

The Travails of the Average Geotechnical Engineer Using the National Seismic Hazard Maps

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Agenda

1. Will not address the use of the National Seismic Hazard Maps for determining the maximum considered earthquake ground motions (MCE_R) for structural design.
2. Instead, address issues that the average geotechnical engineer must now consider in design of structures required by recent building code requirements.
3. Will look at what's available from National Seismic Hazards Mapping program.
4. Will look at what shortcomings there are in the system.
5. Hopefully have constructive suggestions to make life easier for the average geotechnical engineer.

Evaluation of Liquefaction Potential

Geotechnical Investigation Report Requirements – ASCE-SEI 7-10

- ▶ Section 11.8.2 requires evaluation of “potential geologic and seismic hazards” including:
 - ▶ Slope instability
 - ▶ Liquefaction
 - ▶ Total and differential settlement, and
 - ▶ Surface displacement due to faulting or seismically induced lateral spreading or lateral flow
- ▶ Section 11.8.3 also requires evaluation of:
 - ▶ Dynamic seismic lateral earth pressures on basement and retaining walls due to design earthquake ground motions



Evaluation of Liquefaction Potential

Geotechnical Investigation Report Requirements – ASCE-SEI 7-10

- ▶ The potential for liquefaction and soil strength loss is to be evaluated for site peak ground acceleration (PGA), earthquake magnitude, and source characteristics consistent with the MCE_G peak ground acceleration, which can be determined by either:
 - ▶ Site-specific study.
 - ▶ Mapped MCE_G peak ground acceleration (Figs. 22-7 through 22-10).
 - MCE_G peak ground acceleration (PGA) is based on Site Class B
 - PGA_M is adjusted for Site Class effects by Table 11.8-1 Site Coefficients

Evaluation of Liquefaction Potential

Geotechnical Investigation Report Requirements – ASCE-SEI 7-10

- ▶ Figure 22-7
 - ▶ ASCE 7-10 only provides PGA.
 - ▶ No information on Magnitude.
 - ▶ No guidance on how to get it.

CHAPTER 22 SEISMIC GROUND MOTION LONG-PERIOD TRANSITION AND RISK COEFFICIENT MAPS

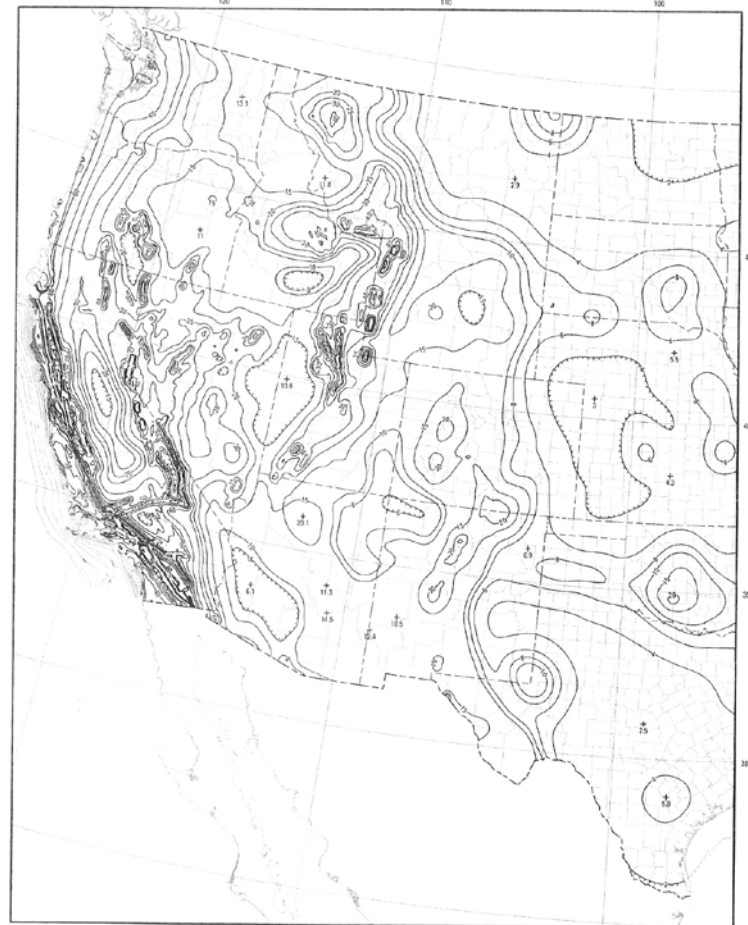


FIGURE 22-7 Maximum Considered Earthquake Geometric Mean (MCE_g) PGA, %g, Site Class B for the Conterminous United States.



