**CITY OF [NAME OF CITY]**

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

**Structural Correction Sheet**

**For Masonry Wall Design**

(2016 CBC)

PLAN CHECK NO.: EXPIRATION DATE: STATUS: PROJECT ADDRESS:

**INFORMATION**

WORK DESCRIPTION:

APPLICANT’S NAME: TEL. NO.: ADDRESS: EMAIL:

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,

**INSTRUCTIONS**

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.

 **References:**

**NOTE**

* ASCE 7-10 - The Minimum Design Loads for Buildings and other structures by American Society of Civil Engineers. Including Supplemental No.1 and 2, excluding Chapter 14 and Appendix 11A;
* TMS 402-13/ACI 530-13/ASCE 5-13 - Building Code Requirements for Masonry Structures;
* TMS 602-13/ACI 530.1-13/ASCE 6-13 - Specification for Masonry Structures;
* CBC 2016 - California Building Code, Jan 2016.

(Note: unless noted otherwise, all sections of code referenced within this article shall refer to ACI 530-13)

1. **PLAN DETAILS**
2. Masonry Shear walls in seismic design category D, E, or F shall be designed for the requirements of special reinforced masonry shear walls as per 7.3.2.6 and Table 12.2-1 of ASCE-7.
3. Vertical reinforcement in masonry walls shall comply with the following:
	1. At least 0.20-in2 in cross sectional area shall be provided (7.3.2.3.1):
		1. At corners,
		2. Within 16-in. of each side of an opening 6-in. or more,
		3. Within 8-in. of the ends of walls or movement joints,
	2. Maximum spacing shall not exceed 1/3 the length of the shear wall, 1/3 the height of the shear wall, 48 inch for masonry laid in running bond, nor 24 inch for masonry not laid in running bond. (7.3.2.6 (a)).
	3. The minimum cross sectional area of vertical reinforcement shall be of 1/3 of the required shear reinforcement. (7.3.2.6 (c)).
4. Horizontal reinforcement in masonry walls shall comply with the following:
	1. Spacing of horizontal reinforcement shall not exceed 1/3 the length of the shear wall, 1/3 the height of the shear wall, 48-in for masonry laid in running bond, nor 24-in for masonry laid in other than running bond. (7.3.2.6 (b))
	2. Horizontal reinforcement shall be located at the bottom and top of wall openings 16-in. or more and shall extend minimum 24-in., or 40 bar diameter past the opening, whichever is greater. (7.3.2.3.1)
	3. Continuous horizontal reinforcement shall be provided at structurally connected roof and floor levels and be provided within 16-in. of the top of walls. (7.3.2.3.1)
5. Shear reinforcement shall be anchored around vertical reinforcing bars with a standard hook (7.3.2.6 (d))
6. Provide minimum reinforcement for masonry walls as follows:
	1. The sum of horizontal and vertical reinforcement shall not be less than 0.002 times the gross cross sectional area of the wall. (7.3.2.6 (c))
	2. For masonry laid in running bond, both of the horizontal and vertical reinforcement shall not be less than 0.0007 times the gross cross sectional area of the wall. (7.3.2.6 (c) 1)
	3. For masonry laid in other than running bond, vertical reinforcement shall not be less than 0.0007 times the gross cross sectional area of the wall, and horizontal reinforcement shall not be less than 0.0015 times the gross cross-sectional area of the wall. (7.3.2.6 (c) 2)
7. Only Type S or type M cement-lime mortar, masonry cement mortar, or mortar cement mortar shall be used as part of the lateral force resisting system. (7.4.4.2.2)
8. 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 7.3.1. Isolation joints and connectors between these elements and the structure shall be designed to accommodate the design story drift. (7.3.1)
9. Masonry columns shall comply with the following:
	1. The distance between lateral supports a column shall not exceed 99 multiplied by the least radius of gyration r (5.3.1 (a))
	2. Columns shall have a minimum side dimension of 8-in. nominal. (5.3.1 (b))
	3. Columns shall be designed to resist loads with a minimum eccentricity equal to 0.1 times each side dimension, considering each axis independently. (2.3.4.3)
	4. Vertical column reinforcement shall not be less than 0.0025An nor exceed 0.04An. Minimum number of vertical bars shall be four. Provide splice detailing where reinforcement exceeds 0.02An (5.3.1.3)
	5. Vertical reinforcement shall be enclosed by lateral ties at least 1/4-in. diameter with spacing not exceeding, 16 longitudinal bar diameters, 48 lateral tie diameters, or least cross-sectional dimension of the member, (5.3.1.4 (a)& (b))
	6. 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. No bar shall be farther than 6 in. clear on each side from such a laterally supported bar (5.3.1.4 (c))
	7. Lateral ties shall be located vertically not more than one-half lateral tie spacing above the top of footing or slab in any story and not more than one-half of lateral tie spacing below the lowest horizontal reinforcement in beam, girder, slab, or drop panel above. (5.3.1.4 (d))
10. 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 minimum of two No. 4 lateral ties provided in the top 5 in. of the column. (7.4.3.2.1)
11. Beams supporting reactions from discontinuous walls or frames shall have transverse reinforcement spaced no more than one-half of the nominal depth of the beam. Transverse reinforcement ratio shall not be less than 0.0015. (7.4.3.2.5)
12. Columns and Piers used to resist seismic load and to support reactions from discontinuous stiff elements shall comply with:
	1. Seismic response modification factor , R, is no greater than 1.5 (7.4.3.2.4)
	2. Transverse reinforcement shall meet the requirements of 7.4.3.2.5.
13. Sizes of reinforcement shall comply with the following:
	1. The maximum size of reinforcement used in masonry shall be No. 11 (6.1.2.1).

