RCC Pavements Design and Construction: Best Practices and Benefits

CPTech Center at Iowa State University
May 27, 2026 Webinar

Fares Y. Abdo, PE
RCCPC Co-Chair/Research Committee Chair
Director of Technical Services
Morgan Corp.
fabdo@morgan-corp.com

Tech Center

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RCC PAVEMENT COUNCIL

ABOUT MORGAN CORP. | www.morgan-corp.com

OPERATIONS STATISTICS

#1	Among the largest Civil Construction companies in the Southeast
80+	Consecutive Years in Business
350+	Late model Heavy Equipment Pieces in our fleet
850+	Employees spread across four office locations and six divisions

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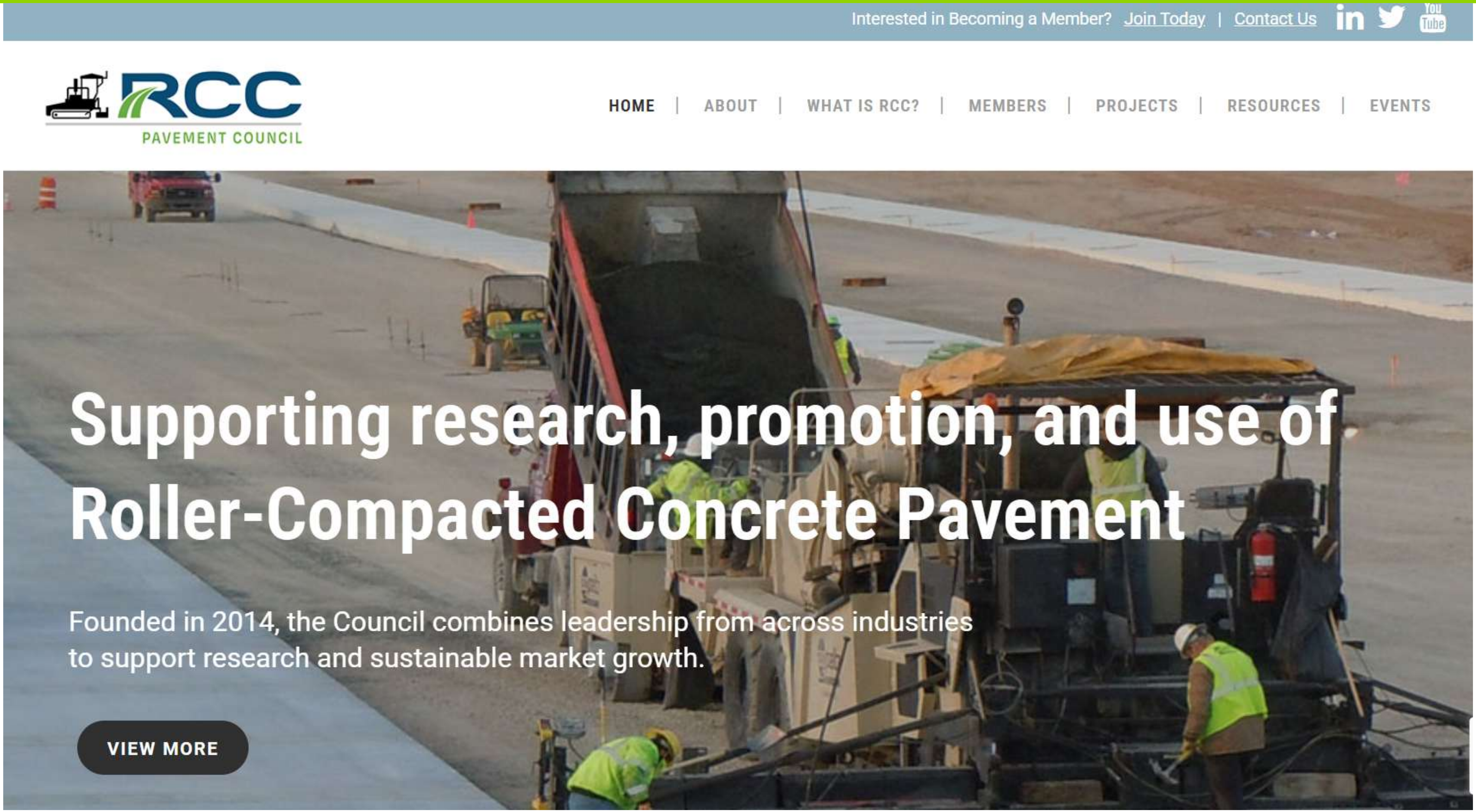
ABOUT THE RCC PAVEMENT COUNCIL | www.rccpavementcouncil.org



- Introduction to RCC Pavements
  - What is RCC Pavement?
  - Utilization/Example Projects
  - Benefits and Limitations
- Construction Means and Methods
  - Mixing
  - Placement, Compaction, Curing and Finishing
- Design Considerations
  - Mixture Proportioning
  - Structural Design
  - Paving Plan and Joint layouts
  - Construction Sequence and Coordination

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Panelists

Halil Ceylan, Ph.D., Dist.M.ASCE

Pitt-Des Moines, Inc. Endowed Professor in Civil, Construction and Environmental Engineering

Fares Y. Abdo, P.E.

RCCPC Co-Chair/Research Committee Chair

Director of Technical Services

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Definition

- "Roller-Compacted Concrete (RCC) is a no-slump concrete that is compacted by vibratory roller."
  - Same materials as conventional concrete
  - Zero slump
  - No forms
  - No reinforcing steel
  - No dowels

After curing, RCC engineering properties are similar as PCC

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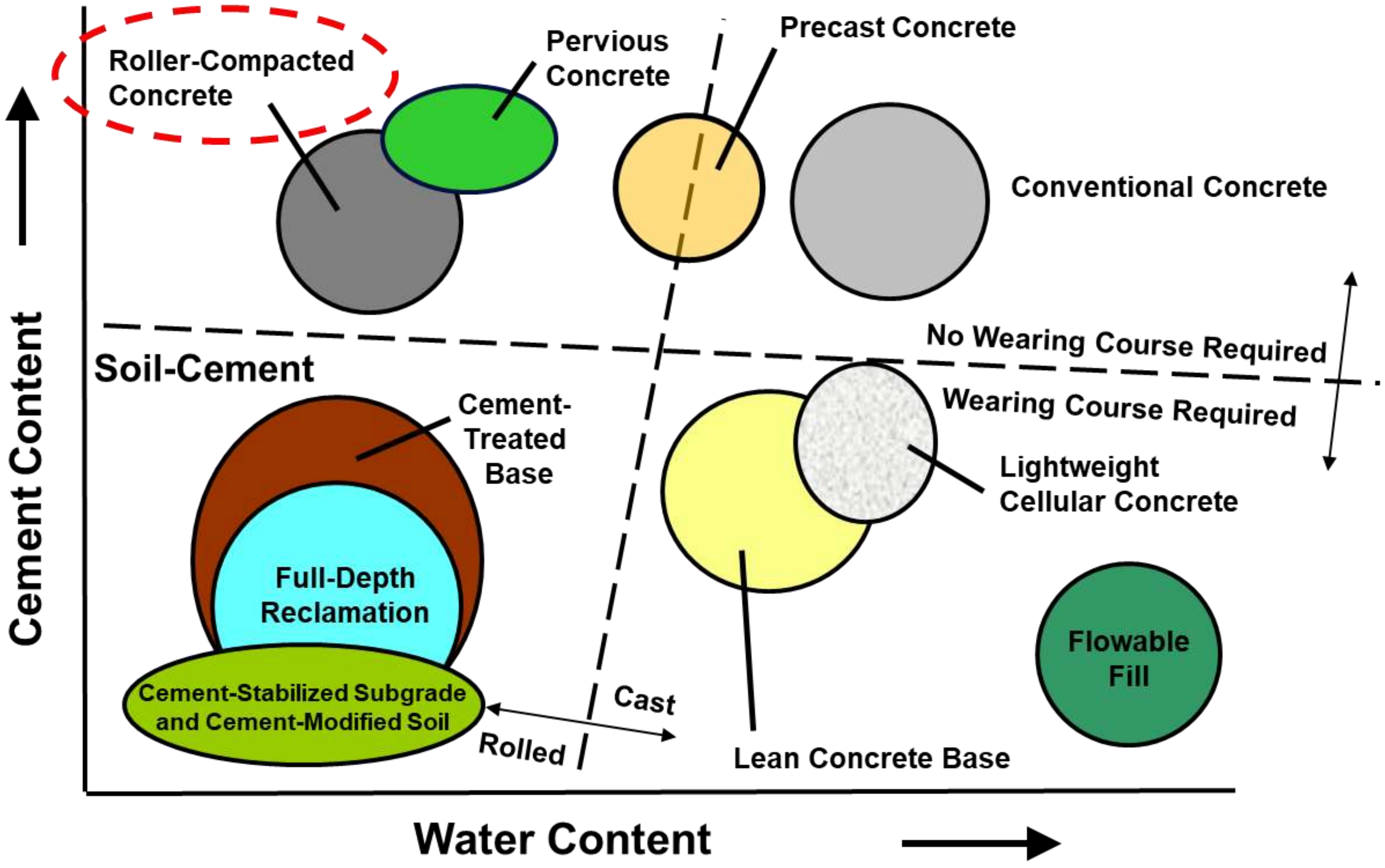
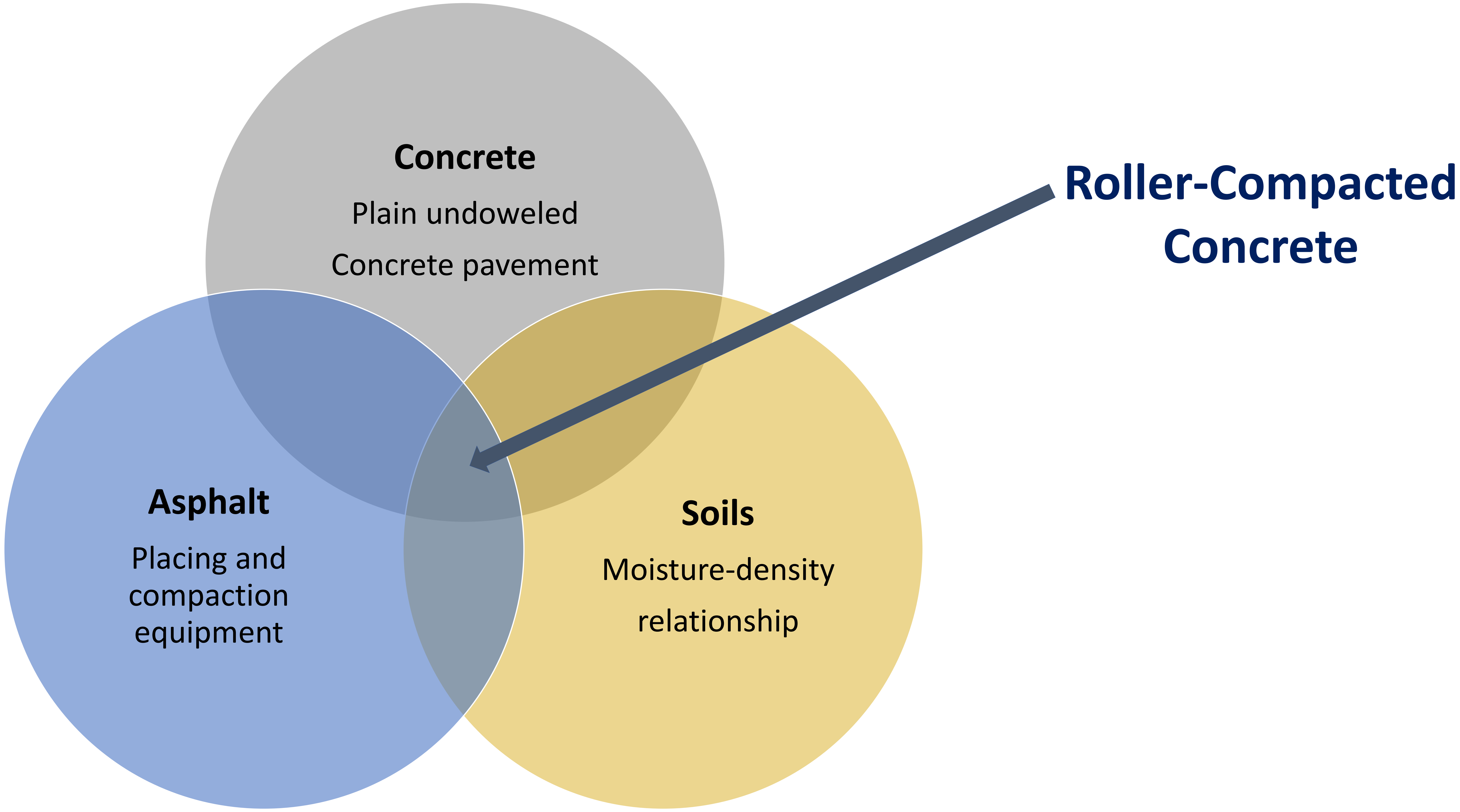
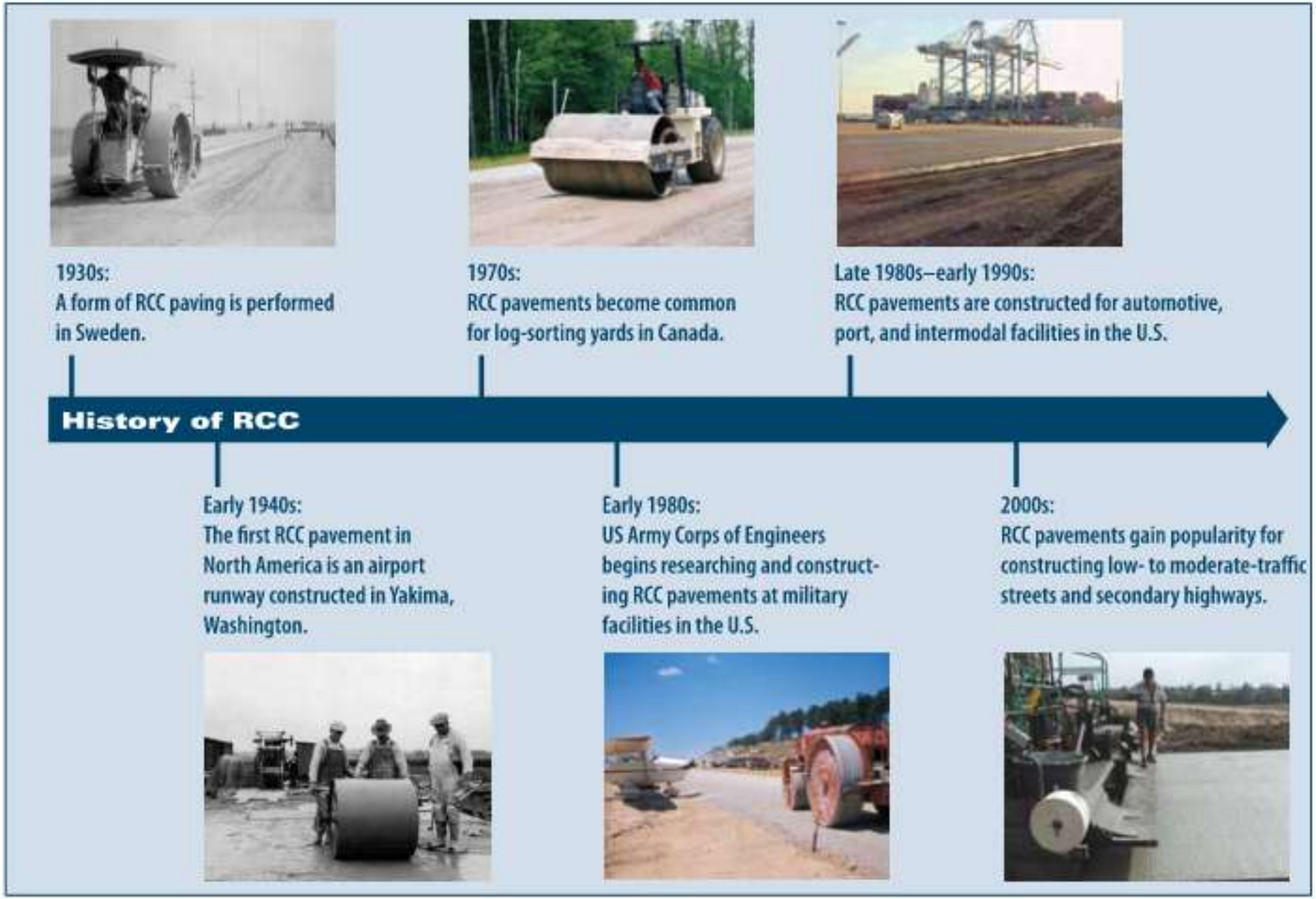
Cement –Based Pavement Materials