Evaluation of Liquefaction Potential

What's available from the Hazards Program?

The screenshot displays the USGS Earthquake Hazards Program website. The header includes the USGS logo and navigation links for Home, About Us, and Contact Us. The main navigation bar lists categories: EARTHQUAKES, HAZARDS, DATA & PRODUCTS, LEARN, MONITORING, and RESEARCH. The 'Hazards' section is highlighted, and a message states: "The USGS has recently released updated 2014 seismic hazard maps for the conterminous U.S. The maps, documentation, and data will be posted here as they become available."

Key sections on the page include:

- Seismic Hazard Maps and Data:** Offers probabilistic and scenario ground-motion hazard maps, input and output data, and documentation. Includes filters for Lower 48, Alaska, Hawaii, Puerto Rico & U.S. Virgin Islands, Guam & Marianas, Samoa & Pacific Islands, Urban & Regional, Scenarios, Time-Dependent EQ Probability Maps, and Foreign.
- Seismic Hazard Analysis Tools:** Provides tools to create customized hazard and probability maps, hazard curves, interactive deaggregations, and custom earthquake probability maps.
- Seismic Hazards Primers:** Lists resources such as "Earthquake Hazards 101: The Basics", "Earthquake Hazards 2014 Technical Q&A", "Fact Sheet - what are hazard maps?", and "FAQ".
- About the NSHM Project:** Includes links for Publications, Workshops, and Personnel.
- Faults:** Provides information on where faults are in a user's area and when they last had a large earthquake.
- Seismic Design Maps, Data, and Tools for Engineers:** Offers ground motion parameter values for building and bridge design.

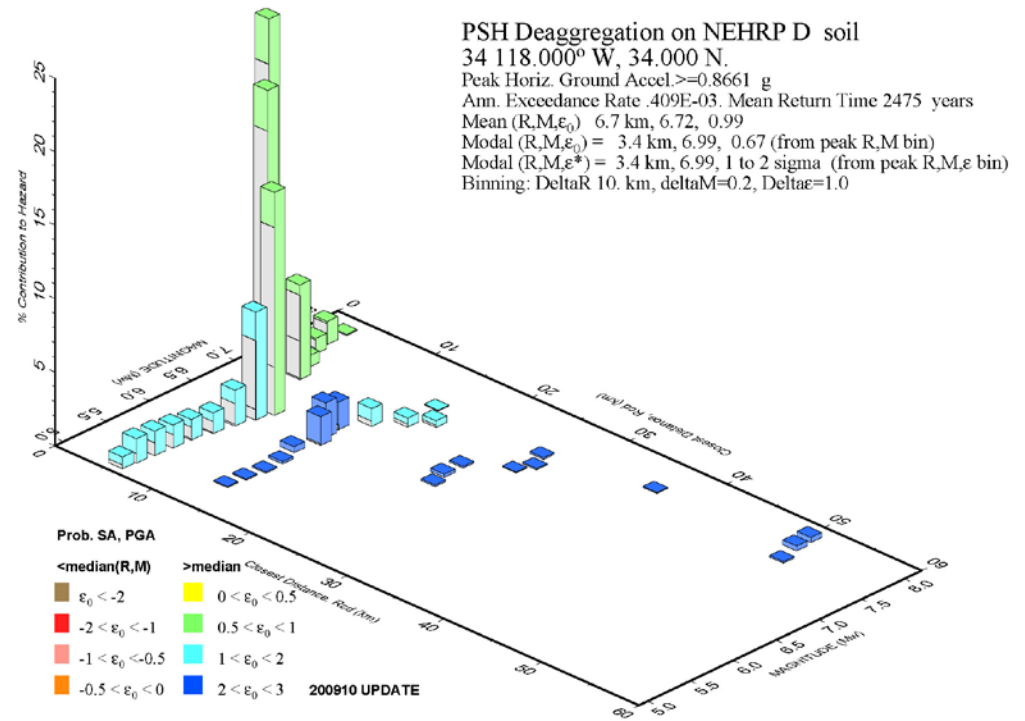
At the bottom, there is a navigation menu with links for EARTHQUAKES, HAZARDS, DATA & PRODUCTS, LEARN, MONITORING, and RESEARCH, each with sub-links to various resources. Social media sharing options for Facebook, Twitter, Google+, and Email are also present.



Evaluation of Liquefaction Potential

What's available from the Hazards Program?

- Deaggregations available from Hazards website
- Typical Geotechnical Engineers unaware of availability.
- Guidance not provided in ASCE/SEI 7-10 or IBC.



