National Earthquake Hazards Reduction Program

… a research and implementation partnership

NIST
Earthquake Risk Mitigation R&D Program Update

Advisory Committee on Earthquake Hazards Reduction

August 18, 2014

nehrp

FEMA

NIST National Institute of Standards and Technology

NSF

USGS science for a changing world

national earthquake hazards reduction program

Presentation Outline

- Overall NIST Program Overview
- Budget Information
- Recent Accomplishments
- Current and Planned Projects
- NIST Response to 2013 ACEHR Recommendations

2015 Administration-Requested NEHRP Agency Budgets

Requested Agency NEHRP Budgets ($M)[1]					
FY	FEMA[2]	NIST[3]	NSF[4]	USGS[5]	NEHRP Total
2015	7.8	3.9	52.2	59.0	122.9

Notes:

1. USGS budget reflects amount requested for USGS NEHRP activities. FEMA, NIST, & NSF budgets reflect planned agency allocations for NEHRP activities from total requested agency appropriations. Budgets shown were reported by agencies as of 05/14/14. Amounts reported to nearest $0.1M.
2. FEMA planned NEHRP budget includes program activities, excluding employee salaries & expenses (S&E).
3. NIST planned NEHRP budget supports all expenses for both NEHRP Secretariat (Lead Agency) and NIST Earthquake Risk Reduction in Buildings & Infrastructure R&D Program.
4. NSF planned NEHRP budget supports program activities, excluding Agency Operations and Award Management (AOAM) costs. Budget includes support for George E. Brown, Jr. Network for Earthquake Engineering Simulation and Global Seismographic Network, but excludes *EarthScope* activities.
5. USGS requested budget supports program activities, including the USGS portion of the Global Seismographic Network ($5.2M).

Overarching Principle

NEHRP Mission

To develop, disseminate, and promote knowledge, tools, and practices for earthquake risk reduction – through coordinated, multi-disciplinary partnerships among the NEHRP agencies and their stakeholders – that improve the nation's earthquake resilience in public safety, economic strength and national security.

Fulfilling the mission requires NEHRP (and NIST) to support the advancement of performance-based design and engineering principles!

Program Management

- Working under priorities established by outside experts:
  - ATC-57 Roadmap
  - NEHRP Five Year Strategic Plan adopted in 2008
  - National Research Council (NRC) roadmap for needed U.S. earthquake risk mitigation implementation activities; completed in 2011
  - Building Seismic Safety Council (BSSC) at National Institute of Building Science (NIBS) roadmap report; completed in 2013
    - Mapped NRC report onto NIST's scope of work
  - NIST engagement through technical committee work with BSSC, AISC, ACI and others

Program Philosophy: The "ATC-57 Roadmap"

- A "…gap between engineering and scientific knowledge and its practical application (for design and construction of economical, earthquake-safe structures) has dramatically widened …"
- "The informational link between theory, research results, and practice is weaker than it should be."

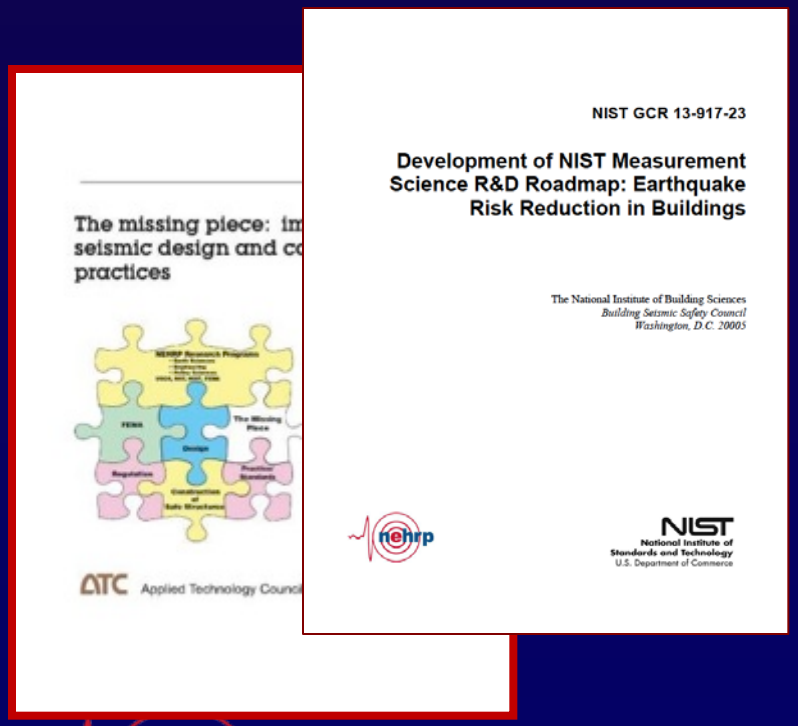
Roadmap Elements

1. Technical support for seismic practice and code development.
2. Problem-focused, user-directed research to support development of performance-based seismic design concepts and guidelines.
3. Problem-focused research and technical resources (*e.g.*, guidelines and manuals) development to improve seismic engineering practice.
4. Evaluated technology made available to practicing professionals in the design and construction communities.
5. Tools to enhance the productivity, economy, and effectiveness of the earthquake-resistant design and construction process.

The ATC-57 Roadmap ➔ The BSSC Roadmap

NIBS/BSSC developed a compressive roadmap of topics for NIST consideration when developing the annual research plan.

Builds on ATC-57 document and on NRC Study



Roadmap Philosophy

- Program should be community-- and needs-driven
- Appropriate evaluations and assessments
- Balanced efforts of government, academic, and private sector to achieve results
- Assess costs and benefits

Additional Program Planning Resources

Specific research needs are identified via interactions with earthquake professional community and review of resource documents, *e.g.*:

- Participation in BSSC PUC and ASCE 7/41
- NEHRP *Recommended Provisions* research needs statement
- AISC TC-9
- ACI 369, 374 and 318

RESEARCH NEEDS
IDENTIFIED DURING DEVELOPMENT OF THE 2009
NEHRP RECOMMENDED SEISMIC PROVISIONS FOR NEW BUILDINGS AND OTHER STRUCTURES

As part of its efforts to regularly update the *NEHRP Recommended Seismic Provisions for New Buildings and Other Structures*, the Building Seismic Safety Council (BSSC) is charged by the Federal Emergency Management Agency (FEMA) to identify research needed to advance the state of the art of earthquake-resistant design and to serve as the basis for future refinement of the *Provisions*. During the project to generate the 2009 edition of the *Provisions*, the various working groups identified specific needed research that was beyond the scope of the 2009 *Provisions* update. Please direct any feedback regarding these research issues to: bssc@nibs.org.

DESIGN AND ANALYSIS

Several items related to the design and analysis requirements of the 2009 *Provisions* require fundamental research based on the methodology outlined in *Quantification of Building Seismic Performance Factors*, FEMA P-695. In addition, specific issues requiring attention if defensible changes are to be made in current requirements include system irregularities (both vertical and horizontal), dual frame systems, strong-column/weak-beam requirements for special moment frames, and importance factors for Occupancy Category III and IV structures.

Among the design and analysis issues identified for attention are the following:

1. With FEMA P-695 now complete and benchmarking of the methodology with several existing system types identified in ASCE/SEI 7-05 Table 12.2-1 (including the requirement that $C_d = R$, which has specific consequences), Design Coefficients and Factors for Seismic Force-Resisting Systems, under way, efforts to simplify Table 12.2-1 are warranted. Envisioned is a table that would be more generically based on anticipated level of ductility (ordinary, intermediate, and special) for all material types (i.e., special, intermediate, and ordinary systems would have the same seismic design coefficient factors regardless of material type). Likewise, the need for the system to be dependent on Seismic Design Category and the need for height limits should be reviewed and verified. Finally, the R factor basis should be verified (i.e., whether seismic designs are best categorized as "life safety" or "collapse"). Clearly, however, the performance goals of nonstructural systems also need to be considered, refined, and modified as necessary to produce the desired results. The determination of the structural performance goals should be based, at least in part, on

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NIST Scope of Work

- External Work Completed by Contractor -- NCJV/ATC
  - TechBriefs
  - Reports

- Internal Work Completed by NIST/NEHRP Staff
- Two Experimental Projects at Outside Laboratories
- Technical Committee Activity
- Outreach

NIST Research Portfolio Summary

- TechBriefs:
  - TO 3/TechBrief 1 *Concrete Moment Frames*
  - TO 3/TechBrief 2 *Steel Moment Frames*
  - TO 7/TechBrief 3 *Reinforced Concrete Diaphragms*
  - TO 8/TechBrief 4 *Nonlinear Analysis*
  - TO 14/TechBrief 5 *Concrete on Metal Deck Diaphragms*
  - TO 15/TechBrief 6 *Reinforced Concrete Shear Walls*
  - TO 24/TechBrief 7 *Concrete Mat Foundations*
  - TO 29/TechBrief 8 *Steel Concentric Braced Frames*
  - TO 35/TechBrief 9 *Special Reinforced Masonry Shear Walls**
  - TO 36/TechBrief 10 *Wood Light-Frame Structural Diaphragms**

