

March 14<sup>th</sup>, 2008

**Shoring Design Criteria for OSHPD Approval:**

**Please add the following to Section D of the Alternate Method of Compliance form:**

**Description of Proposal:**

1. Design, Construction, Quality Control / Quality Assurance shall comply with the 2007 California Building Code (CCR. Title 24, Part 2), 2007 California Administrative Code (CCR. Title 24, Part 1) and OSHPD approved Geotechnical / Geohazard reports in addition to the requirements of this Design Criteria.
2. Earth retaining shoring design, construction, quality control / quality Assurance shall be in accordance with attached draft OSHPD amendments to the CBC 2007 Appendix J.

**Applicable Code Section:** CBC 2007, Appendix Chapter 1 Section 104.11.

**Reason:** CBC 2007 does not address shoring design.

**List of Enclosure:** Draft of OSHPD amendments to the CBC 2007 Appendix J.

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**CALIFORNIA BUILDING CODE, 2007**  
**APPENDIX J**  
**GRADING**

***J106.2 [OSHPD 1, 2, & 4] Earth Retaining Shoring***

***J106.2.1 General.*** *The requirements of this section address the use of temporary and permanent earth retaining shoring using soldier piles and lagging with or without tie-back anchors in soil or rock.*

***J106.2.2 Duration.*** *Shoring shall be considered temporary when elements of the shoring will be exposed to site conditions for a period of less than 180 days, and shall be considered permanent otherwise. At the end of the construction period, the existing and new structures shall not rely on the temporary shoring for support in anyway. All components of the shoring shall have corrosion protection or preservative treatment for their expected duration. Wood components of the temporary shoring shall be removed after the shoring is no longer required. Wood components shall not be used for permanent shoring lasting more than 2 years. Permanent shoring shall account for the increase in lateral soil pressure due to earthquake.*

***J106.2.3 Surcharge:*** *Surcharge pressure due to footings, traffic, or other sources shall be considered in design. If the footing surcharge is located within the semi-circular distribution or bulb of earth pressure (when shoring is located close to a footings), lagging shall be designed for lateral earth pressure due to footing surcharge. Alternatively, provide continuously contacting drilled pier shafts near the footings. The lateral surcharge design pressure shall be derived using Boussinesq equations modified for the distribution of stresses in an elastic medium due to a uniform, concentrated or line surface load as appropriate.*

***J106.2.4 Design and Testing:*** *Except for the modifications as set forth in Sections J106.2.4.1 and J106.2.4.2 below, all Prestressed Rock and Soil Tie-back Anchors shall be designed and tested in accordance with PTI Recommendations for Prestressed Rock and Soil Anchors (PTI-2004). Drilled pier concrete shafts or piles shall comply with Chapter 18A.*

***J106.2.4.1 Geotechnical Requirements:*** *The geotechnical report for the earth retaining shoring shall address the following:*

- 1. Minimum diameter and minimum spacing for the anchors including consideration of group effects.*
- 2. Maximum unbonded length and minimum bonded length of the tie-back anchors.*
- 3. Maximum recommended anchor tension capacity based upon the soil or rock strength / grout bond and anchor depth / spacing.*
- 4. Allowable bond stress at the ground / grout interface and applicable factor of safety for ultimate bond stress for the anchor.*
- 5. Minimum grout pressure for installation and post-grout pressure for the anchor.*
- 6. Class I Corrosion Protection is required for all permanent anchors, unless they will be exposed to site conditions for a period of 1 year or less. The geotechnical report shall specify the corrosion protection recommendations for temporary anchors.*
- 7. Performance test for the anchors shall be at a minimum of 2 times the design loads and shall not exceed 80% of the specified minimum tensile strength of the anchor rod. A creep test is required for all prestressed anchors that are performance tested. All production anchors shall be tested at 150% of design loads and shall not be greater than 70% of the specified minimum tensile strength of the anchor rod.*
- 8. Earth pressure, surcharge pressure and the seismic increment of earth pressure loading, when applicable.*
- 9. Maximum recommended lateral deformation at the top of the soldier pile, at the tie-back anchor locations and the drilled pier concrete shafts at the lowest grade level.*
- 10. Allowable vertical soil bearing pressure, friction resistance and lateral passive soil resistance for the drilled pier concrete shafts and associated factors of safety for these allowable capacities.*

11. *Soil-pier shaft/pile interaction assumptions and lateral soil stiffness to be used in design for drilled pier concrete shaft or pile lateral loads.*

12. *Acceptable Drilling methods.*

13. *Geotechnical observation and monitoring recommendations.*

**J106.2.4.2 Structural Requirements:**

1. *Tendons shall be thread-bar anchors conforming to ASTM A 722.*

2. *Design Loads shall be based upon the load combinations in Section 1612A.3.1 and shall not exceed 60 percent of the specified minimum tensile strength of the tendons.*

3. *The anchor shall be designed to fail in grout bond to the soil or rock before pullout of the soil wedge.*

