



Seismic and Geotechnical Data Requirements in the 2010 California Building Code

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Overview

- Introduction
- Chapter 16 (Soil lateral and eq. loads)
- Chapter 18 (Soils and Foundations)
- Chapter 34 (Existing Structures)
- Appendix J (Grading)
- Conclusions

Introduction

- 2010 CBC effective January 1, 2011
- Based on 2009 IBC, ASCE 7-05 and ASCE 41-06
- Will discuss changes relevant to our practice

American Society of Civil Engineers

ASCE/SEI
7-05
Including
Supplement No. 1

Minimum Design Loads for Buildings and Other Structures

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ASCE

SEI
Structural Engineering Institute
of the American Society of Civil Engineers

DER
at Solutions.

Another state agency called Office of Statewide Health Planning and Development (OSHPD) regulates:

- Hospitals
- Skilled nursing facilities
- Intermediate-care facilities
- Correctional treatment centers

The OSHPD-regulated buildings are classified into the following categories:

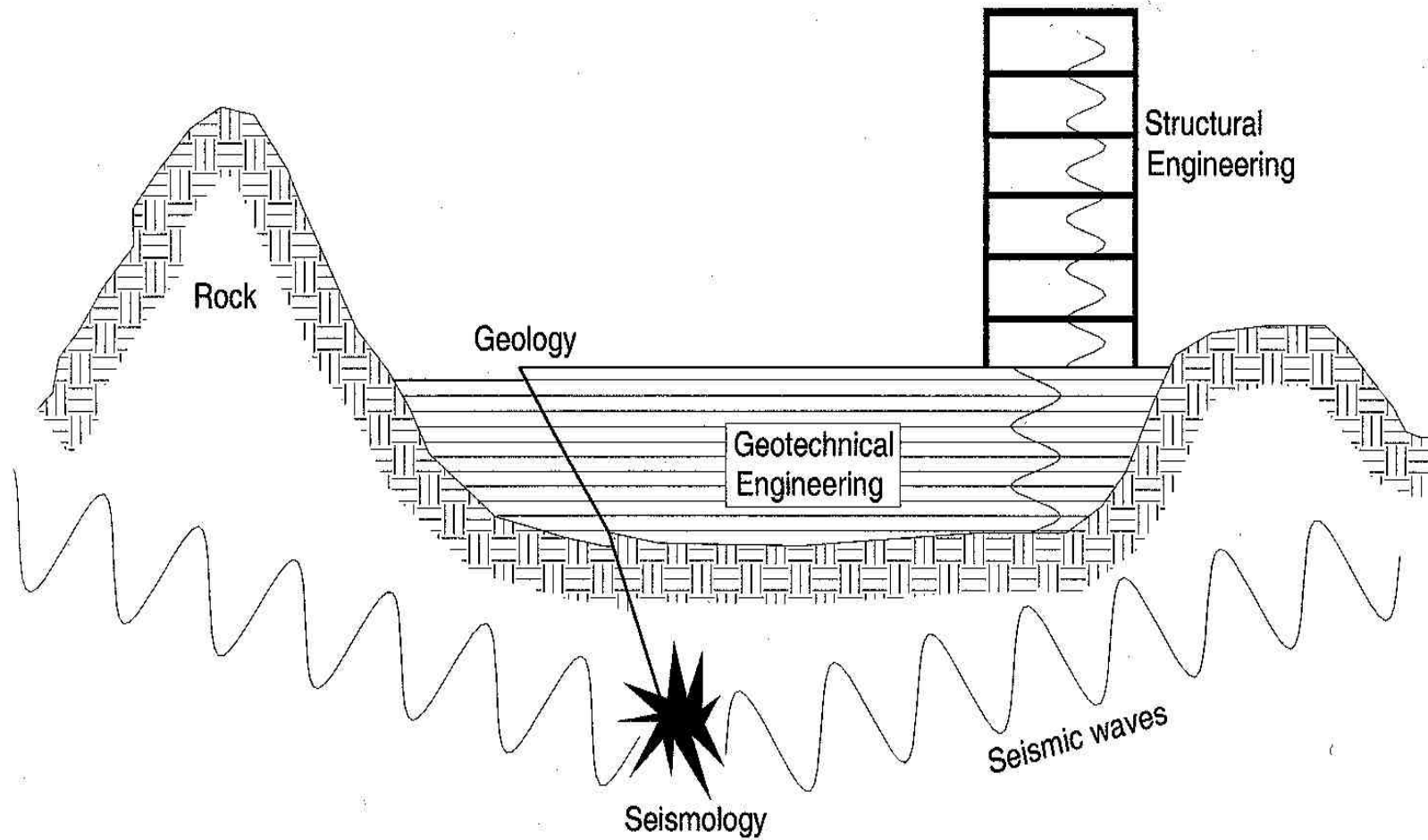
OSHPD 1 – General acute-care hospitals and skilled nursing and/or intermediate-care facilities

OSHPD 2 – Single-story skilled nursing and/or intermediate-care facilities utilizing Type V wood or light steel-frame construction

OSHPD 3 – Licensed clinics

OSHPD 4 – Correctional treatment centers





Chapter 16

Soil Lateral and earthquake Loads

Soil Lateral Loads

- General ...Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805.4.2 and 1805.4.3.

