Errata No. 1
SEAOC "Recommended Lateral Force Requirements and Commentary"
1999, Seventh Edition

Page xii, Table of Contents.

Add the following for Chapter 7 Steel:

Page 19, 108.2.4 Deformation Compatibility.

Modify the last sentence of the second paragraph to read as follows: (changes underlined)

> Inelastic deformations of members and connections are acceptable provided the assumed calculated capacities are consistent with member and connection design and detailing. Appropriate detailing for reinforced concrete structures is specified in UBC Section 1921.7 and Section 402.14, Frame Members not Part of the Lateral-Force-Resisting System.

Page 20, 108.2.8 Anchorage of Concrete or Masonry Walls.

Modify the second from last sentence to read as follows: (changes underlined)

> Requirements for developing anchorage forces in diaphragms are given in Sections 108.2.8.1 and 108.2.9 below.

Page 21, 108.2.9 Diaphragms.

Modify Item 6 to read as follows: (changes underlined)

Connections of diaphragms to the vertical elements in structures in Seismic Zones 3 and 4 that have a plan irregularity of Type 1, 2, 3, or 4 (Table 104-5), shall be designed without considering either the one-third increase or the duration of load increase considered in allowable stresses for elements resisting earthquake forces, or shall be designed using a factor of 1.25 times the required seismic forces when Strength Design is used.

EXCEPTION: When connection forces are determined using the Special Load Combinations of Section 101.7.4.

For buildings having a plan structural irregularity of Type 4 (Table 104-5), diaphragms or horizontal bracing that transfer forces between horizontally offset vertical lateral force resisting elements shall be designed using the Special Load Combinations of Section 101.7.4. For this case, the reliability/redundancy factor may be taken equal to 1.0.

Page 48, Table 104-7.

Revise the sixth line to read: (changes underlined)

> " . . . system nominal horizontal air gap is greater than 0.25 inches, the design force for the anchors calculated . . ."

Page 67, Reinforced Concrete.

Add a complete new Section 402.14 as follows:

402.14 Frame Members Not Part of the Lateral-force-resisting System.

Modify: **UBC Section 1921.7.1** by adding the following sentence to the end of the Section:

Slab-column connections shall comply with Sections 1921.7.5 through 1921.7.7. Compliance to Section 1921.7 satisfies the deformation compatibility requirements of UBC Section 1633.24.

Modify: **UBC Section 1921.7** by adding the following subsections after subsection 1921.7.4:

1921.7.5 Reinforcement to Resist Slab Punching Shear.

Reinforcement to resist punching shear shall be provided in accordance with UBC Sections 1911.12, 1921.7.5.1, and 1921.7.5.2 at slab-column connections where story drift ratio exceeds $[0.035 - 0.05\ (V_u/\varphi V_c)]$. Shear reinforcement need not be provided where $V_u/\varphi V_c$ is less than 0.2, or where the story drift ratio is less than 0.005, except as required in UBC Section 1911.12 for gravity loads without consideration of seismic effects. V_u equals the factored punching shear from gravity load excluding shear stress from unbalanced moment. V_u is calculated for the load combination $1.2D + f_1L + f_2S$ of UBC Section 1612.2.1.

1921.7.5.1 The slab shear reinforcement shall provide V_s not less than $3.5\sqrt{f'_c}$.

1921.7.5.2 The slab shear reinforcement shall extend not less than 5 times the slab thickness from the face of the column.

1921.7.6 Bottom bars or wires within the column strip shall conform to ACI Section 13.3.8.5 except that splices shall be Class B.

1921.7.7 Within the effective slab width defined in UBC Section 1913.5.3.2, the ratio of non-prestressed bottom reinforcement to gross concrete area shall not be less than 0.004.

Page 67, Reinforced Concrete.

Add a complete new Section 402.15 as follows:

402.15 Footings

Modify: **UBC Section 1915.2.1** by adding the following sentence:

The appropriate induced reactions for strength design may be computed as those due to a factor of 1.5 times the net soil pressures from the gravity load combinations and the seismic load combinations of Section 1612.3.

