Overview of 2013 CBC and CGS Note 48

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Note 48 Overview

- Concise 2-page checklist format that provides an overview of all hazards CGS is concerned with.
- Transparency for consultants and their clients; insights for owners/architects for scoping of contracts.
- Uniformly used by Engineering Geologists within CGS for our review of consultants' reports.
- Provides Guidelines – not enforceable.
- Citations specific to 2013 CBC and ASCE 7-10.

Jurisdiction

Under both Alquist-Priolo EQ Fault Zoning Act and Seismic Hazard Mapping Act – CGS creates zones, but has no authority to review or approve projects in those zones. This is the responsibility of the "lead agency" – generally cities and counties.

Under contract to OSHPD and DSA, CGS acts as an advisor regarding geologic hazards, and regarding compliance with above laws and CBC. We have no independent authority, and OSHPD/DSA remains the code enforcement official.

Jurisdiction

Under contract with OSHPD, CGS reviews the following:

- OSHPD 1 – Acute Care Hospitals
- OSHPD 2 – Skilled Nursing Facilities
- OSHPD 3 – Licensed Clinics

We generally do not review:

- OSHPD 4 – Correctional Treatment Centers
- Medical office buildings
- Unattached parking structures? – depends…

Jurisdiction

Under MOU with DSA, CGS reviews the following:

- DSA-SS – public K-12 schools and *state-owned* essential services buildings
- DSA-SS/CC – Community College (optional track)

Per DSA directive, we contract directly with school districts for these reviews.

We generally do not review:

- Neighborhood fire station
- Private schools
- Charter schools? – depends…

Note 48 – Project Location

Describe project scope, site location, and data collected

- street address
- plot on topo map – provides all kinds of context
- plot plan – show structures, borings, trenches, etc.
- provide latitude & longitude

Note 48 – Site Characterization

- Geologic setting –
  - show me: geologic map, fault map, site geologic map and cross sections
  - describe geologic setting
- Describe fault rupture hazard –
  - AP Zones *and other known active faults*
- Identify regulatory zones –
  - CGS (Seismic Hazard Mapping Act) and Local (City & County General Plan)
- Ensure geotechnical engineer & geologist are coordinated

Note 48 – Site Characterization

Unique to schools & hospitals:

Minimum of 2 borings per building,

and 1 per 5000 square feet of footprint

CBC §1803A.1

Photo courtesy Great West Drilling

Note 48 – Site Characterization

Occasional points of contention:

- adequate # of borings
- sufficient depth of exploration
- appropriate exploration methods
  - ✓ CPT in combination with SPT – check for consistency
  - ✓ appropriate methods to characterize gravels
  - X hand-auger borings

Note 48 – Site Characterization

Unique to schools & hospitals:

- CBC requires both geotechnical (§1803A.2) and "geohazards" (§1803A.6) reports.
- Signed by GE and CEG

Note 48 – Site Characterization

Unique to schools & hospitals:

Be aware of a *new requirement* for "site data reports"
Prepared by project architect, and intended to "get everybody on the same page". (§1603A.2)

CBC 2013 Section 1603A.2

1603A.2 Site Data Reports. *Geotechnical and Geohazard reports for review by the enforcement agency shall be accompanied by a description of the project prepared by the Registered Design Professional (RDP) in responsible charge, which shall include the following:*

1. *Type of service such as General Acute Care Facility, Skilled Nursing Facility, Intermediate Care Facility, Acute Psychiatric Facility, Central Utility Plants, etc.*
2. *Construction materials used for the project such as Steel, Concrete. Masonry, Wood, etc.*
3. *Type of construction such as new, addition, alteration, repair, etc.*
4. *For existing buildings, extent of construction such as incidental, minor, major, and/or voluntary seismic improvements as defined in Sections 202 and 3402A.*
5. *Seismic Force Resisting System used for each structure in the project.*
6. *Foundation system that will be used for each structure in the project such as spread footing, drilled piers, etc.*
7. *Analysis procedure used and basis of design such as ASCE 7 Equivalent Lateral Force Procedure, ASCE 41 Nonlinear Dynamic Procedure, etc.*
8. *Building characteristics such as number of stories above and below grade, foot print area at grade, grade slope on site, etc.*
9. *Special features such as requirement for shoring, underpinning, retaining walls, etc.*

Note 48 – Site Characterization

Unique to schools & hospitals:

Under load combinations (CBC §1605A.1.1):

"… When using allowable stress design, factor of safety for soil bearing values shall not be less than the overstrength factor of the structures supported."

