# CITY OF [NAME OF CITY]

Department of [NAME OF DEPARTMENT]
[NAME OF DIVISION OR BUREAU]

# MASONRY WALL DESIGN
## PLAN REVIEW CHECKLIST

**INFORMATION**

PLAN CHECK NO.: EXPIRATION DATE: STATUS:

PROJECT ADDRESS:

WORK DESCRIPTION:

APPLICANT'S NAME: TEL. NO.:

ADDRESS: EMAIL:

**INSTRUCTIONS**

Your application for a permit, together with plans and specifications, has been examined and you are advised that the issuance of a permit is withheld for the reasons hereinafter set forth. The approval of plans and specifications does not permit the violation of any sections of the Building Code or other local ordinances or state laws.

In an effort to streamline the plan review process, please follow the steps outlined below to ensure that there is no delay in processing your application and reviewing your responses to these plan check comments.

- Comments with circled item numbers apply to this plan check.
- Revised plans and calculations shall incorporate or address all comments marked on the original checked set of plans, calculations, and this plan review checklist. Provide a written response to each comment and show where and how it has been addressed. Identify the sheet number and detail or reference note on the revised plans where the corrections are made. Time spent searching for the corrected items on the revised plans or calculations will delay the review and approval process. Once all comments on the plans, calculations, and this checklist have been addressed, contact the plan check staff to **schedule an appointment** to review the changes made.

  PLAN REVIEWER: _____ TEL. NO.: _____

  ADDRESS: _____

  EMAIL: _____ WEBSITE: _____

  Should you have any questions or need clarification pertaining to the comments made on your project, you may contact the plan check staff by telephone from to M T W TH F.

- Bring the original checked set of plans and calculations along with this checklist to the meeting. Do not schedule an appointment meeting with the plan check staff until all comments have been addressed.
- Incomplete, indefinite or faded drawings or calculations will not be accepted.

**NOTE**

Numbers within the parenthesis ( ) refer to the section of the applicable code. 2007 Edition of the California Building Code (CBC). Table (T). Los Angeles Regional Uniform Code Program (LARUCP). ASCE Minimum Design Loads for Buildings and Other Structures, Includes Supplement No. 1 and Errata (ASCE-7). Building Code Requirements for Masonry Structures (ACI-530). ACI Building Code Requirements for Structural Concrete (ACI-318).

## STRUCTURAL CALCULATION

### A. GENERAL

1. Design forces shall be in accordance with the Factored Load and Combinations specified in CBC 1605.2.

2. Provide structural calculations and details of reinforcement for piers, columns, beams, and for the distribution of concentrated vertical loads at walls.

3. Provide structural calculations for the design of masonry columns and walls considering the effects of combined axial and bending stresses due to eccentricity and lateral loading. (ACI-530 Section 2.3.3.2.2)

4. Provide calculations for design of anchor bolts in masonry considering edge distance and effective embedment depth in accordance with ACI-530 Section 2.1.4.2 for allowable stress design or ACI-530 Section 3.1.6 for strength design.

5. Only the net area of hollow masonry units shall be used in design of shear walls. (ACI-530 Section 1.9.1)

6. The design of masonry structures shall comply with the working stress design provisions of CBC 2107, or the strength design provisions of CBC 2108, and with the "General Design and Construction Requirements" of CBC 2101 through 2104, and CBC 2106. All design calculations shall be based on specified dimensions. (CBC 2101.2 & ACI-530 Section 1.9.1)

### B. WORKING STRESS DESIGN (ASD)

1. Shear walls shall be designed to resist 1.5 times the forces required by CBC 1613. (CBC 2106.5.1)

2. Allowable axial compressive stresses shall be in accordance with the formulas in ACI-530 Section 2.3.3.2.1.

3. Allowable flexural compressive stresses or flexural compressive stresses with axial load shall not exceed $F_b = 0.33\ f'_m$, per ACI-530 Section 2.3.3.2.2.

4. Allowable shear stress in shear walls ($F_v$) shall not exceed values specified in Sec. 2.3.5.2.2 ACI 530:
   $M/V_d < 1$, $F_v = (1/3)[4-(M/V_d)](f'_m)^{1/2}$, (80-45[$M/V_d$]) psi max.
   $M/V_d > 1$, $F_v = (f'_m)^{1/2}$, 35 psi max.