RCC Characteristics | A Hybrid System





RCC pavements have been around for a long time

Credit: CPTech Center / PCA Guide for RCC Pavements, 2010

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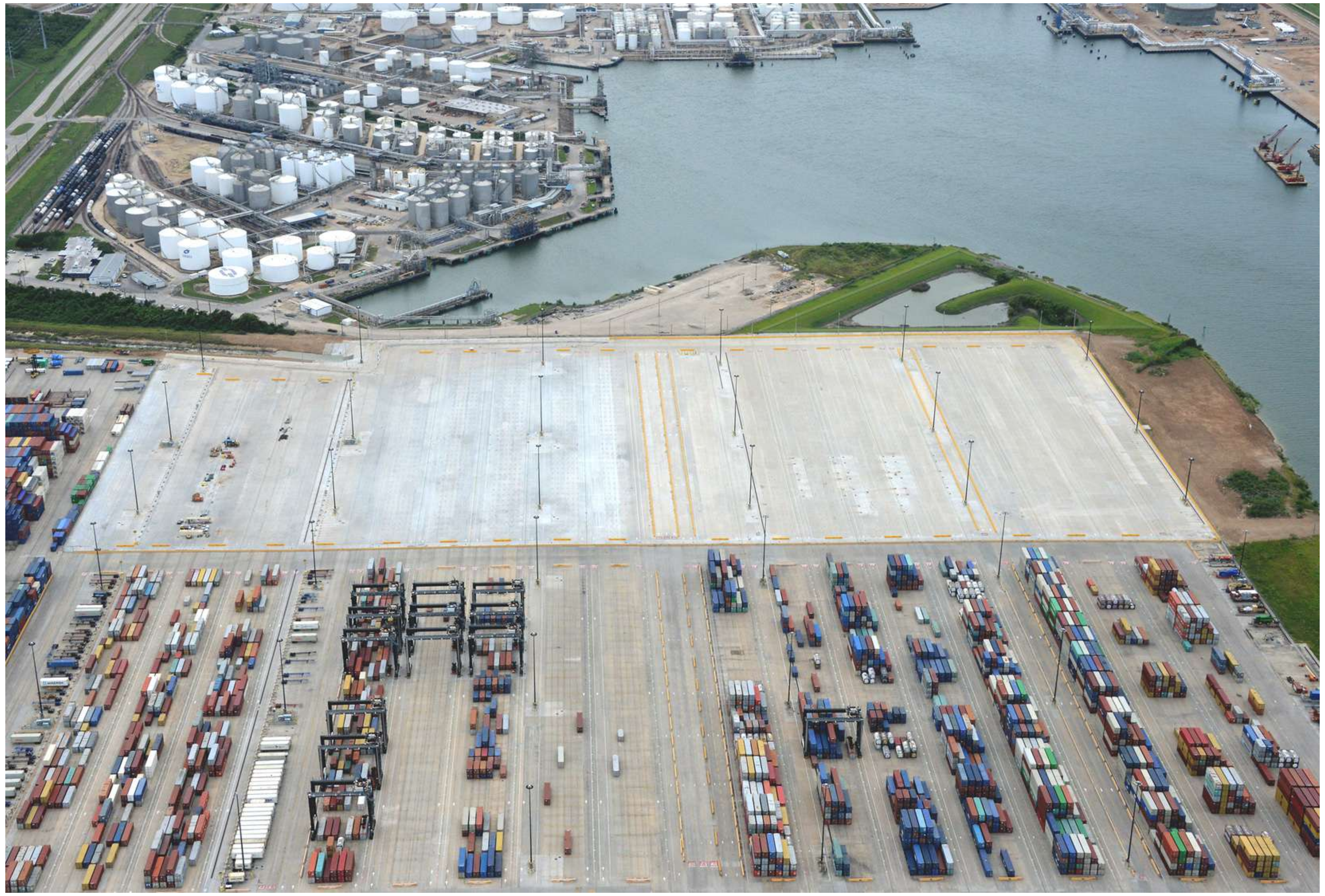
APPLICATIONS

APPLICATIONS

Highway Shoulders

Arterial Highways

APPLICATIONS



Port Container Yards

Port Roll-on/Roll-off Facilities

APPLICATIONS

Port Roll-on/Roll-off Facilities

High Abrasion Resistance Applications

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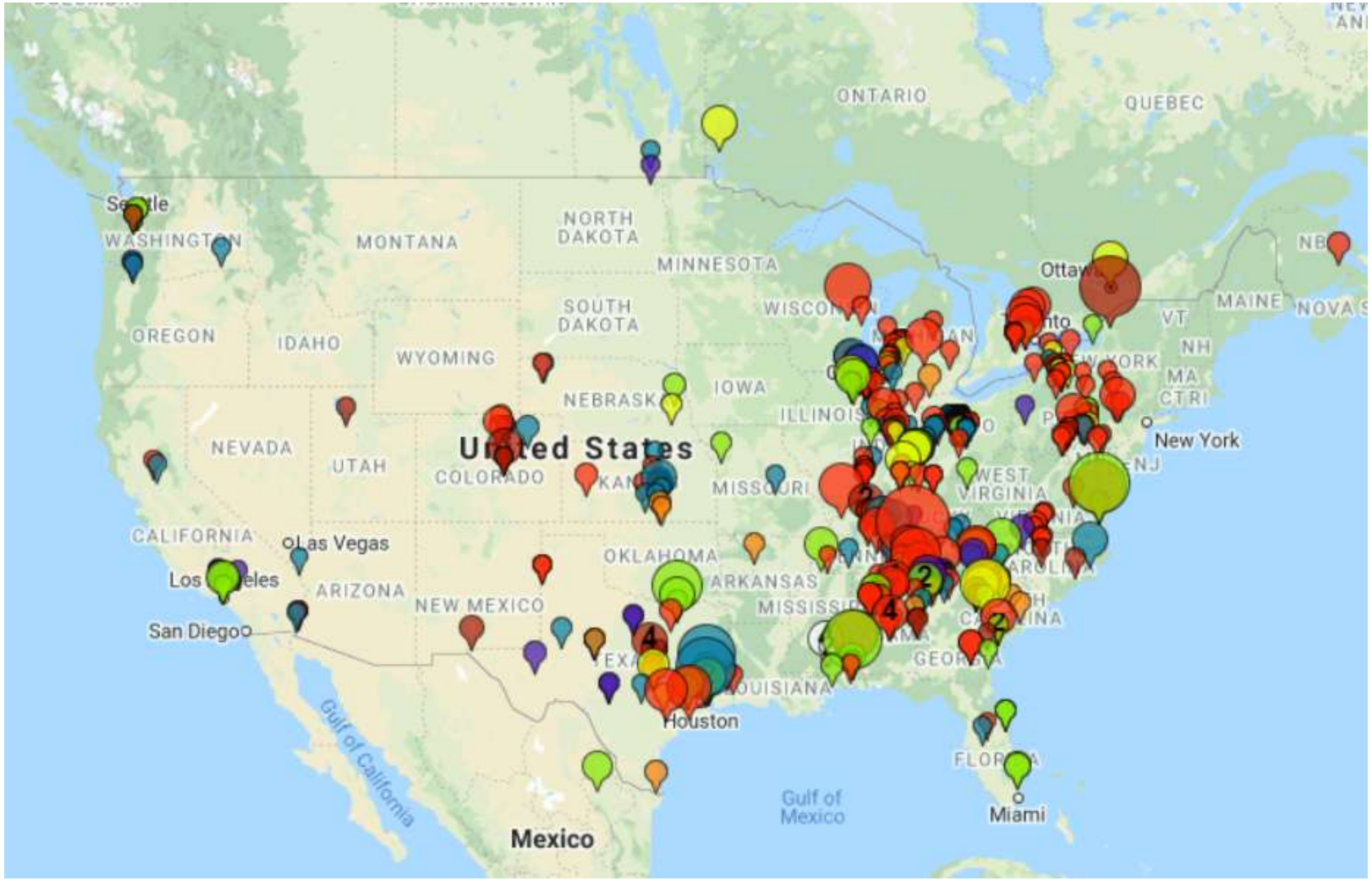
UTILIZATION | AS OF 2019 REPORT (ACPA RCC EXPLORER, UPDATE IS UNDERWAY)

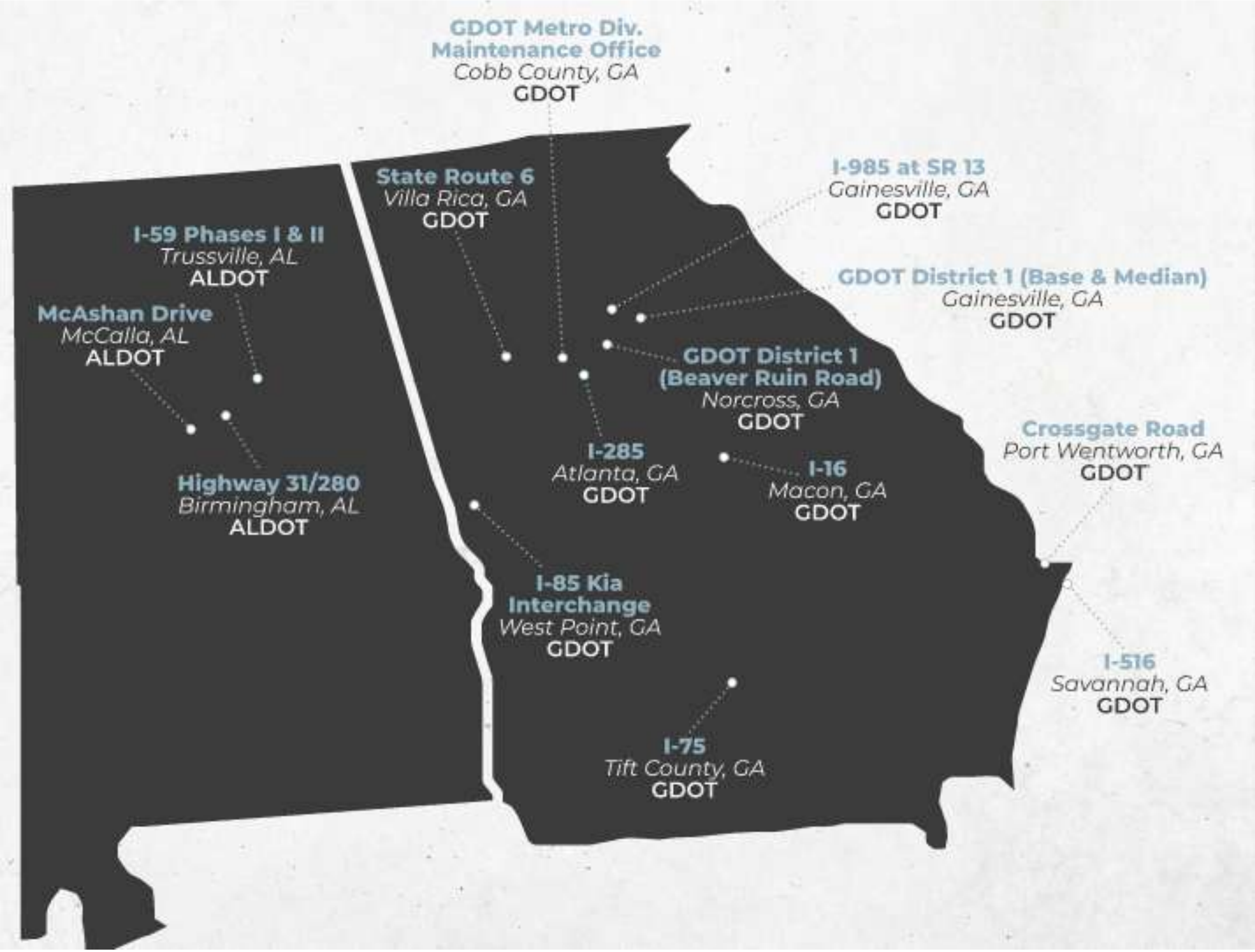
Reported by the RCC Pavement Council Members