From OSHPD Geotech Standard Comments (G4):

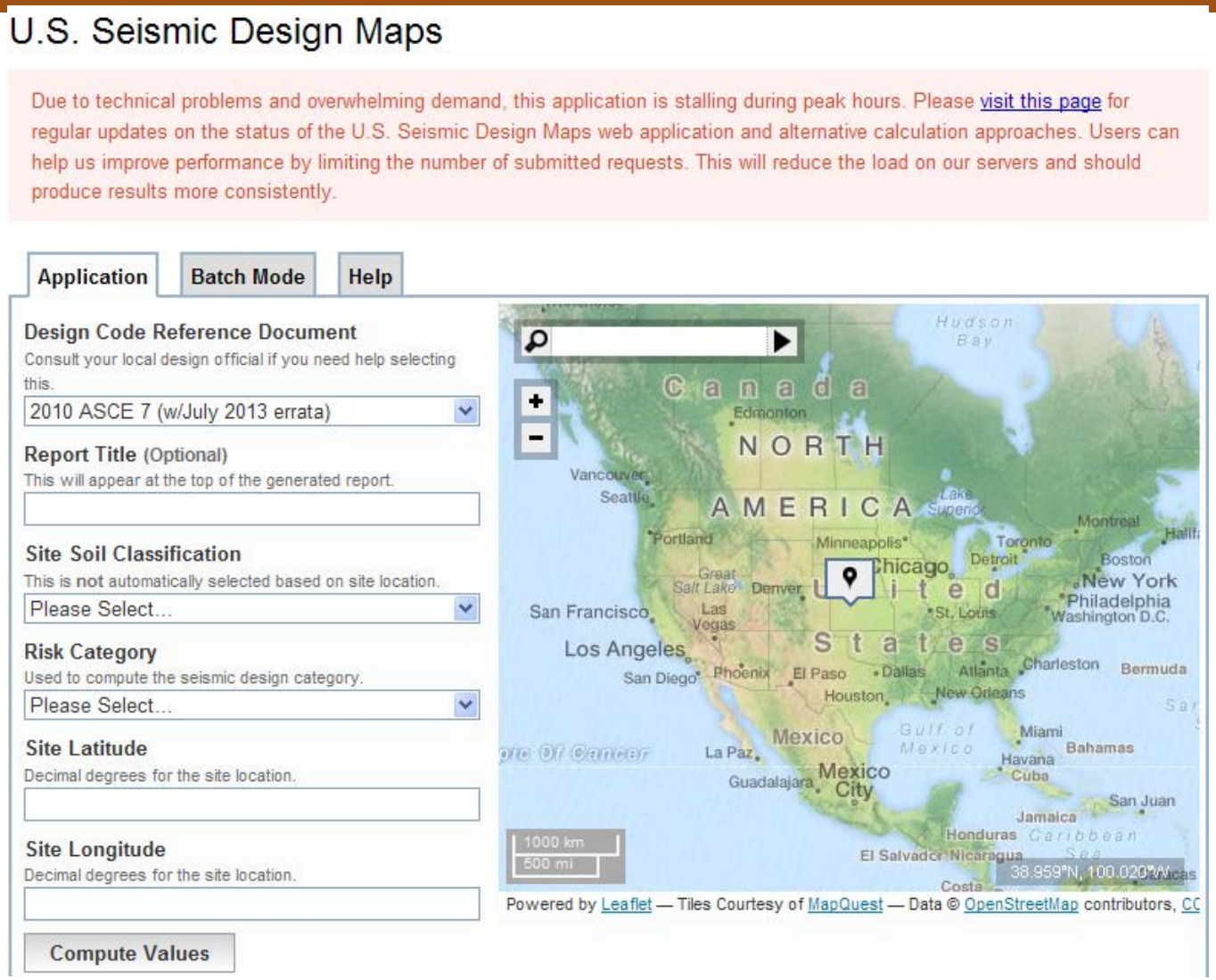
a. The geteochnical engineer shall specify allowable/ultimate bearing capacity and the corresponding factor of safety.

2013 CBC Ground Motion

Most projects will follow General Procedure

map values of S_S and S_1

taken from USGS calculator



http://earthquake.usgs.gov/designmaps/us/application.php

2013 CBC Ground Motion

"D minimum" is unique to schools & hospitals:

1613A.3.5 Determination of seismic design category. Structures classified as Risk Category I, II or III that are located where the mapped spectral response acceleration parameter at 1-second period, S_1, is greater than or equal to 0.75 shall be assigned to Seismic Design Category E. Structures classified as Risk Category IV that are located where the mapped spectral response acceleration parameter at 1-second period, S_1, is greater than or equal to 0.75 shall be assigned to Seismic Design Category F. All other structures shall be assigned to Seismic Design Category *D*.

