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CONSORTIUM MEMBERS:

Missouri University of Science and Technology
University of Illinois at Urbana-Champaign
Rutgers, The State University of New Jersey
University of Miami
Southern University and A&M College

Director's Message

Fall semester is in full swing, as are the changing colors on the Missouri S&T campus and other RE-CAST consortium institutions. This is a busy time of year for academic institutions, so I would like to take a moment and present a few updates on the RE-CAST Center’s activities.

On October 3rd, the 3rd Annual Missouri S&T/MoDOT Transportation Infrastructure Conference took place. With over 100 attendees, we feel this was a great success for our Center. Associate RE-CAST Director, Dr. Hani Nassif, RE-CAST team members, Drs. Jeffery Volz and Dimitri Feys, and RE-CAST Advisory Committee member, Mr. Ross Anderson, presented at the event. This showcased the truly collaborative environment in which our Center operates.

The RE-CAST team has several other noteworthy accomplishments to be proud to share. In the following pages, I invite you to read about what our team has been up to over the past few months.

Our research program is in full swing, and our students are working diligently with one another to accomplish the project objectives.

The RE-CAST UTC integrates activities of five university consortium members. We invite you to periodically visit our website (recast.mst.edu) as well as our Facebook and LinkedIn pages (see last page of newsletter for links) to stay up-to-date with our activities.

-Kamal H. Khayat
RE-CAST Director
The third annual Missouri S&T/MoDOT Transportation Infrastructure Conference took place on the S&T campus on Friday, October 3, 2014. With over 100 attendees, the conference is considered a great success. The audience consisted of 56% from industry and government agencies and 44% from academia. The Center for Infrastructure Engineering Studies (CIES) at Missouri S&T and the Missouri Department of Transportation (MoDOT) organized and co-hosted the event. The conference was chaired by Dr. Kamal H. Khayat of the CIES and Mr. William Stone of MoDOT (RE-CAST Research Advisory Committee President).

This year's conference showcased findings of projects supported by the Center for Transportation Infrastructure and Safety, a national University Transportation Center that ended in June 2014, as well as RE-CAST-related projects, in the areas of advanced construction materials, non-destructive testing and structural health monitoring of transportation infrastructure. The event also included a post-conference tour of the newly inaugurated Advanced Construction Materials Laboratory (ACML) and some of the other outstanding research facilities at S&T, notably the highbay structural engineering research laboratory.
COLLABORATION / TECHNOLOGY TRANSFER

3rd Annual Missouri S&T/MoDOT Transportation Infrastructure Conference (continued)

KEYNOTE SPEAKERS

David Ahlvers
State Construction and Materials Engineer, MO Dept. of Transportation
Topic: Capturing Innovation at the DOT

Dr. Hani Nassif
Professor and Co-Director, Rutgers Infrastructure Monitoring and Evaluation Group, Rutgers University (RE-CAST Associate Director)
Topic: Structural Health Monitoring for the Assessment of Cracking Potential in Concrete Structures

Mark Luther
Technical Service Engineer, Holcim (US) Inc.
Topic: New Specification Development: Type IL Cement for Concrete

Ross Anderson
Senior Vice President, Bowman, Barrett & Associates (RE-CAST Research Advisory Board Member)
Topic: The O’Hare Airport Modernization Program: Engineering Challenges
FEATHERED PROJECT
Repair of Damaged Prestressed Concrete Girder with FRCM and FRP Composites
- Antonio Nanni, Ph.D., Professor of Civil Engineering, University of Miami
- Vanessa Pino, P.E., Ph.D. candidate, University of Miami

The University of Miami is working with Virginia Polytechnic Institute and State University (Virginia Tech) and the Virginia DOT to evaluate existing methods of repair of impact-damaged precast, prestressed bridge beams and develop guidelines for the best methods of repair. Intentionally damaged AASHTO Type III prestressed concrete girders will be strengthened using fabric-reinforced-cementitious-matrix (FRCM) and fiber-reinforced polymer (FRP) composite materials to restore moment capacity compromised by the loss of four (3/8-in.) diameter prestressing tendons. When adhered to concrete or masonry, FRCM and FRP form a structural system that acts as supplemental, externally bonded reinforcement (Figure 1).

