BY JULIE GARBINI

Cambridge Collaboration

MIT Concrete Sustainability Hub enters a second decade set to further frame criteria driving building and construction decisions

Having secured another five-year industry commitment through 2024, the Massachusetts Institute of Technology Concrete Sustainability Hub (MIT CSHub) is prepared to take its innovative research to the next level in revolutionizing the way building and construction design decisions are made.

Two of the key benefits of the MIT CSHub have been the close collaboration between researchers and industry, and participants' ability to take a holistic approach to positioning concrete as a solution to sustainable development challenges. This concentrated effort has propelled the industry forward, making it a natural decision for the Ready Mixed Concrete (RMC) Research & Education Foundation and Portland Cement Association to continue co-funding the collaboration for another five years.

In its first decade, the MIT CSHub produced research and tools to better inform design decisions for pavements and buildings, with an emphasis on full life cycle assessment and life cycle cost analysis. For the first time, research factored the important "use phase," filling gaps in other models that focused exclusively on embodied impacts. Researchers also developed tools and data to support more resilient construction and modeling. Starting with analysis at the atomic level, they worked on ways to increase durability and better predict structures and properties to improve how cement and concrete are designed.

MIT CSHub researchers also developed tools to accurately quantify how concrete can contribute to sustainable and resilient construction, and where the industry can continue to improve. This has proved invaluable as the world focuses on solutions to climate change. The first decade of MIT CSHub work has informed better decision-making by designers and owners, along with legislators, regulators and code officials—all grappling with the balance between sustainability, cost and performance.

NEXT PHASE CHARGE

The 2019-2024 agenda continues the legacy of decade one work, while also taking on new challenges for improving industry sustainability and performance. The agenda was developed in close collaboration between industry leaders and MIT CSHub researchers. Executives and content experts brought forth their real-world experiences with cement and concrete industry challenges and potential opportunities. Researchers brought a more global perspective, as well as innovative technology advancements to be applied to industry issues. The combination of industry experience and a broader, more forward-thinking approach from MIT has proved to be exceptionally powerful. The ability to draw on the talent of MIT researchers from a wide cross-section of disciplines, and apply them to concrete, is allowing the industry to tackle issues in ground-breaking ways.

The Hub's first decade produced foundational research for a "push" of information to designers and owners for better decision-making. In this next phase, collaborators intend to draw or "pull" more target audiences like policy makers, regulators and venture capitalists to concrete using big picture topics. The cement and concrete industries are under a lot of scrutiny and often portrayed as being part of the "problem." There are plenty of people out there who want to regulate or legislate the industry because of that mind set. However, there are many misperceptions about the industry's environmental impacts. MIT CSHub research is helping the industry dispel the myths and focus on communicating and implementing the real opportunities for improvement.

Concrete is the most used building material in the world. It's vital to civilization. The concrete industry provides affordable and sustainable shelter to the world, and protects lives and building investments in the process. Concrete can be, and is, a solution to sustainable development and achieving societal goals. The MIT CSHub provides third-party credibility and a platform for taking these messages into the public and political discourse.

CROWD-SOURCED DATA

The next phase of Hub activity will use "big data," machine learning and advanced technologies to further position concrete as a solution to sustainable development. For example, the MIT CSHub is using crowd-sourced data to promote sustainable infrastructure through the Carbin app. It uses a device most people carry in their pockets—a smartphone. Accelerometers orient smartphone screens and perform other tasks. The accelerometers are so sensitive that they can detect the slightest bumps in a pavement from within a moving vehicle. Carbin utilizes a phone's accelerometer by recording the motion of a vehicle roughly 6,000 times every minute and then uses an algorithm to determine a road's roughness.

Carbin-collected data can be used to

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demonstrate the need for increased infrastructure investment to policy makers. It can also provide important information to state Departments of Transportation (DOTs) and municipalities about the condition of their roadways so that they understand which thoroughfares are performing best and can appropriately direct their infrastructure dollars. Until now, it has been very costly and time-consuming for state DOTs to collect data to identify roads in need of repair or reconstruction. Now, transportation-related businesses like ready mixed concrete companies, along with the general public, can help collect this valuable data to help promote better, safer roadways.

