ACI Fall Convention 2017
Anaheim, CA

International Workshop on Structural Concrete

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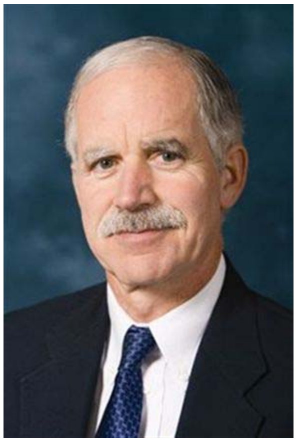
American Concrete Institute
Always advancing

Session 1 – New Tools from ACI

Moderated by James K. Wight



This session contains a series of presentations describing new reports and standards from ACI that should be of particular interest to the international community, including new Spanish translations of ACI 301 Tolerances and ACI 117 IPS-1 Updated to ACI 318-14; ACI 318-14 Chapter 26 on Construction Documents and Inspection; and major updates expected for ACI 318-19.

Presentation 1 – New Spanish Translations (ACI 301 Tolerances, ACI 117 IPS-1 Updated to ACI 318-14)

Jose Izquierdo-Encarnacion

Starting with the ACI 318-05, ACI officially published the Spanish version 318S-05. It was based on the challenging task of the creation of an official technical English - Spanish Glossary. All Latin-American ACI Chapters and Partners worked together to standardize the official version. In addition, ACI created agreements with different countries to be able to print 318S and reduce cost throughout the region. As a natural consequence, Committee 318S was charged to translate or officially review other ACI technical documents. The committee and ACI established priorities to better serve Spanish speaking countries. There are now 20 translated documents. In addition to ACI 318, the most significant translations are ACI 301 - Specifications for Structural Concrete, ACI 314 - Guide to Simplified Design for Concrete Buildings and the American Society for Concrete Construction extraordinary publication The Contractor's Guide to Quality Concrete Construction.

Presentation 2 – ACI 318 Chapter 26

Dean Browning

With the reorganization of ACI 318-14 complete, Chapter 26 changes the presentation of construction and material requirements from previous versions ACI 318. Chapter 26 collected all the construction and material requirements that were sprinkled throughout ACI 318 and present them in a new way. The following will be discussed:

1. Organization of Chapter 26
2. Benefits of the reorganized chapter.
3. General impact of the reorganization on the LDP and the contractor.

Preview of change proposals being vetted for ACI 318-19.

Presentation 3 – Update for ACI 318-19

Jack Moehle

The ACI 318 Building Code Committee is well on its way to completing the next edition of ACI 318. While code reorganization was a major effort in the ACI 318-14, in the current code cycle the committee has had the opportunity to focus on needed technical revisions. Important revisions include simplification of the one-way shear provisions, introduction of size effect for one- and two-way shear, effective stiffness for beam and one-way slab deflections, update and reorganization of the shells standard and the anchoring to concrete chapter, introduction of high-strength reinforcement, new requirements for beam-column joints, seismic design of deep foundation elements, and various other new provisions for earthquake-resistant construction.

Session 2 – Nonlinear Analysis in Earthquake-Resistant Design

Moderated by Jack Moehle

Nonlinear analysis is increasingly used in the earthquake-resistant design of buildings. This session will present examples of the use of nonlinear analysis in the earthquake-resistant design of buildings in the United States and Chile, and will include a presentation on the development of ACI 318-19 provisions for the use of nonlinear analysis methods.

Presentation 1 – USA – Examples

Ronald Klemencic

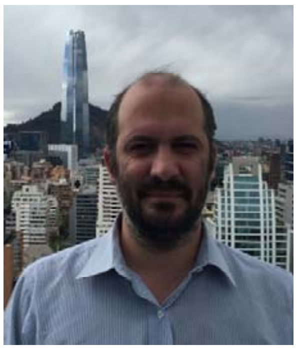
Performance-Based Seismic Design Best Practices

Over the last 20 years, performance-based seismic design (PBSD) has evolved and improved. Starting in 1995, Magnusson Klemencic Associates (MKA) began to explore a design methodology known then as Displacement Based Design. This approach quickly evolved into the earliest applications of PBSD for buildings in Manila, and Seattle and Bellevue, Washington. Since then, nearly 100 high rise buildings have been designed using this approach, which results in more consistent, reliable, and safer building performance.

