The 2nd JCI & ACI Joint Seminar

-Resilience of Concrete Structures-

TOKYO

July 13, 2015
Toshi Center Hotel
Tokyo, JAPAN

JCI 50th Anniversary Commemorative Symposium

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-Resilience of Concrete Structures-

Time Table	July 13, 2015 (Monday)
8:50-9:00	**Welcome and Opening Address** (Chair: Hiroshi Mutsuyoshi) JCI President: Hirozo Mihashi ACI President: Sharon Wood  
9:00-11:45	**Session 1: Seismic Design for RC Structures** (Chair: Tomoko Ishida) ➢ 9:00-9:25 ACI paper #1 Title**:** *Reorganization of the ACI 318-14 Building Code and Changes in Seismic Design Provisions* Presenter: Andrew Taylor Affiliation: KPFF Consulting Engineers, Seattle, USA ➢ 9:25-9:50 JCI paper #1 Title**:** *Seismic Design of Headed Bars for Reinforced Concrete Beam-column Joints in Japan* Presenter: Hitoshi Shiohara Affiliation: The University of Tokyo, Tokyo, Japan ➢ 9:50-10:15 ACI paper #2 Title**:** *Performance-Based Seismic Design of Tall RC Core Wall Building: State of Practice on the West Coast of the U.S.* Presenter: Jeff Dragovich Affiliation: Consulting Structural Engineer, Seattle, USA ➢ 10:15-10:30 Coffee break ➢ 10:30-10:55 JCI paper #2 Title**:** *Recent Shaking Table Tests of RC Building Model Structures* Presenter: Hideo Katsumata Affiliation: Obayashi Corporation, Tokyo, Japan

	➢ 10:55-11:20 JCI paper #3 Title: *Evaluation of Limit States of RC Columns in Performance-Based Seismic Design of Bridges* Presenter: Jun-ichi Hoshikuma Affiliation: Public Works Research Institute, Tsukuba, Japan ➢ 11:20-11:45 ACI paper #3 Title: *Experimental Testing of Bridge Columns Using Long Duration Ground Motions* Presenter: David Sanders Affiliation: University of Nevada, Reno, USA
11:45-13:00	**Lunch**
13:00-15:20	**Session 2: Assessment and Monitoring of Concrete Structures** (Chair: Mitsuyoshi Akiyama) ➢ 13:00-13:25 ACI paper #4 Title: *Life Extension of Reinforced Concrete Structures* Presenter: James Jirsa Affiliation: The University of Texas at Austin, Austin, USA ➢ 13:25-13:50 JCI paper #4 Title: *Structural Health Monitoring for Optimization of Concrete Bridge Management* Presenter: Tohru Makita Affiliation: Central Nippon Expressway Company Limited (NEXCO-Central), Nagoya, Japan ➢ 13:50-14:15 ACI paper #5 Title: *Collapse Simulation of Slab-Column Moment Frame Building* Presenter: Adolfo Matamoros Affiliation: University of Texas at San Antonio, San Antonio, USA ➢ 14:15-14:30 Coffee break ➢ 14:30-14:55 JCI paper #5 Title: *Image Based Detection for Concrete Fracture* Presenter: Tomohiro Miki Affiliation: Kobe University, Kobe, Japan

	➢ 14:55-15:20 ACI paper #6 Title: *Structural Health Monitoring (SHM) for Evaluation and Quality Control of Concrete Structures* Presenter: Hani Nassif Affiliation: Rutgers, The State University of New Jersey, USA
15:20-15:30	**Closing Address** (Chair: Eisuke Nakamura) JCI: Kyuichi Maruyama ACI: Andrew Taylor
15:30	**Adjourn Seminar and Group Photo**
16:00-17:30	**JCI & ACI Planning Meeting**

