



## INFORMATION SHEET

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**NO. G-29**

**DATE** : September 25, 2024

**SUBJECT** : General

**TITLE** : Commercial-to-Residential Adaptive Reuse – Code Provisions

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**PURPOSE** : The purpose of this Information Sheet is to highlight pertinent code provisions and possible code exceptions to aid commercial-to-multi-family residential adaptive reuse projects in the San Francisco downtown area per San Francisco Building Code Section 111A and Planning Code Section 210.5.

**REFERENCES** : San Francisco Building Code, Current Edition  
San Francisco Existing Building Code, Current Edition  
California Building Code (CBC), Current Edition  
California Existing Building Code (CEBC), Current Edition and Revised 2022 CEBC Intervening Code Cycle, effective 7/1/2024  
San Francisco Green Building Code, Current Edition  
California Historical Building Code, Current Edition  
California Mechanical Code, Current Edition  
San Francisco Fire Code (SFFC), Current Edition  
California Fire Code (CFC), Current Edition  
San Francisco Planning Code (SFPC), Current Edition  
Seismic Evaluation and Retrofit of Existing Buildings, American Society of Civil Engineers / Structural Engineering Institute (ASCE/SEI) 41-16 and ASCE/SEI 41-23  
Recommended Post-Earthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings, FEMA-352  
American Institute of Steel Construction (AISC) 342  
Standard for the Installation of Sprinkler Systems, National Fire Protection Association (NFPA) 13, and Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies, NFPA 13R  
NFPA 72 National Fire Alarm and Signaling Code

**OVERVIEW:**

Adaptive reuse projects are building alteration projects that involve the change of occupancy classification of a building, as a whole or of a portion of a building. The California Existing Building Code (CEBC) requires buildings that undergo changes of occupancies to comply with the California Building Code (CBC) for the resulting occupancy, per CEBC 506, under the *Prescriptive Compliance* method. The purpose of this information sheet is to identify pertinent code provisions and to highlight possible code exceptions to aid commercial-to-multi-family residential adaptive reuse projects under SFBC 111A. This information sheet is applicable to buildings in the downtown area, as defined in SFPC Section 210.5.

Where design complexities and hardships exist that make it difficult or infeasible to comply with code requirements, design equivalencies to code requirements may be proposed by the design professional for consideration and approval per SFDBI Administrative Bulletin AB-005 *Procedures for Approval of Local Equivalencies*. A pre-application meeting may also be requested to confirm code interpretations.

Alternatively, CEBC Chapter 10 of the *Work Area Compliance* method may be used for change of occupancy alterations. Note that a change of occupancy from commercial to multi-family residential results in a higher hazard category per CEBC Chapter 10 Table 1011.5 Means of Egress Hazard Categories and Table 1011.6 Heights and Areas Categories.

**DISCUSSION:**Building Envelope

Any building converting from commercial occupancy to multi-family residential occupancy must comply with the allowable building height, number of stories, and floor area specified in CBC Chapter 5. The new residential occupancy must be fully fire sprinklered and comply with CBC 903.2.8.

California Energy Code (CEC) Section 180 requirements for insulation and fenestration shall apply for projects with building envelope changes. For qualified historic buildings, the California Historical Building Code (CHBC) may allow exceptions for existing elements to remain, or for new elements where the historic significance of the building or character-defining features are threatened.

Exterior Walls & Exterior Wall Opening Protection

Exterior walls are required to have fire-resistance ratings in compliance with CBC 705.5, with the required rating dependent on the fire separation distance from property line and on the type of construction of the building. The change from commercial occupancy to multi-family residential occupancy would generally not trigger the need to increase the fire resistance rating of the exterior walls, as residential occupancies have either less restrictive or equal fire rating requirements for exterior walls as commercial occupancies. However, the change to residential occupancy may require certain exterior walls to be rated for fire exposure from both sides of the wall, whereas in prior occupancies, rating for fire exposure was required only from the inside. If not already in compliance, the fire-resistance rated assemblies of exterior walls shall be improved to comply with the ratings, as set forth in CBC 705.5.