Numerous resources and guidelines have been published in recent years to assist designers to navigate the complex and rigorous analysis and calculations inherent in performance-based design. This presentation will highlight the current state of engineering practice and will offer some of the important lessons-learned through examples of built projects.

Presentation 2 – Chile – Nonlinear analysis in the quest for resilience

Rene Lagos and Mario Lafontaine



Chile is characterized by the largest seismicity in the world. The different types of earthquakes mean that buildings can be severely affected by near source events as well as by far events. The short interval between large earthquakes of magnitude 8.0 and the general good structural behavior observed, has conditioned the Chilean society to expect for their buildings immediate occupancy performance level under these extreme events, despite the fact that the Chilean Code declares a scope of life safety performance level.

High-rise concrete buildings constructed in Chile in the past 25 years performed well during the 2010 earthquake. Nevertheless, the earthquake produced significant structural damage on some new mid-rise shear wall buildings never seen in previous earthquakes. The presentation will describe some of the upgrades to the Chilean seismic design codes in 2011 that are intended to improve future designs.

The presentation will also describe the application of a tool to create simplified nonlinear models and its application to a 32 story RC building located in Chile. Comparison between the capacity curves of a simplified model using ETABS and a more realistic model using Perform 3D will be presented and discussed.

Presentation 3 – ACI 318 N: Nonlinear Dynamic Analysis

Luis Garcia

The *ACI 318 Structural Concrete Building Code Committee* has recently added *Subcommittee 318-N: Nonlinear Dynamic Analysis*. The purpose of the subcommittee is to address nonlinear dynamic analysis in conformance with the 318 Building Code. The requirements will be included in the 318-2019 edition of the Structural Concrete Building Code. Topics covered include: scope, earthquake ground motions, load factors and combinations, modeling and analysis, effective stiffness, expected strength, expected deformation capacity, strength reduction factors, design strength for force-controlled actions, expected deformation capacity, reinforcement detailing and independent structural design review.

The requirements are being written to be consistent with related requirements in *ASCE 7-16* and the recently published *TBI – Tall Buildings Initiative – Guidelines for Performance-Based Seismic Design of Tall Buildings*, Version 2.03, Report No. 2017/06, May 2017.

The purpose of the presentation is to provide a snap shot of what is anticipated for inclusion in the 318-19 building code.

Lunch Session

BIM (Building Information Modeling)

William Klorman

Session 3 – Seismic Design of Walls

Moderated by Ken Bondy

Structural walls are widely used as vertical and lateral-force-resisting elements throughout the world. Three presentations in this session will cover the use of walls in three Latin-American countries (Chile, Colombia, and Mexico), followed by a presentation of how ACI 318 might accommodate these international applications.

Presentation 1 – Chile – Use of 318-14 and Walls

Leonardo M. Massone

The Mw 8.8 earthquake in 2010 in Chile provided valuable information regarding the damage and potential design code changes for reinforced concrete (RC) structures. Many modern RC buildings suffered severe damage, mainly in the form of concrete cover spalling, followed by longitudinal boundary bar buckling and concrete crushing. The absence of wall boundary detailing explains such behavior, but older structures and thousands of other buildings suffered minor or no damage at all.
Analyses of some potential factors that influenced the observed damage is carried out and the fundamental principles for the Chilean RC design code changes are exposed. Currently, a displacement-based approach is used for detailing of the wall boundary elements as well as for establishing damage limitation. Compressive concrete strain cannot exceed 0.008, limiting indirectly the axial load, which is one of the potential precursors of the damage. Transversal reinforcement is also provided in zones of potential yielding of the longitudinal reinforcement such that buckling due to compression preceded by tension is minimized; this buckling is more likely in asymmetric cross-sections, such as T-shaped sections, where usually the web goes into larger tensile and compressive strains given the variation of location of the neutral axis for the web under tension or compression.
This presentation will outline the main requirements for design and detailing of structural walls as presented in the Chilean building code, supplemented by recent experimental and analytical studies on structural walls.

