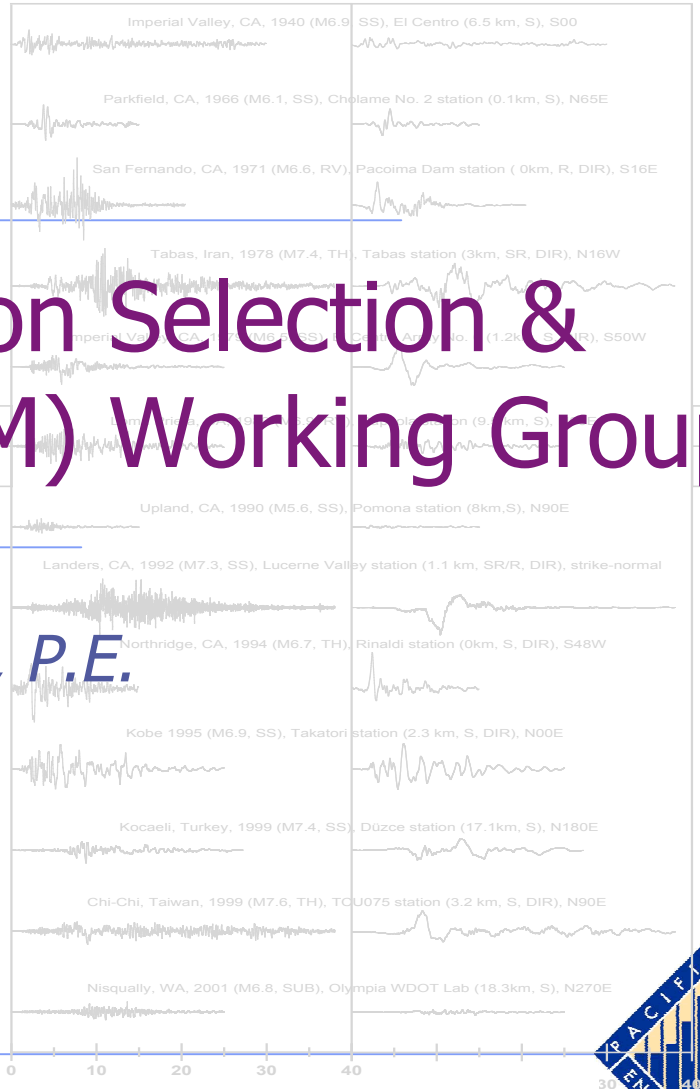

PEER Ground Motion Selection & Modification (GMSM) Working Group

Yousef Bozorgnia, *Ph.D., P.E.*
PEER Associate Director

PEER GMSM,
COSMOS Annual Meeting,
November 17, 2006

Current state-of-the-practice in GMSM

- Is confusing
- Structural engineers rely on geotechnical engineers
- Geotechs/seismologists have little understanding on how the selected THs will be used by structural engineers
- GMSM methods have different objectives
- Methods can give VERY different results, even if they have the same objective

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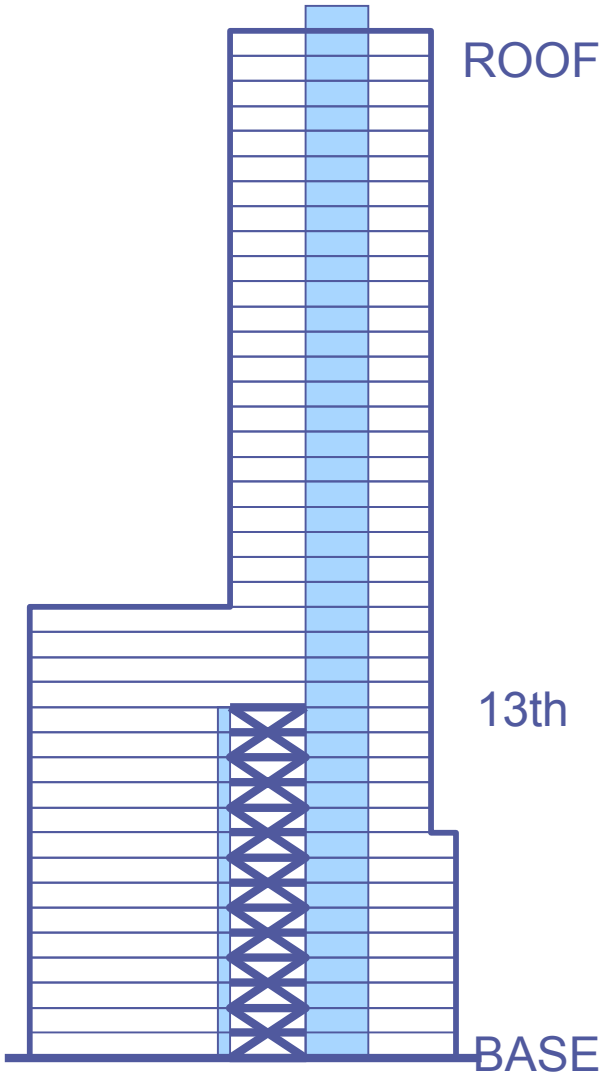
Design values?