1613A.3.5.1 Alternative seismic design category determination. *Not permitted by DSA-SS OSHPD.*

2013 CBC Ground Motion

Unique to schools & hospitals:

- Projects where Seismic Design Category (SDC) is E or F are required to use site-specific ground motion analysis (CBC §1616A.1.3). OSHPD and DSA now aligned

- This is the case for all projects **where S_1 is greater than or equal to 0.75**

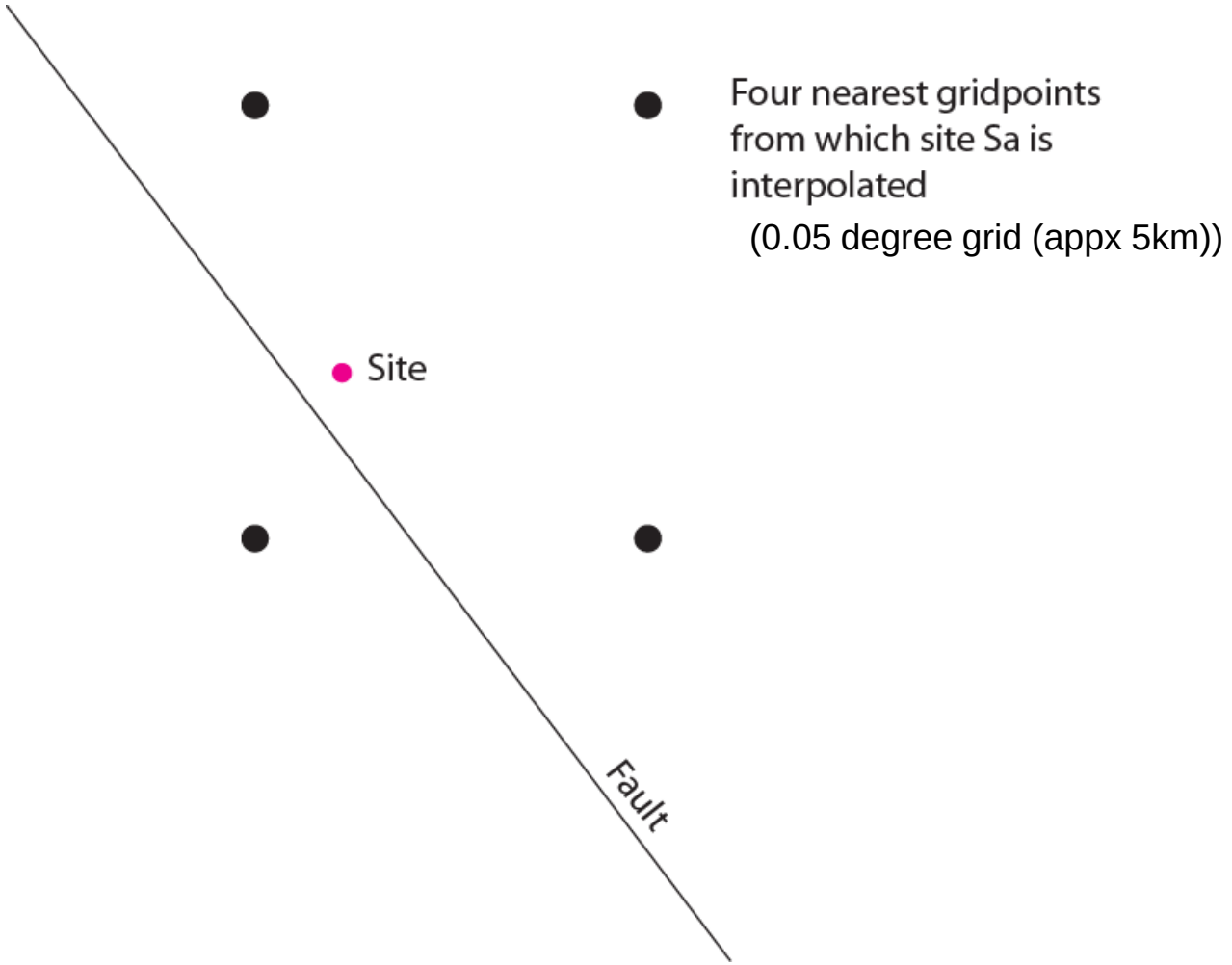
15. Seismic Design Category: Report if $S_1 > 0.75$

2013 CBC Ground Motion

Unique to schools & hospitals:

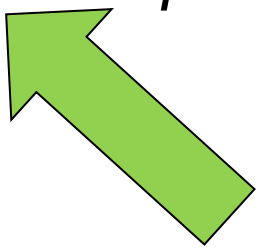
Rationale:

If very close to a fault, the interpolation from grid may underestimate site Sa.