Presentation 2 – Colombia – Thin Walls

Carlos Arteta

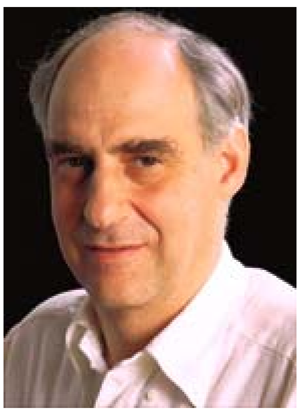
Thin reinforced concrete walls (thickness of 8 to 12 cm) have become a popular building construction practice in Latin America in the last two decades. Several studies indicate that the inelastic deformation capacity could be limited and the level of damage could be severe even at low levels of plastic rotation. Until recently, there is a lack of laboratory test data and practically no field post-earthquake observations related to this construction system.

Recent analytical studies have explored the likely inelastic demands on typical walls in Latin American prototype buildings. These studies have been supplemented by analytical and laboratory studies on the behavior of thin walls.

This presentation will describe the prevalent use of thin walls and present recent research results related to their earthquake resistance.

Presentation 3 – Mexico—318-14 and Walls

Roberto Stark



In the past twenty years, there is an increase trend of including shear walls in concrete buildings in Mexico. Basically for two reasons: the first due to an increase in the number of stories and second due to reduce the lateral displacements.

ACI 318 has a great influence in our practice and Code. Our actual Mexico City Code 2004 is according to ACI 318 – 02; A new version of our Code is about to be published and will have new requirements on special moment frames and walls.

In this talk the main differences will be presented between ACI 318 – 14 and the Mexico City Code. Also some case studies will be presented showing the decision made during the design process and the importance of incorporate shear walls to limit the lateral displacements.

One of the case studies that will be presented is Torre Koi, the tallest building in Mexico. In this structure it was developed a "virtual outrigger" system that used stiff diaphragm slabs and reinforced concrete belt walls at the perimeters of the mechanical spaces at the 21st, approximately 40% of the building height, and the 62nd floor, two stories from below the roof slab. These elements work together as indirect outriggers to transfer part of the overturning moment from the core to the perimeter columns; the stiff floor diaphragms cause the belt walls to tilt and follow the core's rotation. The virtual outriggers efficiently increase structural stiffness without significantly affecting architectural or mechanical layouts. The virtual outrigger system results in a reduction of building period of 20%, a reduction of the core base overturning moment of 25% and a reduction in lateral drift of 30% in the North/South direction over a core only lateral force-resisting system. Reductions in the East/West direction were approximately half of those in the North/South direction.

Presentation 4 – Summary of the Speakers and Where 318-H is Headed

Andrew Taylor

The purpose of this presentation is to synthesize and compare the information presented on seismic design of structural walls by representatives from Chile, Colombia, and Mexico. This will be followed by a discussion of the direction that ACI subcommittee 318H, “Seismic Provisions,” is taking with regard to seismic design of structural walls in the United States. Emphasis will be placed on overall analysis of behavior, and on reinforcement detailing of critical areas, such as special boundary elements, web regions, and the interface between foundations and walls.

Session 4 – New News

Moderated by James Cagley

Structural concrete design is a continually advancing science. Three presentations today will discuss strut and tie modeling, advancements in adoption of high strength reinforcement use in ACI 318, and initial reports from Mexico City's recent earthquake(s).

Presentation 1 – Strut and Tie Update

Lawrence C. Novak

The strut and tie method provides an excellent holistic tool for the straight forward solution of any structural concrete design problem. Traditional sectional design is thoroughly covered in a structural engineering curriculum; unfortunately, typically the strut and tie method is only briefly touched on at the university undergraduate level. Our goal is to demystify the underlying principles behind the design and detailing of reinforced concrete members utilizing the ACI 318-14's strut and tie procedures.