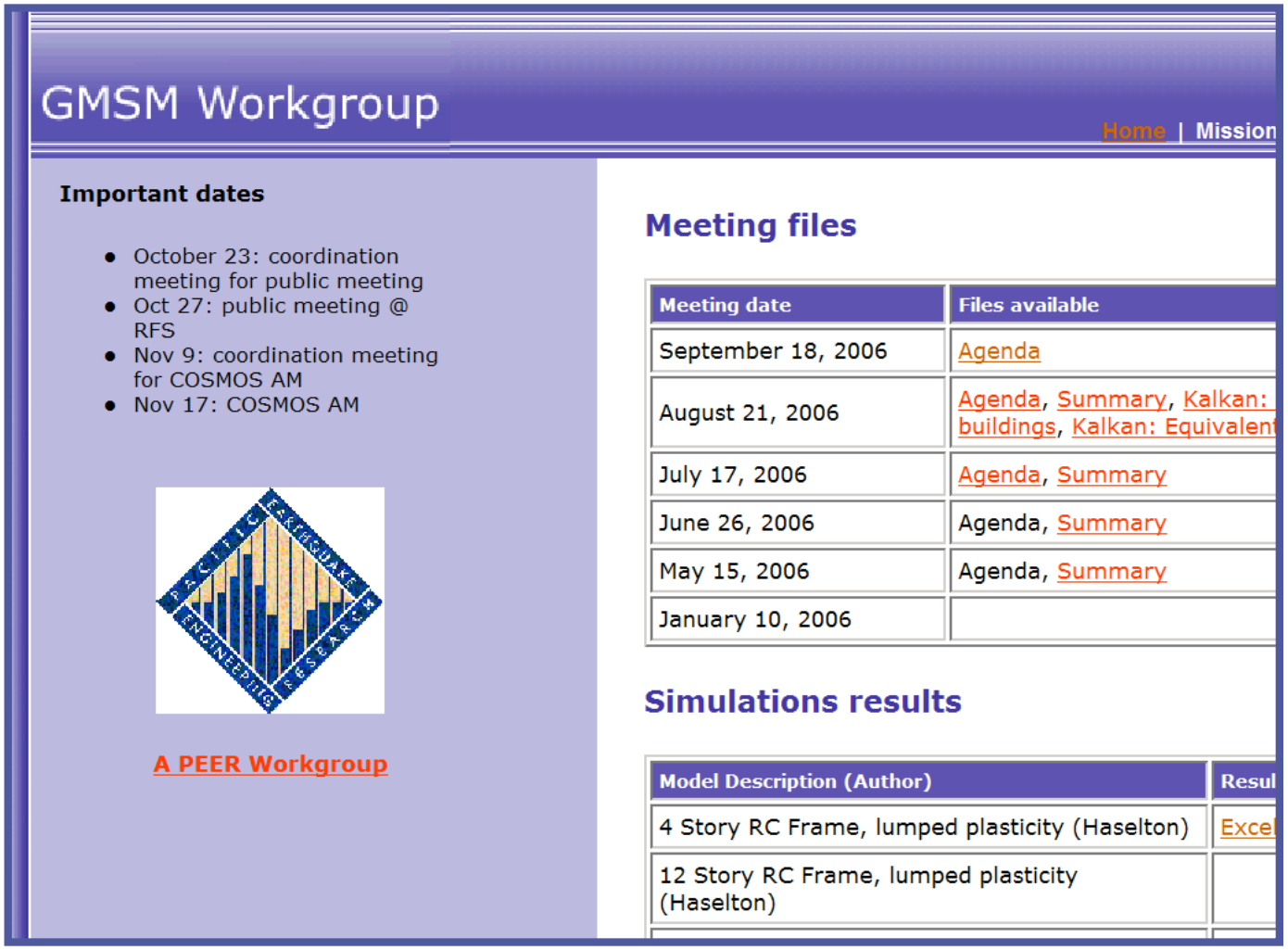
	Roof drift, ft	Wall base shear, k	Wall moment at 13th floor, 1000 x k-ft
Minimum	2.1	7600	513
Maximum	6.7	29700	1080
Mean (m)	4.2	15500	900
m + σ	5.4	22200	1090
c.o.v.	0.23	0.43	0.21
Nonlinear static		5500	760

Summary of results

The only possible improvement is:

- To assemble a multi-disciplinary team of:
  - Seismologists
  - Geotechs
  - Structural engineers
- They interact in frequent meetings & workshops
- They interact with other groups
- Come up with an evaluation platform

PEER GMSM Working Group



GMSM Workgroup

Home | Mission

Important dates

- October 23: coordination meeting for public meeting
- Oct 27: public meeting @ RFS
- Nov 9: coordination meeting for COSMOS AM
- Nov 17: COSMOS AM

A PEER Workgroup

Meeting files

Meeting date	Files available
September 18, 2006	Agenda
August 21, 2006	Agenda, Summary, Kalkan: buildings, Kalkan: Equivalent
July 17, 2006	Agenda, Summary
June 26, 2006	Agenda, Summary
May 15, 2006	Agenda, Summary
January 10, 2006	

Simulations results

Model Description (Author)	Resul
4 Story RC Frame, lumped plasticity (Haselton)	Excel
12 Story RC Frame, lumped plasticity (Haselton)	

PEER GMSM Working Group: Started in May 2006

GMSM Web Site:

