



Planning & Development Department
Building and Safety Division



City of Berkeley Framework Guidelines for Unique Wood Building Configuration 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:

Buildings meeting all the following criteria are eligible for retrofit:

- Wood-framed building, and*
- One or more of the following:*
 - Building construction does not consist of typical wall, floor, and roof wood light-frame assemblies, or*
 - Size or geometry of building fall outside of normal light-frame construction, and*
 - Registered design professional has identified one or more vulnerabilities for which retrofit would improve seismic performance.*

Commentary: *The intent of this retrofit framework guideline to capture buildings with construction and geometry different enough from common light-frame construction, such that earthquake performance of wood-framed buildings in past earthquakes may not properly predict future earthquake performance. See Figure 1 for an example illustration of a possible unique wood building configuration.*

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/>

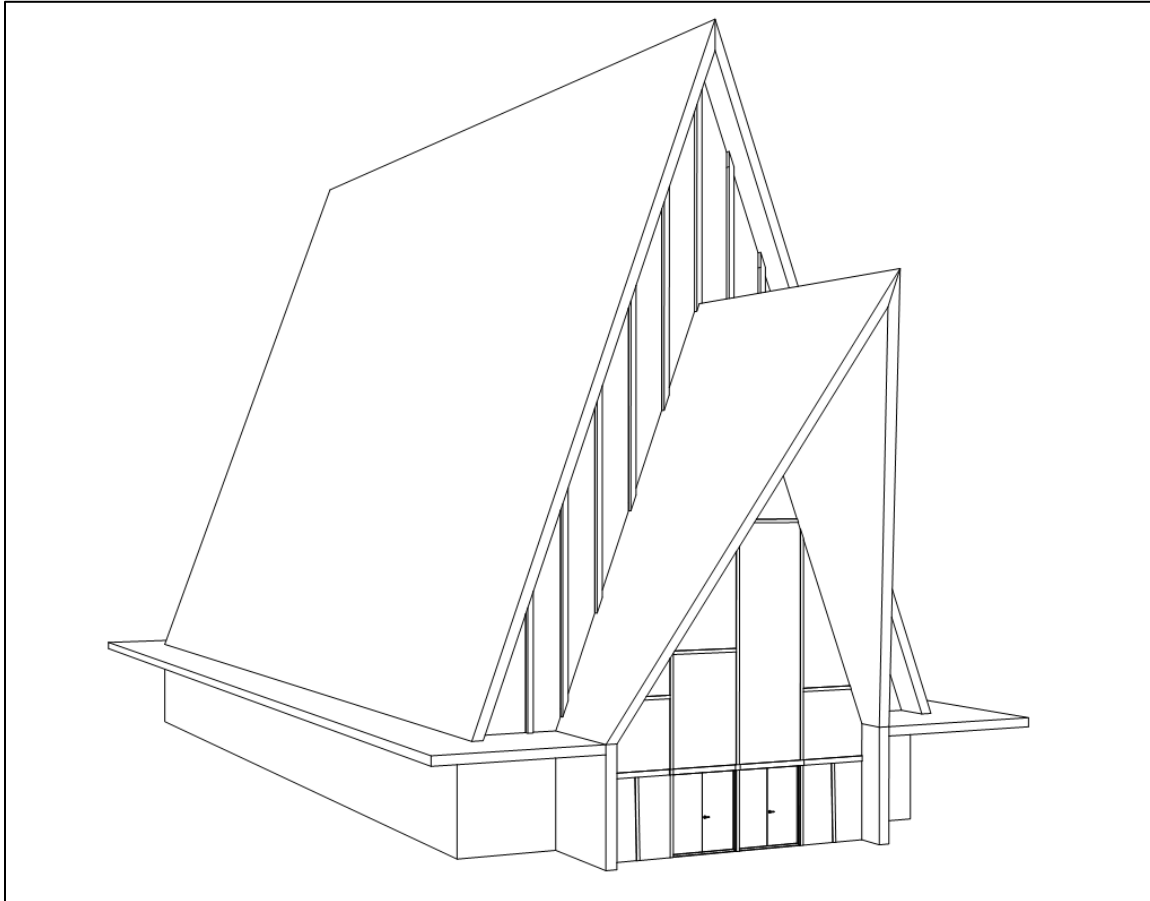


Figure 1: Example illustration of a possible unique wood building configuration. The A-frame building geometry falls outside normal light-frame construction.

Outline:

Part A. Requirements for All Unique Wood Building Configuration Voluntary Retrofit Projects

- A.1 Intent, Scope, and Criteria
- A.2 Permit Submittal Requirements
- A.3 Assessment of Existing Building Conditions
- A.4 New Material and Components
- A.5 Site Seismicity, Soil, and Geotechnical Considerations
- A.6 Testing and Inspection
- A.7 Requirements for Project Completion
- A.8 Resources

Parts B-C. Application of Specific Engineering Procedures

- B 2019 CBC
- C ASCE 41-17

References

Part A. Requirements for All Unique Wood Building Configuration 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

Regardless of which engineering criteria are used, these Guidelines do not require retrofit actions beyond the following:

Retrofit Scope: *Extent of evaluation and retrofit is permitted to be determined by the retrofit design engineer, with the provision that the requirements of the California Existing Building Code (CEBC) Section 503.13 for voluntary seismic retrofit must be met.*

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 Unique Wood Building Configurations.” 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 Unique Wood Building Configurations (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 Unique Wood Building Configurations (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 hardware, connectors, or components.
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 the general locations and lengths of interior and exterior walls at each story.*
- Identify typical building materials and wall finishes.*
- 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. 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.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 concrete 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.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 or requested.
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

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 , Ω_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	$f'_c=2,500 \text{ psi}$
Other buildings	$f'_c=2,000 \text{ psi}$
Douglas Fir wood	Same as DF No.1
Reinforcing steel	$f_y = 40,000 \text{ psi}$
Structural steel	$F_y = 33,000 \text{ psi}$

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>

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