HOME, SAFE HOME.

SEISMIC SAFETY & REHABILITATING HISTORIC HOMES

Six webinars. A team of preservation professionals. One goal.

Welcome.

Office of Historic Preservation

Office of Historic Preservation

HOME, SAFE HOME.

SEISMIC SAFETY & REHABILITATING HISTORIC HOMES

Six webinars. A team of preservation professionals. One goal.

RETROFIT PROJECTS

Workshop #4 | October 6, 2022

Presented by

John Lesak, AIA, FAPT, Principal, Page & Turnbull

Mel Green, SE, Structural Engineer/Historic Preservation, Melvyn Green & Associates, Inc.

David Cocke, SE, Principal, Structural Focus

Maria Mohammed, SE, Project Engineer, Structural Focus

Sarah Brummett, Senior Associate, Page & Turnbull

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Workshop #1: What Makes My Home 'Historic'? | Thursday, June 23, 2022

Workshop #2: Is 'Compatible' 'Matchy-Matchy'? | Tuesday, July 26, 2022

Workshop #3: Seismic Retrofit Basics| Tuesday, August 30, 2022

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Workshop #5: Keep it Lookin' Great | Tuesday, November 8, 2022

Workshop #6: The Nuts and Bolts of Retrofits | Thursday, December 15, 2022

Program offered by:

Office of Historic Preservation

Grant funding from:

FEMA

Presented by:

P&T PAGE&TURNBULL

STRUCTURAL FOCUS

GREEN Structural Engineering Historic Preservation

CALIFORNIA PRESERVATION FOUNDATION

WORKSHOP #4 OBJECTIVES

Following the workshop, you will be able to:

- Learn from examples of residential retrofit projects.
- How differing house types, styles, construction types, and parts of a house may require different seismic strategies.
- Explore strategies to maximize the benefits of individual projects, such as including structural and insulation upgrades when replacing a roof or integrating other improvements.
- Determine how much it may cost to retrofit your house.
- Typical seismic retrofit measures for historic homes and the parts of your home that are likely to require retrofit.
- Apply methods of protecting your home's historic features while performing work.
- Identify incentive programs, like the California Earthquake Authority (CEA) Earthquake Brace + Bolt Program

Victorian-era homes in Sacramento, CA

Agenda

1. Workshop #3 Recap
2. Evaluate Your House
3. Retrofit Strategies
4. Retrofit Techniques & Examples
5. Priorities & Phasing
6. Summary & Questions

In what region do you live?

Did you attend Workshop #3 or any of the prior workshops?

- In what capacity are you interested in this topic? As a…?

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Workshop #3 Recap

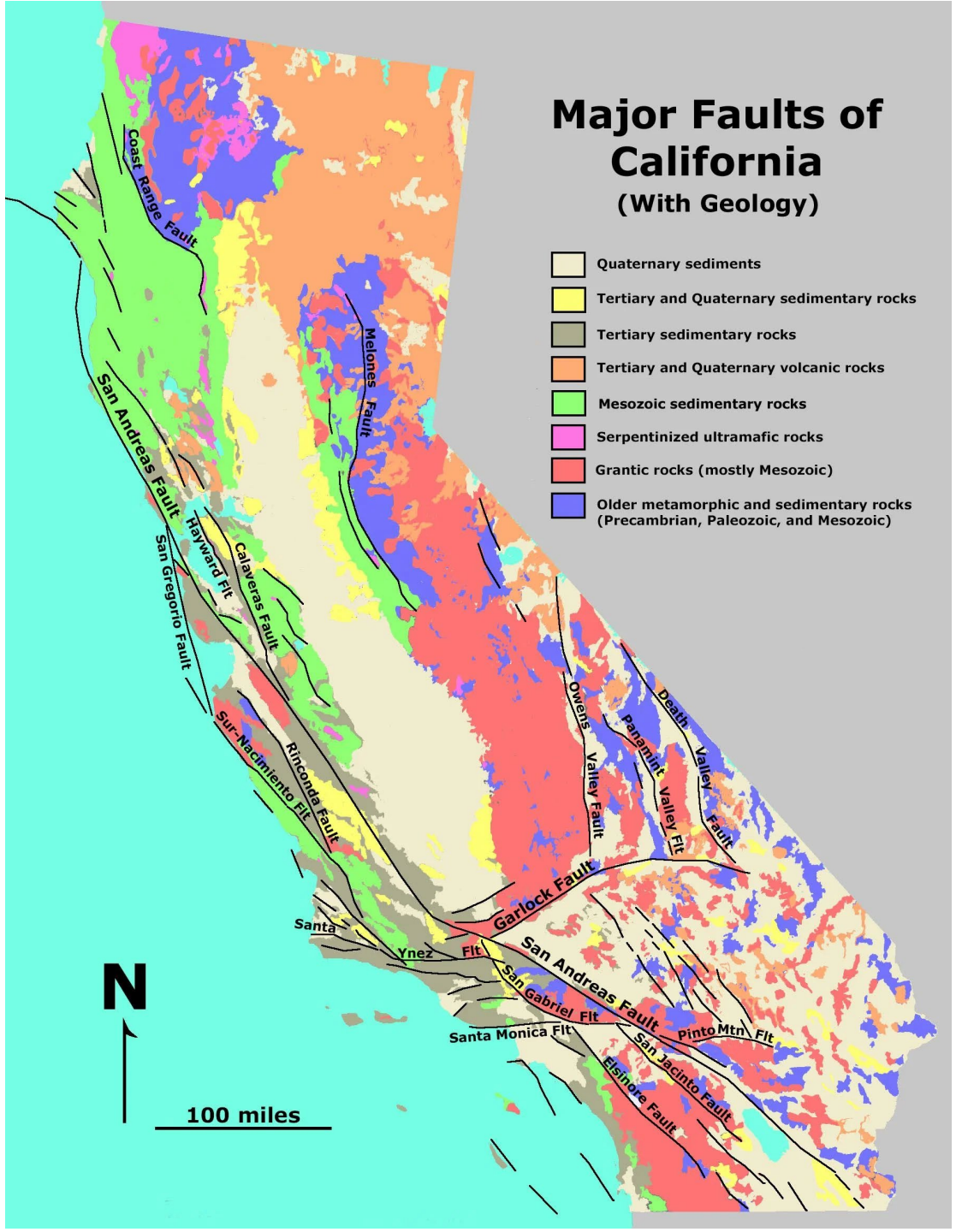
1. Seismic Vulnerability in California – not many regions that are not vulnerable
2. How to identify commonly found construction types for single-family houses
3. California Historic Building Code provisions
4. Potential phasing of retrofit

Blacker Carriage House, Pasadena
Source: David Cocke

Seismic Vulnerability in California

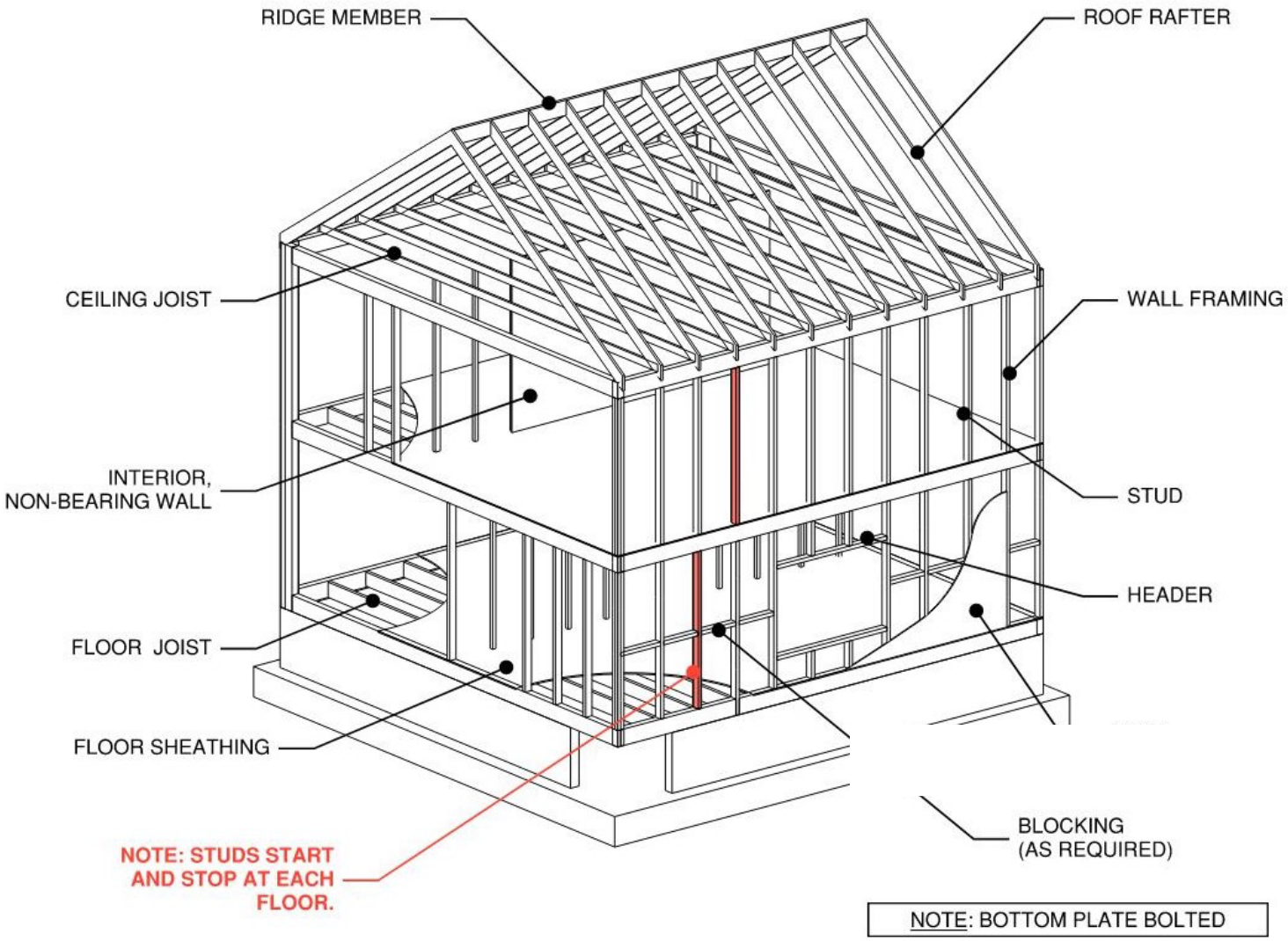
- Northwestern California - Eureka
- Sierra Nevada and Lake Tahoe
- San Francisco Bay area
- Bakersfield
- Los Angeles
- San Diego
- San Bernadino & Riverside
- Imperial Valley

Virtually all of California is at risk…



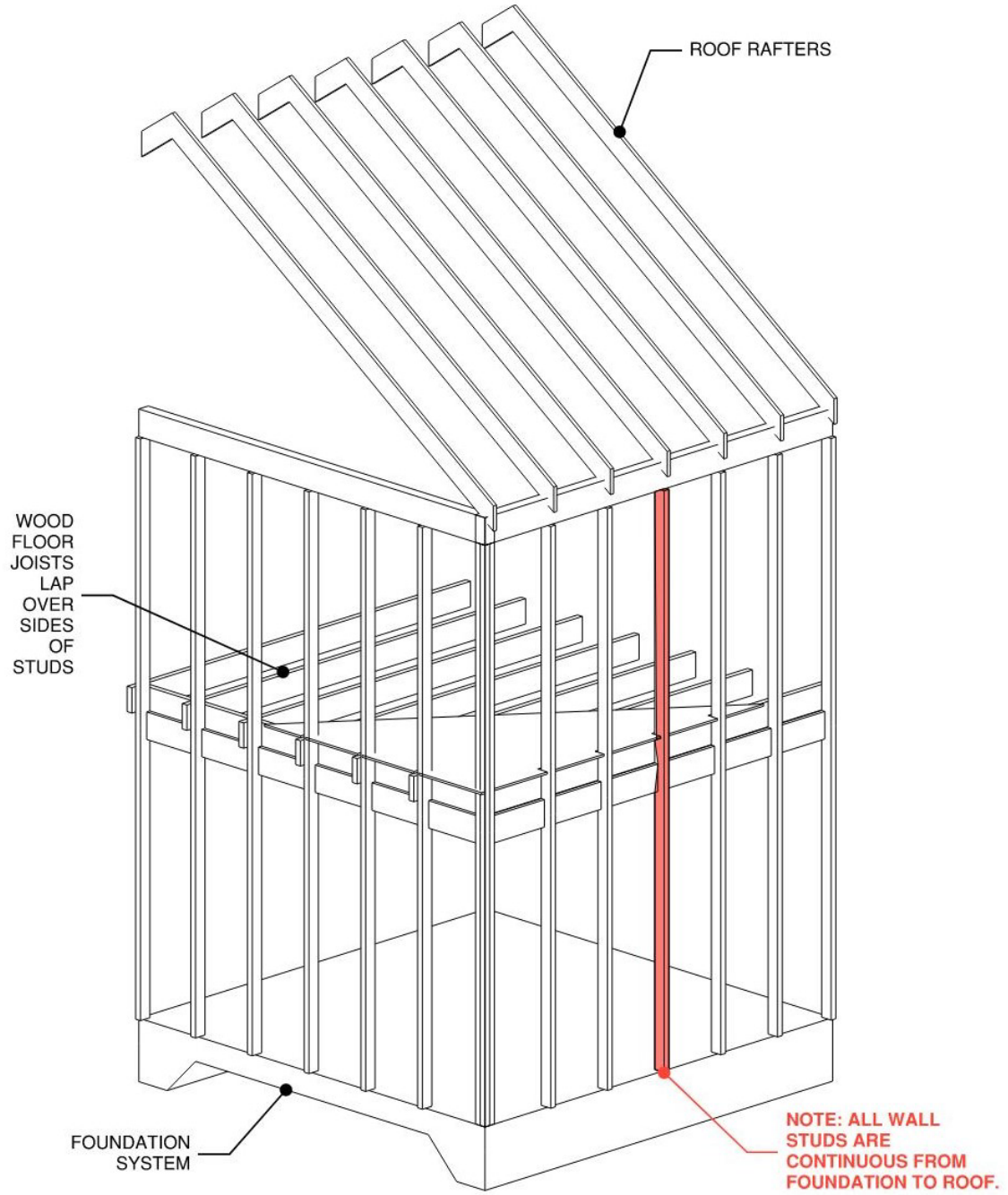
Common Construction Types for Older Single-Family Dwellings:

Wood Frame – Platform Framing



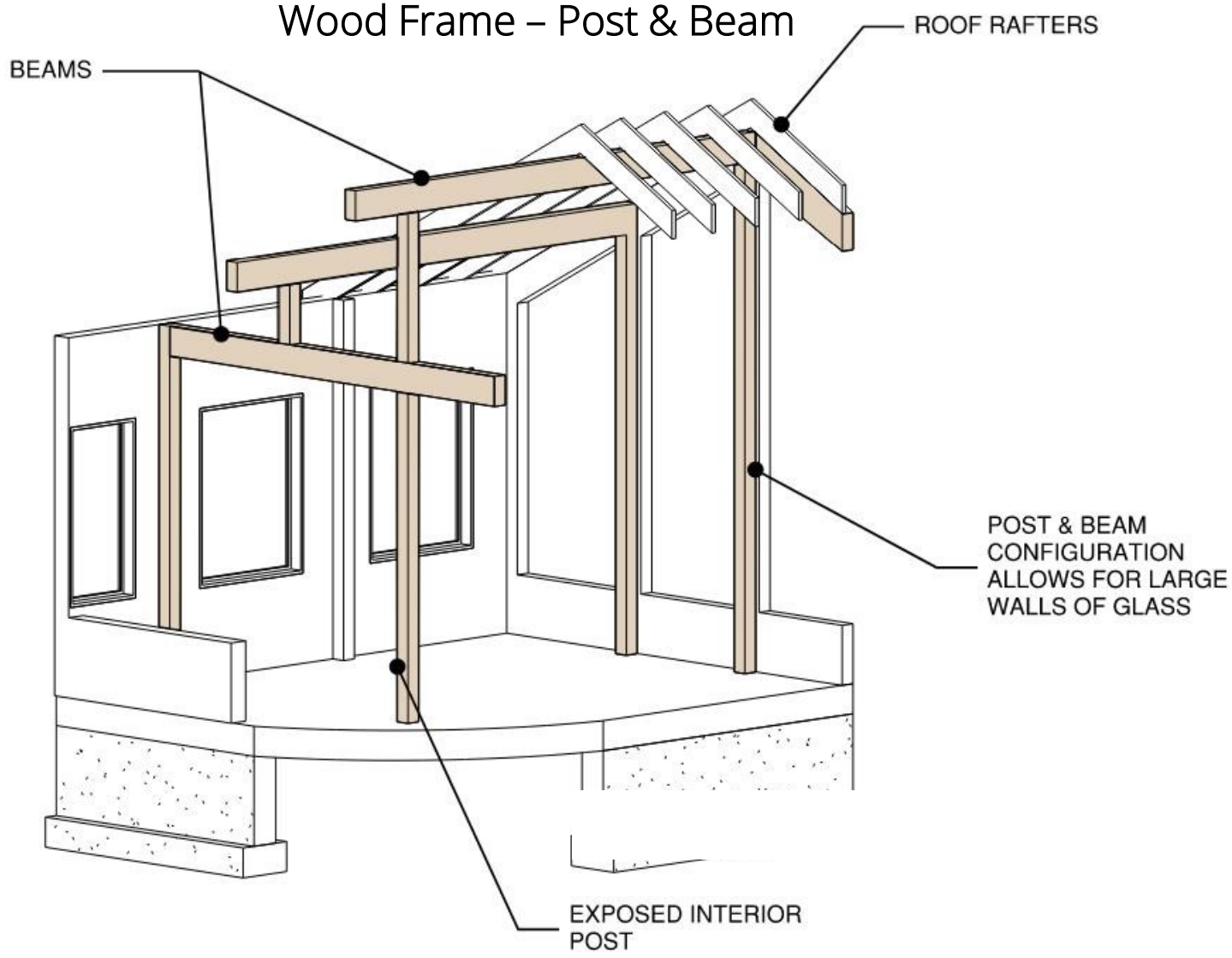
Common Construction Types for Older Single-Family Dwellings:

Wood Frame – Balloon Framing



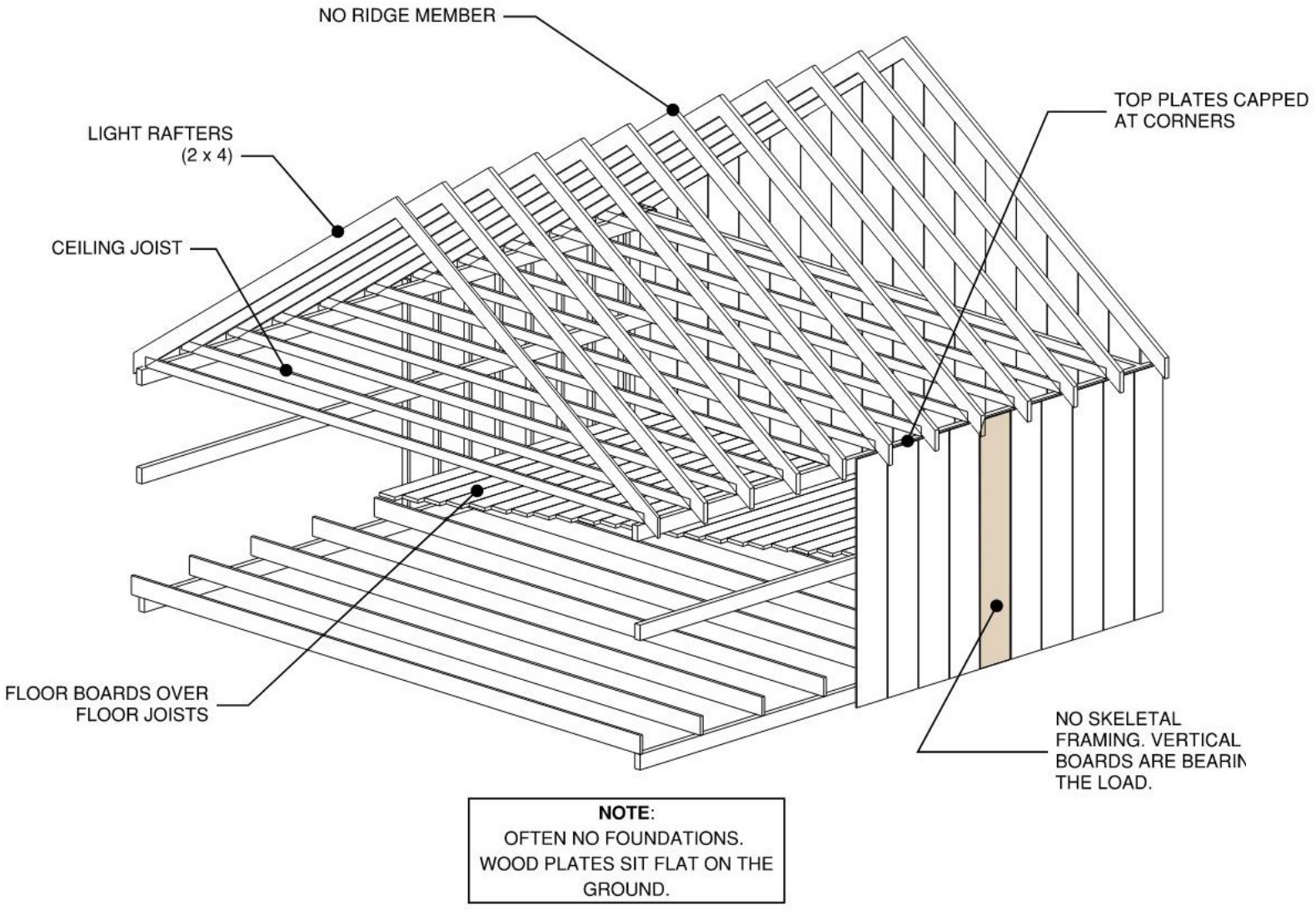
Common Construction Types for Older Single-Family Dwellings:

Wood Frame – Post & Beam



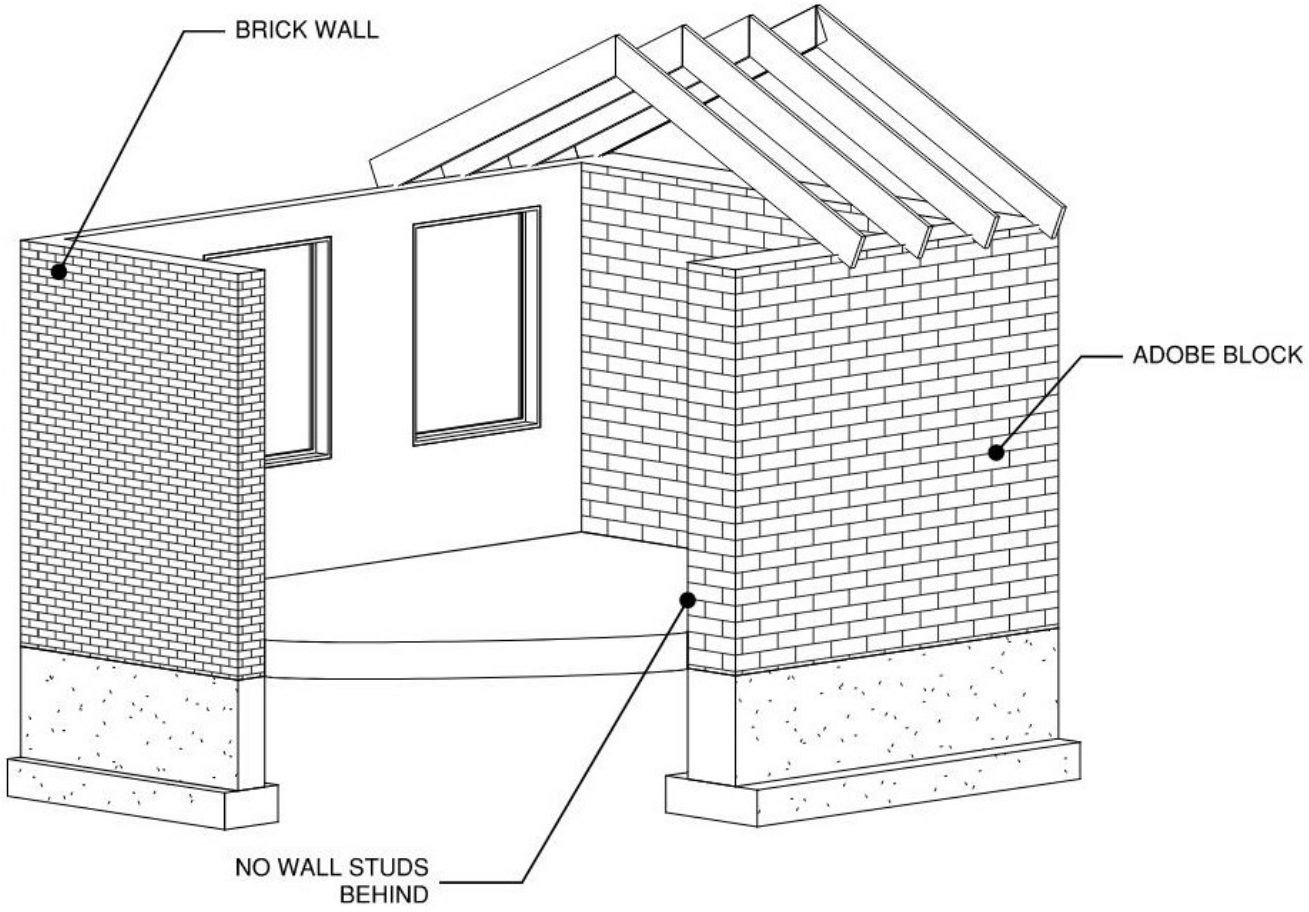
Common Construction Types for Older Single-Family Dwellings:

Wood Frame – Single Wall Construction



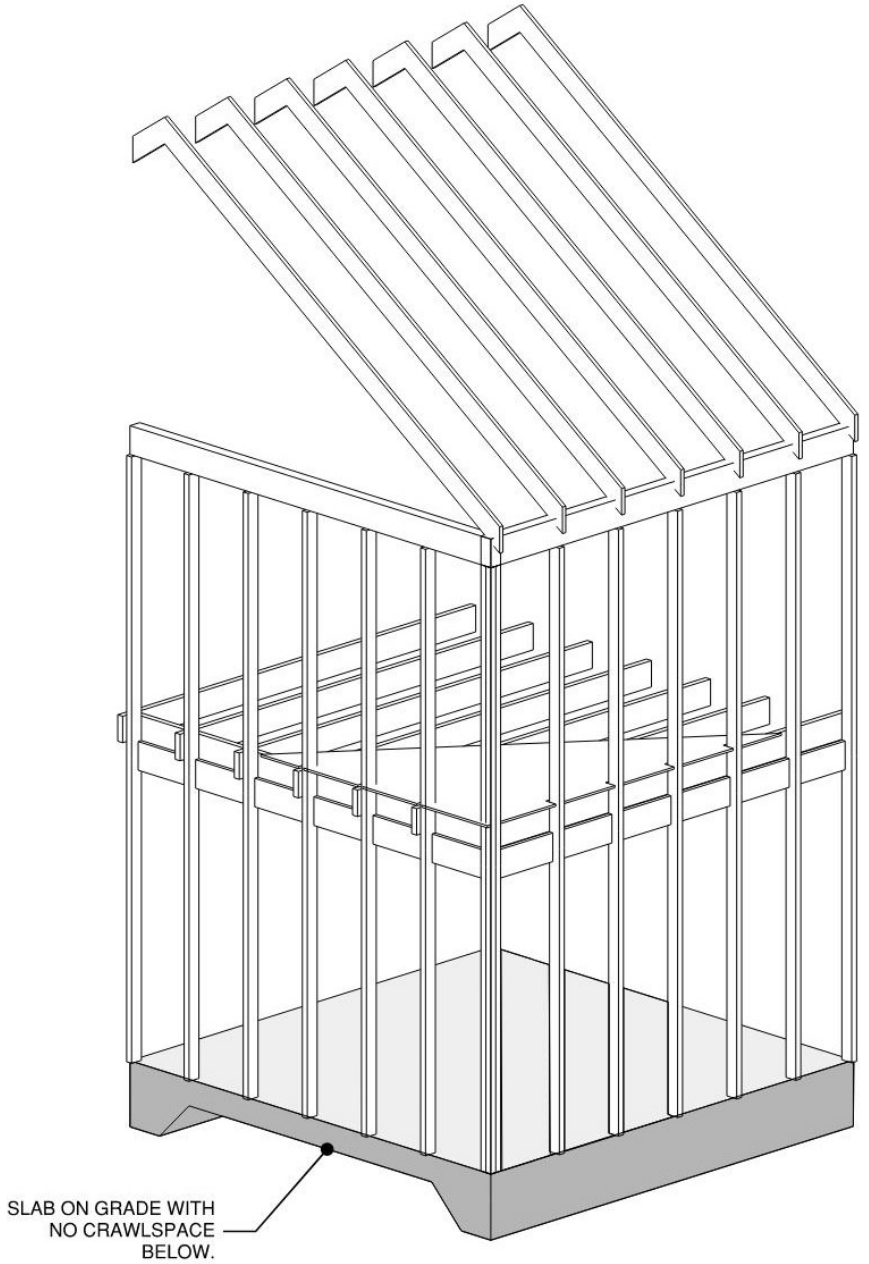
Common Construction Types for Older Single-Family Dwellings:

Masonry: Brick / CMU / Stone / HCT / Adobe Bearing Walls



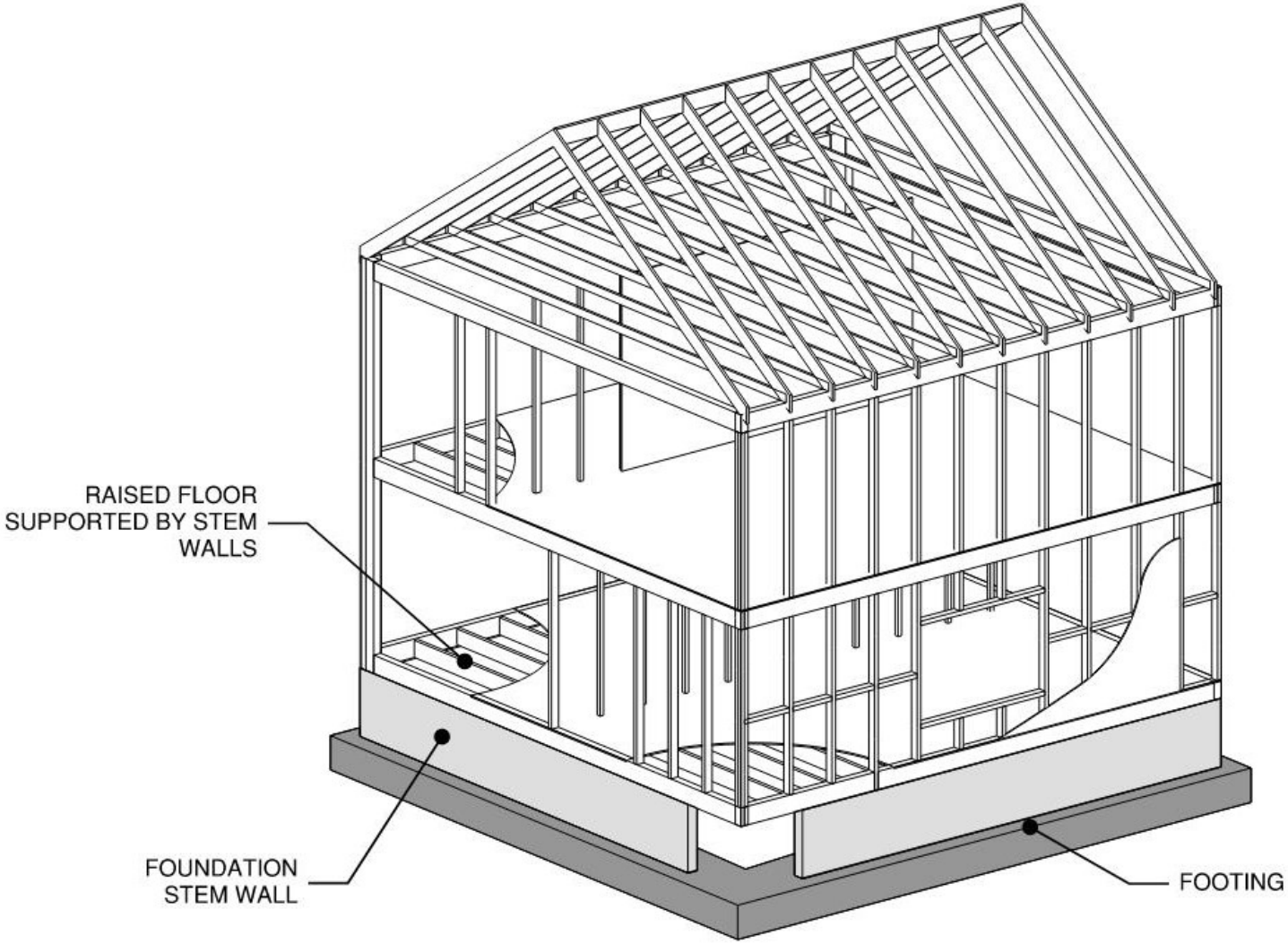
Common Construction Types for Older Single-Family Dwellings

Foundations: Slab-on-Grade



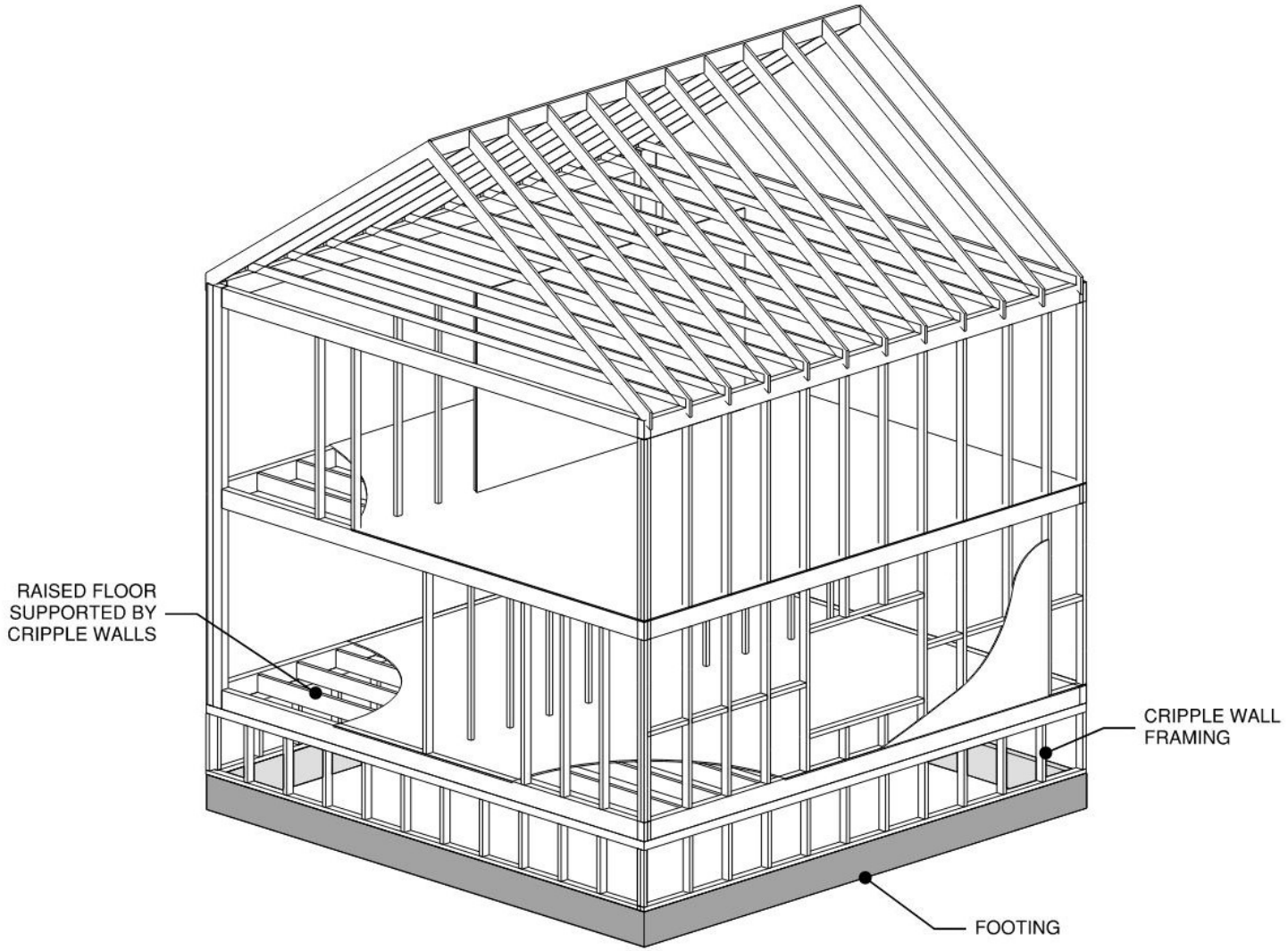
Common Construction Types for Older Single-Family Dwellings

Foundations: Raised Floor / Stem Walls



Common Construction Types for Older Single-Family Dwellings

Foundations: Raised Floor / Cripple Walls



The California Historical Building Code

- There are no triggers in the CHBC
- Seismic provisions are only mandatory when triggered by other code issues or ordinances
- When voluntary, partial upgrades are allowed:

"Nothing in this code shall prevent voluntary and partial seismic upgrades when it is demonstrated that such upgrades will improve life safety and when a full upgrade would not otherwise be required."

(Also CEBC Appendix Ch. A-3 & A-4 cover cripple walls & residential open front buildings, if not eligible for CHBC)

Hindry House, Pasadena
Source: Kelly Sutherland McLeod Architects

What are you getting?

- Safer house
- Lower repair costs
- Costs?

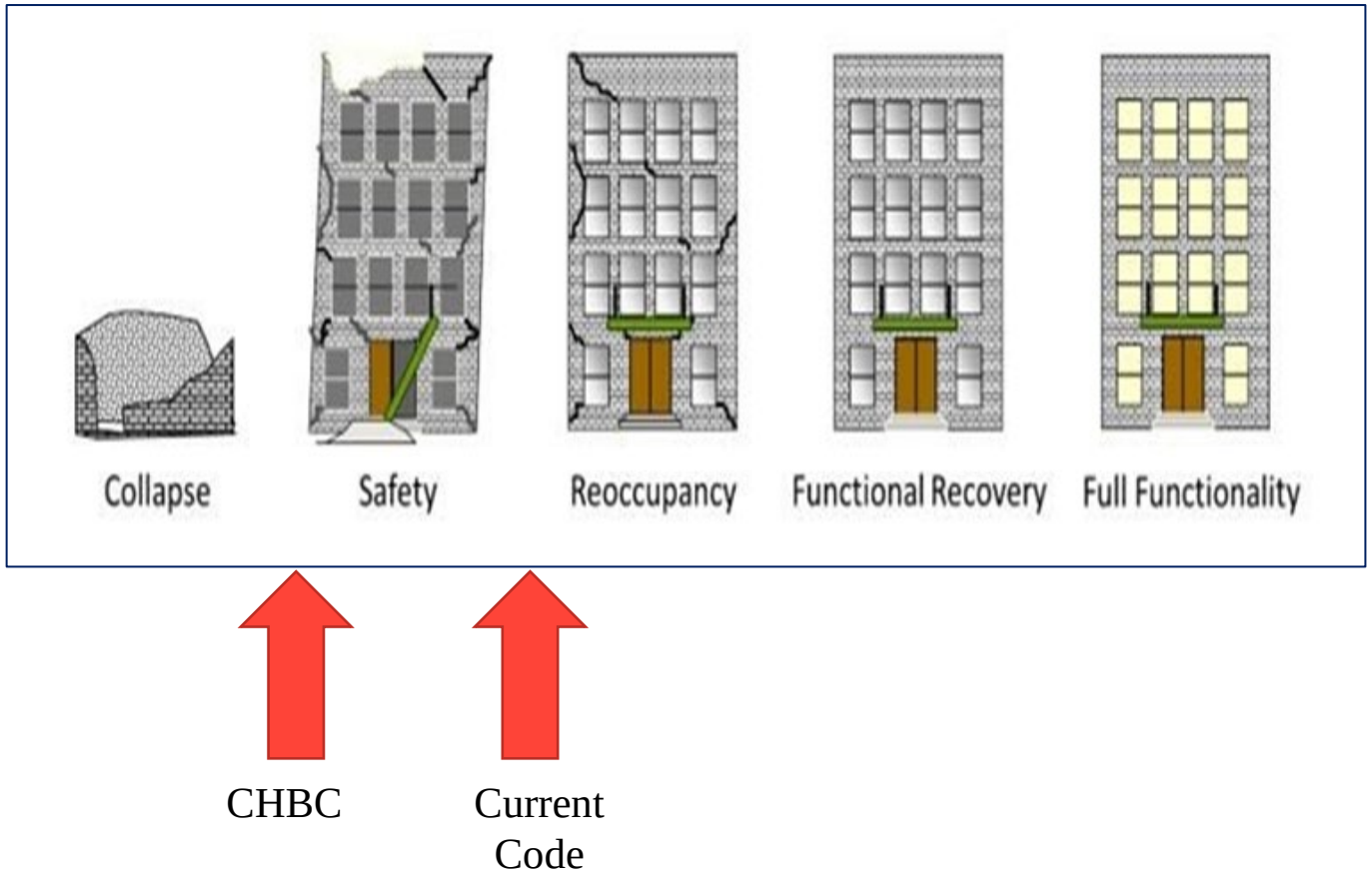
Ask for prioritized list

- Get more bang for your buck
- Ask about expected damage and repairs costs

EQ Insurance?

