Association for Bridge Construction and Design

Central Ohio Chapter

www.abcdcoh.org

abcdcoh@gmail.com

Ed Herrick
Franklin County Bridge Engineer

Jim Render
Specification Products

Dan McCoy
R.L. McCoy, Inc.

FRANKLIN COUNTY ENGINEER
BRIDGE

Ed **Herrick, III**
Bridge Engineer

Dave **Dibling**
Asst Bridge Engineer

Ron **Morgan, II**
Bridge Utility Maint Supt

Sean **Shon**
Bridge Admin Specialist

Kailen **Akers**
Bridge Design Engineer

Joel **Moehrman**
Bridge Project Engineer in Training

Jeremy **Good**
Bridge Design Sr Tech

Matt **Balster**
Engr Tech IV

Jeff **Helwagen**
Bridge Utility Supv

Chuck **Weimer**
Bridge Utility Supv

John **Alford**
Bridge Utility Supv

Andrew **Kayati**
Equip Oper III

Derrick **Charles**
Equip Oper III

Jim **Burns**
Bridge Utility Worker III

Joe **Birkefeld**
Bridge Utility Worker III

Ryan **Malone**
Bridge Utility Worker III

Tim **Blanton**
Bridge Utility Worker I

Shane **Furrow**
Bridge Utility Worker I

Kevin **Hayes**
Bridge Utility Worker I

John **Korzenborn**
Bridge Utility Worker I

Danny **McCall**
Bridge Utility Worker I

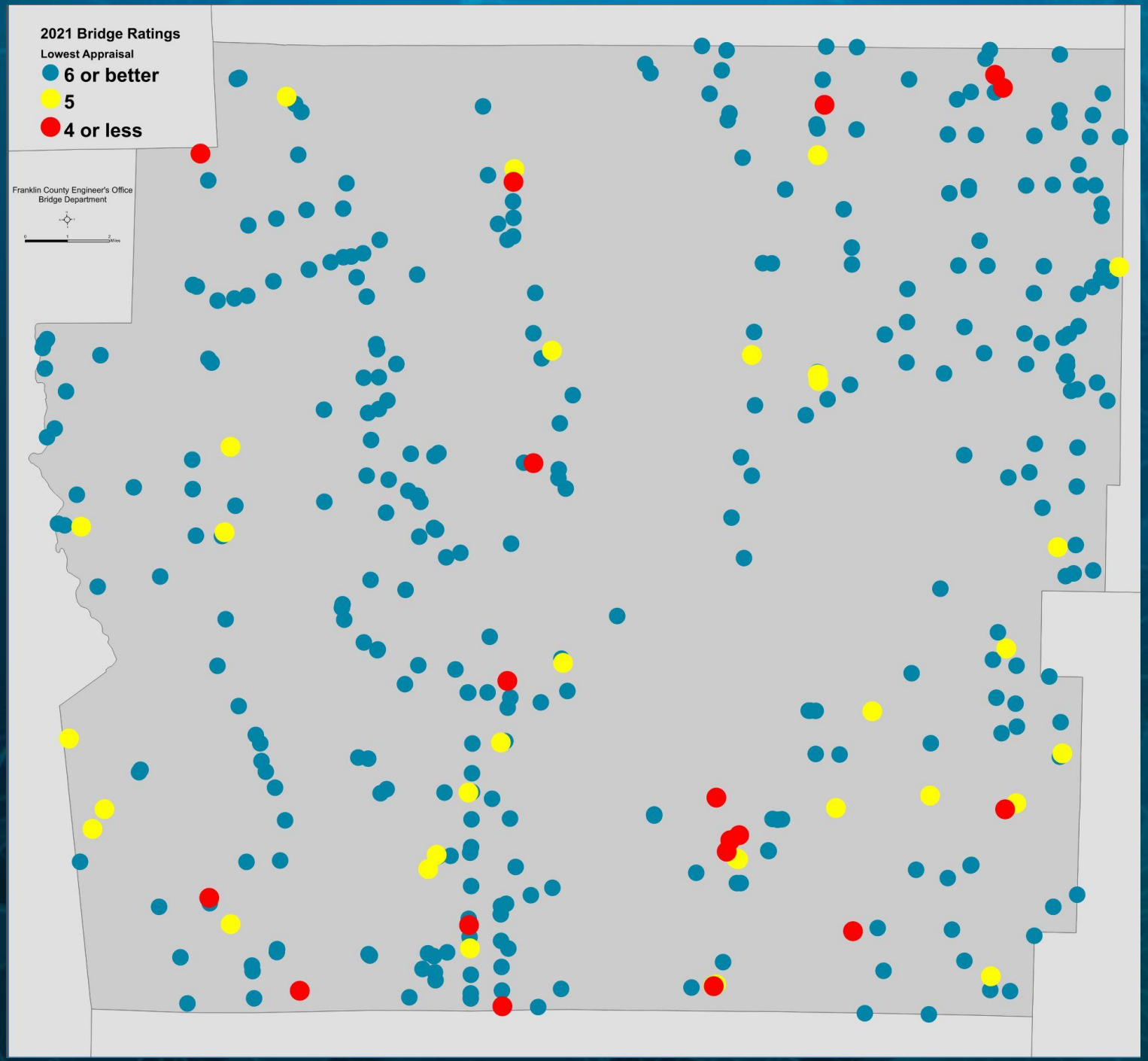
Zach **Newsome**
Bridge Utility Worker I

Tony **Ruzicka**
Bridge Utility Worker I

Philip **Shotwell**
Bridge Utility Worker I

Ron **Starkey**
Bridge Utility Worker I

Sam **Summerlin, Jr**
Bridge Utility Worker I


2021 Bridge Ratings
Lowest Appraisal
6 or better
5
4 or less
Franklin County Engineer's Office
Bridge Department

CORNELL R. ROBERTSON, P.E., P.S.
FRANKLIN COUNTY ENGINEER

Franklin County Engineer
Summary of 2021 Annual Bridge Inspection Report – February 2022
Presented to the
Franklin County Board of Commissioners

In 2021, Franklin County had 374 bridges to inspect.

- 374 Bridges and culverts 10 feet and over in span were inspected – **100%**.
  - (9 of the structures inspected are owned by railroads).
- **97.0%** of the Franklin County Bridges (354 of the 365) were rated **Fair** or **better.**
- **71.2%** of the Franklin County Bridges were rated **Good, Very Good,** or **Excellent**.
- **47** Franklin County Bridges are over 100 years old.
- **103** Franklin County Bridges are over 75 years old.
- **11** Franklin County Bridges are rated in **Poor** Condition.
- **30** Franklin County Bridges are rated in **Fair** Condition.
- No Franklin County Bridge is closed due to structural deficiencies.
- **2** Franklin County Bridges are posted with weight reduction limits.
- No Franklin County Bridge is listed as being in serious or critical condition.
- No Franklin County Bridge presents an immediate or potential danger to life or property.

970 Dublin Road, Columbus, OH 43215 (614) 525-3030 Fax: (614) 525-3359
www.franklincountyengineer.org


Carbon
reducing
PRODUCT
E5
LIQUID
NANO SILICA
THE REVOLUTION HAS BEGUN.

Specification Products

E5™

- Based in Noblesville Indiana
- Patented Technology
- Process as well as chemical
- Revolution - Industry Disruption
- Changing the Industry

Product Development

First Admixtures Developed by a Concrete Contractor for Field Construction

Bleeding

Crusting

Shrinkage

Curling

Field Certified Admixture

Most admixtures are laboratory tested
Internal Cure was developed in the Field
Reduced Bleed
Reduced Crusting
Reduced Shrinkage
Reduced Curling
Hardened the Surface

Research & Development

PURDUE UNIVERSITY

Luna Lu (luna@purdue.edu
ACPA Professor Lyles School of Civil Engineering
Director Center for Intelligent Infrastructure

How Did We Get Here?

Rebar Corrosion – Salt Intrusion
Lower Permeability
Lower W/C Ratios
Higher Cementitious Contents
High Range Water Reducers
Addition of SCM
All these made the concrete harder to finish
Increased Crack Potential

Cement Industry Changes

Cement Fineness

1920’s – Blaine Fineness - 300

Modern Type I Blaine Fineness – 400

New Type IL Blaine Fineness – 450+

Do our W/C Ratios provide enough water???