➢ Industrial/Trucking	257
➢ Local Streets	166
➢ Port/Intermodal	68
➢ Military	32
➢ HWY Shoulders	28
➢ Arterial Streets	23
➢ Airports	2
➢ Other	48



DOT Roadway Projects in AL and GA

www.rccpavementcouncil.org



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PUBLICLY FUNDED RCC ROADWAY PROJECTS COMPLETED BY RCCPC MEMBERS

DOT Roadway Projects in NC and SC

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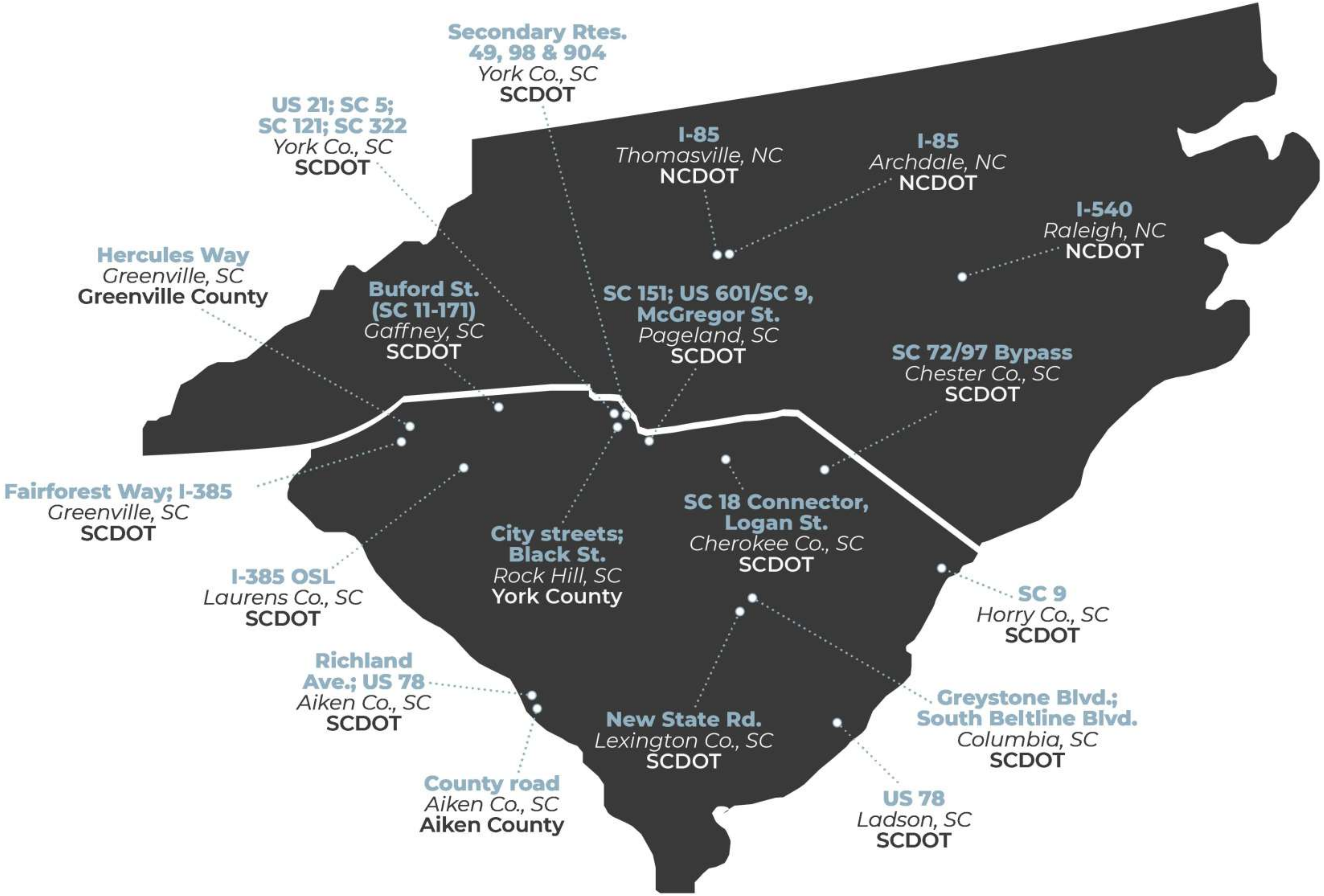

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Roadway Projects in NE and KS

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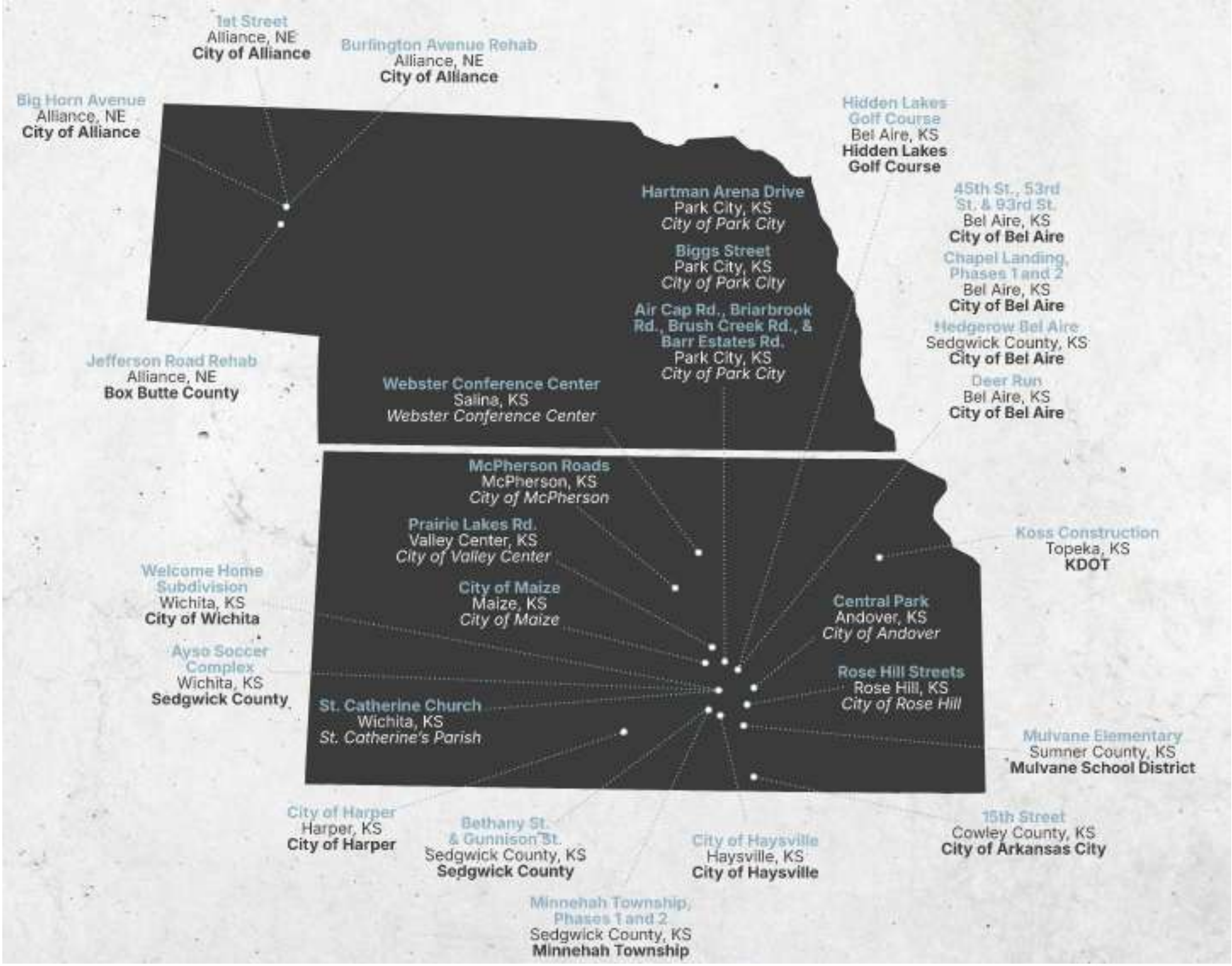

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PUBLICLY FUNDED RCC ROADWAY PROJECTS COMPLETED BY RCCPC MEMBERS

Roadway Projects in TX

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PUBLICLY FUNDED RCC ROADWAY PROJECTS COMPLETED BY RCCPC MEMBERS

Projects in CA

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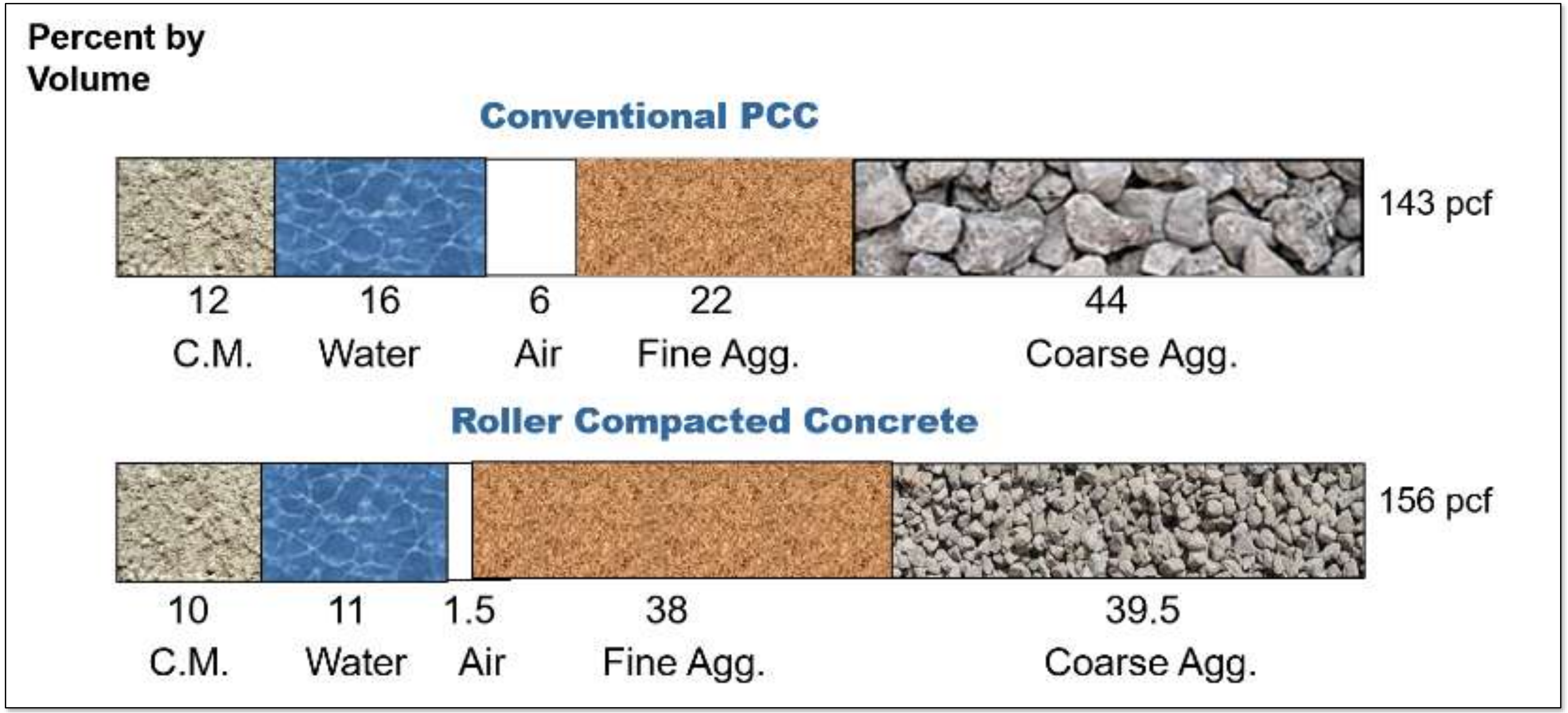
RCC VS. CONVENTIONAL CONCRETE MIXES

- Well-graded combined aggregates
- Most mixes have ¾”or ½” max size of aggregates
- With or without SCM
- SCMs where available
  - Fly ash
  - Slag
  - Silica fume
- Admixtures
  - Retarders



RCC CONSISTENCY

- Less water content and less cementitious content as compared to zero-slump conventional concrete
- Consistency is similar to dense graded aggregate base but with added cementitious materials and sometimes admixtures

RCC CONSISTENCY

Why Chose RCC?

