

Pavements Research at ASU and its Relevance to Arizona

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Global Institute of Sustainability

November 16, 2016

Arizona Pavements and Materials Conference, Tempe, AZ



Research in transportation infrastructure

**Materials, structures, and
construction**

ASU Research in Pavements and Materials

**Example projects and their relevance
to Arizona**

Pre-Assessment Question 1

Which of the following is asphalt binder?

(a)



Source: VDOT

(b)



Source: wikipedia

Pre-Assessment Question 2

Which of the following is a pneumatic tire roller?

(a)



(b)



Pre-Assessment Question 3

Which of these will you pull for on Saturday?

(a)



(b)



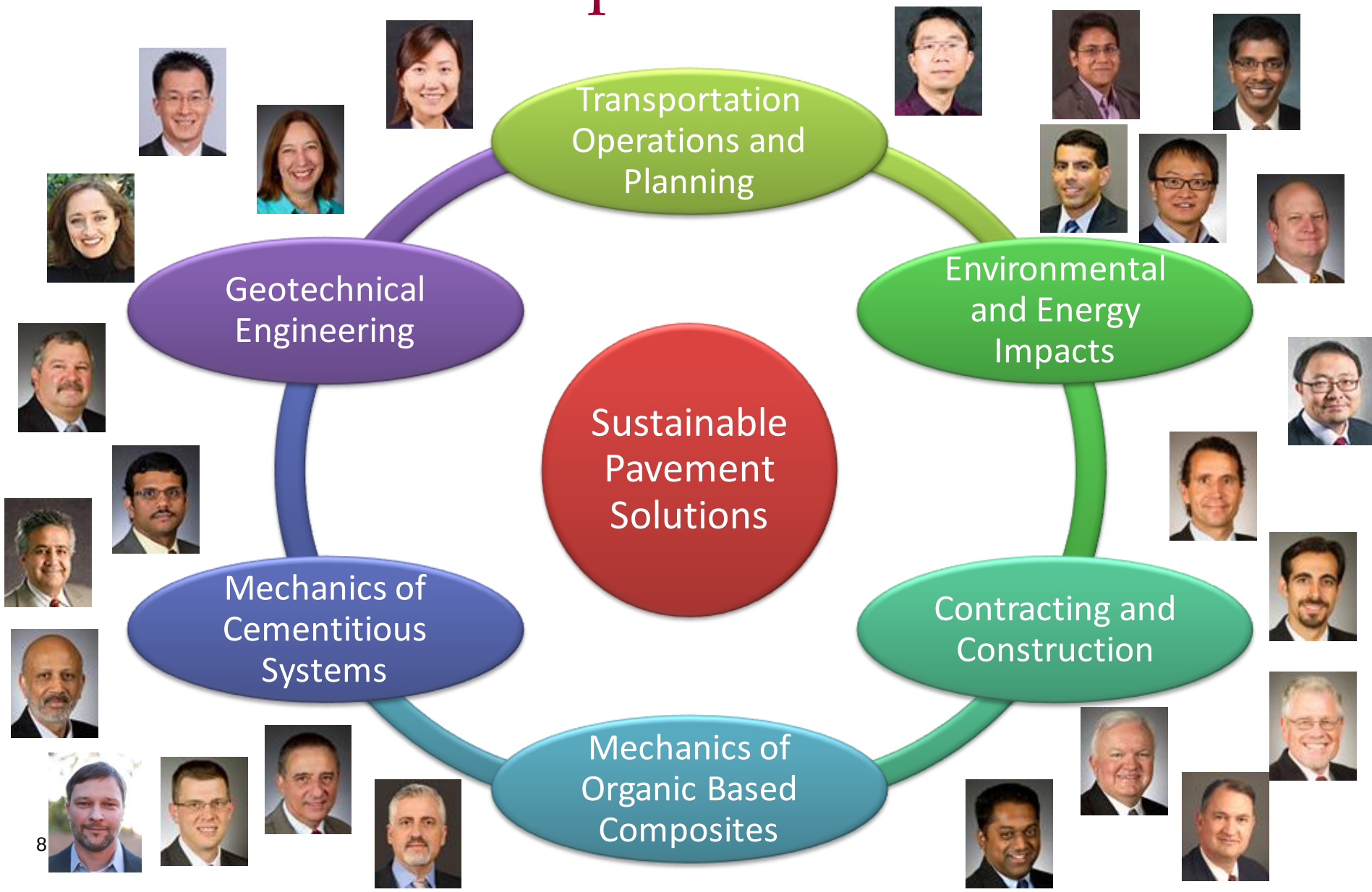
Research in transportation infrastructure

**Materials, structures, and
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ASU Research in Pavements and Materials

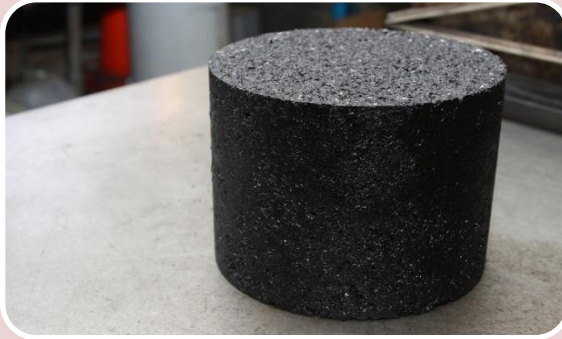
**Example projects and their relevance
to Arizona**

Research in Transportation Infrastructure



Examples of Recent Research

Sustainable Pavements



Materials

- MSCR binder evaluation
- High Perf. PCC
- Fiber Reinforced AC
- Fiber Reinforced PCC
- Hydrated lime and portland cement in AC
- RAP in AC
- Rubberized AC



Structures

- TRC PCC for structural applications
- Pavement Design ME
- Phase change materials in pavements
- Autonomous vehicles and pavements
- Extreme events and Resiliency

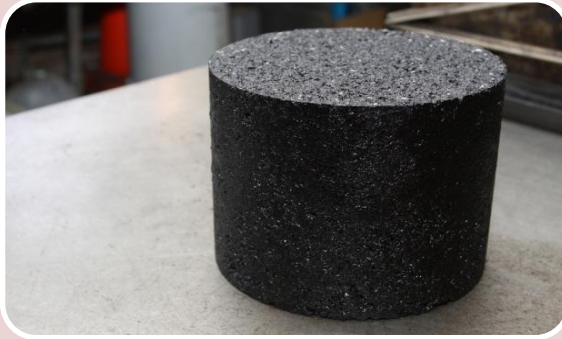


Construction

- Performance of alternative delivery projects
- Performance effects from nighttime construction
- Technologies and water quality impacts