- Yousef Bozorgnia, PEER, UC Berkeley
- Norm Abrahamson, UC Berkeley and PG&E
- Allin Cornell, Professor, Stanford University
- Christine Goulet, PhD Student, UC Los Angeles
- Curt Haselton, PhD Student, Stanford University
- Erol Kalkan, CSMIP
- Nico Luco, USGS
- Frank McKenna, PEER
- Tom Shantz, Caltrans
- Jonathan Stewart, Associate Professor, UC Los Angeles
- Polsak Tothong, PhD Student, Stanford University
- Jennie Watson-Lamprey, PhD Student, UC Berkeley
- Farzin Zareian, Assistant Professor, UC Irvine
- Jack Moele, PEER and UC Berkeley
- Tony Yang, Post Doctoral Fellow, UC Berkeley
- Coreen McQuoid, PhD Student, UC Berkeley
- Marcello Bianchini, PhD Student, University of Bologna, Visiting Researcher at Stanford University

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GMSM Working Group Objectives

- To bring together researchers who work on GMSM methods,
- Examine existing GMSM methods,
- Examine emerging GMSM methods,
- Cast a platform for "objective" evaluation and comparison of GMSM methods

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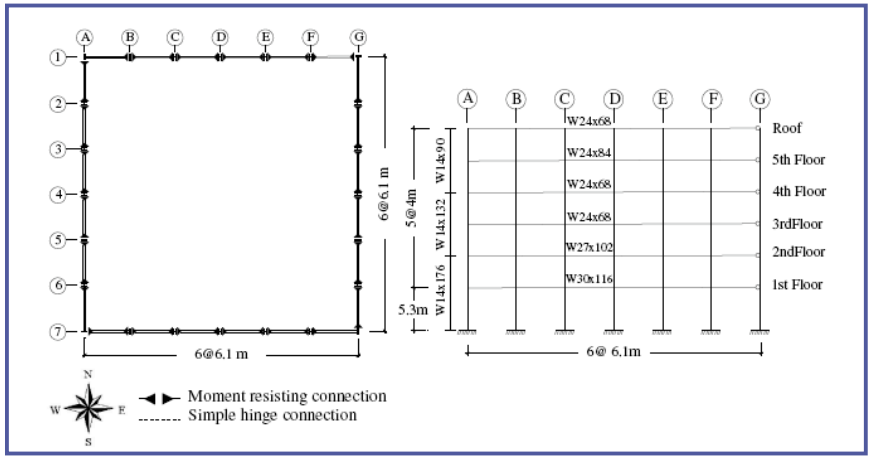
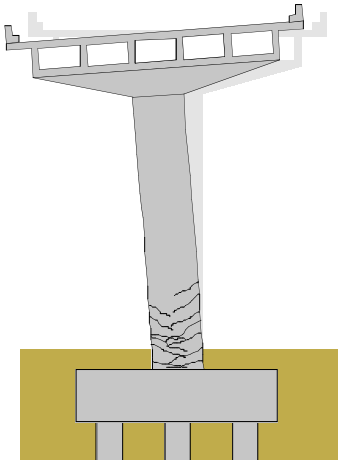
GMSM Methods to be Tested for Nonlinear Analysis of:

- Buildings ← **So far**
- Bridges
- Earth structures
- Non-structural





What GMSM Working Group Has Done:

- Compiled and classified as many as GMSM methods as possible

- Compiled existing building models of:
  - Different building sizes
  - Different structural systems
  - OpenSees, DRAIN and PERFORM models of various buildings

#	Parameters for selection	Scaling scheme	Reference/example
1	M, R, etc.	None	Basis of comparison
2	M, R, etc.	Scale to target $SA(T_1)$	PEER testbeds
3	M, R, etc.	Scale to UHRS	Building Code
4	M, R, etc.	Scale to median RS	Current DGML
5	M, R, etc.	Match to median RS	Consulting practice
6	M, R, etc. AND ε	Scale to target $SA(T_1)$	PEER RC Benchmark
7	Expected spectral shape given M, R, etc. AND ε	Scale to target $SA(T_1)$ and expected RS	Baker & Cornell (2006)
8	Random selection; M, R, etc. and/or ε if necessary	Scale to target $SA_{AVG}(T)$	Tothong/Cornell, Baker & Cornell (2006)
9	Random selection; M, R, etc. and/or ε if necessary	Scale to target $SD_I(T_1, d_y)$	Shantz, Bozorgnia, Tothong/Cornell
10	Random selection; M, R, etc. and/or ε if necessary	Scale to target $IM_{1,0\&2,E}$	Luco et al (2002), Tothong & Luco (2006)
11	$SA(T_2)$ / $SA(T_1)$	Scale to target $SD_I(T_1, d_y)$	Luco et al (2004)