The project includes an extensive material characterization of FRCM and FRP composite materials. Further progress has been made on both FRP and FRCM material characterization. FRCM material characterization has been performed per ACI 434. Tests completed to date include: compression of matrix mortar, FRCM interlaminar shear, FRCM bond, FRCM bond over repair mortar, durability of FRCM bond, and FRCM Direction tension for 1-ply specimens (Figure 2).

Further testing will be performed for FRP direction tension for 2-ply specimens. FRP material characterization has been performed per ACI125. Tests completed to date include: FRP interlaminar shear (Figure 3), FRP Tg tests, FRP direct tension for 1-ply specimens, and FRP bond. Further testing will be performed for FRP direction tension for 2-ply specimens and durability of FRP bond. The material characterization of FRP and FRCM will enable a firm understanding of the material behavior and performance capabilities. Accordingly, the results from the material characterization will be useful in the design and application of FRP and FRCM as a strengthening material for damaged prestressed concrete girders.
EDUCATION and WORKFORCE DEVELOPMENT

Missouri S&T Undergraduate Students Introduced to Self-Consolidating Concrete (SCC)

- Dimitri Feys, Ph.D., Assistant Professor of Civil Engineering, Missouri S&T

In the framework of CE 3116, Construction Materials, Properties and Testing, undergraduate class (26 students) at the Missouri University of Science and Technology, Dr. Dimitri Feys and his research team demonstrated the production and testing of self-consolidating concrete (SCC).

The laboratory demonstration reinforced the understanding of the students in concrete mix design, production, as well as the influence of chemical admixtures on workability. The students were introduced to the latest rheological testing that can be used for the evaluation of high-performance concrete with adapted rheology, which is one of the research themes of RE-CAST.
COLLABORATION / TECHNOLOGY TRANSFER

RE-CAST Director Gives Keynote Speech

at the 2014 Oklahoma Transportation Research Day

The Oklahoma Department of Transportation and the Southern Plains Transportation Center (SPTC) hosted the 2014 Oklahoma Transportation Research Day on October 21, 2014 at the Oklahoma State University-Oklahoma City Conference Center. Dr. Kamal H. Khayat, RE-CAST Director, gave the Keynote address at the Conference and spoke about the research program being performed by the RE-CAST team on formwork pressure exerted by flowable concrete.

During his visit, he met with SPTC Director, Musharraf Zaman, to discuss future collaborations between the two Centers. SPTC is a U.S. Department of Transportation Region 6 Regional University Transportation Center that was established in 2013 to conduct multidisciplinary research in the strategic area of State of Good Repair.

“On behalf of RE-CAST, I am privileged to support this type of technology transfer activity. I believe opportunities such as these are essential for generating synergism between the various technical and non-technical missions of the University Transportation Centers, which is part of our mission at RE-CAST.”

- K. H. Khayat, RE-CAST Director
FEATURED PROJECT

SCC UNDER PRESSURE - Formwork Pressure Research Program

- David Lange, Ph.D., Professor of Civil Engineering, University of IL at Urbana-Champaign
- Kamal H. Khayat, Ph.D., Professor of Civil Engineering, Missouri S&T

Prof. Kamal Khayat from Missouri S&T (top right) and Prof. David Lange from UIUC (bottom right) contributed their expertise to a major test program on self-consolidating concrete (SCC). The “SCC Under Pressure” test program was organized by Mr. Lloyd Keller at EllisDon Corporation and made possible by contributions from several suppliers and university research teams. The center piece of the August 2014 program was a set of eight tall columns cast with SCC having a range of rheological properties. The formwork pressure was continuously monitored using special pressure cells. Researchers measured fresh properties using an assortment of methods that seek to capture the structural buildup of SCC. The SCC material properties measured during the early hours after placement are used to predict formwork pressure. These predictive methods are among the various models being considered by ACI Committees 347 and 237 for guiding construction of wall and column elements cast with SCC.