   Where reinforcement is designed to take all shear:
   $M/V_d < 1$, $F_v = (1/2)[4-(M/V_d)](f'_m)^{1/2}$, (120-45[$M/V_d$]) psi max.
   $M/V_d > 1$, $F_v = 1.5(f'_m)^{1/2}$, 75 psi max

5. Allowable stresses in reinforcement shall conform to ACI-530 Section 2.3.2.1.

6. The min. area of shear reinforcement shall not be less than $A_v = V_s/F_{sd}$.

7. Reinforcement in shear walls with $M/V_d$ equal to or greater than 1 and having an axial load greater than $0.05(f'_m)(A_n)$ shall not exceed the max. reinforcement ratio determined by CBC Equation (21-3). The reinforcement ratio is not applicable for the out-of-plane direction.

8. Development length of reinforcing bars in tension or compression shall be determined in accordance with CBC Equation (2-9), but not less than 12".

9. Lap splices of reinforcing steel shall be determined in accordance with CBC Equation (21-2). Reinforcement larger than No. 9 bar shall be by approved mechanical connections in accordance with ACI-530 Section 2.1.10.7.3. (CBC 2107.6)

### C. STRENGTH DESIGN (LRFD)

1. The design strength is the nominal strength multiplied by the strength reduction φ as specified in ACI-530 Section 3.1.4.

2. Walls shall be designed for out of plane loads in accordance with ACI-530 Section 3.3.5:
   a. Factored axial stress shall not exceed $0.20(f'_m)$
   b. When slenderness ratio exceeds 30, factored axial stress shall not exceed $0.05(f'_m)$.
   c. Calculate the mid-height, out-of-plane wall deflection for service lateral and vertical load (without load factors) and limit it to $0.007h$. (ACI-530 Section 3.3.5.5)
   d. Check stress at mid height of wall in accordance with ACI-530 Section 3.3.5.4.
   e. The factored moment and axial force at the mid-height of the wall shall be computed using ACI-530 Equation (3-24) and (3-25) of.
   f. The nominal moment shall be calculated using ACI-530 Equations (3-27) and (3-28) if the reinforcing steel is placed in the center of the wall.
   g. The design strength shall satisfy ACI-530 Equation (3-26) as follows: $M_u \le \phi M_n$

3. Wall shall be design for in-plane loads in accordance with ACI-530 Section 3.3.6.5:
   a. Amount of vertical reinforcement shall not be less than 1/2 the horizontal reinforcement.
   b. Nominal flexural and axial strength shall be determined in accordance with ACI-530 Section 3.3.4.1.1.
   c. Nominal shear strength shall be determined in accordance with ACI-530 Section 3.3.4.1.2 & CBC 2106.5.2.
   d. Shear walls shall meet the requirements of ACI-530 Section 3.3.3.5 or Sections 3.3.6.6 through 3.3.10.

4. Development length of reinforcing bars in tension or compression shall be determined in accordance with ACI-530 Equation (3-15), but not less than 12".

5. Splices of reinforcement shall be determined by ACI-530 Equation (3-15) and shall not be less than 12". (ACI-530 Section 3.3.3.4)

**D. OUT-OF-PLANE WALL ANCHORAGE**

1. Provide calculations and details on the plans for the sub-diaphragm and continuous cross-tie system required for all wood diaphragms providing lateral support to masonry walls. The spacing of continuous ties shall not exceed 40'. (LARUCP 16-09)

2. Provide details, properly referenced, of the anchorage system between the wood roof and floor diaphragms to the masonry walls per ASCE-7 Section 12.11.

