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.
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…
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…
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
• 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
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
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, footprint area at grade, grade slope on site, etc.
9. Special features such as requirement for shoring, underpinning, retaining walls, etc.
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 geotechnical engineer shall specify allowable/ultimate bearing capacity and the corresponding factor of safety.
Most projects will follow General Procedure map values of $S_S$ and $S_1$ taken from USGS calculator

“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.
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 $S_1 > 0.75$
Unique to schools & hospitals:

Rationale:

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

Four nearest gridpoints from which site Sa is interpolated (0.05 degree grid (appx 5km))
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

The result is the probabilistic $\text{MCE}_R$
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?
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

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
• 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, \( S_o \), 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.

**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**
- $S_{am} = 1.5 F_a$
- $S_{am} = 0.6 F_v/T$

**Determine $C_R$ at each period, and multiply times spectral acceleration. This is pbb MCE$_R$ response spectrum.**

**Choose the lesser of these two values. This is the Site-Specific MCE$_R$ response spectrum.**

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

**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**

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Site-Specific Design Acceleration Parameters

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

\[ S_{D1} = \text{larger of:} \]
\[ \cdot S_a \text{ at } 1s, \text{ OR} \]
\[ \cdot 2(S_a) \text{ at } 2s \]

\[ S_{MS} = 1.5 S_{DS} \]
\[ S_{M1} = 1.5 S_{D1} \]
2013 CBC Ground Motion

Both structures are in some form of “collapse”
How CGS Reviews GM

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)?
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.
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)
- $\text{PGA}_M$ 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)
A. Hazardous materials
B. Volcanic
C. Flooding
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

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### 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.)

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AEG-Inland Empire Short Course, May, 2014
# Hints on Reading CBC

**CALIFORNIA BUILDING CODE – MATRIX ADOPTION TABLE**

**CHAPTER 16 – STRUCTURAL DESIGN**

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AEG-Inland Empire Short Course, May, 2014
Hints on Reading CBC

Double lines in margin indicates new provision.

Brackets further designate applicability

Italic font represents California amendments to model code language

NEW peer review language

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.


7. Deep foundation information in accordance with Section 1803A.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 1803A.5.8.

10. Controlled low-strength material properties and testing in accordance with Section 1803A.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

- References to ASCE 7
  (see Chapter 35 – Referenced Standards)

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

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

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• USGS ground motion tool & associated explanation

• CGS SP 117A Guidelines

• SCEC Procedures (2) for liquefaction and landslides
  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
Unique to schools & hospitals:

• CGS Note 48

• DSA Interpretation of Regulations (IR) A-4.13

• OSHPD Best Practices document (Section 2)
  [Link: http://www.oshpd.ca.gov/Boards/HBSB/Meetings/20121107-meeting/GWP_10'10'12_FINAL-V4kb.pdf]

• OSHPD Standard Geotechnical Comments
## 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.

### Checklist Item or Topic Within Consulting Report

<table>
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<tr>
<th>Checklist Item or Topic Within Consulting Report</th>
<th>Adequately Described; Satisfactory</th>
<th>Additional Information Needed</th>
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### 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 ft², 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.  
15. Seismic Design Category: Report if S_h > 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, (d) 84% deterministic spectrum, (e) deterministic lower limit, (f) site-specific MCE, (ASCE 7 §21.2.3), (g) 86% of map-based General Response Spectrum, (h) design response spectrum (ASCE 7 §21.3). Also provide S_d and S_f values per ASCE 7 §21.4.
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 N10<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 PGAM (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](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 (i.e., (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


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)