Examples of Recent Research

Sustainable Pavements



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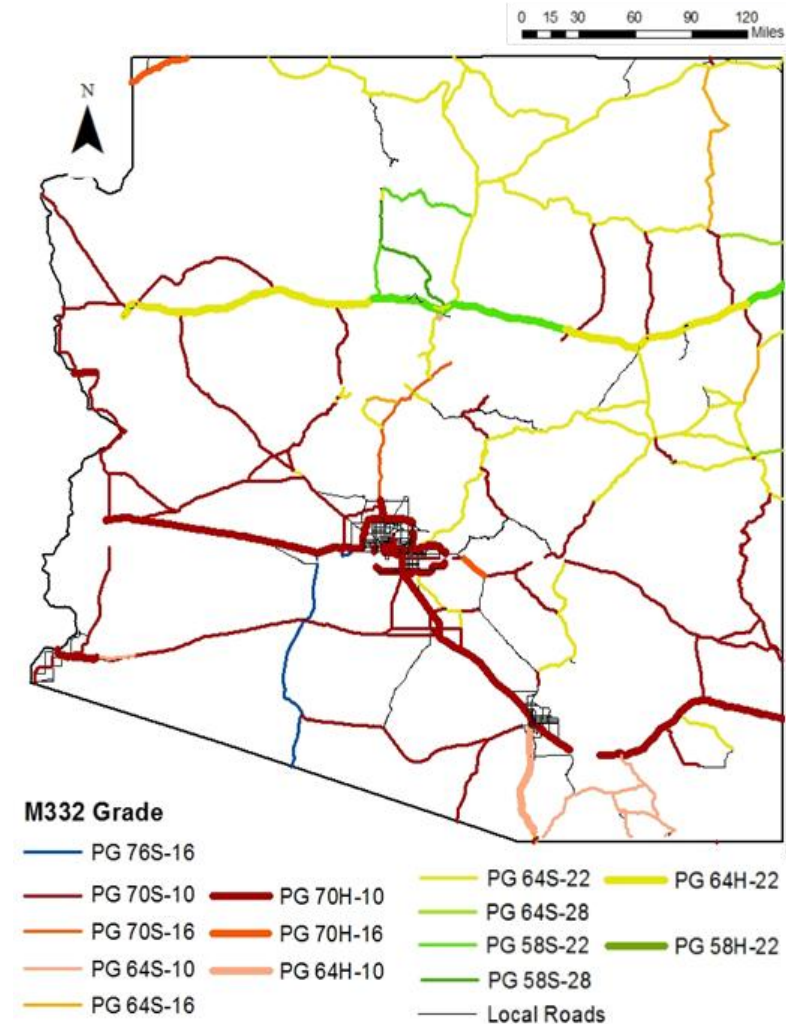
Construction

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MSCR of Asphalt Binder

Overview

- The **M**ultiple **S**tress **C**reep **R**ecovery test is a new method to test and grade asphalt binders.
 - Subjects asphalt to higher stress levels than current methods.
 - Material responds in a way that is purportedly more similar to in-service conditions.



MSCR of Asphalt Binder

Research Objectives and Relevance to Arizona

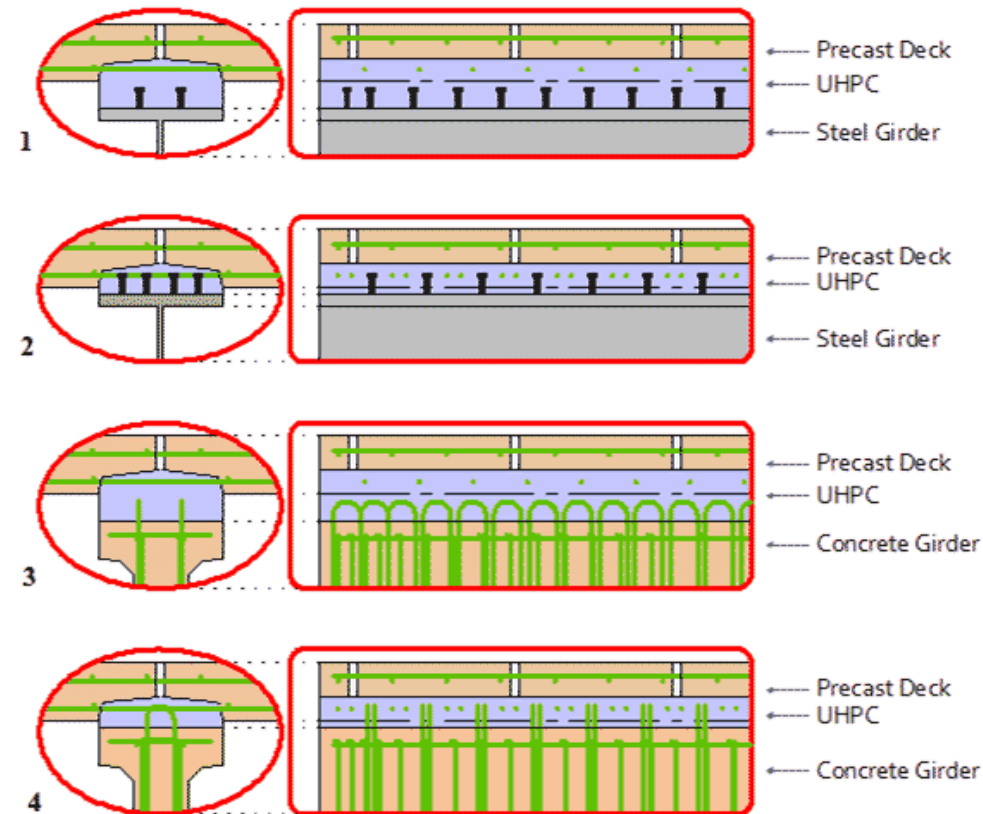
1. Determine if the test parameter is a better indicator of the rutting performance of Arizona asphalt pavements than the currently used parameter.
2. Determine whether there are other undesirable performance impacts associated with using the MSCR test parameter.
3. Confirm the applicability of the MSCR test to Arizona binders and conditions.
4. Determine how key industry representatives anticipate possible economic effects to Arizona asphalt binder suppliers if ADOT chooses to adopt M332.



Ultra High Performance Concrete

Overview

- Develop and optimize non-proprietary, sustainable UHPC mixtures for AZ bridge element connections
- Concrete with strength ~ 22 ksi, high ductility and crack resistant, durability
- Very high flowability needed for compaction in tight sections

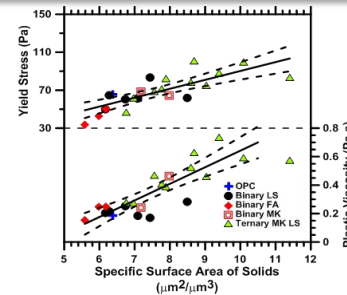
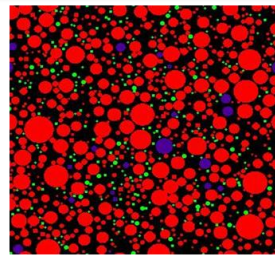




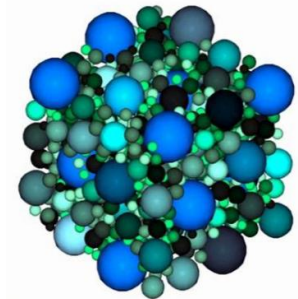
Ultra High Performance Concrete

Study Approach

Rheology (Flow)-based design for cementitious materials

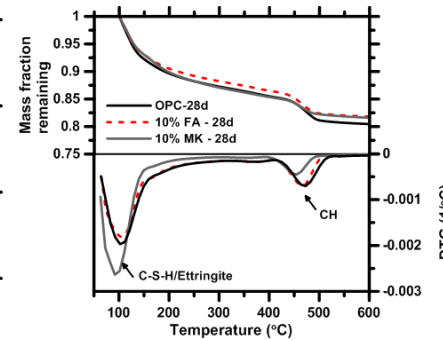
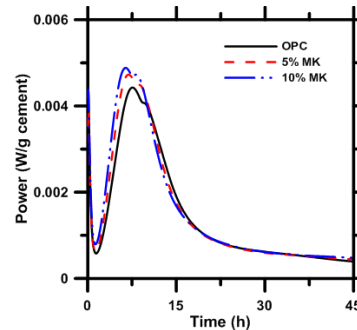
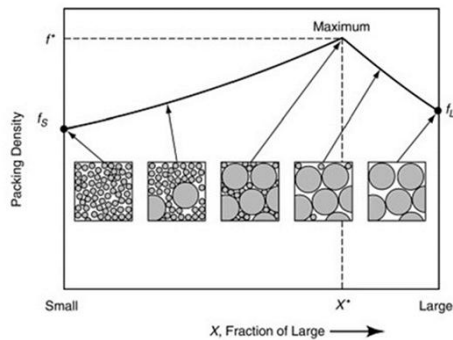