- Consider deductible amount
- Retrofit is "self insurance“
- Available programs: California Earthquake Authority (CEA)

Range of Performance During EQ Shaking



Pre-Quiz:
Addressing Common Vulnerabilities

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing

B. Shear Walls

C. Foundation Anchor Bolt

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing

B. Chimney Bracing

C. Shear Walls

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing

B. Shear Walls

C. Foundation Anchor Bolt

What kind of retrofit is required to address this vulnerability?

A. Cripple Wall Sheathing
B. Shear Walls
C. Foundation Anchor Bolt

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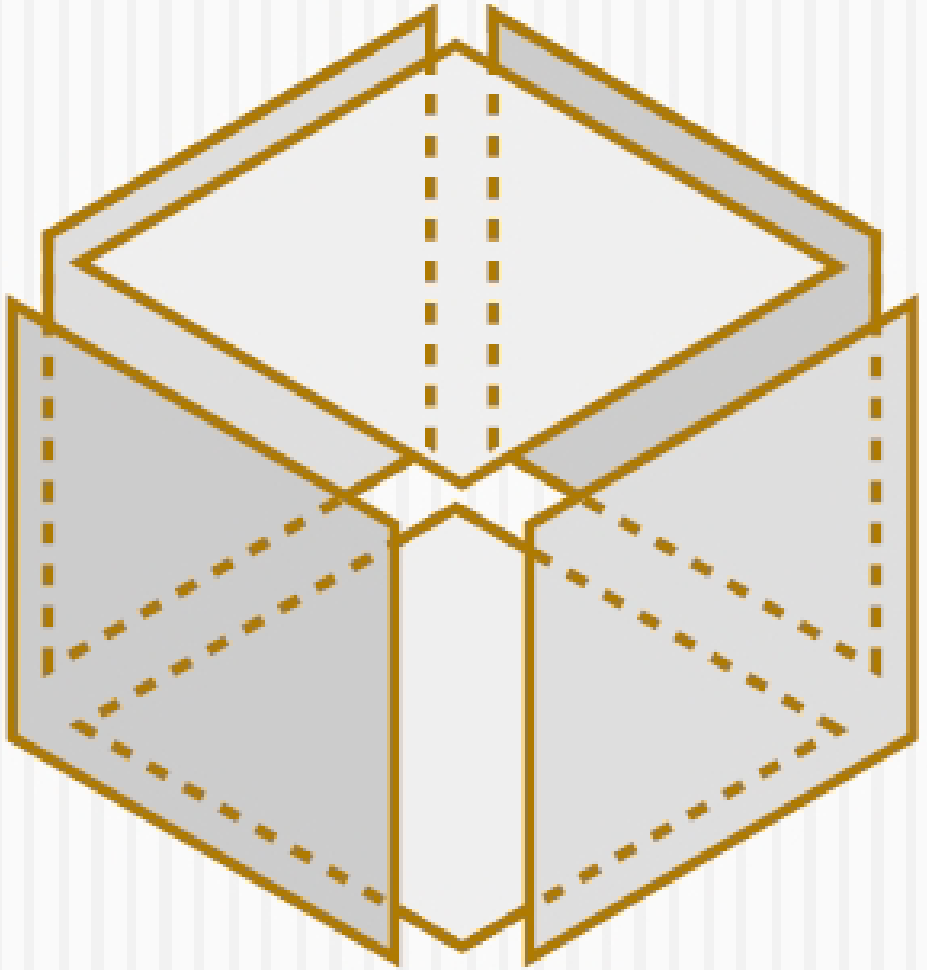
Global Look at Your House

- Building Layout and Configuration
- Load Path
- Connections

PRINCIPLES OF A BOX-TYPE STRUCTURE



All edges of each element must be attached to all edges of adjacent

Building Layout and Configuration

- Box Type Structure
- Re-entrant Corners (Irregularities)
- Open Front Buildings

Building Layout and Configuration

- Box Type Structure
- Re-entrant Corners (Irregularities)
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Building Layout and Configuration

- Box Type Structure
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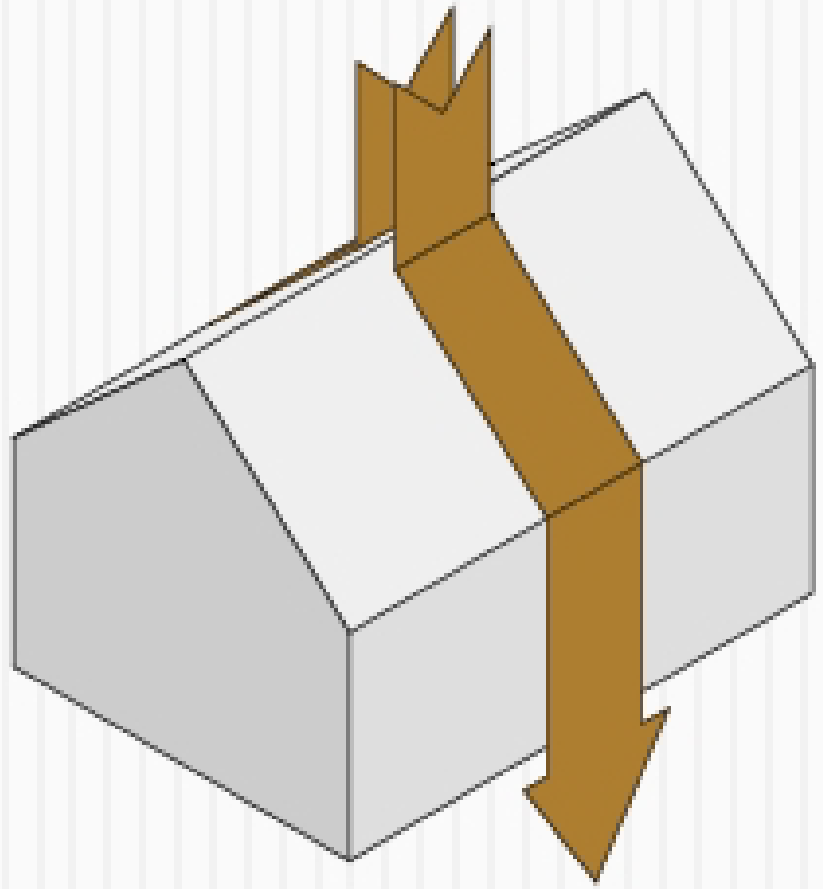
Load Path