    **completion by September 30*
  - TO 40/TechBrief 11 *Buckling Restrained Braced Frames (FY2015)*

NIST Research Portfolio Summary

- Completed Projects since 2011:
  - ATC 76-2/TO 2 *Ports and Harbors* (2012)
  - ATC 82/TO 9 *Scaling EQ Ground Motions* (2011)
  - ATC 83/TO 10 *Soil-Structure Interaction* (2012)
  - ATC 76-1/TO 11 *Quantification of Building System Performance and Response Parameters (2012)*
  - ATC 90/TO 17 *Research Plan for Study of Seismic Behavior and Design of Steel Beam-Columns (2011)*
  - ATC 92/TO 19 *US-Chilean Building Code Comparison (2012)*
  - ATC 93/TO 20 *Chilean Building Damage Repository (2012)*

NIST Research Portfolio Summary

- Recently Completed Projects:
  - ATC 94/TO 21 — *Recommendations Seismic Design Concrete Wall Buildings – Chile (2014)*
  - ATC 95/TO 22 — *Collapse Assessment of Existing Nonductile Reinforced Concrete Buildings (2013)*
  - ATC 96/TO 23 — *Nonlinear Analysis Study & Development Program for PBSE (2013)*
  - ATC 98/TO 25 — *Use of High Strength Reinforcing Steel (2013)*
  - ATC 101/TO 27 — *Update Plan for Post-EQ Investigations (2013)*
  - ATC 102/TO 28 — *Research Plan for EQ Resilient Lifelines (2014)*
  - ATC 105/TO 31 — *NEHRP FY12 Annual Report (2012)*
  - ATC 108/TO 34 — *Cost-Benefit Analysis of…EQ Resistant Construction – Central US (Memphis) (2014)*

NIST Research Portfolio Summary

- Notable Continuing Projects:
  - ATC104/TO 30 *NIST Slender Structural Wall Research Program*
    - *Testing at ERDC/CERL*
    - *Peer Oversight Through ATC*
    - *Analysis by NIST*
  - ATC 106/TO 32 *Deep Slender Steel Beam-Columns*
    - *Testing at UCSD*
    - *Analysis by NIST*

NIST Research Portfolio Summary

- External Projects Underway – FY 2014:
  - ATC 113/TO 37 –*NEHRP FY13 Annual Report*
  - ATC 114/TO 38 – *Analysis, Modeling and Simulation for PBSE - Evaluation of ASCE 41 Technical Approach*
  - ATC 115/TO 39 – *Evaluation and Updates for ASCE 7 Concerning Nonstructural Systems*

- New Proposed External Projects – FY 2015
  - *Updates for TechBriefs1-3 and ICSSC RP 8*
  - *Performance Assessment of Ordinary RC Columns*
  - *Ultimate Strength Design of Shallow Foundations*
  - *NEHRP FY14 Annual Report*

NIST Response to 2013 ACEHR Recommendation

- ACEHR Recommendation: Develop a Building Performance Rating System That Can Stimulate Mitigation Activities

The Committee recommends that a building performance rating system be developed and implemented, and that to accomplish this, NIST should make the development of required tools and standards a priority, and FEMA should make implementation of the system a priority.

NIST Response to 2013 ACEHR Recommendation

- FEMA/NIST Response:

FEMA began examining the issue of developing building performance rating systems several years before the ACEHR made this recommendation, so it was appropriate to engage FEMA in the NEHRP response to the recommendation. FEMA has produced a substantial white paper, *NEHRP Response to 2013 ACEHR Recommendation Regarding Building Rating Systems*, on this topic that is included at the end of this document. The white paper includes brief discussion of related NIST activity.

Snapshots

Highlighted Completed External Projects

- ATC-89 / TO 16/34 Cost-Benefit Analysis of Codes and Standards for Earthquake-Resistant Construction in Central US – Memphis
  - Project conducted comparative design and cost evaluation:
    - **3-story apartment building, wood**
    - **1-story large warehouse, tilt-up**
    - **1-story box retail, tilt-up**
    - **4-story office building, steel braced frame**
    - **5-story hospital, concrete shear wall**
    - **1-story reinforced masonry school building**
  - Results showed ~3% or less cost increase for design using ASCE 7 seismic provisions versus design for wind alone.
  - Report sent to local engineers supporting efforts for adoption of 2012 IBC Seismic Provisions in Shelby County -- successful Fall 2013.
  - A *major cooperative effort* of USGS + FEMA + NIST

Highlighted Completed External Projects

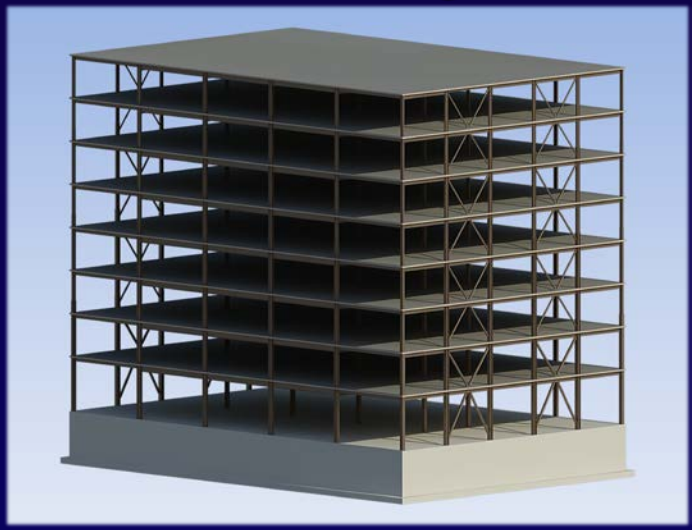
- ATC 82/TO 9 *Improved Procedures for Selecting and Scaling Earthquake Ground Motions for Performing Time-History Analyses*
  - Used in development of new chapter on Nonlinear Response History (ASCE 7 Ch. 16) in 2015 NEHRP provisions. ASCE 7-16 subcommittee removed that portion during transferring from PUC to ASCE 7.
- ATC-83/TO 10 *Improved Procedures for Characterizing and Modeling Soil-Structure Interaction for Performance-Based Seismic Engineering*
  - Portions on kinematic interaction adopted in ASCE 7-16 and ASCE 41-16

Highlighted Completed External Projects

- ATC-84/TO 11 *Quantification of Building System Performance and Response Parameters*
  - Used as the basis for a Part 3 resource paper in the 2015 NEHRP provisions
  - Being used as basis for evaluation of seismic performance objectives

Highlighted Active Internal Projects

- Assessment of First Generation Performance-Based Design Methods for New Concrete and Steel Buildings



- *Major* Project Completed for Steel Buildings:
  - 18 Buildings Designed per ASCE 7-10
  - 4, 8, and 16-story SMF, SCBF, EBF
    - SDC D_{max} and D_{min}
  - D_{max} assessment per ASCE 41
  - Three reports completed and now under final editorial review.
  - Publication by October 1.

What is the research plan?

Design a suite of structures using ASCE 7

- Develop archetypes
  - Risk category II – Ordinary Use
  - SCD: D_{max}
  - 4, 8 and 16-story buildings
  - Steel – SMFs (finished)
  - Steel – SCBFs (finished)
  - Steel – EBFs(finished)
  - Steel – BRBFs
  - RC – SMFs
- Design two different ways:
  - ELF
  - RSA

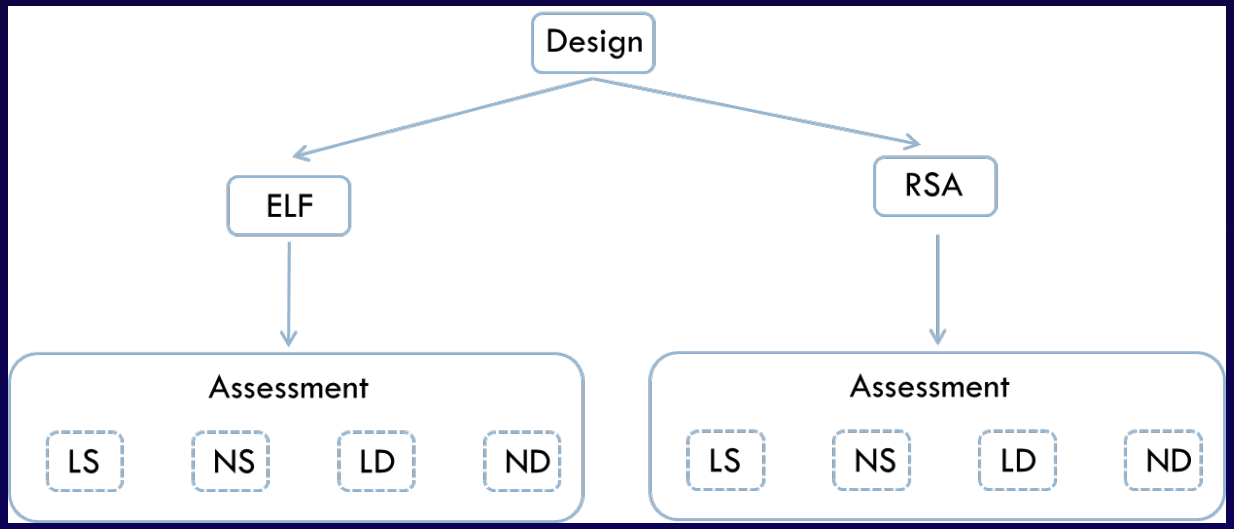
Assessment of designs using ASCE 41

- Use prescribed analysis methods and acceptance criteria
- Heavy emphasis on nonlinear dynamic modeling and analysis to evaluate building performance beyond ASCE 41