- Cost savings
- Fast construction
- Early opening to traffic
- Low maintenance
- High load carrying capacity
- Sustainability attributes
  - Durability
  - About 10% reduction in cementitious content vs. PCC

https://www.youtube.com/watch?v=mfkprEuFg6o https://www.youtube.com/watch?v=mfkprEuFg6o

Why not consider RCC for pavements?

LIMITATIONS

- Project size to absorb mobilization and plant set-up cost
- Geometric shape/obstacles
- Ride smoothness for high speed (may require diamond grinding)
- Thickness in one lift
  - 4” minimum
  - 10” ± maximum
- Proper equipment and personnel experience is critical
  - Design
  - QA/QC
  - Construction means and methods

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LIMITATIONS

- Difficulties to entrain air due to the zero-slump mix consistency
- Even without air entrainment, RCC pavements have been performing well in areas subjected to freeze-thaw cycles
- For higher freeze-thaw durability, it is recommended to:
  - Use higher strength RCC and include supplementary cementitious materials to reduce permeability
  - Compact the RCC to a high density
  - Provide positive drainage to prevent RCC saturation
  - Use less aggressive deicers

- Introduction to RCC Pavements
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  - Utilization/Example Projects
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- **Construction Means and Methods**
  - **Mixing**
  - **Placement, Compaction, Curing and Finishing**
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Continuous Pugmill Mixers set-up at or near the job site

- Minimum 2 acres for small sized projects and 3-4 acres for large sized projects
- Two-inch water line with good pressure
- Power supply: 480V, 3 phase, 400 amps
- Excellent mixing efficiency and consistency for RCC mixes

Continuous Pugmill Mixers

Continuous Pugmill Mixers

Batch-Type Pugmill Mixers

CONSTRUCTION MEANS & METHODS | HOW IS RCC MIXED?

Drum Mixers

Horizontal Shaft Mixers

- Reduced production rate
- Longer mixing time
- Dedicated supply
- Frequent cleaning

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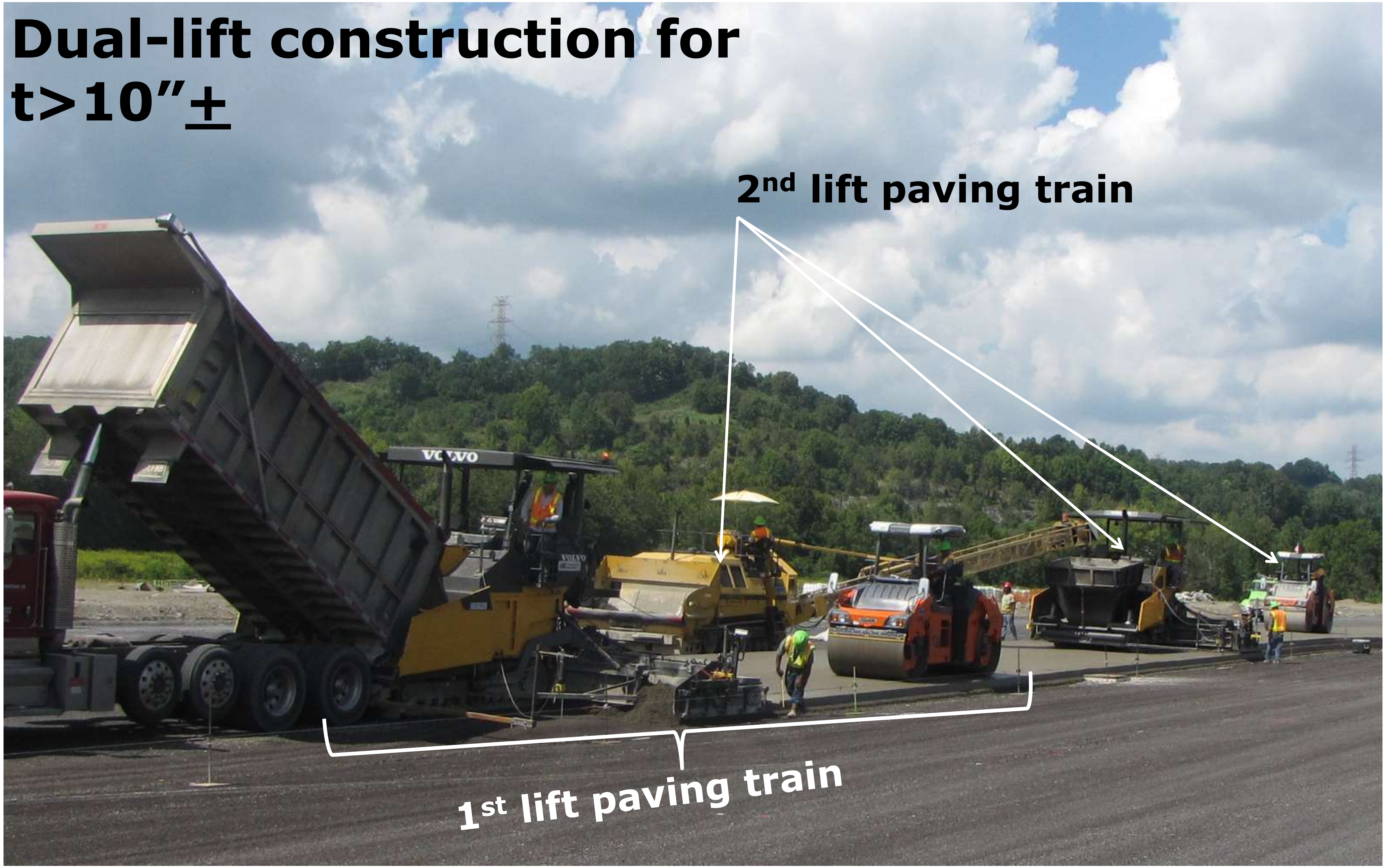
CONSTRUCTION MEANS & METHODS | HOW IS RCC TRANSPORTED?

- Rear dump trucks
- Limit transport time
- Align number of trucks with placement speed
- Covers are required

- Material transfer device operating outside the paving lane is recommended
- High Density Pavers
  - Vibrating screed
  - Dual temping bars or single temping bar and a pressure bar
  - Paver compaction $\geq$ 90% of Reference Wet Density
  - Smoothest RCC profile
- Conventional Asphalt Pavers
  - Not recommended when:
    - RCC thickness > 6" or
    - Smooth surface is required

Dual-lift construction for t>10"±



CONSTRUCTION MEANS & METHODS | COMPACTION

- Initial compaction by the paver
- Screeds are modified with edge shoes and additional edge compactors for higher density at the edge
- Vibratory rollers to compact to 98% of Reference Wet Density
- Smaller rollers for finishing and removal of roller marks

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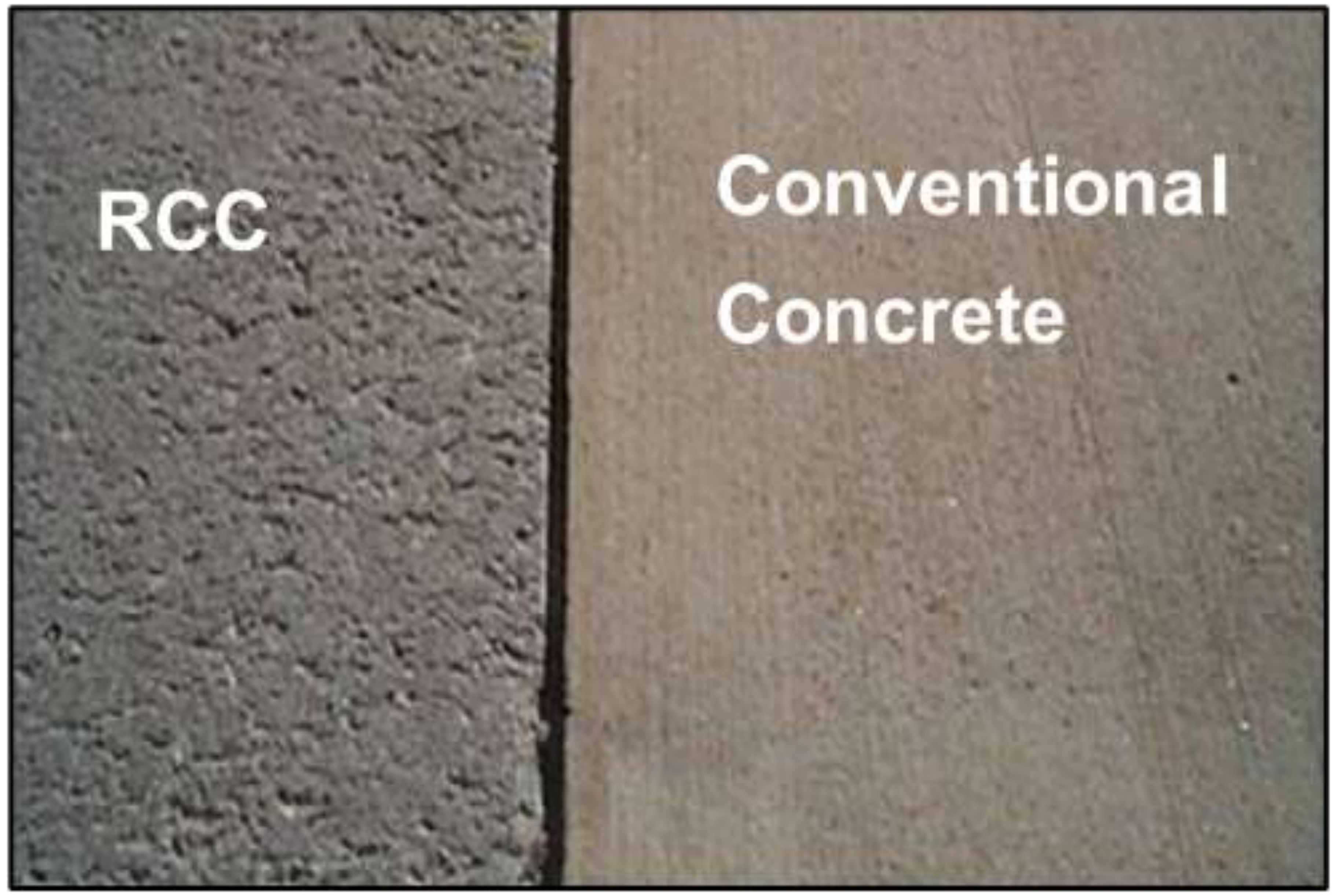
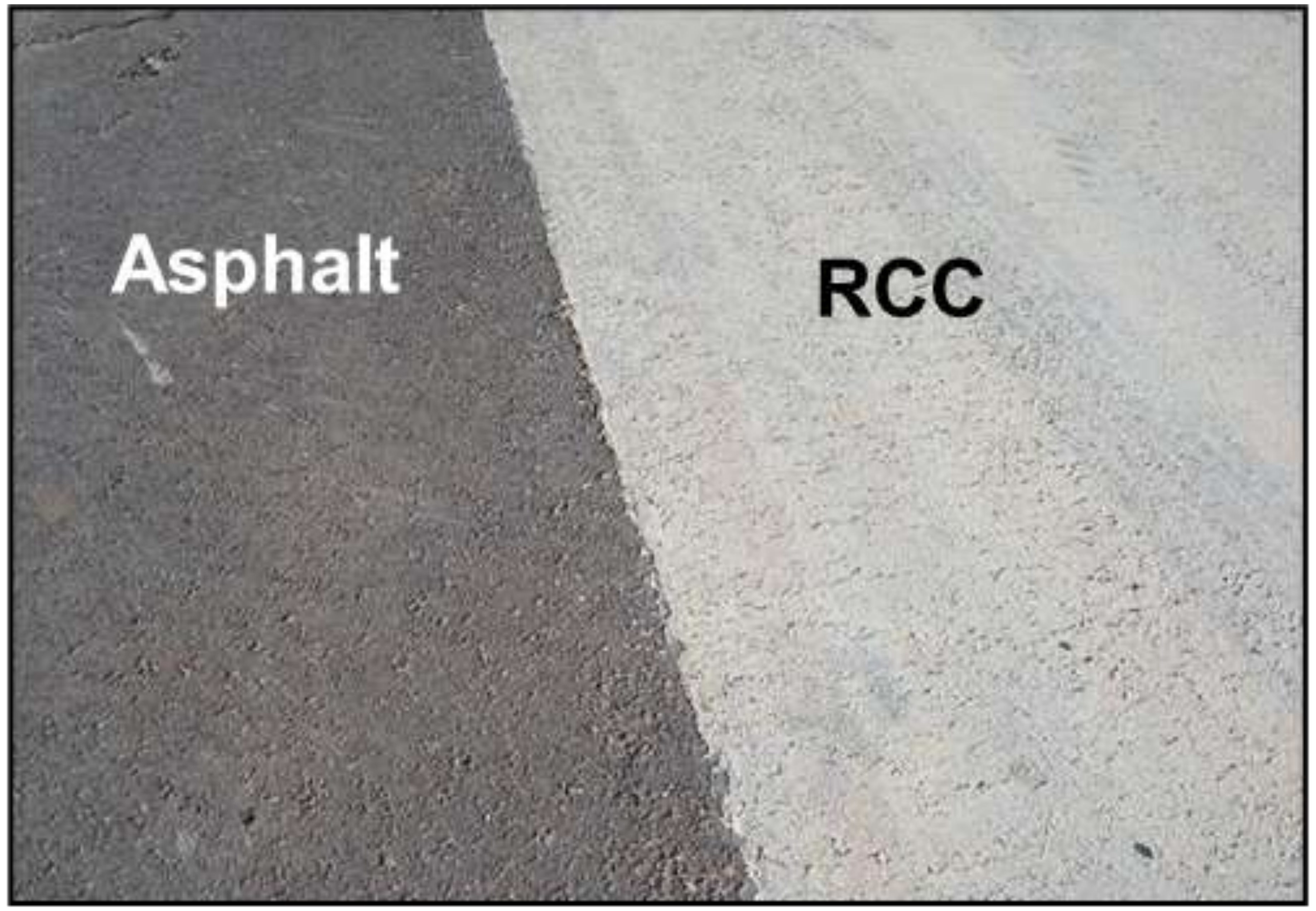
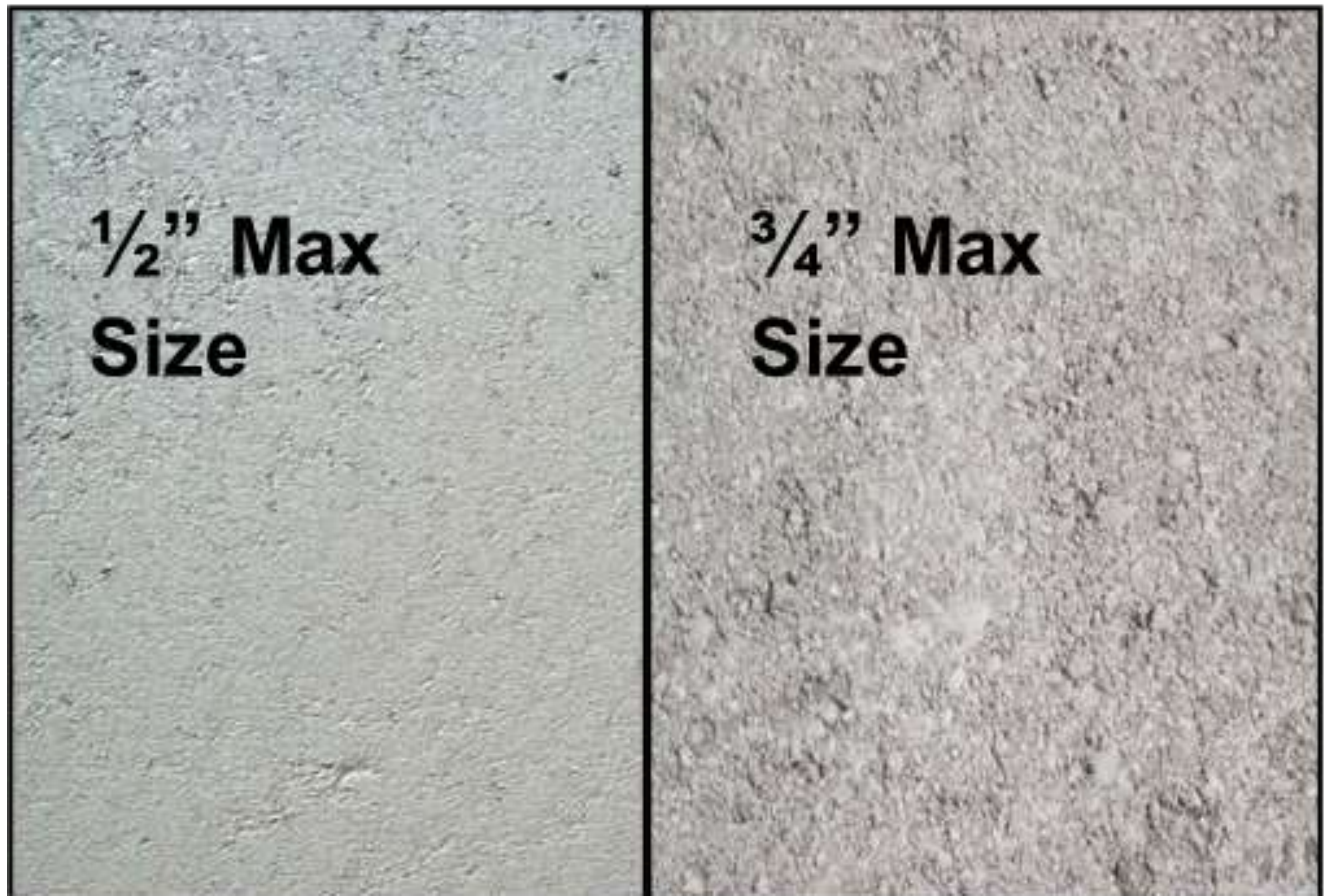
CONSTRUCTION MEANS & METHODS | EDGE DETAILS

