# SUPPLEMENTAL PLAN CHECK CORRECTION SHEET FOR CONCRETE SPECIAL MOMENT RESISTING FRAME
**(2023 LABC)**

Plan Check #: _____ Permit Application Number: _____

Job Address: _____

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This is a supplemental correction sheet. Please see the master correction sheet for instructions and additional information.

If you have any questions or need clarification on any plan check matters, please contact your plan check engineer and/or his or her supervisor.

This Supplemental Plan Check Correction Sheet applies to Special Concrete Moment Frames assigned to Seismic Category D, E, or F only (ASCE 7-16, Table 12.2-1). A Special Moment Frame is defined as a cast in place frame complying with requirements of 18.6 through 18.8.5.5 and Chapters 1 through 25 of ACI 318-19.

Italicized numbers refer to Code Sections of ACI 318-19.

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## PART I: PLAN DETAIL REQUIREMENTS

### A. FLEXURAL MEMBERS

1. For flexural members of frames, provide details as follows:
   a. Clear span ln shall be at least 4d. *18.6.2.1.a*
   b. Width $b_w$ shall be at least the lesser of: *18.6.2.1.b*
      i. 0.3h (h = overall thickness of member) and
      ii. 10 in.
   c. Projection of beam width beyond the width of supporting column on each side shall not exceed the lesser of: *18.6.2.1.c*
      i. width of supporting member, $c_2$, and
      ii. 0.75 of the overall dimension of supporting member, $c_1$.
2. For longitudinal reinforcement, splices, provide details as follows: *18.6.3*
   a. Provide hoop or spiral reinforcement overlap length of flexural reinforcement. *18.6.3.3*
   b. Spacing of the transverse reinforcement enclosing the lap-spliced bars shall not exceed d/4 and 4 in. *18.6.3.3*
   c. Longitudinal bar lap splices shall not be used at following locations: *18.6.3.3*
      i. Within the joints,
      ii. Within a distance of twice the member depth from the face of the joint.
      iii. Within a distance of twice the beam depth from critical sections where flexural yielding is likely to occur as a result of lateral displacements beyond the elastic range a behavior.

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3. Welded splices shall conform to 18.2.8 and mechanical splices shall conform to 18.2.7. *18.6.3.4*

4. For transverse reinforcement of the flexural frame member, provide details as follows: *18.6.4*

    a. Hoops shall be provided in the following regions of frame members: *18.6.4.1*

        i. Over a length equal to 2 times the member depth measured from the face of the supporting member toward mid-span, at both ends of the flexural member;

        ii. Over lengths equal to 2 times the member depth on both sides of a section where flexural yielding may occur in connection with inelastic lateral displacements of the frames.

    b. Where hoops are required, longitudinal bars on the perimeter shall have lateral support conforming to Sec. 25.7.2.3 and 25.7.2.4. The spacing between longitudinal bars restrained by legs of crossties or hoops shall not exceed 14". *18.6.4.2*

    c. Hoops in beams shall be permitted to be made up of two pieces of reinforcement; a stirrup having seismic hooks at both ends and closed by a crosstie as specified in Sec. 18.6.4.3

    d. The first hoop shall be located not more than 2" from the face of a supporting member. *18.6.4.4*

    e. The spacing of the hoops shall not exceed the smallest of following: *18.6.4.4*

        i. d/4,

        ii. For Grade 60, 6 times the diameter of smallest primary bars excluding the longitudinal skin reinforcement required by Section 9.7.2.3

        iii. For Grade 80, 5 times the diameter of smallest primary bars excluding the longitudinal skin reinforcement required by Section 9.7.2.3

        iv. 6 in.

    f. Where hoops are not required, stirrups with seismic hooks at both ends shall be placed at a distance no more than d/2 throughout the length of the member. *18.6.4.6*

    g. In beams having factored axial compressive force exceeding $A_g f'_c/10$, hoops satisfying 18.7.5.2 through 18.7.5.4 shall be provided along lengths given in 18.6.4.1. Along the remaining length, hoops satisfying 18.7.5.2 shall have spacing s not exceeding the lesser of six times the diameter of the smallest longitudinal beam bars and 6 in., 6$d_b$ of the smallest Grade 60 enclosed longitudinal beam bar, and 5$d_b$ of the smallest Grade 80 enclosed longitudinal beam bar. Where concrete cover over transverse reinforcement exceeds 4 in., additional transverse reinforcement having cover not exceeding 4 in. and spacing not exceeding 12 in. shall be provided. *18.6.4.7*