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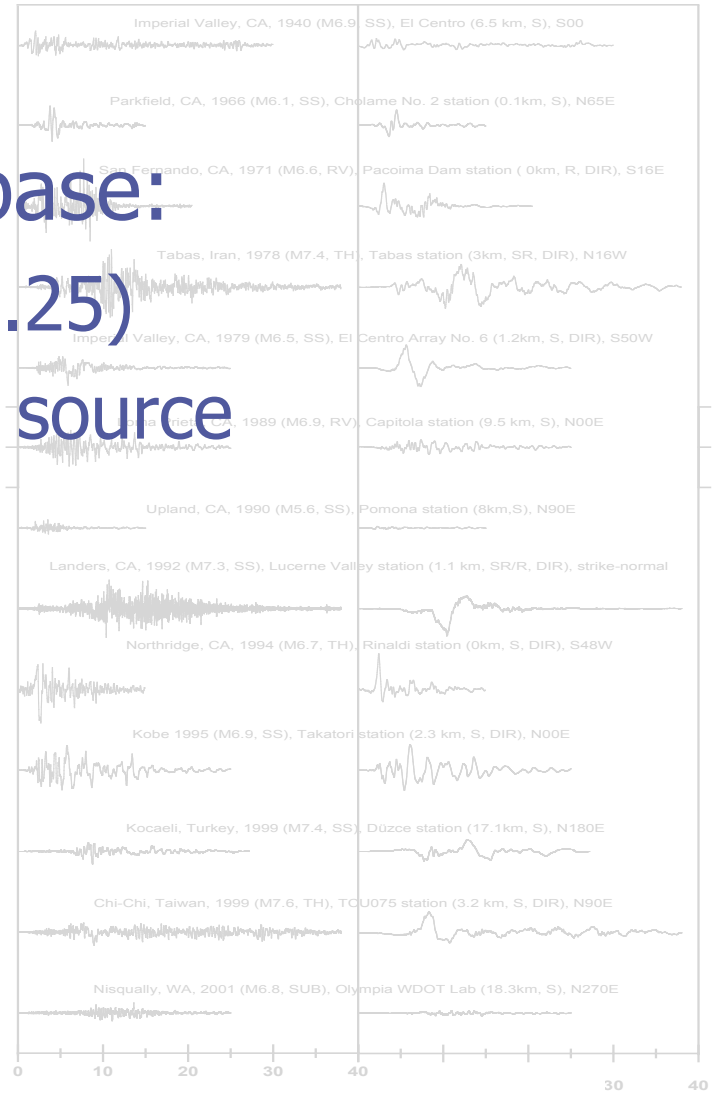
Started with…

- A subset of NGA database:
  - Magnitude 7 (6.75 to 7.25)
  - Distance of 10km from source (0-20 km)
- ➔98 Records



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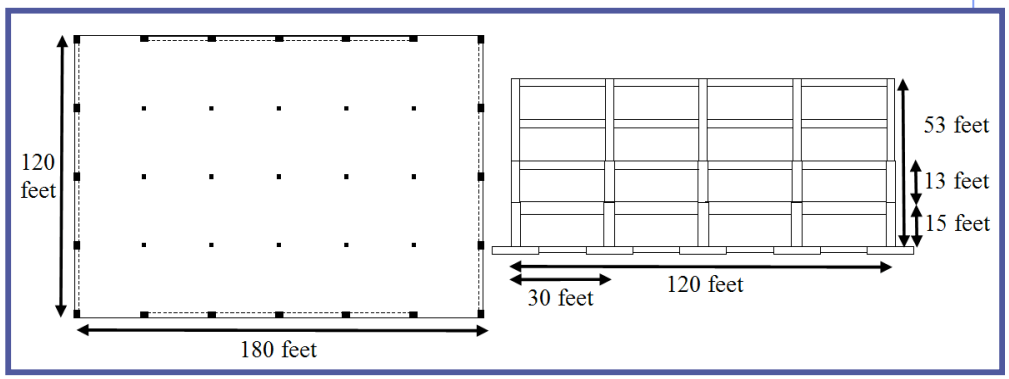
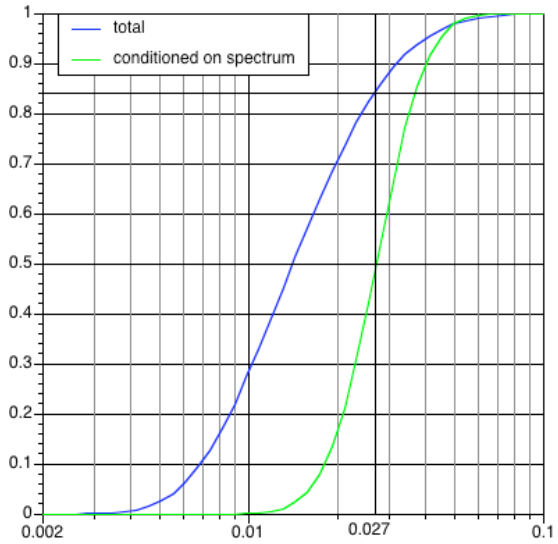
Structural Models Are Subjected to…

- Hundreds of input GMs
  - Suppose you have unlimited resources



- Compute statistics of various structural responses (EDPs)



