July 21, 2016 CENA Site Amp Panel

Attending in person. Panel members Atkinson, Boore, Darragh, Hashash, Silva, Stewart. Panel advisors: Bozorgnia, Petersen. Observers/contributors: Kishida, Parker

Attending by phone. Panel member Goulet. Observers: Harmon and Okan

This document has two section. First is meeting notes, second is discussion from end of meeting on key issues for panel to address in order to produce our recommendations.

Schedule for future meetings at bottom of file.

Meetings Notes

Jon Stewart:

Project introduction – see attached slides

Key points:

- Goal is site factors to be used in the hazard integral for range of oscillator periods for the CENA region. These will operate in the background within USGS hazard tool. There will no longer be published site coefficients for use in ELF analysis (Chap 11).
- Primary site parameter expected by Project 17 / USGS is VS30. We can advocate for additional parameters like f_{peak}. They can be introduced into Chapter 21 commentary at a minimum, we need to see about whether this could be part of the USGS web site as an optional predictive parameter
- As we contemplate alternative models, we need to think about two components – the linear model and the nonlinear model. The linear model is VS30, depth, and/or frequency dependent. The nonlinear model is VS30 dependent and uses PGA or PSA on reference condition.

Mark Petersen:

USGS maps mid 2018 update, later 2020 update

Modeling updates needed by Feb 2017

USGS National Crustal Model (NCM) – sediment thickness, depth to basement, Moho depth. First output is Z1.0, Z2.5. Developers are Oliver Boyd and Anji Shah. Boyd works in Mark's group.

USGS NCM – May ultimately be useful to investigate what depth parameter has predictive power for site response in CENA? Goal of NCM is to compile Z1 and Z2.5, as well as depth to basement. How is depth to basement defined?

> Discussion: Not yet known, project is in early stages. Mark says that we should not count on outputs of this project being ready in time for application in our work for this project.

Mark qns:

- Are our site factors applicable to all NGA-East GMMs and older GMMs?

- What basin factors will be included?

- How to deal with Gulf Coast, Embayment? Gulf coast region excludes Mississippi embayment

- Do we need separate factors for FAS and PSA?

- Need 760/3000 factors, how to pair these with other x/760 models?

Gulf Coast: Adjustments for GMPEs are given, they modify the path term, both geometric spreading and anelastic attenuation. Two modifications, combined as weighted average. These appear in PEER report 2016/18.

Youssef Hashash:

Description of simulation framework and results. NGA-East GWG.

Summary of key points:

- Massive simulation effort using Deepsoil
- Range of profiles spanning geologic conditions in CENA, nonlinear curves, weathered bedrock profiles, and depths. Range of input motions.
- Analyses run linear, EL, NL, with strength control.
- Models fit to analysis results. These are denoted here as NGA-S
- The models of most direct relevance for this project are for the linear VS30 scaling, F (760/3000) terms, linear resonance around f_0, and nonlinear term. There is also a depth term, but we are unlikely be able to use this due to lack of mapped depths across CENA.
- The simulation results may be archived in a database format – discussion of possible PEER support for this effort.

Dave question – what is the reason for the max error at 0.03 sec when a VS30 based model is used? Differences between models become less significant as T increases.

The VS30 scaling from the simulation models have parabolic shape, producing low amplification, or de-amplification, for slow VS30. The amplification peaks near 400 m/s.

Grace Parker:

Presented analysis of NGA-E data to evaluate site amplification. See attachment for details. Some key points:

- Work performed as part of GWG. Denoted GWG-E
- Amplification is relative to 760.
- Amp levels are consistent when analyzed using three types of GMMs, indicating stability.
- Distinct VS30 scaling in glaciated and non-glaciated regions, with stronger scaling for glaciated.
- For non-glaciated, little trend with T
- For glaciated, stronger scaling for short T than long T; opposite of ACR models

- For use with a 3000 m/s GMM, the site amp from this model needs to be coupled with a F (760/3000) model.