Earthquake Loads

- State-owned buildings, including those of the University of California, CSU and Judicial Council, **shall not be constructed** where any portion of the foundation would be within a mapped area of **earthquake-induced liquefaction of landsliding or within 50 feet of a mapped fault rupture hazard** as established by Section 1802.7

New Section 1615 Additional Requirements (DSA-SS/CC)

- Earthquake loads portion the same as Section 1615A Modification to ASCE 7. Except for section 1615.10.25 applicable to Isolated systems (Adds paragraph on NGA attenuation relations to Section 17.3.2 ASCE 7-05)

Chapter 16A

Soil Lateral and Earthquake Loads

- **Scope**

- Buildings, structures and buildings regulated by DSA-Structural Safety (DSA-SS); OSHPD 1 & 4

- **Construction Documents**

- Geotechnical information. The design load-bearing values of soils shall be shown on the construction documents

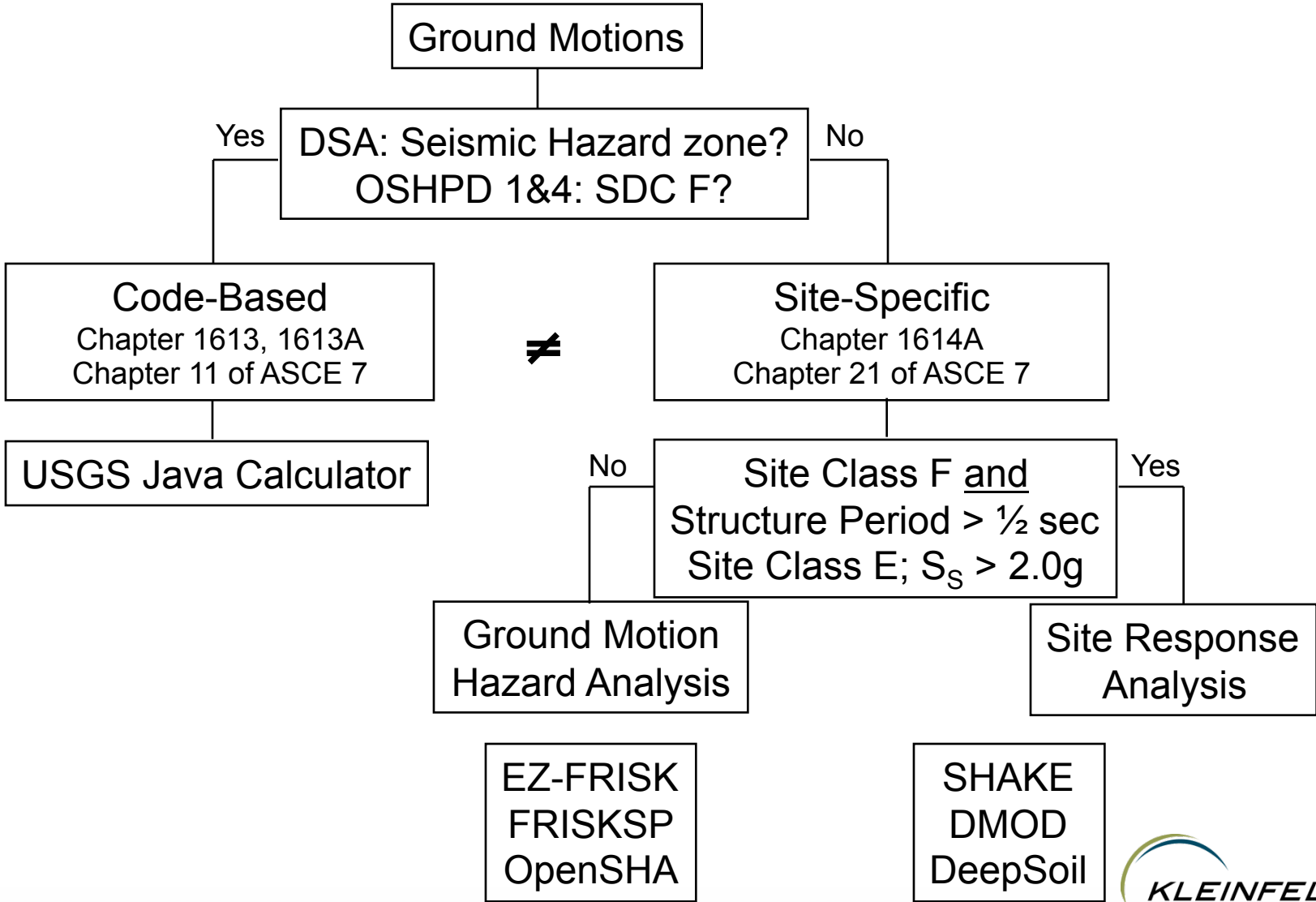
Soil Lateral Loads

- General. ...Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805A.4.2 and 1805A.4.3.