+



Involves selection of cement and replacement materials

Optimized Packing of Aggregates



Physical effects
Packing

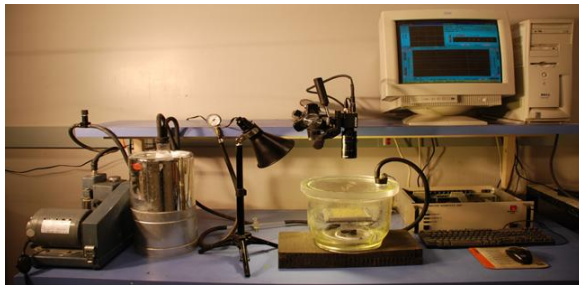
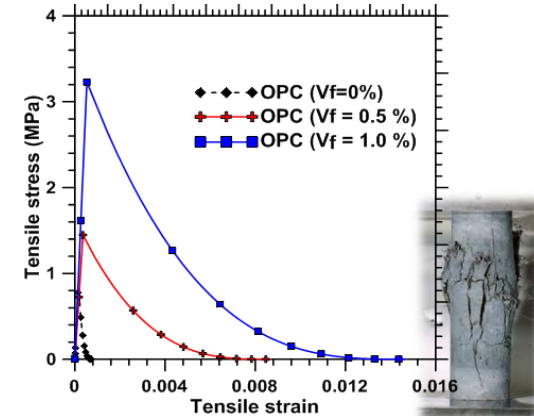
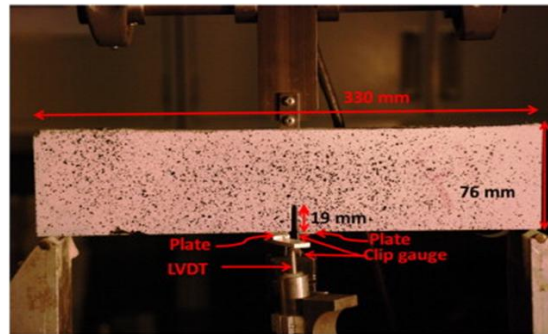
Chemical effects
Heat release Reaction products

Porosity
minimization to
enhance
mechanical and
durability properties

Ultra High Performance Concrete

Study Approach

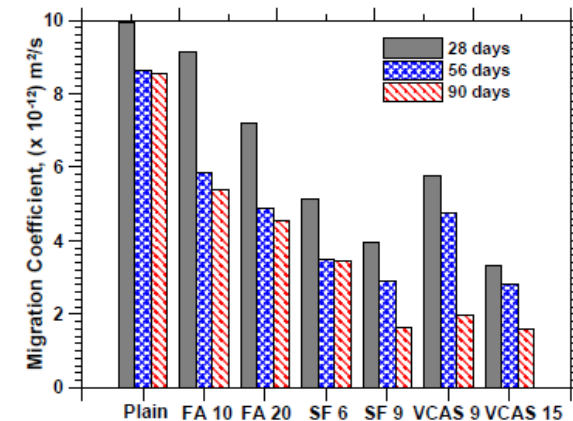
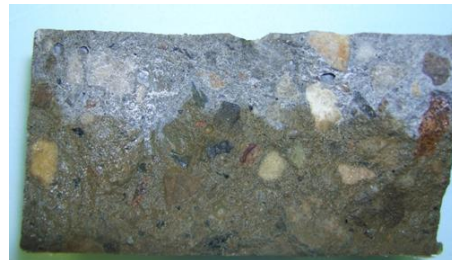
Compressive and Flexural response, including ductility (with and without fibers)



Chloride ion transport (durability against steel corrosion under deicing conditions)



Shrinkage and cracking (early and later ages)



Mineral Admixtures in AC

Objectives

- ❑ Arizona is currently the only state that permits either hydrated lime or portland cement admixtures.
- ❑ The primary purpose for these admixtures is to prevent moisture damage, but benefits are also known with respect to mitigation of oxidation.



