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

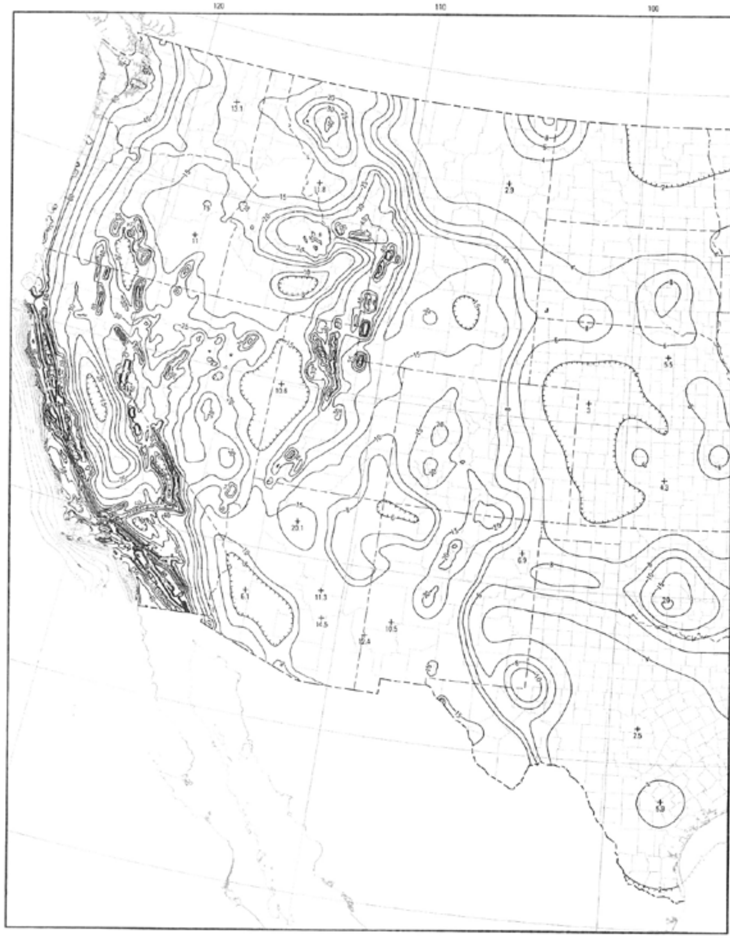


FIGURE 22-7 Maximum Considered Earthquake Geometric Mean (MCE_G) PGA, %g, Site Class B for the Conterminous United States.

Evaluation of Liquefaction Potential

Seed-Idriss Simplified Method of Analysis

- Magnitude is important
  - Cyclic Stress Ratio induced in the soil:
    - $CSR = 0.65 (t_{max} / s'_{vc})$
      $CSR = 0.65 (s_{vc} / s'_{vc}) (a_{max} / s'_{vc})$
  - Cyclic Resistance Ratio is the threshold for liquefaction initiation.
    - CRR has been calibrated to the number of cycles corresponding to a magnitude 7.5 earthquake to cause liquefaction.

