Research on Concrete Applications for Sustainable Transportation

RE-CAST

MISSOURI S&T

Vol. 3 :: Issue 3 :: SUMMER 2016

In this issue:

CONSORTIUM MEMBERS:

Missouri University of Science and Technology

University of Illinois at Urbana-Champaign

Rutgers, The State University of New Jersey

University of Miami

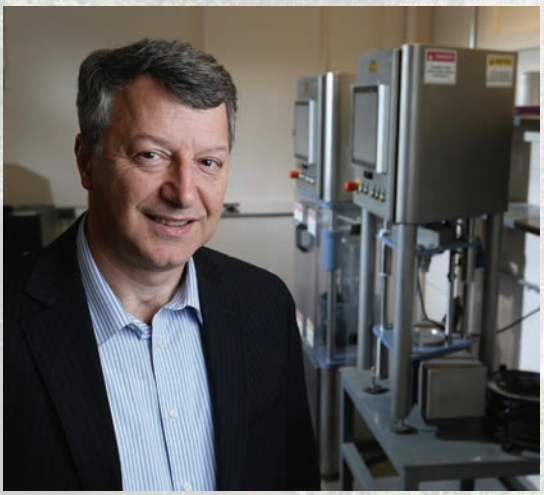
Southern University and A&M College

Director's Message

As the summer semester semester comes to an end, we would like to take a moment and let our readers see what our team has spent these summer months accomplishing.

We are excited to report the successful completion of a milestone technology transfer event that the RE-CAST team has helped organized. The SCC2016 international conference took place in Washington, DC in May and we are very happy with the outcome. Over 300 people from around the world attended the event. More details about the event are in the pages to come.

We hosted a joint online international workshop on FRP with the University of Bath, UK on July 28. Dr. Antonio Nanni of the RE-CAST team was one of the presenters. We also have a webinar scheduled on August 12 which will feature the cutting edge work of RE-CAST research Dr. Kaan Ozbay from New York University. Please watch our website for other upcoming webinars and events.



We would also like to share with you some of our students' recent successes, which we feel are recognition of their hard work and the importance of their research. See our Student Spotlights for more details.

Kamal H. Khayat
RE-CAST Director

OUTREACH

High school students learn about engineering at Summer Transportation and Energy Institute

Dr. Alex Shin, RE-CAST researcher (center), speaks at Southern University and A&M College Summer Transportation and Energy Institute (STEI)

Southern University and A&M College hosted **Summer Transportation and Energy Institute** (STEI) during June 6 - 30, 2016. The College of Engineering served as the housing facility for the institute's classroom-based activities and construction projects. This year, seventeen high school students (9th and 10th grade) were selected to participate from the Baton Rouge metro area and other states including Arizona and Georgia.

Participants were engaged in engineering building projects (maps, planes, cars, and rockets), math enrichment, technical writing, and underwater robotics. Students also visited several Department of Transportation sites as well as the Johnson Space Center in Houston.

Dr. Alex Shin of RE-CAST, pictured above with this year's students, participated in the STIE as the speaker on June 20, 2016. He presented his on-going research on rapid pavement repair sponsored by RE-CAST and related subjects. RE-CAST financially has supported the STEI activities since 2015.

TECHNOLOGY TRANSFER

RE-CAST co-organizes international conference

- Kamal H. Khayat, RE-CAST Director / Jones Endowed Professor, Missouri S&T

Dr. Kamal Khayat with RE-CAST graduate students at SCC2016

Dr. Kamal Khayat with Dr. Surendra Shah (SCC2016 Distinguished Honoree)

On behalf of Missouri S&T and the RE-CAST UTC, Dr. Kamal Khayat and his team organized the Eighth International RILEM Symposium on Self-Compacting Concrete and the Sixth North-American Conference on the Design and Use of Self-Consolidating Concrete (SCC), from May 15-18, 2016, in Washington, D.C. This conference was held simultaneously with the 11th Annual International Concrete Sustainability Conference of the National Ready Mix Concrete Association (NRMCA). **SCC2016** (*Flowing toward Sustainability*) was designed to bring researchers and practitioners together to exchange the latest knowledge and tools used in building sustainable concrete structures with SCC.

Nearly 170 papers were submitted to SCC2016, from 32 countries, covering a wide range of timely and original subjects from around the world. Topics covered in the conference proceedings include SCC mix design, materials, test methods, rheology and workability, production and placement, flow modeling, pumping, formwork pressure, mechanical and physical properties, durability, structural performance, fiber reinforcement, sustainability, and case studies. These papers reflect the most recent advances in research, design, and implementation of SCC worldwide. Nearly 120 papers were presented during three parallel sessions in addition to 25 papers discussed during the poster session. The conference proceedings included a peer-reviewed volume (RILEM PRO 100) with 47 papers and a supplementary volume with the remaining papers. Over 300 participants from around the world attended the event.