- Building Layout and Configuration
- Load Path
- Connections

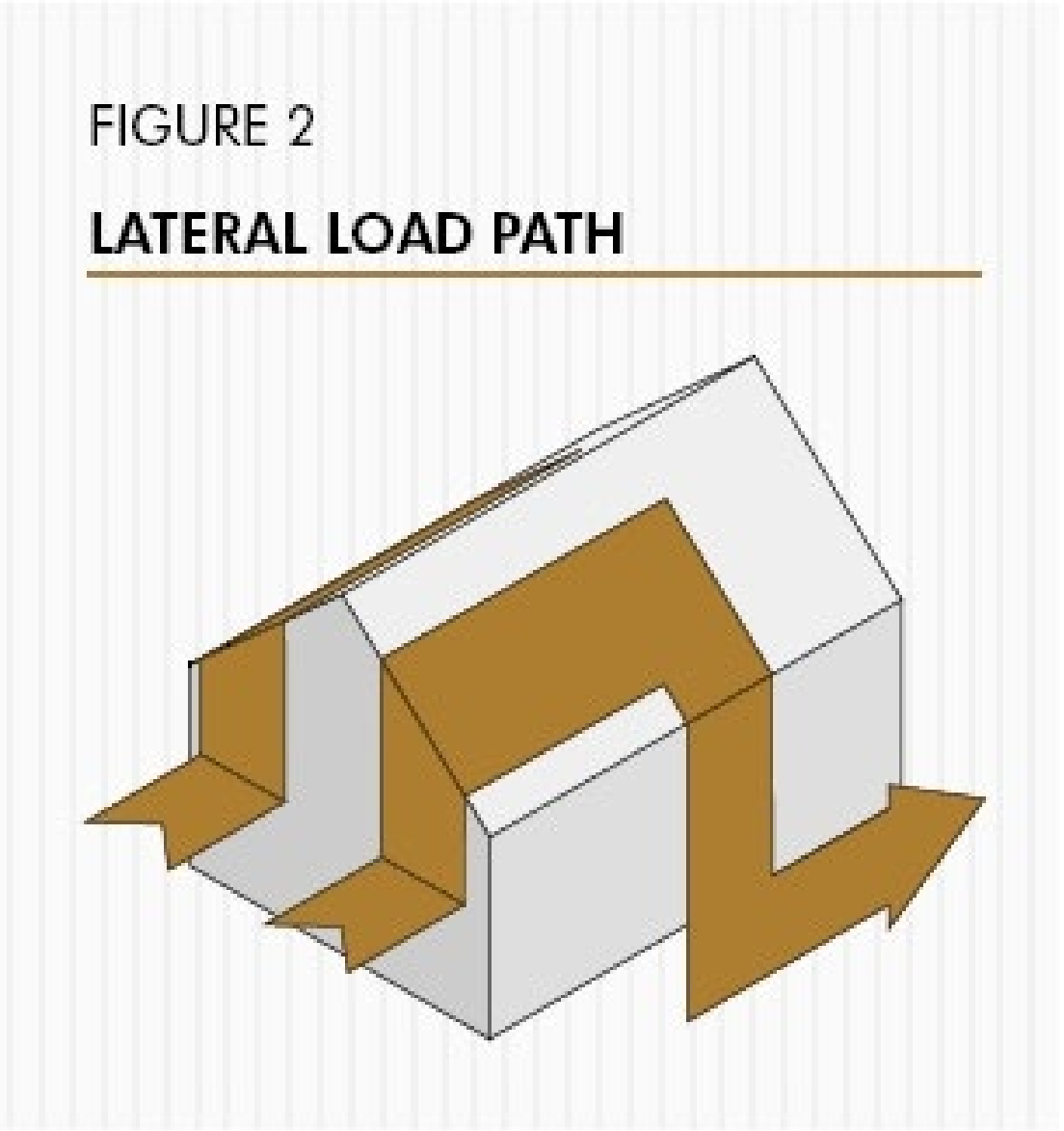
FIGURE 1

VERTICAL LOAD PATH

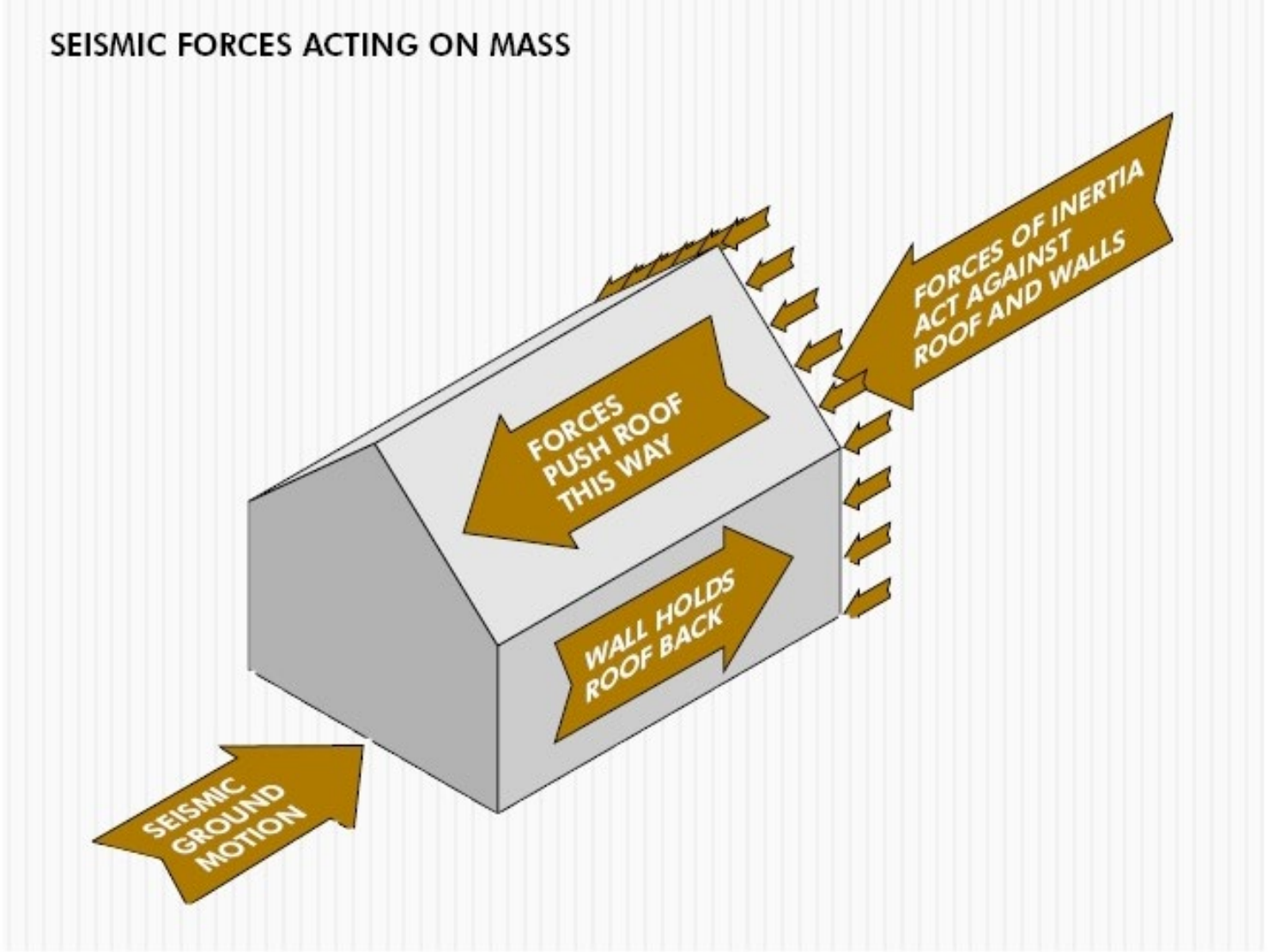


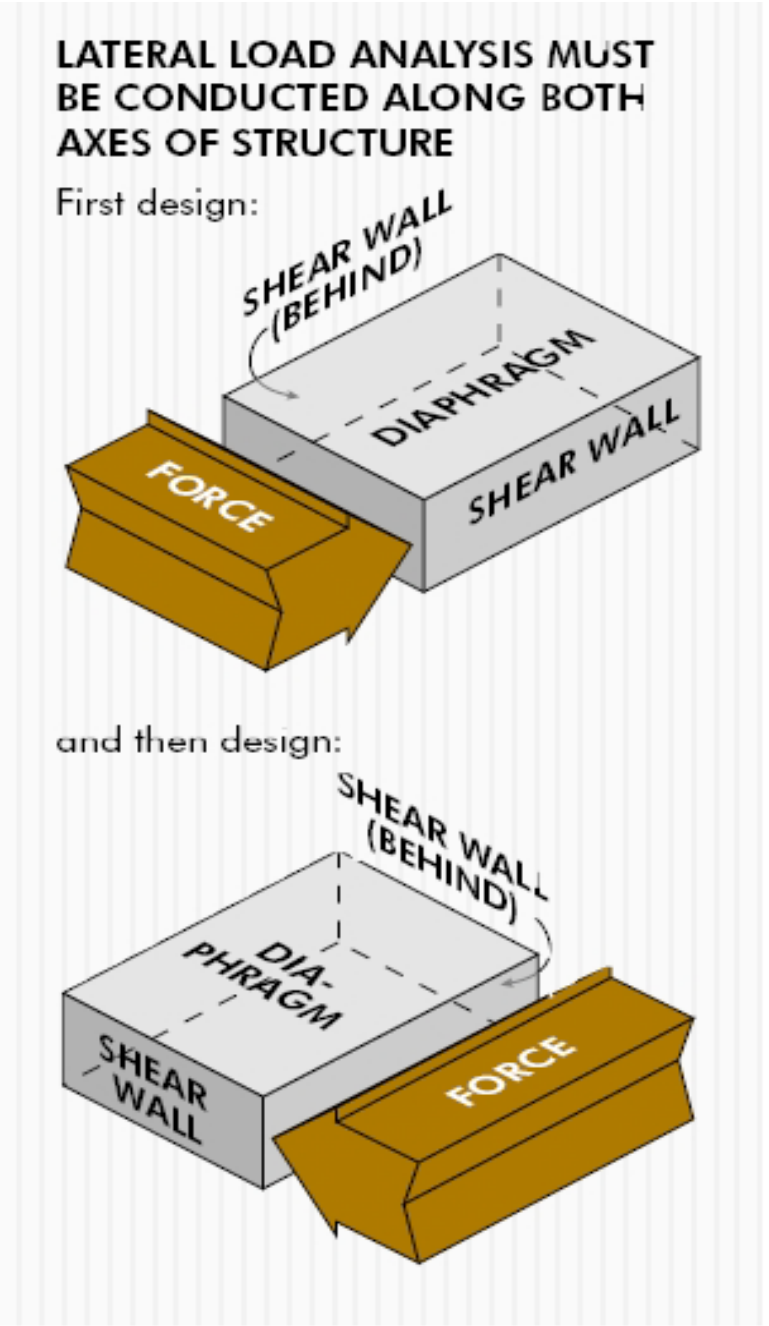
Load Path

- Building Layout and Configuration
- Load Path
- Connections



Load Path


SEISMIC FORCES ACTING ON MASS
FORCES OF INERTIA ACT AGAINST ROOF AND WALLS
FORCES PUSH ROOF THIS WAY
WALL HOLDS ROOF BACK
SEISMIC GROUND MOTION


LATERAL LOAD ANALYSIS MUST BE CONDUCTED ALONG BOTH AXES OF STRUCTURE
First design:
SHEAR WALL (BEHIND)
DIAPHRAGM
SHEAR WALL
FORCE
and then design:
SHEAR WALL (BEHIND)
DIA-PHRAGM
SHEAR WALL
FORCE

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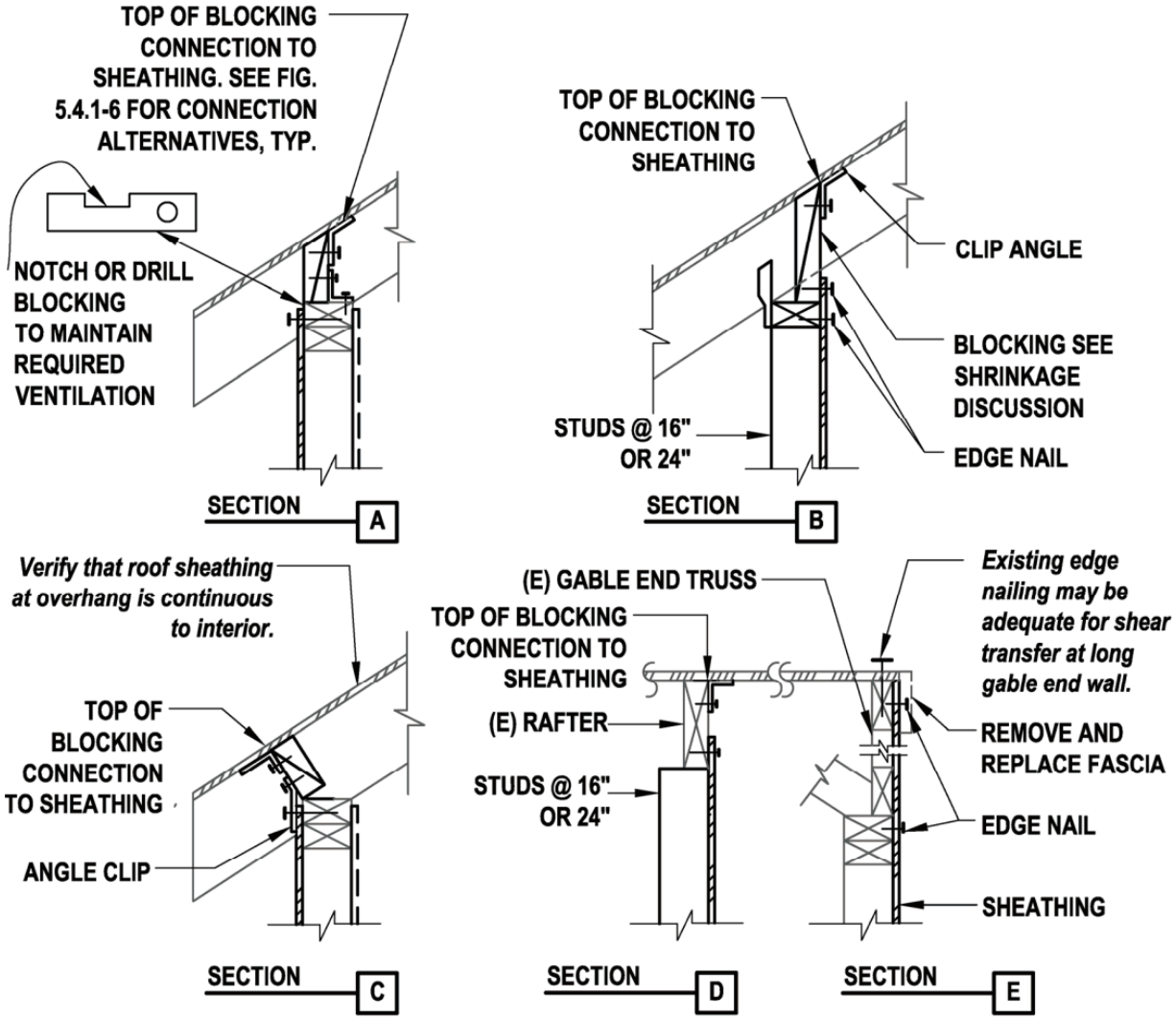
Retrofit Strategy Options

- Enhance Performance of Existing Elements
- Add Elements
- Improve Connections
- Weak Links

Global Look at Your House

- Enhance Performance of Existing Elements
- Add Elements
- Improve Connections
- Weak Links



Global Look at Your House

- Enhance Performance of Existing Elements
- Add Elements
- Improve Connections
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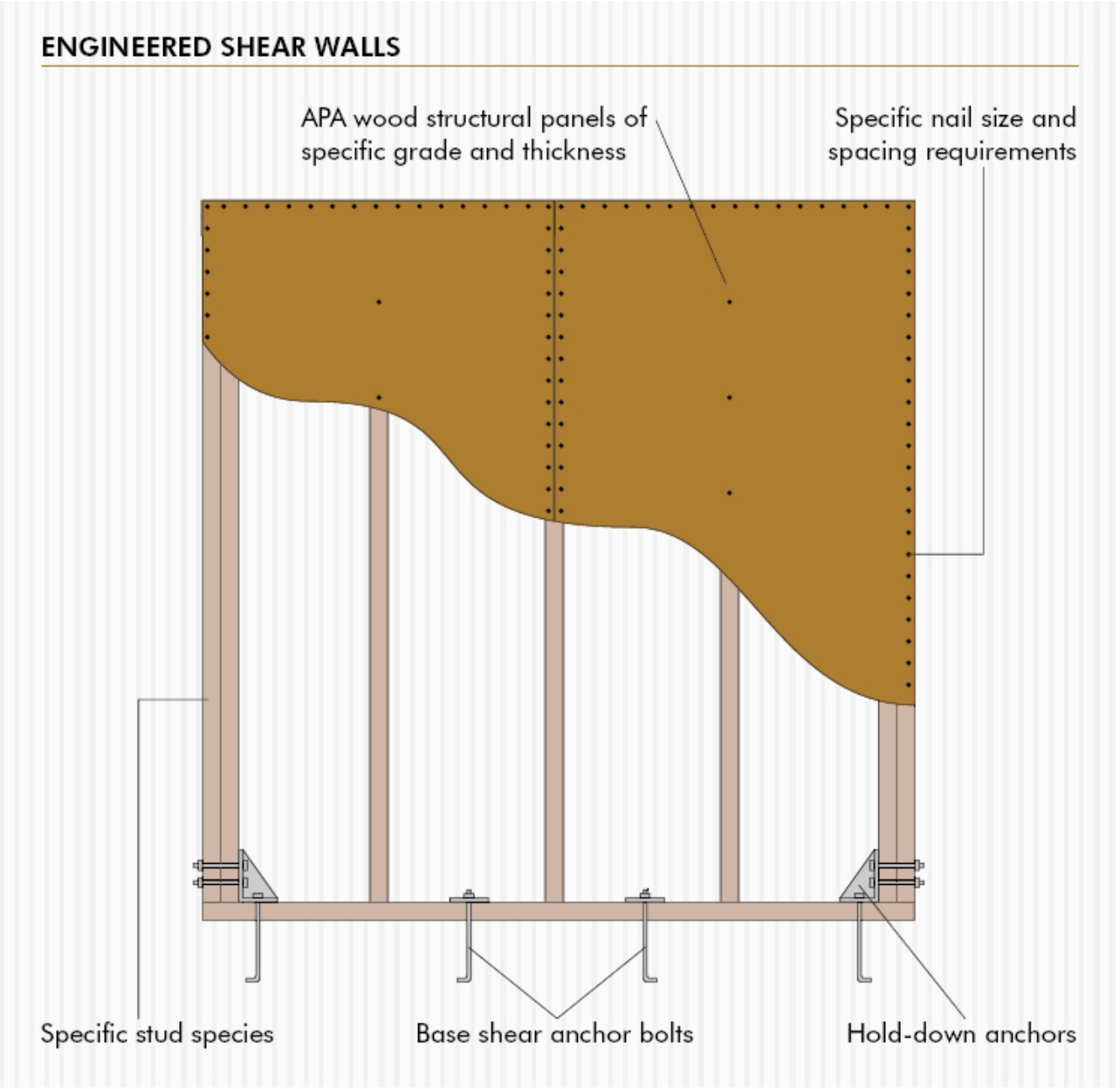

Questions?

- What do you think is your house’s construction type?

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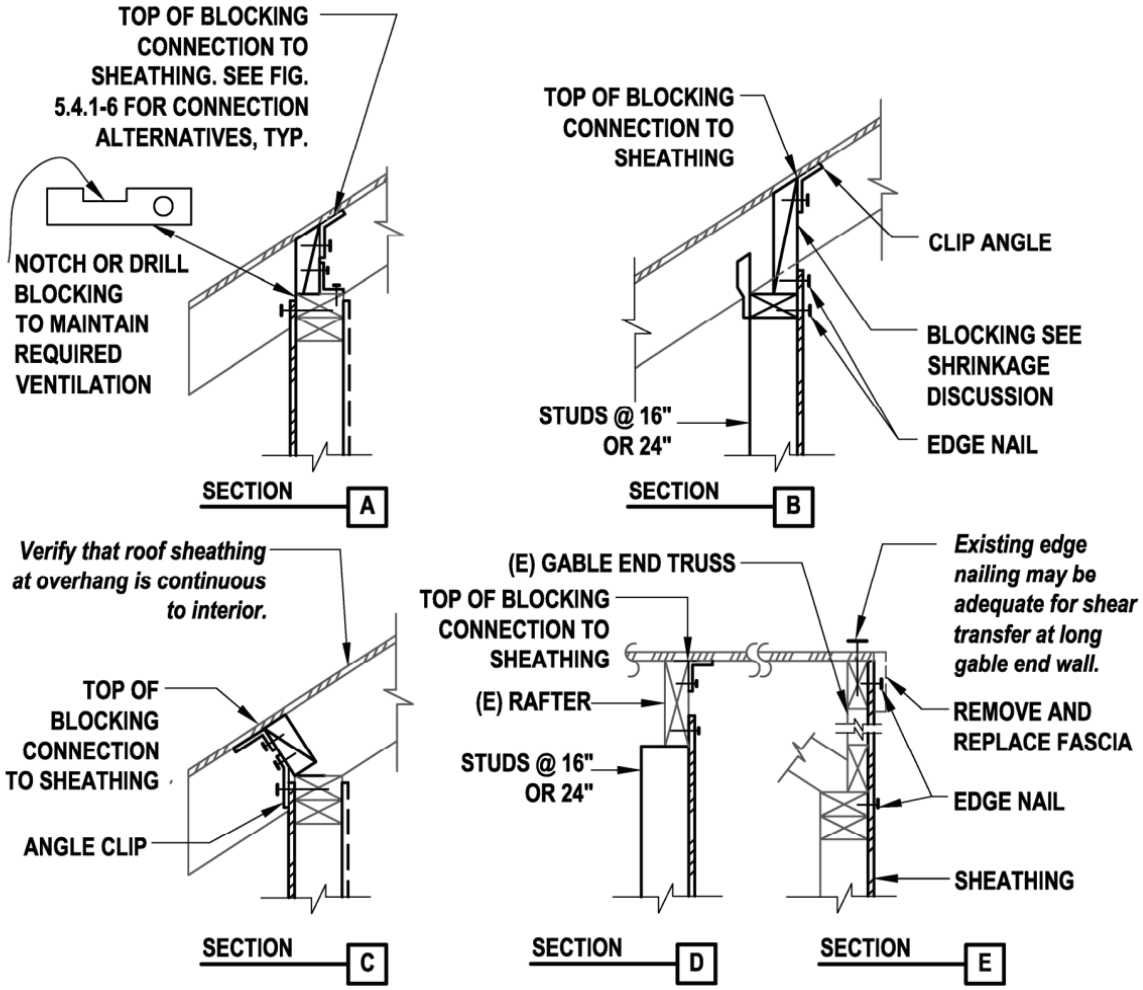
Retrofits – Roof Sheathing

Plywood sheathing on the roof creates load path for uniform connections between walls.