Earthquake Loads

- Active earthquake fault definition: *A fault that has been the source of earthquakes or is recognized as a potential source of earthquakes*, including those that have exhibited surface displacement within Holocene time (about 11,000 years) as determined by CGS under the A-P Act, *those included as type A or type B faults for the USGS National Seismic Hazards Maps*, and faults considered to have been active in Holocene time by an authoritative source, federal, state or local government agency.

Estimation of Ground Motions



Code-Based

- Using Mapped Values or USGS Java Calculator
- Given: site coordinates and site class
 - Determine
 - $S_S, S_1,$
 - $F_a,$ and F_v
 - $S_{MS} = F_a S_S$ and $S_{M1} = F_v S_1$
 - $S_{DS} = 2/3 S_{MS}$ and $S_{D1} = 2/3 S_{M1}$
 - Develop design response spectra

Design Response Spectrum

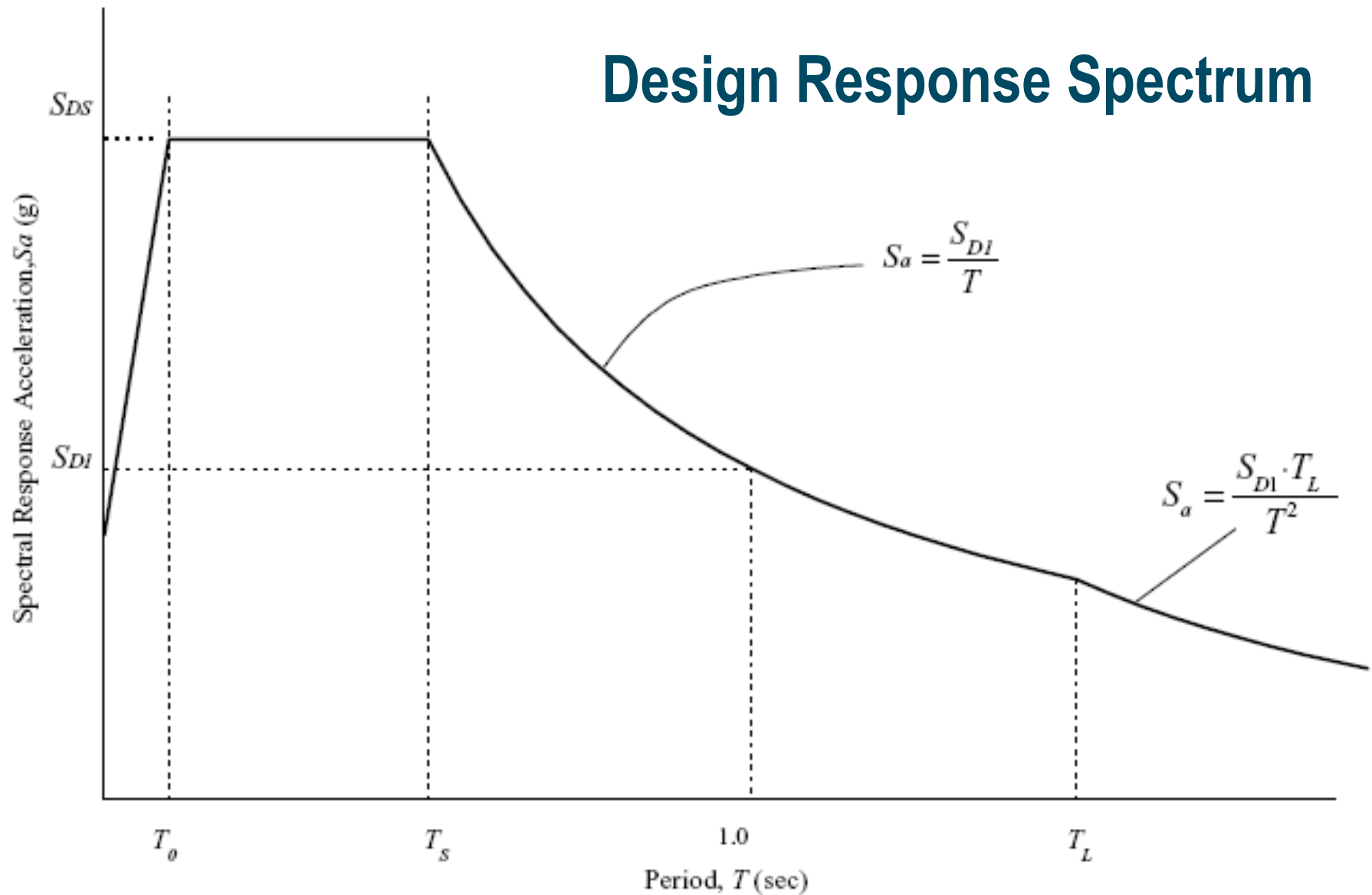


FIGURE 11.4-1 DESIGN RESPONSE SPECTRUM

T_L Maps (ASCE 7-05)