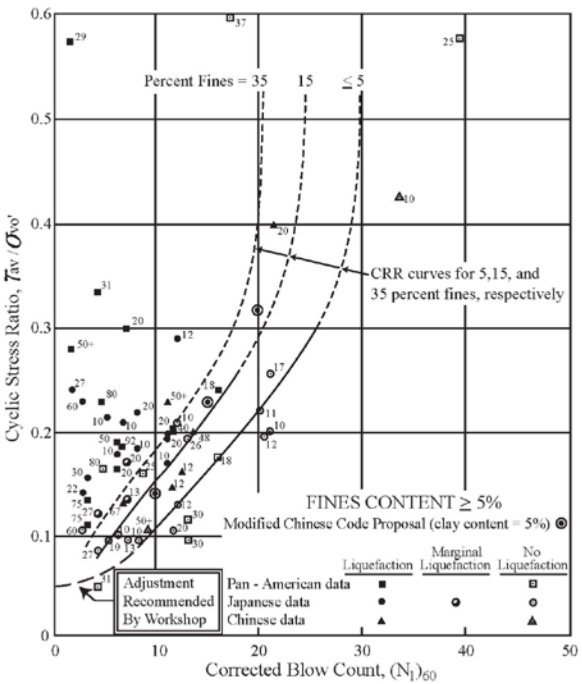
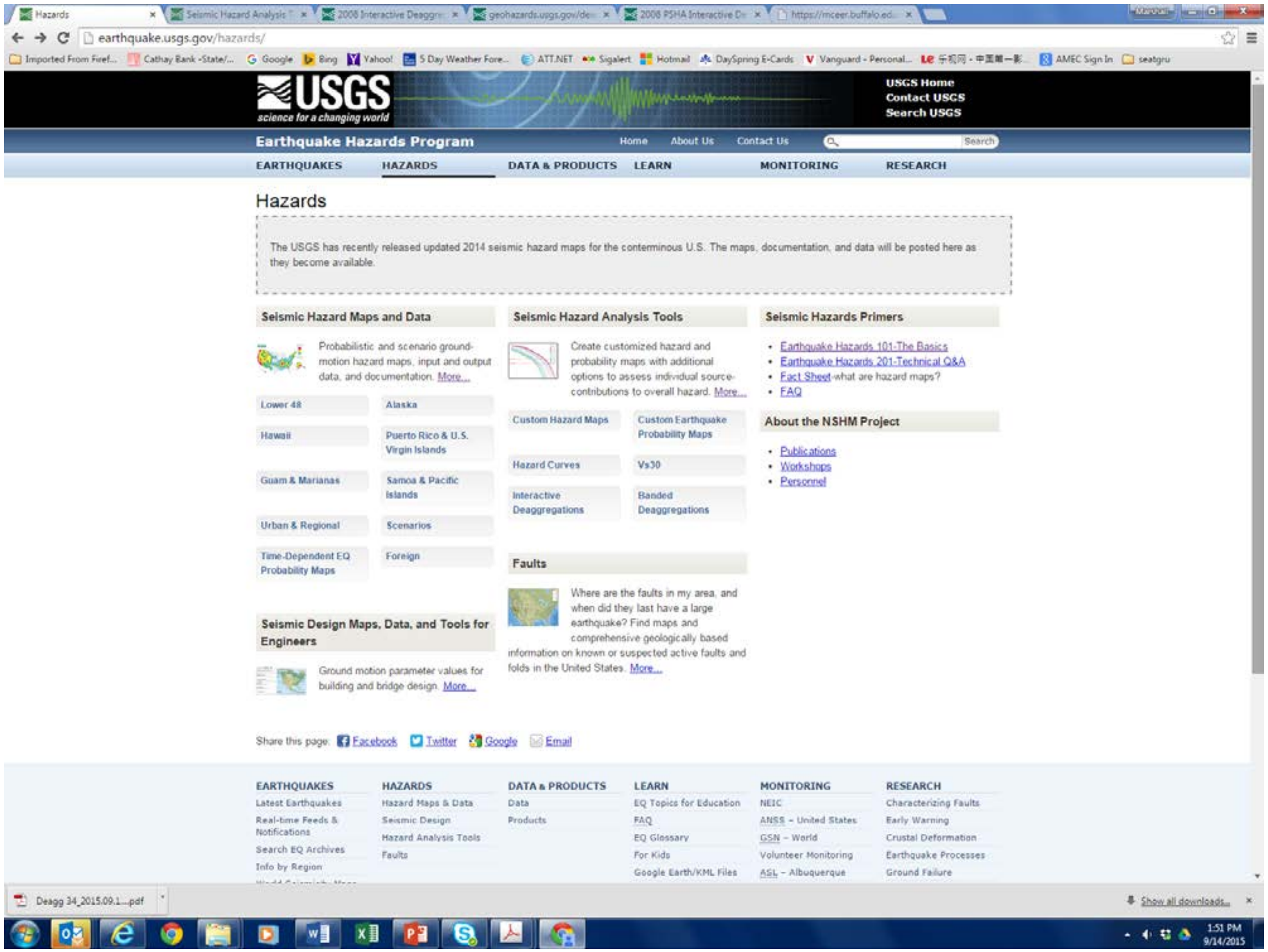


Figure 2 Simplified Base Curve Recommended for Calculation of CRR from SPT Data along with Empirical Liquefaction Data (modified From Seed et al., 1985)