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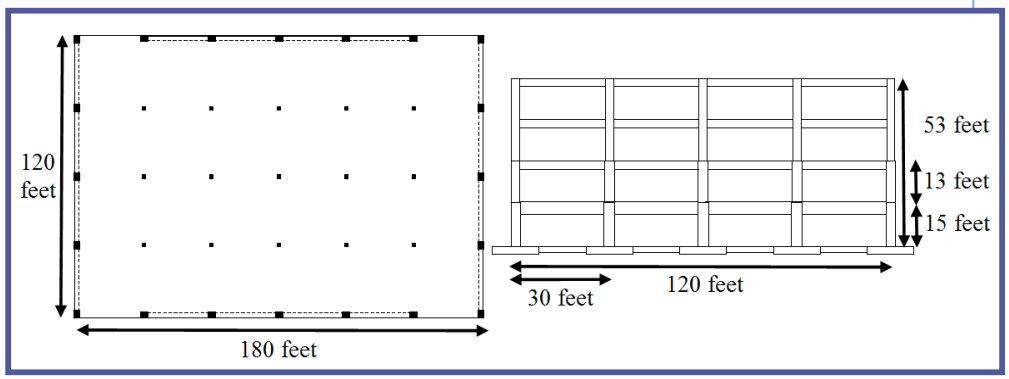
Structural Models Are Also Subjected to Selected & Modified GMs

- Asked the authors of GMSM methods to provide a set of scaled/modified records



- Ran the models with the scaled/modified GMs

EDPs of smaller subset are being compared with the results of larger set of GMs

GMSM Working Group Link to Other R&D Projects

- PEER NSF ("core") research projects
  - Several of researchers have funding from PEER NSF program
- Tall Buildings Initiative
- Caltrans research projects on bridge structures
  - Projects will start next year

Link to Tall Buildings Initiative (TBI)

- Two-year, ~$1.2M initiative to develop design guidance for seismic design of tall buildings
- Main participants
  - PEER, SCEC, USGS, SEAOC, LATBSDC, SFDBI, LADBS, FEMA, ATC, OES(?)
- Management Committee
  - J. Moehle, Y. Bozorgnia
  - N. Abrahamson, M. Lew, P. Somerville
  - R. Hamburger, H. Krawinkler, M. Moore, F. Naeim
  - R. Lui, LADBS representative pending
- August 2006 – August 2008

Scope of Tall Buildings Initiative

- Tall buildings
- Seismic design of structural system
- Coastal California
- Concrete and steel
- Residential focus, but not excluding other occupancies

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TBI Tasks

- Establish and operate Tall Buildings Initiative Project Advisory Committee (T-PAC)
- Research tasks
  - Consensus performance objectives (Holmes)
  - Assessment of ground motion selection and scaling procedures (Moehle)
  - Synthetically generated ground motions (Somerville)
  - Review of synthetically generated ground motions (Naeim)
  - Guidelines on ground motion selection and modification (Bozorgnia)
  - Guidelines on modeling and acceptance criteria (ATC)
  - Input ground motions for tall buildings with subterranean levels (Stewart)
  - Other tasks to be defined….
  - Guidelines for seismic design of tall buildings
- Guidelines for tall building instrumentation
- Workshops, presentations, etc.
- Final report to sponsoring organizations

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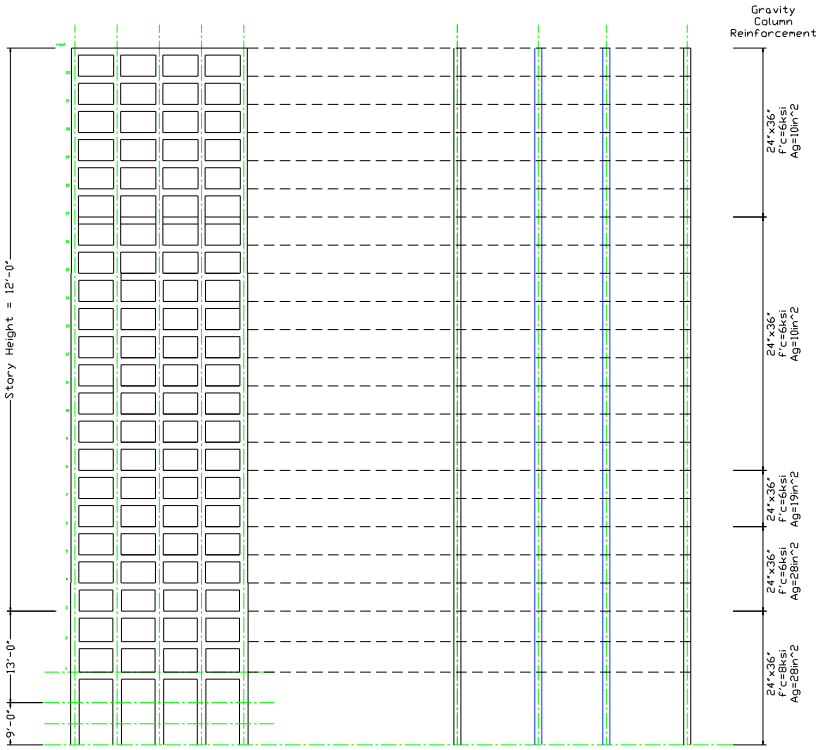
TBI: Selection and scaling of ground motion



- Recorded Ground Motions
- Simulated GM

1. Select bin of ground motions
2. Analyze building models to develop statistics of response (drift ratio, shears, plastic rotations, drag forces, etc.) for that bin
3. Test various ground motion selection and modification methods against the “reference” result.