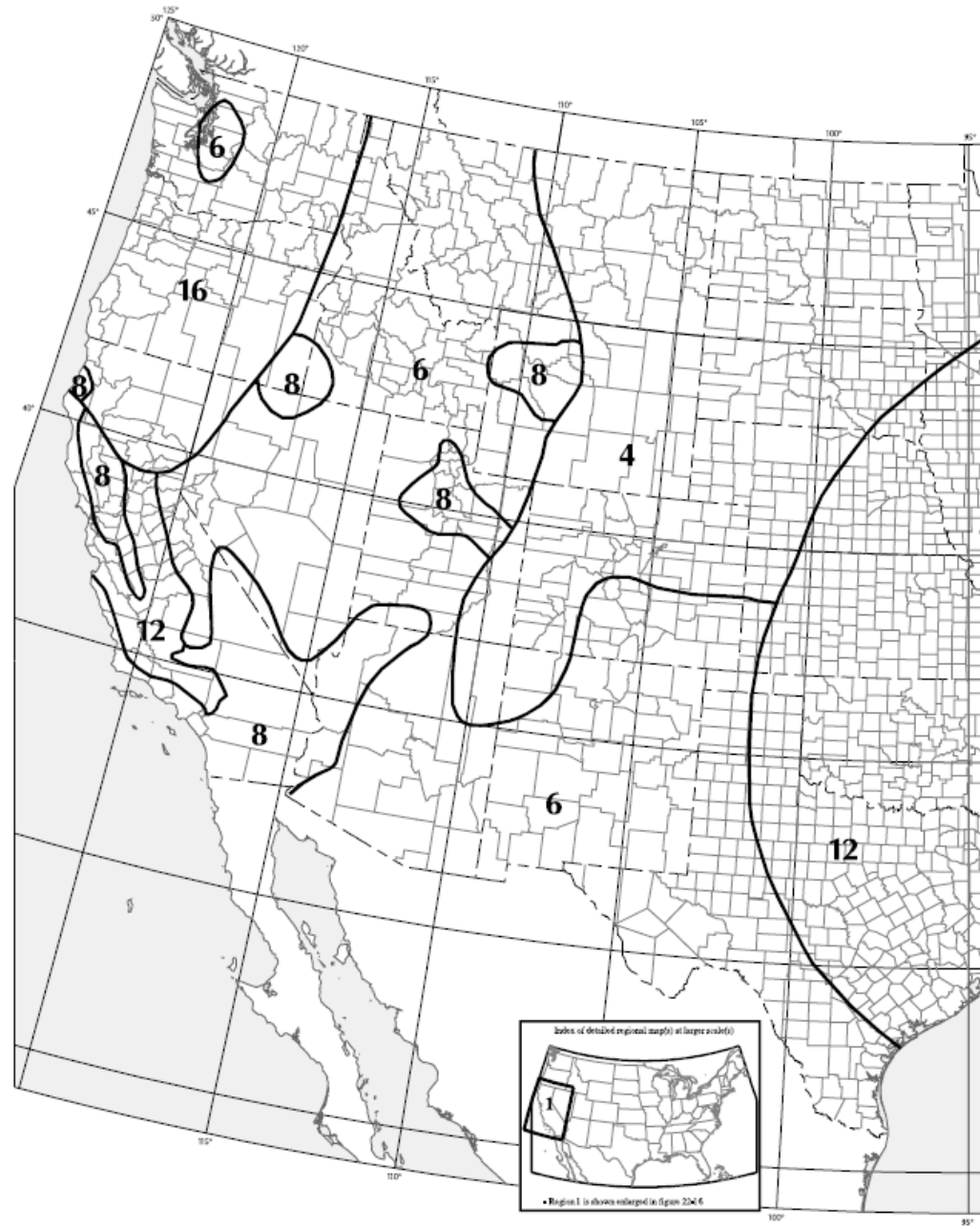


FIGURE 22-15 LONG-PERIOD TRANSITION PERIOD, T_L (SEC), FOR THE CONTERMINOUS UNITED STATES

Code-Based

Be Careful for the Site Class E

Sometimes the S_{M1} value exceeds the S_{MS} value

Example:

Site in Rialto –

Latitude: 34.083N Longitude: 117.400W

$S_S = 1.502$

$S_1 = 0.6$

Site Class E:

$F_a = 0.9$

$F_v = 2.4$

$S_{MS} = 1.351$

$S_{M1} = 1.440$

$T_o = 0.213$

$T_s = 1.066$

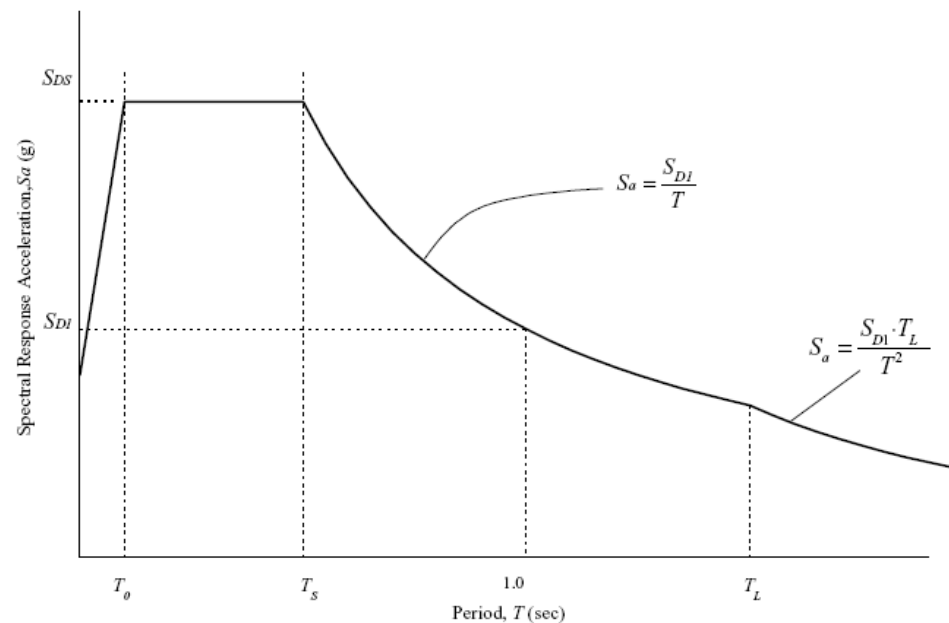
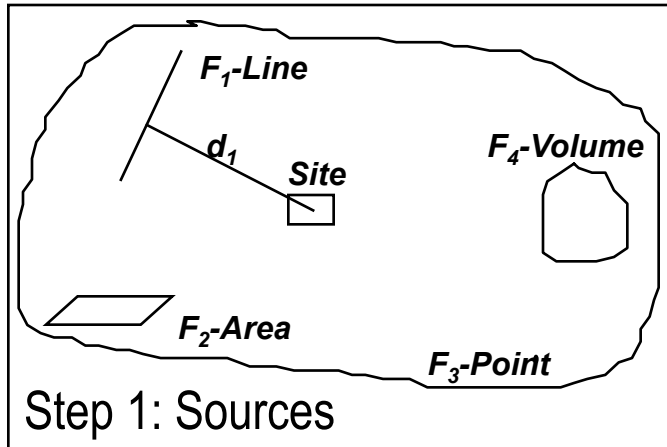