Page 102, C105.1.1.1 Reliability/Redundancy Factor (Equation 105-3).

After the fourth paragraph add the following additional text:

The ρ factor is not to be applied to the seismic forces used for the evaluation of the torsional amplification factor A_x given by Equation 105-17.

The ρ factor is intended to be applied to the individual seismic action E_h on a given element, and not to the seismic loading of the structural system. Therefore, the ρ factor does not apply to the evaluation of displacement, drift, torsion, and overturning effects.

The seismic design forces given in Section 105.5 are to be used for the evaluation of the element actions E_h and the displacements δ and drifts Δ.

The ρ factor shall either not be applied, or shall be taken as equal to 1.0, in the following situations:

1. When calculating the displacements required for the evaluation of the torsional amplification factor in Section 105.7.

2. When calculating the deformation Δ_S in Section 105.9.

3. For design calculations required by Sections 107 and 109.

4. For evaluation of sliding, overturning moment, and soil bearing at the soil-structure interface as per Section 104.1.

5. For proportioning and section design of foundation elements (excluding connections between the foundation and superstructure elements).

For a story with a flexible diaphragm immediately above, r_{max} may be calculated from an analysis that assumes rigid diaphragm behavior.

Page 133, C108.2.6 Collector Elements.

Delete all of the existing text and replace with the following:

Collector elements are required to transfer tributary diaphragm loads to the vertical elements of the lateral force-resisting system. The collector (also called drag strut or drag element) also includes the connections between the collector member and the vertical elements. It is important that these connections be designed to prevent localized failure, which would in turn prevent inelastic energy dissipation from developing in the lateral force-resisting system as assumed.

It is required that collector elements and their connections be designed to have the strength to resist Ω_o times the specified seismic design forces, unless the "yield" force of the diaphragm or the vertical resisting element is smaller, in which case this may be used as the design strength of the collector and its connections. It is important to ensure that inelastic energy dissipation occurs in the ductile lateral force-resisting elements (frames, braces, walls) rather than in the collectors and connections.

The concept of a collector and the special seismic load combinations (Section 101.7.4) are not intended to apply to the linear shear transfer joint between floor or roof diaphragms and the vertical elements of the lateral-force-resisting system, unless the collector is part of a horizontal transfer diaphragm.

Page 134, C108.2.8.1 Out-of-Plane Wall Anchorage to Flexible Diaphragms.

Add the following sentence to the end of the first paragraph:

It should be noted that this Section is intended to stand alone, and the Section 107.2 requirements that $R_p = 1.5$ for shallow anchors does not apply for flexible diaphragms in Seismic Zones 3 and 4.

Page 170, Figure C109-1.

Delete the existing figure and insert revised Figure C109-1 given at the end of this errata.

Page 171, Figure C109-2.

Delete the existing figure and insert revised Figure C109-2 given at the end of this errata.

Page 184, Draft Requirements Currently Under Study.

Change Exception 1 to read: (change underlined)

Equation C402-1 need not be satisfied for the columns directly below the roof.

Page 188, Reinforced Concrete.

Add a complete new section C402.14 as follows:

C402.14 Frame Members Not Part of the Lateral-force-resisting System.

Provisions for slab-column connections are added to UBC Section 1921.7. The added provisions aim to prevent punching shear failures that can occur when flat-slab gravity systems are subjected to earthquake deformation. Such punching shear failures resulted in unrepairable earthquake damage in the Northridge earthquake and could lead to slab collapse in cases where integrity reinforcement is insufficient. With the added provisions, UBC Section 1921.7 covers columns, beams, and slabs that are not designated as part of the lateral-force-resisting system.

UBC Section 1633.2.4 requires all structural elements not designated as part of the lateral-force-resisting system to be designed to support gravity loads while subjected to the lateral design displacement Δ_M. For concrete structures, meeting UBC Section 1921.7 satisfies this requirement for the columns, beams, and slabs of the gravity system.