GMT 2015 Sep 14 17:18:28 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 300. m/s top 30 m. USGS CQHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

Evaluation of Dynamic Seismic Earth Pressures

Traditional analysis for dynamic seismic earth pressure is the **Mononobe-Okabe method.**

- ▶ For new construction, the seismic earth pressure is to be evaluated for site peak ground acceleration (PGA), earthquake magnitude, and source characteristics consistent with the MCE_G peak ground acceleration. Again, can be evaluated by:
 - ▶ Site-specific study.
 - ▶ Mapped MCE_G peak ground acceleration (Figs. 22-7 through 22-10).
 - MCE_G peak ground acceleration (PGA) is based on Site Class B
 - PGA_M is adjusted for Site Class effects by Table 11.8-1 Site Coefficients

Evaluation of Dynamic Seismic Earth Pressures

Mononobe-Okabe Method (described by Seed & Whitman)

- ▶ Requires the PGA
 - ▶ PGAs in CA, New Madrid, and Charleston can be as high as 100 to 150% of gravity per ASCE 7.
 - ▶ Full analysis method is unstable for large PGA values as equations blow up.

CHAPTER 22 SEISMIC GROUND MOTION LONG-PERIOD TRANSITION AND RISK COEFFICIENT MAPS

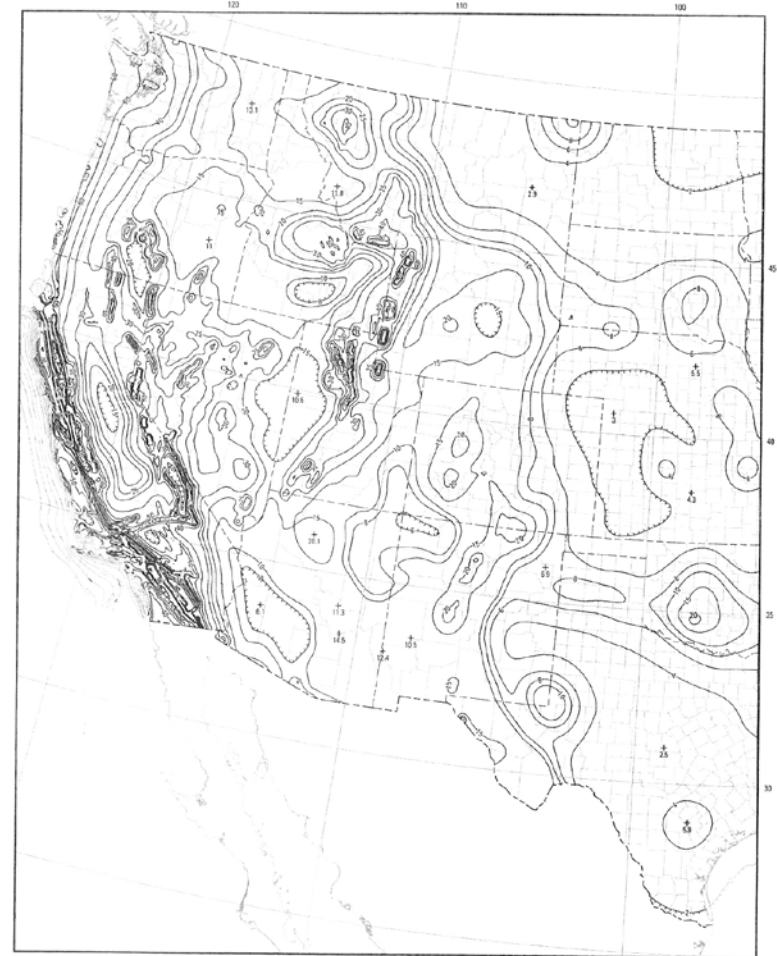


FIGURE 22-7 Maximum Considered Earthquake Geometric Mean (MCE_c) PGA, %g, Site Class B for the Conterminous United States.

Evaluation of Dynamic Seismic Earth Pressures

Mononobe-Okabe Method (described by Seed & Whitman)

- ▶ For practical purposes, Seed and Whitman proposed to separate the total maximum earth pressure into two components, the initial static (active) earth pressure and the dynamic earth pressure component.
- ▶ For the dynamic earth pressure component, Seed and Whitman approximation for the dynamic lateral earth pressure coefficient of $\Delta K_{AE} \sim (3/4) k_h$, where k_h is the “horizontal ground acceleration divided by gravitational acceleration.”
- ▶ For PGAs of 100% to 150% g, ΔK_{AE} would be ~ 0.75 to 1.125 . Since a typical value for the lateral active earth pressure may be 0.25 to 0.30, the seismic lateral earth pressure may be some 3 to $4\frac{1}{2}$ times the static lateral earth pressure.
- ▶ Does this make sense?