FIGURE 11.4-1 DESIGN RESPONSE SPECTRUM

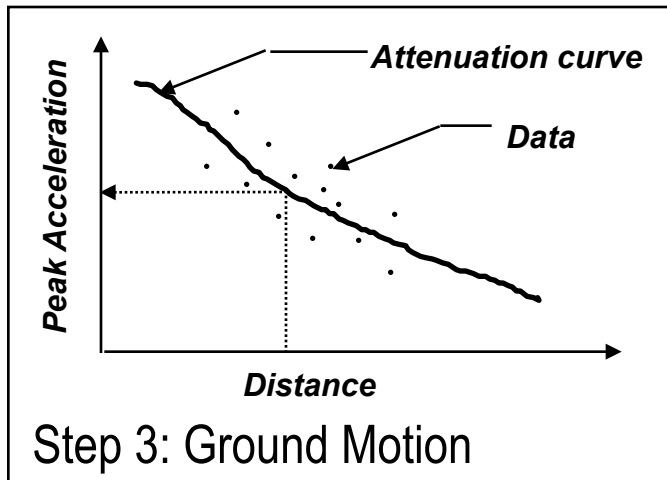
Deterministic Seismic Hazard Analysis



Fixed Distance: d

Fixed Magnitude: M

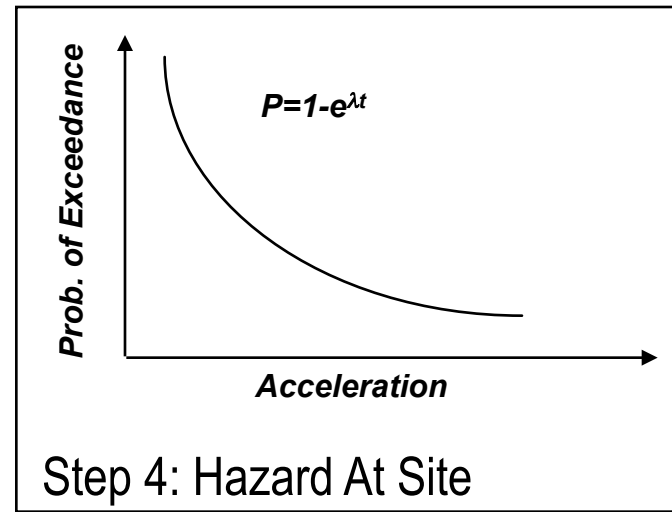
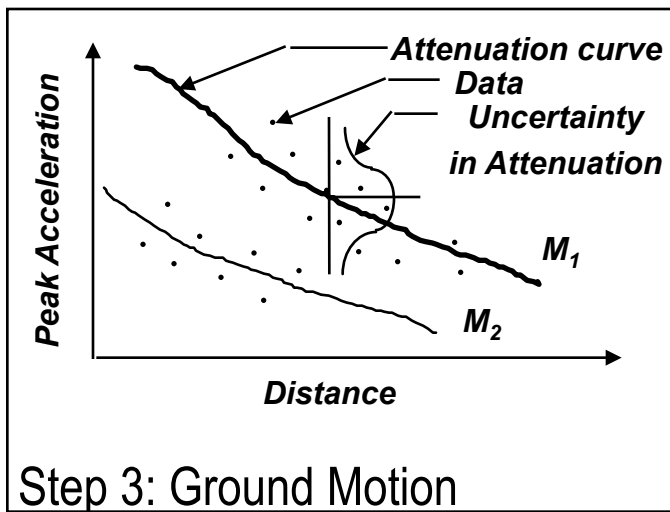
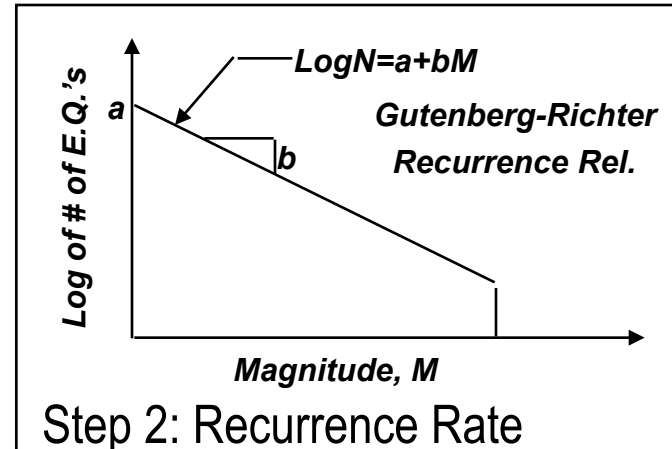
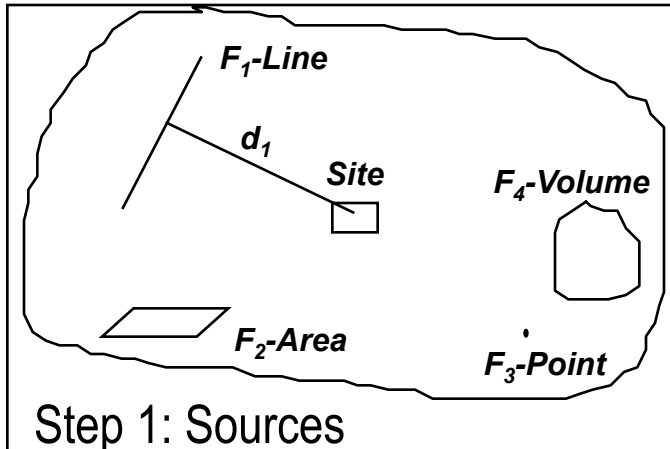
Step 2: Select Controlling E.Q.



**Fixed Peak Acceleration
or other
Ground Motion
Measures**

Step 4: Hazard At Site

Probabilistic Seismic Hazard Analysis



Next Generation Attenuation (NGA) Models

<http://peer.berkeley.edu/ngawest/>

- Abrahamson-Silva
- Boore-Atkinson
- Campbell-Bozorgnia
- Chiou-Youngs
- Idriss

Earthquake Spectra Special Edition May 2008

Earthquake Loads

- NGA definition: Attenuation relations used for the 2008 USGS seismic hazards maps (for the Western United States) or their equivalent as determined by the enforcement agency
- Modifications to ASCE 7-05, Site-specific procedures
 - Section 1803A.6 (NGA, PSHA and DSHA)

Earthquake Loads (DSA-SS)

- Modifications to ASCE 7-05, Site-specific procedures
 - *The building site is located in an area identified in Section 4-317 (e) of the California Administrative Code (Part I, Title 24, C.C.R.)*

instead of

- *The building site is located within 10 km of an active fault*

Section 4-317 (e) of the California Administrative Code (Part I, Title 24, C.C.R.)

