ADMINISTRATIVE BULLETIN

NO. AB-XXX :

DATE : DRAFT by ATC 6 May 2025

SUBJECT : Seismic Retrofit Provisions for Concrete Buildings

TITLE : **Application of Engineering Criteria in SFEBC Appendix A, Chapter A6**

PURPOSE : The purpose of this Administrative Bulletin is to provide technical details and commentary on the application of engineering criteria in SFEBC Appendix A, Chapter A6 which covers the seismic evaluation and retrofitting of concrete buildings.

REFERENCES : 2022 San Francisco Existing Building Code (SFEBC)
ASCE 7-16 *Minimum Design Loads for Buildings and Other Structures*
ASCE 41-17 *Seismic Evaluation and Retrofit of Existing Buildings*
ACI 318-19 *Building Code Requirements for Structural Concrete*

DISCUSSION :

San Francisco Existing Building Code (SFEBC) Chapter A6 outlines the seismic retrofit provisions aimed at reducing the collapse risk of vulnerable Concrete Buildings (CB), as defined in Chapter 5G. This includes certain types of concrete buildings and their associated vintage as well as buildings with rigid-walls and flexible diaphragms. Chapter A6 establishes structural engineering criteria, including Engineering Criteria Options (per Table A6.4-1) that a Concrete Building must satisfy through seismic evaluation or retrofit. The document also specifies other retrofit triggers, such as substantial structural or non-structural alterations, which necessitate adherence to these provisions. A key focus is on addressing common seismic deficiencies, detailed in Table A6.4-2, which include weak stories, irregularities in lateral-force-resisting elements, non-ductile moment frames, shear-governed concrete columns or wall piers, punching shear in concrete slabs, weak connections of concrete walls to flexible diaphragms, and inadequate bearing connection lengths.

This bulletin provides further clarification by offering commentary on selected sections of Appendix A, Chapter A6 of the SFEBC.

In addition to this commentary, this bulletin provides the specific technical requirements for how to identify, evaluate, and retrofit the seismic deficiencies of Table A6.4-2 when using Engineering Criteria Option (a).

SFEBC Chapter A6 Commentary:

I. A6.2 Definitions

Commentary: This subsection of Chapter A6 includes a definition of the term “wall pier,” which is used in the chapter to specify buildings that are exempt from the requirements of the chapter and to specify seismic deficiencies that are required to be addressed by Engineering Criteria Option (a). The definition of wall pier is per Section 2.3 of ACI 318-19.

II. A6.3 Design professionals

Commentary: Chapter A6 requires that evaluations and design be performed by or under the supervision of “appropriately licensed individuals.” The State of California governs the registration of professional

engineers and requires that engineers practice only in areas where they have demonstrated competence. The registration status of any licensed professional engineer can be checked at

http://www.bpelsg.ca.gov/consumers/lic_lookup.shtml.

The successful execution of a seismic retrofit project and the resulting building performance in an earthquake rely heavily on the analysis and design work done by the Owner's Engineer. Building owners are encouraged to seek references for the engineer that they plan to engage, and to understand the engineer's experience and qualifications applicable to the building type, size, and other characteristics.

Questions that an owner may want to ask a structural or civil engineer before selecting them include:

- Do you have experience with seismic retrofitting of concrete buildings?
- Do you have experience using the seismic evaluation and retrofit standard ASCE 41?
- Can you describe structures that you have evaluated or retrofitted that are most similar to my building?

III. A6.4 Structural engineering criteria

A. A6.4.1 Engineering criteria

Commentary: Table A6.4-1 provides two options for engineering criteria that engineers may use for seismic evaluation or retrofit of Concrete Buildings. Option (b) specifies greater seismic forces. Option (a) specifies lower seismic forces, but it requires also addressing the seismic deficiencies that are listed in Table A6.4-2.

i. Criteria Option (a)

For Engineering Criteria Option (a), addressing the seismic deficiencies in Table A6.4-2 is required, even if analysis indicates that the building satisfies Collapse Prevention for the BSE-1E earthquake level without addressing a listed deficiency. Addressing the seismic deficiencies in Table A6.4-2 is intended to enable gravity-load-resisting elements to undergo severe earthquake movements, greater than BSE-1E, while maintaining their capacity to support gravity loads. These seismic deficiencies can be critical contributors to the collapse vulnerability of concrete buildings; they do not include all possible seismic deficiencies.

