Supplemental Structural Correction Sheet
Steel Brace Frame Design
(2014 LABC)

Plan Check Submittal Date:_____

Plan Check / PCIS App #:_____

Job Address:_____

Applicant:_____Phone:_____

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If you have any questions or need clarification on any plan check matters, please contact a plan check supervisor or call our Customer Hotline at (213) 482-0056.

For instruction and other information, read the master plan check correction sheet attached.

Reference:

- ☐ AISC 341-10: Seismic Provisions for Structural Steel Buildings, by American Institute of Steel Construction.
- ☐ ASCE 7-10: Minimum Design Loads for Buildings and Other Structures by American Society of Civil Engineers.
- ☐ AWS D1.8/D1.8M:2009 and AWS D1.4/D1.4M:2005 Structural Welding Code by American Welding Society.
- ☐ LABC - 2014 Los Angeles Building Code

I. PLAN DETAILS

A. GENERAL

1. For all building columns, including those not designed as part of the SFRS, column splices shall be located 4 ft. of more away from the beam-to-column flange connections - See exceptions. Detail this on the plan.

   (AISC 341-Part D2-5a)

2. Provide a beveled transition detail where changes in thickness and width of flanges and webs occur in complete joint penetration groove welded column splices.

   (AISC 341-Part I-8.4a, AWS D1.8-09 2.7.1, 2.16.1.1)

3. Beveled transitions are not required when changes in thickness and width of flanges and webs occur in column splices where PJP grove welded joints are used. ***(AISC 341-8.4a,b)***

B. ORDINARY & SPECIAL CONCENTRICALLY BRACED FRAMES (OCBF/SCBF)

1. In built-up brace members, the spacing of connectors shall be uniform. Not less than two connectors shall be used in a built-up member. Connectors shall not be located with the middle one-fourth of the clear brace length. ***(AISC 341-F2-5b)***

2. In a V-type and inverted V-type brace frame, a beam that is intersected by braces shall be continuous between columns and laterally braced. ***(AISC 341-F1-7a,F2-4b,F4-4a)***

3. Show Protected Zone *of SCBF* per requirements of AISC 341-F2-5c.

4. K-type braces are not permitted for use in SCBF. ***(AISC 341-F2-4c)***

5. K-type braces are not permitted for use in OCBF. ***(AISC 341-F1-4b)***

6. The use of rectangle HSS are not permitted for bracing members, unless filled solid with cement grout having a minimum compressive strength of 3000 psi at 28 days. ***(LABC-2205.3)***

C. ECCENTRICALLY BRACED FRAME (EBF)

1. The web or webs of a link shall be single thickness without doubler-plate reinforcement and without web penetration. ***(AISC 341-F3-5b)***

2. Provide full-depth web stiffeners on both sides of the link web at the diagonal brace ends of the link. ***(AISC 341-F3-5b(4))***

3. Provide full-depth intermediate web stiffeners in link as required per AISC 341-F3-5b(4).

4. Lateral Bracing shall be provided at both the top and bottom link flanges at the ends of the link for I-shaped sections. ***(AISC 341-F3-4b)***

5. In an EBF system, beam-to-column connections shall be designed to resist moment with consideration of the required strength of the brace connection and beam connection, including the amplified diaphragm connector forces, or designed as a simple connection with specification section B3.6a ***(AISC 341-F3-6b)***

6. Links in EBFs are a protected zone, and shall satisfy the requirements of Section D1.3. Show protected zone on plan. ***(AISC 341-F3-5c)***

7. All demand critical welds shall satisfy the requirements of Sections A3.4b and I2.3. See AISC F3-6a for types of welds considered as demand critical welds. ***(AISC 341-F3-6a)***

II. CALCULATIONS

A. GENERAL

1. The total static design base shear in a given direction shall be determined per Section 12.8 of ASCE 7.
2. Use amplified loads ***where*** required by Sections 12.3.3.3 or 12.10.2.1 of ASCE 7. In addition to the load combination specified in 91.1605.2 and 91.1605.3, ***use the special*** seismic load combinations per Section 1605.1 and Section 12.4.3.2 / 12.14.3.2 of ASCE 7.