Poor road quality not only impacts the driving public, but also the environment. On California's highways, MIT CSHub researchers determined that rough pavement caused cars to consume 1 billion gallons of excess fuel over just a five-year period. Carbin calculates this impact on the environment as well, providing a more comprehensive snapshot to decision-makers. The Carbin app can be downloaded from both iTunes and Google Play. When users have the app active while driving, the captured data is analyzed and contributes to a growing public map of pavement and emissions levels that can help inform infrastructure repair and fight climate change. Data by geographical region can be viewed at www.fixmyroad.us.

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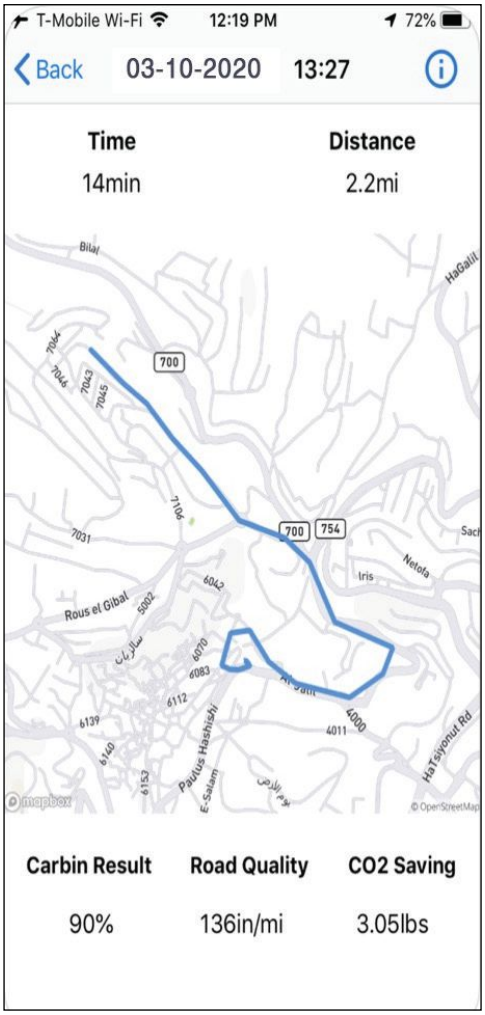

The Carbin app went live in 2019 as CSHub's first widely deployed, crowd sourced data tool. Users help gather data on pavement conditions, which in turn informs decisions on what road building and repair decisions can have the greatest impact on traffic improvement and vehicle emissions reduction. Carbin functions will be explored in a March 12 ConExpo-Con/Agg session (note Tech Experience, page 54).

IMPROVING CONCRETE CONSTRUCTION INDUSTRY PRODUCTIVITY: WORKSHOPS IN PROGRESS

MIT CSHub researchers teamed up with an organizing committee of industry leaders and the American Concrete Institute's Strategic Development Council to host a February 2020 workshop on Concrete Construction Industry Productivity. The goal of the Charleston, S.C. gathering was to develop a network of stakeholders to evaluate the productivity of the concrete construction sector, and to identify solutions for improvement. Participants represented a diverse set of stakeholders who are either active in concrete construction or analyzing and improving sector productivity, and included architects, engineers, general contractors, subcontractors, concrete producers, other material suppliers, digital technology suppliers, automation technology suppliers, owners, researchers, and industry associations.

Key questions raised included:

- What are the appropriate metrics for productivity in the concrete construction sector?
- What are the drivers of productivity for stakeholders in the sector?
- What is the potential for proposed solutions to improve productivity?

Workshop outcomes will be used to create a roadmap for evaluating and improving the concrete construction sector productivity. Future workshops are also planned.

BY JULIE GARBINI

PATH TO A LOWER CONCRETE CONSTRUCTION CARBON FOOTPRINT

Dr. Jeremy Gregory

Dr. Brent Constantz

Dr. Nicholas DeCristofaro

Dr. Sean Monkman

Dr. Gaurav Sant

MIT CSHub Executive Director Dr. Jeremy Gregory joined officials from some of the world's leading carbon capture companies, American Institute of Architects Connecticut, CT Green Building Council, and the National Ready Mixed Concrete Association's Build with Strength Coalition earlier this year to discuss issues of sustainability, carbon sequestration, and the movement of the design and construction industry towards a carbon-streamlined future. Under a Net Zero School Summit banner, they gathered in New Haven, Conn. at Yale University School of Architecture's Rudolph Hall. Widely known for mid-century building designs interpreted in reinforced concrete and concrete masonry, architect Paul Rudolph designed the facility during his tenure as School of Architecture dean.