Presentation 2 – High Strength Reinforcing

Dominic J. Kelly

A major effort in the ACI 318-19 code cycle is to introduce the more general use of high-strength reinforcement. The code development effort has been assisted by studies funded by the National Institute of Standards and Technology and a major research program led by Pankow Foundation. Likely Building Code revisions include: new standards for material properties, modification of the net tensile strain limits for beams, and a host of revisions for design of earthquake-resistant buildings.
The presentation will provide an overview of the technical studies and the latest versions of proposed revisions for the ACI 318 Building Code.

Presentation 3 – The 7S and 19S, 2017 earthquakes in Mexico: a first look at their impact

Sergio Alcocer

On September 7th (7S) and 19th (19S), two intra-slab earthquakes affected large portions of the southeast and central regions of Mexico. The M8.2 7S event has been the largest earthquake measured in the country since 1932 and was located 700 km away from Mexico City. This event, formally called the Tehuantepec Earthquake, affected primarily the coastal states of Oaxaca and Chiapas, causing the loss of life of 96 persons. Damage was concentrated in vernacular housing, made of unreinforced masonry and adobe that were destroyed or severely damaged, and in school buildings. Bridges, health facilities, and power and oil refining equipment and installations were also affected. Although shaking was felt in Mexico City and surrounding states, most of the damage was recorded in near epicenter states.

The M7.1 19S earthquake, just 120 km away from Mexico City, is the largest event recorded in recent times at close distance from the capital city (Puebla-Morelos Earthquake). Over 360 people, most of them in Mexico City, died due to building collapse. Less than 1% of the total building inventory of the city was affected with varying degrees of damage. Of the total number of collapsed building, less than 15% were built after the 1985 earthquake that led to a complete overhaul of the city´s building code. Damage is credited to the frequency content and some directivity of the earthquake that excited soil deposits in the range of 1-to-1.5 s. Buildings with vulnerable typologies, such as soft stories, stiffness and strength irregularities (corner buildings) and non-ductile reinforced concrete structures suffered the most. Morelos and Puebla suffered extensive damage in historical monuments, mainly colonial churches, and housing.

During the presentation, an overview of the seismological aspects of the events, as well as of the performance of the built environment (buildings, bridges, aqueducts, power stations, etc.) will be presented. First lessons, from the structural engineering, emergency preparedness and response, and social response points of view will be discussed. Considerations for the communities' reconstruction will be also presented.

Poster Session/Reception

Poster 1 – Retrofit and Revitalization of Historic Southern Pacific Warehouse Building

Eric Velazquez

Alameda Building 3 (AB3) is a 6-story above grade, with a single level below grade reinforced concrete warehouse built by the Southern Pacific Railroad in 1918 located at 757 Alameda St, Los Angeles CA. The floor area of each level was approx. 60500 sq. ft. The structure was framed with a slab-beam-girder system at the northern portion of the building and a joist-beam system at the south end of the structure. The existing structure consisted a space frame as the existing lateral system. Since this structure is considered a non-ductile concrete building it falls under the City of Los Angeles Ordinance 183893 for retrofit of non-ductile concrete buildings. The project was one of the first ones to be reviewed under the mandatory ordinance. The retrofit incorporated four concrete core walls located within the center of the structure to resist 75% of the current code level seismic forces. In addition, the retrofit shall be capable of sustaining drifts associated with 100% of the code level forces.

Poster 2 – Ministry of Taxation, Baku, Azerbaijan

Lizabeth DuBay

The analysis and design of a structurally complex 34-story tower in Baku, Azerbaijan that is currently in construction. The building contains a circular reinforced concrete core wall running the height of the building. Concrete floor slabs rotate at each level resulting in a ~35 degree total rotation of the tower. Five column-free levels in the tower create a series of stacked "cubes" and required the design of a complex gravity load transfer system below each cube that takes load back to the central core wall. The transfer system consists of 8 steel trusses one story tall that cantilever out from the core about 10m and pick up gravity loads at columns on the edge of the slabs. The top and bottom chords of the trusses are SRC beams and the concrete slabs at the top and bottom levels act as a tension and compression diaphragm sharing in the transfer of load back to the circular core wall. PT beams along the perimeter of each floor slab allow for the large spans between columns (~15m) and large cantilevered corners (~8m). Due to the tower being in a high-seismic region and the core wall height restriction per ASCE 7, performance-based seismic design was completed using nonlinear time history analyses of MCE and SLE-level earthquakes for the design of the core wall lateral system.