Field Reality

Concrete is starved for Water

Lab-Crete vs Real-Crete

Cylinders are cured in water

Real Concrete in the field dries out

Advent of More Powerful Microscopes

Autogenous Cracking

Density and Permeability is Compromised

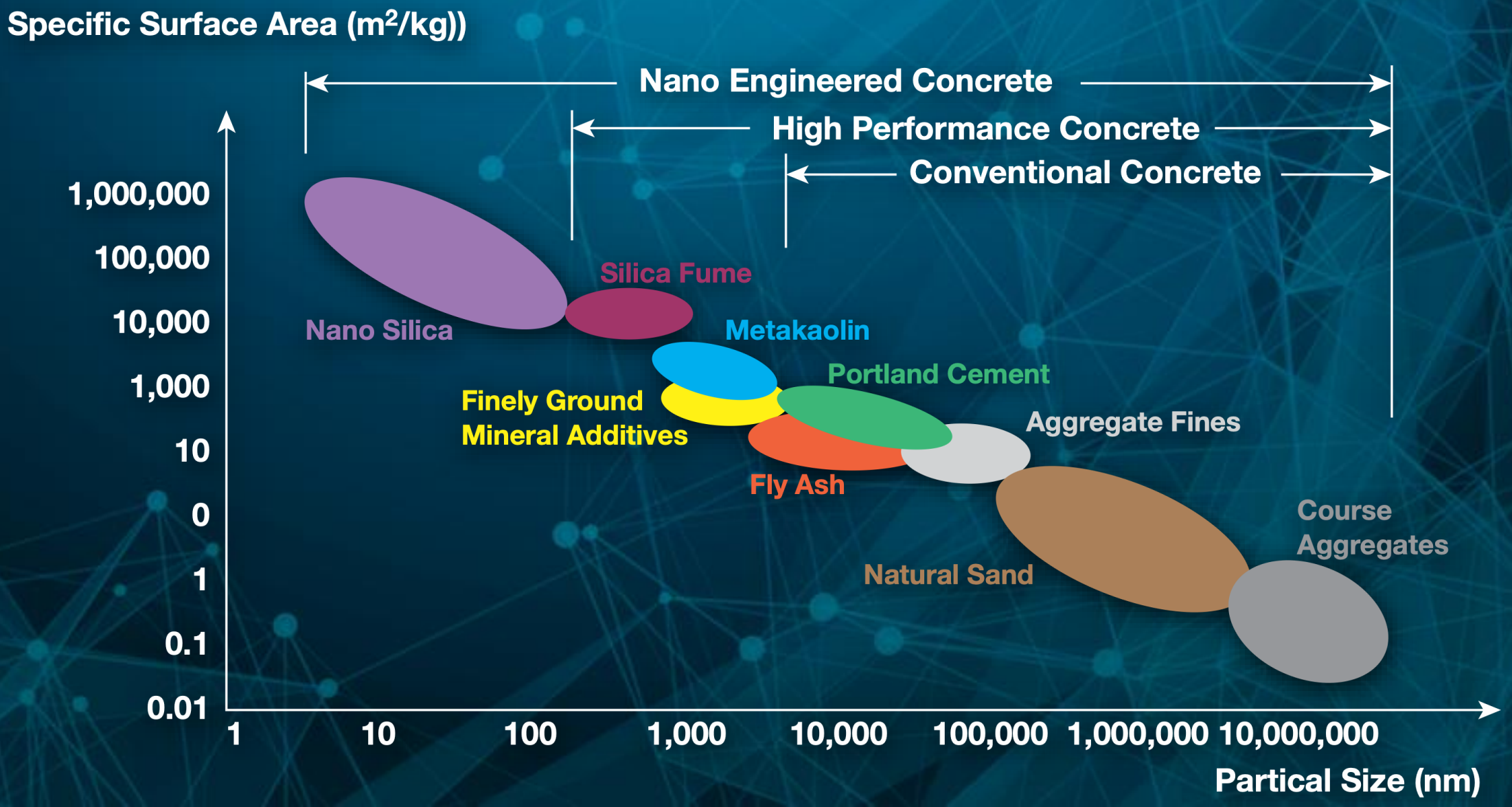
Almost no one cures concrete properly

Nano Silica Science

- Liquid Admixture @ 4 oz/cwt
- ASTM C 494 Type S
- Nano Particles of Silica
- Precisely Sized
- Must be added after the cement is wetted and thoroughly mixed
- Typically with the flush water

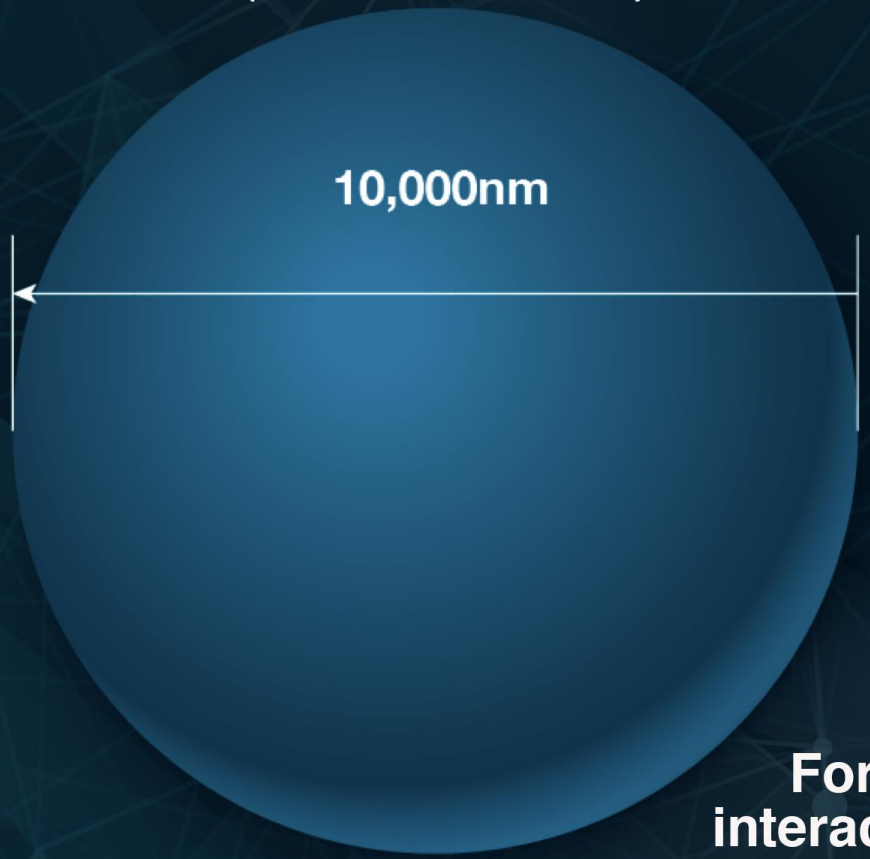
- Anionic Particles
- Physically Attracted to Water
- Bonds to the Water
- 30% More Water Retained
- Water of Transport Cures
- Curing starts Immediately
- Reduces Slump Loss

Surface Area



Specific Surface Area

MICROSPHERE
(Cement Grain)

