Planning & Development Department
Building and Safety Division

# City of Berkeley Framework Guidelines for Inadequate Anchorage to Foundation and Cripple Wall Bracing Retrofit Design

*This document presents Guidelines for voluntary retrofits performed as part of the Retrofit Grants Program. To be eligible for the Retrofit Grants Program using these Guidelines, buildings shall be in accordance with the following:*

***Eligibility Criteria:***

***Inadequate Anchorage to Foundation:*** *Buildings meeting all the following criteria are eligible for retrofit of anchorage to the foundation:*

- ☐ *Wood-framed building or portion of building, and*
- ☐ *Wood framing extends from the foundation to the roof, and*
- ☐ *Anchorage to foundation has one or more of the following deficiencies:*
  - ☐ *No anchorage can be identified, or*
  - ☐ *One story with anchor bolts or retrofit anchors on average more than six feet spacing, or*
  - ☐ *Multi-story building with anchor bolts or retrofit anchors on average more than four feet spacing, or*
  - ☐ *Under the engineering criteria for evaluation and retrofit, the demand-to-capacity ratio of existing anchorage is 1.5 or greater, or*
  - ☐ *More than 20 percent of anchor bolts have significantly reduced capacity due to corrosion (more than 10 percent loss of cross-sectional area) or sill plate decay.*

***Inadequate Cripple Wall Bracing:*** *Buildings meeting all the following criteria are eligible for retrofit of cripple wall bracing:*

- ☐ *Wood-framed building or portion of building, and*
- ☐ *Wood-framed cripple wall extends from the foundation or foundation stem wall to the lowest wood-framed floor, and*
- ☐ *Cripple wall bracing has one or more of the following deficiencies:*
  - ☐ *Cripple walls are not currently sheathed with plywood or OSB, or*
  - ☐ *Under the engineering criteria for evaluation and retrofit the demand-to-capacity ratio of existing cripple wall bracing is 2.0 or greater.*

*See Figure 1 for an example illustration of a building with cripple walls. See Figure 2 for an illustration of anchorage to foundation and cripple wall bracing. Cripple walls that have some plywood or OSB sheathing can be further evaluated with respect to demand-to-capacity ratio to see if they are eligible for retrofit.*

*Refer to the Retrofit Grants Program Rules for additional eligibility requirements, grant*

*application procedures, and program details. Please visit the Retrofit Grants Program webpage at:* https://www.cityofberkeley.info/retrofitgrants/

