Knowledge to Practice:

ACI Foundation Funds Eight Research Projects in 2018

The ACI Foundation's Concrete Research Council (CRC) will fund an unprecedented eight research projects this year. The funding displays the industry's need for research and the ACI Foundation's commitment in addressing that need. More information about each of this year's awarded projects is available at **www.acifoundation.org**.

Pre-Standard for Performance-Based Design for Wind

The ACI Foundation and ACI are joining the Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE) and other organizations in this industry-wide coalition to encourage performance-based design (PBD) for wind. PBD can improve efficiency of design and construction and potentially improve structural performance. The 2016 edition of ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, introduced target reliability tables into the basic requirements for structural design, within its general provisions. To provide a PBD approach for wind, system reliability targets must be developed into the basic requirements to achieve target performance objectives corresponding to various levels of wind hazard. No guidance currently exists for designers on a performance-based approach for wind, beyond the ASCE/SEI 7 provisions that permit its use.

This research project will document specific building response parameters (such as strains, deformations, and loads) and acceptance target limits for the main wind-force-resisting system and cladding envelope system subjected to wind effects and environment demands.

The information developed will assist ACI Committee 375, Performance-Based Design of Concrete Buildings for Wind Loads, when updating its current documents. The information is also expected to assist in the eventual incorporation of PBD approaches in the ACI 318 Code. Don Scott, Senior Principal with PCS Structural Solutions, is the project principal investigator (PI). The project is supported by the ACI Foundation, the Charles Pankow Foundation, ASCE, American Institute of Steel Construction, the Federal Emergency Management Agency, the National Institute of Standards and Technology, and several structural design firms.

Ann Daugherty is the Director of the ACI Foundation, a not-for-profit subsidiary of ACI. The Foundation facilitates collaboration among a cross section of concrete industry leaders to problem-solve technical issues, accelerate the acceptance of innovative technologies, and bring more young people into the concrete industry. For more information, contact ann.daugherty@acifoundation.org.

Enhanced Ductility RC Coupled Wall Systems

Seismic force-resisting systems that integrate coupled shear walls of concrete are suitable for multi-story reinforced concrete buildings—but are not recognized in the structural systems Table 12.2-1 of ASCE/SEI 7. Consequently, such systems are designed using response modification factors (R-values) that don't account for the benefits of having the coupling beams, which can dissipate much of the energy generated by the earthquake. The researchers will conduct FEMA P695 studies, which are required for new systems proposed for inclusion in Table 12.2-1. These studies will determine appropriate design factors for buildings using coupled shear walls as part of the seismic-force-resisting system. ACI Committee 318, Structural Concrete Building Code, supports this project.

John Wallace, University of California, Los Angeles, CA, will serve as the project's PI, with Kristijan Kolozvari, California State University, Fullerton, acting as Co-PI. The ACI Foundation and the Charles Pankow Foundation are co-funding this project.

Behavior of Reinforced Concrete Coupled Walls

Buildings are often designed with reinforced concrete coupled walls to resist lateral demands from earthquakes and wind. The response of coupled walls subjected to lateral demands is highly dependent on the behavior of the coupling beams. The primary research objective is to develop nonlinear modeling parameters and acceptance criteria for reinforced concrete coupling beams.

Through large-scale laboratory testing, the proposed research will fill knowledge gaps on the behavior of diagonally reinforced concrete coupling beams subjected to axial load. Based on this new and previously existing work, a database will be created and used to develop new recommendations for nonlinear modeling parameters and acceptance criteria. The research is expected to provide key parameters that influence load-deformation behavior and address gaps in industry documents.

Christopher Motter, Washington State University, Pullman, WA, is the project PI. This project is co-funded by the ACI Foundation and Washington State University, and supported by ACI Committee 374, Performance-Based Seismic Design of Concrete Buildings. The research results may be used to update ACI 374 documents and to make future ACI 318 Code recommendations.

Shear Friction Capacity of Concrete Joints with High Strength Reinforcement

Limits imposed on shear strength and steel strength prevent engineers from using high-strength steel in designs. This project will investigate parameters affecting the shear friction capacity of concrete joints with high-strength reinforcement (HSR). Specific research objectives include expanding the database of shear friction tests; evaluating current design expressions for shear friction, with an eye toward implementing HSR in future ACI 318 Code editions; and investigating parameters such as large bar sizes, cold joints, and mechanisms used to achieve roughened surfaces.

The results will be used to improve the shear-friction expressions as well as allow contractors to consider different roughening techniques. If successful, the project results will have a significant impact on design and construction, possibly reducing the requirements for surface roughening and permitting the use of HSR.

