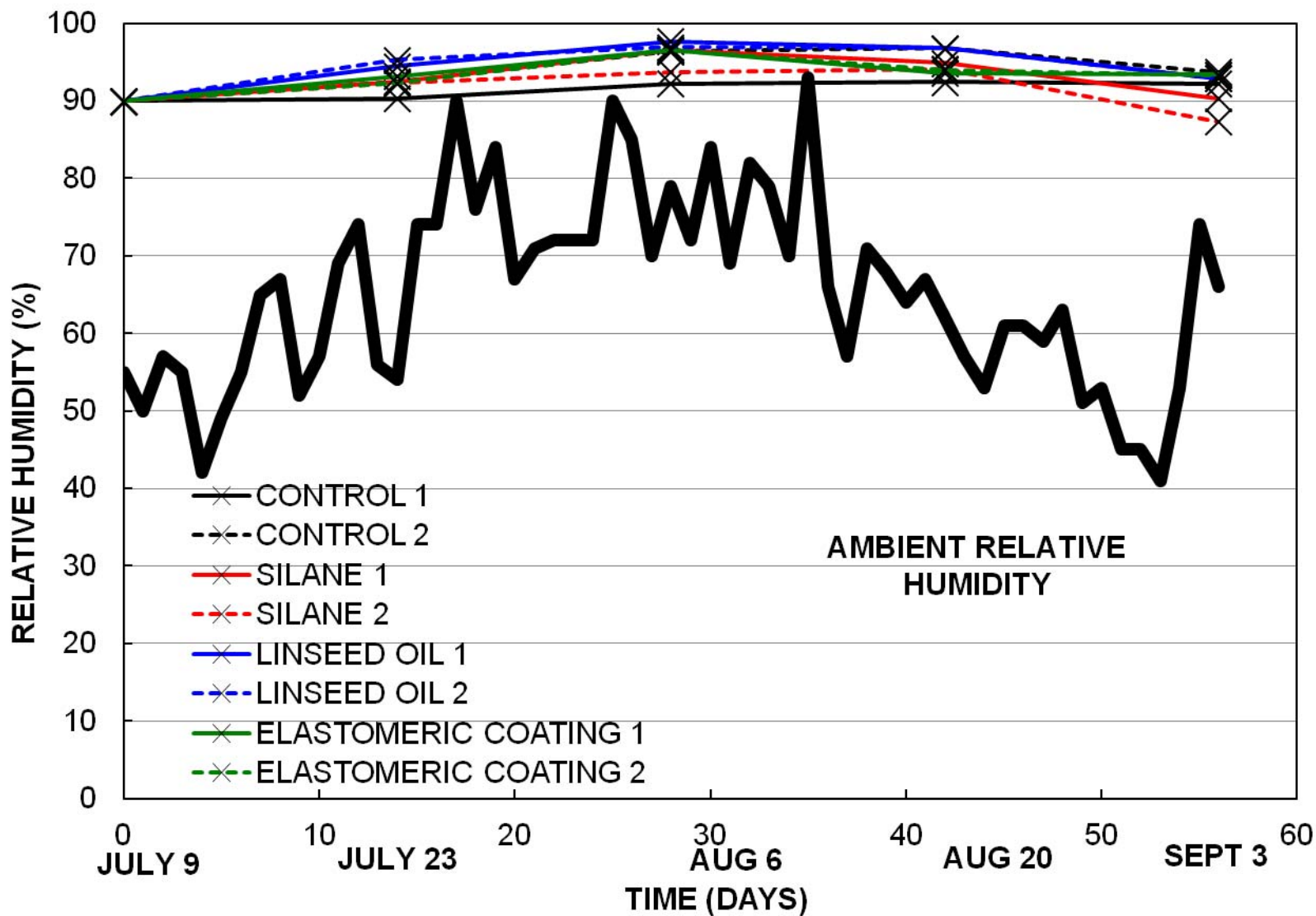


INTERNAL TEMPERATURE





INTERNAL RELATIVE HUMIDITY





COST

- SPRAY APPLICATION: SILANE & LINSEED OIL
- BRUSH APPLICATION: ELASTOMERIC PAINT

COATING	COST \$ / liter (\$ / gal)	APPLICATION RATE m ² / liter (ft ² / gal)	COST \$ / m ² (\$ / ft ²)
SILANE	11.4 (43)	3.68 (150)	3.10 (0.29)
ELASTOMERIC PAINT	13.2 (50)	2.46 (100)	5.37 (0.50)
LINSEED OIL	9.3 (35)	7.37 (300)	1.26 (0.12)



CONCLUSIONS

- ASR REACTION
 - REACTIVE FORM of SILICA + ADEQUATE ALKALI + 85% RH = ALKALI SILICA GEL
- ASR PREVENTION
 - CLASS F / CLASS N POZZOLAN
- ASR REMEDIATION
 - SURFACE TREATMENT (SILANE, LINSEED OIL, AND ELASTOMERIC COATING)



FUTURE RESEARCH

- SURFACE TREATMENT EFFECTIVENESS
- APPLICATION FREQUENCY
- OUTDOOR EXPOSURE SITE (LONG TERM TESTING)



CURRENT 16/34 CONDITION





ACKNOWLEDEMENTS

- Arkansas Highway & Transportation Dept.
- Northwest Arkansas Regional Airport



GO HOGS GO!



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