3. Provide calculations and details on the plans for the sub-diaphragm and continuous cross tie system required for all wood diaphragms, providing lateral support to masonry walls: (CBC 1604.8)
   a. The wall anchorage shall provide a positive direction connection between the wall and floor or roof construction, capable of resisting a horizontal force specified in CBC 1604.8 & ASCE-7 Section 12.11.2. In addition, a diaphragm to wall anchorage using embedded straps shall have the straps attached to or hooked around the reinforcing steel or otherwise terminated to effectively transfer forces to the reinforcing steel.
   b. Elements of the wall anchorage system shall be designed for the forces specified in CBC 1604.8. The value of $F_p$ used for the design of the elements of the wall anchorage system shall not be less than 280 plf of wall substituted for E.
   c. When elements of the wall anchorage system are not loaded concentrically or are not perpendicular to the wall, the system shall be designed to resist all components of the forces induced by the eccentricity.
   d. When pilasters are present in the wall, the anchorage force at the pilasters shall be calculated considering the additional load transferred from the wall panels to the pilasters. However, the min. anchorage force at a floor or roof shall be that specified in "b" above. (ASCE-7 Section 12.11.2.2.7)
   e. The strength design forces for steel elements of the wall anchorage system shall be 1.4 times the forces otherwise required above. (ASCE-7 Section 12.11.2.2.2)
   f. Floor and roof diaphragms shall be designed to resist the forces per ASCE-7 Section 12.10.1. Max. aspect ratio of 3:1 for unblocked diaphragm.
   g. The max. diaphragm shears used to determine the depth of the sub-diaphragm shall not exceed 75% of the diaphragm shear. (LARUCP 16-09)
   h. The max. length-to-width ratio of the wood structural sub-diaphragm shall be 2.5:1 per ASCE-7 Section 12.11.2.2.1.
   i. The wall anchorage shall not be accomplished by use of toenails or nails subject to withdrawal. Wood ledgers or framing shall not be used in cross-grain bending or cross-grain tension.
   j. Connection of a diaphragm to the vertical elements in structures having vertical irregularities identified in ASCE-7 T-12.3-2 shall be designed per the section referenced for the seismic design category specified in the table.
   k. Structures having a horizontal structural irregularity of Type 2 in ASCE-7 T-12.3-1 for diaphragm chords and drag members shall be designed considering independent movement of the projecting wings of the structure. Each of these diaphragm elements shall be designed for the more severe of the following two assumptions:
      i. Motion of the projecting wings in the same direction.
      ii. Motion of the projection wings in opposing directions.
   l. When designing the diaphragm to comply with the requirements stated above, the return walls, and fins/canopies at entrances shall be considered. Seismic compatibility with the diaphragm by either seismically isolating the element or by attaching the element and integrating its load into the diaphragm.

## STRUCTURAL DETAIL

**E. REINFORCEMENT**

1. Vertical reinforcement in masonry walls shall comply with the following: (ACI-530 Sections 1.14.2.2.2.1 & 1.14.2.2.5)
   a. Provide at least 0.20 sq. in. in area and:
      i. Shall be provided at corners.
      ii. Located within 16" of each side of an opening.
      iii. Located within 8" of the ends of walls or moment joints.
      iv. Spacing shall not exceed 1/3 the length of the shear wall, 1/3 the height of the shear wall, nor 48".
   b. A min. area of 1/3 of the required shear reinforcement.

2. Horizontal reinforcement in masonry walls shall comply with the following: (ACI-530 Sections 1.14.2.2.2.1 & 1.14.2.2.5)
   a. Spacing of horizontal reinforcement shall not exceed 1/3 the length of the shear wall, 1/3 the height of the shear wall, nor 48".
   b. Located at the bottom and top of wall openings and shall extend min. 24" or 40 bar diameters past the opening, whichever is greater.
   c. Continuous horizontal reinforcement shall be provided at structurally connected roof and floor levels and be provided within 16" of the top of walls.

3. Shear reinforcement shall be anchored around vertical reinforcing bars with a standard hook complying with ACI-530 Section 1.13.5.

4. Provide min. reinforcement for masonry walls as follows: (ACI-530 Section 1.14.6.3)
   a. The sum of horizontal and vertical reinforcement shall not be less than 0.002 times the gross cross sectional area of the wall.
   b. Horizontal reinforcement shall not be less than 0.0007 times the gross cross sectional area of the wall.
   c. Vertical reinforcement shall not be less than 0.0007 times the gross cross sectional area of the wall.

5. Beams supporting reactions from discontinuous walls or frames shall have transverse reinforcement spaced no more than 1/2 of the nominal depth of the beam. Transverse reinforcement ratio shall not be less than 0.0015. (CBC 2106.4.1)

6. For ASD, the bar diameter shall not exceed 1/8 of the nominal wall thickness and shall not exceed 1/4 of the least dimension of the cell, course or collar joint in which is placed. (CBC 2107.7)

## F. WALLS AND COLUMNS

1. Masonry partition walls, screen walls and other elements that are not designed to resist vertical or lateral loads shall be isolated from the structure in accordance with 1.14.5.2.2. Isolation joints and connectors between these elements and the structure shall be designed to accommodate the design story drift. (CBC 2106.1, ACI-530 Section 1.14.5.2.2)

2. Masonry shear walls in Seismic Design Category D, E or F shall be designed for the requirements of special reinforced masonry shear walls per ACI-530 Section 1.14.2.2.5 and ASCE-7 T-12.2-1. Other masonry shear wall types are not permitted in seismic design category D and higher.