## B. COLUMNS OF THE FRAME

1. For members of concrete special moment resisting frame resisting earthquake induced forces subject to combined bending and axial loads, size of the frame member shall comply with:

    a. The shortest cross-sectional dimension, measured on a straight line passing through the geometric centroid, shall be at least 12 in. *18.7.2.1.a*

    b. The ratio of the shortest cross sectional dimension to the perpendicular dimension shall be at least 0.4. *18.7.2.1.b*

2. Lap splices shall be permitted only within the center half of the member length, shall be designed as tension lap splices, and shall be enclosed within transverse reinforcement in accordance with 18.7.5.2 and 18.7.5.3. Mechanical splices shall conform to Section 18.2.7 and welded splices shall conform to 18.2.8. *18.7.4.4*

3. Flexural strengths of columns shall satisfy Eq. 18.7.3.2:

$$\sum M_{nc} \geq \left(\frac{6}{5}\right) \sum M_{nb} \qquad 18.7.3.2$$

4. If Sec. 18.7.3.2 is not satisfied at a joint, the lateral strength and stiffness of the columns framing into that joint shall be ignored when calculating strength and stiffness of the structure. These columns shall conform to 18.14. *18.7.3.3*

5. Area of longitudinal reinforcement, $A_{st}$, shall be at least $0.01A_g$ and shall not exceed $0.06A_g$. *18.7.4.1*

6. Transverse reinforcement shall be in accordance with (a) through (f): *18.7.5.2*

    a. Transverse reinforcement shall comprise either single or overlapping spirals, circular hoops, or rectilinear hoops with or without crossties.

    b. Bends of rectilinear hoops and crossties shall engage peripheral longitudinal reinforcing bars.

    c. Crossties of the same or smaller bar size as the hoops shall be permitted, subject to the limitation of 25.7.2.2. Consecutive crossties shall be alternated end for end along the longitudinal reinforcement and around the perimeter of the cross section.

    d. Where rectilinear hoops or crossties are used, they shall provide lateral support to longitudinal reinforcement in accordance with 25.7.2.2 and 25.7.2.3.

    e. Reinforcement shall be arranged such that the spacing hx of longitudinal bars laterally supported by the corner of a crosstie or hoop leg shall not exceed 14 in around the perimeter of the column.

f. Where $P_u > 0.3A_g f'_c$ or $f'_c > 10{,}000$psi in columns with rectilinear hoops, every longitudinal bar or bundle of bars around the perimeter of the column core shall have lateral support provided by the corner of a hoop or by a seismic hook, and the value of $h_x$ shall not exceed 8 in. $P_u$ shall be the largest value in compression consistent with factored load combinations including E.

7. For transverse reinforcement (confinement), provide details as follows:

   a. The spacing of transverse reinforcement shall not exceed the smallest of following: *18.7.5.3*

      i. 1/4 of minimum member dimension,

      ii. For Grade 60, $6d_b$ of the smallest longitudinal bar

      iii. For Grade 80, $5d_b$ of the smallest longitudinal bar

      iv. $s_o = 4 + \left(\frac{14 - h_x}{3}\right)$
      The value of $s_o$ shall not exceed 6 in. and need not be taken less than 4 in.

   b. Amount of transverse reinforcement shall be accordance with table 18.7.5.4.