Where strength design is used the maximum size of reinforcement shall be No. 9 (9.3.3.1).

* 1. The diameter of reinforcement shall not exceed one-half the least clear dimension of the cell, bond beam, or collar joint in which it is placed (6.1.2.2)
	2. For Allowable stress design, 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. (2107.4 of the 2016 CBC)
1. **CALCULATIONS**
2. Provide structural calculations and details of reinforcement for piers, columns, beams, and for the distribution of concentrated vertical loads at walls.
3. The design of masonry structures shall comply with the allowable stress design provisions of Section 2107, or the strength design provisions of Section 2108, and with the General Design and Construction Requirements of Section 2101 through 2104, and 2106. All design calculations shall be based on specified dimensions. (2016 CBC)
4. Special reinforced masonry shear walls shall be designed with increased design value in accordance with 7.3.2.6.1.1 for strength design or 7.3.2.6.1.2 for allowable stress design.
5. Only the net cross-sectional area of masonry shall be used in design of shear walls. (4.3.1.1)
6. Mechanical splices in flexural reinforcement in plastic hinge zones shall develop the specified tensile strength of the spliced bar. (7.3.2.6 (e))
7. **For Allowable Stress Design:**
	1. 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. (8.3.4)
	2. Allowable compressive force due to axial load shall be in accordance with the formulas in Sec. 8.3.4.2.1;
	3. Allowable flexural compressive stresses or flexural compressive stresses with axial load shall not exceed Fb = 0.45 f’m, per Sec. 8.3.4.2.2;
	4. Allowable shear stress in shear walls(Fv) shall not exceed values specified in Sec. 2.3.6.1.2:

Fv = (Fvm + Fvs) γg (Eq. 8-25)

Fv ≤ 3 √f’m for M/Vd ≤ 0.25 (Eq. 8-26)

Fv ≤ 2 √f’m for M/Vd ≥ 1.0 (Eq. 8-27)

γg = 0.75 for partially grouted shear walls and 1.0 otherwise.

Where allowable shear stress resisted by masonry only:

Fvm = (1/2)[(4.0 – 1.75(M/Vd))√f’m] + 0.25(P)/An where M/Vd ≤ 1 (Eq. 8-29)

For special reinforced masonry shear walls:

Fv = (1/4)[(4.0 – 1.75(M/Vd))√f’m] + 0.25(P)/An where M/Vd ≤ 1 (Eq. 8-28)

The allowable shear stress resisted by the steel reinforcement:

Fvs = 0.5(Av Fs d)/ (An s) (Eq. 8-30)