*...A geologic and earthquake hazard report shall be submitted with the application for all new school sites, and for all construction on existing school sites located in a **Seismic Hazard Zone**, an A-P Earthquake Fault Zone, or in a seismic hazard zone designated in the **Safety Element of a Local General Plan**.*

*...No school building shall be constructed, rehabilitated, reconstructed or relocated **within 50 feet** of the trace of an active faults, which has experienced surface displacement within Holocene time (approximately 11,000 years).*

Earthquake Loads (OSHPD 1 & 4)

- Modifications to ASCE 7-05, Site-specific procedures
 - *For buildings assigned to Seismic Design Category F, or when required by the building official; or for ground motion response history analysis*
 - *SDC F = Occupancy Category IV and $S_1 \geq 0.75$*

Modifications to ASCE 7-05, Section 16.1.3.2 (3-D analysis, Seismic Response History Procedures)

- Where NGA are used in accordance with Section 1803A.6.2, each pair of motions shall be scaled such that in the period range from $0.2T$ to $1.5T$, the **average of the SRSS spectra from all horizontal component pairs does not fall below the corresponding ordinate of the design response spectrum** determined using NGA relations
- At sites within **3.1 miles (5 km) of an active fault** that controls the hazard, each pair of components shall be **rotated to the fault-normal and fault-parallel direction of the causative fault**, and shall be scaled so that average of the fault-normal components is not less than the MCE response spectrum determined using NGA relations for each period range from $0.2T$ to $1.5T$.

Spectra Matched Time Histories

- Development of Spectra Matched Time Histories for Time-History Dynamic Analyses
- Used in Performance Based Earthquake Engineering
- Needed for Soil-Structure Interaction Modeling
- Especially Needed for Structures with Base Isolation or Dampers

PEER Ground Motion Database

http://peer.berkeley.edu/peer_ground_motion_database

**Do you want to select and download the records
without scaling?**

Do you want to select and scale Ground Motions?



Modifications to ASCE 7-05, Section 16.2.4 (Response Parameters, Seismic Response History Procedures)

a) Where site is located **within 3.1 miles (5 km) of an active fault** at least seven ground motions shall be analyzed and response parameters shall be based on larger of the average of the maximum response with ground motions applied as follows:

1. Each of the ground motions shall have their maximum component at the fundamental period aligned in one direction
2. Each of the ground motion's maximum component shall be rotated orthogonal to the previous analysis direction

Modifications to ASCE 7-05, Section 16.2.4 (Response Parameters, Seismic Response History Procedures)

b) Where site is located more than 3.1 miles (5 km) of an active fault **at least 10 ground motions** shall be analyzed. The ground motions shall be applied such that one-half shall have their maximum component aligned in one direction and the other half aligned in the orthogonal direction. The average of the maximum response of all the analyses shall be used for design.

Ground Motion Histories for Isolated Systems

(Replace ASCE 7-05, Section 17.3.2)

- Where response history procedures are used, ground motions shall consist of pairs of appropriate horizontal ground motion acceleration components developed in accordance with Section 16.1.3.2 except that **0.2T and 1.5T shall be replaced by $0.5T_D$ and $1.25 T_M$** , respectively, where T_D and T_M are defined in Section 17.5.3.

Design Acceleration Parameters, Site-specific GM Procedures

(Replace ASCE 7-05, Section 21.4)

Where the site-specific procedure is used to determine the design ground motion in accordance with Section 21.3, the parameter S_{DS} shall be taken as the spectral acceleration, S_a , obtained from the site-specific spectra at a period of 0.2 sec, except that it shall not be taken less than 90 percent of the peak spectral acceleration, S_a , at any period larger than 0.2 second. The parameter S_{D1} shall be taken as the greater of the spectral acceleration, S_a , at a period of 1 sec or two times the spectral acceleration, S_a , at a period of 2 sec.

For use with the equivalent lateral force procedure, the site specific spectral acceleration, S_a at T shall be permitted to replace S_{D1}/T in Equation 12.8-3 and $S_{D1}T_L/T^2$ in Equation 12.8-4.

The parameter S_{DS} calculated per this section shall be permitted to be used in equations 12.8-2 and 12.8-5. The mapped value of S_1 shall be used in Equation 12.8-6. The parameters S_{MS} and S_{M1} shall be taken as 1.5 times S_{DS} and S_{M1} , respectively. The values so obtained shall not be less than 80 percent of the values determined in accordance with Section 11.4.3 for S_{MS} and S_{M1} and Section 11.4.4 for S_{DS} and S_{D1} .