The conference also honored over 50 years of outstanding contributions of Professor Surendra Shah to the field of concrete science and education (shown in photo above).

FEATURED PROJECT

All Concrete and Composites Pedestrian Bridge

- Antonio Nanni, Ph.D., Professor of Civil Engineering, University of Miami

Although this pedestrian bridge named **"Innovation Bridge"** is a simple, single-span, 70 ft.-long construction, it offers a number of striking features intended to ensure a 75-year service life to its owner, the University of Miami (UM). The project was initiated in November 2015 with the order to proceed issued to the precast fabricator and completed in May 2016. The bridge consists of the following concrete elements: auger-cast piles; cast-in-place pile caps, side blocks and back walls; precast prestressed girders; and, cast-in-place deck topping and curbs. Even though this project initially specified the use of steel-strand prestressed concrete (PC) girders supported on traditional steel RC piles and pile-caps, UM deliberately chose to adopt the use of composites as internal reinforcement to demonstrate its commitment to innovation and sustainability for this pedestrian bridge used by students to access the sports and intermural fields on campus. As a result, there is not a single pound of "black steel" in any element of the bridge; in fact, all reinforcement and tendons are made of FRP composites. In particular, the structure combines basalt FRP (BFRP), glass FRP (GFRP), carbon FRP (CFRP) and novel composite manufacturing technologies (continuous close stirrups and automated-preassembled pile cages) to ensure that degradation due to steel corrosion no longer reduces the longevity of the bridge. Reinforcing bars, prestressing tendons and concrete at various locations were instrumented with a total of 16 vibrating wire gages (VWGs) to allow for monitoring of the bridge elements over time and, in the case of the girders, during construction, to measure effective strains and transfer lengths.

Precast prestressed double-tees

In addition to CFRP tendons (nine per stem with a diameter of 0.6 in.), the reinforcement grids for both stems and flange were made of pre-assembled interwoven BFRP bars (#3 and #4 at spacing 6 in. o.c., respectively) (**See Figure 1**).

Figure 1.
Double-tees casting bed and detail of reinforcement at casting

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FEATURED PROJECT

All Concrete and Composites Pedestrian Bridge *(continued)*

Figure 2.
Double-tee static load test at precast yard

The static load test of one of the two double-tees at the precast yard 26 days after casting is shown in **Figure 2**. The simply supported girder was loaded with three concrete blocks at its mid-span for a total load of 27 kips plus self-weight.

Site construction

The eight, 16-inch diameter, 40 foot-long auger-cast piles were reinforced with a prefabricated cage of six #6 BFRP bars and #3 equivalent BFRP spirals. The cages (in the shape of hexagons) were prefabricated at the composites manufacturer plant and delivered to the site, ready for installation. The pile caps, side blocks (to support the lampposts) and back-walls are made of concrete reinforced with straight BFRP bars, bent GFRP bars and continuous close BFRP stirrups. The application of continuous close BFRP stirrups is a U.S. "first" which takes advantage of performance efficiency of the composite reinforcement when continuity of the fibers is assured. **Figure 3** shows the completed assembly of the reinforcement cage for pile cap, side blocks and back-wall.

Figure 3.
Reinforcement cage for pile cap, side blocks and back-wall

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FEATURED PROJECT

All Concrete and Composites Pedestrian Bridge *(continued)*

Figure 4.
Load testing with pick-up truck

Field Load Test

Figure 4 shows the fully loaded pick-up truck used for the first field load tests. The total weight of the vehicle was 12,080 lb. with the heavier axle weighing 7,720 lb. Strains and deflections measured during the test were consistent with the analytical predictions.