Source: Structural Focus



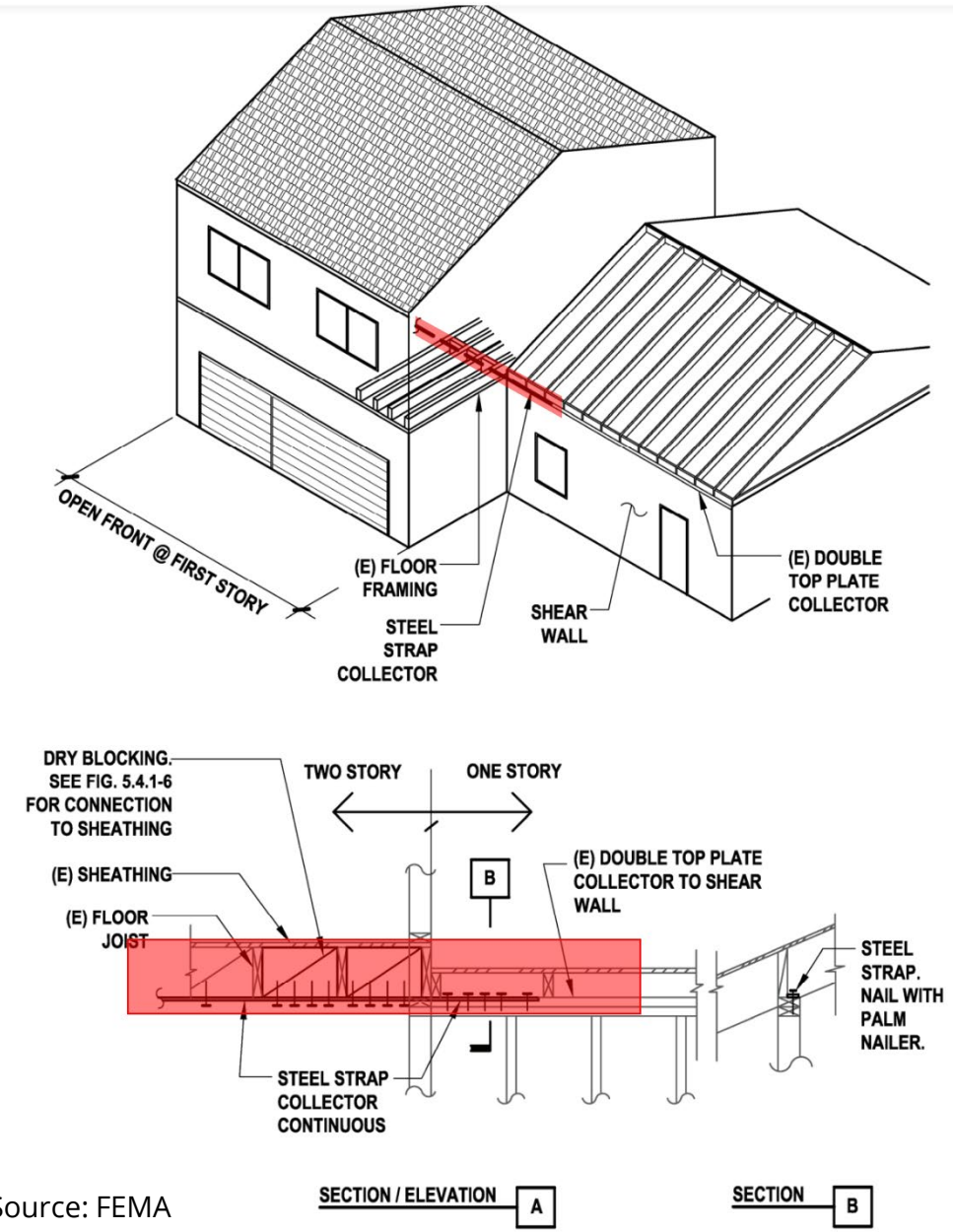
Source: FEMA

Retrofits – Roof Sheathing Complimentary Work

- Add attic insulation
- Improve roofing and drainage systems

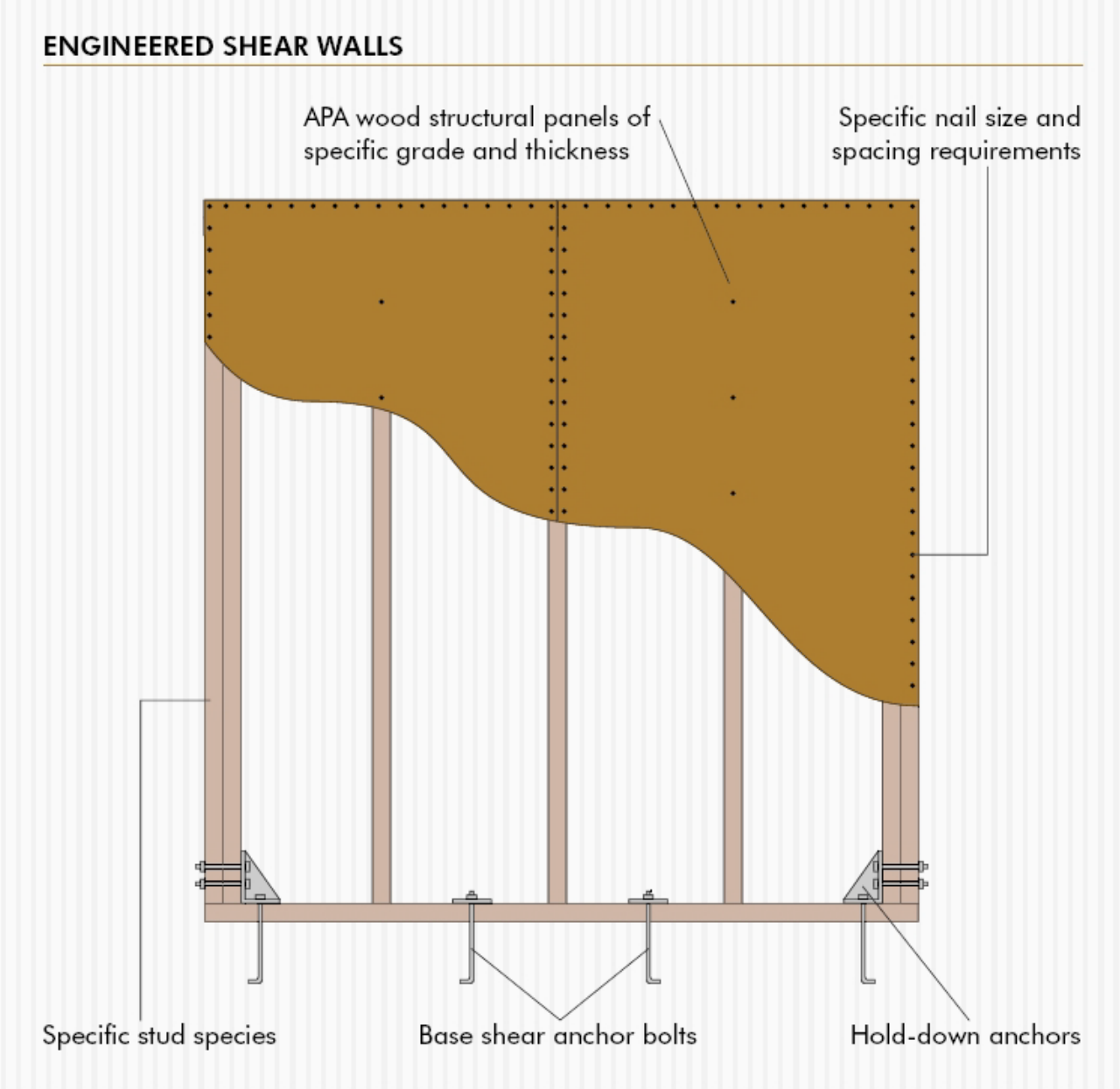
Retrofits – Collectors

Adding collectors insures uniform movement for various parts of a house



Source: FEMA

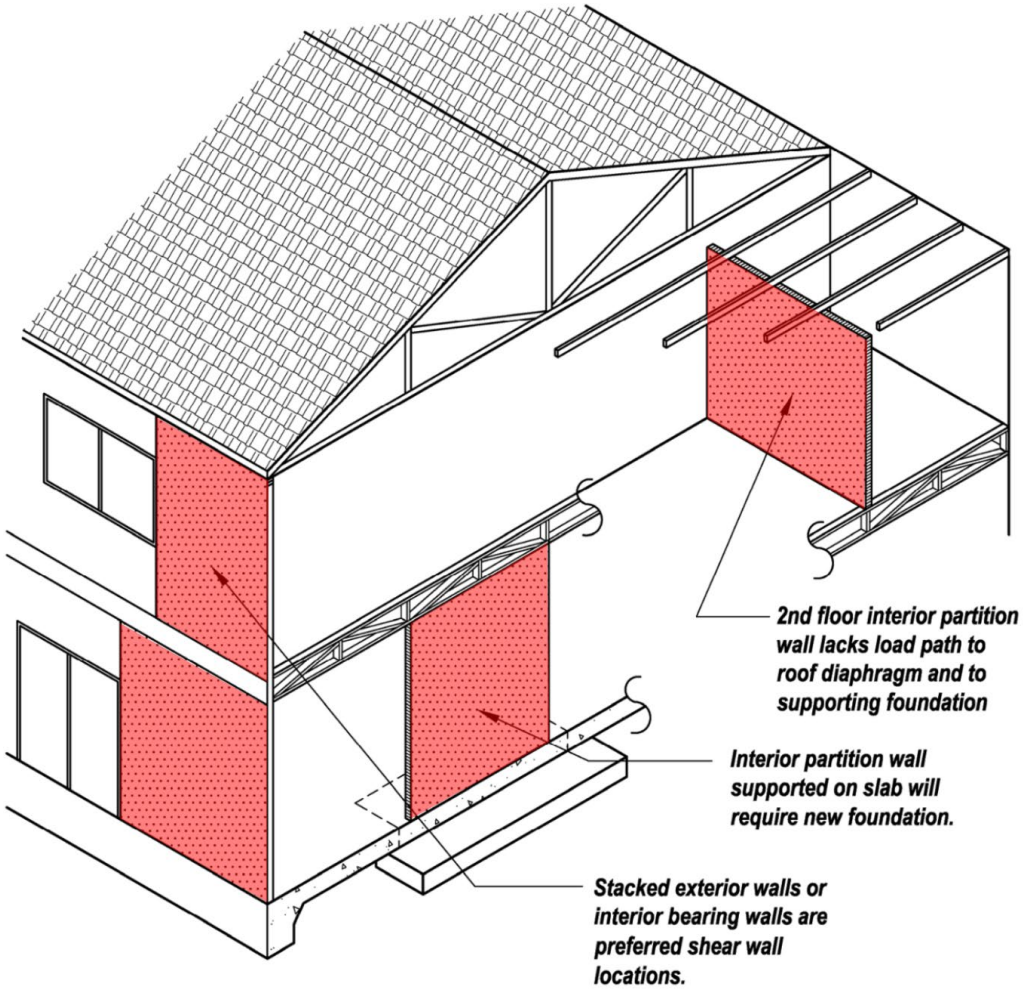
Retrofits – Shear Walls



Retrofits – New Shear Walls

Plywood sheathing can be added on existing walls to create shear walls, alternatively, additional nails can be added to strengthen existing sheathing on walls