Existing non-rated exterior walls may be maintained, provided the exterior wall is protected with a water curtain design approved by the Department of Building Inspection (DBI) and San Francisco Fire Department (SFFD) as a local equivalency to fire-resistance rating for fire exposure from the exterior side. There are limitations to the amount of wall openings allowed in exterior walls per CBC 705.8. The exterior walls of a building are additionally protected through CBC 705.8 which specifies the maximum area of exterior wall openings based on the building's distance away from the property line. Wherein the existing building is non-conforming to the code requirements, and existing area of openings exceed the allowable area of openings, or where the project proposes to provide additional exterior wall openings exceeding that allowed by the Code, then design equivalencies for exterior wall opening protection may be proposed by the Design Professional for consideration. SFDBI Administrative Bulletin AB-009 *Local*

*Equivalency for Approval of New Opening in New and Existing Building Property Line Walls* may provide a path for accommodation.

### Means of Egress

The means of egress components will be evaluated to comply with SFBC and CBC Chapter 10. Some major elements to consider are the number of exits required per story, minimum distance required between exits, minimum common path-of-travel distances, exit access travel distances, emergency escape and rescue access/paths for sleeping rooms, etc.

There are allowances for existing buildings, such as:

- Existing stairways are allowed exceptions to current code compliance where the existing space and construction does not allow a reduction in pitch or slope. CEBC 506.3
- There are size tolerances for operable windows serving as emergency escape and rescue openings. CEBC 506.4
- Accessible means of egress are not required unless triggered by CBC 11A or 11B. Where CBC 11B is applicable, the exceptions in CBC 11B-207 apply.
- Qualified historic buildings are permitted to use existing fire escapes per CHBC 8-502.5 where the fire escapes are inspected and improved to comply with SFDBI Administrative Bulletin AB-019.

### Interior Environment - Ventilation

All new dwelling units shall be provided with natural or mechanical ventilation.

In addition, other than high-rise residential buildings, public corridors, public hallways and other public spaces having openings into adjoining dwelling units, also need to be naturally ventilated by means of openable windows. In lieu of the required exterior openings for natural ventilation, mechanical ventilation may be provided as detailed in SFBC 1202.5.

Independent exhaust systems are required for the kitchen hood, bathroom(s), and dryer exhausts.

Adaptive reuse projects in the Air Pollutant Exposure Zone shall incorporate an enhanced ventilation system to comply with San Francisco Health Code Article 38, mandated by the San Francisco Department of Public Health.

### Interior Environment – Lighting

Natural light is required for all habitable rooms per CBC and SFBC 1204.1. Where obtaining direct natural light through an exterior opening from the public way or yard is a hardship, light courts with dimensions complying with CBC 1205, or skylights may be used. See SFDBI Information Sheet IE-02 for additional clarification for sizing yards and courts adjacent to exterior openings that provide the required natural light and/or ventilation.

Where direct natural light is not achievable, natural light may be obtained through exterior glazed openings of adjoining spaces per CBC 1204.2.1 and SFDBI Information Sheet IE-01.

Habitable rooms in qualified historic buildings are permitted to have windows complying with CHBC 8-303.6 for light and ventilation.

### Minimum Unit Size

SFBC 1208.4, Efficiency Dwelling Units, establishes minimum sizing requirements for dwelling units, including required kitchen amenities, and bathroom fixtures, with existing buildings requiring larger unit

sizes than those for new construction. SFDBI will take into consideration, when accompanied with SFDBI Administrative Bulletin AB-005 Approval of Local Equivalency, to allow commercial-to-multi-family residential adaptive reuse projects with minimum dwelling unit size for new construction rather than that required in existing buildings. In such a case, SFDBI will evaluate the current or proposed egress systems in relationship to the proposed occupant load in accordance with the requirements of CBC 1004 and CBC 1005.

### Seismic

Buildings undergoing vertical and/or horizontal additions shall satisfy current code requirements for wind and seismic design of new buildings per SFEB 502.