Chapter 18

Soils and Foundations

Chapter 18

(Soils and Foundations)

- “This chapter has been revised in its entirety” ...actually reorganized in its entirety

Chapter 18A

Soils and Foundations



- “This chapter has been revised in its entirety” ...actually reorganized in its entirety plus new important additions

Section 1803A.6.2 Supplemental ground-response report

...The **three NGA relations used for the 2008 USGS seismic hazard maps for WUS shall be utilized** to determine the site-specific ground motion. When supported by data and analysis, other NGA relations, that were not used for the 2008 USGS maps, shall be permitted as additions or substitutions. No fewer than three NGA relations shall be utilized.

Next Generation Attenuation (NGA) Models

<http://peer.berkeley.edu/ngawest/>

- Abrahamson-Silva
- Boore-Atkinson
- Campbell-Bozorgnia
- Chiou-Youngs
- Idriss

Earthquake Spectra Special Edition May 2008

Section 1803A.6.2 Supplemental ground-response report

...Site-specific **Probabilistic Site Hazard Analyses (PSHA)** for structures that incorporate the NGA relations shall use the *maximum rotated* component of ground motion

Site-specific **Deterministic Site Hazard Analyses (DSHA)** for structures that incorporate the NGA relations shall use *the 84th percentile* of the maximum rotated component of ground motion

New Section 1811A Prestressed Rock and Soil Foundation Anchors

- The requirements of this section address the use of vertical rock and soil anchors in resisting seismic or wind overturning forces resulting in tension on **shallow foundations**
- All prestressed rock and soil foundation anchors shall be designed in accordance with **PTI (Post-Tensioning Institute)** Recommendations for Prestressed Rock and Soil Anchors
- New section lists geotechnical and structural requirements

Chapters 34 and 34A

Existing Structures

(Seismic Rehabilitation: Ground Motions and Design Spectra)



- **Chapter 34:** Buildings and DSA buildings follow ASCE 41-06
- **Chapter 34A:** OSHPD buildings follow new buildings regulations (Chapter 16A and 18A). BSE-2 (ASCE 41-6) same as MCE (ASCE 7-05)

Appendix J

GRADING

- **New:** Section J106.2 Earth Retaining Shoring (OSHPD 1 &4)
- **Scope:** Temporary and permanent earth retaining shoring using soldier piles and lagging with or without tie-back anchors in soil or rock
- Only when existing or new OSHPD 1 or 4 facilities are affected

Topics

- Duration (Temporary less than 1 year)
- Surcharge (Boussinesq equations)
- Design and Testing
 - Geotechnical requirements
 - Structural requirements
 - Testing of tie-back anchors (Post-Tensioning Institute 2004)
- Construction
- Inspection, survey monitoring and observation
- Monitoring of existing OSHPD 1 and 4 structures
- Tolerances (for soldier piles and tie-back anchors)

CBC Geotechnical

- For Seismic Design Category C
 - | Slope instability, liquefaction, and surface rupture due to faulting or lateral spreading should be addressed
- For Seismic Design Category D, E, or F, following additional items should be addressed
 - | Lateral pressures on basement and retaining walls due to earthquake motions
 - | Potential consequences and mitigation methods due to liquefaction

Geotechnical Earthquake Engineering

- Liquefaction/Lateral Spreading
- Lateral Earth Pressure
 - Retaining Walls
 - Basement Walls
- Pile Curvature
- Slope Instability

Code Requirements

- Sections 1802.2.6, 1802.2.7, 1808.2.23.2.1 of IBC
- Sections 1802A.2.6, 1802A.2.7, 1808A.2.23.2.1 of CBC
- Sections 1802.2.6 or 1802A.2.6
 - For Seismic Design Category C, an investigation shall be conducted and an evaluation shall be made for slope instability, liquefaction, surface rupture due to faulting, and lateral spreading

Code Requirements

- Sections 1802.2.7 or 1802A.2.7
 - For Seismic Design Category D, E, or F, following additional requirements should be met
 - A determination of lateral pressures on basement and retaining walls
 - An assessment of potential consequences of any liquefaction and soil strength loss including estimates of differential settlement and lateral movement and should address mitigation measures

Code Requirements

- Sections 1808.2.23.2.1 or 1808A.2.23.2.1
 - For Seismic Design Category D, E, or F, following requirements should be met for pile or pier design
 - Piles or piers shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and structure response
 - Both inertial and kinematic response should be considered

Conclusions

- New fault definition
- New evaluation procedures of seismic hazard (NGA, maximum rotated components, 84% deterministic)
- Site-specific SHA: For schools (DSA) within seismic hazard zone (CGS or local); for hospitals (OSHPPD) when SDC is F
- New Grading requirements for OSHPPD 1 and 4 buildings