2013 CBC Ground Motion

- 2% in 50 years – using current fault model, 2008 NGA, maximum rotated component
- multiply by risk coefficient (C_R) to get ground motion with 1% *pbb of collapse* in 50 years



NEW

The result is the probabilistic MCE_R

2013 CBC Ground Motion

- 2% in 50 years – using current fault model, 2008 NGA, maximum rotated component

The latest Calif. EQ source model was released Nov, 2013.

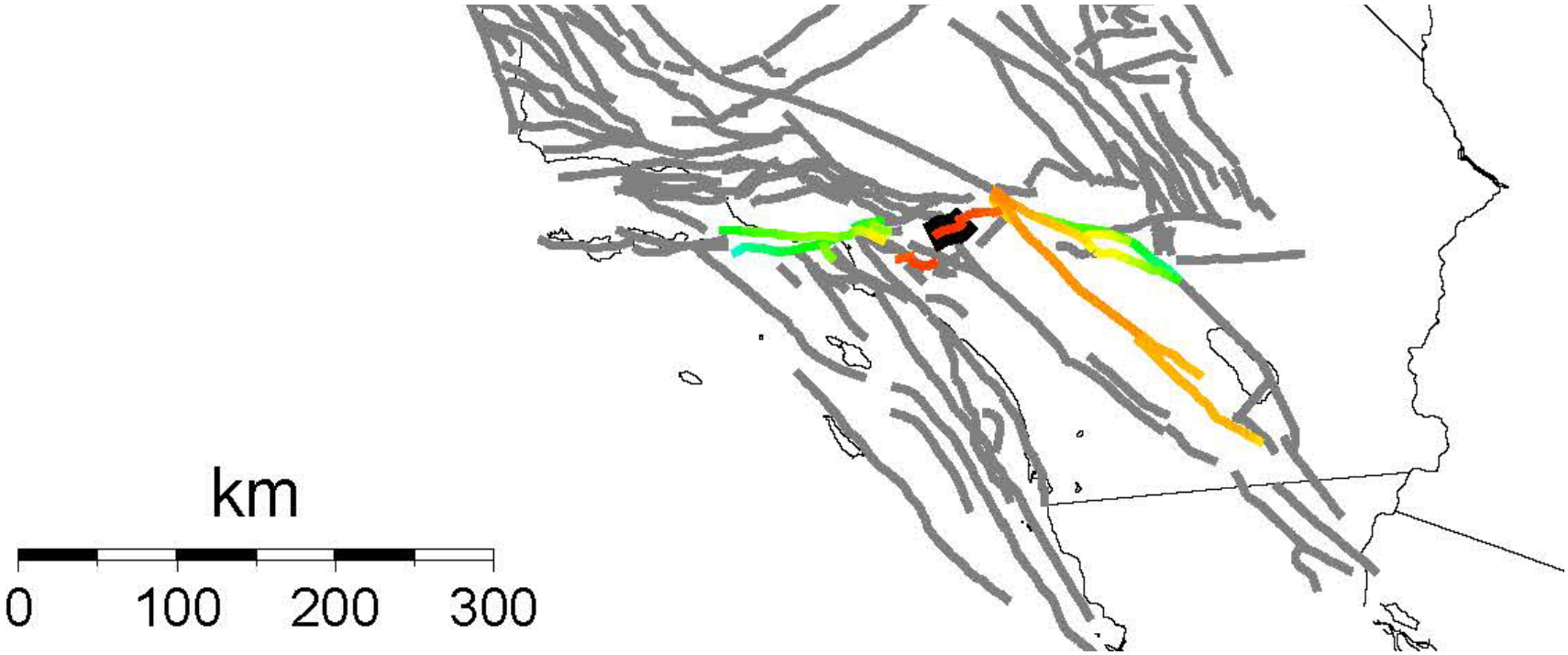
UCERF3 report available CGS and USGS web sites:

http://www.conservation.ca.gov/cgs/rghm/psha/Pages/sr_228.aspx

UCERF3 allows fault-to-fault rupture cascades. Allows most faults to participate in very large-Magnitude EQ, though they do so infrequently.

How to assign M for deterministic analysis under ASCE 7?

2013 CBC Ground Motion



Participation of San Jose fault (color indicates probability of multi-fault participation).

How to assign M for deterministic analysis under ASCE 7?