Source: Pavement Interactive

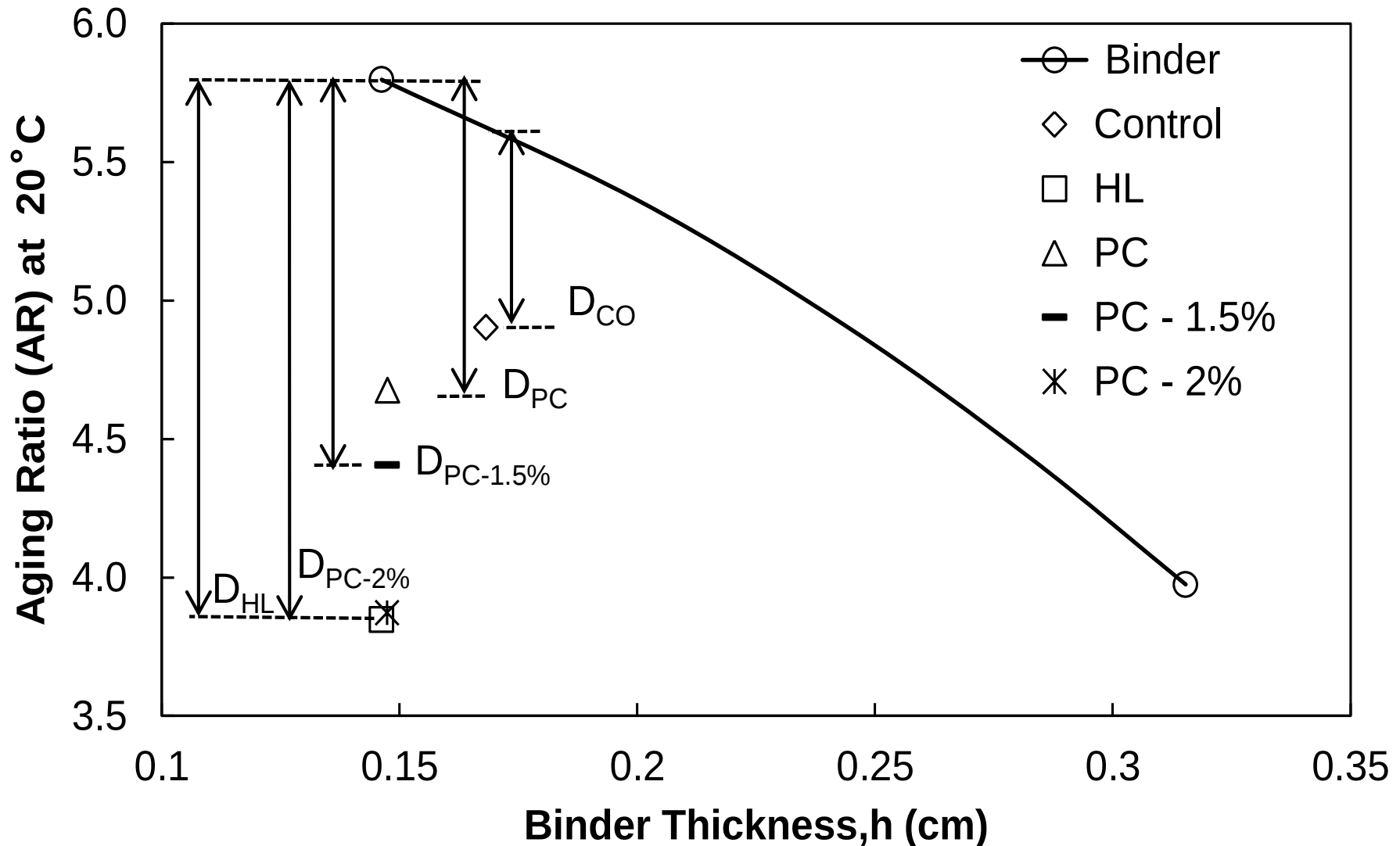
Mineral Admixtures in AC

Objectives

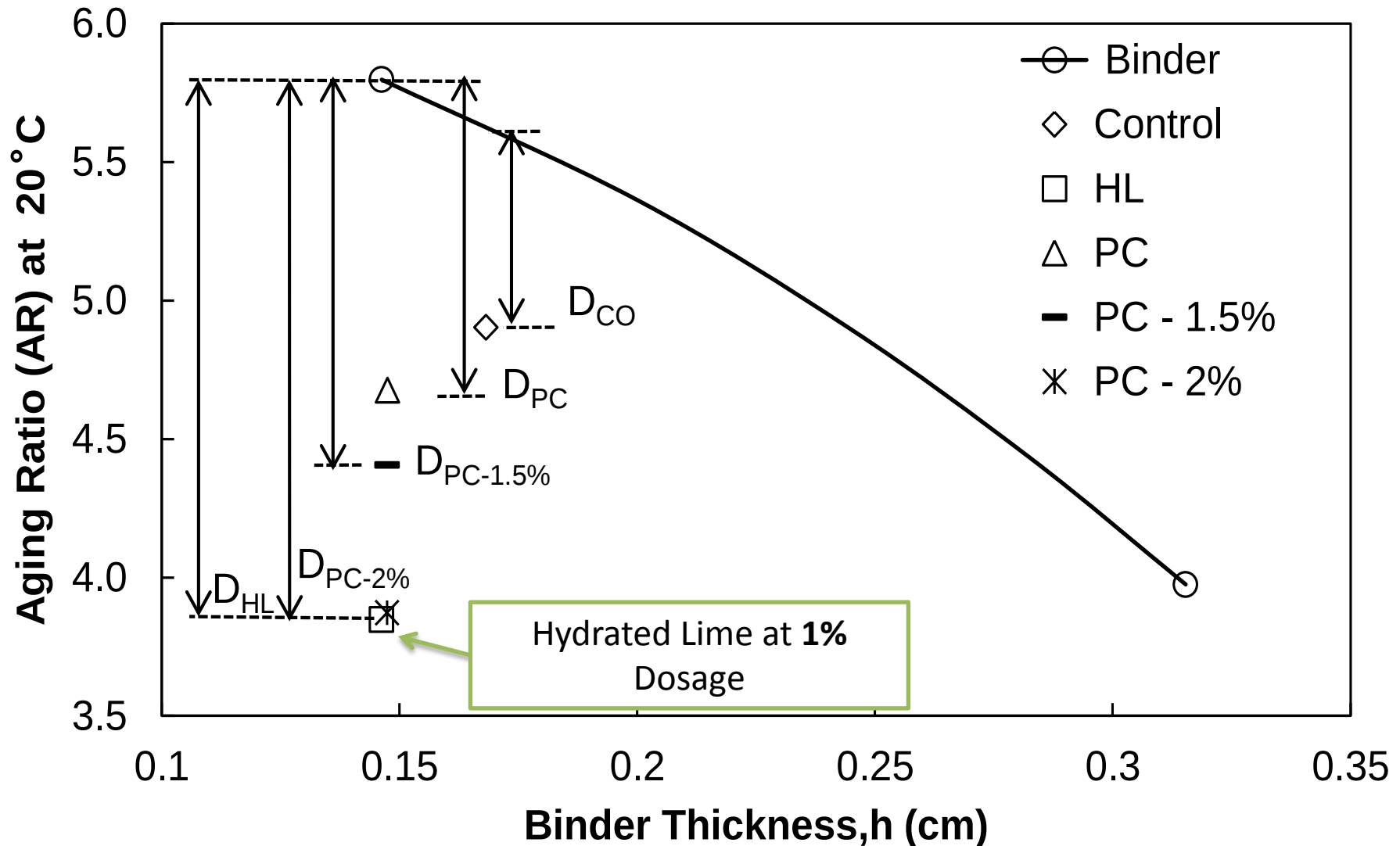
- Quantify the differences in oxidation mitigation for hydrated lime and portland cement using typical dosage and materials for Arizona.



