PEER-CEA Woodframe Project

Task 3: Ground Motion & Loading Protocol

Panel Of Experts Mtg I

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Panel Discussion + Action Items

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CEA CALIFORNIA EARTHQUAKE AUTHORITY

Meeting Agenda

- Introductions
- Review Objectives
- High-level discussion of each deliverable
- Detailed Discussion Topics:
  - Site selection & site class
  - Sample PSHA of one site (Nick & Linda)
- Detailed discussion of each deliverable

Task 3.1: Selecting and Scaling Ground-Motion Records

Deliverable:

Sets of selected and scaled ground motions appropriate for testing and analytical investigations

Experts Workshop

Written report documenting the process and outcome.

Workshops

Report

Meeting Participants

- Yousef Bozorgnia, UC Berkeley — PI
- Silvia Mazzoni, UC Berkeley — Ground Motions & Simulation
- Linda AlAtik, consultant — Seismology
- Nick Gregor, consultant — Seismology
- Jack Baker, Stanford — Ground Motions
- Greg Dieirlein, Stanford — Numerical Simulation
- Farzin Zareian, UC Irvine — Numerical Simulation
- Chia-Ming Uang, UC San Diego — Experiments
- Badie Rowshandel — CEA
- Shizza Fatima — PEER

PANEL DISCUSSION

Methodology

A. Ground motions for analysis

1. Determine objective of ground motions: Fragility-Curve Development
2. Select number of ground-motion suites per site
3. Select Sites & Site Conditions
4. Perform Seismic Hazard Analysis
5. Define Uniform-Hazard Spectra, different hazard levels
6. Define Target Spectra for ground-motion suites at each hazard level
   - UHS – one Target Spectrum per hazard level
   - CMS – one Target Spectrum per hazard level + conditioning period
7. Determine number of ground motions in each suite
8. Determine dimensions and directionality of ground motions
   - 2D
     - The Target Spectrum was computed for rotD50
     - How do you handle each component response
   - 1D
     - How do you determine equivalency
     - Decision based on scope of Fragility curves
9. Search records based on deaggregation at size, hazard and period
10. Consider Synthetic Records
11. Scale records based on target spectrum. Modify records, if necessary
12. Compute inelastic spectra for records
13. Deliver Records to analyst

B. Ground Motions for experimental testing

1. Define objective of ground motions
2. Select Records based on the objectives and results from analysis
3. Discuss with researchers

A'. Additional Topics

14. Variability & Uncertainty

1. Objective of GM

A. Ground motions for analysis

1. Determine objective of ground motions: Fragility-Curve Development

PANEL DISCUSSION:

A. Confirm MSA

B. Select IM

C. Number of GM Suites

PANEL-DISCUSSION SUMMARY:

- The ultimate goal is to develop loss functions to deliver to the loss modelers. Loss functions typically have a spectral-acceleration value as the Intensity Measure (IM) in the abscissa (x) and a loss function in the ordinate (y).
- We need to determine what IM loss modelers use, is it PSA at T=1sec?
- As researchers, we may want to consider a vector Intensity Measure (Sa, spectral shape, duration, site conditions, pulse) to be able to influence industry

2.Number of GM suites per site

PANEL DISCUSSION:

- Approve multiple suites: Select different ground motion suites for different hazard levels to preserve spectral shape

PANEL-DISCUSSION SUMMARY:

- Determine how many stripes will be used. We are not just looking at collapse, so we are interested in lower levels IM
- Depends on spectra shape and deaggregation and representation of stripes
- ~20-40 analyses per IM level to feed into SP3
- Communicate with loss modelers to determine what IM they need in the horizontal axis. We then chose stripes with ground motions that are representative of these values

3. Select Sites & Site Condition

PANEL DISCUSSION:

A. Number of sites

B. Site Class

PANEL-DISCUSSION SUMMARY:

- CEA (Badie) will give us feeback on addition/removal of sites based on population and Vs30. Badie will look at CEA portfolio and make recommendations based on population and site characteristics.
- Do we need to consider Vs30 range, based on population? We can select a small number of sites to represent different seismicities and then vary Vs30 for these sites.
- Widen initial list of sites
- Look at Northern Northern CA (Eureka) as well. The Cascadia subduction sources are not expected to control the hazard in the period range of interest <1sec
- Consider a site in the Sierras where there is low seismicity, but there will alse be low population
- Consider Napa as there is significant data from that region.
- Even though spectral shape is the same, deaggregation is different
- Silvia can perform simple inelastic analyses to determine whether the additional parameters make a difference. We need to develop a representative inelastic model. The results from these analyses can be used to make the final selection of sites.
- Duration? Duration will be represented by the time histories directly.
- Communicate with loss modelers to determine what is the actual input of interest
- Shawna at CEA has loss models and can be first response to loss-modeling questions. She can give us feedback before getting loss modelers involved
- Are the sites supposed to represent all places, or just critical places?
- Badie recommended we use Northridge rather than San Fernando to represent the San Fernando Valley since we have data from the Northridge EQ
- Once we have finalized our site selection, we can ask UCLA to estimate Vs30 more accurately
- Team members will get feedback from practitioners who work on houses to estimate typical Vs30
- Keep period range on interest into account when evaluating spectra (T<1sec)
- Is Vs30 significant in developing loss functions?