Source: Structural Focus

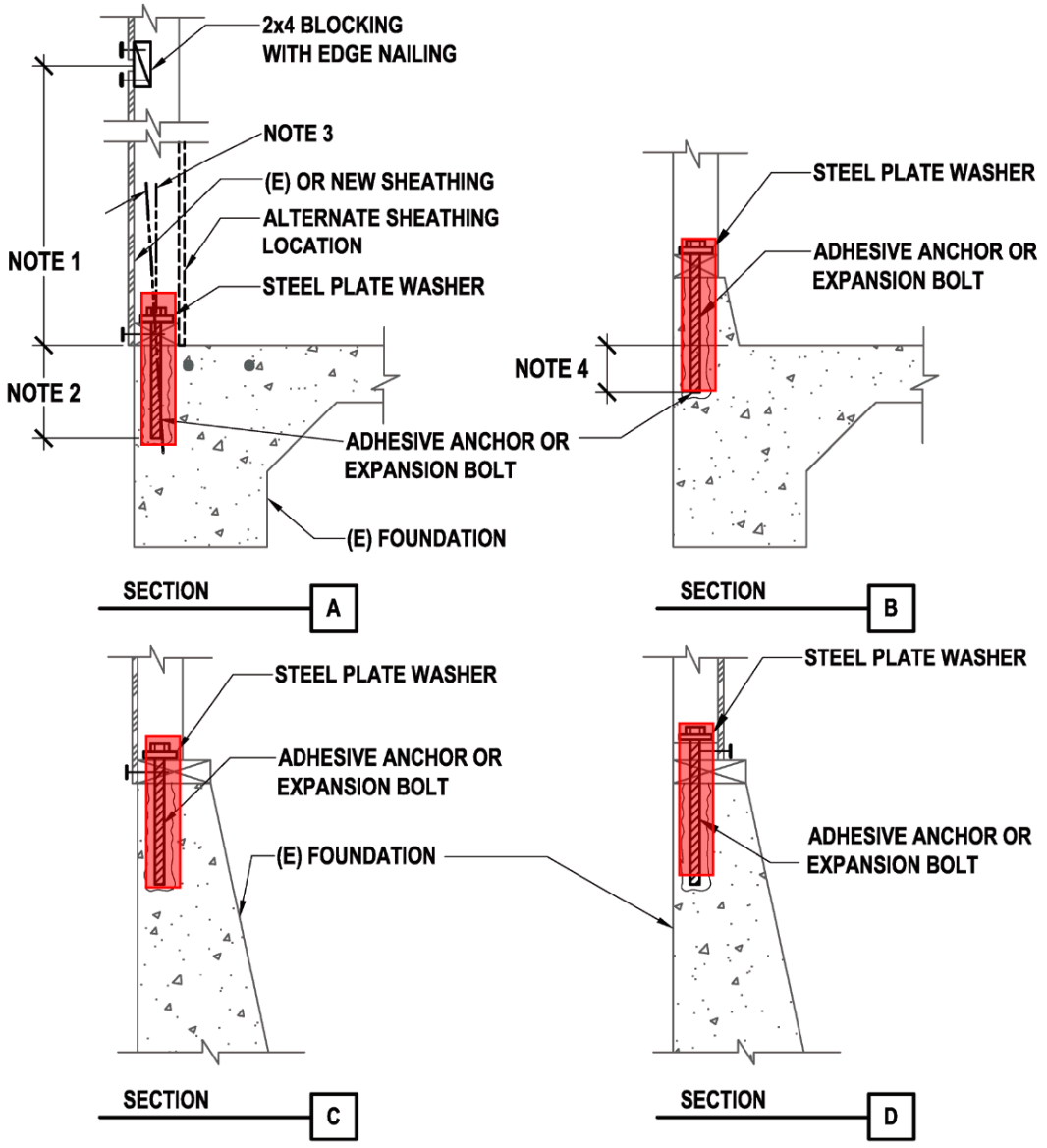


Source: FEMA

Retrofits – Foundation Anchors

Foundation anchors prevent houses from sliding off of foundations

Source: Structural Focus

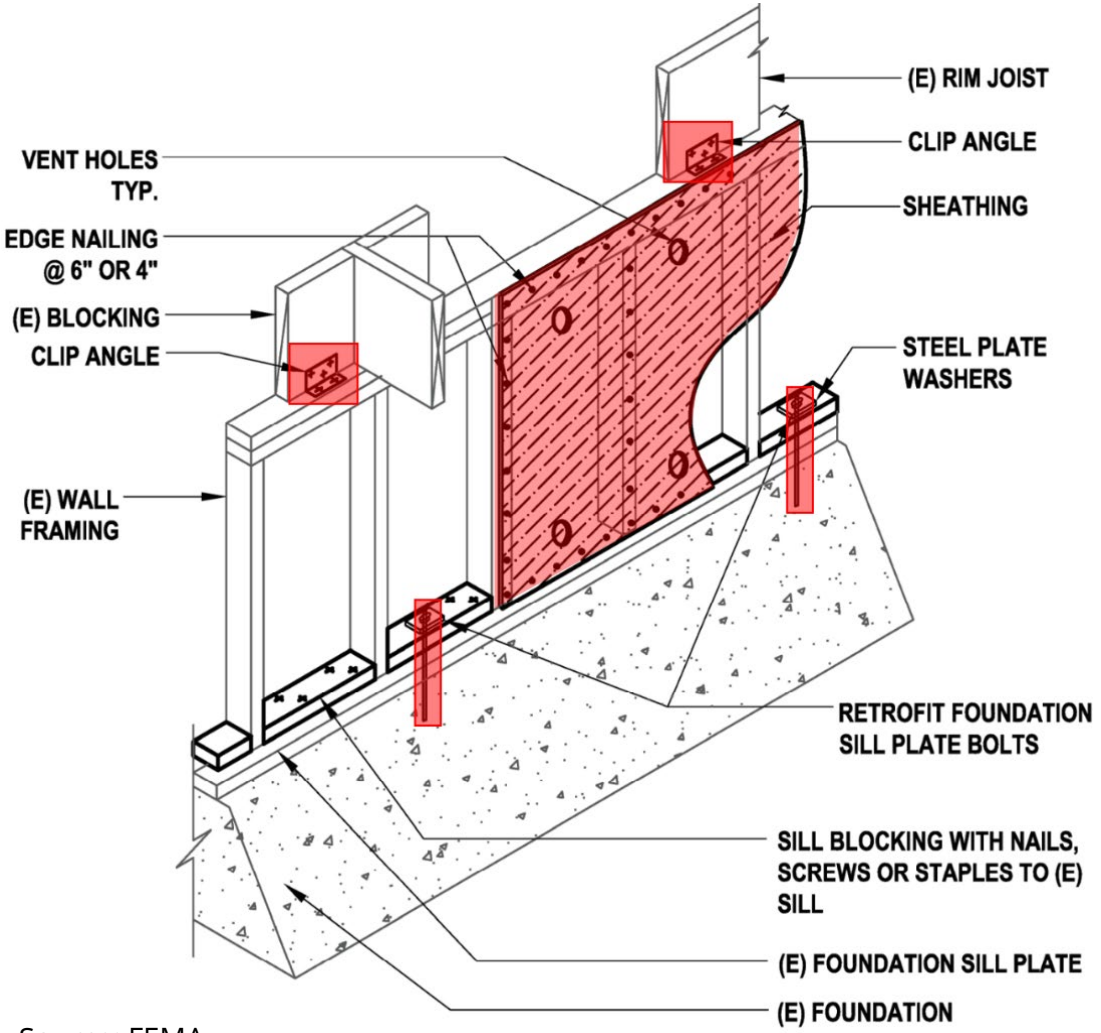


Source: FEMA

Retrofits – Cripple Wall Bracing

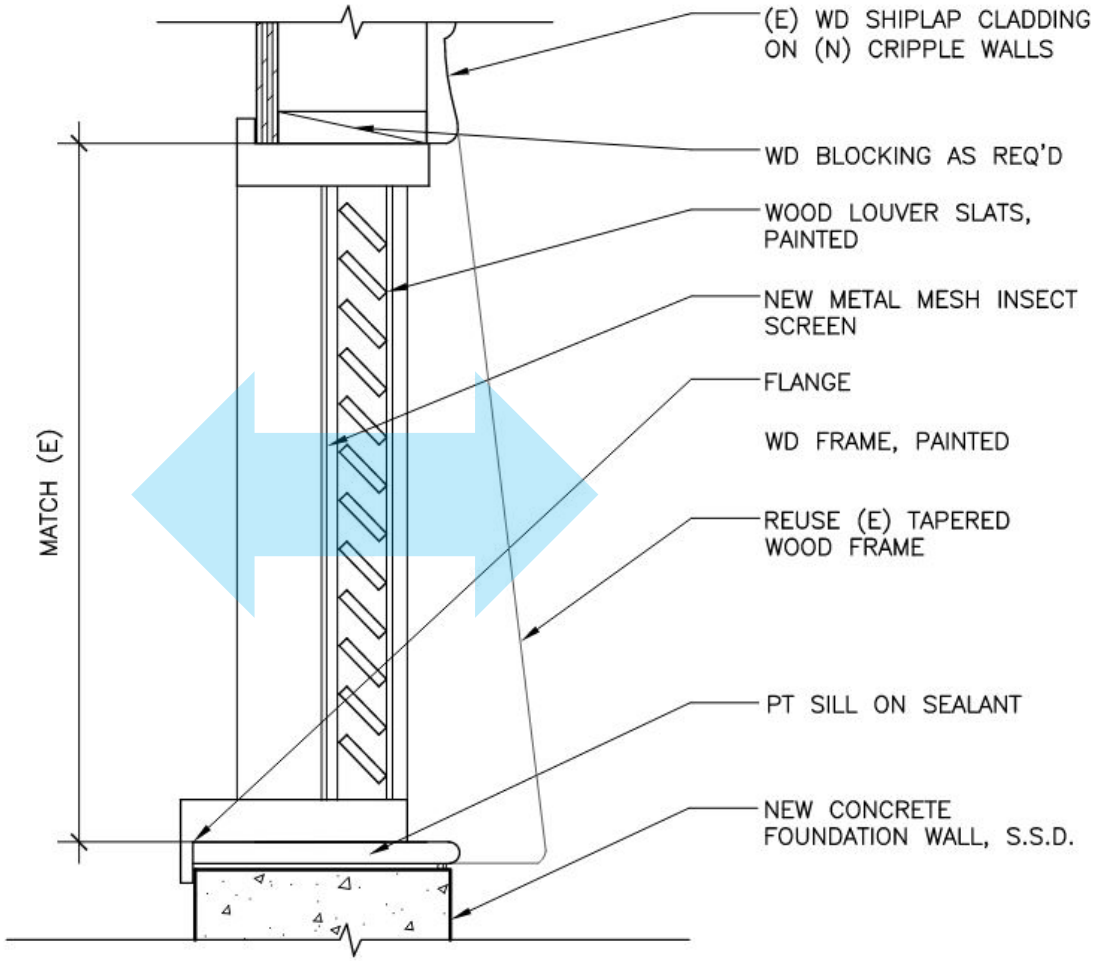
Plywood sheathing can be added on existing walls

Source: Structural Focus



Source: FEMA

Retrofits – Cripple Walls
Crawl Space Considerations



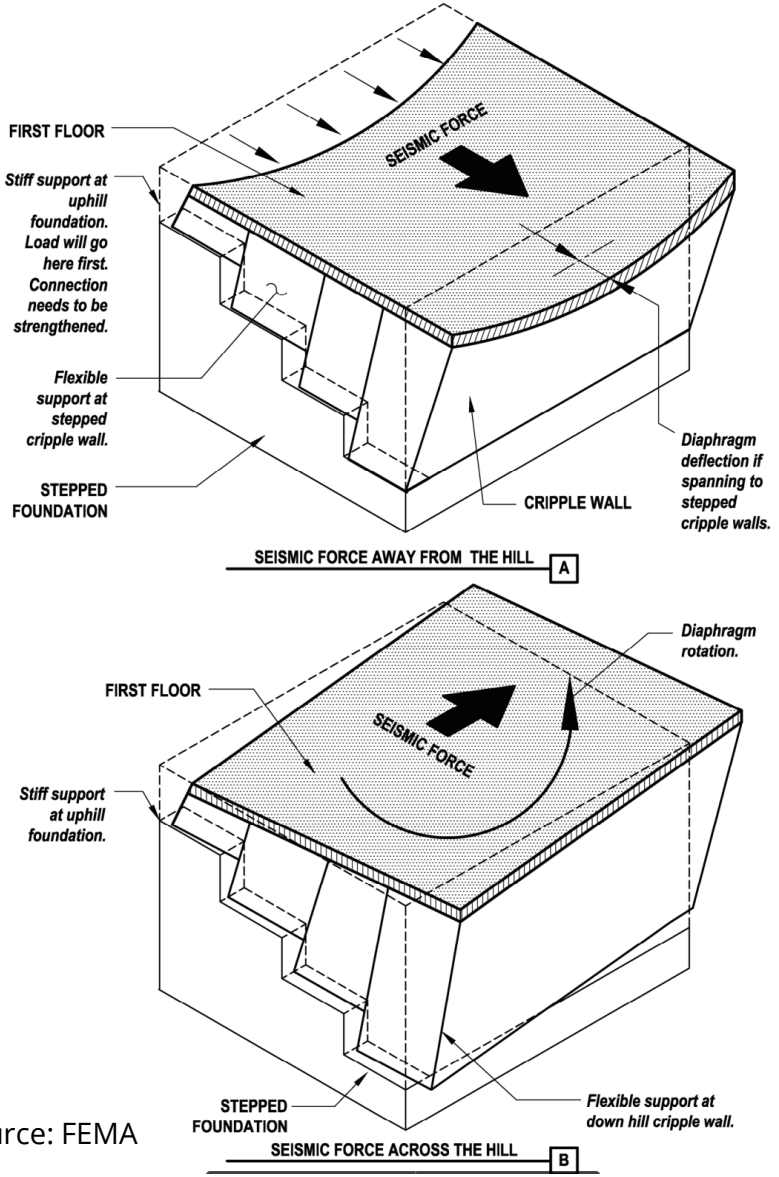
8 WD LOUVER AT CRAWL SPACE
SCALE: 3"=1'-0"

Retrofits – Cripple Wall Bracing: Brace and Bolt

California Earthquake Authority provides Brace and Bolt grants for retrofitting cripple walls.

- https://www.