Take aways from comments provided:

- Add in Gulf Coast & MS embayment data with adjustments to the GMPEs (PEER 2016/18)
- PIE data were included in the analysis. Need to look at the PIEs event terms and within-event residuals; are the within-event residuals biased relative to non-PIE events?
- Al Noman and Cramer 2015 model was not selected as a source model for Sammons. However, the problems with this model that caused it to not be selected may not matter in the range of the data, where it is being used.
- The GMMs selected to evaluate reference site ground motions have been adjusted since the original PEER report. The adjustments likely do not matter in the range of the data where being applied, but updated versions should be used. These GMM adjustments include extrapolating to large distances
- Look at residuals vs distance and M when GWG-E site model is coupled with the GMMs.
- Try to explain the different VS30 trends in glacial and non-glacial areas. Two ways to do this: (1) sample the profile database in glacial/non-glacial areas to see if gradients are different. There is not sufficient time to analytically demonstrate why the scaling is different based on profile characteristics, but can look for qualitative differences in profile characteristics. (2) Are there different percentages of sites with identified f_{peak} values in G and NG regions, and are the values of f_{peak} different (look at histograms).
- Look for local peaks in the amp-VS30 plots near the VS30 for which f_{peak} aligns with the oscillator period
- From Dave - Look at effect of older (Illinoisan, Kansan) glacial extent from Reed and Bush (2005), compare to Wisconsin

Gail to send Grace f_{peak} value for NGA-East stations. It would be interesting to see if residuals of GWG-E model correlate to f_{peak} (they almost certainly do). This is an interesting research exercise, but likely not critical for the present project.

<u>Gail Atkinson:</u>

Best parameter for describing site amp is f_{peak}.

Recent papers explore the use of f_{peak} to derive site amp, and f_{peak} to VS30 correlations.

Discussion that it may be best to use VS30 and f_{peak} together, since f_{peak} is effective at high frequencies, and VS30 is often most effective at longer T. Both likely to be considered in GMPEs.

Slide 9: shows model that takes H/V spectrum and adjusts to Fourier amp S/B ratios. Japan data.

Model presented that predicts amp relative to 2000 m/s. Attributes:

- Amp is plotted as a function of f_{peak}. If the PSA oscillator period is T, the amp is peaking at f_{peak} = 1/T. For example, 0.2 sec PSA amp peaks at f_{peak} = 5 Hz.

- The amp referenced to 760 m/s is not very different than that for 2000 m/s. Hence, should not adjust amp rel to 2000 m/s using F (760/2000) factors. For comparison plots, best to use her model that is directly referenced to 760 m/s.
- As currently configured, Atkinson model difficult to compare to others, since the amp is conditioned on f_{peak}, which produces the peaked behavior described in first bullet – this would not occur if the original conditioning were on VS30.

Qn: If we do microtremor, do we get the same fpeak as in an earthquake? Satoh et al. 2001 says they match for fpeak > 1 Hz. Gail has done some measurements in Quebec that support this, but doesn't have data for lower frequency sites (thus far).

Look into European studies on this issue, lots of work on H/V ratios

<u>Bob Darragh:</u>

Linear elastic amp factors for FAS spectral inversion – this is what appears in the 2015 PEER report (2015/04). NEHRP site category amps

Assume deep soil profiles and soft/firm conditions similar in E and W

Assumed similarity, if true, would imply same within-cat amp for E and W

Kamai et al. (2013) profiles (developed for W) used in simulations

We probably don't want to use the linear amps from this study. The nonlinear amps can be compared to those derived for CENA by GWG-S. This can be conveniently done using the f2 values from the SS14 model.

Discussion/Critical Issues/Next Steps

See slides 20-23 for summary.

Suggestions for terminology other than "reverse scaling" to describe parabolic trend of GWG-S VS30 scaling. Perhaps 'parabolic scaling'

Investigate the glacial effect observed in the GWG-E amps – details above. Profiles, f_{peak} distributions.