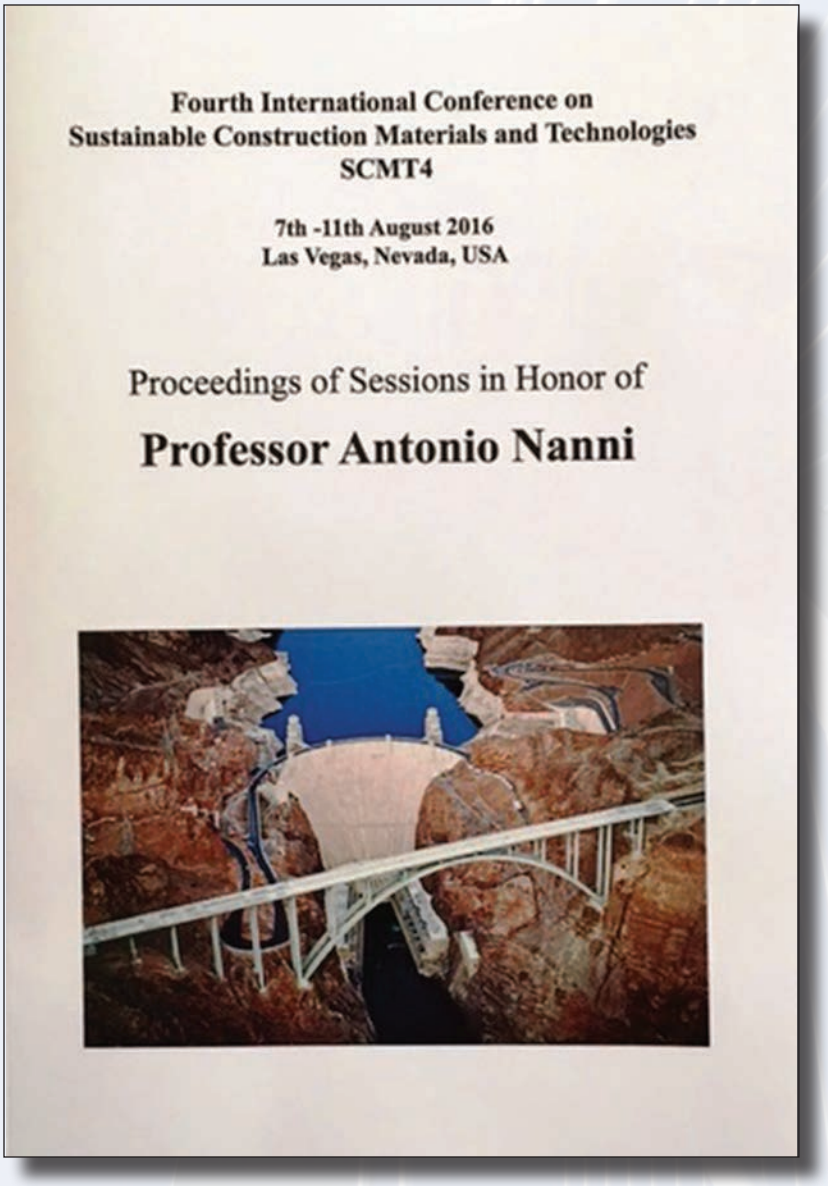
Credits

Industry and financial participants and their roles in the project were:

- RE-CAST UTC (Financial support)
- OHL Arellano Construction Co. (General Contractor)
- ANZAC Contractors Inc. (Bridge Subcontractor)
- Brill Rodriguez Salas & Associates Inc. (Engineer of Record)
- University of Miami (Architectural Design & Designated Engineer)
- University of Miami - Structures and Materials Laboratory (Research Coordinator)
- Coreslab Structures Inc. (Double Tees Fabricator)
- Tokyo Rope/Tokyo Rope USA (CFRP Manufacturer)
- No Rust Rebar (BFRP Manufacturer)
- Hughes Bros. (GFRP Manufacturer)
- Titan America (Concrete Supplier)
- MAPEI (Surface Products Supplier)

LEADERSHIP SPOTLIGHT

RE-CAST Associate Director honored with special session at international conference



RE-CAST Associate Director, **Professor Antonio Nanni**, from the University of Miami, was honored for his lifetime achievements in the field of materials for Civil Engineering during the Fourth International Conference on Sustainable Construction Materials and Technologies (SCMT4) held in Las Vegas, NV August 7-11, 2016.

Three technical sessions were organized in his name with 15 papers presented by former and current students and colleagues as well friends. The papers were collected in a separate proceedings volume, shown on the left.

Read more at https://www.unlv.edu/scmt4/honorees.

STUDENT SPOTLIGHTS

RE-CAST students recieve ACI awards

Iman Mehdipour: ACI Charles Pankow Student Fellowship recipient

Iman Mehdipour (pictured left), a RE-CAST graduate student pursuing a Ph.D. degree in civil engineering at Missouri S&T has been awarded the 2016-2017 American Concrete Institute (ACI) Charles Pankow Student Fellowship.

As part of the award, Mehdipour will receive an educational stipend for tuition, residence, books, and materials, as well as paid travel to the next two ACI conventions. Fellowships are offered to high-potential and outstanding graduate students whose research studies relate to concrete engineering and are identified by ACI-Member Faculty. The selection process consists of evaluating the applicants based on the resume and essay highlighting research areas and all accomplishments. For the final selection, finalists are then exposed to an interview process at the ACI Spring Convention that took place in Milwaukee in April 2016.

"***This award is not only a great honor for Mr. Mehdipour, but also for the RE-CAST UTC. It recognizes the quality of research our students conduct at Missouri S&T***," says Dr. Kamal H. Khayat, the Vernon and Maralee Jones Prof. of Civil Engr. at Missouri S&T and Mr. Mehdipour's advisor and nominator.