A major RE-CAST research project is underway at UIUC and Missouri S&T to improve understanding of concrete material performance for challenging construction situations aimed at the construction and rehabilitation of transportation infrastructure.
Missouri University of Science and Technology
Ph.D. candidate Zena Aljazaeri and Dr. John Myers have been studying the strengthening of reinforced concrete elements using a fabric reinforced cementitious matrix (FRCM) system. One objective of this study is to evaluate the fatigue resistance of this new innovative material in terms of stiffness degradation at cyclic rates as high as two million cycles of applied service load. The other objective is to investigate the durability of the FRCM system after exposure of FRCM strengthened beams to severe environmental conditions. A total of 15 reinforced concrete beams have been fabricated to date for this series of tests. The scale of the test specimens under investigation are 8 in. wide by 12 in. in depth, with a length of 84 in.

The strengthening system can be applied in a single ply or multiple ply format at the substrate level of the concrete surface depending on the upgrade needs. The test matrix is divided into three groups. Group one, beams are maintained in laboratory conditions to serve as a control test. Group two, beams are placed into the environmental chamber and exposed to varying cycles of freezing and thawing, elevated temperature, and high relative humidity. Some of these beams are subjected to self-weight loading conditions only and, while others are subjected to sustained load up to 40% of the expected ultimate load capacity of the strengthened beam. Group three, beams are maintained in an outdoor environment for 1 year.

Currently, the first test beam, as shown in the Figure below is undergoing fatigue cycling up to two million cycles.

Once the laboratory testing phase of the project is completed, and the system performance has been validated, a field demonstration project in Missouri is planned using multiple strengthening systems. The cooperative field implementation will include research partners from both Missouri S&T and University of Miami (UM).
LEADERSHIP

RE-CAST Associate Director, Dr. Hani Nassif, Invited as Keynote Speaker at International Conference

Dr. Hani Nassif, Professor of Rutgers University and Associate Director of RE-CAST, was invited to the 56th Brazilian Congress of Concrete (IBRACON) as a keynote speaker. IBRACON is the largest Brazilian Congress for technical discussions on concrete technology and innovation in structural analysis and design, construction methods, building materials and their properties, and various aspects related to the civil industry. Professor Nassif presented a keynote talk entitled “Structural Health Monitoring for the Assessment of Cracking Potential in Concrete Structures”, which highlighted various structural health monitoring projects applied to concrete bridge structures in New Jersey.

In addition to the keynote presentation, Dr. Nassif presented two research papers entitled “Structural Health Monitoring for the Evaluation of Railroad Bridges” and “Field Monitoring of Rebar Vibrations in Concrete Bridge Decks under Traffic Loads”.

After the Congress, Dr. Hani Nassif and Dr. Túlio Nogueira Bittencourt, President of IBRACON and Professor at the University of São Paulo, discussed various collaborative endeavors between the RE-CAST team, Rutgers University and IBRACON and São Paulo University. They have agreed that both universities and the RE-CAST Center will work closely for the international collaboration.
FEATURED PROJECT

Effects of Polypropylene Fibers on the Restrained Shrinkage Behavior of Self-Consolidating Concrete

- Zeeshan Ghanchi, Graduate Research Assistant, Rutgers, The State University of New Jersey
- Hani Nassif, Ph.D., RE-CAST Associate Director and Professor, Rutgers University
- Chaekuk Na, Post-Doctoral Associate, Rutgers, The State University of New Jersey

The Rutgers team has been evaluating the restrained shrinkage performance of fiber-reinforced self-consolidating concrete (FR-SCC) as part of RE-CAST Project 3A. The advantage of the use of SCC is to reduce the time and labor requirements of concrete pouring and consolidation. Despite the advancements, the problems associated with standard high-performance concrete are prevalent in SCC mixtures as well. The objective of this research is to evaluate the cracking potential of FR-SCC under restrained and free shrinkage behavior. Three FR-SCC mixes were prepared including ¼” (6.35mm) long polypropylene fibers added to the concrete mix at rates of 0.10%, 0.15% and 0.20%, by volume. In addition to three FR-SCC mixtures, one control SCC mixture without fibers was also prepared. Restrained shrinkage cracking potential has been monitored in accordance with AASHTO PP34 with the modification of sensor arrangement, as shown in Figure 1. Vibrating wire strain gauges embedded directly into the concrete, in addition to the foil strain gauges attached, to the steel ring are used to monitor the development of shrinkage stresses and identify the location of initial cracking. The free shrinkage strain in accordance with ASTM C 157 has been found to be reduced by 9%, while the required cracking strain calculated by the splitting tensile strength (ASTM C 496) divided by modulus of elasticity (ASTM C 469), increased by over 22% when fibers were added at a volume of 0.20%. Combined, these increased