ii. Criteria Option (b)

Engineering Criteria Option (b) uses the BSE-2E earthquake hazard level for Collapse Prevention and equates to the requirements of ASCE 41 for the Basic Performance Objective for Existing Buildings (BPOE) except that non-structural evaluation and retrofitting is limited to elements of unreinforced masonry, and evaluation of the Life Safety performance level for the BSE-1E earthquake level is not required. Addressing the seismic deficiencies specified in Table A6.4-2 is not necessarily required in meeting Engineering Criteria Option (b). For buildings assigned to Risk Category I or II, the criteria for Engineering Criteria Option (b) will typically also provide compliance with triggered retrofit requirements for Substantial Alteration (Section 304.3.2 of the SFEBC).

For Engineering Criteria Option (b), evaluation of the Life Safety performance level for the BSE-1E earthquake level need not be evaluated, because for San Francisco earthquake hazard parameters, it will not govern over Collapse Prevention for the BSE-2E level. This is because the ratio between these earthquake ground motion levels is typically around 1.8, while the ratio between the Collapse Prevention and Life Safety acceptability limits in ASCE-41 does not exceed 1.33.

iii. "75% of code" criteria not permitted in Appendix A6

The option (in Section 304.3.2) to use 75 percent of the prescribed forces of the new building code is intentionally not included in Chapter A6, and thus is not permitted for use in Chapter A6 because this option does not make clear how to address (a) the design of gravity framing for

imposed deformations and (b) structural detailing that does not conform to that of any concrete seismic-force-resisting system that is permitted in high seismic design categories.

iv. Buildings assigned to Risk Category III or IV

Chapter A6 provides retrofit criteria intended to achieve basic safety for Risk Category II buildings. The criteria can be applied to Risk Category III or IV buildings if the goal is only to achieve this basic safety (i.e., Structural Collapse Prevention (S-5) for the BSE-2E earthquake hazard level). It is not in the scope of Chapter A6 to provide retrofit criteria to achieve the higher performance related to safety or recovery that is associated with new structures assigned to Risk Category III and IV.

v. Elements of unreinforced masonry

Both engineering criteria options in Table A6.4-1 require removing or retrofitting unreinforced masonry elements (if any). This requirement addresses the safety risk from elements such as unreinforced masonry chimneys, hollow clay tile partitions, and brick masonry walls falling out-of-plane. Except for these elements, Chapter A6 does not require seismic retrofitting of nonstructural components.

B. Flexible floor- or roof-diaphragms

Requirements: For buildings with one or more flexible diaphragms, compliance with Appendix A, Chapter A2 is sufficient to comply with the portions of Chapter A6 related to the wall anchorage system and collectors.

In addition, for buildings satisfying all of the following, compliance with Chapter A2 is sufficient to meet the structural requirements of Chapter A6:

(a) The building has no more than two stories above grade plane, excluding mezzanines.

(b) The building does not include concrete columns nor wall piers, as defined in Chapter A6.

(c) The building's floor and roof diaphragms are both flexible in-plane, meaning sheathed with plywood, wood decking (e.g., 1x or 2x), or metal deck without concrete topping slab.

Commentary: Rigid-wall-flexible-diaphragm (RWFD) buildings are addressed by Chapter A2. Chapter A6 is not expected to be invoked for one-story buildings. For Concrete Buildings taller than one story, where Chapter A6 is invoked and the structure satisfies all of (a), (b), and (c) above, the wall-to roof diaphragm and wall-to-floor diaphragm anchorage system and collectors are the only structural aspects of such buildings that are required to be addressed per Chapter A6.

C. Combinations of seismic-force-resisting systems

Requirements: For buildings having structural systems that are partially concrete and partially other structural materials, the building shall comply with Chapter A6 as a combined system, except:

(a) **Vertical combinations of seismic-force-resisting systems:** For vertical combinations of seismic-force-resisting systems (meaning different seismic-force-resisting system in upper story(s) compared to lower story(s)) where only the lower system is of concrete, if the existing upper system (including the lateral-force-resisting system and gravity system) is not of concrete construction, the existing upper system need not comply with Chapter A6.