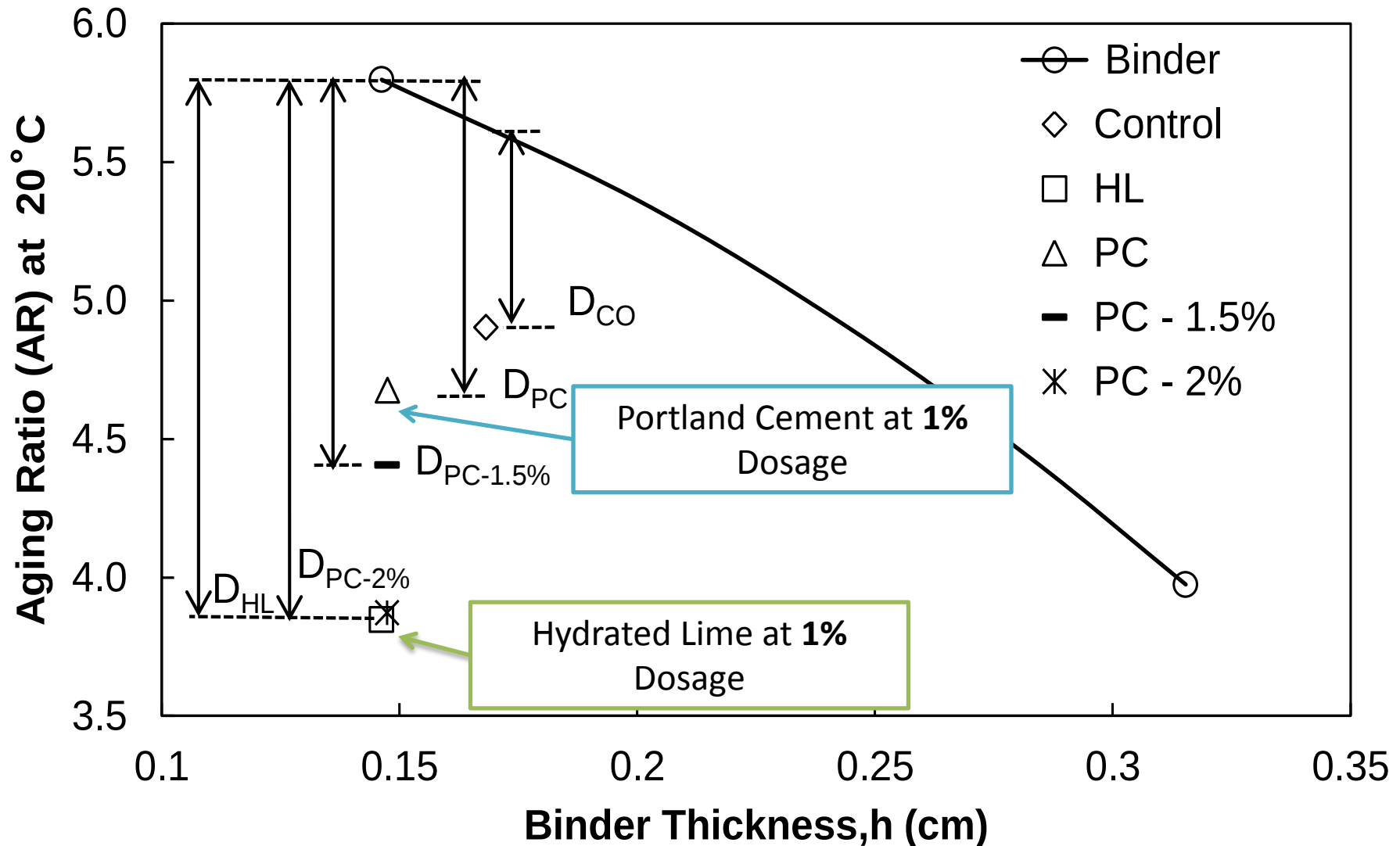
Mineral Admixtures in AC



Mineral Admixtures in AC

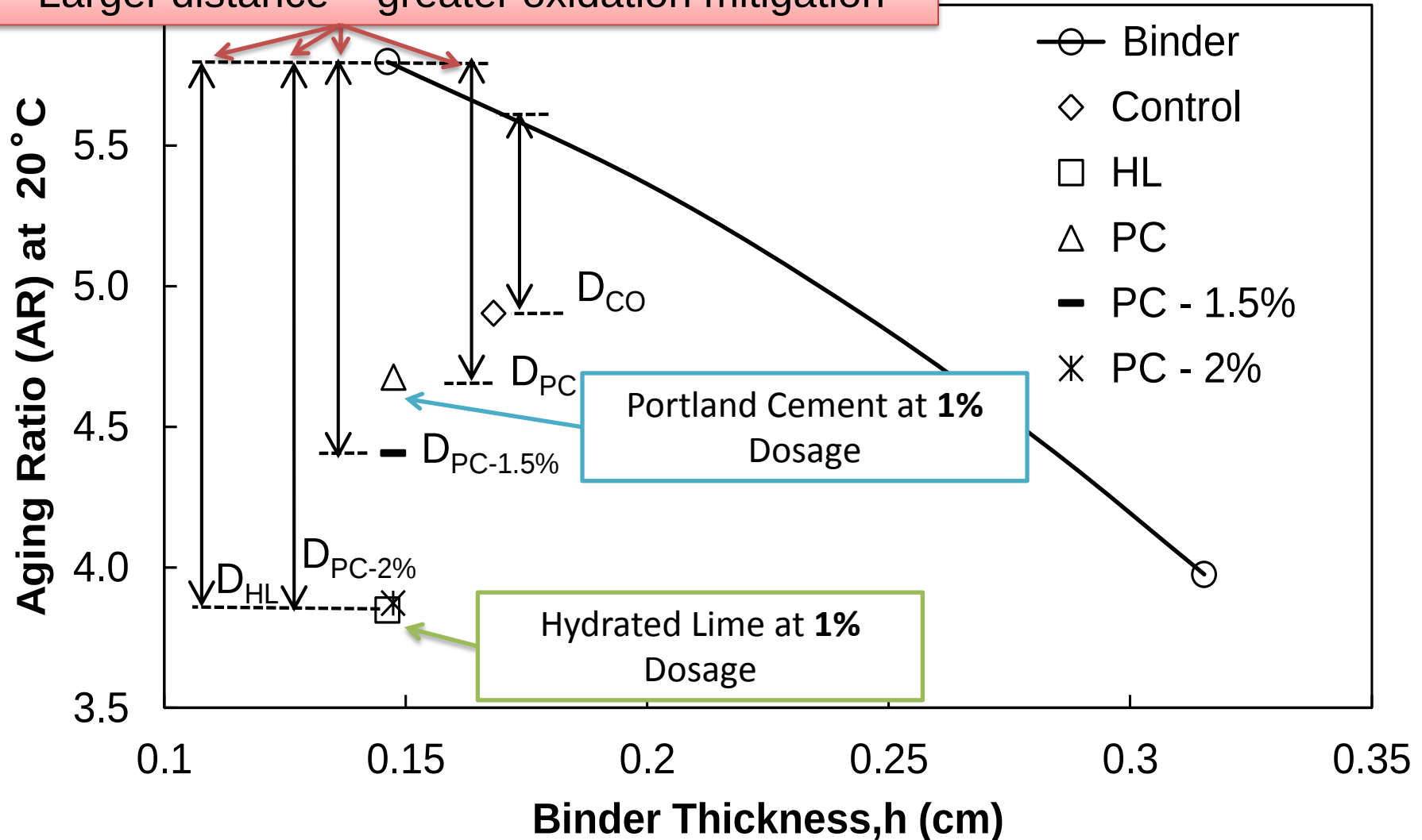


Mineral Admixtures in AC



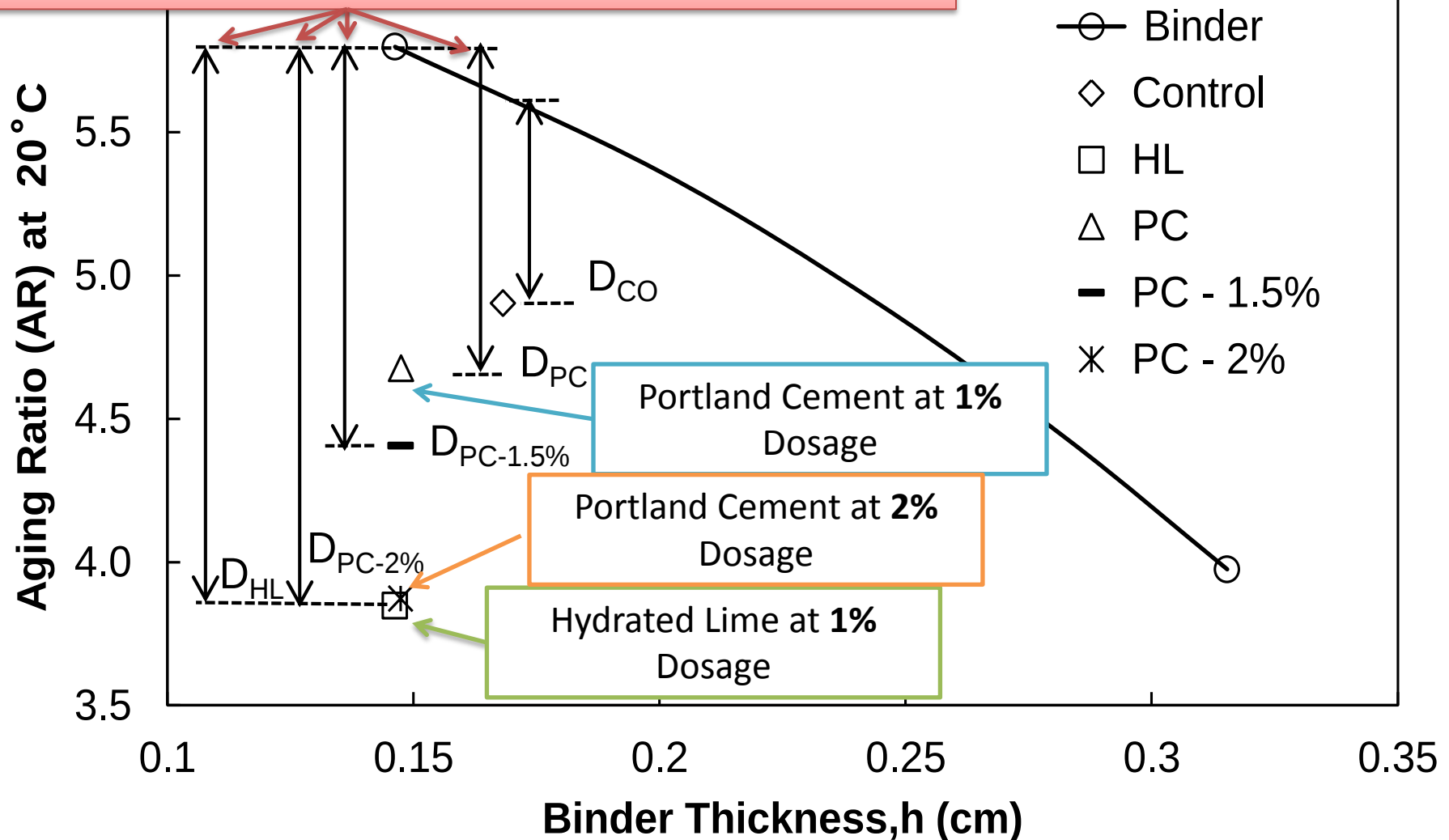
Mineral Admixtures in AC

Larger distance = greater oxidation mitigation



Mineral Admixtures in AC

Larger distance = greater oxidation mitigation

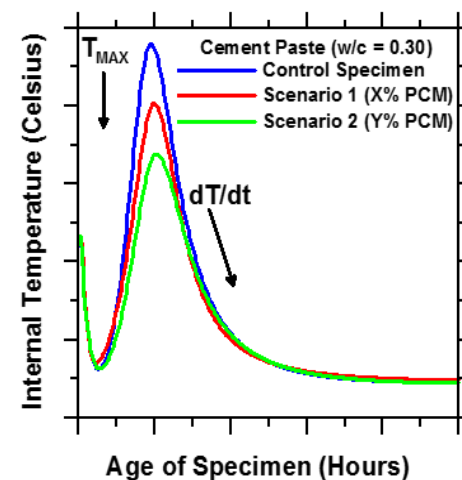
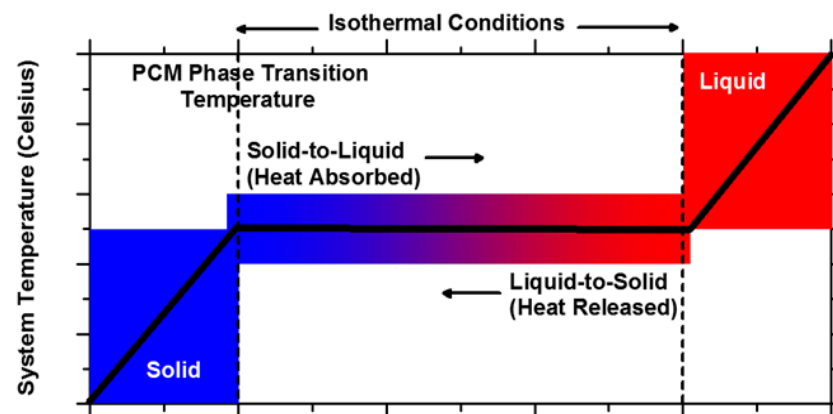




Phase Change Materials in Concrete

Overview

- ❑ Thermal cracking induced damage in concrete structures/pavements
 - Early-age cracking, Long-term fatigue damage, Freeze-thaw related damage
- ❑ Internal storage/release of thermal energy to regulate concrete's internal environment
- ❑ PCMs = auto-adaptive additive to concrete
- ❑ A joint US-EU project (partly funded by FHWA)