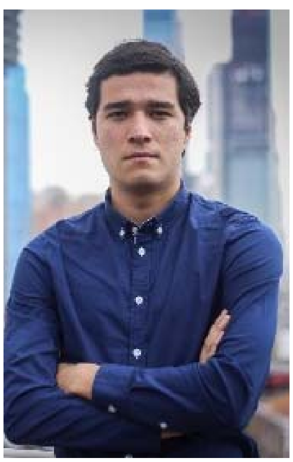
Poster 3 – Westfield University Town Center

Andy Luu

The LEED Gold $550 million Westfield University Town Center in the La Jolla project will add approximately 389,150 square feet of net new retail shops to an existing retail center, as well as two new 5 story parking of a combined 470,000 square feet. The parking garages at Westfield UTC were constrained by several factors: maximum overall building height, tall ADA required minimum clearance standards, and programing elements which dictated a 60ft column spacing. Conventional design would result in either reducing the beam span or increasing the beam depth; neither option was available at UTC. Instead, KPFF developed a post-tensioned structural slab and beam system that could span 60ft while being only 20” deep. We created a detailed finite element analysis model and applied dynamic loads to determine the vibration performance of the proposed design to ensure the long and shallow structure will not have problems with excessive vibration. Using conventionally designed parking garages as a basis, KPFF designed the innovative shallow long span beams to meet or exceed the vibration performance of conventional parking garages.

Poster 4 – Cable Stay Bridge Over the Magdalena River--Colombia

Francisco A. Galvis



A Cable Stay Bridge that is currently under construction in Colombia, the Honda Bridge over the Magdalena river.

The Honda Bridge is a three-span concrete structure with two lateral spans of 79m each and a 247m main span. The latter is one of the longest spans in Colombia. The bridge crosses the Magdalena river, the longest river of our country. The concrete deck is 15m wide supported by two plans of stay-cables anchored in longitudinal concrete girders with 1.40m depth. The bridge has two concrete pylons of 70m and 90m height placed at the flood zone of the river; therefore, extensive scour is expected. In addition, the structure is located in a moderate hazard seismic zone. To reduce the effect of earthquake demands, a passive control system, using viscous dampers and seismic isolators, was designed. The deck is currently under construction using a cast-in-place segmental-cantilever method. Due to the un-balanced nature of the spans, the bridge has two counterweights that received some of the stay-cables.

Poster 5 – Museu do Amanha

Rafael Timerman and Fabricio Gustavo

Museu do Amanhã is the main work of revitalization project of the harbor area of Rio de Janeiro, with a unique location on the old pier, providing a wonderful view in front of Guanabara Bay.
The challenges arising from the bold architecture of Calatrava resulted in a unique structure, also showing a perfect synergy between the steel roof and the concrete structure of the museum.

Poster 6 – SOMA Hotel

Catherine Chen

SOMA Hotel is a new 17-story building located at the corner of 3rd Street and Channel Street in Mission Bay, San Francisco. The structure has a concrete shear wall lateral system, a post-tensioned flat slab gravity system and a piled foundation to address soil liquefaction concerns. SOMA Hotel is one of the first structures approved by the San Francisco Department of Building Inspection through a peer review process to implement the use of high-strength reinforcement, in particular ASTM A706 Grade 80 rebar, in the seismic force resisting system. Currently, ACI-318-11 and ACI 318-14 do not permit the use of high-strength reinforcement (f'c exceeding 60 ksi) to resist earthquake-induced axial and flexure. The poster will highlight how high-strength reinforcement is used in the shear walls, columns, foundations and diaphragms, chords and collectors in the building. The poster will also discuss the concerns raised by the peer review panel and describe the special detailing used to meet and exceed code equivalent performance.