3. The elastic drift or horizontal displacements of the structure shall be computed as required in ASCE 7-12.8.6 and shall be amplified (C_d) as required in ASCE 7-12.8.6. Story drift limits shall be determined as specified in ASCE 7-12.12
4. Orthogonal earthquake effects shall be included in the analysis as required in ASCE 7-12.5.3 and 12.5.4.
5. For columns in the SFRS, the compressive axil strength and tensile strength shall be determined using the load combinations stipulated in the 2014 LABC including amplified seismic load. ***(AISC 341-D1-4a)***
6. R, Ωo and C_d shall be based on ASCE 7-Table 12.2-1.
7. Foundation of the steel frame shall be designed to resist applicable sliding shear, uplift force, and/or moment.
8. Column splices shall be designed per requirements of AISC 341-D2-5a and D2-5b. Welded column splices that are subject to a calculated net tensile shall be shall satisfy all of the following requirements:
   a. PJP weld if used shall have the capacity at least equal to 200 percent of the required strength.
   b. The available strength for each flange splice shall be at least equal to 0.5 $R_yF_yb_ft_f$ (LRFD) or $(0.5/1.5)R_yF_yb_ft_f$ (ASD), where b_ft_f is the flange area of the smaller column connected.
   c. Butt joints in column splices are made with CJP welds, when tension stress at any location in the smaller flange exceeds $0.30F_y$ (LRFD) or $0.2F_y$ (ASD), tapered transitions are required between flanges of unequal thickness or width.
9. The required strength of column bases shall be calculated in accordance with AISC 341-D2-6.

B. SPECIAL CONCENTRICALLY BRACED FRAMES (SCBF)

1. Bracing members shall have slenderness ratio $Kl/r \leq 200$. ***(AISC 341-F2-5b)***
2. The expected brace strength in tension is $R_yF_yA_g$. The expected brace strength in compression is permitted to be taken as the lesser of $R_yF_yA_g$ and $1.14F_{cre}A_g$. The expected post-buckling brace strength shall be taken as a maximum of 0.3 times the expected brace strength in compression. ***(AISC 341-F2-3)***
3. Along any line of bracing, braces shall be deployed in alternate directions such that, for either direction of force parallel to the bracing, at least 30% but no more than 70% of the total horizontal force is resisted by brace in tension, unless the available strength of each brace in compression is larger than the required strength resulting from the application of the appropriate load combinations stipulated by the applicable building code including the amplified seismic load. See AISC SP-13.2 for definition of "a line of bracing". ***(AISC 341-F2-4a)***
4. Columns and Braces shall satisfy the requirements of AISC 341-D1-1 for highly ductile members. Beams shall satisfy the requirements of AISC 341-D1-1 for moderately ductile members. ***(AISC 341-F2-5a)***
5. For built-up brace members, the spacing of the connectors shall be uniform and not less than two connectors shall be used. Bolted stitches are not permitted within the middle one-fourth of the clear brace length. ***(AISC 341-F2-5b)***
6. For built-up braces, the spacing of connectors shall be such that the slenderness ratio, a/r_i, of individual elements between the connectors does not exceed 0.4 times the governing slenderness ratio of the built-up member. ***(AISC 341-F2-5b)***
7. Design the bracing connections (including beam-to-column connection if part of the bracing system) for the lesser of the following:

a. The expected yield strength, in tension, of the bracing member, determined $R_yF_yA_g$ (LRFD) or $R_yF_yA_g/1.5$ (ASD)

b. The maximum load effect, indicated by analysis that can be transferred to the brace by the system. ***(AISC 341-F2-6c)***

8. Address the design flexural strength of the bracing connection in the direction the brace will buckle. The minimum required flexural strength of the bracing connections shall be equal to or greater than the expected nominal flexural strength of the brace $1.1R_yM_p$ (LRFD) or $(1.1/1.5)R_yM_p$ (ASD), about critical buckling axis of the brace (see exceptions by use of gap at the end of brace).
(AISC 341-F2-6b)

9. The design of the gusset plate of the bracing connection shall include the required compressive strength based on buckling limit states that is at least equal to $1.1R_yP_n$ (LRFD) or $(1.1/1.5)R_yP_n$ (ASD), where P_n is the nominal compressive strength of the brace member. ***(AISC 341-F2-6b)***