Expected Major Outcomes

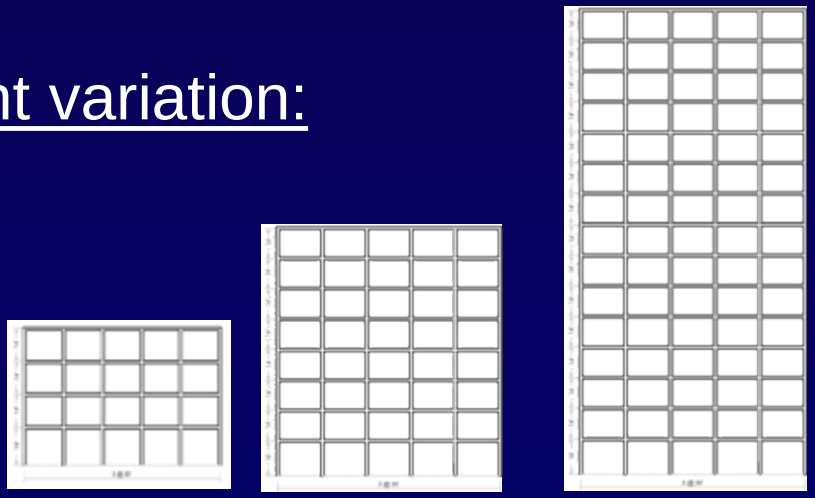
- Correlate performance objectives between ASCE 7 & ASCE 41
- Quantify implied target performance levels
- Compare the results of the four ASCE 41 analysis method results
- Provide input to future ASCE 7 & ASCE 41 editions

Two design and four assessment approaches for each building:



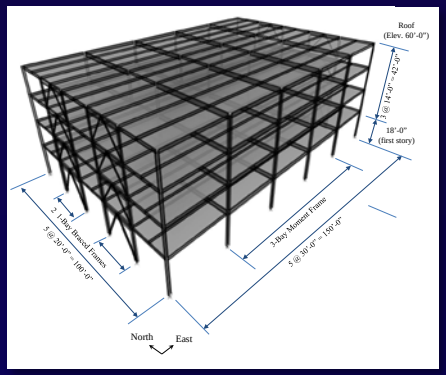
Building height variation:

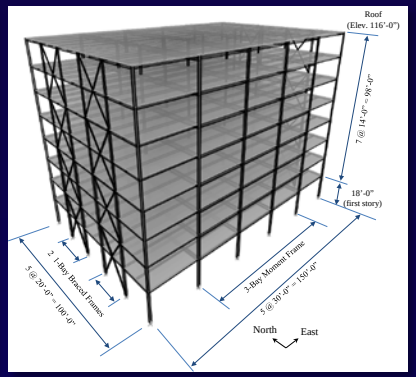
4, 8 and 16 stories

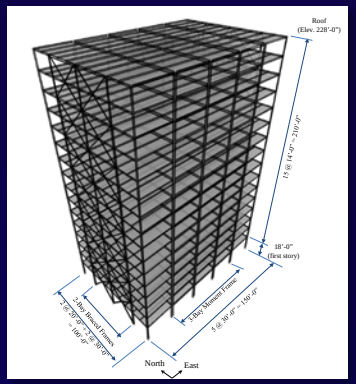


What are the results?

3 volume NIST-TN submitted for final editorial review.







BSO Performance Summary of Archetype Buildings, Linear Procedures

Archetype	Design	LSP BC	LSP CM	LSP PZ	Design	LDP BC	LDP CM	LDP PZ
4-Story	**ELF**	**Fail**	Pass	Pass	ELF	Pass	Pass	Pass
	RSA	**Fail**	Pass	Pass	**RSA**	**Fail**	Pass	Pass
8-Story	**ELF**	Pass	**Fail**	Pass	**ELF**	Pass	**Fail**	Pass
	RSA	**Fail**	**Fail**	Pass	**RSA**	Pass	**Fail**	Pass
16-Story	**ELF**	Pass	**Fail**	Pass	ELF	Pass	Pass	Pass
	RSA	**Fail**	**Fail**	Pass	**RSA**	**Fail**	**Fail**	Pass

BSO Performance Summary of Archetype Buildings, Nonlinear Procedures

Archetype	Design	NSP BC	NSP CH	NSP PZ	Design	NDP (based on mean of set) BC	NDP CH	NDP PZ
4-Story	ELF	Pass	Pass	Pass	ELF	Pass	Pass	Pass
	RSA	**Fail**	Pass	Pass	**RSA**	**Fail**	Pass	Pass
8-Story	**ELF**	Pass	**Fail**	Pass	**ELF**	**Fail**	**Fail**	Pass
	RSA	Pass	**Fail**	Pass	**RSA**	**Fail**	**Fail**	**Fail**
16-Story	ELF	Pass	Pass	Pass	ELF	Pass	Pass	Pass
	RSA	Pass	Pass	Pass	**RSA**	**Fail**	**Fail**	Pass

Analytical results based on component-level performances indicate that **new steel buildings** designed in accordance with ASCE 7 have **difficulty achieving** the ASCE 41 BSO for an existing building intended to be equivalent to a new building.

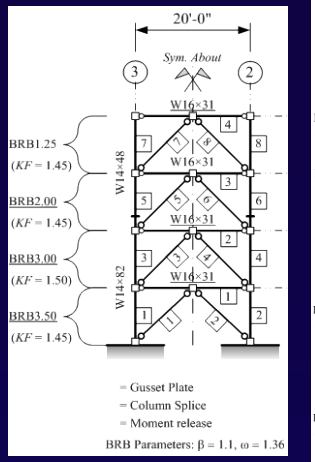
What is the next phase?

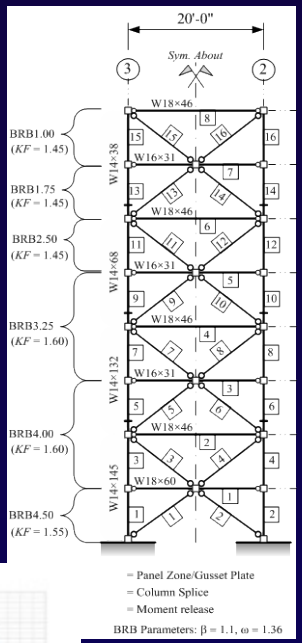
Examine Performance of BRB Steel Frames Using Same Process

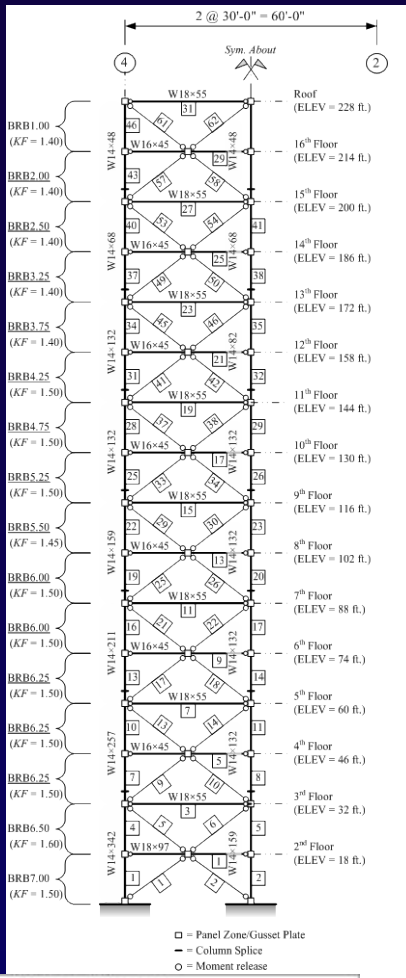
Completed design of 6 BRBF (two 4, 8, and 16-story frames) (Speicher)

- Industry experts consulted to ensure solid design approach
- VBA design tool to assist in capacity design and preliminary assessment of frame

Q4: Complete ASCE 41 assessment of 6 BRBF (anticipated) (Speicher)







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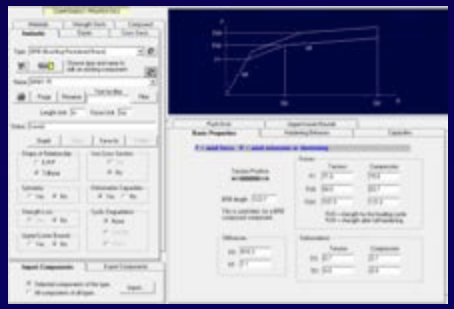