2013 CBC Ground Motion

Unique to schools & hospitals:

- 2% in 50 years – using current fault model, 2008 NGA, maximum rotated component

CBC §1803A.6

> *The three Next Generation Attenuation (NGA) relations used for the 2008 USGS seismic hazards maps for Western United States (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.*

2013 CBC Ground Motion

- deterministic MCE – 84th percentile of ground motion, using current fault model, 2008 NGA, maximum rotated component
- deterministic lower limit
- select lower of probabilistic MCE_R and deterministic MCE to obtain site-specific MCE_R

2013 CBC Ground Motion

- 2/3 of MCE_R to obtain design response spectrum (with 80% rule in ASCE 7 §21.3)
- calculate S_{DS} and S_{D1} (with rules in ASCE 7 §21.4)

> 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 Eq. 12.8-3 and $S_{D1}T_L/T^2$ in Eq. 12.8-4. The parameter S_{DS} calculated per this section shall be permitted to be used in Eqs. 12.8-2, 12.8-5, 15.4-1, and 15.4-3. The mapped value of S_1 shall be used in Eqs. 12.8-6, 15.4-2, and 15.4-4.

SE may use either in design, depending on analysis method (ASCE 7 §21.4)

Site-Specific Spectra

using both determ. & pbb elements

Probabilistic MCE

Response spectrum with 2% probability of exceedance in 50 years. Use rot. max. component, and 5% damped response.

Determine C_R at each period, and multiply times spectral acceleration. This is pbb MCE_R response spectrum.

Deterministic MCE

Calculate 84th percentile determin. spectral response acceleration. Use Mmax for each known fault, rotated maximum component, and 5% damped response.

Calculate deterministic lower limit
$S_{aM} = 1.5\ F_a$
$S_{aM} = 0.6\ F_v/T$

Choose the greater of these 2 values. This is the deterministic MCE

Choose the lesser of these two values This is the Site-Specific MCE_R response spectrum.

Calculate 2/3 of the MCE_R value. This creates the Site Specific Design Response Spectrum.

Cannot be less than 80% of General (i.e., map-based) Response Spectrum

Site-Specific Design Acceleration Parameters

S_{DS} = S_a at 0.2s, and shall not be taken less than 90% of peak spectral acceleration S_a at any period larger than 0.2s.

S_{D1} = larger of:
- S_a at 1s, **OR**
- 2(S_a) at 2s

Site-Specific S_{DS} and S_{D1}

S_{MS} = 1.5 S_{DS}
S_{M1} = 1.5 S_{D1}

Site-Specific S_{MS} and S_{M1}

2013 CBC Ground Motion

Both structures are in some form of "collapse"

How CGS Reviews GM

SAME as NSHM which is used by USGS to make design maps

Unique to schools & hospitals:

1) Run "State-Wide Model" to obtain 2% in 50 years pbb and 84th percentile deterministic spectra.

2) Compare consultants' pbb and deterministic spectra with State-Wide Model. Reasonably similar? If significantly different, can we see why? Do consultants apply rotated max component, use "accepted" attenuation?

3) Does consultants' analysis follow remaining steps consistent with ASCE 7 (§21.2 through 21.4)?

How CGS Reviews GM

Unique to schools & hospitals:

16. Site-Specific Ground Motion Analysis. Adequately addressed. The consultants' deterministic and probabilistic MCE spectra appear reasonable based on comparison with results from the State-Wide Model (from Petersen and others, 2008). The consultants' site-specific ground motion analysis indicates that the site-specific seismic design parameters are **S_{DS}=1.42g** and **S_{D1}=0.89g**. The site-specific ground motion analysis presented appears to be reasonable and in accordance with ASCE 7-10.

In addition, if using the Equivalent Lateral Force Procedure, S_a at T may be taken from [the eighth column of Table 3] in the consultants' report, in accordance with ASCE 7 §21.4.

Note 48 – Liquefaction

Consequences of Liquefaction:

- Loss of Bearing
- Ground deformations
  - settlement
  - differential settlement
  - lateral spreading

M7.6 earthquake Izmit, Turkey, 1999
Photo: T. Holzer, U.S. Geological Survey

Note 48 – Liquefaction

1) Screening
   - ✓ seismicity
   - loose, granular sediments (silt, sand, gravel)
   - ground water – historical high
2) Settlement calculations – provide for reviewer
   - MCE-level ground motion (CBC §1803A.5.12)
3) Other effects (MCE-level ground motion)
   - bearing capacity
   - lateral spread
4) Mitigation
   - soil improvement should discuss with CGS

Note 48 – Liquefaction

New in 2013 CBC:

- MCE-level ground motion for liquefaction analysis (CBC §1803A.5.12)
- PGA_M developed separately, using geomean (ASCE 7, §11.8.3 or 21.5)
- Stone columns

