



# HOME, SAFE HOME.

## SEISMIC SAFETY & REHABILITATING HISTORIC HOMES

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## WORKSHOP 4: RETROFIT PROJECTS

### I. EVALUATE YOUR HOUSE TO IDENTIFY SEISMIC VULNERABILITIES

- a. There are building configurations that are more vulnerable to seismic failures. Evaluate the overall layout of your house to identify these vulnerabilities. Refer to workshop #3 supplemental information for the list of vulnerabilities.
- b. Once the configuration and vulnerabilities are identified, create a load path to properly connect various parts of your house and resist seismic loads. Seismic load path needs to start at the roof level of a house and transfer down to the foundation through various components and connections.
- c. Various retrofit strategies are used to create seismic load path. The strategies include enhancement of existing house components or addition of new ones. For example, enhancement of existing house components can include addition of new plywood sheathing on an existing wall, addition of a new component would be building a new shear wall at a new location within a house.
- D. Connections play a crucial part in seismic retrofits. There are faults throughout the state of California with very few locations that are not vulnerable to potential earthquake shaking.
- E. Earthquake shaking produces lateral loads on structures which are in addition to the weight of the structure and contents already in place.
- F. Older structures were not necessarily designed and constructed to resist the lateral loads of earthquake shaking.

### II. RETROFIT STRATEGIES AND TECHNIQUES

- a. Various retrofit strategies are used to create seismic load path. The strategies include enhancement of existing house components or addition of new ones. For example, enhancement of existing house components can include addition of new plywood sheathing on an existing wall, addition of a new component would be building a new shear wall at a new location within a house.
- b. Connections play a crucial part in seismic retrofits. In order to transfer seismic inertial loads from roof to foundation, roof diaphragm needs to connect to shear walls with nails and clips, and shear walls need to connect to the foundation with anchor bolts. In multi-story houses, upper level shear walls need to connect to lower level shear walls with nails, clips and holdowns.





- c. Commonly found retrofit techniques for houses include:
  - i. Addition of plywood sheathing on the roof of a house to create load path throughout the roof
  - ii. Addition of collectors to connect various parts of the house to shear walls
  - iii. Addition of plywood sheathing on walls to enhance existing shear walls or create new ones
  - iv. Addition of anchor bolts to connect shear walls to foundations
  - v. Addition of plywood sheathing and anchor bolts on existing cripple walls to brace the wall and connect it to the foundation
  - vi. Bracing of components that are susceptible to falling hazards such as chimneys
  - vii. Addition of roof anchors for masonry homes

### III. RETROFIT PRIORITIES AND PHASING

Required retrofits for a house can be prioritized and phased. The priorities are based on addressing the vulnerabilities from the most impactful to the least such as starting with foundation retrofits and moving up to bracing of components. Since there may be several elements of a building requiring strengthening, a complete single stage project may not be feasible.

It may be possible to divide the work into specific activities such as foundation anchorage and cripple work retrofit, chimney bracing or rebuilding, and adding shear walls.

It may also be feasible to integrate retrofit work into other building improvements such as adding plywood to existing walls if they are being altered or refinished.

### ADDITIONAL RESOURCES & FURTHER READING

The following is a list of sources referenced in the Workshop 4 presentation. These are good sources of additional information if you would like to learn more about securing your home

- **NPS Preservation Brief #41: The Seismic Rehabilitation of Historic Buildings**  
- <https://www.nps.gov/tps/how-to-preserve/briefs/41-seismic-rehabilitation.htm>
- **Earthquake Country “Staying Safe Where the Earth Shakes” Statewide handbook:**  
[https://www.earthquakecountry.org/library/StayingSafeWhereTheEarthShakes\\_StatewideEdition.pdf](https://www.earthquakecountry.org/library/StayingSafeWhereTheEarthShakes_StatewideEdition.pdf)
- **Earthquake Country “Secure Your Space Checklist”**  
[https://www.earthquakecountry.org/library/ECA\\_Step\\_1\\_SecureYourSpace\\_Document-EN.pdf](https://www.earthquakecountry.org/library/ECA_Step_1_SecureYourSpace_Document-EN.pdf)





- **California Earthquake Authority Brace & Bolt Program:**  
<https://www.californiaresidentialmitigationprogram.com/How-to-Pay-for-a-Seismic-Retrofit/Our-Seismic-Retrofit-Grant-Programs>
- **CalCAP/Seismic Safety Financing Program**  
(<https://www.treasurer.ca.gov/cpcf/cap/calcap/seismic/summary.asp>)

## GLOSSARY OF TERMINOLOGY

The following is a glossary of common terminology related to the seismic retrofitting of historic resources.