10. In addition to meeting requirements of Section 8.4, column splices in SCBF shall meet:

a. At least 50 percent of the lesser available flexural strength of the connected members.

b. The required shear strength shall be at least $\Sigma M_{pc}/H$ (LRFD) or $\Sigma M_{pc}/1.5H$ (ASD), where ΣM_{pc} is the sum of nominal plastic flexural strengths of columns above and below the splice.
(AISC341-F2-6d)

11. Use *R* value of 6 for the base shear determination. Table 12.2-1 of ASCE 7.

C. ORDINARY CONCENTRICALLY BRACED FRAMES (OCBF)

1. OCBF braces in V or inverted V configuration are required to have slenderness $Kl/r \leq 4\sqrt{(E/F_y)}$ to be used in K, V or inverted V-type configurations. ***(AISC 341-F1-5b)***

2. Braces shall satisfy the requirements of Section D1-1 for moderately ductile members.
(***AISC 341-F1-5a)***

3. OCBF is permitted up to 35 feet building height in Seismic Design Category D, E and, in single-story buildings up to a height of 60 ft where the roof dead load does not exceed 20 psf and in penthouse structures. ***(ASCE 7 - Table 12.2-1, footnote j)***

4. **Beams** in V-type and inverted V-type OCBF and **Columns** in K-type OCBF shall be continuous at bracing connections away from the beam-column connections and shall meet the following requirements:

a. The required strength shall be determined based on the load combinations of the applicable building code assuming that the braces provide no support for dead and live loads. For load combination that include earthquake effects, the earthquake effect, E, on the beam shall be determine as follows:
   i. The forces in all braces in tension shall be assumed to be the least of the following:
      (a) the expected yield strength of brace in tension, $R_yF_yA_g$
      (b) the load effect based upon the amplified seismic load
      (c) the maximum force that can developed by the system
   ii. The forces in all adjoining braces in compression shall be equal to $0.3P_n$

b. As a minimum, one set of lateral braces is required at the point of intersection of the braces, unless the member has sufficient out-of-plane strength and stiffness to ensure stability between adjacent brace points. ***(AISC 341-F1-4a)***

5. The required strength of diagonal brace connection is the load effect based upon the amplified seismic load, but need not exceed:

   a. In tension, the required strength determined by $R_yF_yA_g$ (LRFD) or $R_yF_yA_g/1.5$ (ASD).

   b. In compression, the required strength determined by the lesser of $R_yF_yA_g$ (LRFD) or $R_yF_yA_g/1.5$ (ASD) and $1.4F_{cre}A_g$ (LRFD) or $1.14/1.5F_{cre}A_g$ (ASD)

   (See AISC 341-F1-6a)

6. Use R value of 3.25 for the base shear determination. ***(ASCE 7-Table 12.2-1)***

7. Comply with AISC 341-F1-7 for OCBF above Seismic Isolation Systems. ***(AISC 341-F1-7)***

D. ECCENTRICALLY BRACED FRAMES (EBF)

1. Brace members shall satisfy the requirements for moderately ductile members and columns shall satisfy the requirements for highly ductile members per AISC 341-D1-1. ***(AISC 341-F3-5a)***

2. The required shear strength of Link members V_u shall not exceed member, $\varphi_v(0.6F_yA_{lw})$ **(LRFD)** or $(0.6F_yA_{lw})/\Omega_v$ **(ASD).** ***(AISC 341-F3-5b(2))***

3. If the required axial strength $\mathbf{P_u}$ **(LRFD)** or $\mathbf{P_a}$ **(ASD)** in a Link member exceeds $0.15P_y$ *(LRFD)or* $(0.15/1.5)P_y$ (ASD*)*, the following shall be met per AISC 341-F3-5b(2):
   a. The design shear strength of the link shall be the lesser of $\varphi_v(0.6F_yA_{lw}\sqrt{}(1-(P_u/P_y)^2)$ (LRFD) or $(0.6F_yA_{lw}\sqrt{}1-(1.5P_a/P_y)^2)$ (ASD)
   b. The length of the link shall not exceed:
      i. $1.6M_p/V_p$ when $\rho' = [(P_r/P_c)/(V_r/V_c)] \leq 0.5$ nor
      ii. $(1.6M_p/V_p)(1.15-0.3\rho')$ when $\rho' = [(P_r/P_c)/(V_r/V_c)] > 0.5$