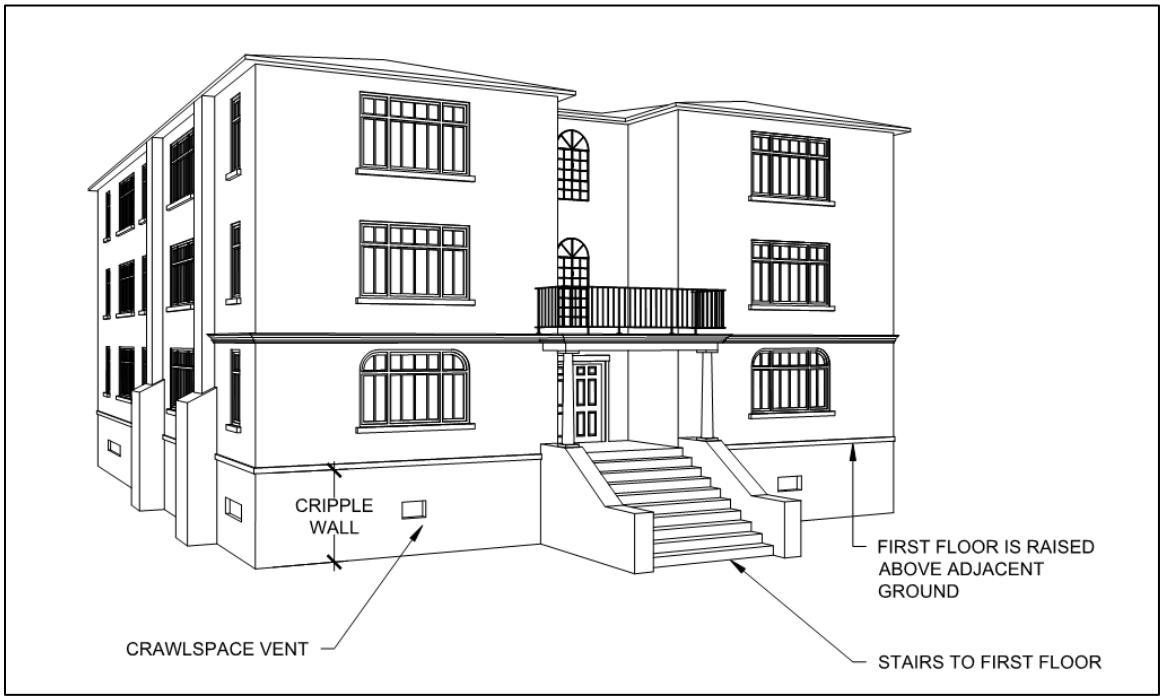


**Figure 1: Example of building with cripple walls. Stairs to first occupied floor and vents to area below the occupied floors are indications of possible cripple walls.**

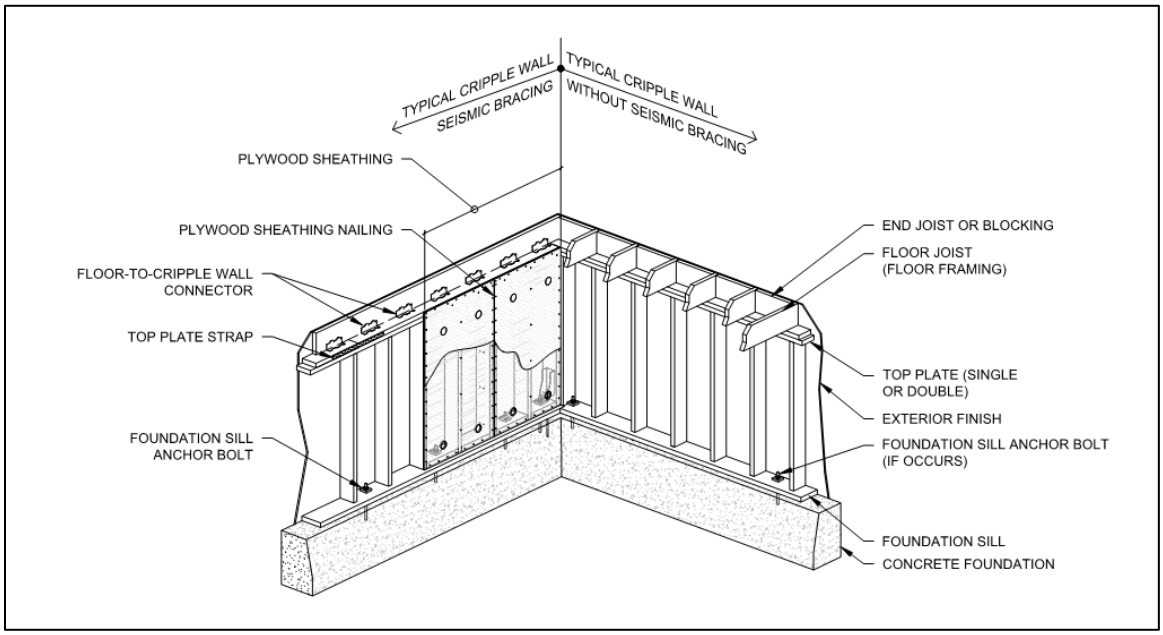


**Figure 2: Illustration of anchorage to foundation and cripple wall bracing, as seen from an under-floor crawlspace or partial basement. Anchor bolts to the foundation and plywood on inside face of walls are commonly provided as part of seismic retrofit.**

# Outline:

# Part A. Requirements for All Inadequate Anchorage to Foundation and Cripple Wall Bracing Building Retrofit Projects

## A.1 Intent, Scope, and Criteria

### A.1.1 Retrofit Intent

These Guidelines describe requirements for voluntary seismic retrofits to reduce earthquake risks by limiting structural damage in vulnerable wood-frame buildings. The engineering criteria addressed in these Guidelines were selected to support this overall intent. Compliance with these Guidelines is not intended to achieve the seismic performance expected of a new building. Instead, the provisions aim to reduce risk by addressing common seismic weaknesses of wood-frame buildings with significantly less design effort, construction cost, and tenant disruption than would be needed to achieve new building equivalence. Risk reduction does not take a comprehensive approach to life safety, does not aim to protect property or function, and is not necessarily equivalent to new construction under the current building code.