Safety Edge

- Edge compaction at longitudinal cold joint
- Edge at 10 degrees or less from vertical


RCC
Conventional
Concrete


Asphalt
RCC


½" Max
Size
¾" Max
Size


Diamond
Ground
Conventional
Concrete
Diamond
Ground
RCC

- Became common over the past decade
- Proprietary finishing aid added at the surface
- Troweling with ride-on trowel machines
- Closer look to broom- or burlap-finished concrete

CONSTRUCTION MEANS & METHODS | CURING

- Similar to conventional concrete
- Higher application rate is recommended

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- Early-entry joint saw cutting
- Sawing window is approximately 2 to 6 hours after finishing, dependent on the mix design and environmental conditions

YOUTUBE: RCC FOR MASSIVE RESIDENTIAL SUBDIVISION IN SE TENNESSEE

https://www.youtube.com/watch?v=QH0auJzgclU

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RCC MIXTURE DESIGN

Modifications needed in no-slump concrete mixture procedures (ACI 211.3R) because RCC for pavements is:

- Dryer and stiffer than zero slump
- Not air entrained (not yet)
- Lower cementitious content
- Higher fines content
- Nominal maximum size aggregate ½" to ¾"

ASTM D1557 Modified to Include Cement

- Most common method in the U.S.
- Testing equipment readily available
- Three major steps
  1. Select aggregate blend approaching maximum density
  2. Determine optimum moisture content
  3. Determine cementitious content

Modified Proctor
ASTM D1557

SOIL-COMPACTION METHOD OF MIXTURE DESIGN

1. Aggregate Selection

- 70% - 80% of mix by volume
- Impacts segregation, workability, paveability, stability, compactability, and strength.
- ¾” or smaller top size to reduce segregation
- Must consider locally available materials
- Must meet C-33 quality requirements, but not necessarily gradation requirements

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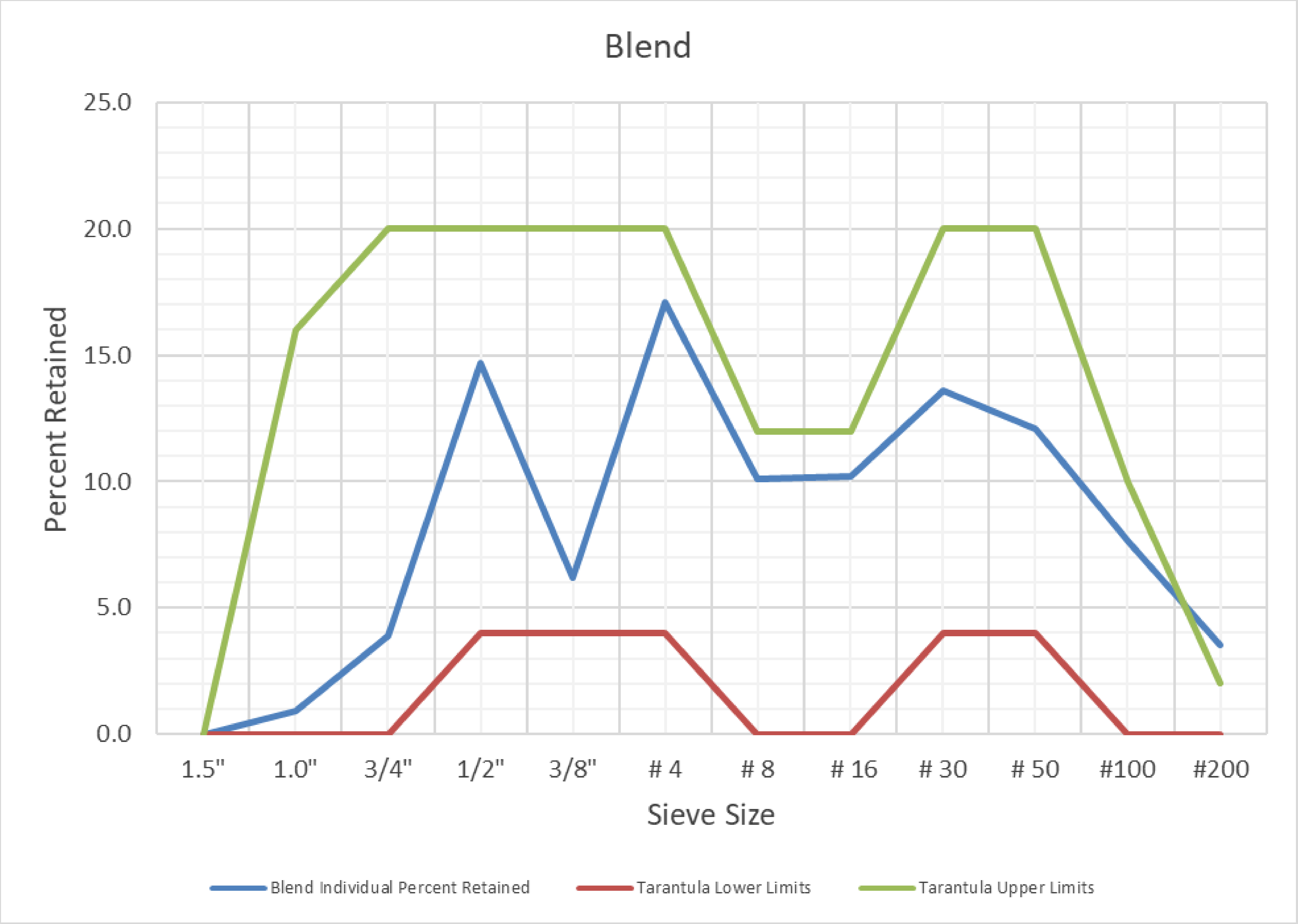
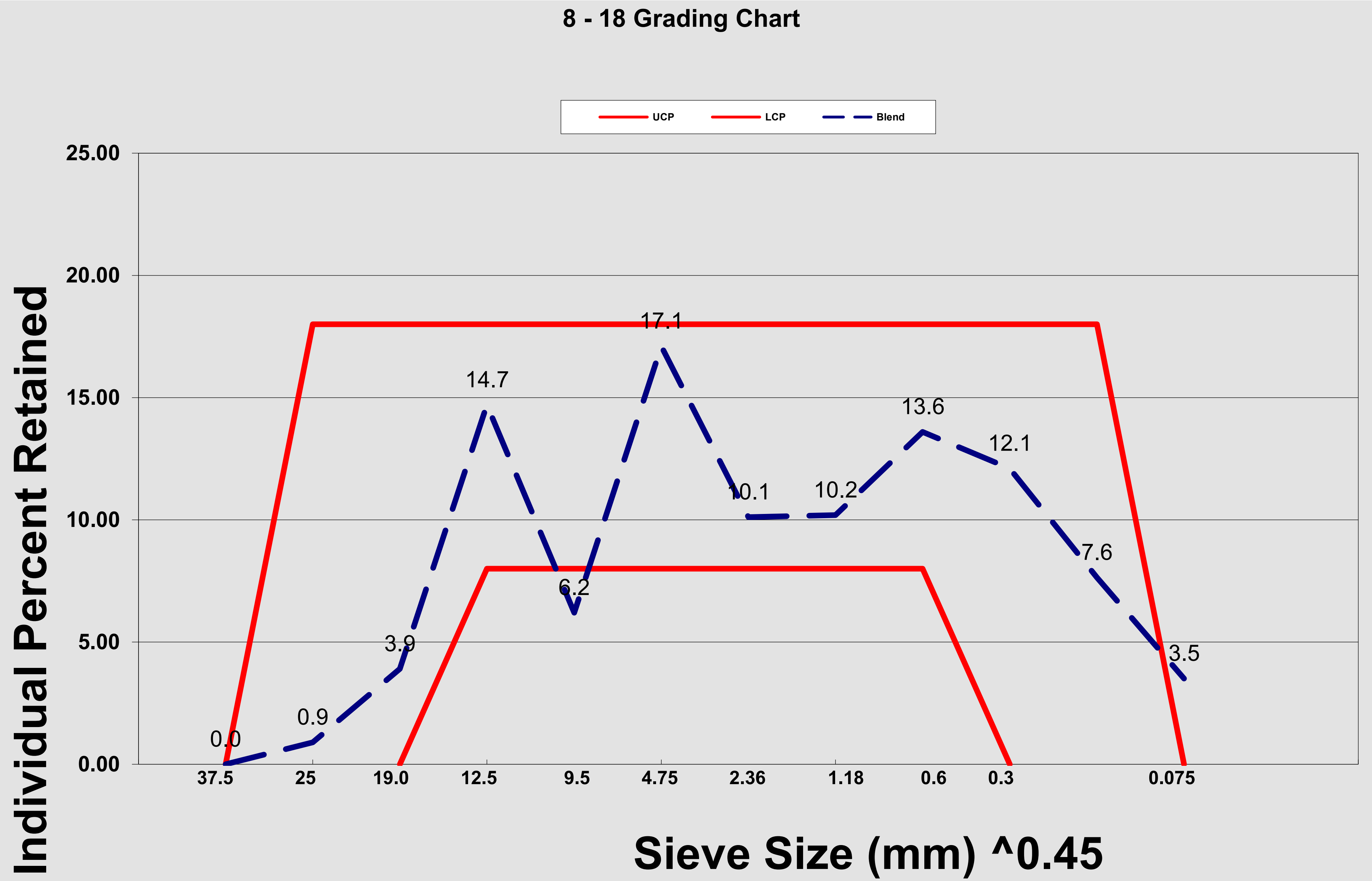
SOIL-COMPACTION METHOD OF MIXTURE DESIGN