Paolo Martino Calvi and Dawn Lehman, University of Washington (UW), Seattle, WA, are the project PIs. ACI Foundation and UW are co-funding the research. ACI Committee 374, and ACI Subcommittees 318-H, Seismic Provisions, and 318-R, High-Strength Reinforcement, support this project.

A Collaborative Study for the Development of a Standard Critical Chloride Threshold Test Method

When the critical chloride threshold (CT) is reached within a concrete structure, corrosion of steel reinforcement can initiate. This research project is designed to generate a standard test to assess CT. The development of a test method is expected to allow for more consistent quantification of allowable chloride limits for fresh concrete. Also, because CT is one of the most important input variables in service life models used for the prediction of time to corrosion, the research is expected to result in more effective design and maintenance of concrete structures.

Ceki Halman, University of Missouri-Kansas City, Kansas City, MO, is the project PI. The project is supported by ACI Committee 222, Corrosion of Metals in Concrete, which has recently established a task group to develop a standard test method for CT; the method and data set may lead to updating chloride limits in documents published by ACI Committee 222 and could also establish a basis for other committees, such as ACI Committees 201, Durability of Concrete, and 318, to update their published values and maintain consistency.

Structural Nanomodified Concrete: An Investigation of Critical Properties

There is significant interest in concrete with enhanced structural properties. This research project addresses creep, shrinkage, and durability of nanomodified concrete. Given proper handling, small dosages of carbon nanofibers and nanotubes exhibit potential as additives for structural concrete. These additives have the capability to improve critical properties such as modulus of elasticity, flexural strength, and cracking resistance. This study addresses significant gaps in the state of knowledge of nanomodified concrete—gaps that are preventing its use as a structural material. The results of this work could bring new materials to concrete engineers, specifiers, and producers; and new markets could emerge to provide nanomaterials in additive or admixture forms.

David Corr and Surendra Shah, Northwestern University, Evanston, IL, are the PIs. This project is supported by ACI Committee 241, Nanotechnology of Concrete.

Developing a Guideline for Life Cycle Assessment of Structural Concrete through Meta-Analysis and Harmonization

This project will investigate methodological preferences and technical specifications for life cycle analysis (LCA) of existing concrete structures. LCA is mainly implemented to assess the environmental impacts of concrete structures, giving a holistic view over the lifetime of structural elements, from the beginning of materials extraction to disposal. Meta-analysis will be used to develop a quantitative synopsis of the environmental impact of concrete structures via existing research. A harmonized LCA database from the reviewed studies, based on the evaluation of key LCAs and assumptions, will also be developed.

Hessam Azari Jafari and Ben Amor, University of Sherbrooke, Sherbrooke, QC, Canada, are the project PIs. This project is co-funded by the ACI Foundation, the Natural Sciences and Engineering Research Council of Canada, and the Interdisciplinary Research Laboratory on Sustainable Engineering and Eco-Design, University of Sherbrooke. ACI Committee 130, Sustainability of Concrete, supports this research.

Guideline Development for Use of Recycled Concrete Aggregates in New Concrete

This research seeks to develop guidelines for the use of recycled concrete aggregates (RCA) in new concrete and will therefore provide a much-needed link between existing research and practice. Despite extensive existing research and a significant history of use, instructions for use of RCA have not been widely incorporated into North American standards and guidelines. This project will include a holistic review of the existing literature and statistical analyses of existing data. The goals are to develop guidelines for the characterization of

RCA and the creation of specifications for mixtures comprising RCA.

Matthew Adams, New Jersey Institute of Technology (NJIT), Newark, NJ, is the project PI. The project is co-funded by the ACI Foundation and NJIT. ACI Committee 555, Recycled Materials in Concrete, supports this project. Research results may be used to enhance documents for the use of RCA produced by ACI Committees 555 and 221, Aggregates, and the research could support standard and specifications within other industry organizations.

ACI Foundation Call for Award Nominations

The ACI Foundation is seeking nominations for its annual awards. Three awards are bestowed yearly. The Robert E. Philleo and Arthur J. Boase Awards are granted by the CRC to a person or organization in recognition for outstanding research in the field of concrete materials (Philleo Award) and in the field of structural concrete (Boase Award). The Jean-Claude Romain Award is bestowed by the Strategic Development Council (SDC) to an innovator in the concrete industry and honors long-time SDC supporter Jean-Claude Roumain. Nominations must be submitted via **www.acifoundation.org** by August 1, 2018.

Jean-Claude Roumain was a long-time supporter of SDC

Have an idea for research that will benefit the concrete industry or support an ACI document or code change? Visit **www.concreteresearchnetwork.org** and fill out an online concrete research need form.

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