### A.1.2 Retrofit Scope

***Retrofit Scope:*** *These Guidelines require retrofit, or confirmation of adequacy to the engineering criteria selected, of the cripple wall in-plane shear strength, anchorage to floor framing above, and anchorage to the foundation. Regardless of which engineering criteria are selected, these Guidelines do not require retrofit to the floor diaphragm or any other portion of the structure above the cripple wall nor to the existing foundation.*

***Commentary:*** *See Guidelines Section A.8 for resources providing general guidance on approaches to retrofitting.*

*Inadequate Anchorage to Foundation Retrofits: The primary approach to retrofit of anchorage to foundations is anticipated to be addition of new post-installed anchors or retrofit connectors.*

*Inadequate Cripple Wall Bracing: The primary approach to retrofit of cripple walls is anticipated to be retrofit by addition of wood structural panel sheathing on existing or new walls, anchorage to the floor framing above, and anchorage to the foundation. It may be necessary as part of this retrofit work to provide new foundations or supplement existing foundations.*

### A.1.3 Engineering Criteria

Each building subject to these Guidelines shall be evaluated for eligibility (when required by eligibility criteria) and shall be retrofitted in conformance with one of the following engineering criteria. Retrofit in conformance with more stringent engineering criteria is acceptable subject to the approval of Retrofit Grants Program staff and the Building Official.

1. 2019 (or current edition) California Building Code (CBC), using reduced forces (see Guidelines Part B); or

2. ASCE 41-17, Seismic Evaluation and Retrofit of Existing Buildings, using a structural performance objective of Collapse Prevention for the BSE-2E earthquake (see Guidelines Part C).

## A.2 Permit Submittal Requirements

The permit application shall include as part of the “Brief Description of Work” field, the following statement: “This project is intended to comply with the Retrofit Grants Guidelines for Voluntary Retrofits of Inadequate Anchorage to Foundation and Cripple Wall Bracing Buildings.” Please

visit the City of Berkeley's Permit Service Center website for current submittal information at https://www.cityofberkeley.info/Planning_and_Development/Permit_Service_Center/Permit_Submittal_Information.aspx

**A.2.1 Construction Drawings**
Construction drawings shall be prepared by a registered design professional and shall be stamped and signed prior to permit issuance. Drawings shall include, as a minimum:

1. The registered design professional's seal and signature on each drawing sheet.

2. All information necessary for plan review and for construction. Drawings shall accurately reflect the results of the engineering investigation and structural calculations.

3. The first sheet shall include a statement that the work was designed in compliance with the Retrofit Grants Guidelines for voluntary retrofit of _Inadequate Anchorage to Foundation and Cripple Wall Bracing Buildings (see Guidelines Section A.6).

4. Retrofit projects seeking federal funding under the Retrofit Grants Program require an additional environmental and historic preservation (EHP) review as part of a retrofit grant approval process. If the seismic retrofit work results in exterior alterations to the existing building, please include exterior elevation drawings clearly showing any exterior changes when submitting a building permit application, in addition to the structural drawings.

5. The work proposed under the seismic retrofit permit may trigger additional requirements. Please see Building and Safety Division website https://www.cityofberkeley.info/Triggers/ for a list of requirements triggered by building permit submittal based on the type and valuation of work.

6. Any deferred submittals or revisions to approved plans that affect the building's exterior or significantly change the proposed scope of work may impact grant eligibility under the Retrofit Grants Program. Please alert Retrofit Grants Program staff of any deferred submittals or revisions to approved plans, as these may require additional review and approval by Federal Emergency Management Agency (FEMA) staff.

**A.2.2 Structural Calculations and Supporting Documents**
Structural calculations shall be prepared by a registered design professional. Calculations and supporting documents shall demonstrate compliance with the selected engineering criteria. Calculations and supporting documents shall be specific to the engineering criteria used and shall include, at minimum:

1. The registered design professional's seal and signature on the cover page of structural calculations and reports.

2. A statement that the calculations were prepared to demonstrate compliance with the Retrofit Grants Guidelines for voluntary retrofit of Inadequate Anchorage to Foundation and Cripple Wall Bracing Buildings (see Guidelines Section A.6).