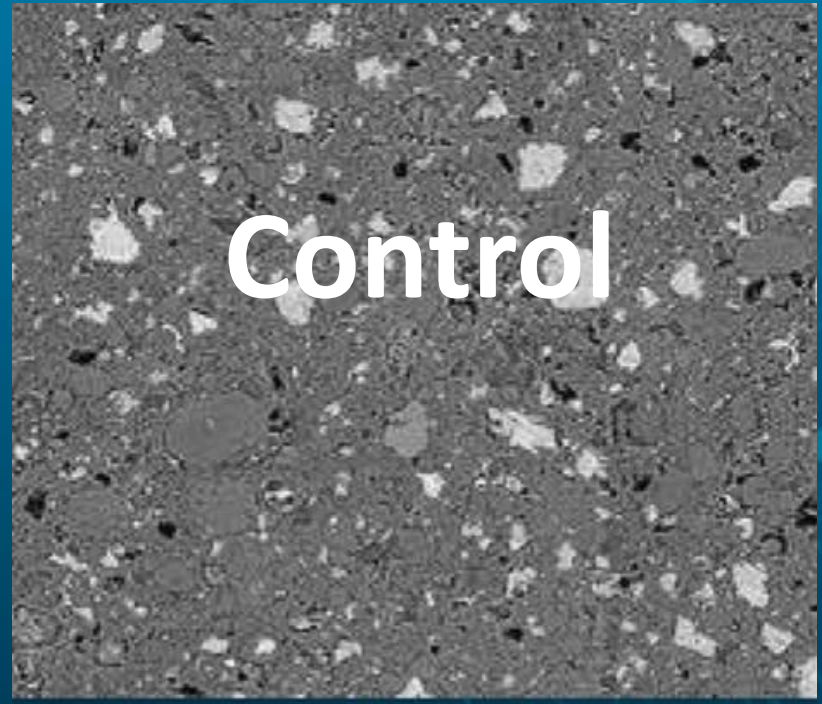


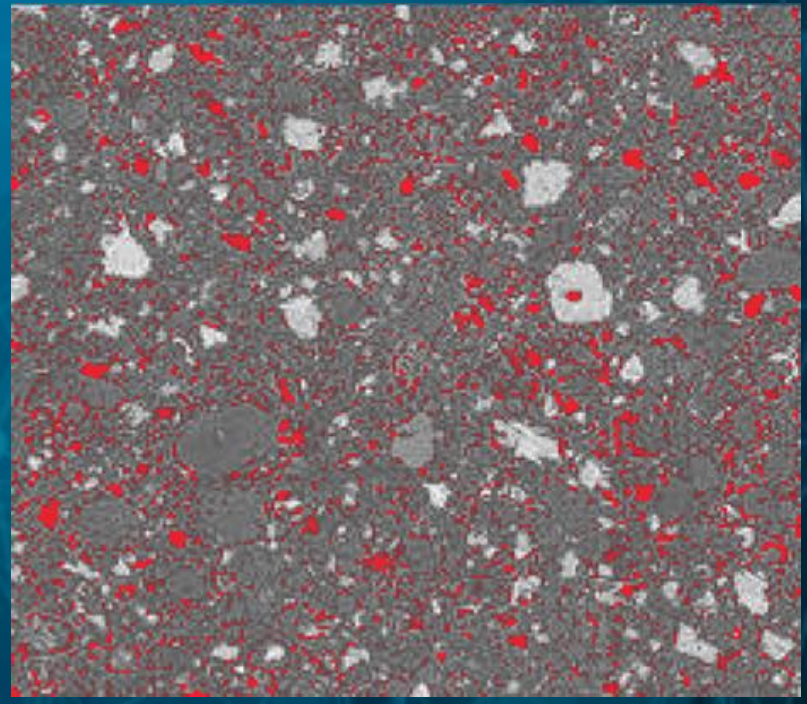
Nano Particles

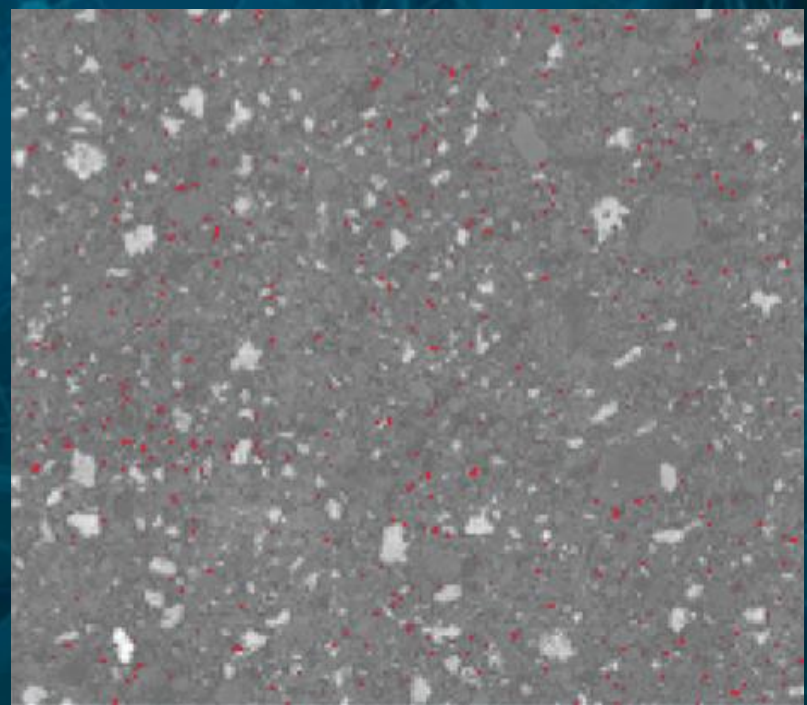
NANOPARTICLE
(E5 Nano Silica)

For same volume, surface interaction is 1,000 times higher

Petrographic Proof Actually Cures Concrete Purdue has Proven Internal Cure Retains 30% more water







Ancillary Benefits

- Improves Pumpability, Placeability & Finishability
- Reduces Shrinkage
- Reduces Curling
- Reduces Segregation – Viscosity Modifying Properties
- Reduces Absorption
- Hardens & Densifies the Surface
- Increases Abrasion Resistance

Densifying the Surface

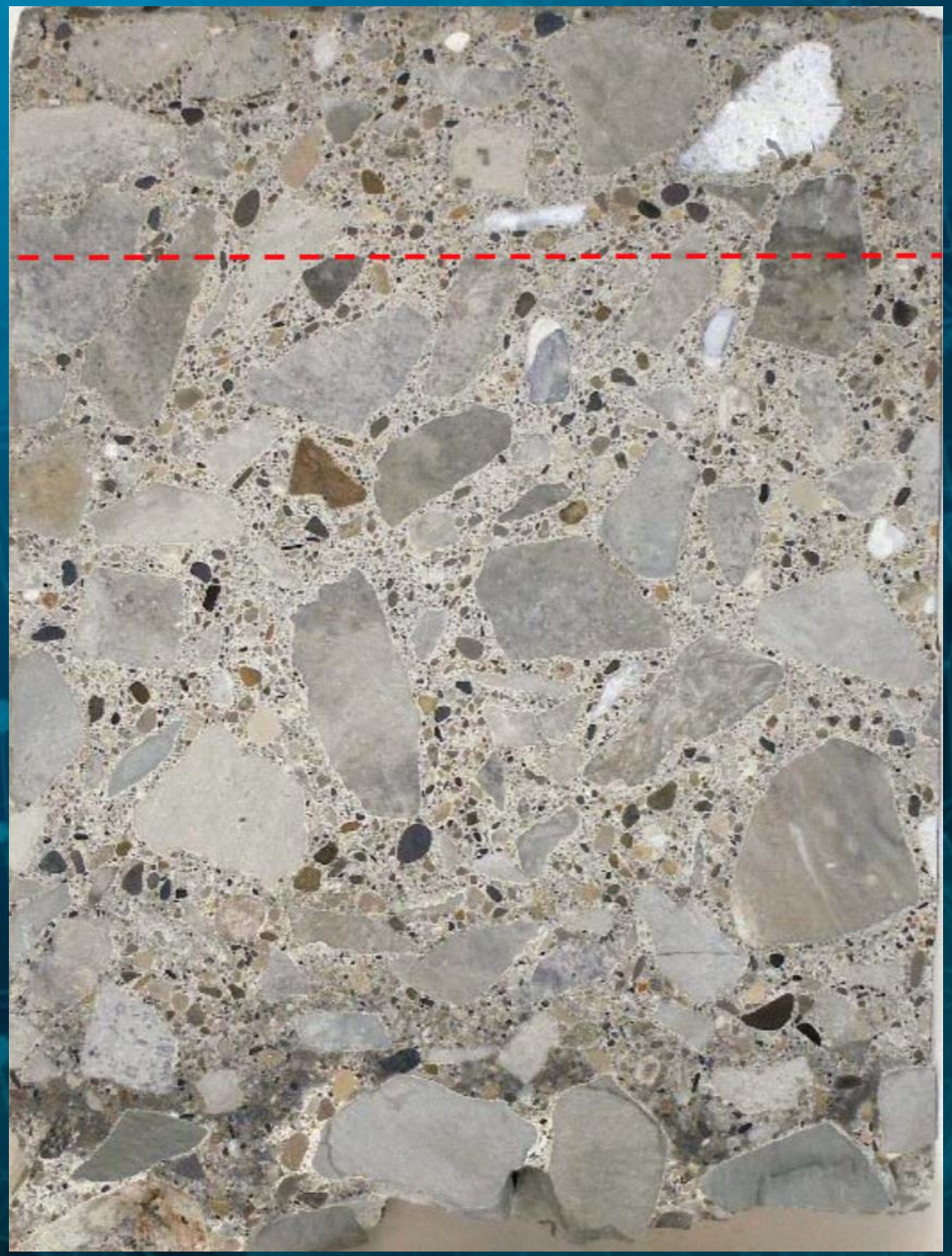
Silica Attaches to Water

Water Carries Silica Up

Densifies the concrete surface

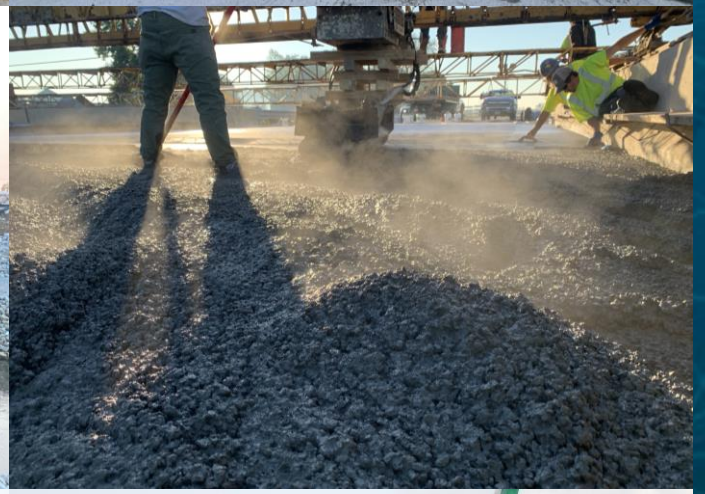
Petrographic Evidence

0.55 to 0.40!