4. Perform Seismic Hazard Analysis (PSHA)

PANEL DISCUSSION:

- Approve use of Haz-45
- Approve use of UCERF-3

PANEL-DISCUSSION SUMMARY:

- UCERF-3 allows for triggering between multi-segment ruptures
- Even though UCERF-3 is more complicated, it is the state of the art. UCERF-3 was implemented by USGS for the seismic maps of California.
- The implementation by Nick and Linda represents the latest implementation of UCERF-3 with significant improvements over past implementation
- Verify that Near-Field and Basin Effects do not need to be taken into account in the PSHA. They can, however, be taken into account in the ground-motion selection by selecting records with NF and Basin effects
- Keep period range on interest into account when evaluating spectra (T<1sec)
- Compute spectra for Vs=270,360,560 m/s

5. Define Uniform-Hazard Spectra

PANEL DISCUSSION:

- Approve Hazard Levels: RP: 72,100,250,475,1000,2475

PANEL-DISCUSSION SUMMARY:

- Evaluate spectral shape difference between different hazard levels
- Financial loss in more interested in lower RP. Revisit 72,100 as the lowest values. Will communicate with loss modelers, ask Shawna (Portfolio vs. site)
- Add RP:5000 to include collapse

6. Define Target Spectra

PANEL DISCUSSION:

- Approve no Deterministic
- UHS vs CMS
- If CMS:
  - Tconditioning
  - Epsilon0

PANEL-DISCUSSION SUMMARY:

- Agreed that the Deterministic spectrum does not apply to the scope of this project.
- Keep both UHS and CMS
- CMS may not provide additional benefit at T<1sec
- Conditional Spectra: tracking of dispersion in ground motions
- At each site, track design-value maps MCE

7. Number of Ground Motions in Each Suite

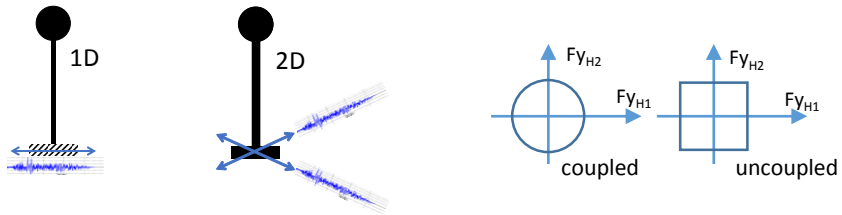
PANEL DISCUSSION:

- Set limits on number of records per suite

PANEL-DISCUSSION SUMMARY:

- 20-40 ground motions per suite (at each hazard level)

8. Record Dimensions & Directionality



- PANEL DISCUSSION:
- Dimension: 2D or 1D
- If 2D:
  - Spectrum Resultant (rotD50?)
  - Analysis model, coupled or uncoupled
  - Measure H1, H2, max(H1,H2), rotD50, Geomean, resultant?

PANEL-DISCUSSION SUMMARY:

- The analytical models will be in 2D. Hence we need horizontal pairs of ground motions
- Vertical motions are not considered in this scope

9. Search Records

PANEL DISCUSSION

- limit on number of records per event

PANEL-DISCUSSION SUMMARY:

- When dealing with a large number of ground motions, there is no set limit on number of records per event. However, it should be kept low to not induce a bias.

10. Synthetic Records

PANEL DISCUSSION:

- Confirm no use of synthetics

PANEL-DISCUSSION SUMMARY:

- No need to go to synthetic records. This will be confirmed in the selection process
- T<1sec, stochastic models are used for synthetics anyways

11.Ground-Motion Scaling & Modification

PANEL DISCUSSION

- Which methods to consider

- In 2D analysis, modification can change results, we need to consider a proxy and check it. How do we reconcile the rotD50.
  - Need 2D modification, or proxy

PANEL-DISCUSSION SUMMARY:

- No spectral matching needed at this point since we have a large enough suite of records.

12. Inelastic Spectra

PANEL DISCUSSION

Confirm inelastic models are consistent with those used by the analyst

PANEL-DISCUSSION SUMMARY:

- Perform simple inelastic analyses to determine whether the additional parameters make a difference. We need to develop a representative inelastic model. The results from these analyses can be used to make the final selection of sites.
- We need to obtain the ATC 110 models.
- Ensure that analysists models are consistent between all groups.
- Greg's group, loading protocol, practitioners and ATC 110 and John Osteraas

13. Delivery

PANEL DISCUSSION

- Any additional considerations?

PANEL-DISCUSSION SUMMARY:

- Continued communication between GM group and analysis will ensure proper delivery within project scope
- We need to develop and maintain specifications and workflow documents for all steps in the ground-motion selection and loss-function development

14. Variability & Uncertainty

PANEL DISCUSSION

- Any additional considerations?

PANEL-DISCUSSION SUMMARY:

- Continue documentation of variability and uncertainty at all levels

Methodology

B. Ground Motions for experimental testing

1. Define objective of ground motions
2. Select Records based on the objectives and results from analysis
3. Discuss with researchers

PANEL-DISCUSSION SUMMARY:

- Need to follow up discussion
- What is the scope of the ground motions for experimental testing? Development of loading protocols.
- Discuss models being used by analysists, to keep consistency
- SDOF/2DOF inelastic model

SUMMARY OF ACTION ITEMS

Summary of Action Items

- Questions for CEA
  - Please review the 10 proposed sites and evaluate them in terms of population in the CEA portfolio.
  - What additional sites are recommended by CEA on the basis of their portfolio?
  - What is the typical Vs30 for the CEA portfolio, if known.
- Questions for Loss Modelers via CEA
  - What are the most used Intensity Measures (IM) in a loss function?
  - When spectral acceleration is used as an IM, at what periods? PGA? 1 second?
  - What return periods are loss modelers most interested in when evaluating a portfolio or a single site?

- Other Action Items:
  - Include Evan in future discussions for selection of index buildings
  - Check with practitioners to get estimates of typical Vs30 for residential homes
  - Confirm that the period of interest <1sec
  - Obtain ATC 110 models to determine initial model for simplified inelastic spectra
  - Develop specification and workflow documents for all steps in GM development and loss-function development