Map of the Venue for the Seminar

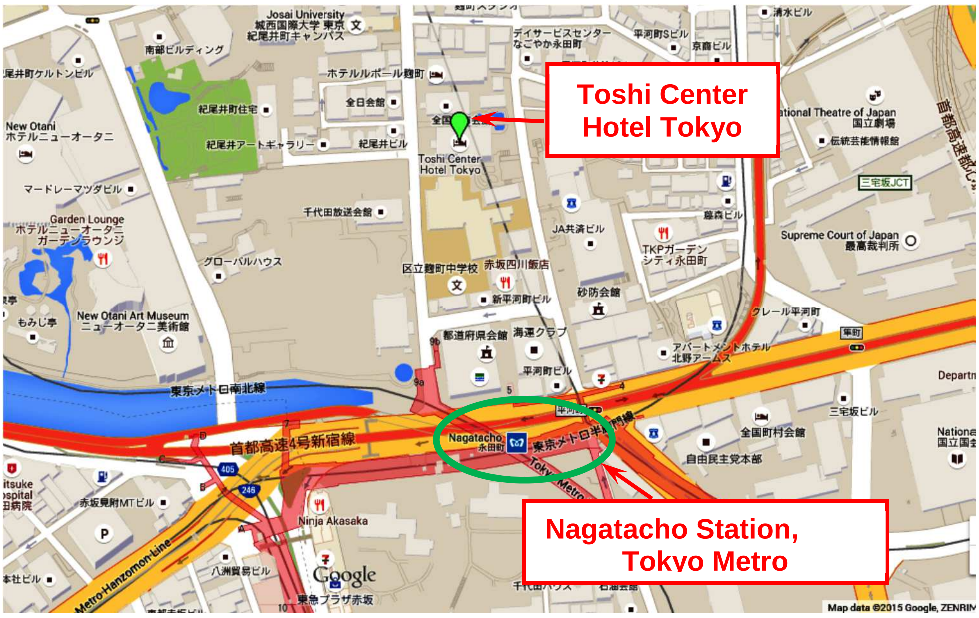
Room 701, Toshi Center Hotel Tokyo, Japan

Address: 2-4-1 Hirakawa-cho, Chiyoda-ku, Tokyo 102-0093, Japan

Phone: +81(0)3-3265-8211

- a 5-minute walk from Nagatacho Station, Tokyo Metro

Map & Directions URL



Floor Map of the Venue

Abstracts and Speakers

ACI paper # 1

Title: Reorganization of the ACI 318-14 Building Code and Changes in Seismic Design Provisions

Author: Andrew W. Taylor, PhD, SE, FACI

Affiliation: KPFF Consulting Engineers, Seattle, Washington, USA
ACI 318 Subcommittee H, Seismic Provisions

ABSTRACT

The American Concrete Institute Building Code Requirements for Structural Concrete, ACI 318-14, was completely reorganized between the 2011 and 2014 editions. This reorganization was undertaken to improve the ease-of-use and clarity of the code, and to create a logical framework for future additions and revisions to the code.

ACI paper # 2

Title: Performance-Based Seismic Design of Tall RC Core Wall Buildings: State of Practice on the West Coast of the U.S.

Author: Jeff Dragovich, PhD, SE, FACI

Affiliation: ACI Committee 374 Performance-Based Seismic Design of Concrete Buildings
Consulting Structural Engineer, Seattle, Washington, USA

ABSTRACT

As an alternative to code-based prescriptive design, engineers are employing a performance-based seismic design philosophy for the design of tall, reinforced concrete core wall buildings. The various aspects of the execution of a Performance-Based Seismic Design (PBSD) are presented: Ground motion selection and scaling, lateral system configuration and detailing, linear and nonlinear modeling, and acceptance criteria. An overview of available consensus PBSD design guidelines and the peer review process are also presented.