INDOT

Bridge Decks and Overlays

INDOT Progress

- Commercial Success in Indiana Led to INDOT Interest
- Presented January 2020
- Test Bridge Deck Placed in June 2020
- Positive Results led to Wider Test
- 26 Decks placed in 2020
- Significantly less cracking & easier to place without water added to the surface

INDOT / Purdue Findings

Concrete with Normal DOT W/C Ratios (0.38 – 0.42) had Significant Autogenous Cracking associated with Un-Hydrated Cement

Autogenous Cracking leads to an Increase in Permeability

Raising the W/C Ratios to (0.44 – 0.47) with the Addition of E5 Internal Cure Significantly Reduced Internal Cracking

History of Internal Curing Concrete

- **Light Weight Aggregate uses the Reservoirs inside the fine aggregate to provide additional water for Hydration**
- **Proven System for improving Internal Hydration and lowering permeability**
- **It is a nightmare for Ready Mix Producers due to bin capacity & length of time to saturate fine LWA**
- **Purdue has proved that Internal Cure admixture while using a different mechanism, accomplishes the same mission, Internal Curing**
- **LWA still needs wet cure to hydrate the surface**

Benefits

Eliminates Wet Cure

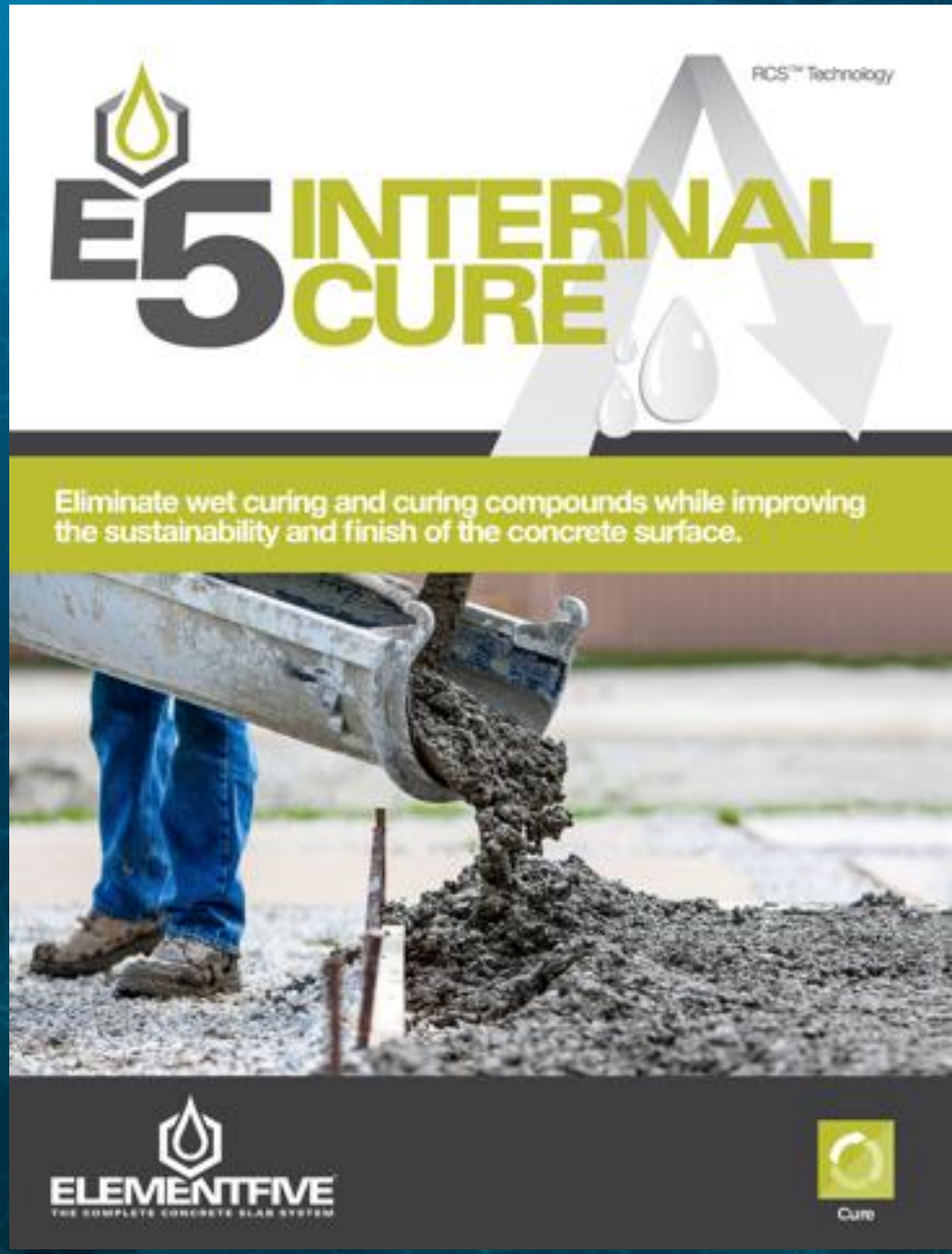
Starts the curing process from addition to the truck

Improves Slump Retention

Improves Abrasion Resistance

Improves Pumpability, Placeability & Finishability

Reduces Shrinkage




E5
LIQUID
FLY ASH
THE REVOLUTION HAS BEGUN.
www.SpecificationProducts.com

Shortage Concerns

- Material Shortages loom on the horizon
  - Cement
  - Slag
  - Fly Ash
  - Lithium Nitrate
- How will we cope with these?

