Focus of “GMSV-SEISM” Efforts

SCEC Ground Motion Simulation Validation (GMSV) Technical Activity Group (TAG) Workshop

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Background

- GMSV TAG “kickoff” workshop held in January 2011
- Proposal for SEISM (Software Environment for Integrated Seismic Modeling) project submitted in July 2011
- “A key objective of SEISM project is to establish a comprehensive validation framework that conforms to end-user requirements.” (from SEISM project proposal)
- Members of GMSV TAG proposed 3-component framework:
  1. GMSV using single-degree-of-freedom (SDoF) oscillators
  2. GMSV for geotechnical systems
  3. GMSV for multi-DoF (MDoF) nonlinear building systems
Subsequent Developments

• TAG has realized that “GMSV for SDoF oscillators / geotechnical systems / MDoF nonlinear building systems” are very broad components

• Broadband Platform Validation Project is focused on GMSV using elastic SDoF oscillators, for use of simulations in developing GMPE’s

• TAG has seen that tighter coordination between GMSV efforts is needed

• All of these have led the “GMSV-SEISM subgroup” to focus on the following …
(3) GMSV for MDoF Nonlinear Buildings

• Focus of GMSV-SEISM subgroup members Lunio Iervolino & Farzin Zareian et al

• Target Engineering Application = Nonlinear Response History Analysis (NRHA) in building code applications

• Objective of NRHA is to estimate mean/median building response (member forces and story drifts) conditioned on an elastic response spectrum

• U.S. building codes already permit the use of simulated ground motion time series
(2) GMSV for Geotechnical Systems

- Focus of GMSV-SEISM subgroup member Jonathan Stewart et al.
- Target Engineering Application = Site Response Analysis (SRA) in building code applications
- Objective of SRA is to transform “bedrock” elastic response spectrum to surface spectrum for site-specific conditions
- Less sensitive to duration than other geotechnical systems

(From C. Goulet)
(2) GMSV for Geotechnical Systems

- Focus of GMSV-SEISM subgroup member Jonathan Stewart (or Ellen Rathje?)

- Target Engineering Application = earthquake-induced landslide displacement (Newmark sliding block) analysis for California Seismic Hazards Mapping Act

- Landslide displacements are sensitive to ground motion duration
Focus of GMSV-SEISM subgroup member Jack Baker et al

Not targeting particular engineering application, but rather identifying relatively simple metrics that …

- have some relevance for more general and complex systems
- have something like a “correct answer” that we can validate against

(1) GMSV using SDoF Oscillators
Coordination of Three Components

- Although focus is GMSV methodologies, for comparisons across components all are using simulated ground motions from Broadband Platform Validation Project, i.e., …
  - simulated ground motions for 23 historical and 3 future scenario earthquakes at ~40 stations each
  - 50 realizations for each earthquake

- Wherever possible, all components are performing the same types of GMSV tests, again for comparison purposes
  - How do GMSV conclusions compare for SDoF oscillators vs. geotechnical systems vs. MDoF nonlinear buildings?
  - 50 realizations for each earthquake
• Compare analysis (e.g., NHRA or SRA) responses to simulated vs. recorded ground motions for historical earthquakes and station locations

• The multiple realizations for each historical earthquake from the Broadband Platform Validation Project make it possible to rate the simulation models via Bayesian Model Selection

• This validation test can also be applied for elastic SDoF oscillators (in coordination with BPVP)

• Ground motion *time series* from Broadband Platform Validation Project will need to be selected/adjusted for consistency with site profile at each station location
GMSV-SEISM Validation Test 2 of 2

- Compare analysis responses to simulated vs. recorded ground motions that have substantially similar elastic (or inelastic?) spectra
- Isolates any differences in responses to simulated vs. recorded ground motions beyond those induced by differences in spectra
- Also tests use of simulated ground motions from an archive/database in building code NRHA or SRA applications
Summary

• GMSV-SEISM subgroup is focused on coordinated validation efforts using/for …
  1. Single-degree-of-freedom (SDoF) oscillators
  2. Geotechnical systems (e.g., site response, liquefaction analysis)
  3. Multi-degree-of-freedom (MDoF) nonlinear building systems

• Some efforts target particular engineering applications:
  1. Nonlinear response history analysis in building code applications (Iervolino & Zareian et al)
  2. Landslide displacement or liquefaction analysis for California Seismic Hazard Mapping Act (Stewart et al)

• Other efforts focus on relatively simple metrics that can serve as “validation proxies” (primarily Baker et al)