ACI paper # 3

Title: Experimental Testing of Bridge Columns using Long Duration Ground Motions

Authors: M. Saeed Mohammed and David H. Sanders

Presenter: David H. Sanders, PhD, Professor, FACI

Affiliation: Department of Civil and Environmental Engineering, University of Nevada, Reno, Nevada, USA

ABSTRACT

The importance of studying the effect of ground motion duration has been highlighted after the long duration shaking that occurred in the 2010 Chile earthquake (M8.8) and the 2011 Tohoku earthquake (M9.0) events. Current seismic design codes do not consider duration effects. This might be attributed to the big differences in conclusions of previous research studies with regard to the effect of ground motion duration and number of cycles on structural performance. This paper presents a comprehensive study that uses experimental methods to investigate the ground motion duration effects. The results of shake table tests of large-scale reinforced concrete bridge columns that are designed and tested under long duration ground motions are presented. The study utilizes ground motion records from both 2010 Chile and 2011 Tohoku earthquakes for shake table input. Moreover, comparisons of the columns structural response with previous tests that used short duration ground motion records are also discussed.

ACI paper # 4

Title: Life Extension of Reinforced Concrete Structures

Author: James O. Jirsa, PhD, Professor

Affiliation: The University of Texas at Austin, Texas, USA

ABSTRACT

Over the past several decades, the rehabilitation of structures in seismic zones has received considerable attention. Structures with inadequate systems to resist earthquake motions represented an unacceptable risk and led to many innovative approaches for improving their behavior. The results of that research have now been incorporated into documents used in the design of such improvements. Attention has now turned to more general life extension problems for our aging and often inadequate infrastructure. The purpose of this presentation is to briefly discuss the lessons learned from research related to seismic performance and how they can be used to extend the life of concrete structures with inadequate resistance to overloads, terrorist actions, and deterioration due to environmental or occupancy issues. The emphasis will be on research for the use of fiber reinforced polymers.

ACI paper # 5

Title: Collapse Simulation of Slab-Column Moment Frame Building

Authors: Adolfo B. Matamoros, Anil Suwal, and Andres Lepage

Presenter: Adolfo B. Matamoros, PhD, Professor, P.E., FACI

Affiliation: University of Texas at San Antonio, Texas, USA

ABSTRACT

Simulating the response of reinforced concrete buildings near collapse is an essential part of the process of evaluating the risk to humans posed by extreme loading events. Several research projects in the recent past have investigated the behavior of reinforced concrete structural components subjected to very large deformations, with the goal of improving our ability to simulate their response. New experimental data from component tests has led to the development of component modeling parameters and element models that can be used to estimate the amount of damage in a structure during an extreme loading event. Furthermore, these component modeling parameters and element models have been used in projects such as ATC-78 and ATC-114 to identify the features that make buildings more likely to collapse during extreme events.

While this research effort has led to more robust data sets to calibrate component modeling parameters, many inconsistencies and unknowns remain. For example, different levels of uncertainty in modeling parameters for beams and columns can introduce a significant modeling bias due to the difference in the level of conservatism between the two. Inconsistencies and unknowns of this nature can cause distortions in the computed hinge pattern in structures and lead to the calculation of incorrect collapse mechanisms, which can cause engineers to reach the wrong conclusion about the expected damage in a structure.

A model was developed to simulate system behavior near collapse of a slab-column moment frame building which was instrumented during several strong earthquakes. The model was used to develop a better understanding of the effect of various modeling approaches on system behavior, and to investigate the limitations of the FEMA P65 methodology to evaluate the collapse safety margin of older buildings.

ACI paper # 6

Title: Structural Health Monitoring (SHM) for Evaluation and Quality Control of Concrete Structures

Author: Hani Nassif, PhD, P.E., FACI, Professor and Director

Affiliation: Rutgers Infrastructure Monitoring and Evaluation (RIME) Laboratory, Department of Civil and Environmental Engineering, Rutgers, The State University of New Jersey, New Jersey, USA

ABSTRACT

Structural Health Monitoring (SHM) of concrete structures during and after construction, as well as over its service life, has recently become more attractive to owners and consulting engineers. With the introduction of new materials and construction methods, various types of concrete structures are being instrumented with monitoring devices to determine their performance as well as their response to various loading conditions. Among many other objectives, this includes monitoring concrete performance at the serviceability and durability limit states. Emphasis has been placed on assessment of cracking potential, rebar debonding, measuring time-dependent deformations such as creep and shrinkage, camber and deflection, evaluation of rebar corrosion, validation of new design or construction provisions, and calibration of reliability-based design code provisions.