Mehdipour's research area has focused on developing and designing advanced cement-based materials, such as environmentally friendly and crack-free cement-based materials and fiber-reinforced composites with adapted rheology. He was also given the opportunity to perform an interdisciplinary collaborative research project to evaluate fiber distribution in concrete and self-healing capability of cement-based materials using microwave and thermography nondestructive testing techniques with Drs. R. Zoughi and K. Donnell from the department of Electrical and Computer Engineering at Missouri S&T.

Over the span of his academic career, Mr. Mehdipour has authored and co-authored two books ("Soil Mechanics" and "Guidelines for Hot Weather Concreting", both published in Persian), 10 peer-reviewed journal articles, and 25 conference papers. His research efforts and professional services have been recognized with several awards. He has received the ACI Missouri Chapter Honorary Abdeldjelil "DJ" Belarbi Scholarship for 2015-2016 and a travel grant award for the 25th ASNT (American Society of Nondestructive Testing) Research Symposium in Spring 2016.

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STUDENT SPOTLIGHTS

RE-CAST students recieve ACI awards

Weina Meng and Mahdi Valipour: ACI Abdeldjelil "DJ" Belarbi Scholarship

Weina Meng and Mahdi Valipour, RE-CAST Ph.D. candidates at Missouri S&T under the direction of Prof. Kamal H. Khayat, were awarded the ACI Missouri Chapter Honorary Abdeldjelil "DJ" Belarbi Scholarship for 2015-2016.

The competition was very tough this year, and the RE-CAST Center is proud of these students' achievement. Both Weina Meng and Mahdi Valipour are working on the field of ultra-high performance concrete and its application. Their academic achievements and community services experience made him a good candidate for this scholarship award.

STUDENT SPOTLIGHT

RE-CAST students win best poster at competition

Congratulations to RE-CAST students Weina Meng, Hayder Owayez, Valter Gora, and Rallabhandhi Sai Pavan! They received an Award of Excellence for Best Poster in the student competition at the First International Interactive Symposium on Ultra High Performance Concrete this July in Des Moines, Iowa.

From left to right: Weina Meng, Dr. John Myers (faculty advisor of Missouri S&T), Hayder Owayez, and Benjamin Graybeal of FHWA

WORKFORCE DEVELOPMENT/OUTREACH

RE-CAST students teach next generation about concrete materials

Dr. Aditya Kumar (pictured above), Weina Meng (pictured below), and Iman Mehdipour presented concrete materials and facilities of RE-CAST to high-school students in a Materials Summer Camp that took place in July in Rolla. Missouri S&T's Materials Camp is a summer residential camp for high school juniors and seniors interested in the science, technology, engineering and math (STEM) fields.

Campers learned about the fresh properties testing of concrete (shown above left). Faculty members and students also gave campers a variety of demonstrations and trips that actively explored concrete materials science and helped them to learn how to use state-of-the-art research equipment (shown above right).

LEADERSHIP/TECHNOLOGY TRANSFER

RE-CAST directors participate in Gordon Research Conference on Advanced Materials for Sustainable Infrastructure Development in Hong Kong

RE-CAST researchers Drs. David Lange and Kamal Khayat participated in the Gordon Research Conference (GRC) on Advanced Materials for Sustainable Infrastructure Development. This conference was held at the Hong Kong University of Science and Technology (HKUST) from July 31 to August 5, 2016.

Dr. Lange served as co-chair of the conference along with Prof. Chris Leung from HKUST. Dr. Khayat was selected as the co-chair for the next GRC conference to be held in 2018 at HKUST, a position that places him in the chairmanship of the 2020 GRC conference which will be held in the USA.

The GRC conference format features invited speakers and extended discussion periods, and attendees often reflect on the quality of debate and collegial interactions. At this recent conference, Dr. Khayat gave an invited lecture on High Performance Concrete with Adapted Rheology, a topic that fits in well with the conference theme on sustainability and summarizes many of the recent research findings carried out by the RE-CAST team.

WEBINAR SERIES

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

August 12, 2016

Presenter: Kaan Ozbay, Professor of Transportation Engineering

New York University

"An Overview of a Network-wide Probabilistic Life Cycle Cost Analysis Methodology and Implementation Framework for New Concrete-based Materials and Construction Techniques"

Extending the Service Life of New Reinforced Concrete Structures by Using Advanced Composite Materials Workshop

- Joint workshop offered with University of Bath (UK)

July 29, 2016

RE-CAST Presenter: Antonio Nanni, Professor of Civil Engineering, Univ. of Miami

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April 1, 2016

Presenter: Maria Juenger, Professor of Civil Engineering

University of Texas at Austin

"The Future of Concrete May be in Its Past"

February 10, 2016

Presenter: Dr. Saverio Spadea

Research Fellow at the University of Bath (UK)

"Bespoke FRP Reinforcement for Optimised Concrete Structures"

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