Technical Data

Liquid Admixture @ 8 oz/cwt

ASTM C 494 Type S

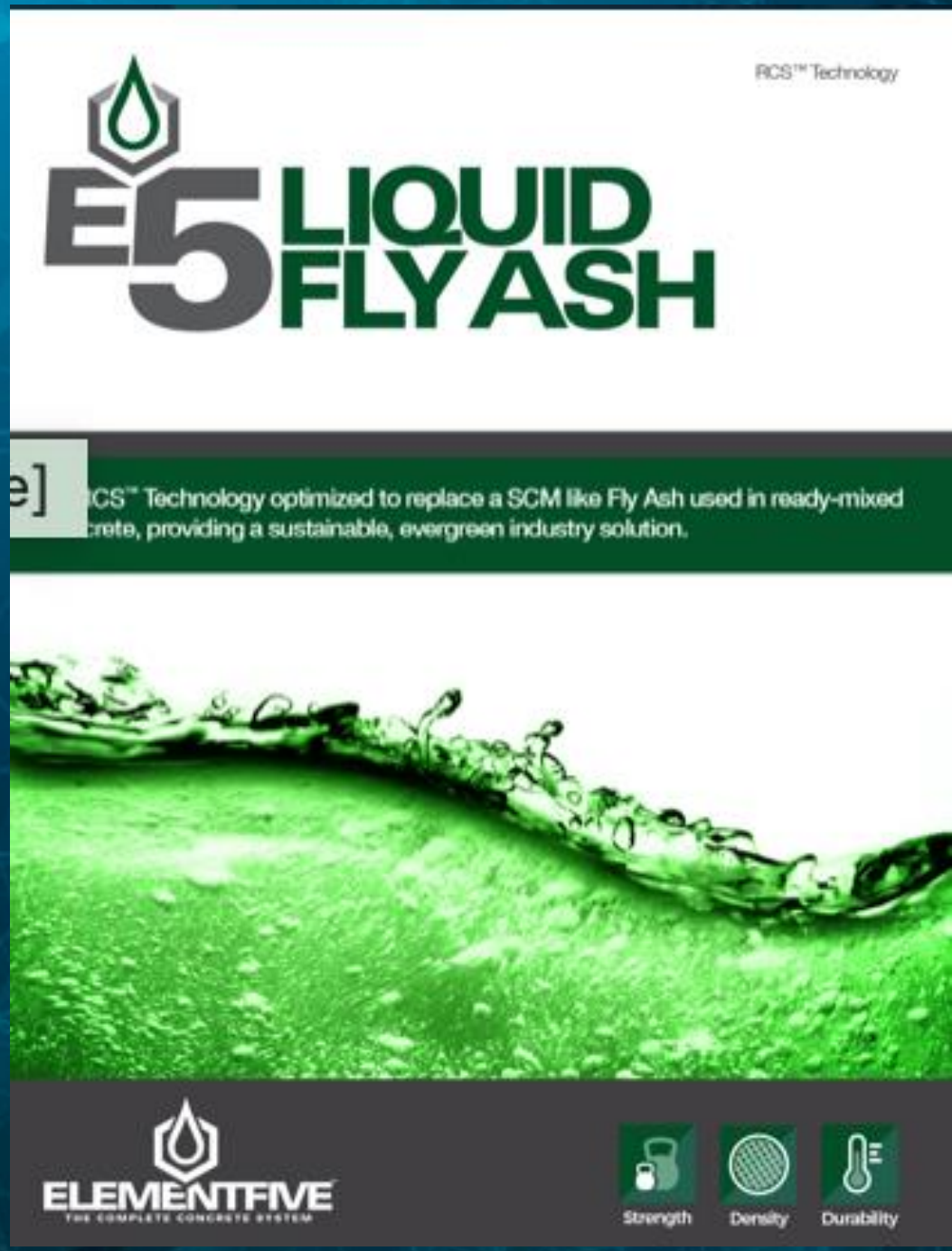
Nano Silica in Suspension

Wider Particle Band

Effective Pozzolanic Replacement

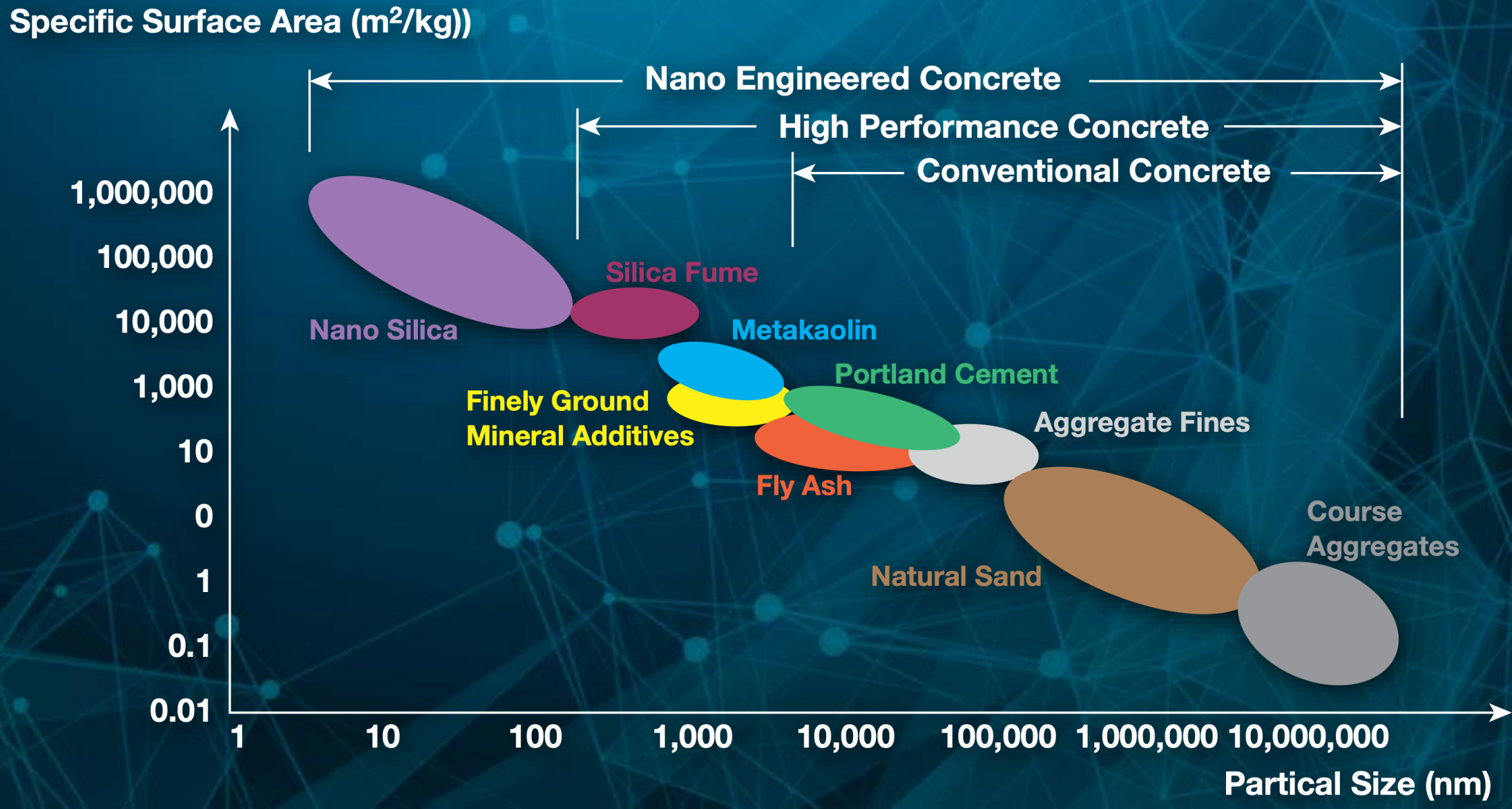
MUST be added after cement is wetted

And Thoroughly Mixed



E5 LIQUID FLY ASH

Surface Area

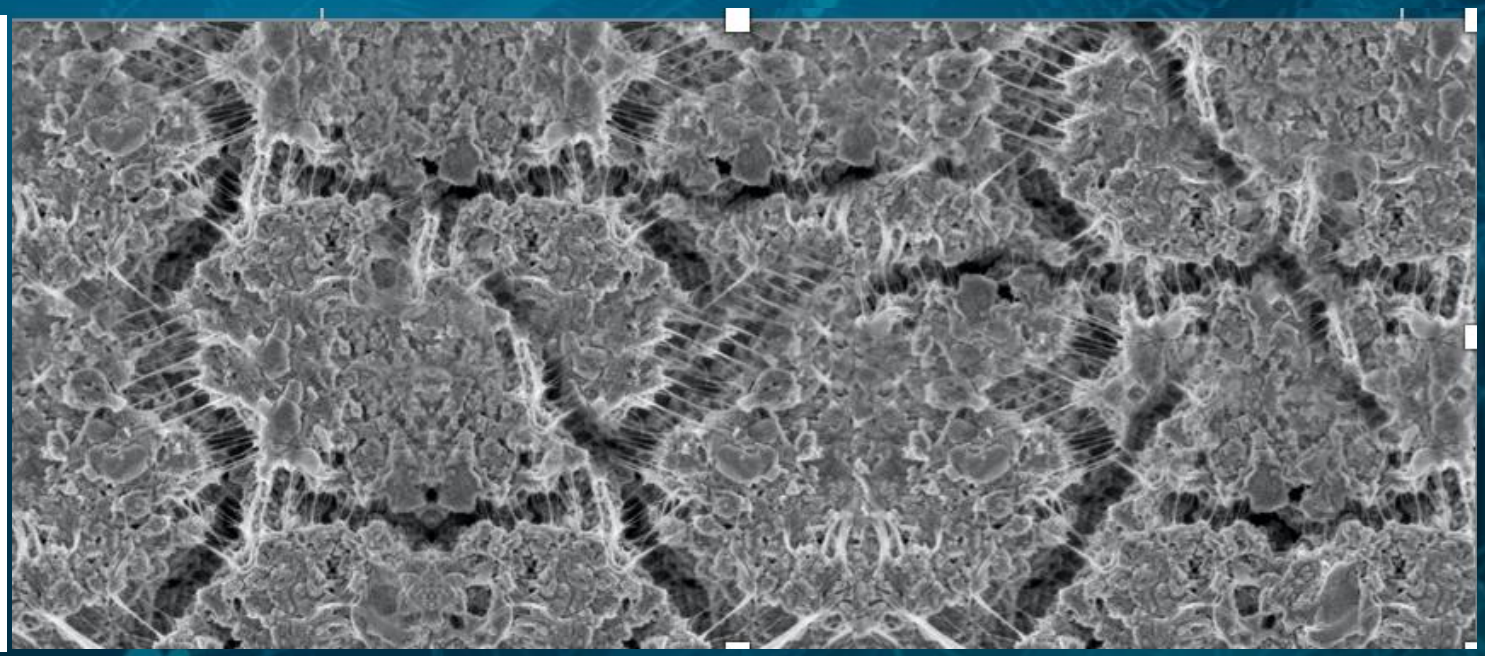


Pozzolanic Reaction

Cement + Water ⟶ C-S-H + CH

- C-S-H = Calcium Silicate Hydrate
- CH = Calcium Hydroxide

Reactive Silica + CH + Water ⟶ C-S-H



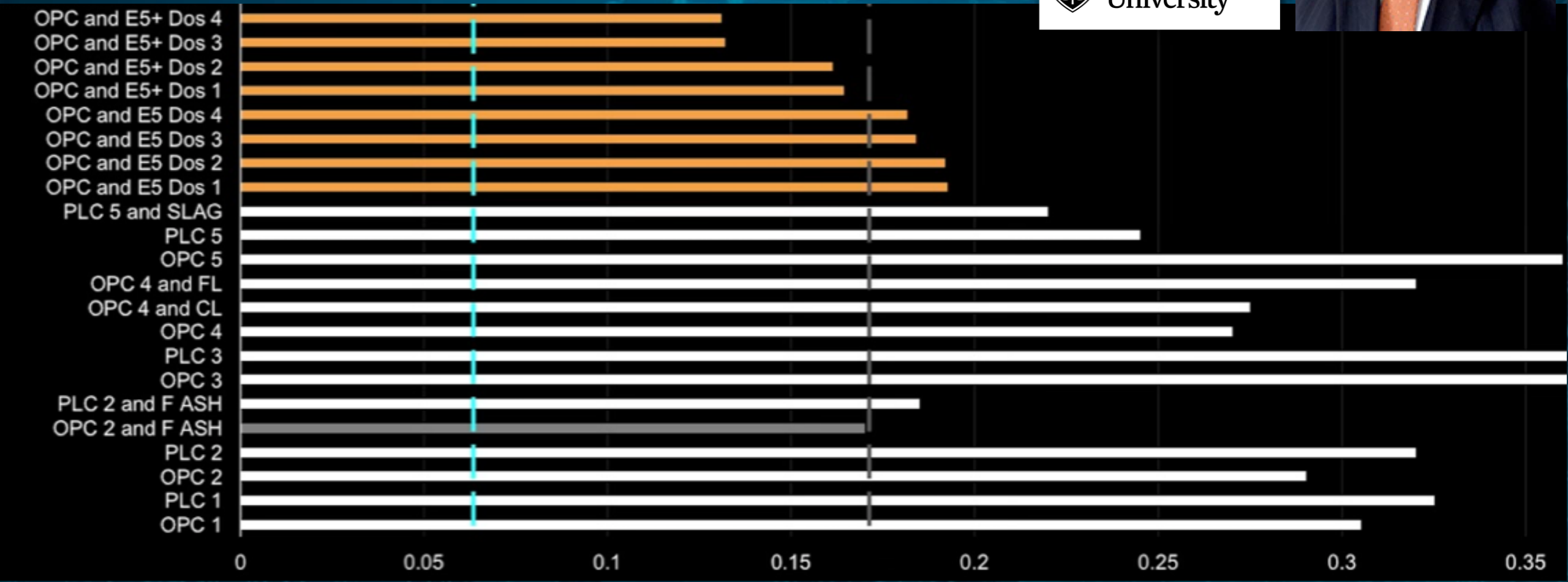
Nano Silica Consumes Calcium Hydroxide

Particle to Particle Packing

Calcium Hydroxide Consumption

Dr. Jason Weiss

Oregon State University



E5 LIQUID FLY ASH

Field Results

Indiana Ready Mix Producer & Paver

Implemented LFA

Eliminated Class F Ash

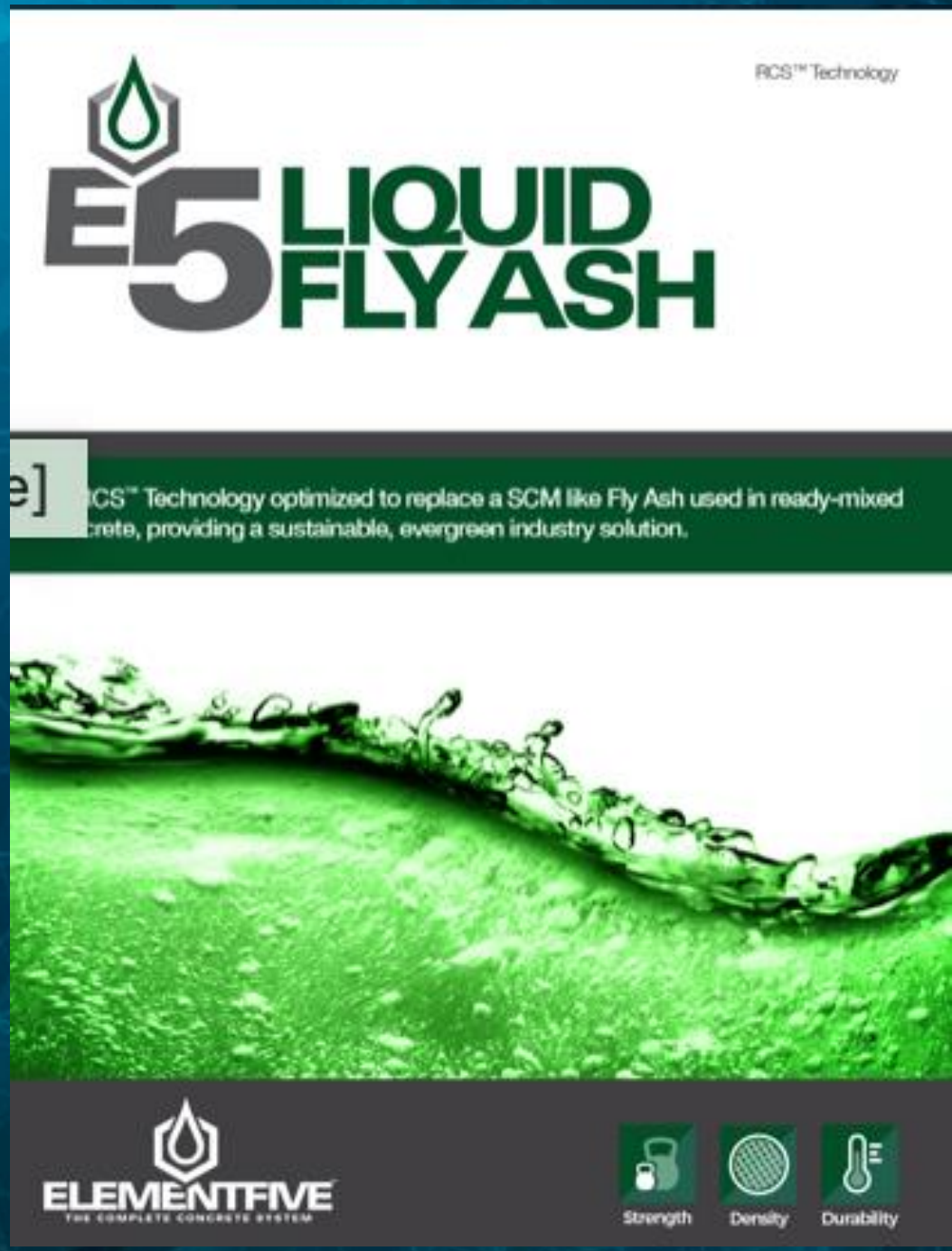
Cementitious Replacement -12%

Eliminated Air Issues

Superior Finishability

Benefits

- Consistent Product
- Ready Availability
- Carbon / Cement reduction
- No Effect on Air
- Reduces Bleed Water
- Reduces Shrinkage
- Consumes Calcium Hydroxide



E5 LIQUID FLY ASH

Synergism

E5 INTERNAL CURE

What if we use them both together?


XTRA

INDOT Issues

Cracking

Inspection – Water added to surface