The principle of Section 1921.7 is to allow flexural yielding of columns, beams, or slabs under the lateral design displacements, and to provide sufficient confinement and shear strength in elements that yield. Columns and beams are assumed to yield if the induced moment from the displacement Δ_M exceeds the moment strength, or if the induced moment is not calculated. Requirements for transverse reinforcement and shear strength are provided according to axial load and whether or not the member yields.

The procedure for checking slabs at columns does not require a calculation of induced moments, and instead is based on (a) the story drift corresponding to the lateral design displacement, and (b) the level of gravity-load shear stress on the punching-shear perimeter. Figure C402-5 illustrates the criterion of Section 1921.7.5, which requires shear reinforcement to be provided where the combined effect of story drift and shear stress could result in a punching shear failure. The criterion derives from test data of slabs subjected to gravity load and lateral displacement [Megally and Ghali 2000, Pan and Moehle 1992].

Section 1921.7.5.1 defines the quantity of shear reinforcement required, and Section 1921.7.5.2 defines the length over which the shear reinforcement shall extend. Sections 1921.7.6 and 1921.7.7 give requirements for slab bottom reinforcement that may yield as a result of seismic deformation. Section 1921.7.6 requires Class B rather than Class A lap splices, and Section 1921.7.7 provides for a minimum amount of bottom reinforcement in the region of the column.

Page 202, References (for Reinforced Concrete).

Add the following additional references:

Megally, Sami, and Amim Ghali, 2000. "Punching Shear Design of Earthquake Resistant Slab-Column Connections," *ACI Structural Journal*, Volume 97, No. 5, September-October.

Pan, Austin D., and Jack P. Moehle, 1992. "An Experimental Study of Slab-Column Connections," *ACI Structural Journal*, Volume 89, No. 6, November-December.

Page 210, Reinforced Concrete.

Add a new Figure C407-5:

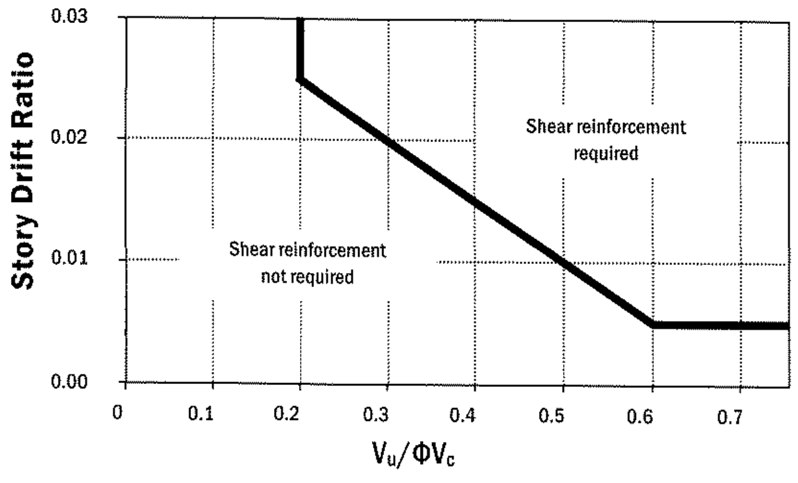


Figure C402-5. Punching shear criterion of §1921.7.5.

Page 400, Step 5A.

Step 5A on page 400 refers to the wrong equation for base shear. In the text, it states to use the base shear obtained in Equation AppIB-3, which is an equation for effective stiffness, not base shear. The correct equation reference is Equation AppIB-11 for the EBD approach, and Equations AppIB-6 and AppIB-7 for the DBD approach.

Page 400, Step 5A.

Replace the phrase: "or by modal analysis scaled to the base shear" with "or by a displaced shape derived from a more detailed analysis".

Page 400, Equation AppIB-11.

Replace "Δ_r" with "Δ_T".

Page 432, Response Spectra as a Function of Site Class.

On the third line:

Replace "S1" with "S_1".

On the fifteenth Line:

Insert a "-" between 16 and Q.

Page 435, Appendix I – Attachment 2.

In the equation defining "T_o", replace "S_{P1}" with "S_{D1}".

Page 436, Table.