**Anchor Bolt** – A fastener connecting a foundation (concrete, brick, etc.) and the building structure.

**Beam** – Typically a horizontal element supporting building and live loads

**Bearing Wall** – A wall supporting weight beyond its own self weight.

**Brick** – A manufactured product that is assembled into walls and other building features. Bricks bear on mortar joints. Bricks may be used in a bearing wall or as a veneer.

**Building** – As related to historic property types, a building is used primarily to shelter human activity. Examples of buildings include: house, carriage house, garage, store, school, hotel, church, shed, stable, barn, theater, train station, post office, fort, dormitory, courthouse, city hall.

**Character-Defining Feature** – For a property to be eligible for national, state, or local designation under criteria related to type, period, or method of construction, the essential physical features that enable the property to convey its historic identity must be evident. These distinctive character-defining features are the physical traits that commonly recur in property types and/or architectural styles. To be eligible, a property must clearly contain enough of those characteristics, and these features must also retain a sufficient degree of integrity. Characteristics can be expressed in terms such as form, proportion, structure, plan, style, or materials.

**Concrete Masonry Unit (also CMU)** - Manufactured units of various sizes that are assembled into walls.



**Condition** – Condition refers to the material and structural appearance, quality, and working order of a resource. Condition is not the same as historic integrity. A building in poor condition may still retain historic integrity if it retains enough of its character-defining features to convey its significance.

**Cripple Wall** - Used to indicate a wall shorter in height than the building's standard wall.

**Design** – As related to historic integrity, design is the composition of elements, including form, plan, structure, style, and organization of spaces, scale, etc.

**Foundation** – The lowest element of a structure and bears on earth. Footings may be continuous or as square/rectangular pads or piers

**Lateral** - A horizontal force or load acting on a building. This may be seismic (earthquake) or wind.

**Local Register** – Many local jurisdictions (towns, cities, counties, etc.) maintain their own registers of historic resources. Typically, a local ordinance will include criteria for inclusion in the register, as well as a process for designating properties and local review process for certain types of projects that involve locally listed historic resources. Local registers may include individual historic resources (sometimes referred to as “landmarks”) and/or historic districts.

**Masonry** – See BRICK or CMU

**Materials** – As related to historic integrity, materials are the physical elements that form a historic property.

**Office of Historic Preservation (OHP)** – The California Office of Historic Preservation, a division of the California state government, administers federal- and state-mandated historic preservation programs to further the identification, evaluation, registration, and protection of California's irreplaceable resources, including managing the California Register of Historical Resources.

**Object** – As related to historic property types, an object is a term used to distinguish from buildings and structures those constructions that are primarily artistic in nature or small in scale. Examples include: a boundary marker, fountain, milepost, monument, sculpture, statue.

**Post and Beam** – Construction where the columns/posts and beams are left exposed as an architectural feature.



**Seismic Loads** – The loads imparted to the building as it's mass is moving due to seismic activity.

**Shear wall** – A wall that resists lateral (seismic) forces in a plane parallel to the wall. Shear walls may be wood, concrete, masonry, and other materials.

**Sill Plate (also Mud Sill, or Bottom Sill)** - A wood plate bearing on the foundation. Typically treated to reduce the potential for biological activity, such as termites.

**Structure** – As related to historic property types, a structure is a term used to distinguish buildings from those functional constructions made usually for purposes other than human shelter. Examples include: airplane, apiary, automobile, boat, bridge, canal, dam, earthwork, fence, gazebo, grain elevator, highway, lighthouse, railroad grade, tunnel, windmill.

**Stem Wall** – A wall extending from the foundation to the first-floor line. Stem walls vary in height depending on the site.

**Wood Frame** - A type of construction with wood vertical and horizontal elements.

**Workmanship** – As related to historic resources, workmanship is the physical evidence of the crafts of a culture in a particular time period.