1. Aggregate Selection

- Combined gradation methods: 0.45 Power Curve; Tarantula Curve; 8-18 Method
- Confirm performance by laboratory and field testing





SOIL-COMPACTION METHOD OF MIXTURE DESIGN

1. Aggregate Selection – Combined Aggregate Gradation

- From ACPA's Guide Specification for RCC Pavements as Exposed Wearing Surface

Table RCC-2: Combined Aggregate Gradation Ranges for RCC[6]

Sieve Size	Lower & Upper Specification Limits 1/2 in (12.5 mm)		Lower & Upper Specification Limits 3/4 in (19.0 mm)		Lower & Upper Specification Limits 1 in (25.0 mm)	
1.5 in. (37.5 mm)					100.0	100.0
1 in. (25 mm)			100.0	100.0	82.0	100.0
3/4 in. (19 mm)	100.0	100.0	95.0	100.0	72.0	95.0
1/2 in. (12.5 mm)	81.0	100.0	70.0	95.0	61.0	81.0
3/8 in. (9.5 mm)	71.0	91.0	60.0	85.0	50.0	71.0
No. 4 (4.75 mm)	49.0	70.0	40.0	60.0	36.0	55.0
No. 8 (2.36 mm)	33.0	54.0	30.0	50.0	25.0	43.0
No. 16 (1.18 mm)	24.0	40.0	20.0	40.0	15.0	32.0
No 30 (600 ųm)	15.0	30.0	15.0	30.0	10.0	26.0
No 50 (300 ųm)	10.0	25.0	10.0	25.0	5.0	19.0
No. 100 (150 ųm)	2.0	16.0	2.0	16.0	2.0	16.0
No 200 (75 ųm)	0.0	8.0	0.0	8.0	0.0	8.0

ON-SITE AGGREGATE BLENDING

- Combining a minimum of 2 aggregates is strongly recommended
- Typically combining 3 or 4 aggregates works best
- Single stockpile is not recommended and should not be permitted
- Segregation concerns
- Ability to adjust proportions of different sizes on site is important

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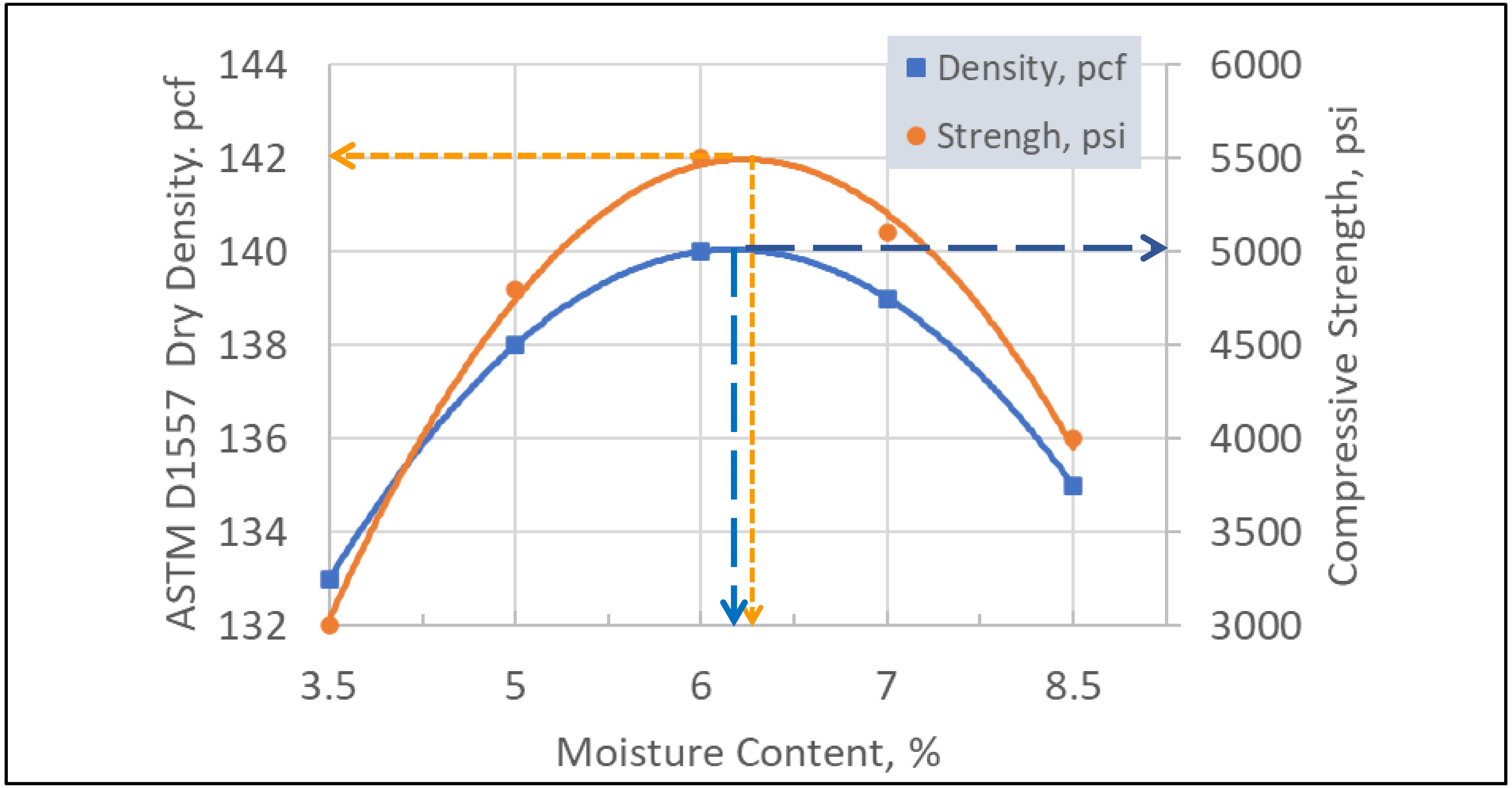
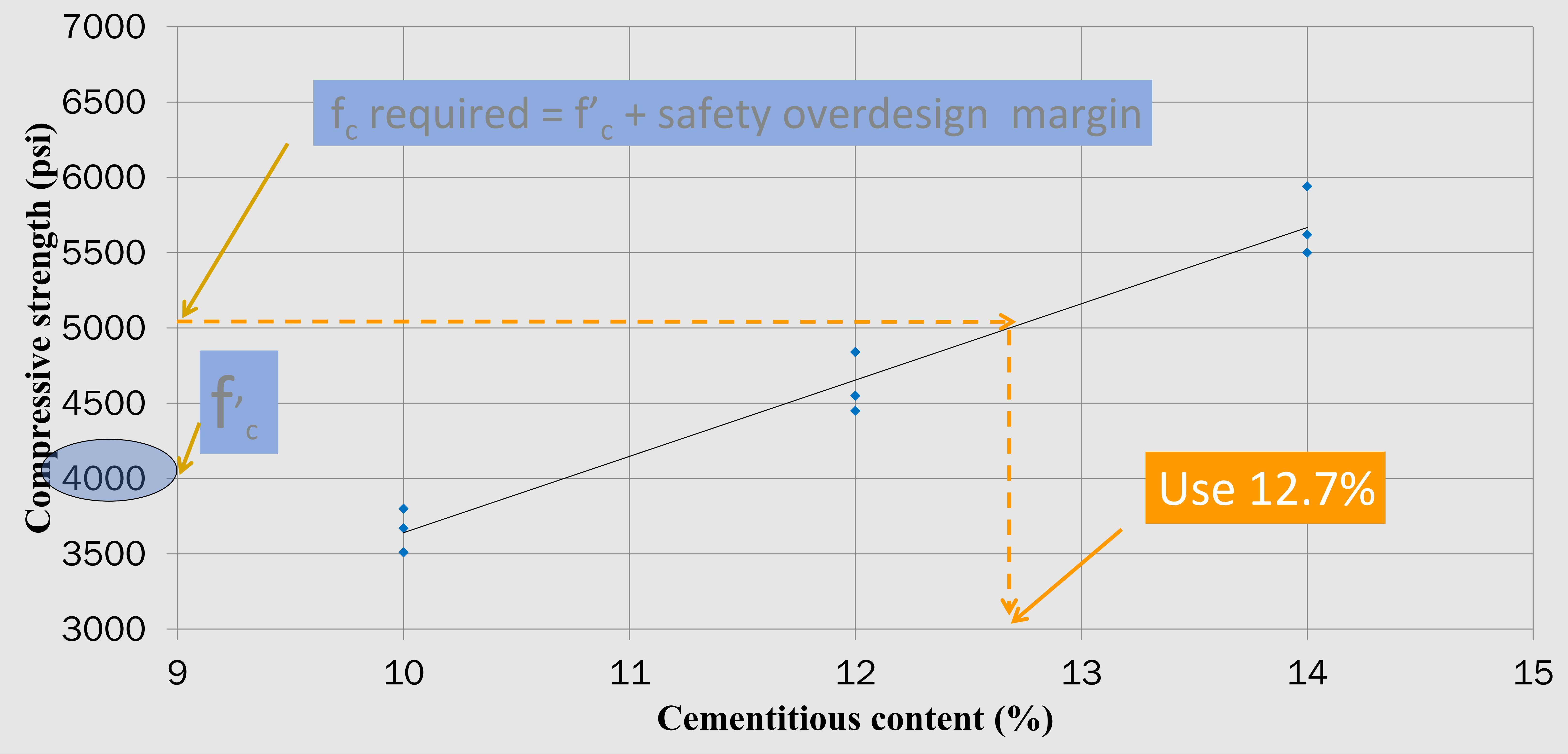
2. Determine Maximum Density and Optimum Moisture content



Note: RCCPC Reference Wet Density for determining percent compaction in the field = Wet Density at OMC

3. Make specimens per ASTM C1435 and determine required cement content



RECENT DEVELOPMENT | SUGGESTED VOIDS FILLED BY PASTE METHOD

- Based on RCC research partially funded by the RCCPC at UIUC
- Credit to Jeffery R. Roesler, PhD and Jordan Ouellet, PhD
- Method is based on calculating the intergranular voids (IGV) of compacted aggregates, and calculating the mix proportions to have a paste content slightly higher than 100 percent of IGV
- The method is currently being evaluated by the RCCPC contractor members
- Preliminary observations:
  - The method appears to produce significantly lower cementitious contents as compared to the soil-compaction method
  - Additional cementitious materials may be needed for surface durability and for sufficient paste to facilitate troweling the surface

- Ongoing research at ISU involving mineral-blended polymeric microspheres shows strong promise for advancing RCC mixtures with enhanced resistance to freeze–thaw damage

Construction and Building Materials 531 (2026) 146618

ELSEVIER

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Mineral-blended polymeric microspheres as an alternative to air-entraining agents in roller compacted concrete pavements

Amir Salimi [a,*], Emin Sengun [b], Md Lutfor Rahman [a], Daniel King [c], Halil Ceylan [a], Sunghwan Kim [a], Peter C. Taylor [c]

[a] Department of Civil, Construction and Environmental Engineering, Program for Sustainable Pavement Engineering and Research (PROSPER), Institute for Transportation, Iowa State University, Ames, IA 50011-1066, USA
[b] Department of Civil Engineering, Ankara Yildirim Beyazit University, Etlik, Ankara 06010, Turkey
[c] National Concrete Pavement Technology Center, Institute for Transportation, Iowa State University, Ames, IA 50011-1066, USA