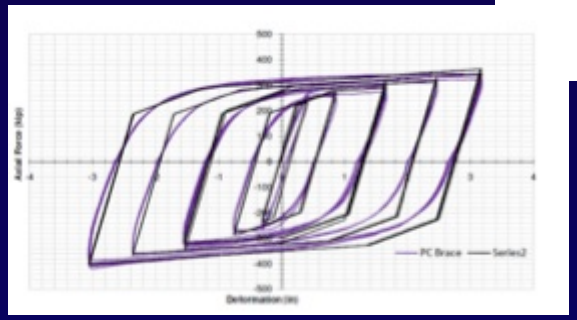

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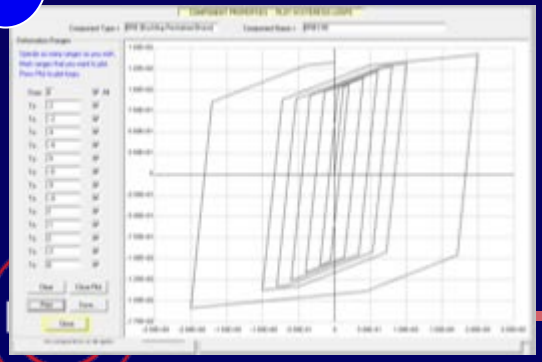

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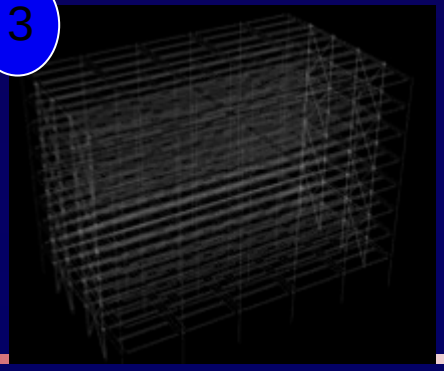

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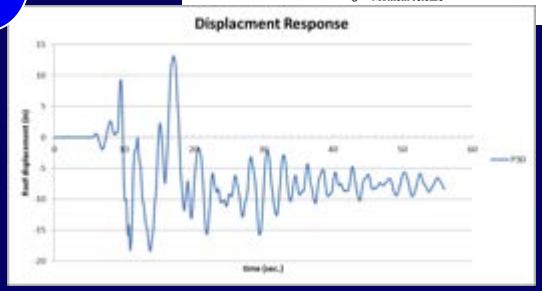


Next phase – concrete

- Assessment of First Generation Performance-Based Design Methods for New Reinforced Concrete Buildings
  - Designing a suite of moment frame buildings per ASCE 7-10 with evaluation against ASCE 41
  - Design space of 4, 8, and 16 story 3D frames; D_{min} and D_{max} SDC
  - Using same building footprint as steel buildings and same overall procedures
  - Completion end of FY2015

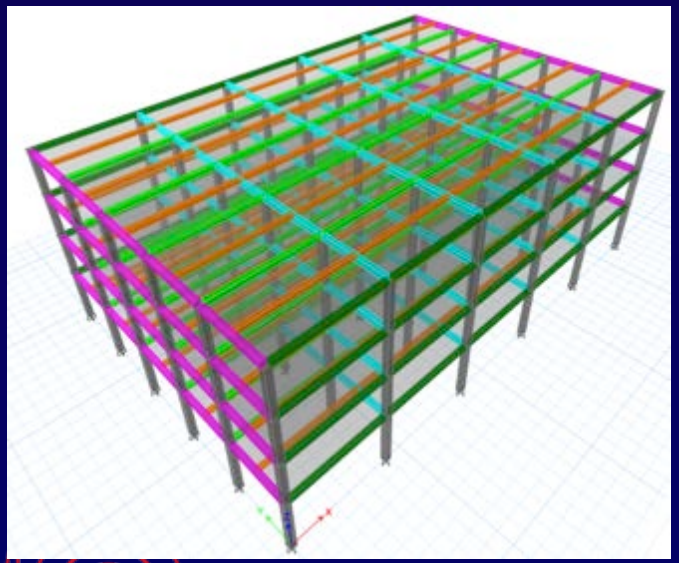
What is the research plan?

FY 2014 Milestones

Q3: Completed design of 4-story RC SMF building

- 4-story building
- Space special moment frame
- Configuration => follows the previous study conducted on steel frames
- ASCE 07-10 and ACI 318-11

Q4: Complete ASCE/SEI 41 assessment of 4-story RC SMF building (anticipated)

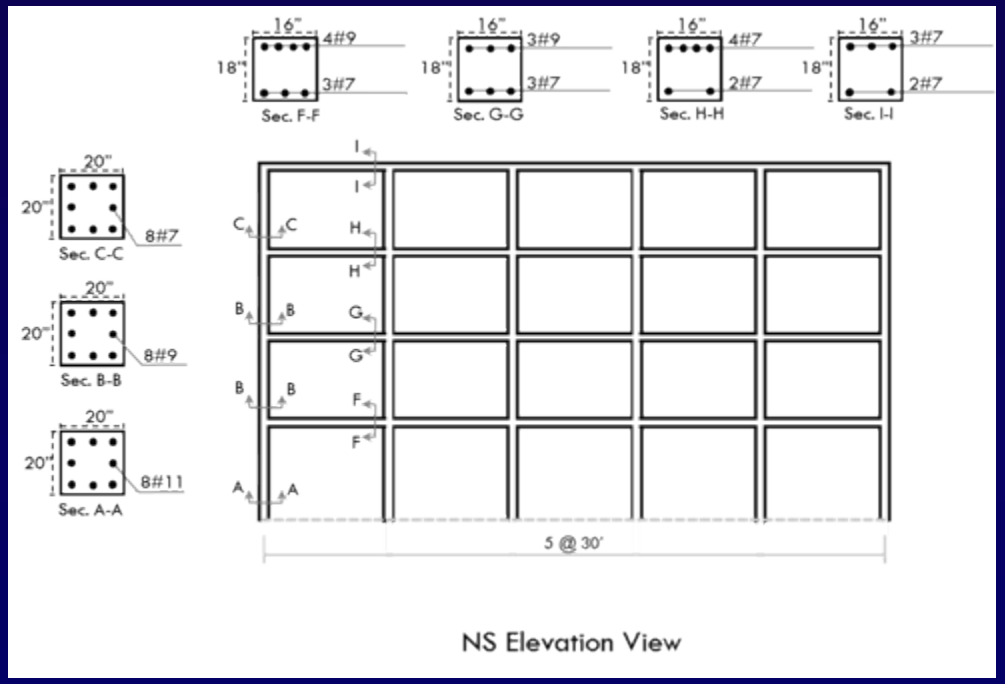


FY 2015 Planned Milestones

Q1 : Complete design and nonlinear modeling of the 8-story RC SMF building.

Q3 : Complete design and nonlinear modeling of the 16-story RC SMF building.

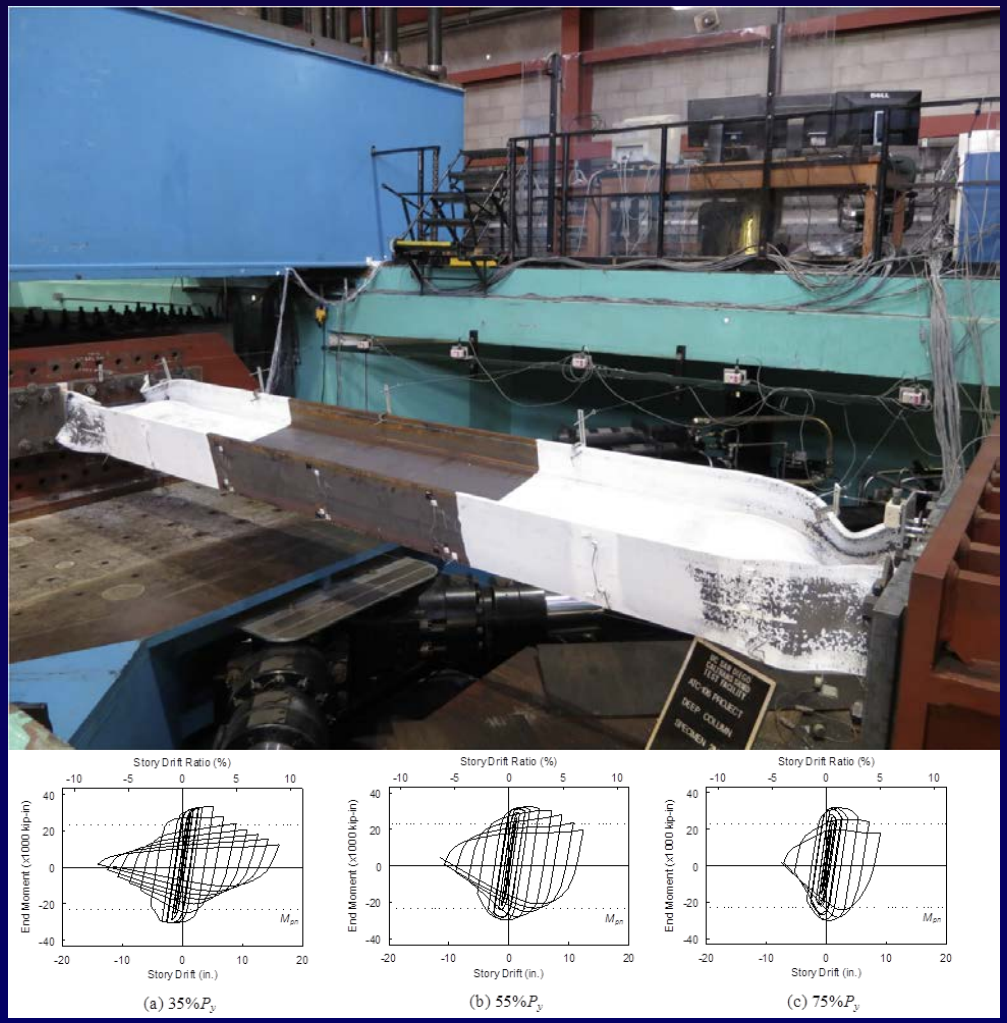
Q4 : Complete ASCE/SEI 41 assessment of the 16-story RC SMF building.