(b) **Combinations of seismic-force-resisting systems in different directions:** For combinations of seismic-force-resisting systems where different seismic-force-resisting systems are used along each of the two orthogonal axes of the structure, if the gravity system is not of concrete construction, the existing non-concrete lateral-force-resisting system need not comply with Chapter A6.

D. Technical requirements for addressing the seismic deficiencies of Table A6.4-2 when using Engineering Criteria Option (a).

Requirements: The following requirements apply to identifying, evaluating, and retrofitting the seismic deficiencies listed in Table A6.4-2.

Potential deficiency	Requirements	Commentary
Weak story: The structure includes one or more stories having lateral strength less than the story above.	The structure shall not have vertical structural irregularity of Type 5a nor Type 5b in Table 12.3-2 of ASCE 7.	If the structure has a weak story or extreme weak story, to meet Engineering Criteria Option (a) the weak story must be eliminated by retrofitting. Otherwise the structure must meet Engineering Criteria Option (b).
Lateral-force-resisting-element irregularity: The lateral-force-resisting system includes one or more concrete walls or frames that are not continuous to the foundation.	The building shall not have a horizontal structural irregularity Type 4 of Table 12.3-1 or vertical structural irregularity Type 4 of Table 12.3-2 of ASCE 7.	If the structure has either of the specified irregularities—in-plane or out-of-plane offset or discontinuity—to meet Engineering Criteria Option (a), the irregularity must be eliminated by retrofitting. Otherwise the structure must meet Engineering Criteria Option (b).
Non-ductile moment frame: The main lateral-force-resisting-system includes concrete moment frames that do not satisfy strong-column-weak-beam requirements or that have shear-governed columns or beams.	Comply with all of the following: 1. Moment frame columns shall satisfy Section 18.7.3 of ACI 318 and Section 18.7.6.1 of ACI 318. 2. Moment frame beams shall satisfy Section 18.6.5.1 of ACI 318.	Section 18.7.3 requires strong-column weak-beam strength proportions. Section 18.6.6.1 requires columns to be flexure governed. Section 18.6.5.1 requires beams to be flexure governed. Such requirements are essential for ductile behavior of concrete moment frames.
Shear-governed concrete column or wall pier: The structure includes one or more concrete columns or wall piers that are shear-governed and are susceptible to failure resulting in loss of gravity load support.	For each column or wall pier, comply with at least one of the following: 1. Columns and wall piers shall have design shear strength satisfying Section 18.7.6.1 of ACI 318 or greater than the maximum shear that can be delivered to the column or wall pier based on a capacity design approach. For wall piers, joint faces shall be taken as the top and bottom of the clear height of the wall pier. 2. Provide or demonstrate an alternate load path to support design gravity load assuming a failure of the column or wall pier such that it cannot support gravity load. 3. For wall piers in buildings that do not have an Extreme Torsional Irregularity per ASCE 7 Table 12.3-1 Type 1b,	1. Shear governed columns or wall piers can be a serious deficiency that leads to building collapse. Retrofitting columns or wall piers by jacketing, such as with fiber reinforced polymer (FRP), can be used to make the elements flexure governed. 2. If failure of columns or wall piers can be shown not to cause collapse because of an alternate load path for gravity load, the shear-governed behavior is permitted. An example of an acceptable alternate load path is a beam that can span over a failed column or wall pier to supports not susceptible to failure, or an added column adjacent to the susceptible column or wall pier. The alternate load path is to be a complete load path, i.e. to the foundation and supporting soil, that does not rely on non-compliant elements.