RECENT DEVELOPMENT | RCC RESEARCH AT ISU

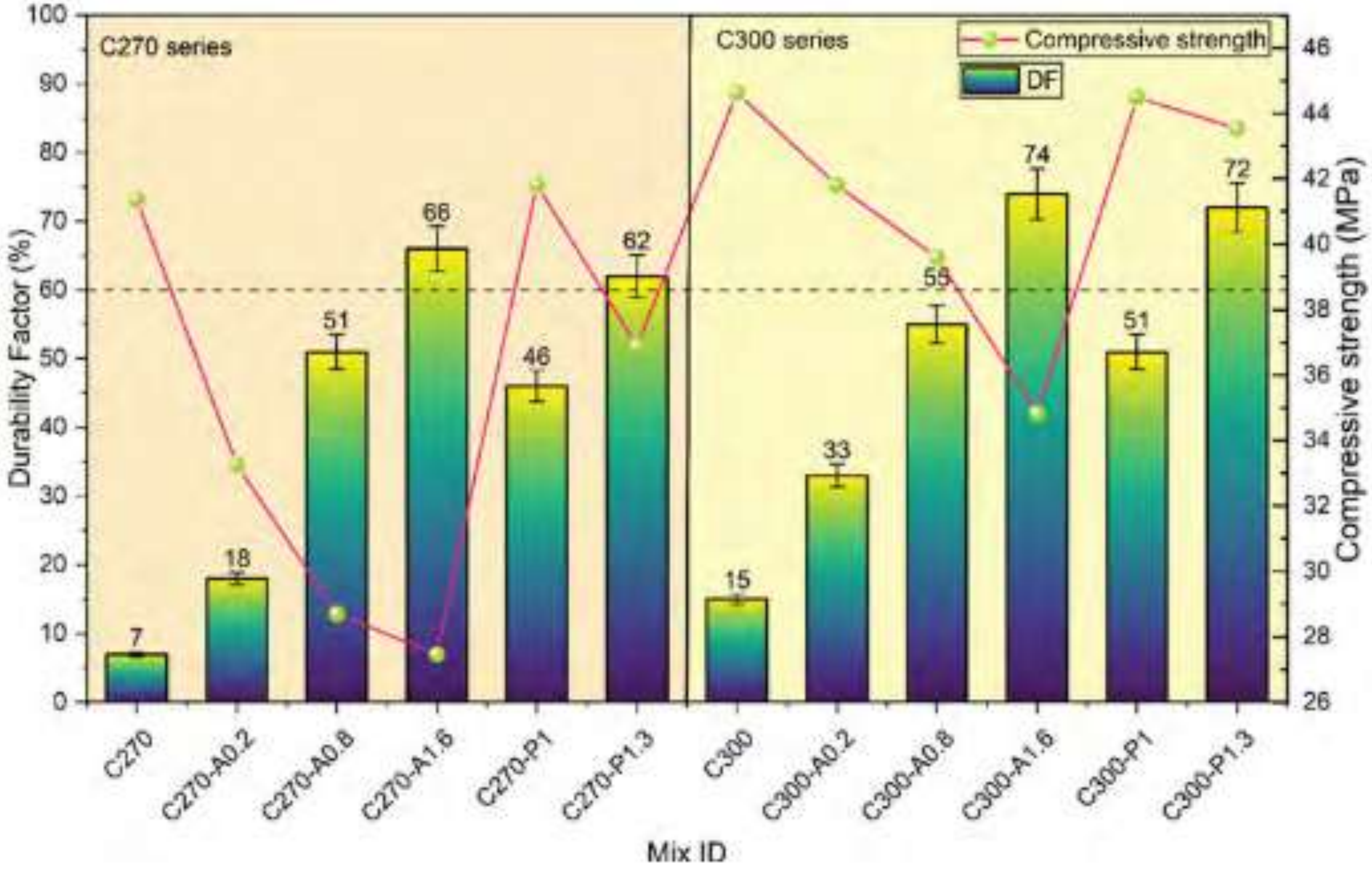


Fig. 25. Durability factor (DF) for all RCC mixtures after freeze-thaw exposure.

- Paper presents research key findings on improving freeze-thaw durability of RCC while maintaining mechanical performance.

FIELD DENSITY TESTING

- Reference density
  - Modified Proctor
  - Average max. density
  - Max. theoretical density
- Average of 5 consecutive field wet density should not be less than 98% of modified Proctor wet density at OMC with no single test below 96%

QC AT PLACEMENT SITE (RCCPC SPEC. FOR RCC PAVEMENTS, 2021)

Table RCC-4: Quality Control Requirements at Placement Site

Item	Method[1]	Frequency or Lot Size	Limits
RCC Moisture Content	ASTM C566	Sample at point of placement from initial truck load, and as required	±1.0% of optimum moisture content per ASTM D1557
In-place Wet Mat Density	ASTM C1040 direct transmission mode	At beginning of placement immediately behind the paver, and within 30 minutes of final compaction; One Test per lot	At least 98% of the laboratory reference wet density by ASTM D1557 based on an average of four consecutive tests with no test below 96%
In-place Wet Joint Density	ASTM C1040 direct transmission mode	One test per lot, and within 30 minutes after final compaction	At least 96% of the laboratory reference wet density by ASTM D1557 based on an average of four consecutive tests with no test below 94%
Longitudinal Joint tightness when sealed joints are specified	Observation after joint saw-cutting ½" wide minimum	All longitudinal joints	Joints shall have square edges. Isolated raveling of aggregates shall not be more than 3/8" wide from the saw-cut edges.
Surface elevations on both sides of longitudinal joint	Surveying, measuring tape, or other appropriate methods to determine difference in elevation	All longitudinal joints	Surface elevations on both sides of joints shall not vary by more than ¼" (6 mm)

- From RCCPC Guide Specification for RCC Pavements as Exposed Wearing Surface, 2021
- PDF can be downloaded from www.rccpavementcouncil.org

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QC AT PLACEMENT SITE (RCCPC SPEC. FOR RCC PAVEMENTS, 2021)

Table RCC-4: Quality Control Requirements at Placement Site

(CONTINUED)

Item	Method[1]	Frequency or Lot Size	Limits
Cylinders for Compressive Strength	ASTM C1435 for molding cylinders; ASTM C31 for curing and handling cylinders; and ASTM C39 for testing cylinders	One set of three cylinders for every lot, or one day of production, whichever is less.	Average strength equal to 100% of the specified strength in Section RCC-4.03, with no single result below 90%.
Surface Smoothness	See Section 7.04	One Test per lot	See Section 7.04
Thickness	ASTM C42	One core for every two lots, or one day of production, whichever is less.	See Section 7.01
Core Visual Inspection	Visual	One core for every two lots, or one day of production, whichever is less.	Visually inspect cores to ensure that compaction at the bottom of the lift is obtained. If significant honeycombing or other signs of lower density are evident, check the cores for strength (See Section 7.03)
Multiple Lift Bond Determination	Core with Normal handling	One core for every two lots, or one day of production, whichever is less.	See Section 7.05

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RCC THICKNESS DESIGN TOOLS

- Fundamentals: Thickness Design of RCC pavements is similar to plain un-doweled conventional concrete pavements
- Truck Traffic
  - PavementDesigner.org
  - StreetPave
  - PavementME
  - ACI Tables
  - AirPave
  - PCASE

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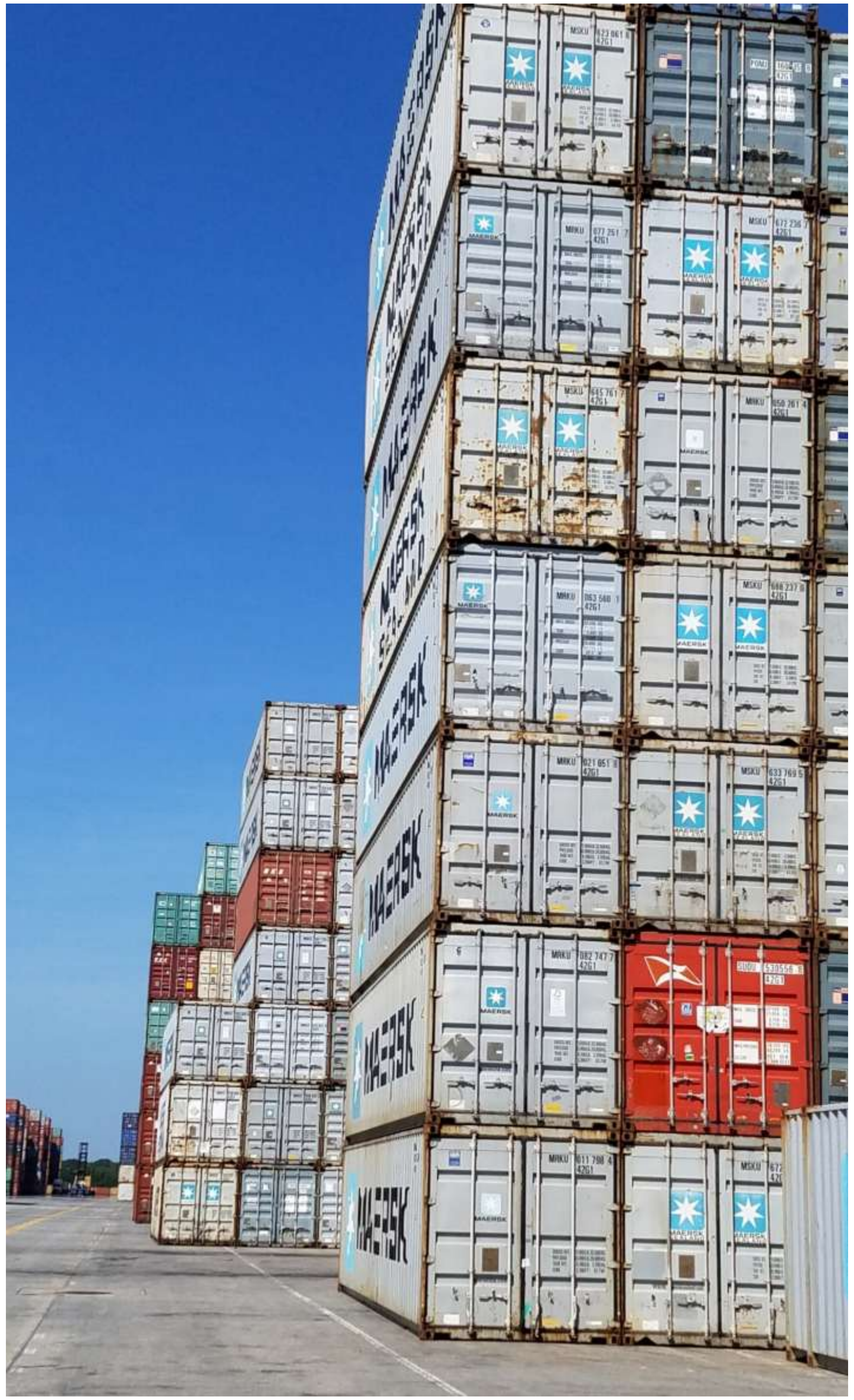
RCC THICKNESS DESIGN TOOLS

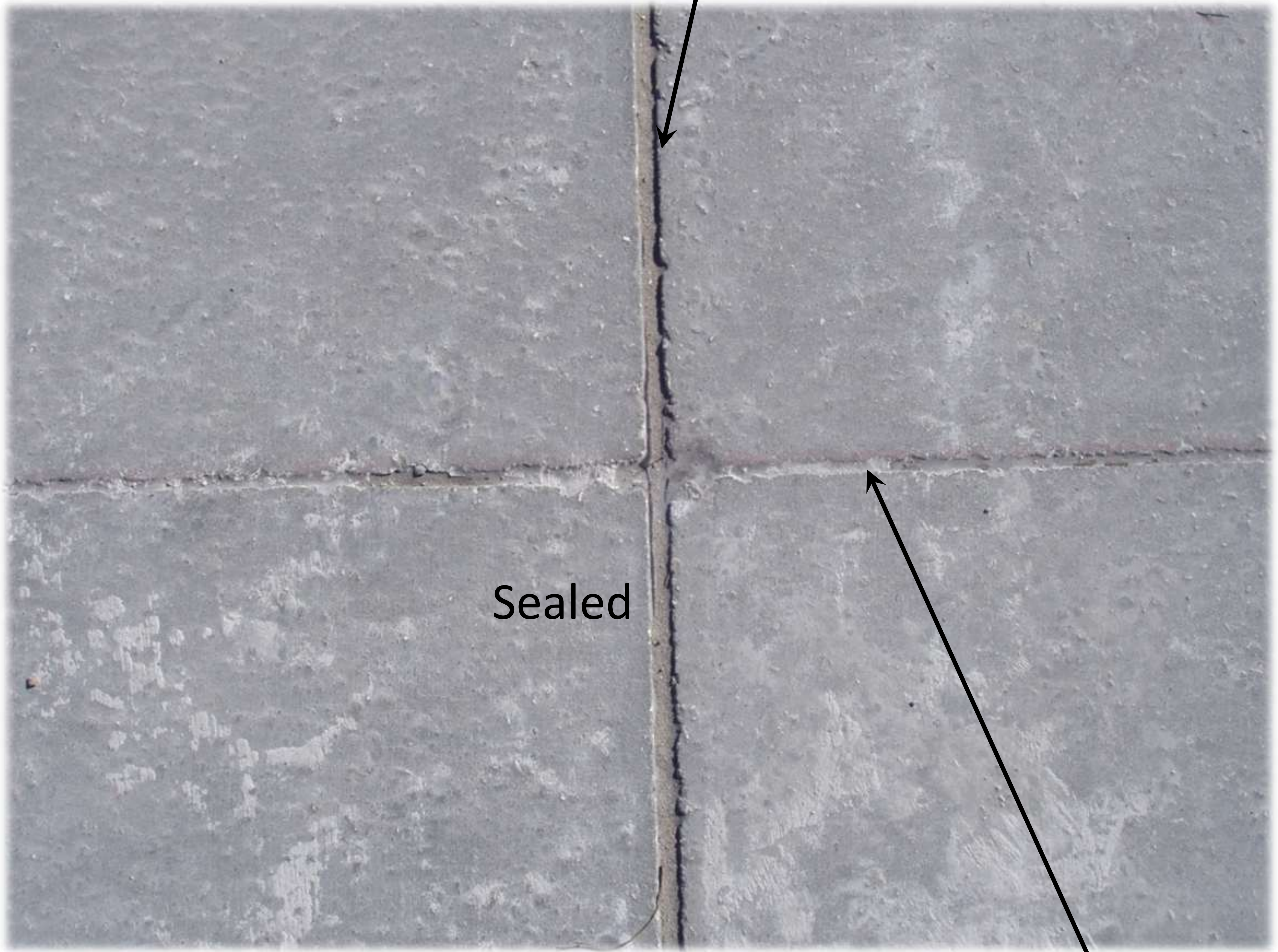
- Container Handlers / RTGs
  - PavementDesigner.org
  - AirPave
  - PCASE
- Stacked Containers
  - New design charts by the RCC research team at ISU
  - PCA Slab-on-Grade Design for Post Loads
  - PIANIC Report 165-2015
  - Prior Experience