This presentation highlights different projects where various types of instrumentation techniques used to monitor and test various types of concrete structures during and after construction. For each case study, various types of sensors are installed on the concrete structure for field-testing and long-term monitoring. These sensors consist of strain transducers, accelerometers, geophones, vibrating wire strain gages, settlement sensors, pressure cells, and weigh in motion (WIM) system. Data was collected to describe the load and resistance parameters to help in the development and calibration of reliability-based design codes. This presentation also provides an overview of how data from various sensors could be processed to assess the actual behavior of the structure at various stages. In addition to implementing SHM procedures, such as data collection, processing, and selection of sensor technology, SHM was complemented with probabilistic simulation models and future predictions for long-term performance and assessment. Results of research work are employed to enable agencies such as New Jersey Department of Transportation (NJDOT) and NJ Turnpike Authority (NJTA) to successfully update their design provisions, technical specifications for materials and construction, and evaluation methods.

JCI paper # 1

Title: Seismic Design of Headed Bars for Reinforced Concrete Beam-column Joints in Japan

Author: Hitoshi Shiohara, FACI, Professor

Affiliation: Department of Architectural Engineering, The University of Tokyo, Tokyo, Japan

ABSTRACT

Building Standard Law and Architectural Institute of Japan do not have structural standards nor provisions for seismic design, the scope of which includes headed deformed bars, as they are proprietary products and relatively new. Instead headed bars have been approved and used for actual application after technical reviews by Building Center of Japan and the other technical appraisal service institutions. They evaluate each proprietary headed bar system by the documents of a) product specification, b) structural design provisions and experimental verification, c) construction standard and d) quality assurance protocol. In recent years, headed reinforcing bars are popularly used as longitudinal reinforcement for large reinforced concrete buildings. The development of seismic design for such headed bars owes to the intensive research by the industry and the academy since late 1990's and they are still going on which includes experimental works; i.e. pull out test of the headed bars embedded in concrete and verification tests of beam-column joint subassemblages subjected to cyclic loading. The purpose of this presentation is to briefly discuss the seismic design of headed bars reinforcement in Japan, including development length, material strength, head size side, clear cover to the head, and recent changes in consideration of column-to-beam flexural strength ratio and joint shear reinforcement.

JCI paper # 2

Title: Recent Shaking Table Tests of RC Building Model Structures

Author: Hideo Katsumata

Affiliation: Obayashi Corporation, Tokyo, Japan

ABSTRACT

Shaking table tests of two scaled reinforced concrete building models were carried out in recent years at E-Defense of Japan. One was a 1/4 scaled high rise building model of 20 storied moment-resisting frames, employing kinds of long period and long duration ground motion predicted for future Nankai Trough Earthquake. The other was a 1/3.3 scaled low rise building model of a 6 storied wall-frame structure, employing the recorded JMA Kobe 1995 ground motion as a representative wave of near-field earthquakes.

From the first test, it was found that structural slabs were fully effective for building strength, which could be expressed by a detail analysis using non-linear FEM. However, the observed hysteretic damping after yielding was fairly smaller than the expected by the current design custom, which caused smaller and unsafe estimated response than the observed one in the test.

From the second test, collapse process of a wall frame structural system was observed in detail. Reloading shaking tests before maximum strength did not progress the collapse process, however, shaking tests after maximum strength accelerated the deterioration of structural performance. Safety margin to the required performance level of the current design codes was estimated to be almost 2.0. Ultimate drift angle of the first story reached to 16 %, however, the columns never failed in shear due to severe regulations of the current design codes.

JCI paper # 3

Title: Evaluation of Limit States of RC Columns in Performance-Based Seismic Design of Bridges

Author: Jun-ichi Hoshikuma

Affiliation: Bridge Structure Research Group, Public Works Research Institute, Tsukuba, Japan

ABSTRACT

The performance-based seismic design concept for highway bridges has been introduced since the 2002 Design Specifications, and the both design requirements and the conventional detailed design methods as examples of acceptable solutions have been clarified. The latest Seismic Design Specifications for Highway Bridges were issued in February 2012 based on lessons learned from the 2011 Great East Japan Earthquake and the recent research findings.

