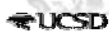


Full-Scale Structural and Nonstructural Building System Performance during Earthquakes & Post-Earthquake Fire

A Joint Venture between Academe,
Industry and Government

Introduction

Tara C. Hutchinson
Professor, UCSD



Project Meeting | September 29, 2010

Outline

- ▶ Welcome & introduction
- ▶ Review of project scope, vision and tasks
- ▶ Goals for this meeting
- ▶ Agenda for today

Welcome!

- ▶ Self-Introductions: Meeting participants
 - ▶ Core project team
 - ▶ Engineering & Regulatory Advisory Committee (ERAC)
 - ▶ Academic/International Liaison Group (AILG)
 - ▶ Englekirk Advisory Board (EAB)
 - ▶ Industry Steering Committee (ISC)

- ▶ Please state your name, affiliation, role/interest in project

Project Scope - Highlights

- ▶ \$5Million, multi-organizational 3 year research project
- ▶ Full-scale shake table test of 5-story office building on the NEES-UCSD LHPOST
- ▶ Fully outfitted with a range of nonstructural components and systems
- ▶ Post-earthquake fire integrity tests following earthquake shaking [parallel effort]
- ▶ Broad Stakeholder participation (industry & government)

Vision

- ✓ To make breakthrough advances in the understanding of total building systems performance (structural *and* nonstructural systems) under moderate and extreme seismic conditions through full-scale testing.
- ✓ Obtain data, which are sorely needed to characterize the earthquake performance of structural and nonstructural building systems, including nonstructural systems with protective measures.
- ✓ Use this data to validate nonlinear simulation tools, which in turn can be used for performance-based seismic design of nonstructural and building systems.
- ✓ Broadly and immediately infuse findings into seismic design guidelines

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Tasks

- ▶ Task A – Structural Systems (SS) [Restrepo & EAB]
 - ▶ Design, instrument, and test, under earthquake shaking, a realistic building to support testing of NCSs & post-earthquake fire tests
- ▶ Task B – Nonstructural Components and Systems (NCSs) [Hutchinson, Hoehler & Wang]
 - ▶ Design & outfit the structure with a variety of NCSs; instrument and test within the dynamic environment of the SS
- ▶ Task C – Protective Systems [Marin, Restrepo & Chen]
 - ▶ Implement protective systems to NCSs (& building)
- ▶ Task D – Simulation [Conte]
 - ▶ Simulate response of building, NCS, and protected NCSs

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Tasks

- ▶ Task E – Construction Management [*Walsh & EAB*]
 - ▶ Facilitate & coordinate construction of building & implementation of NCSs, use BIM technology
- ▶ EOT & Technology Transfer [*Bachman & Walsh*]
 - ▶ K-12 initiatives (Construction Tech Academy)
 - ▶ AILG & ERAC

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Advisory

- ▶ Engineering & Regulatory Advisory Committee (ERAC):
 - ▶ Reviewing and comment on the research program and assist with disseminating findings from the study to design practice
- ▶ Academic/International Liaison Group (AILG):
 - ▶ Reviewing and comment on the research program and relate the efforts of this program to ongoing efforts by the community both in the US and internationally
- ▶ Englekirk Advisory Board (EAB):
 - ▶ Lead building design, construction, and demolition
- ▶ Industry Steering Committee (ISC)
 - ▶ Resources Support for Building & NCS implementation

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Meeting Goals

- ▶ Face-to-face meeting for as many of our project participants as possible
 - ▶ Review project scope & goals
 - ▶ Overview of activities of year I
 - ▶ Discuss goals/milestones for coming year
-
- ▶ Solicit your feedback!

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Meeting Agenda - AM

Item	Description	Lead	From	To	Duration
0	Social time, drinks & light breakfast		8:30	9:00	00:30
1	Introduction				00:30
	Welcome & self-introductions Meeting agenda & goals Project overview & schedule	Hutchinson	9:00	9:30	00:30
2	Fire status	Meacham	9:30	9:45	00:15
3	Building design & construction		9:45	11:15	01:30
3a	Ground motions	Bachman			00:15
3b	Building design process & status (and discussion)	Englekirk/Faghihi			01:00
3c	Base isolation	Marin/Restrepo			00:15
4	Nonstructural components & systems		11:15	12:00	00:45
4a	NCS systems design	McLaughlin			00:30
4b	Specific larger systems	Hoehler/Hutchinson			00:15
5	Construction management & schedule (presentation only)	Walsh	12:00	12:30	00:30

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Meeting Agenda - PM

Item	Description	Lead	From	To	Duration
	Lunch		12:30	13:30	01:00
6	Open Discussion	All	13:30	15:15	02:15
7	Concluding remarks		15:45	16:00	00:15

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Overview of Activities in Year 1 (1/2)

