Brief Recap & Future Work

Nicolas Luco
Research Structural Engineer
USGS, National Seismic Hazard Mapping Project

On behalf of the …
PEER Ground Motion Selection & Modification (GMSM) Program

Mission of PEER GMSM Program

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

Recent Focus of PEER GMSM Program

- Comparisons of various "small n" (aka "smarter selection") GMSM methods ...
  - via continued collaboration with developers of these methods
  - for selected earthquakes, GMs, buildings, and response parameters (the "experiments")
  - relative to a "large n" (aka "high-end") GMSM method for Point-Of-Comparison (POC)
- Full understanding of observations in order to (i) arrive at consensus recommendations and (ii) design future "experiments"

3

Initial Results

- Comparison of "large n" and "small n" methods within and across the following classes:
  - Uniform-Hazard Spectrum (UHS) / Building Code Methods
  - Sa(T_1) Methods
  - Conditional Mean Spectrum (CMS) Methods
  - Spectral Shape Proxy ("ε") Methods
  - Inelastic GM Parameter Methods

4

Initial Observations

For median response given $Sa(T_1)$, M, and R ...

GMSM Method	Unbiased?	Precision?
UHS/Bldg.Code	No, due to UHS	Depends on selection
$Sa(T_1)$	Not for 2σ $Sa(T_1)$	Relatively low
CMS	Yes	Depends on selection
ε (Proxy)	Yes	Moderate
Inelastic	Yes	Depends on selection

5

Initial Recommendations

- To obtain an accurate and precise estimate of median response with a small # of GMs ...

  Base selection & scaling on records properties that are strongly correlated with structural response (e.g., spectral shape)

  Take care to use appropriate "targets" for selection & scaling

- To the extent practical and influential, use GMSM methods that maximize accuracy (minimize bias of median) and maximize precision (minimize variability of median)

6

GMSM for Performance-Based EQ Eng.

- While the recent focus of the PEER GMSM Program has been the building code
  - i.e., "Average" response to 7 GMs
- The GMSM objectives considered are also relevant to PBEE assessments, e.g., those identified by ATC-58 Project:
  - "Time-Based Assessment" (structural response for a given $Sa(T_1)$, M, and R)
  - "Scenario-Based Assessment" (structural response for a given M and R)

7

Near Future Efforts

- PEER Report by mid-Summer 2008, then ...
- Probability distribution (PDF) of response
- Other building response parameters, e.g., ...
  - Individual (vs. Max) Interstory Drift Ratios
  - Peak Floor Accelerations
- Other GMSM studies, e.g., ...

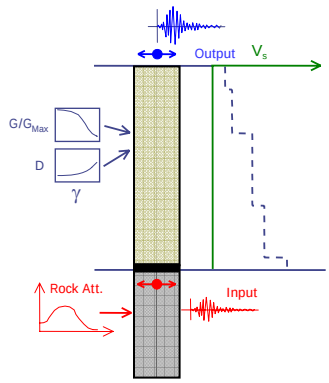
8

GMSM for Ground Response Analyses

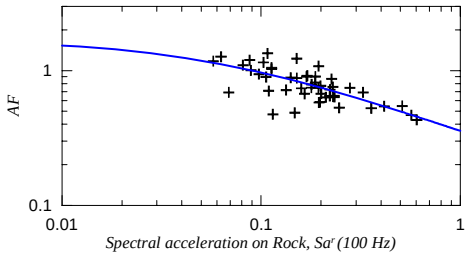
- Ground response analysis (1D wave propagation) is used frequently
- Currently there is no guidance on GMSM
- As for other structures, simulation response can be very sensitive to the GMSM method
- How valid are the response analysis results?
- There is a need to develop guidelines

UCLA

Ground Response Analyses (GRAs)



$$AF(f) = \frac{S_a^{soil}}{S_a^{rock}}$$



$$\ln AF(f) \approx c_0 + c_1\left(\ln S_a^r(f) + c_2\right) + \varepsilon_{\ln AF^{Sa}(f)}\sigma_{\ln AF^{Sa}(f)}$$

UCLA

GMSM Challenges for GRA

- Ground response is significantly different than building response ...
- Soil response is a broadband phenomenon
  - Not controlled by a few meaningful spectral periods like buildings
  - AF is frequency dependent: one response parameter per frequency ➔ book-keeping and modeling challenge

UCLA

GMSM for Bridges

⇨ With support from Caltrans, the GMSM Program will soon venture into bridges.

⇨ Much of what has been learned for buildings can be expected to translate to bridges.

12

2008 and Beyond

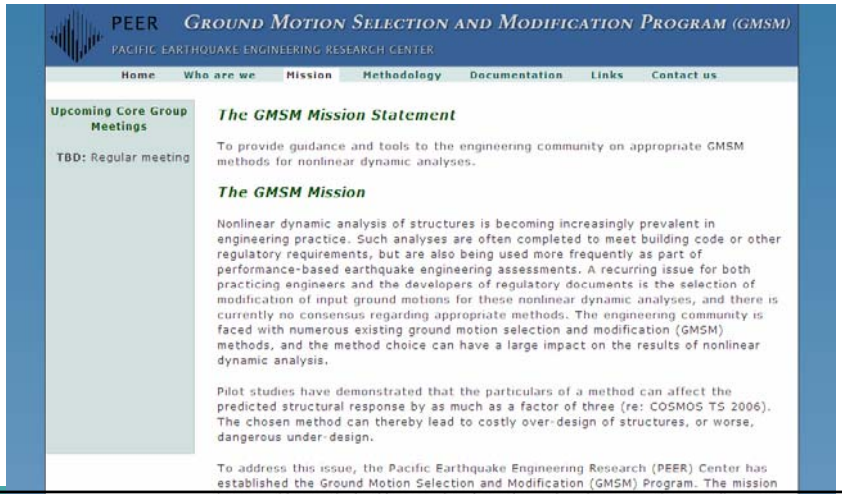
Mission: To develop guidance for the engineering community on appropriate GMSM methods for nonlinear response history analyses.

Vision: To serve as a collaborative and coordinating resource for research projects addressing this key issue.

UCLA

General info and contact

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



Acknowledgements

- Funding from ...

15

Extra Slides ...

16

Initial Observations

- Recommended # records will depend on ...
  - GMSM Objective – e.g., median vs. distribution, for a given M, R only vs. Sa(T_1), M, & R
  - GMSM Method – e.g., Sa(T_1) vs. ε
  - Structure – e.g., influence of nonlinearity and higher modes of response
- Future recommendations should consider/weigh all of these dependencies

17