4. *Design shall account for as-built locations of soil anchors considering all the acceptable construction tolerances.*

5. *Design shall account for both short and long term deformation.*

6. *Drilled pier concrete shafts or piles shall comply Section 1812A, but temporary shoring need not comply with Section 1810A.1.2.2.*

**J106.2.4.3 Testing of Tie-back Anchors:**

1. *The geotechnical engineer shall keep a record at job site of all test loads, total anchor movement and certify their accuracy.*

2. *If a tie-back anchor initially fails the testing requirements, the anchor shall be re-grouted and retested. If anchor continues to fail, the followings steps shall be taken:*

a. *The contractor shall determine the cause of failure – variations of the soil conditions, installation methods, materials, etc.*

b. *Contractor shall propose a solution to remedy the problem. The proposed solution will need to be reviewed and approved by geotechnical engineer, shoring engineer and building official.*

3. *After a satisfactory test, each anchor shall be locked-off at least at the design loads but not more than 70% of the specified minimum tensile strength of the anchor rod. The lock-off load shall be verified by rechecking the anchor. If the lock-off load varies by more than 10% from the design load, the load shall be reset until the anchor is locked-off to the design loads.*
4. *The shoring designer shall specify design loads for each anchor. Geotechnical engineer shall determine the test loads consistent with Section J106.2.4.1.7.*

***J106.2.5 Construction:*** *The construction procedure shall address the following:*

1. *Holes drilled for piles / tie-back anchors shall be done without loss of ground, sloughing or caving of materials and without endangering previously installed shoring members or existing foundations.*
2. *Drilling of earth anchor shafts for tie-backs shall occur when the drill bench reaches the level of tie-back pockets.*
3. *Casing or other methods shall be used where necessary to prevent loss of ground and collapse of the hole.*
4. *Air and / or water shall be injected under the drill stem to remove the drill cuttings from the earth anchor shaft.*
5. *All water and loose materials shall be removed from the holes prior to installing piles / tie-backs.*
6. *Tie-back anchor rods with attached centralizing devices shall be installed into the shaft or through the drill casing. Installation of tie-back anchor rod with attached centralizing devices into the shaft or through the drill casing shall proceed only after approval by the geotechnical engineer and the enforcement agency. Centralizing device shall not restrict movement of the grout.*
7. *After lagging installation, voids between lagging and soil shall be backfilled and compacted immediately to the full height of the lagging.*
8. *The soldier piles shall be plumb and true in the augured hole and braced against displacement during grouting. Fill shafts with concrete up to top of footing elevation, rest of the shaft can generally be filled with lean concrete. Excavation for lagging shall not be started until concrete has cured for at least 7 days or achieved strength of 3000 psi.*
9. *Contractor shall be prepared to address boulders and / or cobbles that may be encountered during the drilling of soldier piles and Tie-back anchors.*
10. *The grouting equipment shall produce grout free of lumps and indispensed*

- cement. The grouting equipment shall be sized to enable the grout to be pumped in continuous operation. The mixer shall be capable of continuously agitating the grout.*
- 11. The quantity of grout and grout pressure shall be recorded. The grout pressure shall be controlled to prevent excessive heave in soils or fracturing rock formations.*
  - 12. Post grouting operation shall be performed after initial grout has set for 24-hours in the bond length only. Tie-backs shall be grouted over a sufficient length (Threaded bar bond length) to transfer the maximum threaded bar force to the anchor grout. Post grout pressure shall be 300 psi, unless specified otherwise by the geotechnical engineer.*
  - 13. Testing of anchors may be performed 3-days after post-grouting operations provide grout has reached strength of 3,000 psi as required by PTI-2004 Section 6.11.*
  - 14. Anchor rods shall be tensioned straight and true. Excavation shall not continue before anchors are tested, approved and certified.*

#### ***J106.2.6 Inspection, Survey Monitoring, and Observation***

- 1. The shoring engineer shall make periodic inspections of the job site for the purpose of observing the installation of shoring system for the following (Not limited to):*
  - a. Observe the installation of at least two soldier piles and tie-back anchors.*
  - b. Observe the soldier pile survey monitoring.*
  - c. Review of weekly monitoring reading.*
- 2. Testing, Inspection, and observation shall be in accordance with testing, inspection and observation requirements established by shoring engineer and approved by building officials. The following activities and materials shall be tested, inspected or observed by the Special Inspector and geotechnical engineer:*
  - a. Sampling and testing of concrete in soldier pile and tie-back anchor shafts.*
  - b. Fabrication of tie-back anchor pockets on soldier beams*
  - c. Installation and testing of Tie-back Anchors.*
  - d. Survey monitoring of Soldier Pile & Tie-back load cells.*
  - e. Survey Monitoring of existing buildings.*
- 3. Inspection and observation shall satisfy the requirements of this code, Chapters 17A, 18A, 19A, 22A, 23, and CCR Title 24, Part 1.*