Highlighted Active Internal Projects

Stability of Steel Wide-flange Beam-Columns in Seismic Loading

Objective: This project will develop accurate behavioral models and corresponding design rules for deep, slender wide-flange steel beam-columns in earthquake-resistant construction and for base plate connections that attach them to the supporting foundation. The models developed will assist designers in characterizing the earthquake behavior of these components, as required for advanced Performance Based Seismic Engineering (PBSE) design methodologies.

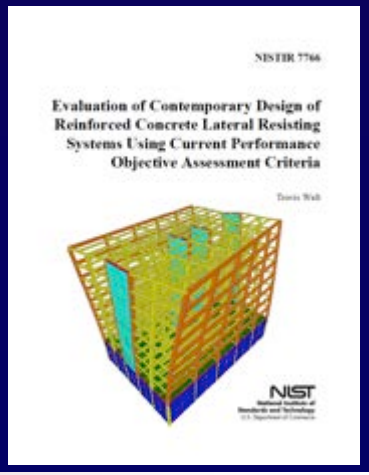


The Plan:

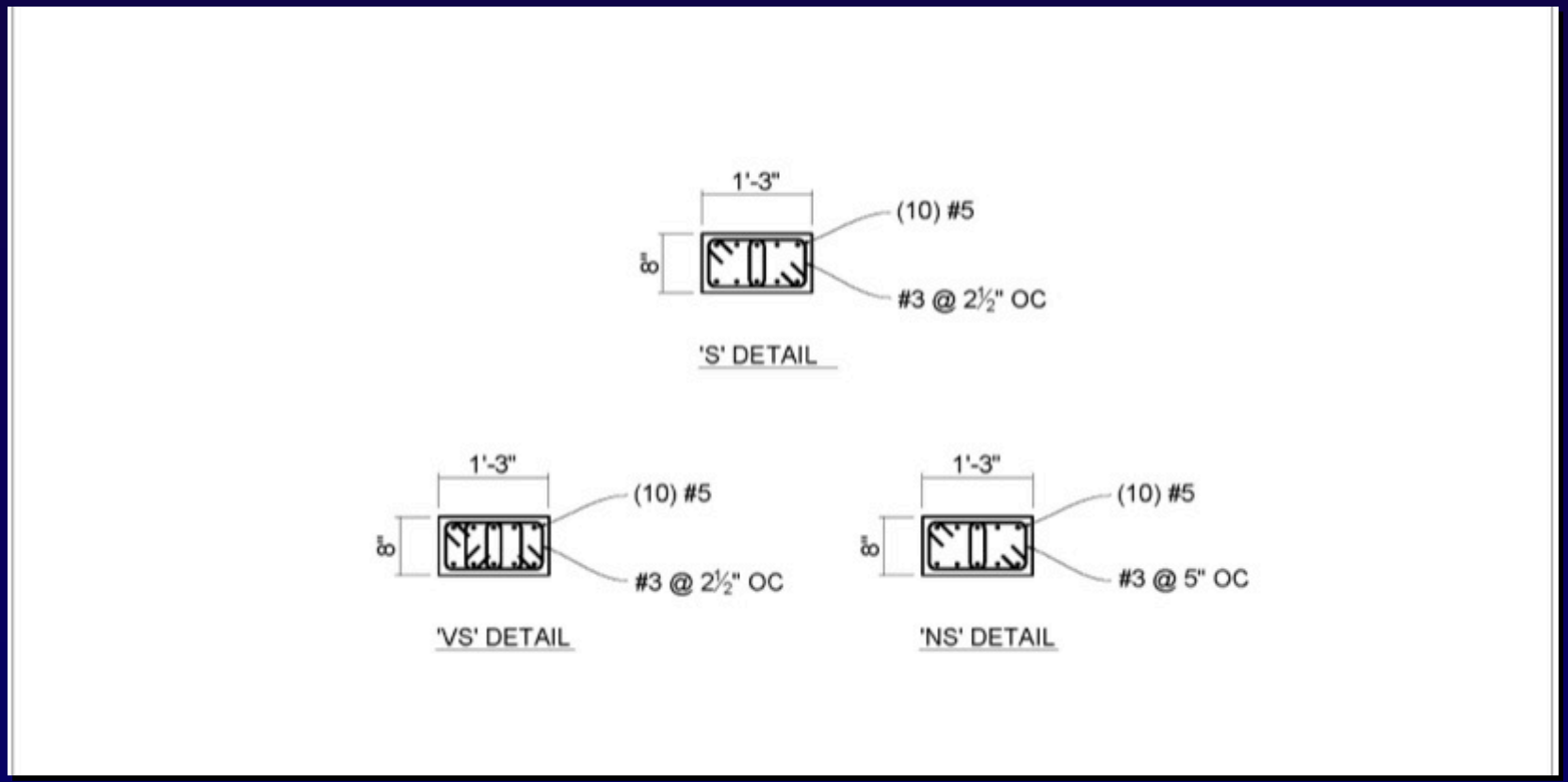
- Test twenty (20) deep beam-column members considered to be stability-sensitive at large deformations (ATC-90/TO 17)
  - UCSD to conduct full-scale tests with completion in FY2015
  - Fixed-fixed idealized boundary conditions
  - Only two-dimensional loading effects addressed in this project.
- NIST will utilize advanced finite element analysis to supplement full-scale experiments to validate test results and design and modeling recommendations for the plastic hinge(s) and base plates.
- Validated computer models will be used to analytically evaluate additional specimens not tested.
- Project will report both analytical and experimental results.
  - All data will be archived in the NEES Data Repository for use by researchers, code developers and practitioners.

Highlighted Active Internal Projects

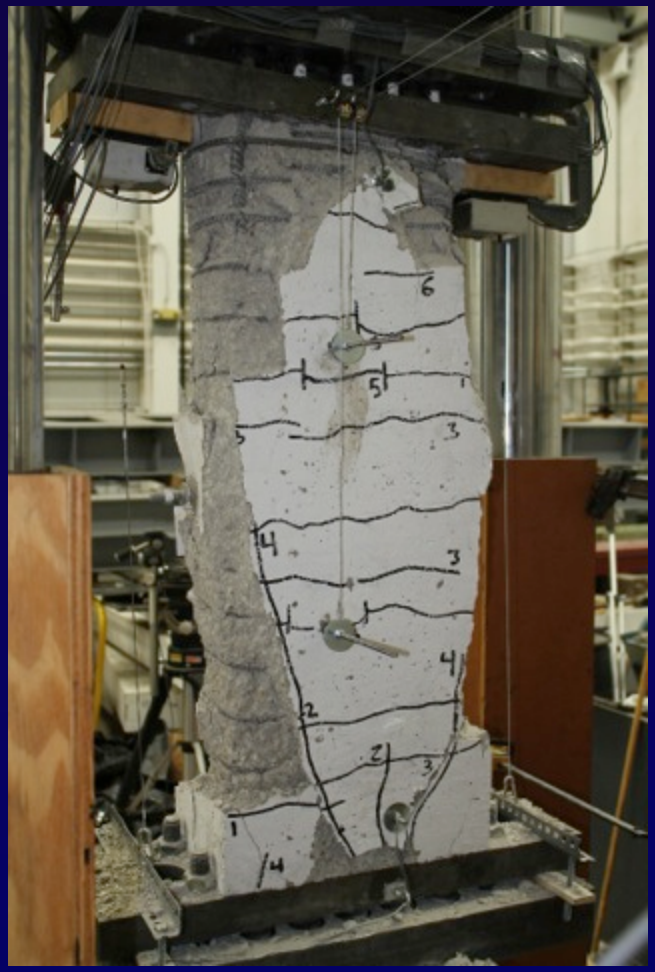
- Seismic Response of Slender Reinforced Concrete Structural Walls
  - Aimed at improved and validated wall modeling capabilities for the engineering community
  - Partially driven by the 2010 Chilean experience
  - Test program supplemented by analytical work using FEA
  - Well coordinated experimental program
  - Wall and prism tests to assess parameter sensitivity (slenderness, tension excursions, axial stress, confinement)
  - Data uploaded to NEES Data Repository