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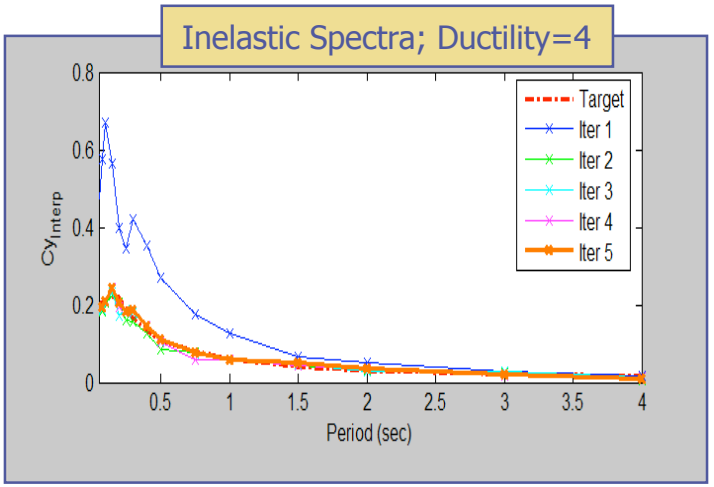
PEER GMSM Working Group Had a Workshop

- Workshop on October 27, 2006
- Presentations will be posted at:

  http://peer.berkeley.edu/gmsm/index.html
- PEER will have more workshops…send us a note if you like to attend: yousef@berkeley.edu



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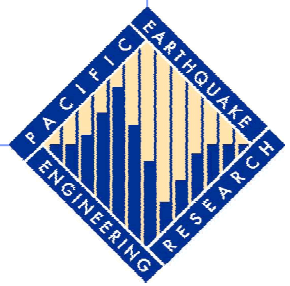
PEER GMSM
Future Technical Tasks and Issues



The Fact…We are Not Done

- Upcoming tasks:
  - Evaluate GMSM methods for other EDPs
  - Expand magnitude, distance, site,… ranges
    - e.g., $\boldsymbol{M}$ 7.5, $\boldsymbol{R_{rup}}$=10km
  - Running & evaluate GMSM methods for other building models
    - More into nonlinear range
  - Give the contributors a common candidate set of GMs to start from

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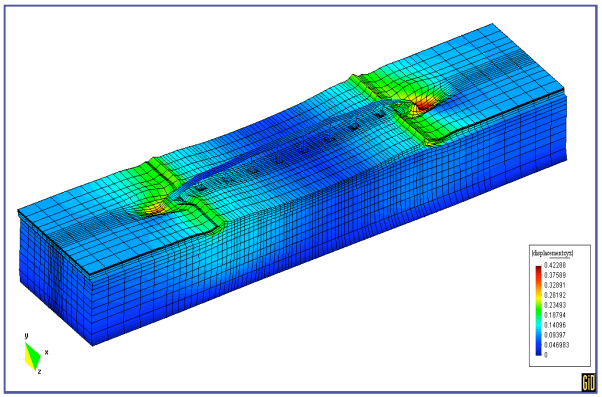
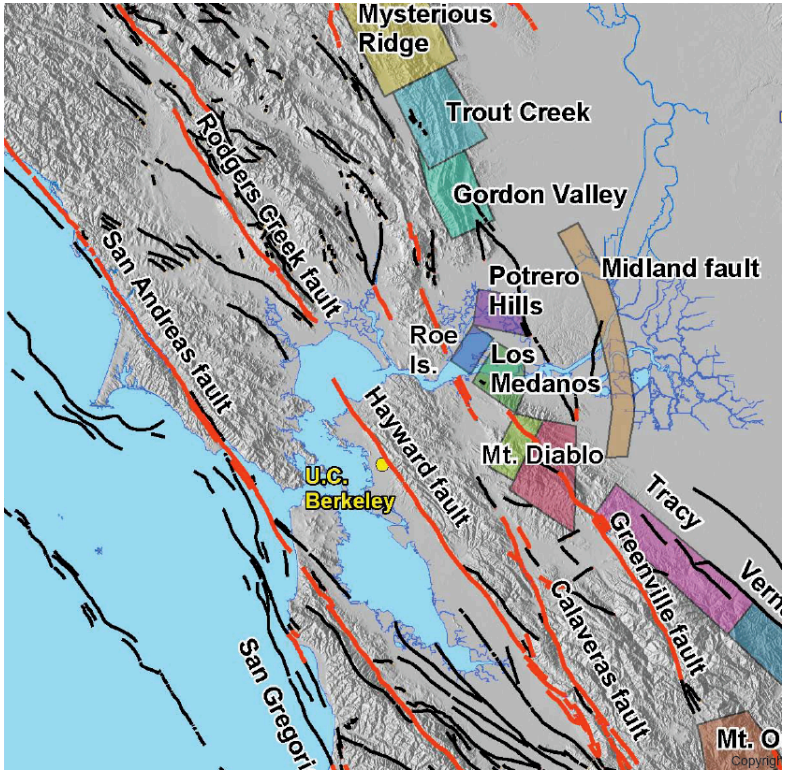
Upcoming Tasks…

- Upcoming tasks:
  - Tall buildings
  - Bridge structures
  - Earth structures
  - …



Issues to be considered …

- Near-fault effects
  - Example: in CA, there are 8386 bridges (out of 12550), **67%** , within 10 km of faults
  - Fault-normal, fault parallel