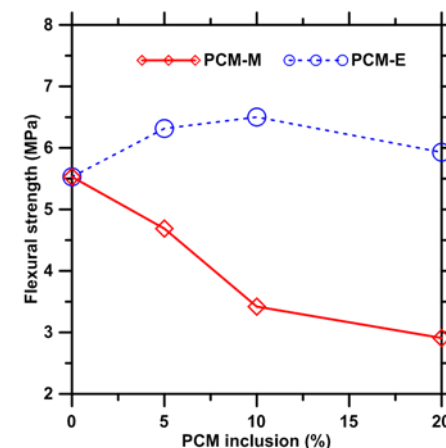
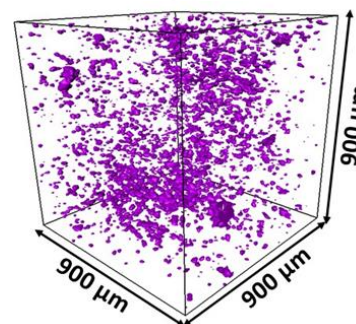
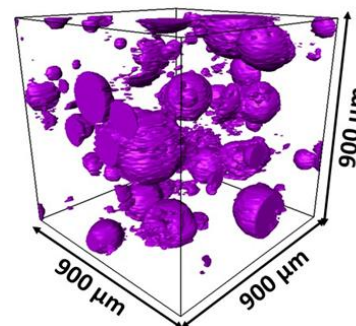
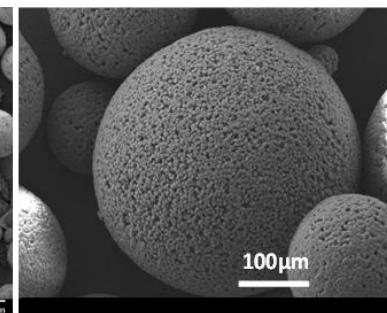
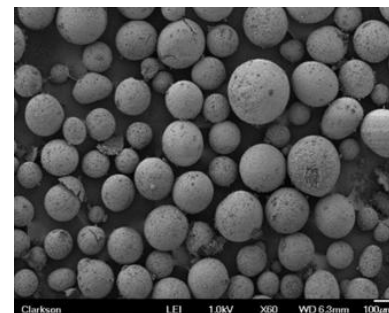




Phase Change Materials in Concrete

Overview

- ❑ Microencapsulated PCMs – organic/ inorganic PCMs in polymeric shells
- ❑ Can also be impregnated into porous hosts such as lightweight aggregates
- ❑ Proportioning strategies designed to minimize strength loss
- ❑ Better fracture and crack resistance





Phase Change Materials in Concrete

Outcomes and Relevance



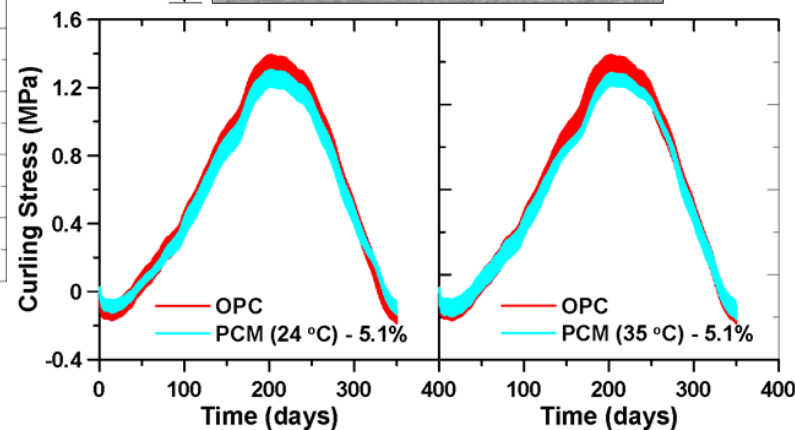
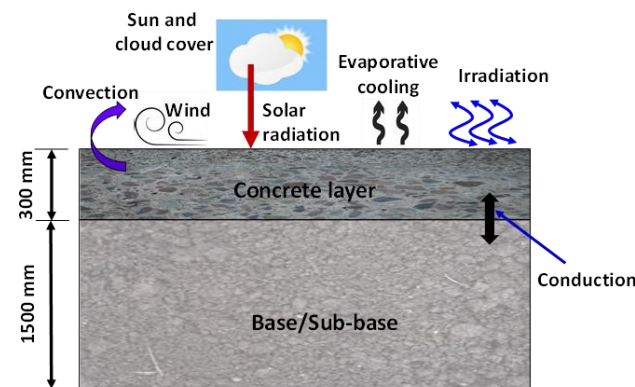
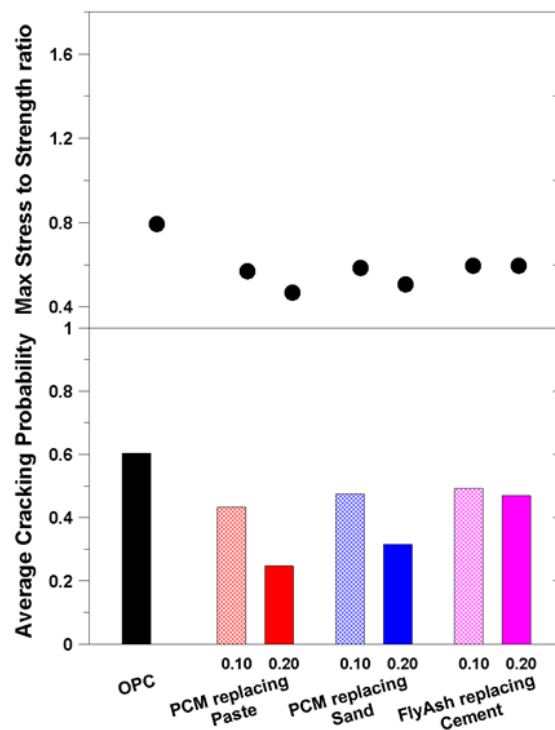
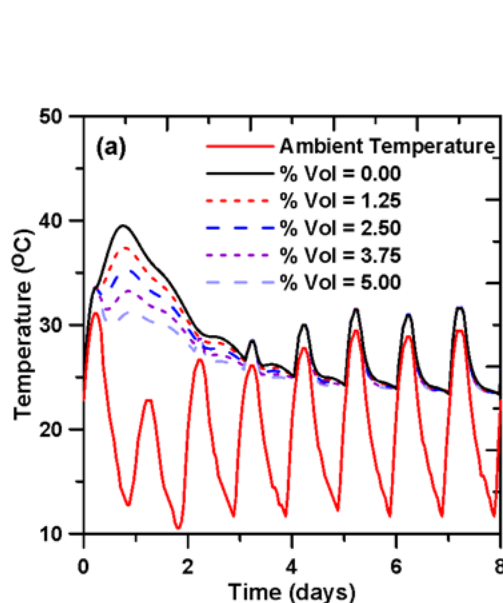
Phase Change Materials in Concrete