Effects of Confinement -- Prisms



‘VS’ vs. ‘VS-a’



‘VS’

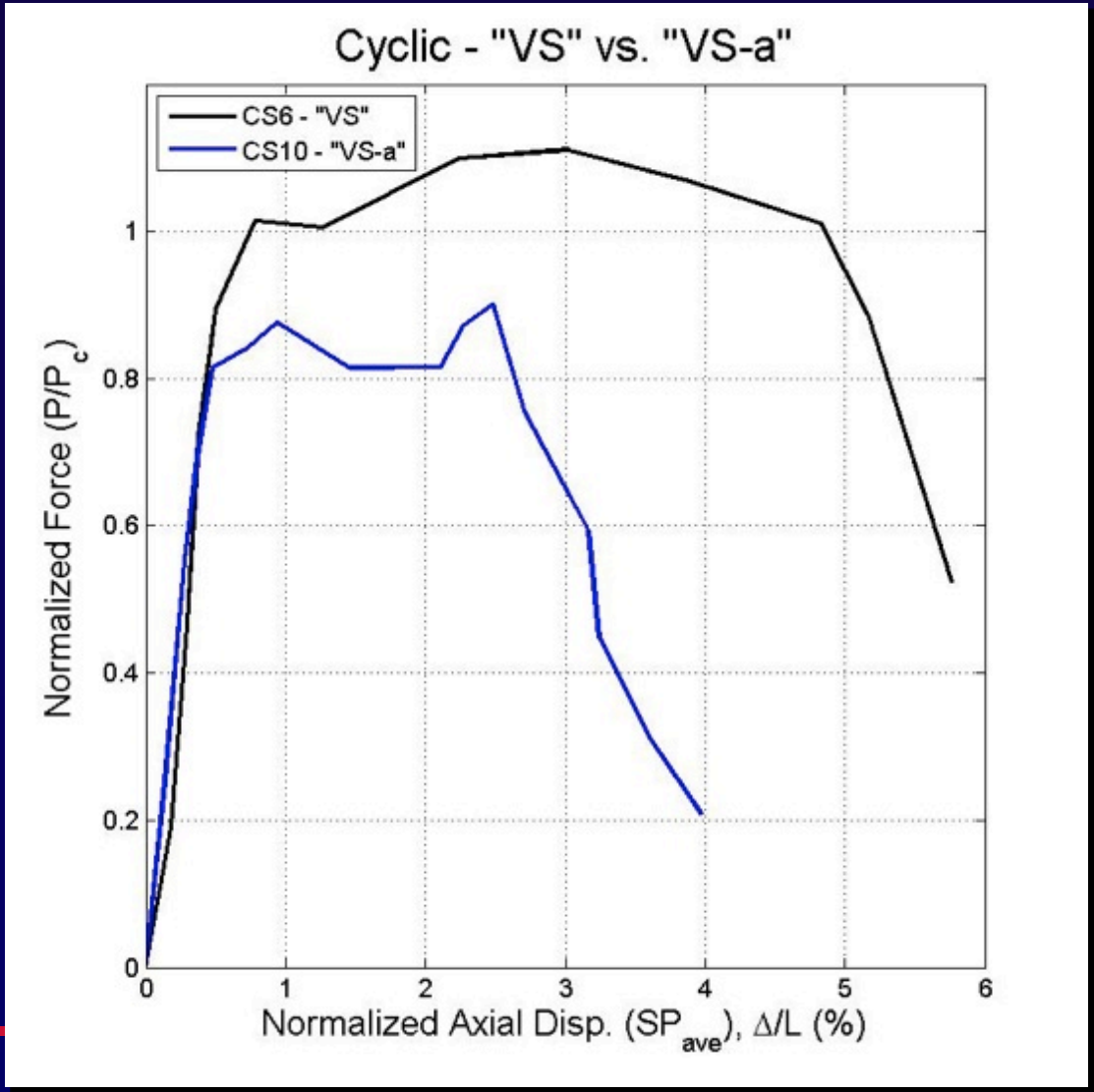
‘VS-a’

‘VS’ vs. ‘VS-a’

‘VS’

‘VS-a’

‘VS’ vs. ‘VS-a’


Cyclic - "VS" vs. "VS-a"
CS6 - "VS"
CS10 - "VS-a"
Normalized Force (P/P$_c$)
Normalized Axial Disp. (SP$_{ave}$), Δ/L (%)
0
0.2
0.4
0.6
0.8
1
0
1
2
3
4
5
6

Half-scale Wall Tests Coming Soon

Proposed External/Internal Project:

Performance of Ordinary Reinforced Concrete Columns under Axial and Seismic Loading

Performance of Ordinary Reinforced Concrete Columns under Axial and Seismic Loading

- Develop new analytical models for the determination of ordinary reinforced concrete column performance under significant levels of axial and cyclic lateral loading.
- The goal is to provide a means to identify performance up to collapse for use in structural evaluation.
- The models will assist designers in characterizing earthquake behavior of ordinary RC columns in new and existing buildings.
- Required for advanced Performance Based Seismic Engineering (PBSE) design methodologies including those found in ASCE/SEI 41.
- Directly connects with ongoing work at FEMA and in LA by USGS

Background Information/Motivation

- What is an ordinary Reinforced Concrete column?
  - A concrete column with “relaxed” confinement detailing requirements

- Why ordinary columns are important for study?
  - Susceptible to shear/axial failure
  - Widely used in the US, especially in low to
  - moderate seismic zones.

- Motivation:
  - Improve shear/axial failure modeling of ordinary columns
  - Important for PBSE evaluation/design of ordinary RC columns and assessment of existing columns.

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- Several models have been developed to simulate:
  - Shear failure: *Vecchio and Collins (1986), Lehman and Moehle (1998), Szen and Moehle (2002), Elwood and Moehle (2004), Ghannoum and Moehle (2012), Baradaran Shoraka and Elwood (2013)*
  - Axial failure: *Elwood and Moehle (2004), Ghannoum and Moehle (2012), Baradaran Shoraka and Elwood (2013)*
- Challenging issues:
  - How well each model can predict shear/axial failure of ordinary columns
  - Recent studies showed the need for improvement of shear and axial failure models for nonductile RC columns (Sattar 2013, ATC-78)

Project is conducted in two phases:

- Element level:
  - Goal:
    - Assess/improve the shear/axial load failure prediction of RC columns

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- System Level:
  - Goals:
    - Improve the understanding of the system response
    - Identify possible improvements of the shear/axial load failure model
    - Improve/evaluate the definition of collapse

In Summary

- Significant progress
- External projects
- Internal projects
- Committee and publications
- Important accomplishments and impact
- Busy days