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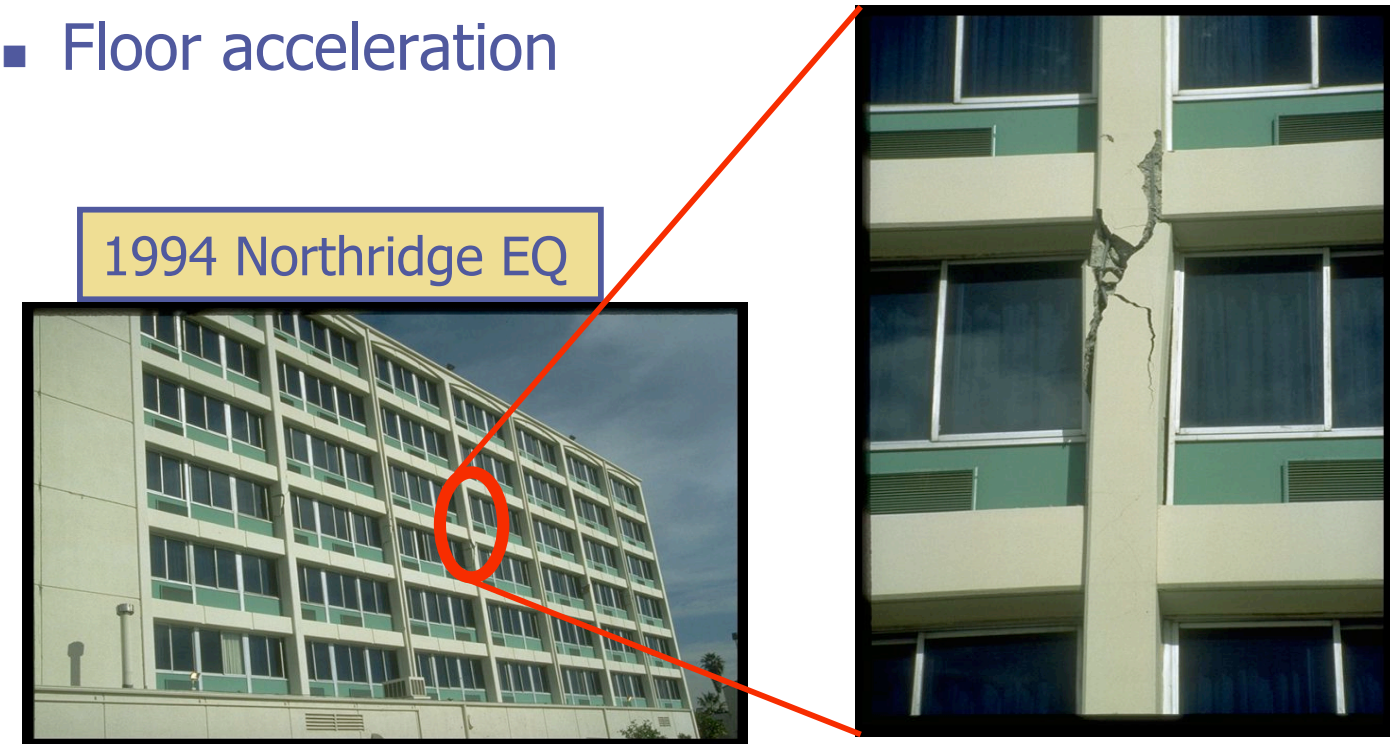
Issues to be considered …

- Higher modes
- Two- (and three-) dimensional structural models:
  - Selection of time series in two (or three) directions
  - Especially, in near-fault areas

Issues to be considered …

- Multiple EDPs, e.g.,
  - Interstory drift and
  - Floor acceleration



Today, We Will…

- Provide progress report:
  - Summary of GMSM methods
  - Example results for a four-story building model
- Get feedback from participants

Disclaimers!

- We are not done!
- We do not have all answers (yet!)

Today…

- Nico Luco:
  - Will present an overview of all methods considered by PEER GMSM Working Group, and their classification
- Curt Haselton:
  - Will give an overview of the structural models under consideration
- Jennie Watson-Lamprey:
  - Will provide an overview of comparison platform and results for a four-story building

