The Role of Concrete in Sustainable Building

Steven H. Kosmatka
Portland Cement Association
MIT Concrete Sustainability Hub: Changing the Rules of the Game
In the past... research focused on changing the properties of concrete.

Now, the CSHub is changing the way concrete is evaluated & implemented in infrastructure projects.
CSHub Mission
Develop breakthroughs that will lead to more sustainable and durable infrastructure, buildings, and homes

1. Provide scientific basis for informed decisions
2. Demonstrate the benefits of a life-cycle perspective
3. Transfer research into practice
MIT is trying to open people’s eyes to the benefits of concrete—using a life cycle perspective.
CSHub approach is holistic and multidisciplinary
1. Provide scientific basis for informed decisions

Concrete science

Pavement-vehicle interaction

Building resilience

Albedo

Paving competition
2. Demonstrate the benefits of a life-cycle perspective.
An integral part of communities
Concrete science

Pavements

Transportation Research Board

Buildings

FHWA

Concrete science

Log[m]

FHWA

Department of Transportation
United States of America

U.S. Green Building Council

FLASH
Federal Alliance for Safe Homes
CSHub research has received extensive media attention
CSHub research has had impact

Towards Sustainable Pavement Systems:
A Reference Document

FHWA-HIF-15-002

South Dakota DOT

MOUNTAIN-PLAINS CONSORTIUM
MPC 14-275 | Xiao Qin, Kai Wang, and Zhiguang Wang
Selection of Interest and Inflation Rates for Infrastructure Investment Analyses
CSHub researchers are sought for their expertise
Technology transfer spectrum

3. Transfer research into practice
PVI research: clear success in transition of innovation to implementation

\[
\delta E = -P \frac{dw}{dx} \approx P \frac{w_{\text{max}}}{\ell_s/2}
\]
Durability Research

- Alkali-Silica Reactivity—Mike Thomas, University of New Brunswick
- Freeze-thaw and deicer—Jason Weiss, Oregon State University
- Modeling interaction—MIT
Durability: the ability of concrete to survive the environment to which it is exposed

Concrete distress mechanisms*

- Internal Attack
  - ASR
- Cold Weather
  - Freeze-Thaw
- Chemical Attack
  - Salt Scaling
- Cracking
- Overload & Fatigue

Distress mechanisms understood, but quantification is a challenge

Current experimental methods do not adequately predict pavement durability

Pavement durability models do not directly account for material properties
Objective: improve concrete pavement durability & demonstrate benefits

- Improve scientific understanding of pavement distresses
- Translate knowledge into pavement design & maintenance
- Demonstrate cost and environmental benefits of durable pavements and pavement networks
Vision: connect pavement materials and performance prediction

- For a given material composition and context:
  - What is the potential for ASR/FT damage?
  - What is the rate at which it would happen?
- Which conditions lead to ASR/FT damage?
There have been several pavement implementation projects:

- **CO**: LCCA case studies
- **MN**: LCCA case studies*
- **DE**: LCA case studies*
- **CA**: PVI network analysis
- **City of LA**: local roads LCA
- **VA**: PVI network analysis

*Projects underway

**Advisory support in LCCA legislation:** AL, MD, NC

**Interactions with DOTs and Federal Agencies:**
AASHTO, FHWA, GAO, OMB, FL, MD, MN, MT, NC, NV, TX
MIT research has influenced pavement projects in several states.

**CA:** Caltrans PVI and network analyses, City of LA streets.

**NV:** Major bypass outside Las Vegas.

**NC:** Mainline paving & RMC in parking lots.

**MD:** Mainline paving & RMC in parking lots.

**FL:** RCC at a port.

*Projects underway.*
Buildings implementation projects on streamlined LCA are beginning now.
Implementation evolution

2010
PCA & NRMCA manage implementation

2013
A few industry partners facilitate projects with MIT

2016
Industry and MIT develop implementation plans
What did it take to achieve success in California?

Local effort

- Objectives
- Strategy
- Understanding of social system
- Dedication
- Patience
A diverse and well-integrated team of experts is critical to designing, building, and implementing an effective strategy.
Detailed analysis identified the “eco-system” of key decision makers, opinion leaders, and other stakeholders.
Key factors that determine rate of adoption of innovations

- Perceived attributes of innovations
- Types of innovation-decisions
- Communication channels
- Nature of the social system
- Extent of promotion efforts
New paradigms require new promotion methods

**Collaborative communication & implementation plans should consider these elements**

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CSHub and industry joint communication efforts support implementation

Research Briefs

Research Brief

Issue 6, 2015

Quantifying Climate Impacts of Surface Albedo

Surface Temperature (albedo) Impact

Figure 1. The changes in surface temperature from elevating urban surface albedo during summers of 2002. The four initial conditions have starting dates of Dec. 1 to Dec. 4, 2004, respectively, while the reference mean is the average of the four initial conditions. Orange color represents cooling from decrease in surface temperature due to elevating albedo, while yellow represents warming.

Presentations

Talking Points

Fact Sheets & Topic Summaries

Newsletter
CSHub is presenting outcomes to a wide range of audiences

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Approximately 40 Presentations for 2016
$6.2M in additional research

International sponsors
- Tata Found a-tion
- BASF
- Cimpor
- Portifici a U Chile
- Siam Cemen t
- Politec-nico Torino

Domestic sponsors
- US Army CoE
- NIST
- Schlum -berger
- OSU
- UNB
- Collaborator s

Collaborators
- French Gov’t
- North-wester n U
- Chile
Without the CSHub: research, publications, conference presentations

With the CSHub: research, publications, conference presentations, administration, implementation, communication, industry interaction, webinars, education, interaction with other industry and research efforts

The CSHub structure extends industry’s investment
Changing the Rules of the Game

The CSHub is changing the way concrete is evaluated & implemented in infrastructure projects.
More information available at:

http://cshub.mit.edu/
cshub@mit.edu