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4. *A complete and accurate record of all soldier pile locations, depths, concrete strengths, tie-back locations and lengths, tie-back grout strength, quantity of concrete per pile, quantity of grout per tie-back and applied tie-back loads shall be maintained by the special inspector and geotechnical engineer. The shoring engineer shall be notified of any unusual condition encountered during installation.*
5. *Calibration data for each test jack, pressure gauge and master pressure gauge to be verified by the special inspector and geotechnical engineer. The calibration tests shall be performed by an independent testing laboratory and within 30 calendar days of the data submitted.*
6. *Monitoring point shall be established at the top and at the anchor heads of each soldier pile and at intermediate intervals as considered appropriate by the geotechnical engineer.*
7. *Control points shall be established outside the area of influence of the shoring system to ensure the accuracy of the monitoring readings.*
8. *The periodic basis of shoring monitoring, as a minimum, shall be as follows:*
  - a. *Initial monitoring shall be performed prior to any excavation.*
  - b. *Once excavation has begun, the periodic reading shall be taken weekly until excavation reached the estimated subgrade elevation and the permanent foundation is complete.*
  - c. *If performance of the shoring is within established guidelines, shoring engineer may permit the periodic readings to be bi-weekly. Once initiated, bi-weekly reading shall continue until the building slab at first floor level is completed and capable of transmitting lateral loads to the permanent structure. Thereafter, readings can be monthly.*
  - d. *Where the building has been designed to resist lateral earth pressures, the periodic monitoring of the soldier piles and adjacent structure can be discontinued once the ground floor diaphragm and subterranean portion of the structure is capable of resisting lateral soil loads and approval by the shoring engineer, geotechnical engineer and building officials.*
  - e. *Additional readings shall be taken when requested by the special inspector, shoring engineer, geotechnical engineer or building official.*
9. *The survey data will be used by the shoring contractor to maintain alignment of the shoring face relative to back face of the new structure wall.*

10. *Monitoring reading shall be submitted to shoring engineer, engineer in responsible charge, and building officials within 3 working days after they are conducted. Monitoring readings shall be accurate to within 0.01 feet. Results are to be submitted in tabular form showing at least the initial date of monitoring and reading, current monitoring date and reading and difference between the two readings.*
11. *If the total cumulative horizontal or vertical movement (from start of construction) of the existing buildings reaches 1/2" or soldier piles reaches 1" all excavation activities shall be suspended. The geotechnical and shoring engineer shall determine the cause of movement, if any, and recommend corrective measures, if necessary, before excavation continues.*
12. *If the total cumulative horizontal or vertical movement (from start of construction) of the existing buildings reaches 3/4" or soldier piles reaches 1 1/2" all excavation activities shall be suspended until the causes, if any, can be determined. Supplemental shoring shall be devised to eliminate further movement and building official shall review and approve the supplemental shoring before excavation continues.*
13. *Monitoring of Tie-back Anchor Loads:*
  - a. *Load Cells shall be installed at the tie-back heads adjacent to buildings at maximum interval of 50', with a minimum of one-load cells per wall.*
  - b. *Load cell readings shall be taken once a day during excavation and once a week during the remainder of construction.*
  - c. *Load cell readings shall be submitted to the geotechnical engineer, shoring engineer, engineer in responsible charge, and building officials.*
  - d. *Load cell readings can be terminated once the temporary shoring no longer provides support for the buildings.*

#### **J106.2.7 Monitoring of Existing Structures**

1. *The contractor shall complete a written and photographic log of all existing structures within 100 ft of the shoring, prior to construction. A licensed surveyor shall document all existing substantial cracks in adjacent existing structures.*

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2. Contractor shall document existing condition of wall cracks adjacent to shoring walls prior to start of construction.
3. Contractor shall monitor existing walls for movement or cracking that may result from adjacent shoring.
4. If excessive movement or visible cracking occurs, contractor shall stop work and shore / reinforce excavation and contact shoring engineer and building official.
5. Monitoring of the existing structure shall take place once a day (in the morning prior to start of work) during the installing of shoring. Monitoring shall be performed by a licensed surveyor and shall consist of vertical and lateral movement of the existing structures. Prior to starting shoring installation a pre-construction meeting shall take place between the contractor, shoring engineer, surveyor, geotechnical engineer, and building official to identify monitoring locations on existing buildings.
6. If in the opinion of the geotechnical engineer, monitoring data indicate excessive movement or other distress, all excavation shall cease until the geotechnical engineer and shoring engineer investigates the situation and makes recommendations for remediation or continuing.
7. All reading and measurements shall be submitted to building official and shoring engineer.

**J106.2.8 Tolerances.** Following tolerances shall be specified on the construction documents.

1. Soldier Piles:
  - i. Horizontal and vertical construction tolerances for the soldier pile locations.
  - ii. Soldier pile plumbness requirements (angle with vertical line).
2. Tie-back Anchors:
  - i. Allowable deviation of anchor projected angle from specified vertical and horizontal design projected angle.
  - ii. Anchor clearance to the existing/new utilities and structures.
3. Design shall account for tolerances specified.