Where work involves substantial structural or non-structural alterations as listed below, the building's lateral-force-resisting system shall satisfy the current code requirements as outlined in the CBC. Reduced seismic forces are permitted in accordance with SFEB 503.11.

1. Structural Alterations: Structural elements that provide support to more than 30 percent of the total floor and roof area of the building or structure (as defined by SFEB 202 *Substantial Structural Alteration*) are modified. The elements counted in this assessment include all structural elements accumulated since the original building was built. SFEB 503.11
2. Non-Structural Alterations: Non-structural alterations are made to elements such as walls, partitions, or ceilings on 2/3 or more of the number of stories of the building. SFEB 503.11.1

Reduced seismic forces are defined in the CEBC as seismic forces that are reduced to 75 percent of the forces prescribed in SFBC 304.4 for new buildings. These retrofit requirements may also be met by employing a performance-based design, which may result in a more efficient and cost-effective project. Performance-based design using the ASCE41 standard is permitted by the CEBC. For Risk Category II, the following performance objectives are required per CEBC 304.3.2:

1. Structural *life-safety* performance objective (S-3) when subjected to the Basic Safety Earthquake (BSE) -1E earthquake hazard level, and
2. Structural *collapse-prevention* performance objective (S-5) when subjected to the BSE-2E earthquake hazard level.

Alternatively, concrete buildings requiring retrofit, per the aforementioned triggers, may meet the forthcoming seismic retrofit standard being developed under the Mayor's Executive Directive 24-01. The standard permits the building to meet the structural *collapse-prevention* performance objective (S-5) when subjected to the BSE-1E earthquake hazard level, as long as the following specific seismic deficiencies are addressed: weak story, discontinuous elements, non-ductile moment frames, slab punching shear at columns, shear governed columns or wall piers, inadequate bearing supports for beams or slabs, and weak connections between walls and flexible floor or roof diaphragms. A commentary of these potential deficiencies and of the mitigation requirements may be found in Attachment 1 of this information sheet. This alternative engineering design criteria for concrete buildings will be made available in the SFEB once pending legislation is approved.

Note that this alternative criteria for concrete buildings may be used unless the building is triggered to be seismically retrofitted per the California state requirements as defined in CEBC 503.11, where *Substantial Structural Alterations* are defined in CEBC 202.

Where work does not involve substantial alterations mandating the building to satisfy full or reduced seismic forces, the following actions are recommended:

1. Perform a seismic evaluation of the building to understand the building's vulnerabilities, and perform targeted strengthening as required.
2. For non-ductile concrete buildings, perform improvements as required to meet one of the acceptable retrofit criteria noted above. Concrete buildings undergoing retrofit to the current code using full or reduced seismic forces, or to the forthcoming concrete retrofit standard, will not be

mandated to retrofit the building again based on limitations and moratorium detailed in the standard being developed under the Mayor's Executive Directive 24-01.

3. For welded steel moment frame buildings, inspect existing joint connections for weld fractures, and, where needed, perform repairs per FEMA 352. Partial joint penetration column splices are another potential vulnerability in steel buildings recommended to be inspected. For the seismic evaluation recommended in Item 1 above, it is recommended that ASCE 41-23, which incorporates AISC 342 be used as the basis of the evaluation.

#### Accessibility and Federal Fair Housing Act:

The change of occupancy from commercial to residential occupancy will be evaluated for the need to comply with the accessibility requirements of CBC Chapter 11A or 11B.

In general, the change of occupancy to residential use within the existing building envelope does not invoke CBC Chapter 11A. However, if the scope of work includes an addition to the existing building, where the addition when considered alone meets the definition of 'covered multifamily dwelling', then the addition, common areas, and path of travel to the new addition will be subjected to Chapter 11A.

Projects which meet the definition of public housing will be subjected to the requirements of CBC Chapter 11B for a certain percentage of units to accommodate mobility and communication features, as well as other accommodations for accessibility.