Evaluation of Liquefaction Potential

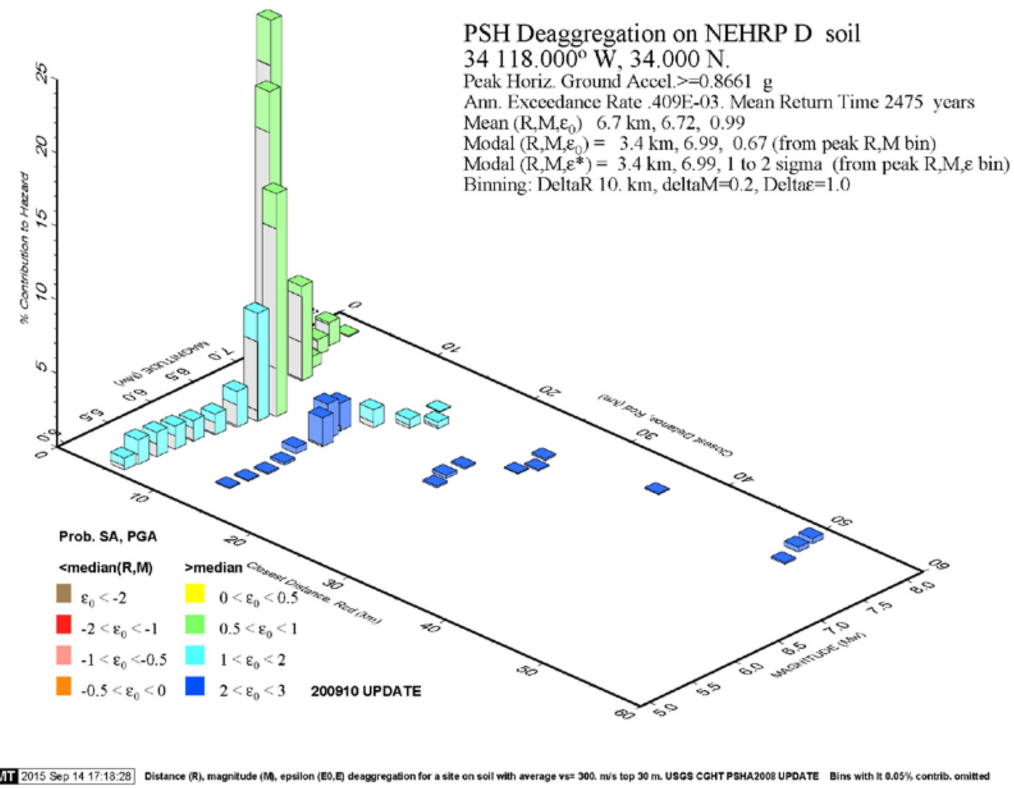
What's available from the Hazards Program?



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.



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

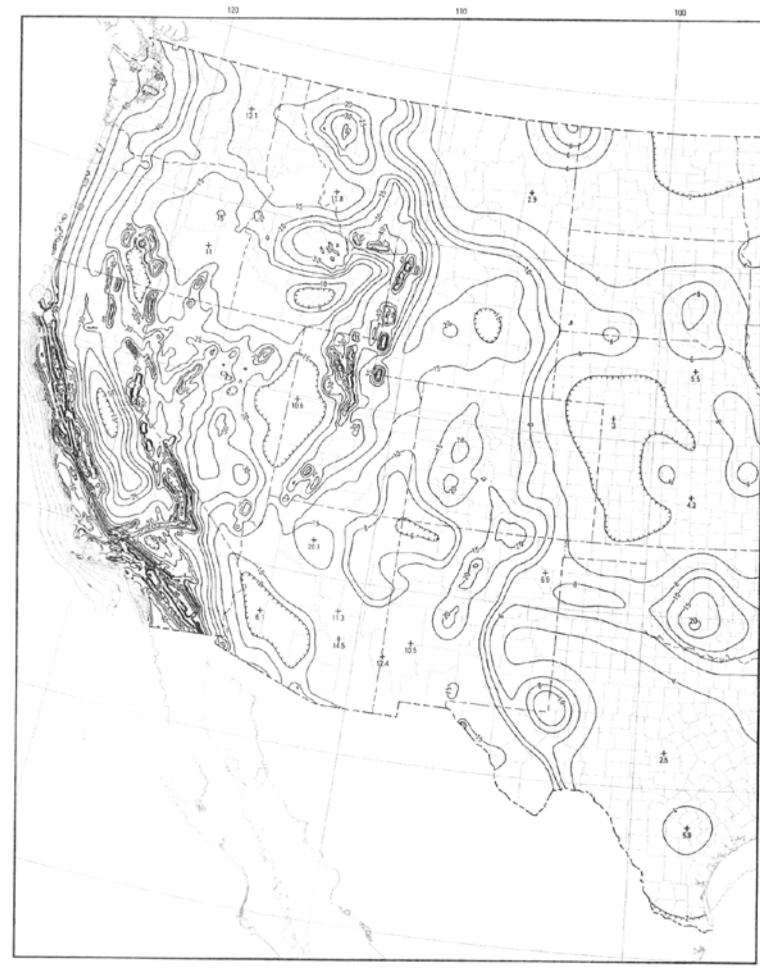


FIGURE 22-7 Maximum Considered Earthquake Geometric Mean (MCE_G) PGA, %g, Site Class B for the Conterminous United States.

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 4½ 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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