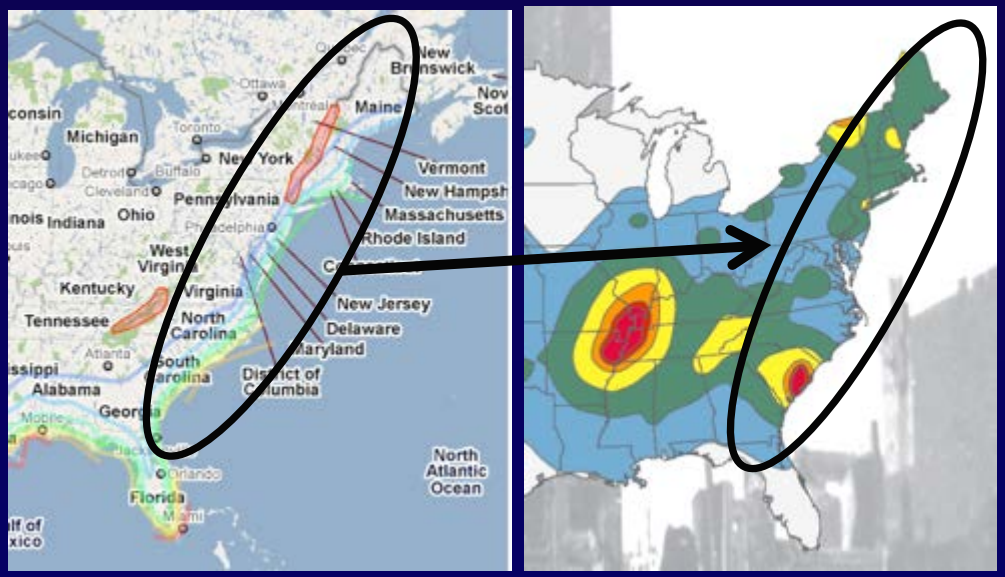
Additional Background Information

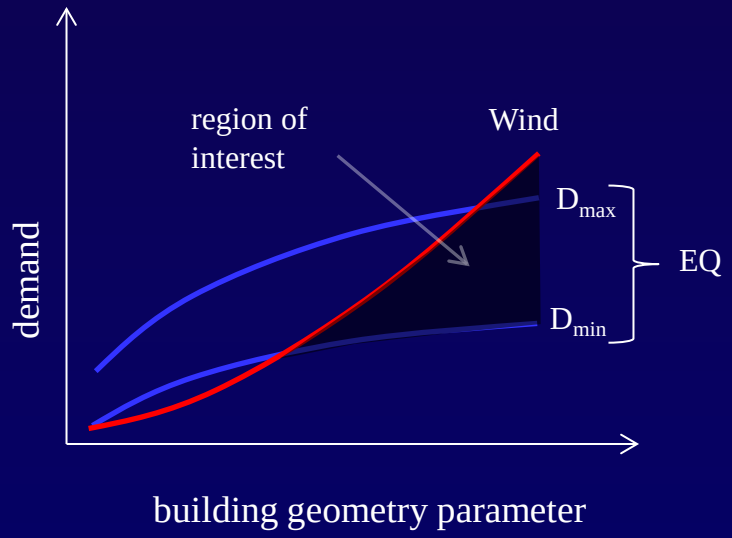
- Other Projects
- NEHRP Staff at NIST
  - Technical Committees and Publications
- Examples of the Connection of Projects to the Program Elements
- ARRA Grant Activity

Other Active Internal Projects

- Seismic Design of Wind Load-Controlled Buildings
  - Objective: Investigated the design of buildings in moderate seismic zones whose design is controlled by wind loads
  - Technical Paper on this work in progress

Wind **Seismic**





Other Active Internal Projects

- Lateral Force Distribution Procedures for Structural System Design
  - Objectives:
    - Develop rules for the distribution of lateral forces based on structural irregularities – vertical and horizontal
    - Develop improved approximate period relationship
  - Work began mid-FY14 and is underway
  - NEHRP interns doing the heavy lifting

Completed External Projects

- ATC-93/TO 20: Ground Motion and Building Performance Data from the 2010 Chile Earthquake
  - Developed a data repository to archive important information for building performance
  - Provide an intuitive, searchable system (keyword, geospatial)
  - Leveraged the Purdue - NEES HUB data experience
  - Prototype for Disaster and Failure Studies Program data system
  - Currently contains over 30,000 photos, ground motion data, 198 earthquake data for buildings, non-copyrighted documents
  - Significant step forward in post-earthquake data collection

Typical Database Page

Map **Chile Earthquake Database : Essential Building Data**

Show All entries — First Previous Next Last — Search:

Structure ID	Building Name	Main Building Photo	Address	City	Lat. [degrees]	Long. [degrees]	Earthquake Name	Photographs	Stories above Ground	Typ. Plan Shape	General Drawings
61	ANCONA		65, 7 NORTE, Vina del Mar	Vina del Mar	-	-	Maule.Chile.2010	Launch Gallery	9	rectangular	first_story_plan.pdf
61	ANCONA		65, 7 NORTE, Vina del Mar	Vina del Mar	-	-	Valparaiso.Chile.1985	Launch Gallery	9	rectangular	first_story_plan.pdf
121	BCO. CONCEPCION		112, ECUADOR, Vina del Mar	Vina del Mar	-	-	Valparaiso.Chile.1985	Launch Gallery	6	rectangular	first_story_plan.pdf second_story_plan.pdf
179	Condominio Alto Rio		776, Arturo Prat,	Concepcion	-36.827949	-73.061822	Maule.Chile.2010	Launch Gallery	15	rectangular	PL-22-ELEV-5 (in Spanish).dwg PL-23-ELEV-8 (in Spanish).dwg
246	Condominio Bosque Mar			San Pedro de La Paz	-36.885822	-73.150838	Maule.Chile.2010	Launch Gallery	-	-	-
187	Condominio Los Reyes de Huechuraba			Santiago	-33.346823	-70.670983	Maule.Chile.2010	Launch Gallery	8	rectangular	-
241	Condominio Sol Oriente			Santiago	-33.475847	-70.600575	Maule.Chile.2010	Launch Gallery	-	-	-
108	CONJ. HAB. LIMACHE			Vina del Mar	-	-	Valparaiso.Chile.1985	Launch Gallery	7	-	-
175	CONJ. HAB. LIMACHE	-		Vina del Mar	-	-	Valparaiso.Chile.1985	Launch Gallery	5	rectangular	typical_plan.pdf
212	Conservador de Bienes Raices		Mar	Vina del Mar	-33.014033	-71.550671	Maule.Chile.2010	Launch Gallery	5	rectangular	-
206	Edificio Concepto & Estilo Concepcion		1255, Freire, Concepcion	Concepcion	-36.822137	-73.043744	Maule.Chile.2010	Launch Gallery	20	rectangular	-

Structure ID | Con | Main Building Ph | Address | City | Lat. | Long. | Earthquake Name | Photographs | Stories above G | Typ. Plan Shap | General Drawings

Show All entries — Showing 1 to 11 of 11 entries (filtered from 306 total entries) — First Previous Next Last

nehrp

national earthquake hazards reduction program

Cold Formed Steel Shear Wall Research Program – Publication of Results

- Conducted at US Army Corps of Engineers Construction Engineering Research Laboratory
- Comprehensive test program looking at lateral load performance of CFS wall systems
- Report provides data comparisons against building code and AISI design equations.
- NIST funded completion of report and data upload to NEES Data Repository

NEHRP Crew

- The Secretariat

Jack Hayes (Our Leader)

Tina Faecke

Felicia Johnson

NEHRP Crew

Jay Harris

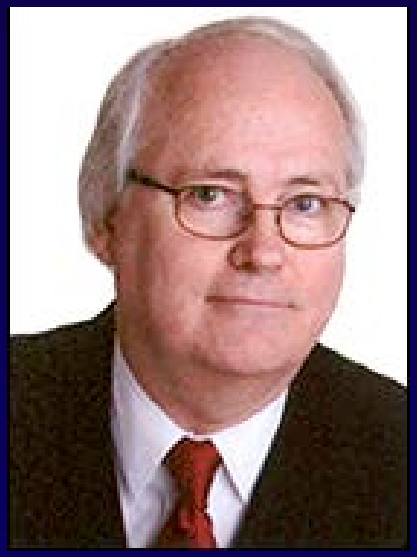
Kevin Wong

Matthew Speicher

NEHRP Crew

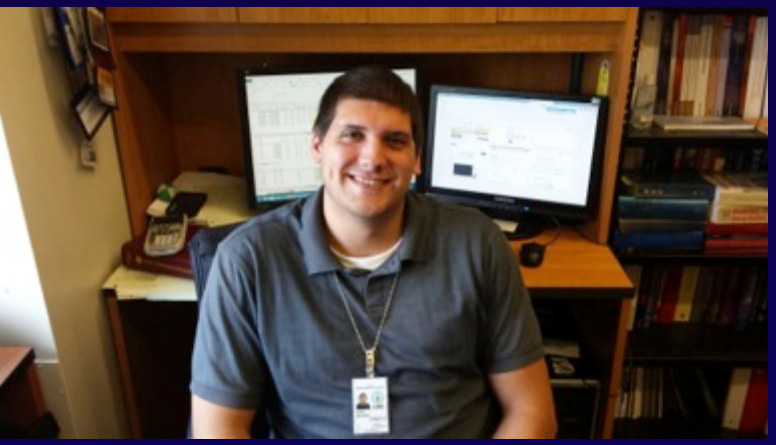
Matt Hoehler

Siamak Sattar



Steve McCabe

NEHRP Crew– The Interns



Mark Solorio
Stanford
Lateral Force Distribution Project

Jeffrey Michel
Texas A & M
Approximate Period Project

Anne Hulsey
UT Austin
ASCE 41 Project

Technical Publications and Committee Work

Jay Harris:

- ASCE 7 *General Provisions, voting member*
- ASCE 41 *Steel Subcommittee* and AISC TC-9 *Ad-hoc committee on ASCE 41, chair and voting member*
- AISC *Committee on Manuals and Textbooks, Seismic Sub-committee M5, voting member*
- NEHRP Provisions Update Committee as the NIST Representative
- Three NIST Technical Reports under final review:
- Assessment of First Generation Performance-Based Design Methods for New Steel Buildings
  - Volume 1: Special Moment Frames
  - Volume 2: Special Concentrically Braced Frames
  - Volume 3: Special Eccentrically Braced Frames

Technical Publications and Committee Work

Jay Harris:

Papers from 10NCEE in Anchorage:

- *RECOMMENDED MODIFICATIONS TO THE SEISMIC ASSESSMENT PROVISIONS FOR STEEL FRAMES IN ASCE 41*
- *ATC-84 PROJECT: IMPROVED SEISMIC PERFORMANCE FACTORS FOR DESIGN OF NEW BUILDINGS*

