PEER Ground Motion Selection and Modification Program

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For the
PEER Ground Motion Selection & Modification (GMSM) Program

Slides preparation in collaboration with Curt Haselton, Jennie Watson-Lamprey, Nico Luco and Jack Baker

Menu du jour : GMSM

- Introduction and overview *Christine Goulet*
- GMSM methods *Jennie Watson-Lamprey*
- Structural models *Curt Haselton*
- Results: building code study *Jack Baker*
- Results: median prediction by groups of methods *Curt Haselton*
- Conclusion and future work *Nico Luco*

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Motivation

- The results of nonlinear response history analyses are very sensitive to the suite of input ground motions.
- There is currently no consensus as to the best method, thus the choice is largely subjective.
- Selection based on seismological principles only leads to large variability of results.
- There are two solutions to this problem:
  - Perform a high end analysis that uses more records
  - Be smarter about picking records

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Focus of the last 2 years

- Hybrid approach – use the high-end approach to test the “smart-selection” methods.
- Compare structural response predictions from various “smart-selection” methods.
- This involves a continued collaboration with many method contributors.
- Purpose:
  - Work toward consensus in the ground motion community.
  - Use results to develop guidance for the engineering community.

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GMSM Mission

To provide guidance to the engineering community on appropriate GMSM methods for nonlinear response history analyses.

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What constitutes a GMSM method

- Given a scenario, the ground motion record *selection* can be based on
  - Magnitude and distance (M,r) bins only
  - M,r plus spectral acceleration or spectral displacement, etc.
- The *modification* can consist in
  - Different scaling schemes : at a single spectral period or over a period range
  - Spectral matching

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GMSM Approach

- Identify applications for which ground motions will be used.
- Identify the goal of the application.
- Identify candidate GMSM methods.
- Develop an evaluation procedure (includes conducting simulations).
- Compare the results of the analyses using the evaluation procedure.
- Hybrid approach – use the high-end approach to test the smart-selection methods

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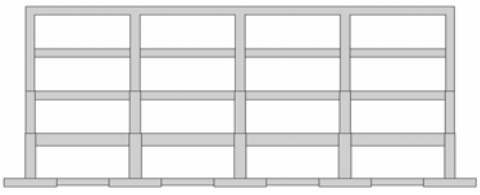
2006 Research – developing the procedure

- Used a well-understood structure to develop the procedure.
  - "Benchmark Structure" used in the past by participants as part of PEER multi-institution project.
  - Typical California 4-story office-type structure
- Deter rio.
- Maxin ratio as struct



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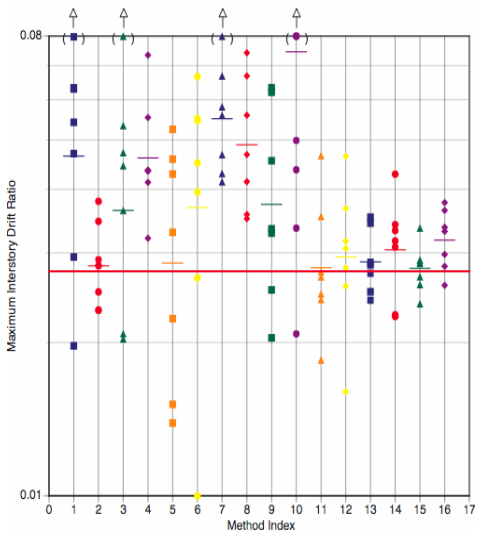
2006 Results



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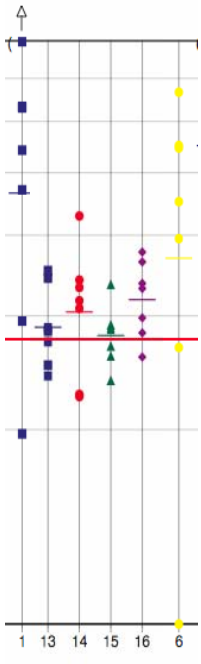
2006 Results

- Large variability in median predictions
- Overestimation of median on average
- Improved predictions for methods that consider the nonlinear response in some way
- Variability of structural response was not accurately predicted



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2007 Research

- Focus on median predictions
- Addition of structural models
- Addition of a deterministic event
- Continued collaboration with method developers
- Sample results shown today

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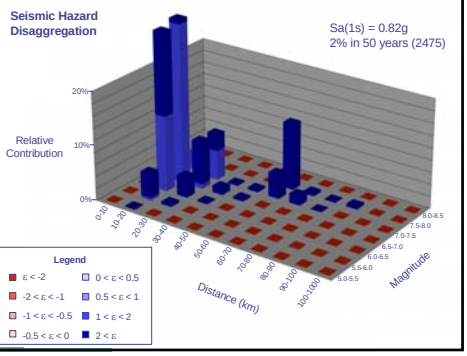
Methodology