This paper focuses on the recent interesting research topics of RC bridge column which have been stipulated in the 2012 Specifications. The ductility evaluation of reinforced concrete bridge columns has been researched with many cyclic loading tests for a few decades. Definitions of the limit states of RC columns are clarified based on the required seismic performance of bridges and a new proposal for an evaluation of the ductility factor for those limit states of RC bridge columns is developed based on many loading test results. Additionally, the cyclic behavior of rectangular thin-wall hollow bridge columns with high longitudinal steel ratio subjected to high axial loading is introduced through some loading tests. Details of structural section and the lateral reinforcing steel for the rectangular hollow column are discussed for preventing vulnerable failure at the ultimate stage.

JCI paper # 4

Title: Structural Health Monitoring for Optimization of Concrete Bridge Management

Author: Tohru Makita

Affiliation: Central Nippon Expressway Company Limited (NEXCO-Central), Nagoya, Japan

ABSTRACT

Recent years have seen growing number of damaged and deteriorated bridges in NEXCO-Central's expressways and management of the bridge assets becomes increasingly difficult, while limited budget and manpower are available for bridge maintenance. Considering society and economy significantly rely on expressways, providing safe and reliable expressway network is essential for our lives. In order to keep the expressway bridges in good condition during their planned service life, bridge maintenance activities such as inspection and evaluation of current condition need to be done more efficiently.

Since the end of last century, Structural Health Monitoring (SHM) has been used in civil engineering fields to help engineers understand the state of constructing and existing structures. In the area of bridge maintenance, SHM is considered to be a promising technology for damage detection and its optimization has been extensively investigated. As damage detection in in-service bridges is conventionally performed by visual inspection, if successfully implemented, SHM may greatly contribute to improvement in bridge maintenance efficiency and reliability because sensor-based SHM can provide us more timely, objective, and quantitative information about damage.

This presentation discusses the applicability of current SHM technologies for concrete bridge management in NEXCO-Central's expressways. A role of SHM in concrete bridge management is specified as a complement to hands-on visual inspection where SHM is expected to detect damage between inspections. By considering the characteristics of various types of damages observed in concrete bridges, damage to be detected by SHM is defined as fracture of prestressing tendons. Results of experimental tests investigating the behavior of prestressed concrete members and the performance of SHM technologies are reviewed and the limits of SHM are understood. Lastly, utilization of SHM in concrete bridge management is discussed.

JCI paper # 5

Title: Image Based Detection for Concrete Fracture

Author: Tomohiro Miki, Associate Professor, Dr. Eng.

Affiliation: Department of Civil Engineering, Kobe University, Kobe, Japan

ABSTRACT

A non-contact measurement technique for the deformation of a target structure has been developed. Image analysis was carried out during the loading test to measure the strain distribution on the target structures. To realize the wide-range application of this method, a microscope, a static digital camera, or a high speed camera was used. One of the examples to present here is an investigation to evaluate the crack propagation in the cracked concrete that is damaged due to alkali-silica reaction (ASR). Three-point bending test for single notched concrete beams were carried out in order to determine the fracture properties of the ASR damaged concrete, i.e. fracture energy and tension-softening curves. To detect the crack propagation, the image analysis by using a digital image correlation method was carried out. In this method of image analysis, a region-based matching technique is used to calculate the displacement of any portion of the concrete surface. As for the macroscopic damage in the concrete the ASR induced cracks that can be observed on the surface of concrete were classified into their widths, lengths and directions. The experiments show that these ASR-induced cracks affect the crack propagation in the specimen under the bending. The presentation will extend to the research on compressive failure of the ASR damaged concrete or a heavily fiber reinforced concrete.

Photo: The 1st ACI & JCI Joint Seminar In Hawaii, U.S.A (2014)