Technical Publications and Committee Work

- Matt Hoehler:
  - Associate member of American Concrete Institute (ACI) Committee 355 “Anchorage to Concrete”
  - Member of the International Federation for Structural Concrete (fib) Special Activity Group “Fastenings to concrete and masonry”
  - Contributor to European Committee for Standardization (CEN) Working Group for the Technical Specification “Design of fastenings for use in concrete”

Technical Publications and Committee Work

Matthew Speicher:

- Associate Member, ASCE 41 Steel Subcommittee and Analysis Subcommittee

- Three NIST Technical Reports under final review:
- Assessment of First Generation Performance-Based Design Methods for New Steel Buildings
  - Volume 1: Special Moment Frames
  - Volume 2: Special Concentrically Braced Frames
  - Volume 3: Special Eccentrically Braced Frames

Technical Publications and Committee Work

- Kevin Wong:
- ASCE 41 – Associate Member Analysis Subcommittee
- SEI Seismic Effects Committee – Member
- 1 NIST Technical Note (in review)
- Book: "*Theory of Nonlinear Structural Analysis*," John Wiley & Sons, 2014.
- Journal Papers:
- **"**Seismic Fragility and Cost Analyses of Actively Controlled Structures,*" The Structural Design of Tall and Special Buildings*, 2013.
- "Performance-Based Evaluation and Strengthening of Tall Buildings in the Los Angeles Region by Using Bayesian Structural Reliability," *The Structural Design of Tall and Special Buildings,* 2014.
- Conference Papers
- "Evaluation of Computational Tools for Performing Nonlinear Seismic Analyses of Structural Collapse," Structures Congress 2013
- "A New Analytical Method for Solving Nonlinear Stability Problems of Framed Structures," Annual Stability Conference (AISC) 2014

Technical Publications and Committee Work

Steve McCabe:

ACI 369 Seismic Retrofit

ACI 374 Performance Based Design

ASTM A01.05 Steel Reinforcement

Paper from 10NCEE in Anchorage:

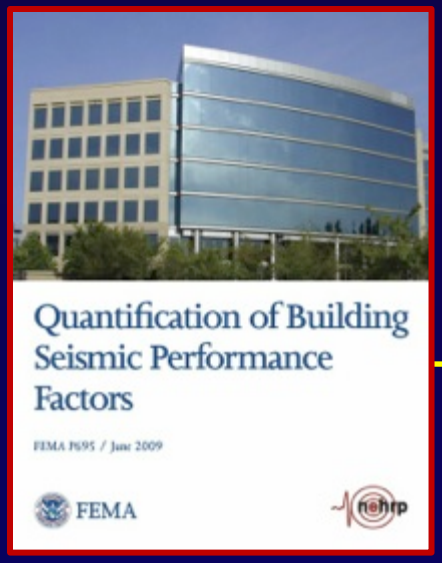
- *PERFORMANCE OF SLENDER REINFORCED CONCRETE WALLS UNDER SIGNIFICANT LATERAL LOADS*

Examples of How Projects Connect with Roadmaps

- Codes and Standards
- Information for Designers
- Performance Based Seismic Engineering

Roadmap Element 1

Technical Support for Seismic Practice & Code Development



- Task Orders 1 & 4: *Quantification of Building System Performance and Response Parameters*
- In-House Project: *Improved Seismic Provisions for U.S. Building Codes*

- In-House Project: *Seismic Performance of Buildings in the Moderate Seismic Zones Designed for Wind*
- Task Order 11: *Improved Structural Response Modification Factors for Seismic Design of New Buildings, Phase I*

Roadmap Element 1

Technical Support for Seismic Practice & Code Development

- Task Order 16: *Cost-Benefit Analysis of Codes and Standards for Earthquake-Resistant Construction in Selected U.S. Regions, Phase 1* (discussed previously)
- Task Order 17: *Seismic Behavior and Design of Deep, Slender Wide-Flange Structural Beam-Column Members, Phase 1*
- Task Order 19: *Comparison of Present Chilean and U.S. Model Building Code Seismic Provisions and Seismic Design Practices*
- Task Order 20: *Ground Motion and Building Performance Data from the 2010 Chile Earthquake*
- Task Order 21: *Analysis of Seismic Performance of Reinforced Concrete Buildings in the 2010 Chile Earthquake*

Roadmap Element 2

Performance-Based Seismic Design Development

- Task Order 6: *Nonlinear Multi-Degree of Freedom Modeling* (report in formal publication review)
- In-House: *Nonlinear Seismic Analysis of Structures*

  - Current focus: Develop an accurate & efficient nonlinear modal analysis methodology that accommodates nonlinear modal superposition using the force analogy and state space methods.
  - Methodology will be peer reviewed in early 2011.

Roadmap Element 2

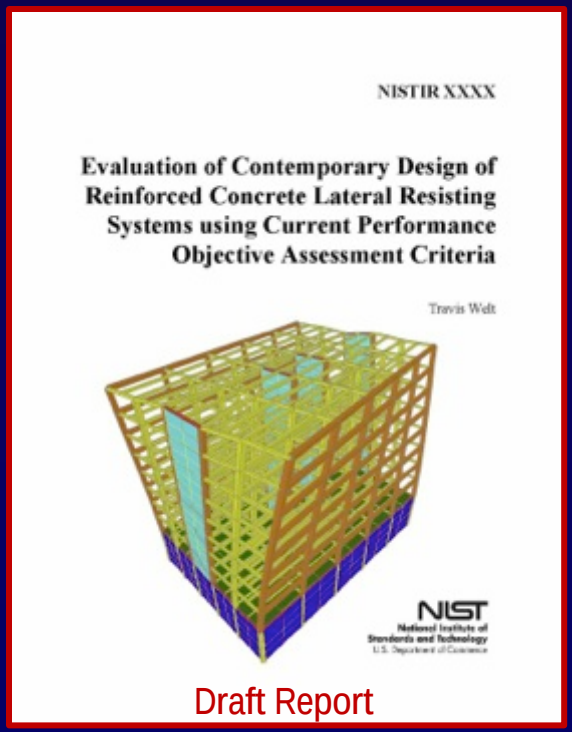
Performance-Based Seismic Design Development

- In-House: *Performance-Based Seismic Engineering Methodologies for Buildings*

Identified in NIST GCR 09-917-2 as Current Practice (CP)* needed research topic CP-1 to support full implementation of Performance Based Seismic Design (PBSD) - *Benchmark current performance-based design methodologies*:

"Results of the ASCE 41 procedures are currently perceived to be conservative, but there has been no systematic effort to critically examine the performance predicted by the procedures, compare them with other evaluation and design methodologies, or thoroughly investigate inconsistencies."

* Assessed by leading experts as needing immediate attention!



Draft Report

Roadmap Element 2

Performance-Based Seismic Design Development

NIST GCR 10-917-6

- Task Order 5: *Integration of Collapse Risk Mitigation Standards and Guidelines for Older Reinforced Concrete Buildings into National Standards, Phase 1*

- Project supported NEES Grand Challenge project at PEER with appropriate applied research and tech transfer. NIST GCR 10-917-7

Roadmap Element 2

Performance-Based Seismic Design Development

- Task Order 9: *Selecting and Scaling Earthquake Ground Motions for Performing Time-History Analyses*
  - Identified in NIST GCR 09-917-2 as Current Practice (CP) needed research topic CP-3 to support full implementation of PBSD
- Task Order 10: *Procedures for Characterizing and Modeling Soil-Structure Interaction for PBSE*
  - Identified in NIST GCR 09-917-2 as Future Practice (FPA) needed research topic FPA-6 to support full implementation of PBSD

BASELINE KNOWLEDGE REPORT ON SOIL-FOUNDATION-STRUCTURE INTERACTION OF BUILDING STRUCTURES

ATC 83 Project, Task 10

Principal Authors:
Jonathan P. Stewart and George Mylonakis

Contributing Authors:
Michael Givens, Tara Hutchinson, and Farhang Ostadan

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Project Director: Jonathan P. Stewart

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Tara Hutchinson	Craig Comartin
Bret Lizundia	Yousef Hashash
Farzad Naeim	Annie Kammerer
Farhang Ostadan	Gyimah Kasali
Curt Haselton	Graham Powell

Applied Technology Council
September 2010

Roadmap Element 4

Evaluated Technology for Practitioners

2008

2009

2010

2010

NIST ARRA Grant Activities

- ARRA Research Grants
  - *PBSD Methods and Tools for Reinforced Masonry Shear Wall Structures* (UCSD)
  - *Development & Evaluation of PBEE-Compliant Structural Systems* (VT)
  - *Modeling Natural Disaster Risk Management* (U DE)

Figure courtesy of UNR

- 2010 Construction Grant: Expansion of the Center for Civil Engineering Earthquake Research Facilities at University of Nevada, Reno (UNR) – Grand Opening June 2014