#### High-rise Buildings

High-rise buildings have additional special detailed requirements as set forth in CBC 403. In particular, the following are notable requirements to keep in mind for commercial-to-residential conversion of high-rise buildings:

A minimum of two fire service access elevators (FSAE) are required for buildings with an occupied floor more than 120 feet above the lowest level of fire department vehicle access, CBC 403.6. Where the existing building did not have FSAE's or did not house two elevator banks, and a hardship to install a new elevator exists, alternative equivalent facilitations may be proposed as an equivalency to satisfy CBC 3003 FSAE. The proposed equivalency shall be reviewed and approved by SFDBI and SFFD in accordance with SFDBI Administrative Bulletin AB-005.

All portions of the high-rise building shall have a smoke control system per CBC 909. Where an equivalent smoke control/management protection system is approved by SFFD as a local equivalency, the mechanical system shall be designed to support the smoke control/management protection system accordingly. SFDBI Administrative Bulletin AB-047 *Specific Submittal Criteria for Reports, Special Inspections, and Final Acceptance Testing of Smoke Control Systems* submittal requirements apply.

Additional emergency systems, where required, such as fire pumps, emergency generators, fire command centers, and others shall comply with CBC 403. Equivalencies may be proposed and will be evaluated on a case-by-case basis.

#### Use of Historical Building Code

Buildings deemed by SF Planning as a qualified historic building as defined in the California Historical Building Code (CHBC) shall be subject to the regulations and standards of the CHBC, provided that the continued use of the building does not constitute a distinct hazard to life safety as defined in the CHBC.

CHBC 8-901.5 exempts qualified historic buildings from compliance with energy conservation standards. However when new non-historic lighting and space conditioning system components, devices, appliances and equipment are installed, they shall comply with the requirements of Title 24, Part 6 of the CEC, except where the historic significance of the building or character-defining features are threatened.

CHBC 8-502.5 allows for the use of an existing fire escape as one of the required means of egress, provided that it extends to the ground, is easily negotiated, and is in good working order. Fire escapes shall comply with the standards of SFDBI Administrative Bulletin AB-019.

California Energy Code

Mechanical and plumbing systems shall be required to comply with the CEC. The energy code requirements consist of mechanical and plumbing equipment efficiency/controls and mechanical ventilation requirements.

Lighting and power distribution systems shall comply with CEC for multi-family occupancies. The requirements consist of efficiency and control of lighting and power distribution systems.

San Francisco Green Building Code

Adaptive reuse projects are exempt from San Francisco Green Building Code requirements as long as the alteration to the building does not fall within the definition of Major Alteration. Major Alteration is defined as alterations and additions in existing B, M, or R occupancies of 25,000 gross square feet or more, where the interior finishes are removed, and there are significant upgrades to the structural and mechanical, electrical, and/or plumbing systems.

Projects that are Major Alterations shall meet San Francisco Green Building Code, SFDBI Administrative Bulletin AB-093 Implementation of Green Building Regulations GS-2 submittal and include the Leadership in Energy and Environmental Design / GreenPoint Rated (LEED/GPR) score card.