  (CBC, Appendix J, §J112)

  See also OSHPD Geotech Standard Comments (G16)

Note 48 – Slope Stability

1) Screening
   Characterize potential for landsliding both on and off-site to affect proposed project
2) Slope-stability calculations – provide for reviewer

   Sometimes in contention:
   - material strength parameters
   - pseudo-static coefficient
3) Ground-motion level to use in analysis *not specified* in code.
4) Design-level ground motion for retaining wall design (CBC §1803A.5.12)

Note 48 – Other…

A. Hazardous materials
B. Volcanic
C. Flooding provide BFE and DFE
D. Tsunami & seiche
E. Radon
F. Naturally occurring asbestos
G. Hydrocollapsible soils
H. Regional subsidence
I. Cyclic softening of clays

Hints on Reading CBC

Title 24, Part 1, CAC (Administration Code) –

- DSA – Chapter 4
- OSHPD – Chapter 7

Defines scope of authority, fees, deferred approvals, definition of “school buildings”, construction inspection, advisory boards, etc.

§4-317(e) – Site data for schools

Hints on Reading CBC

Matrix Adoption Tables – at the start of each chapter

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 16A – STRUCTURAL DESIGN

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

Adopting agency	BSC	SFM	HCD			DSA			OSHPD				BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
			1	2	1/AC	AC	SS	SS/CC	1	2	3	4								
Adopt entire chapter							X		X			X								
Adopt entire chapter as amended (amended sections listed below)																				
Adopt only those sections that are listed below						X														
Chapter / Section																				
1607A.8.2						X														

Hints on Reading CBC

CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE
CHAPTER 16 – STRUCTURAL DESIGN

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user.
See Chapter 1 for state agency authority and building applications.)

Adopting agency	BSC	SFM	HCD			DSA			OSHPD				BSCC	DPH	AGR	DWR	CEC	CA	SL	SLC
			1	2	1/AC	AC	SS	SS/CC	1	2	3	4								
Adopt entire chapter											X									
Adopt entire chapter as amended (amended sections listed below)	X		X	X				X		X										
Adopt only those sections that are listed below					X	X													X	
Chapter / Section																				
1601.1.1								X												
1601.1.2								X												
1601.1.3								X												
1601.1.4								X												
1601.2								X		X										
1601.3								X												
1602.1																				
1603.1										X										
1607.1, Table 1607.1										X										
1607.8			X	X	X															
1607.8.2			X	X	X	X														
1612.3										X										
1613.1										X										
1613.1.1																			X	
1613.1.2	X																			
1613.1.3	X																			
1613.3.1										X										
1613.3.2																				
1613.3.5										X										
1613.3.5.1										X										

Hints on Re

Double lines in margin indicates new provision.

Brackets further designate applicability

Italic font represent California amendments to model code language

NEW

peer review language1803A.8

4. Elevation of the water table, if encountered. *Historic high ground water elevations shall be addressed in the report to adequately evaluate liquefaction and settlement potential.*
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and varying soil strength; and the effects of adjacent loads.
6. Expected total and differential settlement.
7. Deep foundation information in accordance with Section 1803*A*.5.5.
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 1803*A*.5.8.
10. Controlled low-strength material properties and testing in accordance with Section 1803*A*.5.9.
11. *The report shall consider the effects of stepped footings addressed in Section 1809A.3.*
12. *The report shall consider the effects of seismic hazards in accordance with Section 1803A.6 and shall incorporate the associated geohazard report.*

1803A.8 Geotechnical peer review. [DSA-SS and DSA-SS/CC] *When alternate foundations designs or ground improvements are employed or where slope stabilization is required, a qualified peer review by a California-licensed geotechnical engineer, in accordance with Section 3422, may be required by the enforcement agency. In Section 3422, where reference is made to structural or seismic-resisting system, it shall be replaced with geotechnical, foundation, or ground improvement, as appropriate.*

Hints on Reading CBC

ASCE 7-10

- References to ASCE 7

  (see Chapter 35 – Referenced Standards)

- Notice CBC §1616A – *modifications* to ASCE 7.

