



Brief Recap & Future Work

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

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Mission of PEER GMSM Program

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

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Recent Focus of PEER GSM Program

- ⇒ Comparisons of various “small n” (aka “smarter selection”) GSM 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”) GSM method for Point-Of-Comparison (POC)
- ⇒ Full understanding of observations in order to
 - (i) arrive at consensus recommendations and
 - (ii) design future “experiments”

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Initial Results

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

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Initial Observations

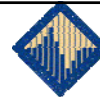


For median response given $S_a(T_1)$, M, and R ...

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

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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)

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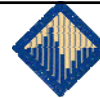
GMSM for Performance-Based EQ Eng.



- ⇒ 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 $S_a(T_1)$, M, and R)
 - ⇒ “Scenario-Based Assessment”
(structural response for a given M and R)

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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., ...

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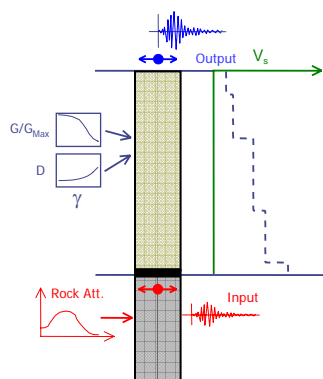
GMSM for Ground Response Analyses

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

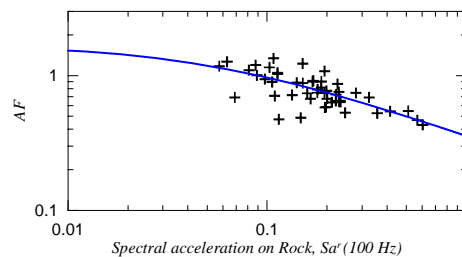
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Ground Response Analyses (GRAs)



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



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

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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

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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.

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2008 and Beyond

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

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

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General info and contact

<http://peer.berkeley.edu/gsm/>

The screenshot shows the website for the PEER Ground Motion Selection and Modification Program (GSM). The header includes the PEER logo and the text "PEER GROUND MOTION SELECTION AND MODIFICATION PROGRAM (GSM) PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER". A navigation menu contains links for Home, Who are we, Mission, Methodology, Documentation, Links, and Contact us. The main content area is divided into two columns. The left column, titled "Upcoming Core Group Meetings", lists "TBD: Regular meeting". The right column, titled "The GSM Mission Statement", contains the following text: "To provide guidance and tools to the engineering community on appropriate GSM methods for nonlinear dynamic analyses." Below this is "The GSM Mission" section, which states: "Nonlinear dynamic analysis of structures is becoming increasingly prevalent in engineering practice. Such analyses are often completed to meet building code or other regulatory requirements, but are also being used more frequently as part of performance-based earthquake engineering assessments. A recurring issue for both practicing engineers and the developers of regulatory documents is the selection of modification of input ground motions for these nonlinear dynamic analyses, and there is currently no consensus regarding appropriate methods. The engineering community is faced with numerous existing ground motion selection and modification (GSM) methods, and the method choice can have a large impact on the results of nonlinear dynamic analysis." A final paragraph notes: "Pilot studies have demonstrated that the particulars of a method can affect the predicted structural response by as much as a factor of three (re: COSMOS TS 2006). The chosen method can thereby lead to costly over-design of structures, or worse, dangerous under-design." At the bottom, a concluding sentence reads: "To address this issue, the Pacific Earthquake Engineering Research (PEER) Center has established the Ground Motion Selection and Modification (GSM) Program. The mission



Acknowledgements

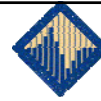


⇒ Funding from ...



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Extra Slides ...



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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