3. Identification of the engineering criteria used for the retrofit design (see Guidelines Section A.1.3).

4. Building investigation and other reports referenced by the calculations, with a report summary indicating how the findings or conclusions are reflected in the calculations (see Guidelines Section A.3.1).

5. Identification of structural properties and capacities assumed for all existing materials and elements, including any capacity reductions for damage, deterioration, or defect.

6. Identification of structural properties and capacities assumed for all new materials and elements, including product literature for proprietary devices.

7. If requested by the Building Official, verification calculations for engineering software.

8. Other information required by the Building Official.

## A.3 Assessment of Existing Building Conditions

### A.3.1 Building Investigation

In support of a retrofit design, the registered design professional shall conduct an investigation of the existing building. The registered design professional shall document procedures, findings, and conclusions of the investigation and incorporate them into the permit submittal documents. The documentation may reference previous engineering evaluation reports or other materials submitted to support findings and conclusions.

**A.3.1.1 Scope of investigation.** At minimum, the investigation shall comply with any investigation and assessment provisions in the specific engineering criteria selected from these Guidelines, as modified by subsequent Parts of these Guidelines. Otherwise, the investigation scope and methods may generally be set at the discretion of the registered design professional. Findings relevant to the evaluation shall be included in the permit submittal documents. The Building Official is authorized to require additional investigation as needed to fulfill the intent of the Guidelines. With the approval of the Building Official, field verification of assumed conditions may be performed during the construction phase.

The investigation shall include identification, verification, and assessment of existing conditions relevant to the engineering assumptions applied in the retrofit design. The investigation shall be based on a combination of non-destructive testing or inspection, destructive testing or inspection, and reference to record documents. Where record documents are used to reduce the scope of testing or other on-site work, appropriate field verification is required.

***The investigation shall as a minimum include:***

*As required to determine eligibility and typical retrofit details.*

- ☐ *General configuration and condition of visible structural elements and connections, including cripple wall framing, visible connections to the floor framing above, and visible anchorage to the foundation.*
- ☐ *Identify presence, or lack thereof, of anchor bolts to the foundation. Where anchor bolts to the foundation are present, document at a minimum the typical size and spacing of anchor bolts, anchor bolt condition (i.e. presence of corrosion or other damage), and sill plate condition (i.e. presence of decay or other damage).*
- ☐ *Identify presence, or lack thereof, of plywood or OSB sheathing at cripple walls. Where sheathing is present, document at a minimum the length and locations of sheathed cripple walls, and, where exposed in the crawl space, the size and spacing of sheathing edge nailing.*
- ☐ *General configuration and condition of visible portions of the existing foundation.*

☐ *Where damage or defects are identified during the investigation, those conditions should be further investigated. The scope of the additional investigation will vary based on conditions observed.*

**A.3.1.2 Timing of investigation.** Unless otherwise required by the specific engineering criteria selected from these Guidelines, as modified by subsequent Parts of these Guidelines, and with the approval of the Building Official, portions of the investigation may be deferred to the construction phase. In such cases, the deferred investigation shall be specified as a deferred submittal item in accordance with CBC Section 107.3.4.1.

**A.3.2 Engineering Evaluation**
Where required to determine eligibility for retrofit, an engineering evaluation of the existing condition shall be provided in accordance with the criteria of Sections A.1.3 and A.3.

**A.3.3 Existing Materials and Components**
Where the applicable engineering criteria specify material or structural properties of existing elements, those criteria shall be used. Otherwise, the general rules of this section apply.

**A.3.3.1 Damage and defects.** The capacity of any element damaged by deterioration, wear, or other causes or altered so as to differ from its intended condition shall be reduced based on the judgment of the registered design professional, subject to review of condition assessment findings and the approval of the Building Official. This provision shall apply where the applicable engineering criteria do not make an explicit provision for capacity reduction.

**A.3.3.2 Concrete footings and stem walls.** Evaluation of existing concrete footings shall be permitted to assume a default concrete strength of 2,500 psi for buildings constructed in 1950 or later, 2,000 psi for buildings constructed prior to 1950, or a larger value, if determined in accordance with ASCE 41-17.

**A.3.3.3 Anchorage to unreinforced brick footings.** The capacity of an existing brick footing to resist shear or pullout of an existing anchor shall be established by testing or by reference to approved tests of similar conditions. Testing is permitted to be in accordance with CEBC Section A107 or as approved by the Building Official. The capacity of anchor bolts attaching wood foundation sill plates to existing foundations is to be taken as the lesser of the capacity assigned by testing of the anchor bolts or the capacity determined in accordance with the 2018 National Design Specification for wood construction (NDS).