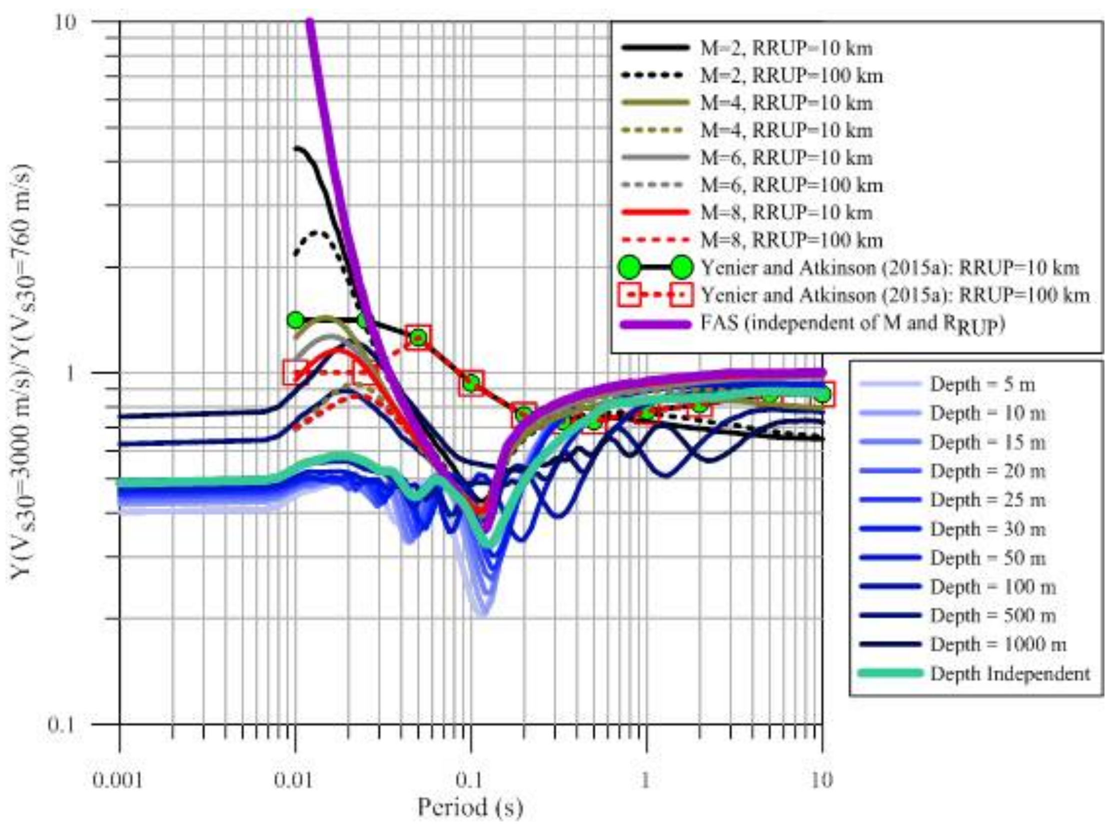
We eliminated several of the linear models from future consideration: Al Noman and Cramer, Grazier. Will continue to look at GWG-S, GWG-E, Atkinson, and ACR models.

A critical issue moving forward is the different VS30-scaling implied by the simulations vs. the empirical data analysis. The panel will need to eventually decide on how to weight these two models.

Two nonlinear models to be considered: GWG-S and ACR. A challenge in these comparisons is that three things are changing – (1) profiles are different (2) NL and EL for GWG, EL only for ACR (3) different nonlinear curves

Want to continue to look at amplification using both 760 and 3000 m/s reference condition for comparison. However, USGS will likely be using NGA-E "final" (i.e. Sammon's map) GMMs that have 3000 m/s as a reference

Discussion of different 3000/760 correction factors. GWG-simulation-based and Boore/Campbell models agree well, however the Yenier and Atkinson is quite different at T < 0.2s. This is shown on the following comparison plot generated by Joseph.



<u>Upcoming meetings:</u>

Aug 23 2016 10-11 am PDT. Phone/ReadyTalk

Oct 13 2016 10-11 am PDT. Phone/ReadyTalk

Nov 10 2016 all day. In-person. PEER center