

Focus of “GMSV-SEISM” Efforts

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

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Background

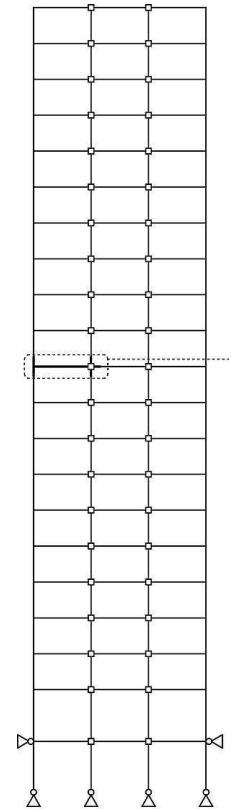
- GMSV TAG “kickoff” workshop held in January 2011
- Proposal for SEISM (Software Environment for Integrated Seismic Modeling) project submitted in July 2011
- “A key objective of SEISM project is to establish a comprehensive validation framework that conforms to end-user requirements.” (from SEISM project 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 ...

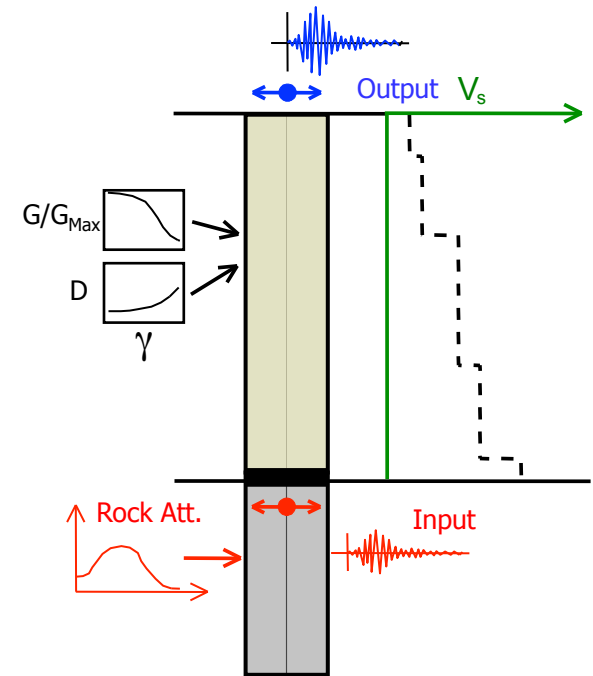
(3) GMSV for MDoF Nonlinear Buildings

- Focus of GMSV-SEISM subgroup members Iunio 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

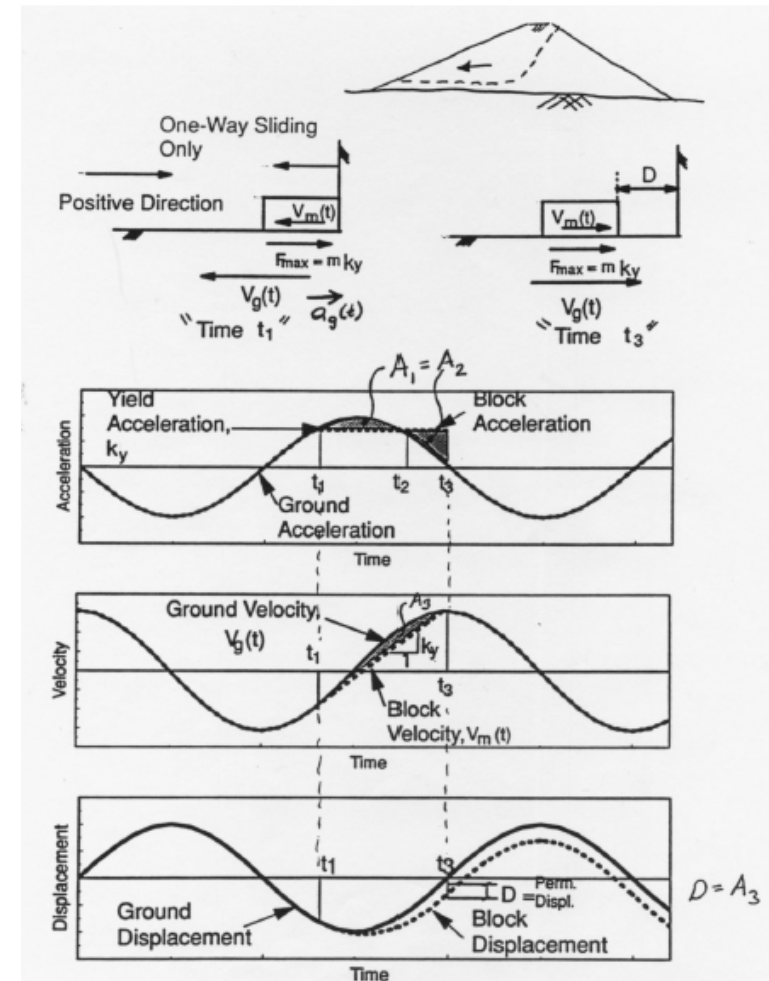
- Focus of GMSV-SEISM subgroup member Jonathan Stewart et al
- Target Engineering Application = Site Response Analysis (SRA) in building code applications
- Objective of SRA is to transform “bedrock” elastic response spectrum to surface spectrum for site-specific conditions
- Less sensitive to duration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