Outcomes and Relevance

Reduction in early age temperatures in pavements in AZ

Reduction in cracking propensities

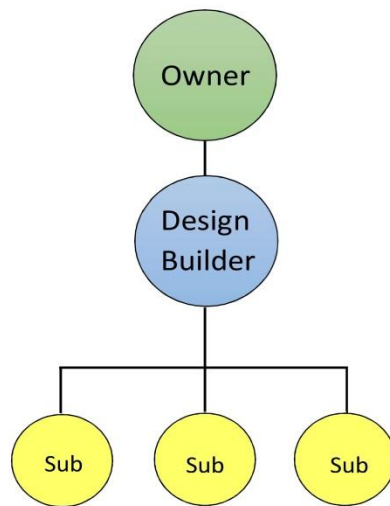
Reduction in curling stresses





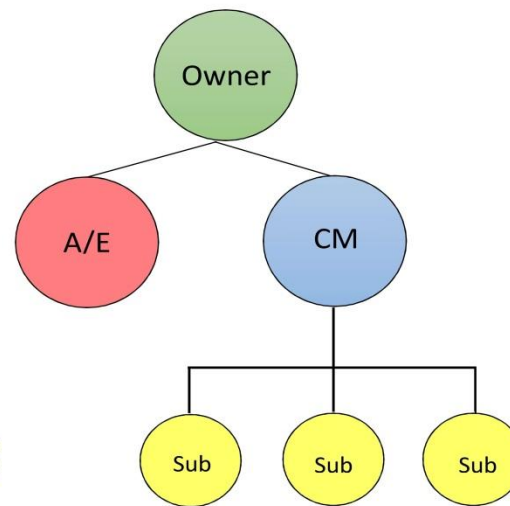
Long-Term Performance of APDM Transportation Projects

Alternative Project Delivery

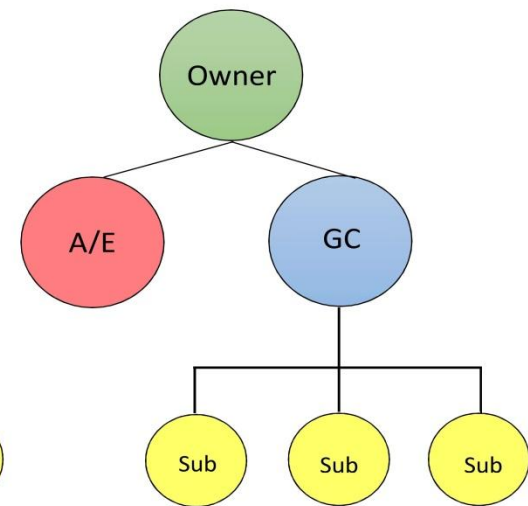


DB

Traditional Project Delivery



CM/GC



DBB

0%  100%
Percent of Design Complete





Long-Term Performance of APDM Transportation Projects

□ Objective

- Quantitatively investigate the effect of APDM on the measured *quality* of highways in the western U.S.

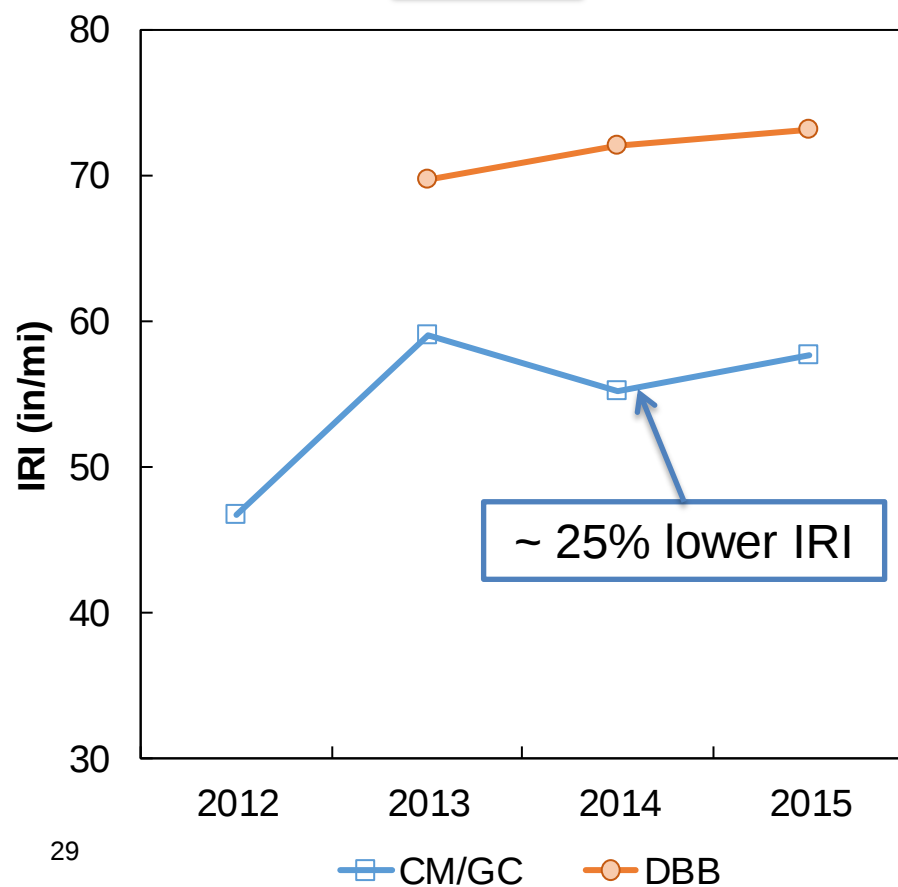
□ Hypothesis

- APDM projects will show superior long-term performance
 - ✓ Compared to similar projects delivered using the traditional method.