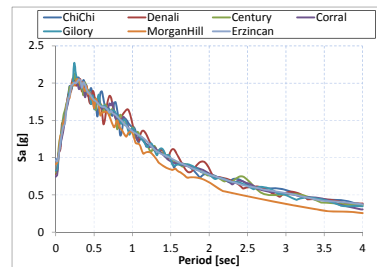
- ▶ Key Technical Activities:
 - ▶ Ground motion selection (in partnership with MacTec)
 - ▶ Building concept design, preliminary detailing, & pre-test numerical modeling
 - ▶ Building base isolation preliminary design
 - ▶ Occupancy and initial layout decisions regarding NCSs (in partnership with ARUP & ISC)
 - ▶ Preliminary construction tracking/schedule diagrams

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Ground Motions [Bachman]

- ▶ Criteria
 - ▶ Site [downtown LA]
 - ▶ Soil conditions [class D]
 - ▶ Hazard levels [Serviceability, Design, & MCE]
 - ▶ Target PSV [87 in/sec]
- ▶ Selection & scaling of 7 ground motions for use in building design
- ▶ Selection of an MCE test motion

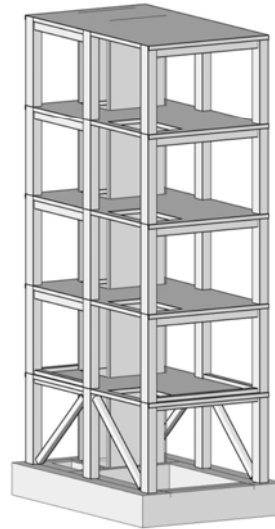


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Building Design [Englekirk & Faghihi]

- ▶ Concept design reviewed & approved in Feb 2010
- ▶ Design development & preliminary detailing underway
- ▶ Pre-test modeling:
 - ▶ Perform (Englekirk & Faghihi)
 - ▶ OpenSees (UCSD)

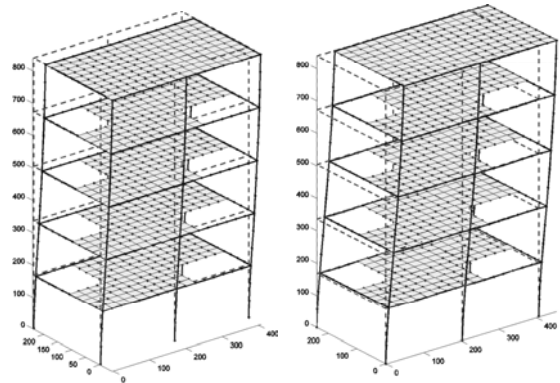


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OpenSees Numerical Model

- ▶ Beam-column: nonlinear force-based element
- ▶ Slab: elastic shell
- ▶ DDC Connection: zero-length fiber element
- ▶ Prestressed strand: truss element



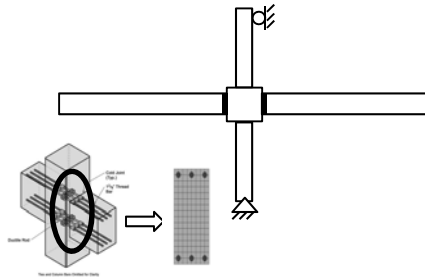
First Mode ($T= 1.30s$)

Second Mode ($T=1.05s$)

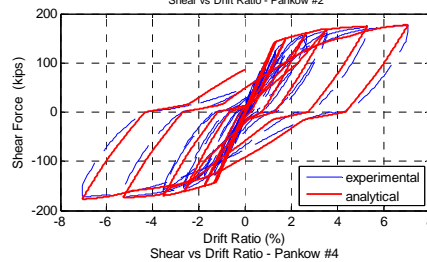
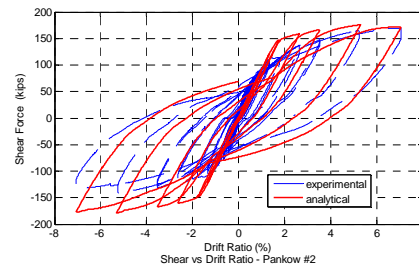
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OpenSees Modeling: Hybrid Beam / DDC Beam



The validity of the component models of the hybrid and DDC beam were calibrated with experimental data from beam-column joint subassembly tests conducted at UCSD



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NTHA Maximum Responses Summary