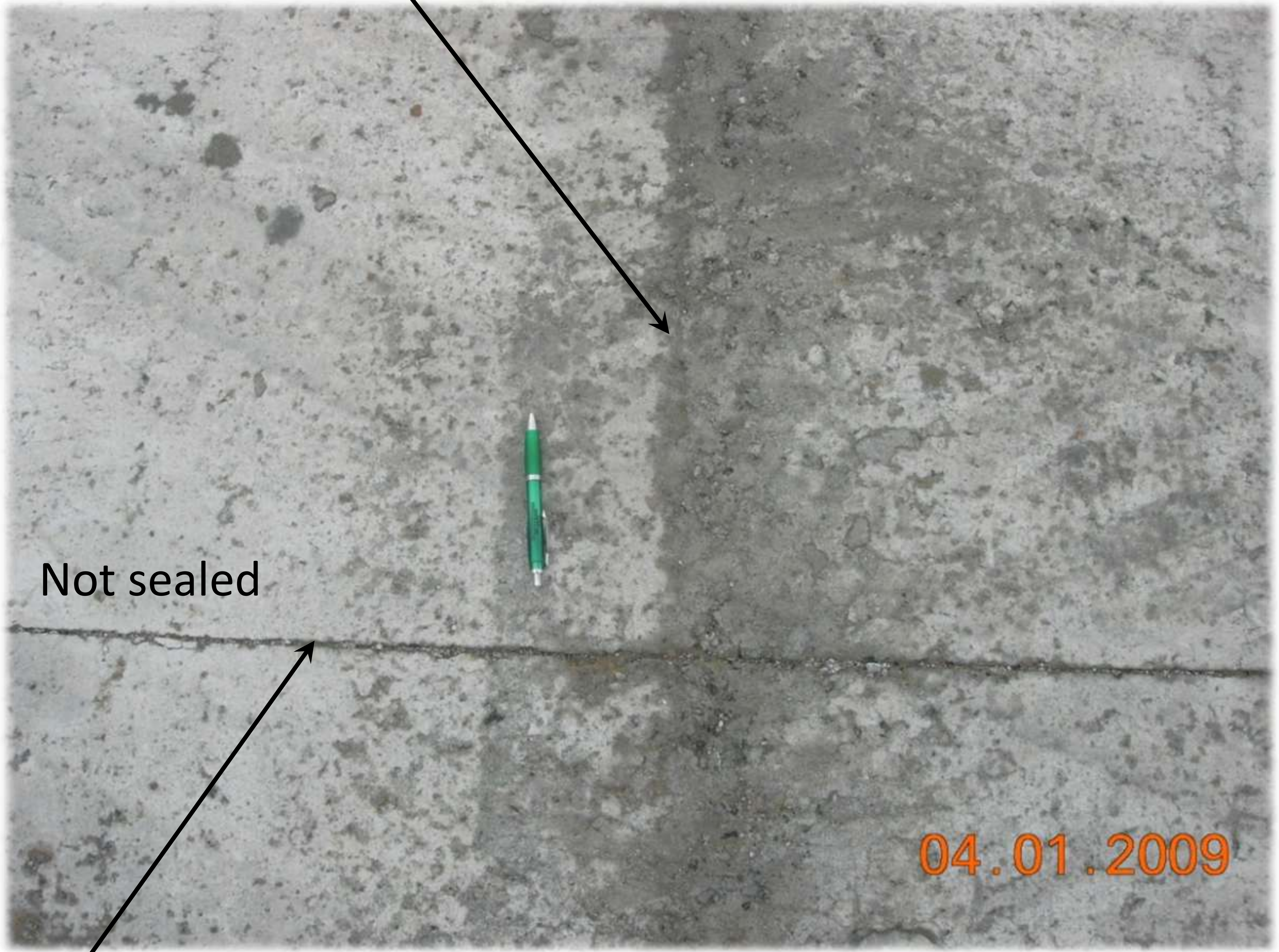


JOINTS

Cold Longitudinal Joint

Fresh Longitudinal Joint (not recommended unless retarders are used and strict specifications are followed)



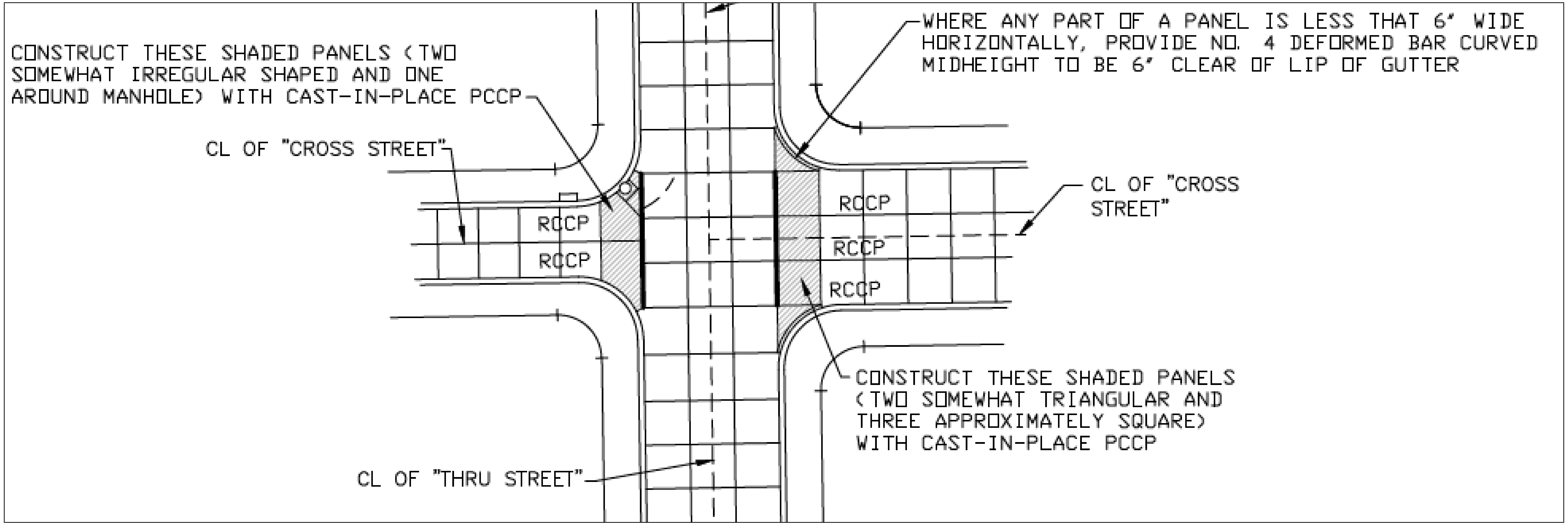


Transverse

JOINTS

- Crack control joints nominal spacing 15 ft. ± for t > 7”; Similar to PCC for t ≤ 7”
- Depth of cut as needed to activate full depth crack, typically about ¼ the slab thickness
- Not all RCC pavements have sawcut control joints or sealed joints, however sealed joints are recommended
- Isolation and expansion joints should be incorporated like for conventional concrete pavements

JOINTS



- Isolation and expansion joints should be incorporated like for conventional concrete pavements
- Use PCC in lieu of RCC where needed due to equipment limitations

TEST STRIP

- Demonstrate contractor's capabilities (personnel and equipment)
- Train personnel
- Check RCC mixture / adjust as needed
  - Density; ease of compaction
  - Compaction rolldown and surface smoothness
  - Mix stability under rollers and at edges
  - Segregation
  - Strength

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TEST STRIP

- All aspects of construction should mimic proposed construction methods
  - Site preparation
  - Base layer construction
  - RCC layer construction
    - Construction equipment
    - RCC Details
      - Longitudinal and transverse construction joints
      - Saw-cut joints
      - Horizontal joints of dual-lift pavements
      - Finishing expectations

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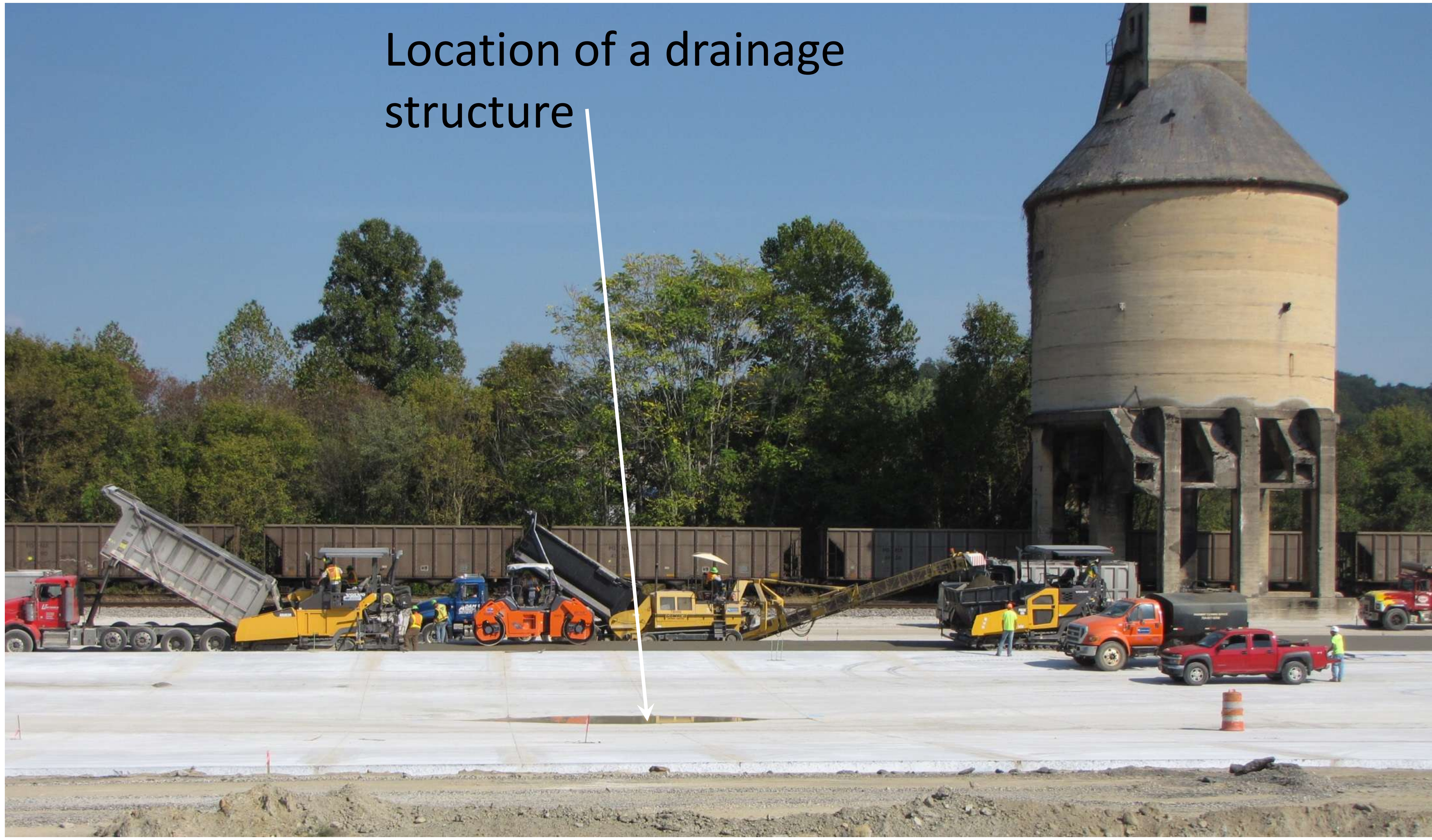
CONSTRUCTION SEQUENCE AT UNDERGROUND UTILITIES



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OBSTACLES

PCC Apron at building wall

Dowels may be needed

Remove RCC, complete drainage structure, and place PCC apron

Isolation Joints

PLANNING FOR UNDERGROUND UTILITIES

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OBSTACLES

AVOID GETTING TRAPPED

- In field above surface of base layer vs. capped at base, paved over, then brought to grade
  - Significant cost impact

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C0NCLUSIONS

- Over the past two decades, roller-compacted concrete (RCC) pavement technology has advanced significantly, delivering proven performance improvements.
- Equipment innovations have enhanced compaction quality, reduced material waste, and produced smoother finished surfaces.
- Optimized mix designs have improved durability, workability, and overall pavement performance.
- Refined construction practices, including joint layout and detailing, have increased long-term reliability.
- Advanced structural design tools now enable more accurate and efficient pavement design.

C0NCLUSIONS

- Enhanced finishing techniques, including the use of finishing aids and improved troweling methods, have elevated surface quality and appearance.
- While RCC pavements may not be the ideal choice for every application, they represent a highly competitive and versatile solution that should be considered for a wide range of facilities.
- Further research is needed to:
  - Establish consistent and standardized quality control practices to improve reliability, comparability, and overall performance across projects.
  - Advance mixing and paving equipment technologies to enhance paveability, minimize material buildup, reduce equipment wear, and lower maintenance and cleaning requirements.
  - Continue improving mix optimization methods and structural design tools.

THANK YOU!
QUESTIONS

Fares Y. Abdo, PE
RCCPC Co-Chair/Research Committee Chair
Director of Technical Services
Morgan Corp.
fabdo@morgan-corp.com

Tech Center

morgan corp.

RCC PAVEMENT COUNCIL

Panelists

Halil Ceylan, Ph.D., Dist.M.ASCE

Pitt-Des Moines, Inc. Endowed Professor in Civil, Construction and Environmental Engineering

Fares Y. Abdo, P.E.

Director of Technical Services

Morgan Corp.