4. The link rotational angle is the inelastic angle between the link and the beam outside the link when the total story drift is equal to the design story drift, Δ. The link rotation angle shall not exceed the following values:
   a. 0.08 radians for link length $1.6M_p/V_p$
   b. 0.02 radians for link length $2.6M_p/V_p$
   c. Value shall be determined by linear interpolation for link length between $1.6M_p/V_p$ and $2.6M_p/V_p$

   (AISC 341-F3-4a)

5. Link-to-column connections shall be fully-restrained (FR) moment connections and satisfy the following:

   a. Capable of sustaining the link rotation angle
   b. The shear resistance of the connection shall be at least equal to R_yV_n per Section F3-5b(2).
   c. The flexural resistance of the connection shall be at least equal to V_n per Section F3-5b(2).

   (AISC 341-F3-6e)

6. Link-to-column connections shall satisfy the above requirements by one of the following:

   a. Use a connection pre-qualified for EBF in accordance with AISC 341 - Section K1.

b. Provide qualifying cyclic test results in accordance with AISC 341 - Section K2.

c. Provide reinforced link-to-column connections per exception of AISC 341-F3-6e(2). ***(AISC 341-F3-6e(2))***

7. Provide lateral bracing at top and bottom flanges of the Link ends for I-shaped sections. The required strength of each lateral brace shall be $P_b = 0.06M_r/h_o$, where h_o is the distance between flange centroids, and $M_r = R_yZF_y$ (LRFD) or $M_r = R_yZF_y/1.5$ (ASD). ***(AISC 341-F3-4b and D1-2C)***

8. The diagonal brace and beam segment outside of the line should be treated as beam-columns in design, where the available strength is defined by Chapter H of this Specification. **(*AISC 341 -15.6a)***

9. Connections of braces designed to resist a portion of the link end moment shall be designed as fully-restrained. ***(AISC 341-15.6c)***

10. Design the beam-to-column connection as a simple connection meeting the requirements of Specification Section B3-6a with rotation taken to be 0.025rad, or shall be designed to resist a moment per AISC 341-F3-6b. ***(AISC 341-F3-6b)***

11. Use R value in accordance with Table 12.2-1 of ASCE 7.

12. Provide web stiffeners at the diagonal brace ends of the Link. Web stiffeners shall meet the design requirements as per AISC 341-F3-5b(4).

13. Design the fillet weld connection between the Link stiffener and the Link web as per AISC 341-F3-5b(4).

III. NOTES ON PLANS

A. GENERAL

1. The seismic design, fabrication, and erection of structural steel shall be in accordance with **Chapters A to F** of the Seismic Provisions for Structural Steel Buildings published by the American Institute of Steel Construction. ***(AISC 341-10)***

2. Welded joints shall be designed in accordance with Chapter J of the Specification and a Welding Procedure Specification (WPS) as required in AWS D1.8/D1.8M and approved by the Engineer of Record. “Provide Welding Procedure Specification” on plans.

3. All complete-joint-penetration groove welds used in the Seismic Force Resisting System shall be made with a filler metal that has a minimum CVN toughness of 20 ft-lbs at minus 20° F and 40 ft-lbs at 70° F.

4. Discontinuities in weld created by errors or by fabrication or erection operations, such as tack welds, erection aids, air-arc gouging and flame cutting, shall be repaired as required by the Engineer of Record.

5. All bolts used as a part of the seismic force resisting system shall be fully tensioned high strength bolts.

6. The specification and Fabrication for steel frames shall comply with attached Welding and Fabrication procedures.

B. SPECIAL CONCENTRICALLY BRACED FRAMES (SCBF)

1. Splices shall be located per requirement of AISC 341-F2-6d.

2. Provide protected zone per AISC 341-F2-5c.

C. ECCENTRICALLY BRACED FRAMES (EBF)

1. Connections of braces designed to resist a portion of the link and moment shall be designed as fully-restrained. ***(AISC 341-F3-6c)***

2. Links are a protected zone. ***(AISC 341-F3-5c)***

ADDITIONAL CORRECTIONS	Code Sec. No.