   c. Transverse reinforcement as specified in 18.7.5.2 through 18.7.5.4 shall be provided over a length ($l_o$) from each joint face and on both sides of any section where flexural yielding is likely to occur because of lateral displacements beyond the elastic range of behavior. Length ($l_o$) shall be at least the greatest of:

      i. the depth of the member at the joint face or at the section where flexural yielding is likely to occur;

      ii. one-sixth of the clear span of the member; and

      iii. 18". *18.7.5.1*

   d. Beyond the length lo specified in 18.7.5.1, the column shall contain spiral or hoop reinforcement satisfying 25.7.2 through 25.7.4 with the spacing s not exceeding the least of 6 in., $6d_b$ of the smallest Grade 60 longitudinal column bar, and $5d_b$ of the smallest Grade 80 longitudinal column bar, unless a greater amount of transverse reinforcement is required by 18.7.4.4 or 18.7.6. *18.7.5.5*

   e. Columns supporting reactions from discontinuous stiff members, such as walls, shall satisfy i and ii:

      i. Transverse reinforcement as required in 18.7.5.2 through 18.7.5.4 over the full height at all levels beneath the discontinuity if the factored axial compressive force in these columns, related to earthquake effect, exceeds $A_g f'_c/10$. Where design forces have been magnified to account for the over-strength of the vertical elements of the seismic-force-resisting system, the limit of $A_g f'_c/10$ shall be increased to $A_g f'_c/4$. *18.7.5.6.a*

      ii. Transverse reinforcement shall extend into the discontinued member at least $l_d$ of the largest longitudinal column bar, where $l_d$ is determined in accordance with 18.8.5. Where the lower end of the column terminates on a wall, the required transverse reinforcement shall extend into the wall at least $l_d$ of the largest longitudinal column bar at the point of termination. Where the column terminates on a footing or mat, the required transverse reinforcement shall extend at least 12 in. into the footing or mat. *18.7.5.6.b*

   f. Where the calculated point of contra flexure is not within the middle half of the member clear height, provide transverse reinforcement as specified in ACI 318 Section 18.7.5.1 items (a) through (c), over the full height of the member
   *LABC 1905.1.9 amendment to add Section 18.7.5.8 to ACI 318-19*

   g. At any section where the design strength, $\varphi P_n$, of the column is less than the sum of the shears $V_e$ computed in accordance with ACI 318 Sections 18.6.5.1 and 18.7.6.1.1 for all the beams framing into the column above the level under consideration, transverse reinforcement as specified in ACI 318 Sections 18.7.5.1 through 18.7.5.3 shall be provided. For beams framing into opposite sides of the column, the moment components may be assumed to be of opposite sign. For determination of the design strength, $\varphi P_n$, of the column, these moments may be assumed to result from the deformation of the frame in any one principal axis.
   *LABC 1905.1.10 amendment to add Section 18.7.5.9 to ACI 318-19*

## C. JOINTS OF THE FRAME

1. At joints of frames, provide details as follows:

   a. Beam longitudinal reinforcement terminated in a column shall be extended to the far face of the confined column core and anchored in tension according to 18.8.5 and in compression according to 25.4.9. *18.8.2.2*

   b. Where longitudinal beam reinforcement extends through a beam-column joint, the depth h of the joint parallel to the beam longitudinal reinforcement shall be at least the greatest of i through iii:

      i. 20 $b_d/\lambda$ of the largest Grade 60 longitudinal bar, where $\lambda$=.75for lightweight concrete and 1.0 for all other cases

ii. (b) 26db of the largest Grade 80 longitudinal bar

iii. (c) h/2 of any beam framing into the joint and generating joint shear as part of the seismic-force-resisting system in the direction under consideration *18.8.2.3*

c. The joint transverse reinforcement shall satisfy 18.7.5.2, 18.7.5.3, 18.7.4, and 18.7.5.7, except as permitted in 18.8.3.2. *18.8.3.1*

d. Where beams frame into all four sides of the joint and where each beam width is at least three-fourths of the column width, the amount of reinforcement required by 18.7.5.4 shall be permitted to be reduced by one-half, and the spacing required by 18.7.5.3 shall be permitted to be increased to 6 in. within the overall depth h of the shallowest framing beams. *18.8.3.2*

e. The hook shall be located within the confined core of a column or a boundary element, with the hook bent into the joint. *18.8.5.1*

f. Longitudinal beam reinforcement outside the column core shall be confined by transvers reinforcement passing through the column that satisfies spacing requirements of 18.6.4.4, and requirements of 18.6.4.2, and 18.6.4.3, if such confinement is not provided by a beam framing into the joint. *18.8.3.3*