- Continued Next Page -
FEATURED PROJECT:

Effects of Polypropylene Fibers on the Restrained Shrinkage Behavior of Self-Consolidating Concrete (continued)

properties resulted in an overall delay in the development of the first crack and cracking propagation. As shown in Figure 2, the first crack appeared 7 days later in the FR-SCC with 0.20% fiber volume compared to the control SCC mixture. The mixtures used in this research limited the overall fiber volume to 0.20% because the workability suffered when higher volume of fibers and low cement content were used. A higher paste volume allows for greater flexibility in fiber rates while still achieving the required passing ability and workability. Future work will include mixes with a higher cement content and higher fiber content as well as correlation of free and restrained shrinkage behavior.

Figure 2. Restrained Shrinkage Results – The initial crack of FR-SCC appeared 7 days later compared to control SCC mix; (a) Control SCC, and (b) FR-SCC with 0.20% fiber volume

RE-CAST Associate Director, David Lange, Receives Fulbright Grant

Prof. David Lange received a Fulbright Grant to support a six month stay in Finland during the first half of 2014. Dr. Lange worked with a team of concrete researchers at the VTT Technical Research Center of Finland. His colleagues in Espoo, Finland included Erika Holt, Markku Leivo, Miguel Ferreira, and Edgar Bohner. Topics included concrete durability, chloride ingress under cycling temperatures, embedded sensors, and stability of entrained air.
RE-CAST Director Meets at ACI Convention

The RE-CAST team met at the American Concrete Institute (ACI) Convention in Washington, D.C. on October 28 to have a face-to-face discussion about the RE-CAST Center and coordinate various activities for the upcoming months. The team meets virtually once a month to discuss the progress of the Center in the areas of research, education, technology transfer, workforce development, and diversity. The team will be having a virtual meeting with the Research Advisory Committee (RAC) in November to discuss the progress of the Center and used the ACI meeting to plan the upcoming meeting. The team is working very cohesively as a group and looks forward to presenting progress to the RAC for feedback and field implementation aimed at moving research into engineering practice.

RE-CAST Director Receives G.H. Tattersall Award

RE-CAST Director, Kamal H. Khayat, received the G.H. Tattersall Award in Reykjavik, Iceland in August 2014. The award was offered the first time in 2003 to Phil Banfill of the U.K. and 2009 to François de Larrard of France. This award recognized Dr. Khayat’s sustained and outstanding contribution in the areas of sustainability and durability of concrete. The award was presented at the gala dinner of the 2014 Eco-crete Conference.
WORKFORCE DEVELOPMENT and TECH TRANSFER

RE-CAST Seminar Series

Visit our Webinar Library at: recast.mst.edu/webinars

September 25, 2014
Presenter: Dr. Tyler Ley, Oklahoma State University
“Using the Super Air Meter to Evaluate Modern Air Entrained Concrete Mixtures”

UPCOMING TECHNOLOGY TRANSFER EVENTS

Save the Dates:

November Webinar
We are in the process of scheduling a research webinar for November 2014.
Please check our website, Facebook or LinkedIn pages for updates.

SCC2016
Dates: May 15-18, 2016 Location: Washington, DC
Overview: The conference combines the RILEM Symposium on SCC and the North American Conference on the Design and Use of SCC and will be held jointly with the National Ready Mix Concrete Association (NRMCA) International Concrete Sustainability Conference The conference is supported by Missouri S&T, the RECAST Center, NRMCA, the Center for Advanced Cement-Based Materials (ACBM), as well as RILEM and ACI. For more information, visit: www.scc2016.com.
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