**SAN FRANCISCO FIRE DEPARTMENT REQUIREMENTS:**Low-Rise Buildings Conversion from B to R-2 Occupancy

1. The new R-2 occupancy must be fully sprinklered per NFPA 13 (National Fire Protection Association), or per NFPA 13R, as indicated in CFC Section 903.3.1.2, and per SFFD Administrative Bulletin AB #2.04. If car stackers, Energy Storage Systems (ESS), or Electric Vehicles (EV) charging stations are proposed, compliance with applicable SFFD Administrative Bulletins AB # 4.25 and AB # 4.29 is required.
2. Class I Standpipe must be provided for the new R-2 occupancy where required by the CFC 905.3.1 and the SFFC Section 905.
3. The new R-2 occupancy shall be required to have a code complaint Fire Alarm (FA) system per current CFC and NFPA 72 and SFFD AB # 2.01. All dwelling units and sleeping units are required to have UL 268 smoke detectors with low-frequency sounder bases. 120 VAC smoke alarms are not permitted by SFFD. Carbon Monoxide detection will be required where required by CFC, Section 915. Other signaling systems such as Two-Way Emergency Communications Systems (2-Way ECS) may be required by the SFFD on a case-by-case basis.
4. A radio test for Firefighters Emergency Two-Way Communication shall be performed within the new R-2 occupancy per SFFD AB # 2.01 Addendum G after the R-2 construction is completed. If the radio test passes, a new Emergency Responders Radio Communications System (ERRCS) is not required. However, if the radio test fails, an ERRCS shall be installed per current applicable codes.
5. Existing elevators are not required to be upgraded to meet current code requirements for gurney size, hoistway construction, and Firefighters Emergency Operation (FEO), including Phase I and Phase II emergency operation. The existing elevators may remain unchanged, or if desired by the owner/applicant, may be modernized to meet current California Elevator Safety Orders Group 4 Regulations. If the existing elevators are modernized, a code compliant FEO interface with the new R-2 fire protection systems is required.
6. The SFFD will only require the heating, ventilation, and air conditioning (HVAC)/Mechanical Air-Moving system to shut down upon smoke detection per the current California Mechanical Code (CMC) requirements.


High-Rise Building Conversions from Commercial to Multi-Family Residential Occupancy


In general, all SFFD requirements for low-rise buildings shall also apply to high-rise buildings. There is not a distinction in code application for commercial to residential adaptive reuse projects for the two SFFD high-rise classifications:

1. *Existing* high-rise buildings (buildings having a site permit application before 10/1974)
2. *Life-safety* high-rise buildings (buildings having a site permit application after 10/1974)

Additional requirements for high-rise buildings (both classifications) are listed below:

1. If the existing high-rise building has an existing wired Fire Department communication system (phone-jack system) which can be maintained and operational in the new R-2 occupancy – a radio test will not be required and an ERRCS will not be required by the SFFD.
2. If the existing high-rise building does not have a Fire Command Center (FCC), a new FCC shall be required for the new R-2 Occupancy. The FCC room sizes not meeting CFC requirements may be evaluated and accepted on a case-by-case basis if specific building limitations prove a hardship to meet current CFC room size requirements.
3. If the existing high-rise building does not have a fire pump, the SFFD may not require a fire pump on a case-by-case basis where the sprinkler system demand for the new R-2 occupancy can be met without a fire pump.
4. If the existing high-rise building does not have a water tank, equivalencies may be proposed.
5. If the existing high-rise building does not have Firefighters Air Replenishment System (FARS), the new R-2 occupancy will not be required to have FARS.
6. The new FA system for the new R-2 occupancy shall be required to have a code complaint Emergency Voice Alarm Communications System (EVACS) utilizing speakers and manual live paging messages per the SFFD AB # 3.05. The new EVACS shall meet Level-3 survivability requirements per the CFC and NFPA 72. All dwelling units and sleeping units will be required to have UL 268 smoke detectors with low-frequency sounder bases (120 VAC smoke alarms are not permitted by SFFD). Carbon monoxide detection shall be provided where required by CFC Section 915.
7. A Fire Alarm system light-emitting diode (LED) annunciator shall be provided at the FCC and shall comply with the SFFD AB # 3.01 specific requirements.
8. The new R-2 occupancy shall have a partial evacuation scheme that complies with the SFFD AB # 3.05.

  
 \_\_\_\_\_ September 25, 2024  
 Patrick O'Riordan, C.B.O.                      Date  
 Director  
 Department of Building Inspection

  
 \_\_\_\_\_ September 27, 2024  
 Ken Cofflin                                      Date  
 Fire Marshal  
 San Francisco Fire Department

Attachment 1: Potential Deficiencies in Concrete Buildings and Mitigation Requirements

This Information Sheet is subject to modification at any time. For the most current version, visit our website at [sfdbi.org](http://sfdbi.org)

### Potential Deficiencies in Concrete Buildings and Mitigation Requirements

The following are requirements for identifying, evaluating, and retrofitting certain potential seismic deficiencies in concrete buildings.