- Select earthquake scenarios
  - M=7, r=10 km, $\mu+2\sigma=+2\varepsilon$
  - M=7.5, r=10 km, $\mu+1\sigma=+1\varepsilon$
- Why $+2\varepsilon$?
  - To push the structures well in the NL range
  - It is not unreasonable

East Bay
• 2% in 50 average: 1.6



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Methodology

- Select structural models (4 different building configurations)
- Define response parameters (EDPs)
  - Maximum Inter-Story Drift Ratio (MIDR)
  - Others considered:
    - Peak Floor Acceleration
    - Base shear
- Request ground motion suites for each method of GMSM
- Perform nonlinear response history analyses
- Compute the distribution for selected EDP response

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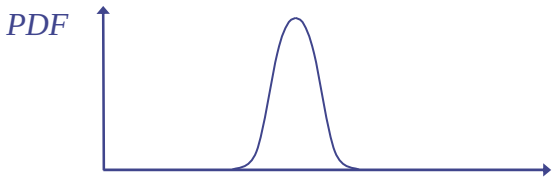
Methodology

- Compute the Point of Comparison (POC) (High end analysis)
  - Use larger set of records corresponding to the scenario
  - Perform the nonlinear response history analyses
  - Compute a regression model that relates the response to the ground motion properties and earthquake metadata
  - Integrate over the ground motion properties to get a distribution of the selected EDP response



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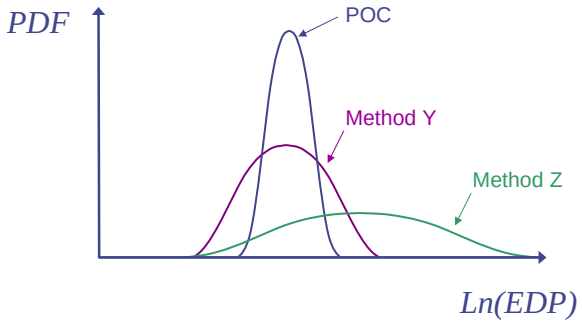
Methodology

- Analysis of results, observations and conclusions
  - Compare results of suites with POC
  - Draw conclusions and recommendations



- ... Repeat the whole procedure for other structures and scenarios ...

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Submitted sets

Objective: predict the MIDR for these structures/scenario combinations

- Building A, C and D scenario M7
- Building B, scenario M7 and M7.5

14 methods
25 variants

- Four sets of 7 records
  - To match building code requirements (7)
  - To allow larger suites for statistics and research purposes (28)

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Collaboration Among Many Researchers – Program members

- Today's presenters +
  - Norm Abrahamson
  - Yousef Bozorgnia
  - Allin Cornell
  - Erol Kalkan
  - Nilesh Shome
  - Polsak Tothong
  - Farzin Zareian

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Collaboration Among Many Researchers - Collaborators

- Arzhang Alimoradi
- Paolo Bazzurro
- Jamshid Ghaboussi
- Charlie Kircher
- Frank McKenna
- Coleen McQuoid
- Steve Mahin
- Preveen Malhotra
- Jack Moehle
- Farzad Naeim
- Maury Power
- Ellen Rathje
- Brian Skyers
- Jonathan Stewart
- Gang Wang
- Andrew Whittaker
- Tony Yang
- Bob Youngs

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2008 and beyond

Mission: To provide guidance to the engineering community on appropriate GMSM methods for nonlinear response history analyses.

Vision: To serve as a resource for major research projects to address this key issue.

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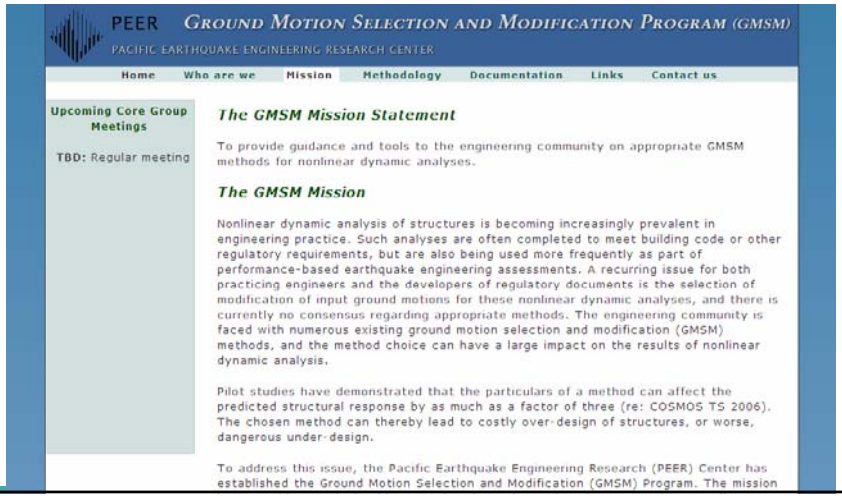
General info and contact

http://peer.berkeley.edu/gmsm/



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Thank you

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