* 1. Allowable stresses in reinforcement shall conform to Sec. 8.3.3.1.
	2. Shear reinforcement shall be provided when fv exceeds Fvm. (8.3.5.2)
	3. Reinforcement in shear walls with M/Vd equal to or greater than one and having an axial load greater than 0.05(f’m)(An) shall not exceed the maximum reinforcement ratio determined by equation 8-23. The reinforcement ratio is not applicable for the out-of-plane direction. (8.3.4.4)
	4. Development length of reinforcing bars in tension or compression shall be determined in accordance with equation 8-12, but not less than 12". (8.1.6.3)
	5. Lap splices of reinforcing steel shall be determined in accordance with equation 8-12 or 21-1 of 2016 CBC. Reinforcement larger than No. 9 bar shall be by approved mechanical connections in accordance with 8.1.6.7.3. (8.1.6.7.1.1, 2107.2.1 and 2107.3 of 2016 CBC)
1. **For Strength Design:**
2. The design strength is the nominal strength multiplied by the strength reduction factor Φ as specified in Section 9.1.4;
3. Walls shall be designed for out of plane loads in accordance with Sec. 9.3.5:
	* 1. P-delta effects shall be considered with both the factored axial load, Pu, and the moment magnified for the effects of member curvature, Mu. The magnified moment shall be determined from Section 9.3.5.4.2 or Section 9.3.5.4.3. (9.3.5.4)
		2. Calculate the mid-height, out-of-plane wall deflection for service lateral and vertical load (without load factors) and limit it to 0.007h. (9.3.5.5).
		3. Check stress at mid height of wall in accordance with Section 9.3.5.4.2.
4. Wall shall be design for in-plane loads in accordance with Sec. 9.3.6:
5. Reinforcement shall be provided perpendicular to the shear reinforcement and shall be at least equal to one-third of the cross sectional area of shear reinforcement, Av;
6. Nominal flexural and axial strength shall be determined in accordance with Sec. 9.3.4.1.1;
7. Nominal shear strength shall be determined in accordance with Sec. 9.3.4.1.2;
8. The maximum reinforcement shall meet either the requirements of Section 9.3.3.5 or Sections 3.3.6.5.1 through 3.3.6.5.5; (3.3.6.5)
9. Development length of reinforcing bars in tension or compression shall be determined in accordance with equation 9-16 but not less than 12" and need not be greater than 72db (2108.2 of 2016 CBC)
10. Splices of reinforcement shall be determined by equation 9-16, but shall not be less than 12” and shall be in accordance with 2108.3 of 2016 CBC.
11. Reinforcement shall have a specified yield strength not exceeding 60,000 psi. (9.1.9.3.1)
12. Provide calculations for design of anchor bolts in masonry considering edge distance and effective embedment depth in accordance with 8.1.3 for allowable stress design or 9.1.6 for strength design.
13. Design of structural walls and their anchorage for out-of-plane forces shall comply with Section 12.11 of ASCE 7-10
14. **NOTES ON THE PLANS**
15. Provide notes on the construction documents in accordance with Section 2101.3 of CBC 2016.
16. Provide material specification for ( ) block, ( ) grout, ( ) mortar, and ( ) reinforcing steel.
17. Construction shall comply with Section 3 of ACI 530.1-13.
	1. Reinforcement shall be supported to prevent displacements beyond the tolerances allowed by 3.4 of ACI 530.1. prior to grouting; (3.4 B of ACI 530.1-13)
	2. Cleanouts shall be provided for all grout pours over 5'-4”; (3.2 F of ACI 530.1-13)
	3. Grout lift height shall not exceed 12.67 ft when the masonry has cured for 4-hrs., the grout slump is maintained between 10 and 11 in., and no intermediate reinforced bond beams are placed between the top and bottom of the pour height. Otherwise grout lift height shall not exceed 5’-4”. (3.5 D of ACI 530.1-13)
	4. All cells and spaces containing reinforcement shall be filled with grout.
18. Where strength design is used, drawings shall note the following: “The actual yield strength shall not exceed 1.3 multiplied by the specified yield strength”.
19. Quality assurance measures shall comply with Sec. 2105 of 2016 CBC and Tables 3.1.1 and 3.1.2 and 3.1.3 of ACI 530 and shall be included in the statement of special inspections required by 1705 of 2016 CBC.
20. Special inspection is required for masonry construction. (1705.4 of 2016 CBC)
21. Joint reinforcement used in masonry exposed to earth or weather shall be stainless steel or protected from corrosion by mill galvanized, hot-dip galvanized, or epoxy coating. (6.1.4.2 & 6.1.4.3)
22. Pipes and conduits embedded in masonry shall not reduce the required strength. (3.2.2)