Potential deficiency	Requirements	Commentary
	demonstrate compliance with the Tier 1 Quick Check for shear stress in concrete walls in that story in each plan direction per Section 4.4.3.3 of ASCE 41. Pseudo seismic force V shall be 2 times the pseudo seismic force at the BSE-1E earthquake level, but need not exceed that at BSE=2E. System modification factor M_s shall be for Collapse Prevention performance.	3. If the building meets the quick-check for shear at the specified level and does not have an Extreme Torsional Irregularity, it is judged that there is enough wall that the consequences of shear failure of wall piers will be limited. Option 3 is not permitted for structures with high plan-torsion irregularity because of a concern that columns or wall pier on one side of the building plan could suffer undo damage in such a case.
Punching shear in concrete slab: One or more concrete floor or roof slabs are supported by columns without beams framing into the column and susceptible to loss of gravity load support following punching shear failure.	Comply with one or more of the following in each principal plan direction at each column: 1. Demonstrate compliance with Section 18.14.5 of ACI 318 with earthquake force E and design story drift Δ_x taken as 2 times the earthquake force and story drift at the BSE-1E earthquake level, but need not exceed that at BSE-2E, determined in accordance with Section 7.4. of ASCE 41. Also comply with Section 8.7.4.2.2 of ACI 318. The slab bottom bars must be continuous through the column or spliced using mechanical or welded splices. 2. Demonstrate the existence of continuity reinforcement in accordance with ASCE 41 Table 10-15 footnote d. 3. For post-tensioned slabs, demonstrate compliance with Section 8.7.5.6 of ACI 318. 4. Provide an alternate load path to support design gravity load, assuming a failure at the slab-column interface such that the slab-column interface cannot support gravity load.	1. Section 18.14.5 addresses acceptable punching shear stress from gravity load as a function of story drift, a key indicator of susceptibility to punching shear of slab-column connections. Section 8.7.4.2.2 requires two slab bottom bars to pass between the column cage longitudinal bars in each plan direction. 2. ASCE 41 Table 10-15 footnote d requires one post-tensioning tendon to pass through the column cage in each plan direction, or slab bottom bars with steel area based on the gravity shear demand on the slab critical section. 3. Section 8.7.5.6 requires two prestressing tendons to pass through the column cage in each plan direction, or slab bottom bars with steel area based on the column and slab geometry. The tendons or bottom bars help prevent collapse of the slab if punching shear initiates. 4. If the existing condition is susceptible to punching shear, a possible retrofit solution is to provide a path of support such as a collar at the top of a column that supports the bottom of the slab beyond the expected punching shear failure plane.
Weak connection of concrete wall to flexible diaphragm: The structure includes one or more concrete walls supporting one or more flexible diaphragms, where the wall is not adequately anchored to the diaphragm.	For each flexible floor or roof diaphragm, comply with Chapter A2, or ASCE 41 with a performance objective of Structural Collapse Prevention with the BSE-2E earthquake level.	The objective of this item is to make it unlikely that a concrete wall will separate from a flexible floor or roof diaphragm in a way that could lead to floor or roof collapse. For floor or roof diaphragms that have timber framing in combination with a complete grid of concrete floor beams, Chapter A2 may be used to demonstrate that existing concrete

Potential deficiency	Requirements	Commentary
		floor beams are connected to the walls in such a way that they resist out-of-plane forces on the walls at least equal to the forces prescribed in Chapter A2.
Inadequate length of bearing connection: One or more beams or slabs are supported by a bearing connection with short bearing length.	Provide bearing length to support gravity load, such that the bearing length satisfies all of the following: 1. Section 18.14.4.1(d) of ACI 318. 2. Two times the displacement demand at the BSE-1E earthquake level, determined in accordance with Section 7.4 of ASCE 41, but need not exceed that at BSE-2E.	In some cases, including at building expansion joints, concrete floor structures, either cast-in-place or precast, have bearing supports. In older structures such bearing supports may not have adequate bearing length compared to earthquake displacement demands. 1. Section 18.14.4.1(d) requires a bearing length of 5 inches for beams, or 2 inches + L/180 for slabs.

E. A6.4.2 Building separation

Commentary: Building separation issues are not required to be considered in Chapter A6 because of the likely impracticalities of addressing property-line separations in San Francisco. Engineers are encouraged to inform the building owner if there is a risk of pounding damage at building separations.

F. A6.4.3 Liquefaction and landslide risk.

Commentary. Similarly, seismic evaluation and retrofit per Chapter A6 is not required to address soil liquefaction or landslide. Engineers are required to notify the owner if their building is in a zone of high or very high risk of liquefaction or landslide.

The exemption from considering the geotechnical hazards of liquefaction and landslide does not apply to lateral earth pressure. Forces from static and dynamic earth pressure on walls (absent liquefaction or landslide) shall be considered in the seismic evaluation in combination with other forces on the structure.

G. A6.4.5 Masonry infill

Commentary. If the infill is of unreinforced masonry, its attachment to the main structure is to be addressed as shown in Table A6.4-1. Additionally, for either reinforced or unreinforced masonry infill, the effect of the infill on building response is to be addressed per this subsection.

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Approved by the Building Inspection Commission on (date)