In the equations, replace "S_{PS}" with "S_{DS}" and "S_{P1}" with "S_{D1}".

Page 437, Figure Appl-Att2-2.

In the figure and in the equations, replace "S_{PS}" with "S_{DS}" and "S_{P1}" with "S_{D1}".

Support Structure

$$V = \frac{C_v}{(R/I)T}W \text{ with } R \text{ from Table 104-6 or 104-8}$$

with $V_{min} > 0.56C_aIW$ and $\frac{1.6ZN_vI}{R}W$ in Zone 4

$$V_{max} = \frac{2.5C_a}{R/I}$$

T based on combined system T
(combine weight of item with weight of support)

Nonbuilding Item and Anchorage

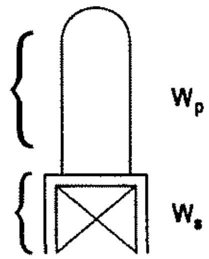
Use the larger of: $F_p = 0.70C_aI_pW_p$

or: $\frac{a_pC_aI_p}{R_p}\left(1 + \frac{3h_x}{h_r}\right)W_p$

with a_p and R_p from Table 104-7

Nonbuilding Item

Support Structure



W_p less than 0.25 W_s
T_E greater than 0.06 sec. (flexible)

Support Structure

$$V = \frac{C_v}{(R/I)T}W \text{ with } R \text{ from Table 104-6 or 104-8}$$

with $V_{min} > 0.56C_aIW$

$$V_{max} = \frac{2.5C_a}{R/I}$$

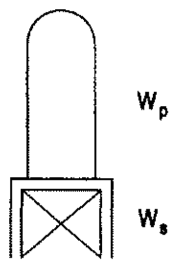
T based on combined system T
(combine weight of item with weight of support)

Nonbuilding Item and Anchorage

Use the larger of: $F_p = 0.70C_aI_pW_p$

or: $\frac{a_pC_aI_p}{R_p}\left(1 + \frac{3h_x}{h_r}\right)W_p$

with a_p and R_p from Table 104-7



W_p less than 0.25 W_s
T_E less than 0.06 sec. (rigid)

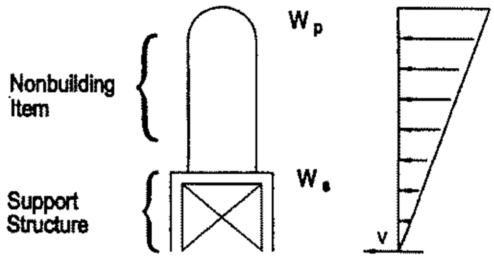
Figure C109-1. *Nonbuilding structures supported above grade ($W_p < 0.25W_s$)*

Support Structure, Nonbuilding Item and Anchorage

$$V = \frac{C_v}{(R/I)T}W$$ with R from the smaller of Table 104-6 or 104-8

$$V_{max} = \frac{2.5C_a}{R/I}W$$

T based on combined system T



W_p greater than 0.25 W_s
T_E greater than 0.06 sec. (flexible)

Support Structure

$$V = \frac{C_v}{(R/I)T}W$$ with R from Table 104-6 or 104-8

$$V_{max} = \frac{2.5C_a}{R/I}$$

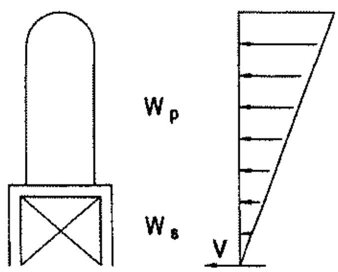
T based on combined system T
(combine weight of item with weight of support)

Nonbuilding Item and Anchorage

Use the larger of: $F_p = 0.70C_aI_pW_p$

or: $$F_p = \frac{a_pC_aI_p}{R_p}\left(1 + \frac{3h_x}{h_r}\right)W_p$$

with a_p and R_p from Table 104-7



W_p greater than 0.25 W_s
T_E less than 0.06 sec. (rigid)

Figure C109-2. *Nonbuilding structures supported above grade (W_p> 0.25W_s)*