Wet Curing Issues

All led to premature failures and remediation

Indiana Bridge Deck Comparison

Material	Reference	E5 Mix
Cement	658	580
Micro Silica	20	
E5 Liquid Fly Ash		8 oz/cwt
E5 Internal Cure		4 oz/cwt
W/C Ratio	0.42	0.47
Compressive Strength	6200	6600
Cement Efficiency	9.4	11.38
Flexural Strength	720	1140

78 Pounds Cement Reduction

Eliminated Silica Fume

INDOT Progress

- E5 Internal Cure approved with a memo in 2021
  - Eliminating Wet Cure
- E5 Liquid Fly Ash Introduced to INDOT
- E5 LFA& E5 IC together test deck in early 2021
- Over 200 Bridge Decks placed to date with E5 IC
- 100 Bridge Decks placed with the combination
  - Lowered the cementitious content 98 #
- Both admixtures now on the approved list
- Multiple states now testing both materials for approval

E5 LIQUID FLY ASH

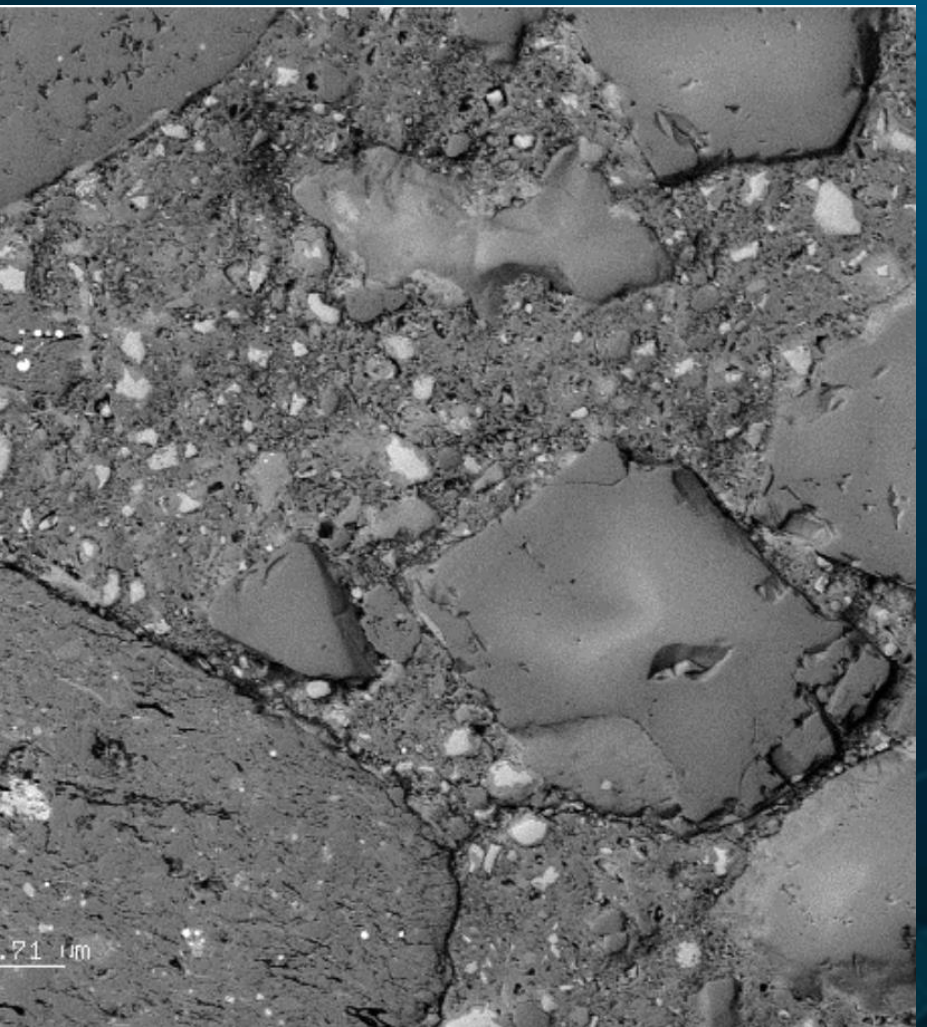
Synergism

E5 INTERNAL CURE

- Synergistic Strength gain from both admixtures
- Increase in Flexural Strength reduces crack potential
- Significant Carbon / Cementitious reduction
- Durability improvement due to more complete cementitious hydration and reduction in Autogenous shrinkage
- Improved Curing & Particle Packing reduces Permeabiity
- Hardens & Densifying the Surface
- Reduced Cracking