**A.3.3.4 Anchorage to reinforced or unreinforced concrete footings.** The capacity of existing anchor bolts attaching wood foundation sill plates to existing foundations may be taken as the capacity determined in accordance with the 2018 National Design Specification for Wood Construction (NDS). The analysis of existing anchors cast in concrete shall be permitted to assume proper anchor embedment (as required to develop the capacity assigned by NDS) for purposes of evaluating shear resistance to lateral loads.

**A.3.3.5 Adjacent buildings and building separation.** For purposes of complying with these Guidelines:

1. Hazards from adjacent buildings do not need to be addressed, except where the buildings have shared structural elements.

2. Building separation provisions do not need to be addressed.

3. Analysis and retrofit design does not need to account for potential pounding.

### A.4 New Materials and Components

All new materials and components incorporated into the retrofit shall conform to the requirements of the 2019 California Building Code.

#### A.4.1 New Cripple Wall Sheathing

Where retrofit work includes the addition of new sheathing on existing cripple walls, new sheathing shall not cause existing vent openings to be blocked or closed unless it can be demonstrated that the remaining vents meet the requirements of the 2019 CBC.

### A.5 Site Seismicity, Soil, and Geotechnical Considerations

#### A.5.1 Seismic Ground Motion Values

Where seismic ground motion values are calculated per ASCE 7-16 Section 11.4 or by similar provisions, and the site class is not known, Site Class D can be assumed. This requirement applies to any code-based procedure for calculating seismicity parameters, such as that used by ASCE 7-16 or ASCE 41-17.

**A.5.1.1 Seismic Base Shear.** The maximum $S_{DS}$ value in determination of $C_s$ and $E_v$ in ASCE 7-16 Section 12.8.1.3 does not apply for retrofits under these Guidelines.

#### A.5.2 Geologic Site Hazards

For purposes of complying with these Guidelines, geologic site hazards, including potential liquefaction, landslide, and fault rupture, need not be analyzed or mitigated.

### A.6 Testing and Inspection

All work shall comply with inspection and testing requirements of CBC Chapters 1 and 17. Additional field verification, testing, and inspection may be required in accordance with the selected engineering criteria or as directed by the Building Official. Where required by the 2019 CBC, structural observation by the registered design professional responsible for the retrofit design is required for seismic retrofit projects performed in accordance with these Guidelines.

### A.7 Requirements for Project Completion

To be eligible for Construction Grant reimbursement, the owner shall do all of the following:

1. Complete the seismic retrofit work along with the required city inspections.

2. Provide the City of Berkeley building inspector with completed special inspection reports, structural observation reports, and any other documents required.

3. Obtain an approved final inspection.

4. Where structural observation is required by the 2019 CBC, provide a final letter of structural observation wet-signed from the responsible registered design professional indicating that structural observation has been performed and the work has been completed in conformance with approved plans. This letter should be addressed to the Building and Safety Division, 1947 Center Street, Berkeley, CA 94704 or to the area inspector.

5. Provide the final affidavit from the special inspection agency for projects requiring special inspections.

## A.8 Resources

The following resources provide general guidance for approaches to retrofitting. Resources listed are intended to provide general retrofit approaches and detailing recommendations. Where the stated purpose, scope, reference codes or other requirements of the resources provided conflict with those of these Guidelines, the provisions of these Guidelines shall apply, subject to the discretion of the Building Official.

1. 2019 CEBC Appendix Chapters
2. FEMA 547
3. FEMA P-1100

# Part B. 2019 (or Current Edition) CBC

## B.1 General Clarifications

Where the stated purpose, scope, reference codes or other requirements of 2019 CBC conflict with those of these Guidelines, the provisions of these Guidelines shall apply, subject to the discretion of the Building Official.

## B.2 Specific Clarifications

### B.2.1 Scope of Analysis

The seismic evaluation and retrofit design are permitted to use reduced seismic forces equal to 75 percent of the prescribed forces in the 2019 CBC. The following values of R, $\Omega_0$, and $C_d$ are permitted to be used for anchorage to foundations, wood structural panel cripple wall sheathing and wood structural panel shear walls:

- R = 6.5
- $\Omega_0$ = 3
- $C_d$ = 4

For other systems the values shall be in accordance with the 2019 CBC.