3. Masonry columns shall comply with the following: (ACI-530 Sections 2.1.6 & 1.14.6.5)
   a. Columns shall a min. side dimension of 8" nominal. (ACI-530 Sections 2.1.6 & 2.1.6.3)
   b. Ratio of effective column height to least nominal dimension shall not exceed 25.
   c. Columns shall be designed to resist loads with a min. eccentricity equal to 0.1 times each side dimension, considering each axis independently.
   d. Vertical column reinforcement shall not be less than $0.0025A_n$ nor exceed $0.04\ A_n$. Min. number of vertical bars shall be 4.
   e. Longitudinal reinforcement shall be enclosed by lateral ties at least 3/8" diameter with spacing not exceeding, 16 longitudinal bar diameters, 48 lateral tie diameters, least cross-sectional dimension of the member, or 8".
   f. Lateral ties shall be arranged so that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a lateral tie with an included angle of not more than 135 degrees.
   g. Lateral ties shall be located vertically not more than 1/2 lateral tie spacing above the top of footing or slab in any story and not more than 1/2 lateral tie spacing below the lowest horizontal reinforcement in beam, girder, slab, or drop panel above.
   h. The nominal width of a column shall not be less than 8".

4. Masonry columns and piers meeting the following requirements may be used to resist seismic load:
   a. Seismic response modification factor, R, not greater than 1.5.
   b. Transverse reinforcement shall meet the requirements of CBC 2106.4.

5. Additional ties shall be provided around anchor bolts which are set in the top of columns. Such ties shall

enclose both the vertical bars in the column and the anchor bolts. There shall be a min. of two No. 4 lateral ties provided in the top 5" of the column. (1.14.5.3.1 ACI 530)

## STRUCTURAL NOTES

### G. GENERAL NOTES

The following general structural notes shall be made part of the construction documents.

1. Identify the following masonry material specifications and add as notes to the structural plans: (CBC 2103)
   a. Concrete masonry units – ASTM C90
   b. Mortar – ASTM C270. Specify mortar proportions per CBC T-2103.8(1) or the mortar properties per CBC T-2103.8(2).
   c. Grout – ASTM C476. Specify grout proportions per CBC T-2103.12 or conform to ASTM C476.
   d. Compressive strength. Specify strength per CBC T-2105.2.2.1.2.

2. Continuous Special Inspection by a registered deputy inspector is required for (engineered masonry) (high-lift grouting). (CBC 1704.4)

3. (Continuous) (Periodic) Special Inspection is required for masonry construction per T-1704.5.1 & T-1704.5.3. (CBC 1704.5.2 & ACI-530 Section 2.3)

4. Where special inspection or testing is required, the registered design professional in responsible charge shall include a "Statement of Special Inspections" on the plans. (CBC 1705)

5. Quality assurance measures shall comply with CBC 2105 and ACI-530 T-1.15.1, T-1.15.2 and T-1.15.3.

6. Type N mortar or masonry cement shall not be used as part of the lateral force resisting system. (ACI-530 Section 1.14.6.6)

7. Cleanouts shall be provided for all grout pours over 5' high.

8. Grout lifts shall not exceed 12.67' when the masonry has cured for 4-hrs., the grout slump is maintained between 10" and 11", and no intermediate reinforced bond beams are placed between the top and bottom of the pour height. Otherwise lifts shall not exceed 5'.

9. All cells and spaces containing reinforcement shall be filled with grout.

10. Pipes and conduits embedded in masonry shall not reduce the required strength. (ACI-530 Section 1.16.2)

11. Reinforcement shall be supported and fastened together to prevent displacements beyond the tolerances allowed by ACI-530 Section 3.4.1 prior to grouting.

12. Joint reinforcement used in masonry exposed to earth or weather shall be stainless steel or protected from corrosion by hot dipped galvanized coating. (ACI-530 Section 1.13.4.2)

### H. ADDITIONAL WRITTEN COMMENTS

| No. | Comment | Code Sec. No. |
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