	Potential Deficiency	Requirements	Commentary
1	<b>Weak story:</b> 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 the alternate engineering criteria for concrete buildings, the weak story must be eliminated by retrofitting. Otherwise, the structure must meet ASCE 41 with a performance objective of Structural Collapse Prevention (S-5) with the BSE-2E earthquake hazard level.
2	<b>Lateral-force-resisting-element irregularity:</b> 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 the alternate engineering criteria for concrete buildings, the irregularity must be eliminated by retrofitting. Otherwise, the structure must meet ASCE 41 with a performance objective of Structural Collapse Prevention (S-5) with the BSE-2E earthquake hazard level.
3	<b>Non-ductile moment frame:</b> 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.



	Potential Deficiency	Requirements	Commentary
4	<p><b>Shear-governed concrete column or wall pier:</b> The structure includes one or more concrete columns or wall piers that is shear-governed and is susceptible to failure resulting in loss of gravity load support.</p>	<p>For each column or wall pier, comply with at least one of the following:</p> <ol style="list-style-type: none"> <li>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. For wall piers, joint faces shall be taken as the top and bottom of the clear height of the wall pier.</li> <li>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.</li> <li>For wall piers in buildings that do not have a torsion irregularity ratio <i>TIR</i> per Section 12.3.2.1.1 of ASCE 7 exceeding 1.4, 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 <i>V</i> 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 <i>M<sub>s</sub></i> shall be for Collapse Prevention performance.</li> </ol>	<ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>If the building meets the quick-check for shear at the specified level and does not have a <i>TIR</i> greater than 1.4, 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.</li> </ol>

	Potential Deficiency	Requirements	Commentary
5	<p><b>Punching shear in concrete slab:</b> One or more concrete floor or roof slabs is supported by columns without beams and is susceptible to loss of gravity load support following punching shear failure.</p>	<p>Comply with one or more of the following:</p> <ol style="list-style-type: none"> <li>1. Demonstrate compliance with Section 18.14.5 of ACI 318 with earthquake force <math>E</math> and design story drift <math>\Delta_r</math> taken as two 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.</li> <li>2. Demonstrate compliance with at least one of the following in each plan direction at each column:                             <ol style="list-style-type: none"> <li>(a) 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.</li> <li>(b) Section 8.7.5.6 of ACI 318.</li> </ol> </li> <li>3. 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.</li> </ol>	<ol style="list-style-type: none"> <li>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.</li> <li>2. Section 8.7.4.2.2 requires two slab bottom bars to pass between the column cage longitudinal bars in each plan direction. Section 8.7.5.6 requires two prestressing tendons to pass through the column cage in each plan direction. The slab bottom bars or tendons help prevent collapse of the slab if punching shear initiates.</li> <li>3. 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.</li> </ol>

	Potential Deficiency	Requirements	Commentary
6	<p><b>Weak connection of concrete wall to flexible diaphragm:</b> The structure includes one or more concrete walls supporting one or more flexible diaphragms, where the wall is not adequately anchored to the diaphragm.</p>	<p>For each flexible floor or roof diaphragm, comply with CEBC Chapter A2, or ASCE 41 with a performance objective of Structural Collapse Prevention with the BSE-2E earthquake level.</p>	<p>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.</p> <p>For floor or roof diaphragms that have timber framing in combination with a complete grid of concrete floor beams, CEBC Chapter A2 may be used to demonstrate that existing concrete 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 CEBC Chapter A2.</p>
7	<p><b>Inadequate length of bearing connection:</b> One or more beams or slabs is supported by a bearing connection with short bearing length.</p>	<p>Provide bearing length to support gravity load, such that the bearing length satisfies all of the following:</p> <ol style="list-style-type: none"> <li>1. Section 18.14.4.1(d) of ACI 318.</li> <li>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.</li> </ol>	<p>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.</p> <ol style="list-style-type: none"> <li>1. Section 18.14.4.1(d) requires a bearing length of 5 inches for beams, or 2 inches + L/180 for slabs.</li> </ol>