Paste Density & Aggregate Bond

Control

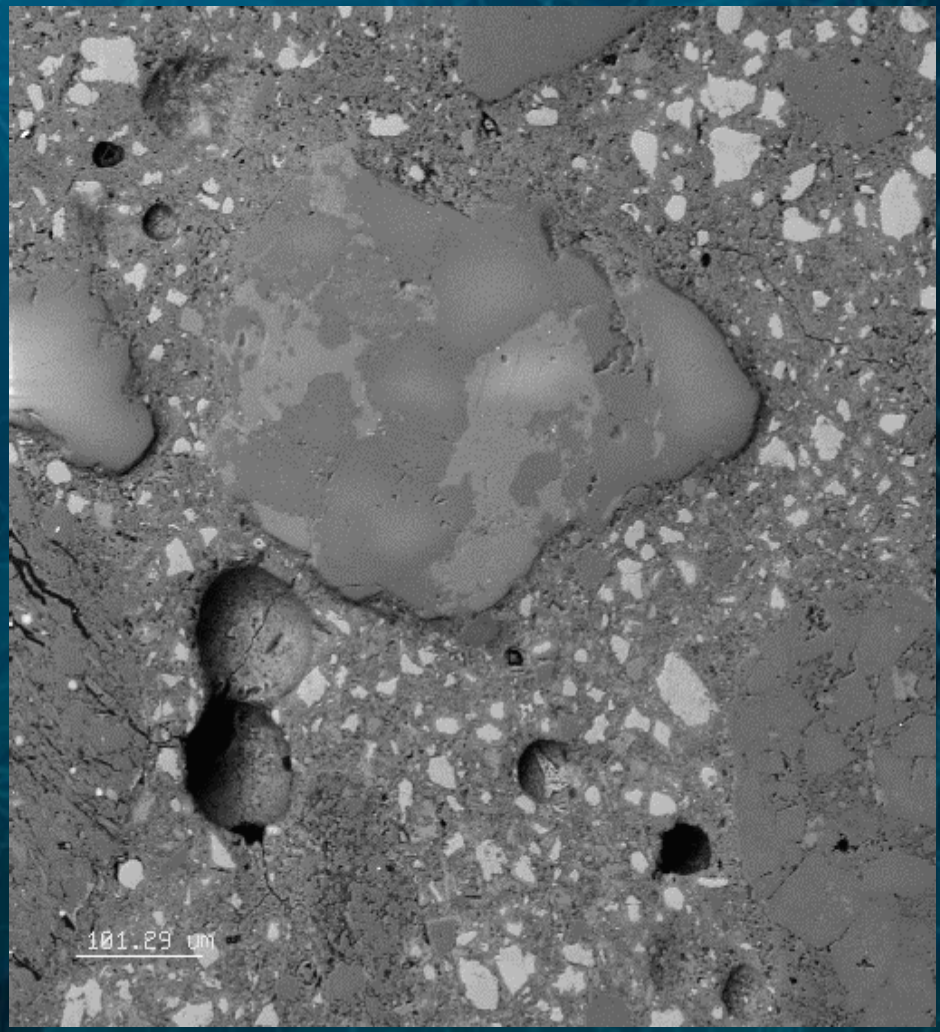


Improved Paste Density & Concrete Ductility

Combination enhances the bond

Reduces Microcracking

Combination



Micro-CT for Concrete w/c=0.42

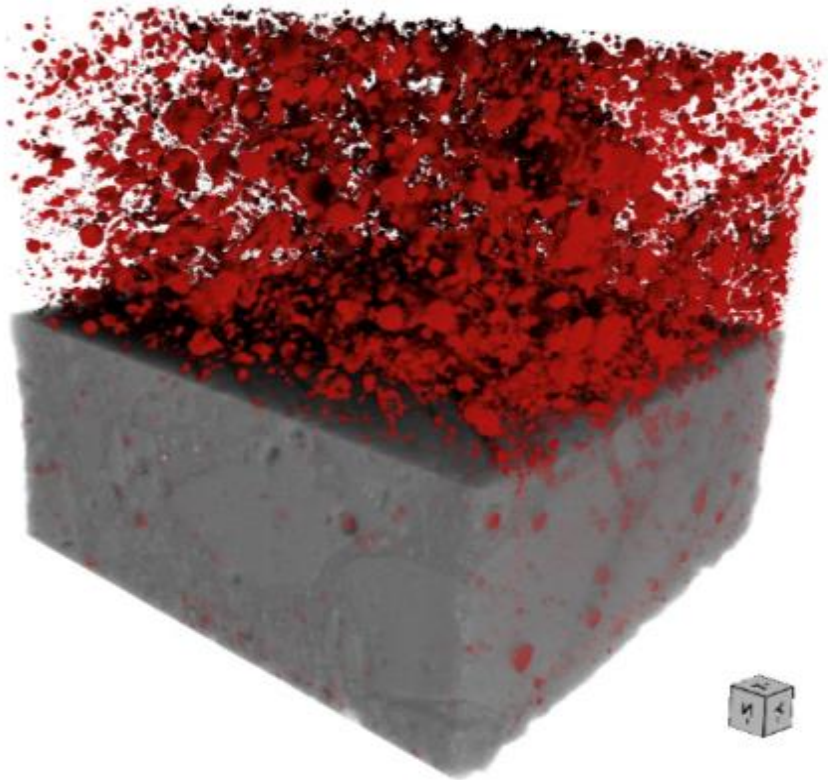
Reference sample

Pore volume: 2,664 mm³

Sample Volume: 53,008 mm³

Porosity: 5.03 %

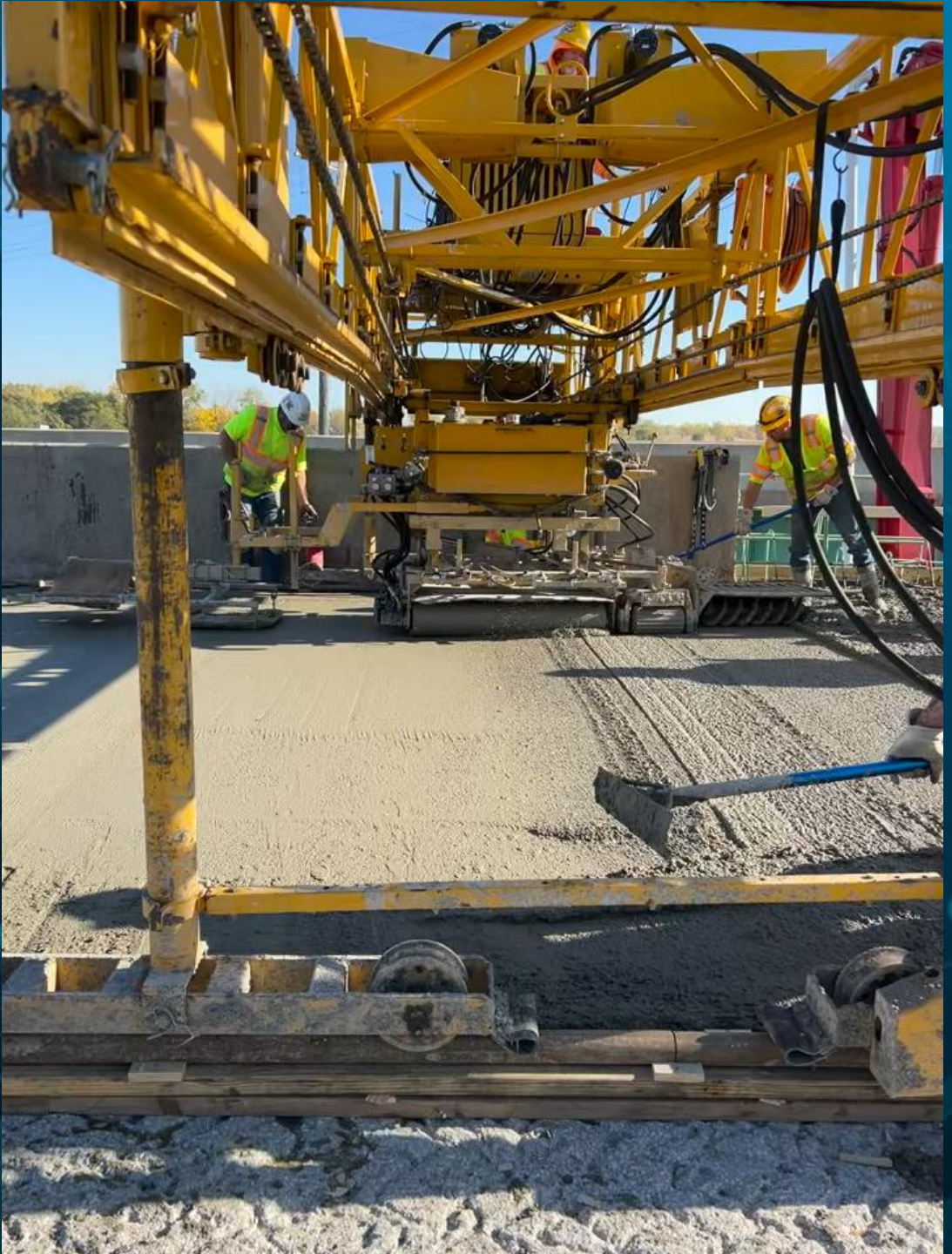
0.6%E5 sample



Pore volume: 1,822 mm³

Sample Volume: 53,462 mm³

Porosity: 3.4 %



INDOT Overlay Mix

Evaporation Rate

0.24

Reduced Cracking!