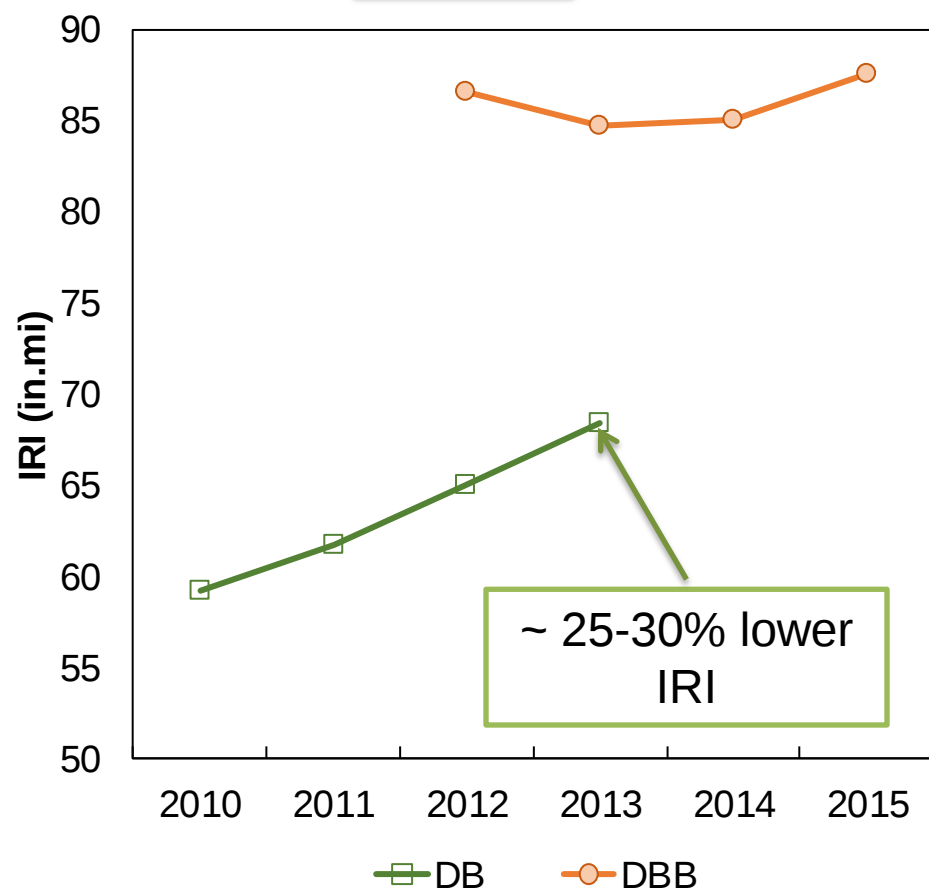


Long-Term Performance of APDM Transportation Projects

SR 89

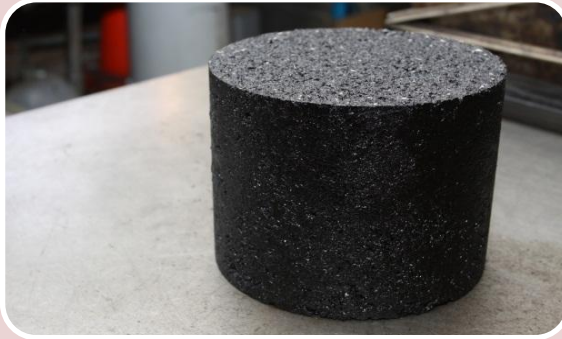


US 191



Wrap-Up

Sustainable Pavements



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Thank You

ARIZONA STATE UNIVERSITY

TRANSPORTATION

Freight Transportation

Friday, February 20, 2015
3:00pm to 4:30pm

Please join us in Schwada Building (SCOB) room 101

Bethany Ma
Associate Professor, Arizona State University
Transportation Institute, Orleans

As Jane Jacobs famously stated, "increased global connectivity means metropolitan hubs have to compete for a higher level of infrastructure, low trade networks. Policymakers in between economies and the domestic and global compete. These issues are national freight strategy a disparate strategies for economic development; industry involvement."



Dr. Stich is an Associate Professor and Director of the Merritt C. University of New Orleans. UNO's two University Investigator for the Department of Maritime Resiliency research has included transportation and revitalizing rail; deep economic development; industry involvement.

<http://goo.gl/A9e8aq>

ARIZONA STATE UNIVERSITY

TRANSPORTATION

Optimizing the Rollout of Alternative-Fuel Vehicles

Friday, April 10, 2015
3:00pm to 4:30pm

Please join us in Schwada Building (SCOB) room 101

Michael Kuby, Ph.D.
Professor, School of Geographical Sciences

Lack of refueling infrastructure is constraining the rollout of electric, hydrogen, and natural gas vehicle based approach to optimizing the location of new fuel stations and maximizing the number of trips that can be made without refueling. This presentation will discuss the challenges of building a network of refueling stations to be built. This presentation approach as well as survey research evidence home or somewhere along their route. This presentation will also be introduced.



Michael Kuby is a Professor in the School of Geographical Sciences, Arizona State University, Graduate Certificate Program in Transportation Planning. He received his Ph.D. in Geography from The University of Chicago in 1988, both in Geography. His research geospatial optimization of sustainable transportation infrastructure in alternative-fuel stations and driver behavior. He is currently serving the U.S. Department of Energy, the National Bank, among others. He currently serves Regional Science Review and the Journal Area Editor for the Journal Networks and the April 2015 Arizona Town Hall Backstage event. Many ASU professors contributed.

<http://goo.gl/A9e8aq>

ARIZONA STATE UNIVERSITY

TRANSPORTATION ENGINEERING SEMINAR

Shared Experiences in Academia and Consultancy

Friday, February 20, 2015
3:00pm to 4:30pm

Please join us in Schwada Building (SCOB) room 101

Matthew M. Witczak, Ph.D., P.E.
Emeritus Professor, University of Maryland; Emeritus Professor, Arizona State University; Partner, ZW Consultants LLC

Dr. Witczak is a Professor Emeritus of Civil Engineering at Arizona State University and the University of Maryland, College Park. His career appointments also include being Chairman of the Civil Engineering Department at the University of Maryland, Vice President of PCS/Law Engineering, and Special Projects Engineer with the Asphalt Institute. Dr. Witczak will present brief highlights of his experience as a Professor of Civil Engineering, provide his overview of how the Civil Engineering curriculum and Civil Engineering students have changed in the past 40 to 45 years; and discuss some general details of several of the most difficult and challenging real world field projects that he has consulted on, over the world, in his career.



With this background presentation, Dr. Witczak will then open up the presentation to audience questions that cover and are applicable to his life in academia (students, curriculum, professional activities and research) and his real world experience in being actively engaged as a consultant in many countries of the world. It is anticipated that both the formal and informal portions of the presentation will be of equal time. Dr. Witczak's presentation will be structured to provide the audience with wide latitude in asking him questions on a range of topics that he has experienced in his 50+ year career in the classical Civil Engineering areas of Geotechnical, Materials and Transportation Engineering.

Dr. Witczak is an internationally recognized expert in the area of highway and airfield pavements. He has authored well over 200 technical papers and reports in the area of highway and airfield pavement design, rehabilitation, materials and management systems. Among many other activities he has served in a consulting capacity to the U.S. military and private industry on road/geotechnical problems and the development of a universal airfield pavement design methodology. He has received eleven engineering, research and construction awards throughout his career, including the National Capital Society of Engineers (Washington, D.C.), U.S. Army Commendation Medal, and Engineering News-Record (ENR) selection as one of the "Construction Men of the Year".

<http://goo.gl/A9e8aq>

ASU Ira A. Fulton Schools of Engineering

Join us at
the Spring
Seminar
Series!

<http://pavements-lab.engineering.asu.edu>

<http://transportationstudies.asu.edu>

<https://ncesmart.asu.edu/>