Reference Material

For all:

- 2013 CBC
- ASCE 7-10; ASCE 41-06; ASCE 24-05

- USGS ground motion tool & associated explanation
  http://earthquake.usgs.gov/designmaps/us/application.php
- CGS SP 117A Guidelines
  http://www.conservation.ca.gov/cgs/shzp/webdocs/Documents/sp117.pdf
- SCEC Procedures (2) for liquefaction and landslides
  http://www.scec.org/resources/catalog/LiquefactionproceduresJun99.pdf
  http://www.scec.org/resources/catalog/hazardmitigation.html#land
- FEMA P-750 Recomm. Provisions (NEHRP 2009)
  http://www.fema.gov/media-library/assets/documents/18152?id=4103

Reference Material

Unique to schools & hospitals:

- CGS Note 48
  http://www.consrv.ca.gov/CGS/information/publications/cgs_notes/note_48/note_48.pdf
- DSA Interpretation of Regulations (IR) A-4.13
  http://www.documents.dgs.ca.gov/dsa/pubs/IR_A-4-13_rev12-19-13.pdf
- OSHPD Best Practices document (Section 2)
  http://www.oshpd.ca.gov/Boards/HBSB/Meetings/20121107-meeting/GWP_10'10'12_FINAL-V4kb.pdf
- OSHPD Standard Geotechnical Comments
  http://www.oshpd.ca.gov/FDD/Plan_Review/Documents/GeotechRptReview_StrdComments_for_OSHPD_1-2013.pdf

California Geological Survey - Note 48

Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings
October 2013

Note 48 is used by the California Geological Survey (CGS) to review the geology, seismology, and geologic hazards evaluated in reports that are prepared under California Code of Regulations (CCR), Title 24, California Building Code (2013 CBC). CCR Title 24 applies to California Public Schools, Hospitals, Skilled Nursing Facilities, and Essential Services Buildings. The Building Official for public schools is the Division of the State Architect (DSA). Hospitals and Skilled Nursing Facilities in California are under the jurisdiction of the Office of Statewide Health Planning & Development (OSHPD). The California Geological Survey serves as an advisor under contract with these two state agencies.

Project Name: _____ Location: _____

OSHPD or DSA File #: _____ Reviewed By: _____

Date Reviewed: _____ California Certified Engineering Geologist #: _____

Checklist Item or Topic Within Consulting Report NA = not applicable NR = not addressed by consultant and therefore not reviewed at this time	Adequately Described; Satisfactory	Additional Information Needed
Project Location		
1. Site Location Map, Street Address, County Name: Correctly plot site on a 7½-minute USGS quadrangle base-map.		
2. Plot Plan with Exploration Data and Building Footprint: One boring or exploration shaft per 5000 ft^2, with minimum of two for any one building. Exploratory trench locations.		
3. Site Coordinates: Latitude & Longitude		
Engineering Geology/Site Characterization		
4. Regional Geology and Regional Fault Maps: Concise page-sized illustrations with site plotted.		
5. Geologic Map of Site: Detailed (large-scale) geologic map with proper symbols and geologic legend.		
6. Subsurface Geology: Engineering geologic description summarized from boreholes or trench logs. Summarize ground water conditions.		
7. Geologic Cross Sections: Two or more detailed geologic sections with pertinent foundations and site grading.		
8. Active Faulting & Coseismic Deformation Across Site: Show proposed structures in relation to Alquist-Priolo Earthquake Fault Zones and/or any potential fault rupture hazard identified from the Safety Element of the local agency (city or county); show location of fault investigation trenches, 50-foot setbacks perpendicular from fault plane and proposed building footprints.		
9. Geologic Hazard Zones (Liquefaction & Landslides): *(If applicable)* Show proposed structures in relation to CGS official map showing zones of required investigation for liquefaction and landslide, and/or any pertinent geologic hazard map from the Safety Element of the local agency (city or county).		
10. Geotechnical Testing of Representative Samples: Broad suite of appropriate geotechnical tests.		
11. Consideration of Geology in Geotechnical Engineering Recommendations: Discuss engineering geologic aspects of excavation/grading/fill activities, foundation and support of structures. Include geologic and geotechnical inspections and problems anticipated during grading. Special design and construction provisions for bearing capacity failure and/or footings or foundations founded on weak or expansive soils. Consideration of seismic compression of fills; cut/fill differential settlement.		
Seismology & Calculation of Earthquake Ground Motion		
12. Evaluation of Historical Seismicity: Prepare a short description of how historical earthquakes have affected the site.		
13. Classify the Geologic Subgrade (Site Class): ASCE 7, Chapter 20.		
14. General Procedure Ground Motion Analysis: Follows CBC §1613A.3. Report parameters S_S, S_1, S_{DS} and S_{D1}. Recommended method for establishing map values found at: http://geohazards.usgs.gov/designmaps/us/application.php.		
15. Seismic Design Category: Report if $S_1 > 0.75$		
16. Site-Specific Ground Motion Analysis: (*If applicable*) Required where Seismic Design Category is E or F (CBC §1616A.1.3), and where required by ASCE 7 §11.4.7. See requirements in CBC §1803A.6. CGS suggests a table showing: (a) 2%-in-50-years probabilistic spectrum, (b) risk coefficients (if using ASCE 7 §21.2.1.1, Method 1), (c) probabilistic MCE_R, (d) 84% deterministic spectrum, (e) deterministic lower limit, (f) site-specific MCE_R, (ASCE 7 §21.2.3), (g) 80% of map-based General Response Spectrum, (h) design response spectrum (ASCE 7 §21.3). Also provide S_{DS} and S_{D1} values per ASCE 7 §21.4.		