ODOT SDC Overlay Mix

- Current Mix Design
  - Too Much Powder
  - Not Enough Water
  - No water of transport left for Internal Cure to work
  - SP will not work with the current mix design
- We are currently testing a proposed change with multiple producers

Material	Current	Proposed	Reduction
Cement	825	650	175
Water	300	300	
W/C Ratio	0.36	0.46	
HRWR	48 oz	12 oz	
Strength	8000	5500	
E5 Internal Cure		26 oz	
E5 Liquid Fly Ash		52 oz	

E5 LIQUID FLY ASH

INDOT Solutions

E5 INTERNAL CURE

E5 Internal Cure in their standard mix designs

Easier Placement & Finishing

No Surface Water needed to close

Same or Better Flexural Strengths

Incorporated E5 LFA with Cementitious Reduction

Similar Compressive Strengths

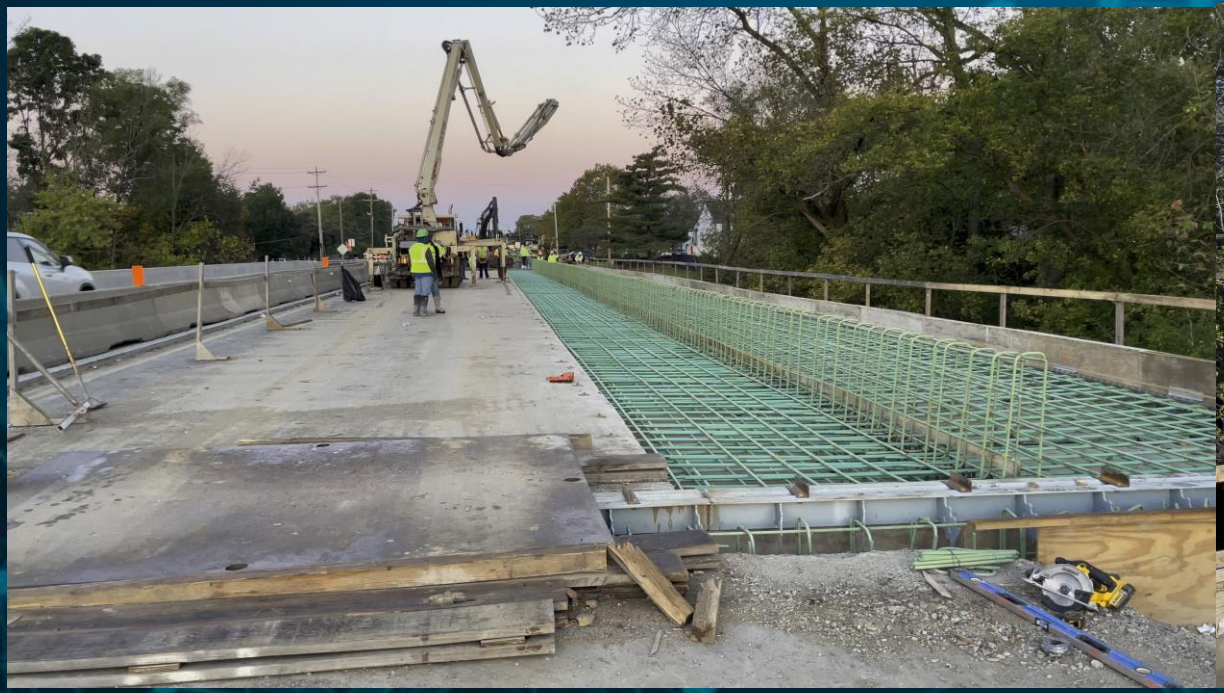
Better Flexural Strengths

Lower Permeability due to Particle Packing

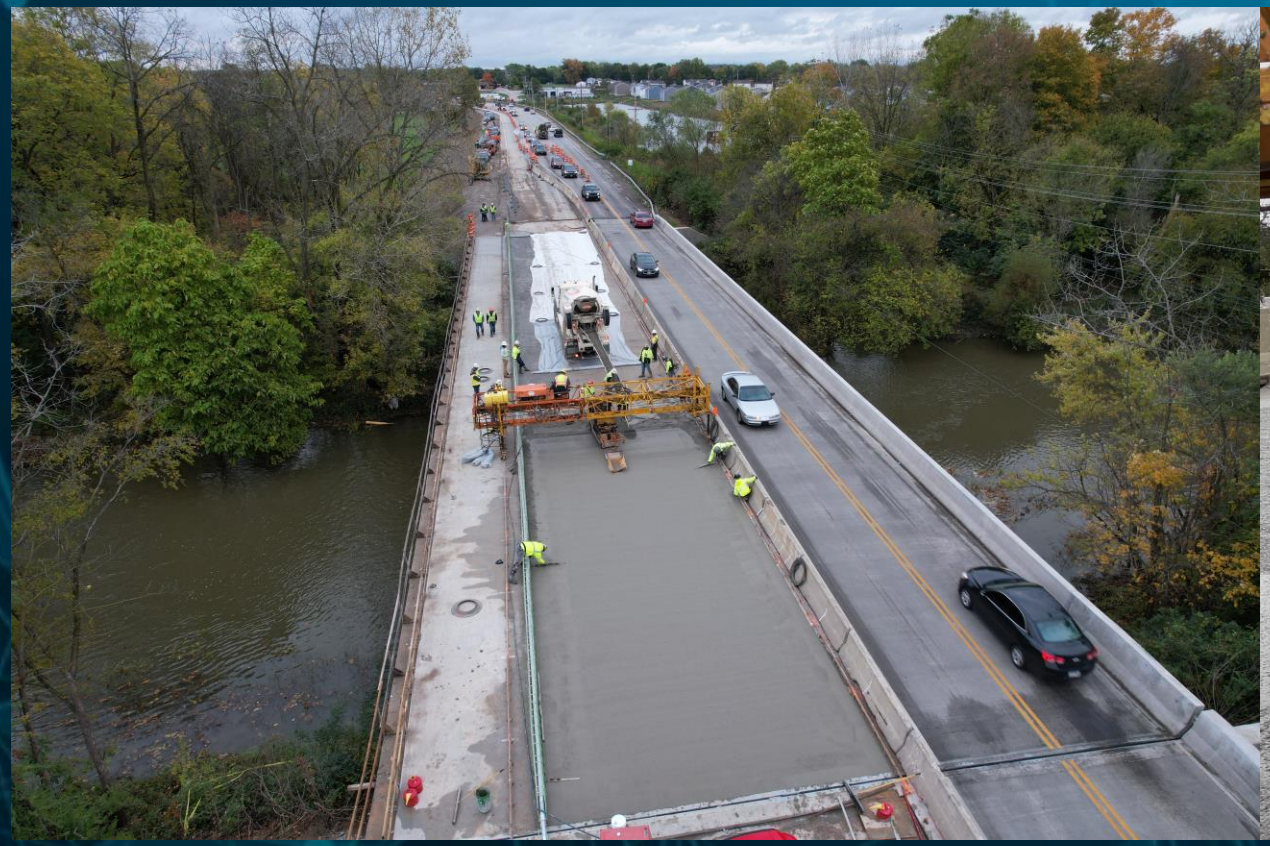
Franklin County Results

Ed Herrick

Refugee Rd Full Depth Placement



Refugee Road Overlay



OHIO DEPARTMENT OF TRANSPORTATION
Mike DeWine, *Governor*
Jack Marchbanks, Ph.D., *Director*

1980 W. Broad Street, Columbus, OH 43223
614-466-7170
transportation.ohio.gov

CONSTRUCTION MEMORANDUM

22-01 September 15th, 2022

TO: District Deputy Directors

District Construction Engineers, Area Engineers, Project Engineers

District Testing Engineers

Ohio Concrete

FROM: Jordan Zamary, Concrete and Cement Engineer

Division of Construction Management

ODOT Memo

E5 Internal Cure Now Allowed in their standard mix designs

Easier Placement & Finishing

No Water Added to the Surface Allowed

Wet Cure Eliminated / White Pigmented Curing Compound

E5 Liquid Fly Ash now Allowed with New JMF in Combination

RCPT Test waived for these bridges

Specification Products Representative MUST be on site until both the contractor & Ready Mix Producer are certified

Ed Conclusions

Ed Conclusions

E5 LIQUID FLY ASH

E5 INTERNAL CURE

Hurdles

Rapid Chloride Permeability Test

SEM & Micro CT Scan

Change in Mindset about Permeability is Required

Change in Mindset about Strength

Higher Strength does NOT Mean more Durable Concrete

E5 LIQUID FLY ASH

E5 INTERNAL CURE

The Future

Nano Silica is the future of the Concrete Industry

More Durable

More Ductile

Ease of Placement and Finish

Reduction of Cracking

Carbon Reduction

Specification Products

E5™

www. SpecificationProducts.com

Conventional Wisdom

Concentration on Compressive Strength

Does Higher Strength mean more Durable?

Does Higher Strength resist Surface Abrasion?

Do Low W/C Ratios produce more Durable Concrete?