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# PART II: CALCULATIONS

## A. LOADS AND SERVICEABILITY REQUIREMENTS

1. Use load combinations per Table 5.3.1 for members in concrete special moment resisting frame resisting earthquake induced forces:. *5.3.1*

2. Strength Reduction Factor Strength reduction factor used to calculate the design strength shall be follows: *Table 21.2.1 and Table 21.2.2*

   a. $\phi$ = 0.75 for shear (also reference to 21.2.4.1 for $\phi$)

   b. $\phi$ = 0.90 for tension-controlled sections

   c. $\phi$ = 0.75* for axial compression load (members with spiral reinforcing)

   d. $\phi$ = 0.65* for axial compression load (members with other reinforced members)

   (* Variation of $\phi$ for transition members per Table 21.2.2)

## B. BEAMS OF SPECIAL MOMENT FRAMES

For flexural members, provide the following:

1. Minimum longitudinal reinforcement (top & bottom) shall be the greater of: *18.6.3.1*

   a. $3\sqrt{f'_c}\, b_w d/f_y$ *9.6.1.2.a*

   b. $200\, b_w d/f_y$ *9.6.1.2.b*

2. Reinforcement ratio shall not exceed 0.025 for Grade 60 reinforcement and 0.02 for Grade 80 reinforcement. *18.6.3.1*

3. At least 2 bars shall be provided continuously at both top and bottom. *18.6.3.1*

4. Positive moment strength at joint shall not be less than 1/2 the negative moment strength provided at the face of the joint. At every section, the positive and negative moment capacity shall not be less than 1/4 the maximum moment strength provided at the face of either joint. *18.6.3.2*

5. The design shear force $V_e$ shall be calculated from consideration of the forces on the portion of the beam between faces of the joints. It shall be assumed that moments of the opposite sign corresponding to probable flexural strength, $M_{pr}$, act at the joint faces and that the beam is loaded with the factored gravity and vertical earthquake loads along its span. *18.6.5.1*

6. Transverse reinforcement over the lengths identified in 18.6.4.1 shall be designed to resist shear assuming $V_c$ = 0 when both of the following conditions occur: *18.6.5.2*

   a. The earthquake Induced shear force calculated in accordance with section 18.6.5.1 represents one half or more of the maximum required shear strength within the lengths;

   b. The factored axial compressive force including earthquake effects is less than $A_g f_c'/20$.

## C. COLUMNS OF SPECIAL MOMENT FRAMES

For the columns of frames, provide the following requirements:

1. Flexural strengths of columns shall satisfy Eq. 18.7.3.2:
   $\sum M_{nc} \geq \left(\frac{6}{5}\right) \sum M_{nb}$
   Otherwise, the lateral strength and stiffness of the columns framing into that joint shall be ignored when determining the calculated strength and stiffness of the structure. *18.7.3.3*

2. Amount of transverse reinforcement shall be in accordance with Table 18.7.5.4:

a. $k_f = \frac{f'_c}{25{,}000} + 0.6 \geq 1.0$ *18.7.5.4a*

b. $k_n = \frac{n_l}{n_l - 2}$ *18.7.5.4b*

where $n_l$ is the number of longitudinal bars or bar bundles around the perimeter of the column core with rectilinear hoops that are laterally supported by the corn of hoops or by seismic hooks.

c. Traverse reinforcement for rectilinear hoop shall be:

i. For $P_u \leq 0.3A_g f'_c$ **and** $f'_c \leq 10{,}000\ psi$, $A_{sh}/sb_c$ shall be the greater of the following two formulas: *Table 18.7.5.4*

$$\frac{A_{sh}}{sb_c} = 0.3\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}}$$

$$\frac{A_{sh}}{sb_c} = 0.09\frac{f'_c}{f_{yt}}$$

ii. For $P_u > 0.3A_g f'_c$ **or** $f'_c > 10{,}000\ psi$, $A_{sh}/sb_c$ shall be the greatest of the following three formulas: *Table 18.7.5.4*