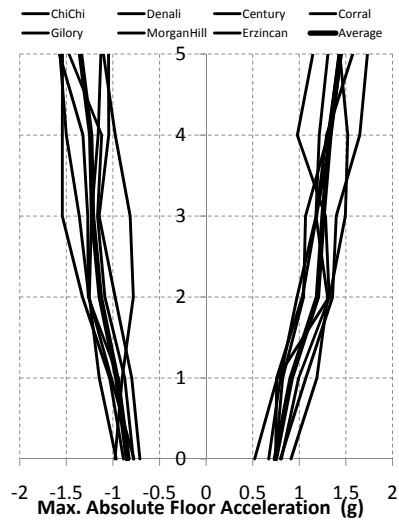
Ground Motion	Max Floor Acc (g)	Max Total Drift (%)	Max IDR (%)
ChiChi	1.32	2.4	3.42
Denali	1.47	2.9	4.23
Century	1.73	2.3	3.28
Corral	1.45	2.4	3.28
Gilroy	1.57	2.0	2.98
MorganHill	1.54	1.8	2.64
Erzincan	1.57	3.1	4.53
Average	1.52	2.4	3.48
Max	1.73	3.1	4.53

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Maximum Floor Acceleration

- ▶ Largest, 1.5g @ roof under test motion MCE Denali
- ▶ Relatively linear distribution with height

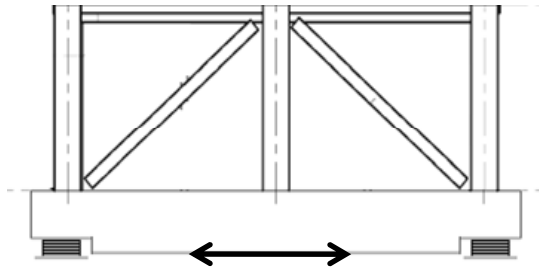


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Building Base Isolation [Marin]

- ▶ 4 isolators
- ▶ Isolation period $\sim 2.5s$
- ▶ Max isolator displacement (MCE) = 29cm
- ▶ Addition of base bracing to transfer frame loads

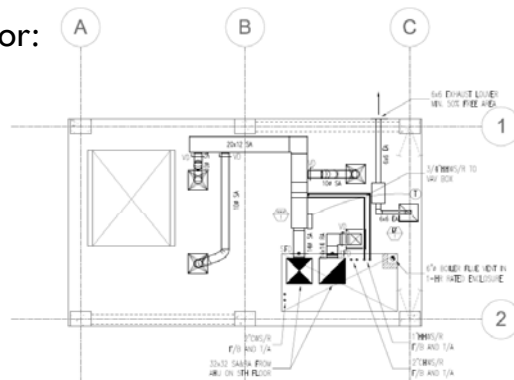


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Occupancy & Initial Layouts – NCSs [McLaughlin]

- ▶ Selection of occupancy
- ▶ Coordination with suppliers of those equipment committed thus far
- ▶ Minimal layout plans for:
 - ▶ Mechanical
 - ▶ Plumbing
 - ▶ IT/Communications
 - ▶ Fire sprinklers



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Construction Management [Walsh]

- ▶ Two Navy Civil Engineer Corps (CEC) officers (Matt Tolhurst and James Sullivan) & one MS graduate student (Eli Espino) @ SDSU
- ▶ Helping keep us honest & in check with our schedule!

CSI Division(s)	Item	Supplier
260000	Electrical	
260529	Hangers & Supports for Electrical Systems	Mason
260536	Cabletrays for Electrical Systems	Schneider Electric
260548	Vibration & Seismic Controls for Electrical Systems	Mason
261000	Medium Voltage Distribution	Schneider Electric
262000	Low Voltage Electrical Transmission	Schneider Electric
265000	Lighting	Schneider Electric
265100	Interior Lighting	Schneider Electric
272000	Data Communications/Computer Hardware	
272100	Data Communications Network Equipment	IBM
272200	Data Communications Mounting Hardware	No commitment
275000	Distributed Communications & Monitoring	
275200	Healthcare Communications & Monitoring	No commitment
283000	Electronic Detection and Alarm	SimplexGrinnell
283100	Fire Detection and Alarm	SimplexGrinnell

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Overview of Activities in Year 1 (2/2)

- ▶ New partnerships & funding resources
 - ▶ California Seismic Safety Commission (\$300k proposal moving forward with legal review; Restrepo PI), three tasks:
 1. Base isolation restraint system design & construction
 2. Integration of an intensive care unit (ICU) on one floor of the building
 3. Professional educational video production
 - ▶ NSF Supplemental Fellowship
 - ▶ Supports a PhD student for the study of base isolating the building
 - ▶ Vulco Weir
 - ▶ Providing isolation system, sliders, isolation system characterization, cash contribution
 - ▶ SIRVE & Prof Juan Carlos de la Llera

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Goals/Milestones for Next 2 Years

- ▶ December, 2010 Design development complete, package sent to bid
- ▶ March 2011 Begin Construction
- ▶ August, 2011 Begin instrumentation
- ▶ October 2011 Construction complete
- ▶ November 2011 Seismic testing
- ▶ January 2012 Fire testing
- ▶ March 2012 Demolition