(From C. Goulet)

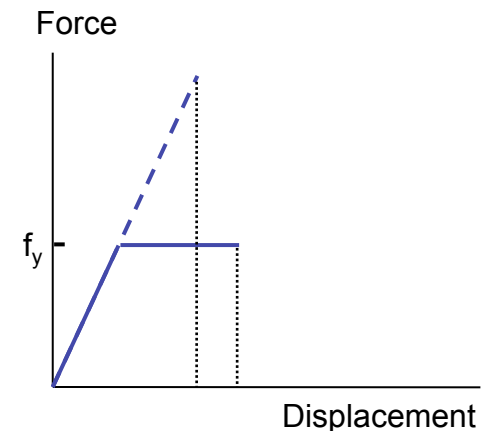
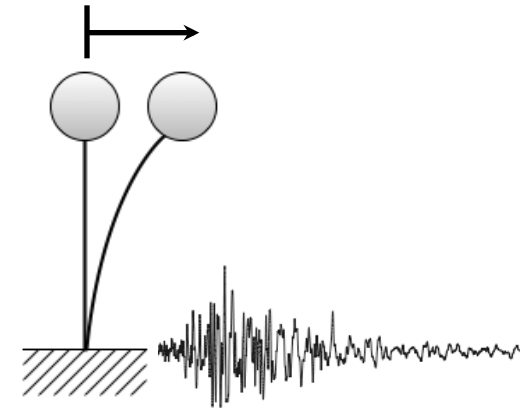
(2) GMSV for Geotechnical Systems

- 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



(1) GMSV using SDoF Oscillators

- 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



Coordination of Three Components

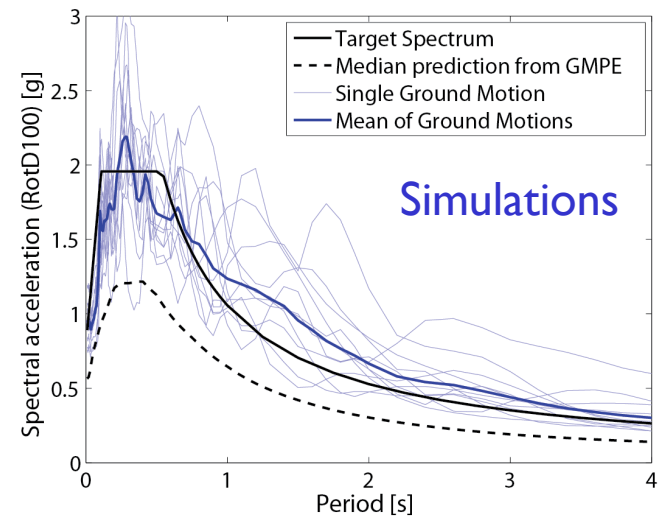
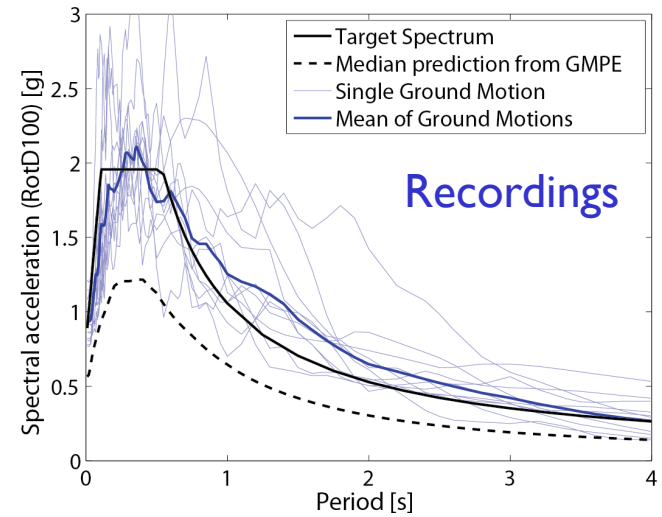
- Although focus is **GMSV methodologies**, for comparisons across components all are using simulated ground motions from Broadband Platform Validation Project, i.e., ...
 - simulated ground motions for 23 historical and 3 future scenario earthquakes at ~40 stations each
 - 50 realizations for each earthquake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

GMSV-SEISM Validation Test 1 of 2

- 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)