According to the Global Alliance for Buildings and Construction, the built environment accounts for 39 percent of global carbon dioxide emissions. The recent development of carbon capture technology has sparked a significant conversation on what the future of the built environment will look like. Dr. Gregory discussed embodied carbon and how it is possible to design a carbon-negative concrete structure. The program continued with a carbon capture-focused panel discussion involving Dr. Brent Constantz, PhD., chief executive officer of Blue Planet, Palo Alto, Calif.; Dr. Nicholas DeCristofaro, chief technology officer, Solidia Technologies, Piscataway, N.J.; Dr. Sean Monkman, senior vice president of Technology Development, CarbonCure Technologies, Dartmouth, Nova Scotia; and, Dr. Gaurav Sant, PhD, associate professor of Civil & Environmental Engineering, University of California, Los Angeles.

The Summit fostered a candid discussion of sustainability and Net Zero schools and provided actionable information for the stakeholders behind facility design and construction. It marked an encouraging first step toward a growing awareness from the design and construction industries of a low-carbon future with concrete. The all-day event attracted 180 attendees and received very high marks from the evaluations reviewed.

BETTER BUILDINGS

The MIT CSHub will continue development of building and community-specific resilience assessments that can be used for rating systems and in design tools. Researchers will also focus on whole building and whole life streamlined life cycle assessment models to be incorporated into commonly used architectural design tools. Highlighting new technology advancements and using the MIT CSHub models will give the design community a clear pathway for deploying concrete to achieve sustainability goals and targets outlined in the Architecture 2030 and Net-Zero 2050 initiatives.

While the MIT CSHub's previous work has helped the industry make the case for the life cycle benefits of concrete, there are still those who are convinced a shorter-term fix and more urgent action are needed to fight climate change. The industry needs to keep lessening environmental impacts and improving productivity in order to stay competitive. Understanding the potential impact of a price or limit on carbon, reducing waste, increasing productivity and the science of carbon uptake in concrete structures are vital issues that are also being tackled by the MIT CSHub and industry collaborators in the next few years.

The investment in the MIT CSHub has been substantial. By the end of this next commitment ending in 2024, the RMC Research & Education Foundation and Portland Cement Association will have invested $30 million in the partnership. However, industry leaders have seen an exponential return on investment from the relationship. This next phase focus on technology, big data and artificial intelligence is going to provide even greater returns and further drive advancement of, and outside investment in, the concrete and cement industries.

MIT CSHUB AND CONEXPO-CON/AGG

MIT CSHub researchers have worked in cooperation with ConExpo-Con/Agg 2020 planners to the help evolve the Tech Experience, which debuted at the 2017 show. This year's main pavilion, centrally located in the Las Vegas Convention Center outdoor exhibits at the foot of the Monorail entry, will provide a look at technologies that are changing the face of the construction industry in three key areas: Modern Mobility, Sustainability and Smart Cities. MIT CSHub researchers will give three presentations in conjunction with the Tech Experience:

The Carbin App
Tuesday, March 10, 2 p.m.

For many of us, smartphones have become an inevitable part of our daily lives. Instant access to the internet with a multitude of apps offers far more than just communication: a remote for your thermostat, source of navigation, or a monitor for your heart. But what if smartphones could also monitor road safety, measure pavement quality and predict their future? In this session, mobile device users will hear how Carbin can be leveraged to monitor and improve the state of our infrastructure and traffic, while reducing vehicle fuel consumption and related emissions.

City Texture/Urban Resilience
Thursday, March 12, 9:30 a.m.

Texture reveals a lot about how a city will respond to high winds in a big storm, heat, or to a major environmental event like a hurricane or earthquake. Hear how data from familiar programs like Google Maps can be used to capture the internal structure of city environments and how the information can be used to improve energy management strategies and to increase building and community resilience.

Conductive Concrete
Saturday, March 14, 9:30 a.m.

Imagine if the walls of your home or office stored enough energy to charge your phone or laptop. What if electric cars could get charged simply by the power stored in parking garage walls? In this session, attendees will hear how researchers are working with smart concrete and turning it into an energy source.