Retrofits – Hillside Buildings

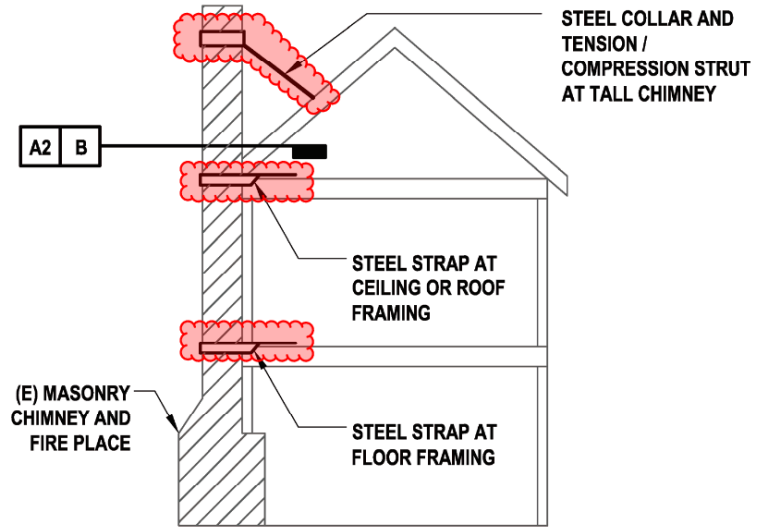


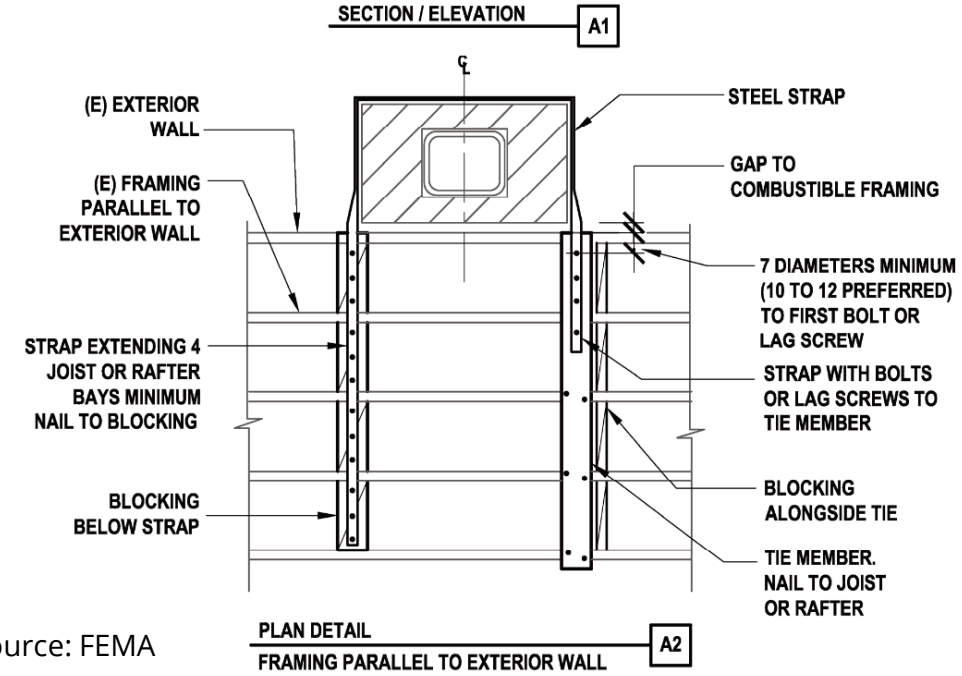
Source: FEMA

Retrofits – Chimneys

Connect chimneys to all levels to prevent separation

Source: Structural Focus





Source: FEMA

Masonry Buildings

- Brick buildings (unreinforced)
- Adobe buildings
- Other construction types – Stone and HCT

Masonry Buildings

Brick buildings (unreinforced)

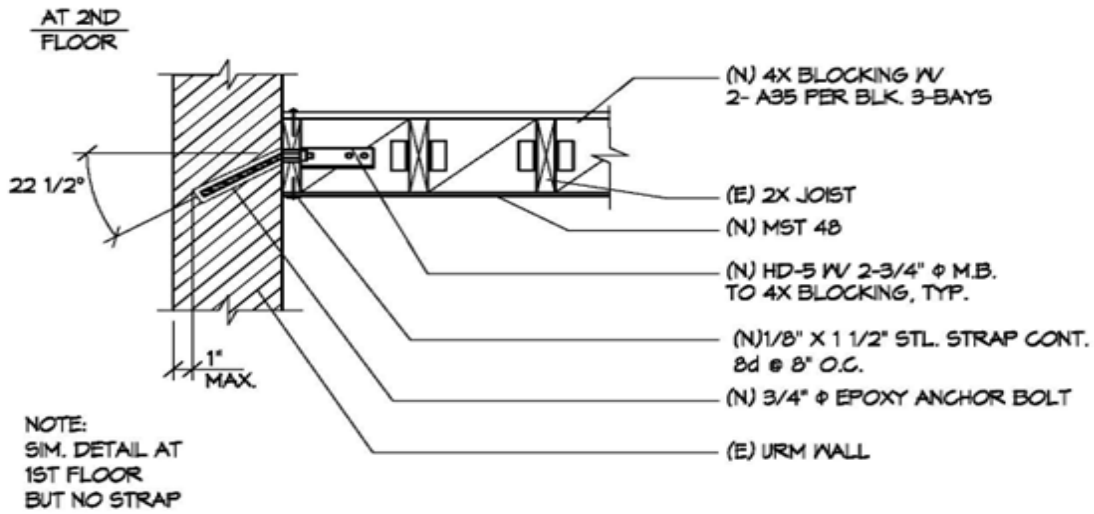
Adobe buildings

Other types – Stone and HCT

Principal type of failure with masonry wall building has been out-of-plane collapse. These details work well for brick structures. With modifications they will work for other masonry structure types.

Note that the bolt does not go through the wall but is attached with epoxy to the masonry.

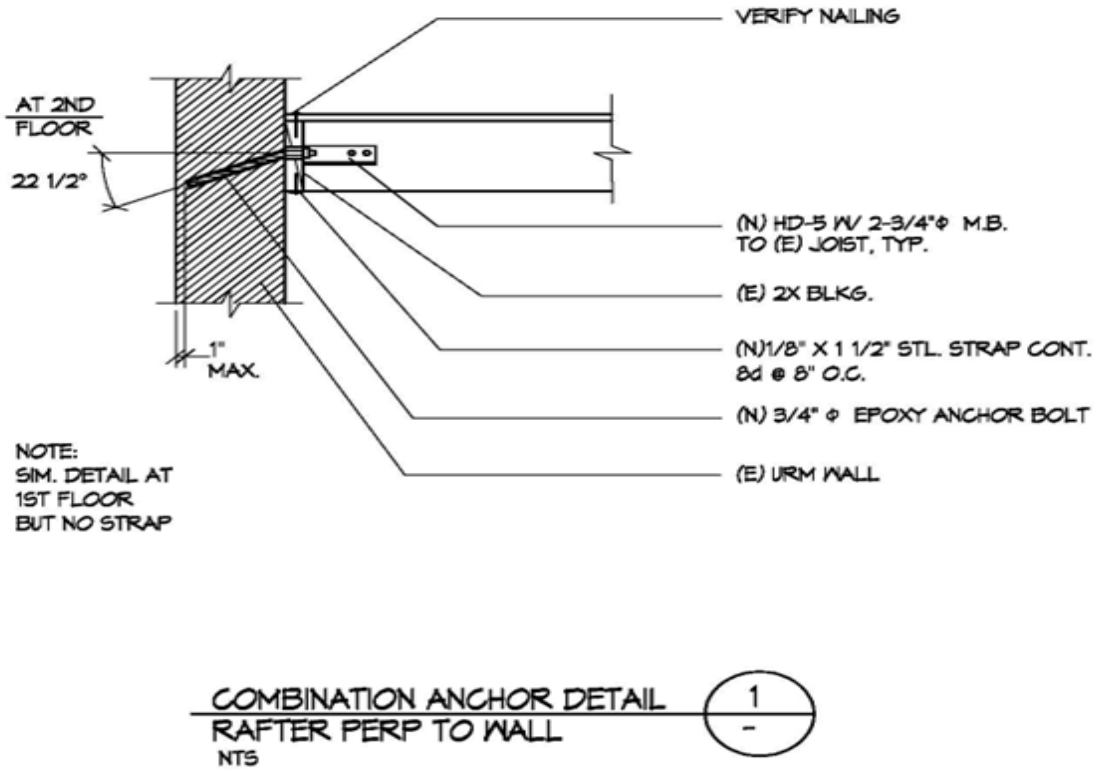
This example is where the joists are parallel to the wall.



COMBINATION ANCHOR DETAIL 2
JOIST PARALLEL TO WALL
NTS

Masonry Buildings

- Brick buildings (unreinforced)
- Adobe buildings
- Other types – Stone and HCT
- Similar to the previous slide, this shows the rafters/joists perpendicular to the wall.



Retrofits – Adobe

- Single family dwelling
- Alterations over the building's lifetime.

Source: FEMA

Retrofits – Adobe

Second floor roof added over an open patio.

Retrofits – Adobe

Living room at the start of the project. Note water intrusion.

Retrofits – Adobe

Upstairs, now enclosed, patio. Vertical posts brace the adobe wall from falling outward.

Retrofits – Adobe

Living room during installation of a steel angle bond beam.

Angle is bolted into the wall and to the floor system.

Source: FEMA

Retrofits – Integration

The new retrofit elements should be incorporated with the existing features of the house as much as possible.

Source: MGA

Quiz:
What type of retrofit addresses the vulnerability in this house?

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing
B. Shear Walls
C. Foundation Anchor Bolt

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing

B. Chimney Bracing

C. Shear Walls

What kind of retrofit is required to address this vulnerability?

A. Diaphragm Sheathing

B. Shear Walls

C. Foundation Anchor Bolt

What kind of retrofit is required to prevent this type of failure?

A. Cripple Wall Sheathing
B. Shear Walls
C. Foundation Anchor Bolt

Questions?

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Priorities and Phasing

- Stand back and review the needs.
- What might be the priorities for my house construction type?
- Are there any home improvements that I might integrate seismic retrofit into?
- For much of this work a qualified Engineer (or Architect) will be necessary.

Ranking Retrofit Measures

Wood Frame Structures

1. Cripple Wall Bracing
2. Anchor Bolts to Foundation
3. Open Fronts
4. Porches / Falling Hazards
5. Shearwall Additions
6. Chimney

Masonry Structures

1. Parapet and Gable Bracing (Chimney?)
2. Falling Hazards
3. Out-of-plane Wall Anchors (Chimney?)
4. Diaphragm Capacity
5. Wall Stability (h/t ratio)
6. In-plane shear

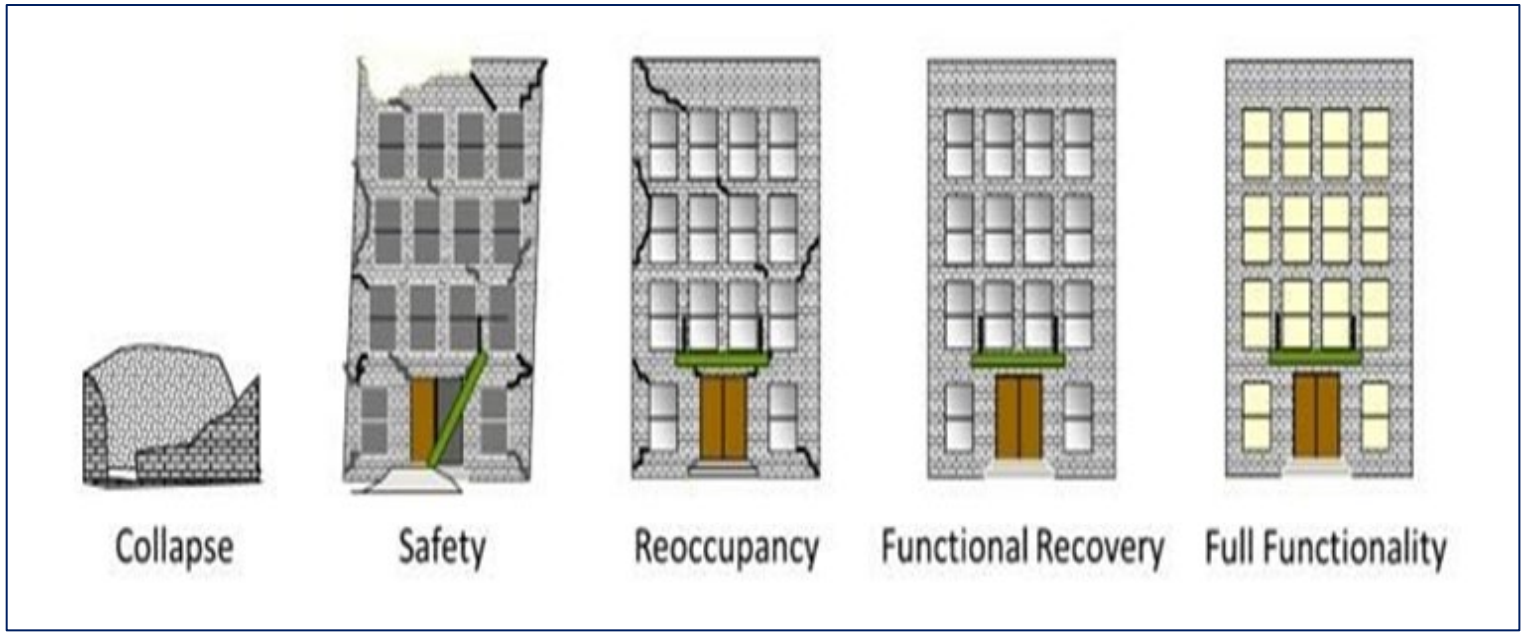
Reminder: Don't forget non-structural features!

https://www.earthquakecountry.org/library/ECA_Step_1_SecureYourSpace_Document-EN.pdf

Priorities and Phasing

- Consider range from zero scope to incremental to full scope of retrofit
- Incremental - Develop priorities for mitigation measures
- Develop cost estimates for each mitigation item
- Integrate with other alteration projects whenever possible
- Consider financial vehicles

Range of Performance During EQ Shaking



In Workshop 5 we will discuss these topics in more detail

Financial Support/Incentives

- California Earthquake Authority's Brace & Bolt Grant Program (2022 registration opens October 18)
- Mills Act Property Tax Abatements
- California Capital Access Program(CalCAP), Seismic Safety Financing Program
- State Historic Rehabilitation Tax Credit (Coming Soon)

More information to come in Workshop #5!

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Summary

- Every Improvement Helps!
- Evaluate Your House
- Retrofit Strategies
- Retrofit Techniques & Examples
- Priorities & Phasing

Blacker Carriage House, Pasadena
Source: David Cocke

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Additional Resources & Further Reading

- 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
- Earthquake Country "Secure Your Space Checklist" 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/cpcfa/calcap/seismic/summary.asp)

Workshop #1: What Makes My Home 'Historic'? | Thursday, June 23, 2022

Workshop #2: Is 'Compatible' 'Matchy-Matchy'? | Tuesday, July 26, 2022

Workshop #3: Retrofitting Basic Training | Tuesday, August 30, 2022

Workshop #4: Seismic Retrofits | Thursday, October 6, 2022

NEXT WORKSHOP -- Workshop #5: Keep it Lookin' Great | Tuesday, November 8, 2022

Workshop #6: The Nuts and Bolts of Retrofits | Thursday, December 15, 2022

Questions?