Checklist Item or Topic Within Consulting Report NA = not applicable NR = not addressed by consultant and therefore not reviewed at this time	Adequately Described; Satisfactory	Additional Information Needed
17. Deaggregated Seismic Source Parameters: (*If applicable*) If needed for liquefaction, slope stability analysis or for earthquake record selection, provide controlling magnitude (M) and fault distance (R). Might be either deterministic or deaggregate for modal M and R.		
18. Time Histories of Earthquake Ground Motion: (*If applicable*) Identify target spectra (MCE or design); justify selected earthquake records; scale to target to meet ASCE 7 §16.1.3 or §17.3 and CBC §1616A.1.32; and show initial and scaled time histories and response spectra.		

Liquefaction/Seismic Settlement Analysis

19. Geologic Setting for Occurrence of Liquefaction: Perform screening analysis to identify where the following conditions apply: ♦ depth of highest historical ground water surface <50 ft. ♦ low-density, non-plastic alluvium, typically *SPT* $(N_1)_{60}$<30.		
20. Seismic Settlement Calculations: (*If applicable*) Evaluate both saturated and unsaturated layers of the entire soil column, based on several detailed geologic cross sections. Provide calculations (no estimates), including all input parameters. Evaluate liquefaction using highest historical ground water elevation. Evaluate using PGA_M (CBC §1803A.5.12), and calculate liquefaction settlement for each layer where FS<1.3 (CGS SP117A).		
21. Other Liquefaction Effects: (*If applicable*) Bearing capacity failure and/or lateral spread.		
22. Mitigation Options for Liquefaction: (*If applicable*) Discuss effectiveness of options to mitigate liquefaction effects. Acceptance criteria for ground-improvement schemes.		

Slope Stability Analysis

23. Geologic Setting for Occurrence of Landslides: Characterize the potential for landsliding both on and off-site affecting proposed project.		
24. Determination of Static And Dynamic Strength Parameters: (*If applicable*) Conduct appropriate laboratory tests to determine material strength for both static and dynamic conditions.		
25. Determination of Pseudo-Static Coefficient (Keq): (*If applicable*) Recommended procedure available from http://www.conservation.ca.gov/cgs/shzp/webdocs/Documents/sp117.pdf. Recommend using design-level ground motion based on geometric mean and without risk coefficient (ie, $(PGA_M)/1.5$), or discuss with CGS.		
26. Identify Critical Slip Surfaces for Static and Dynamic Analyses: (*If applicable*) Failure surfaces should be modeled to include existing slip surfaces, discontinuities, geologic structure and stratigraphy; include appropriate ground water conditions.		
27. Dynamic Site Conditions: (*If applicable*) Site response analysis and topographic effects should be considered, if appropriate.		
28. Mitigation Options for Landsliding/Other Slope Failure: (*If applicable*) Discuss effectiveness of options to mitigate landsliding/slope failure effects. Acceptance criteria for ground-improvement schemes.		

Other Geologic Hazards or Adverse Site Conditions

These exceptional geologic hazards do not occur statewide; however, they may be pertinent to a particular site. Where these conditions exist relevant information should be communicated to the design team.

29. Expansive Soils		
30. Corrosive/Reactive Geochemistry of Geologic Subgrade: soluble sulfates and corrosive soils.		
31. Conditional Geologic Assessment: Including but not limited to - **A. Hazardous materials** methane gas, hydrogen-sulfide gas, tar seeps; **B. Volcanic eruption**; **C. Flooding** Riverine (FEMA FIRMs or local zoning for 100-year flood); see CBC §1612A. Also consider alluvial fan & dam inundation. Is the site elevated or protected from the hazard; **D. Tsunami and seiche inundation**; **E. Radon-222 gas**; **F. Naturally occurring asbestos** in geologic formations associated with serpentine; refer to CGS SP 124; **G. Hydrocollapse** of alluvial fan soils due to anthropic use of water; **H. Regional subsidence**; **I. Clays and cyclic softening**.		

Report Documentation

32. Geology, Seismology, and Geotechnical References		
33. Certified Engineering Geologist: (CBC §1803A.1)		
34. Registered Geotechnical Engineer: (CBC §1803A.1)		