### B.2.2 Default Strength Values for Existing Materials and Components

Default values for seismic evaluation and retrofit design involving existing components in sound condition may be taken from ASCE 41-17, SDPWS (AF&PA, 2015), or Guidelines Table B.2.2, with adjustments for nominal vs. expected strength, ASD, or LRFD as appropriate for code-based design using the IEBC.

**Table B.2.2 Default Nominal Strength Values for Existing Materials and Components**

| Existing Material or Component | Default Nominal Strength Value [1] |
|---|---|
| Roof diaphragms with straight sheathing and roofing applied directly to the sheathing, in shear | 300 plf [2] |
| Roof diaphragms with diagonal sheathing and roofing applied directly to the sheathing, in shear | 750 plf [2] |
| Floor diaphragms with straight tongue-and-groove sheathing, in shear | 300 plf [2] |
| Floor diaphragms with straight sheathing and finished wood flooring with board edges offset or perpendicular, in shear | 750 plf [2] |
| Floor diaphragms with diagonal sheathing and finished wood flooring, in shear | 750 plf [2] |
| Plain concrete footings | |
| Buildings Constructed 1950 and later | *f'c=2,500 psi* |
| Other buildings | *f'c=2,000 psi* |
| Douglas Fir wood | Same as DF No.1 |
| Reinforcing steel | $f_y$ = 40,000 psi |
| Structural steel | $F_y$ = 33,000 psi |

[1] Where element capacities are based on allowable stresses from codes and standards, nominal strengths shall be taken no greater than the allowable stresses multiplied by the following factors: 1.7 for steel; 2.5 for masonry; 2.0 for wood.
[2] For LRFD, the capacity reduction factor or resistance factor may be taken as 1.0.

# Part C. ASCE 41-17

## C.1 General Clarifications

Where the stated purpose, scope, reference codes or other requirements of ASCE 41-17 conflict with those of these Guidelines, the provisions of these Guidelines shall apply, subject to the discretion of the Building Official.

## C.2 Specific Clarifications

### C.2.1 Retrofit Procedures (ASCE 41-17 Sections 1.5.5 and 3.4.1)

For purposes of compliance with these Guidelines, Tier 2 deficiency-based retrofit is required, subject to scope modifications in Guidelines Sections A.1.2 and D.2.1.

### C.2.2 Seismic Hazard (ASCE 41-17 Section 2.4)

For purposes of compliance with these Guidelines, the Site-Specific Procedure of Section 2.4.2 need not be used.

### C.2.3 Seismic Hazard Parameters (ASCE 41-17 Section 2.4.1)

Seismic hazard parameters for the BSE-2E hazard may be obtained using the web tool available at https://seismicmaps.org/.

### C.2.4 Site Classes (ASCE 41-17 Section 2.4.1.6)

Where the Site Class is known from available documents, the known Site Class should be used. Where the Site Class is not known, Site Class D may be assumed.

### C.2.5 Limitations on Use of Linear Procedures (ASCE 41-17 Section 7.3.1.1)

As noted in ASCE 41-17 Section 7.3.1.1, linear procedures are not allowed where the maximum DCR exceeds 3.0, if a weak story, torsional irregularity, or other irregularity exists. To clarify, this limitation applies only if the irregularity would remain in the building as retrofitted. Ideally, the retrofit should eliminate or greatly mitigate these irregularities, so linear procedures should still be usable to demonstrate compliance with these Guidelines.

## References

AF&PA, 2009. *ASD/LRFD Wind & Seismic: Special Design Provisions for Wind and Seismic, 2008 Edition* [ANSI/AF&PA SDPWS-2008]. American Forest & Paper Association, Inc.

ASCE, 2016. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7-16). American Society of Civil Engineers.

ASCE, 2017. *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE/SEI 41-17). American Society of Civil Engineers.

Berkeley, 2020. *Berkeley Municipal Code* (BMC). Available at: http://codepublishing.com/ca/berkeley/

CBC, 2019. *2019 California Building Code*. California Building Standards Commission. Available at: https://www.dgs.ca.gov/BSC/Codes

CEBC, 2019. *2019 California Existing Building Code*. California Building Standards Commission. Available at: https://www.dgs.ca.gov/BSC/Codes

For further information, contact:

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