$$\frac{A_{sh}}{sb_c} = 0.3\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}}$$

$$\frac{A_{sh}}{sb_c} = 0.09\frac{f'_c}{f_{yt}}$$

$$\frac{A_{sh}}{sb_c} = 0.2k_f k_n \frac{P_u}{f_{yt}A_{ch}}$$

d. Transverse reinforcement for spiral or circular hoop shall be: (table 18.7.5.4)

i. For $P_u \leq 0.3A_g f'_c$ **and** $f'_c \leq 10{,}000\ psi$, $\rho_s$ shall be the greater of the following two formulas: *Table 18.7.5.4*

$$\rho_s = 0.45\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}}$$

$$\rho_s = 0.12\frac{f'_c}{f_{yt}}$$

ii. For $P_u > 0.3A_g f'_c$ **or** $f'_c > 10{,}000\ psi$, $\rho_s$ shall be the greatest of the following three formulas: *Table 18.7.5.4*

$$\rho_s = 0.45\left(\frac{A_g}{A_{ch}} - 1\right)\frac{f'_c}{f_{yt}}$$

$$\rho_s = 0.12\frac{f'_c}{f_{yt}}$$

$$\rho_s = 0.35k_f \frac{P_u}{f_{yt}A_{ch}}$$

3. If the thickness of the concrete cover outside the confining transverse reinforcement exceeds 4 in., additional transverse reinforcement shall be provided at a spacing not exceeding 12 in. Concrete over on additional reinforcement shall not exceed 4 in. *18.7.5.7*

*4.* Transverse reinforcement required in 18.7.5.2 through 18.7.5.4 shall be provided over a length lo from each joint face and on both sides of any section where flexural yielding is likely to occur as a result of lateral displacements beyond the elastic range of behavior. Length lo shall be at least the greatest of (a) through (c): *18.7.5.1*

a. The depth of the column at the joint face or at the section where flexural yielding is likely to occur

b. One-six of the clear span of the column

c. 18 in.

5. Assume $V_c = 0$ for transverse reinforcement over the length $l_o$ when both of the following conditions occur: *18.7.6.2.1*

a. The earthquake induced shear force calculated per section 18.7.6.1 represents one half or more of the maximum required shear strength within $l_o$.

b. The factored axial compression force including earthquake effects is less than $A_g f'_c/20$

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## PART III: ADD NOTES ON PLANS

1. For concrete in members resisting earthquake induced forces, the minimum compressive strength of concrete shall be per table 19.2.1.1 *18.2.5.1*

a. 3,000 psi minimum for normal weight concretes.

b. 3,000 psi minimum and 5,000 psi maximum for light weight concrete.

2. For reinforcement in members resisting earthquake induced forces, the reinforcement shall comply with the special seismic systems requirements of 20.2.2. *18.2.6.1*

a. Deformed nonprestressed longitudinal reinforcement resisting earthquake-induced moment, axial force, or both, in special seismic systems and anchor reinforcement in Seismic Design Categories (SDC) C, D, E, and F shall be in accordance with (i) or (ii): *20.2.2.5*

i. ASTM A706, Grade 60, 80, or 100 for special structural walls and Grade 60 and 80 for special moment frames.

ii. ASTM A615 Grade 60 if (a) through (iv) are satisfied. ASTM A615 Grade 80 and Grade 100 are not permitted in special seismic systems.

(1) Actual yield strength based on mill tests

does not exceed $f_y$ by more than 18,000 psi.

(2) Ratio of the actual strength to the actual yield strength is at least 1.25

(3) Minimum fracture elongation in 8 in. Shall be at least 14 percent for bar sizes No.3 through No.6, at least 12 percent for bar sizes No.7 through No.11, and at least 10 percent for bar sizes No.14 and No.18.

(4) Minimum uniform elongation shall be at lease 9 percent for bar sizes No.3 through No.10, and at least 6 percent for bar sizes No.11, No.14 and No.18.

b. The value of $f_{yt}$ used to compute the amount of confinement reinforcement shall not exceed 100,000 psi. *Table 20.2.2.4a*

| **ADDITIONAL CORRECTIONS:** |
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