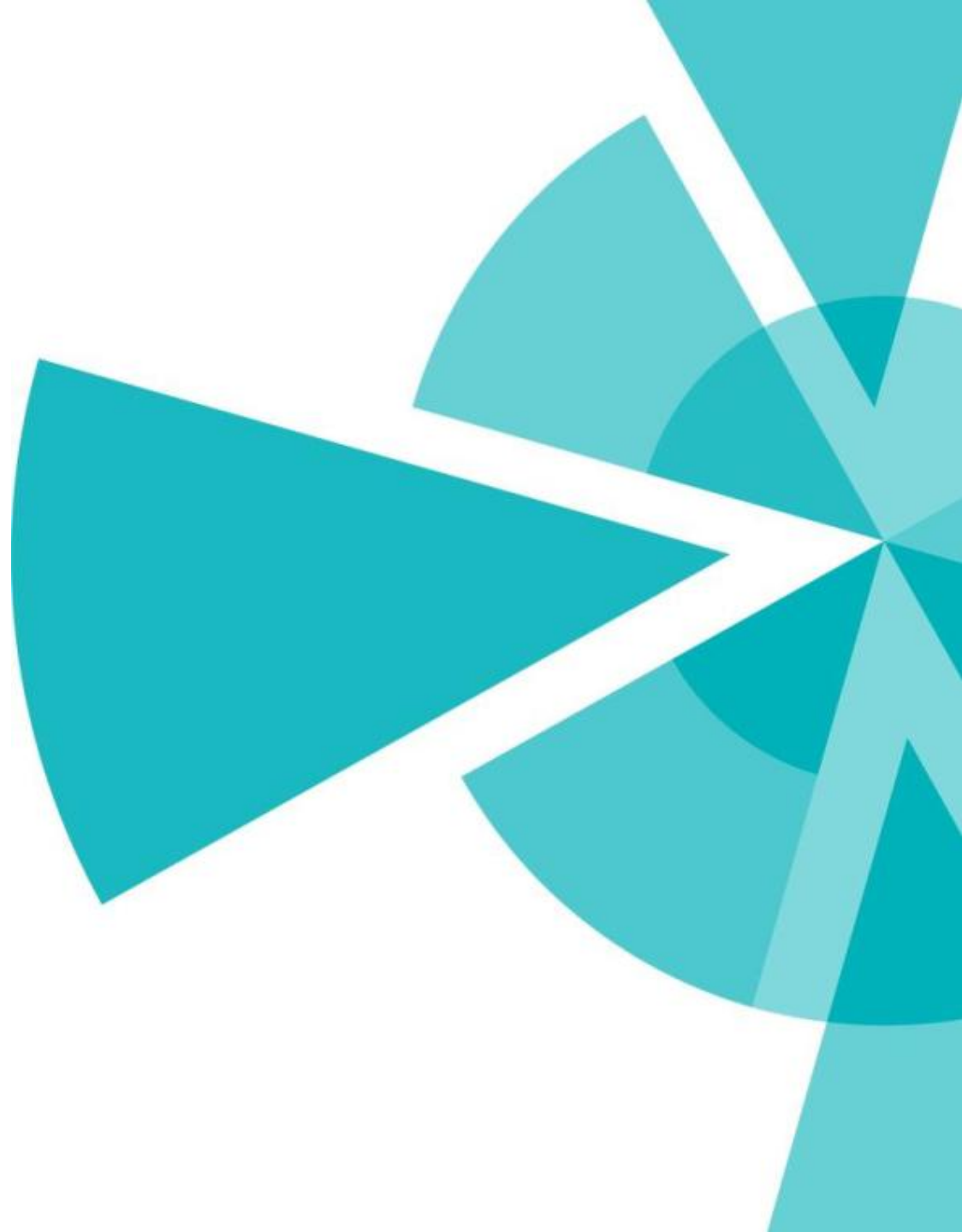


National Seismic Hazard Maps

The Maps are Useful, but Implementation/Use is not optimal

- Are the maps needed?
- Will the maps provide meaningful results?
- Have the maps been vetted for the intended purposes?
- Have case histories been performed?
- Are the right people reviewing the results from use of the maps before they are forced on the average geotechnical engineer?
- Is there proper and adequate training available for the average geotechnical engineer to take full advantage of the mapping program?

Q&A



Thank you!

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