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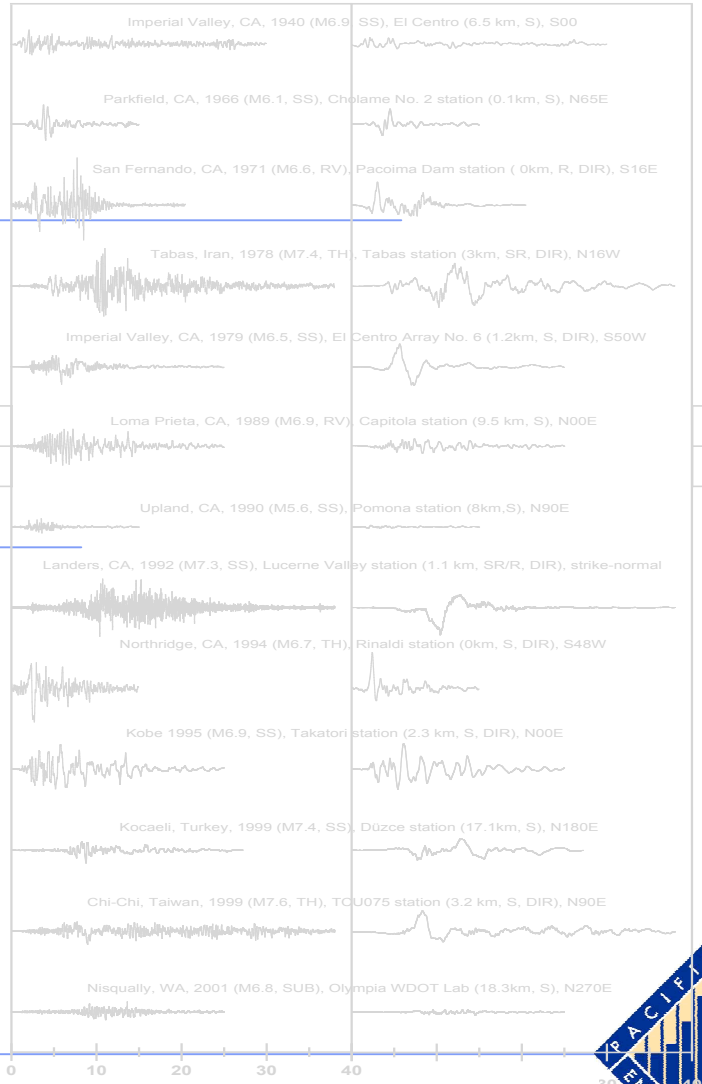
Thank You!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San Fernando, CA, 1971 (M6.6, RV), Pacoima Dam station (0km, R, DIR), S16E
Tabas, Iran, 1978 (M7.4, TH), Tabas station (3km, SR, DIR), N16W
Imperial Valley, CA, 1979 (M6.5, SS), El Centro Array No. 6 (1.2km, S, DIR), S50W
Loma Prieta, CA, 1989 (M6.9, RV), Capitola station (9.5 km, S), N00E
Upland, CA, 1990 (M5.6, SS), Pomona station (8km,S), N90E
Landers, CA, 1992 (M7.3, SS), Lucerne Valley station (1.1 km, SR/R, DIR), strike-normal
Northridge, CA, 1994 (M6.7, TH), Rinaldi station (0km, S, DIR), S48W
Kobe 1995 (M6.9, SS), Takatori station (2.3 km, S, DIR), N00E
Kocaeli, Turkey, 1999 (M7.4, SS), Düzce station (17.1km, S), N180E
Chi-Chi, Taiwan, 1999 (M7.6, TH), TCU075 station (3.2 km, S, DIR), N90E
Nisqually, WA, 2001 (M6.8, SUB), Olympia WDOT Lab (18.3km, S), N270E
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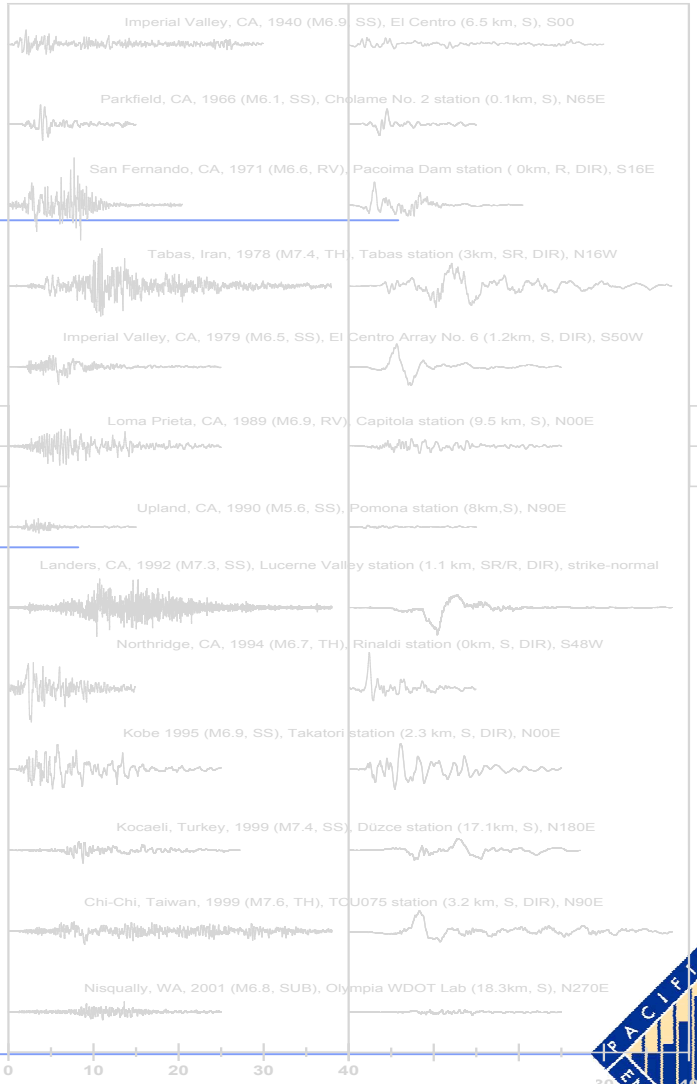
Nico Luco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