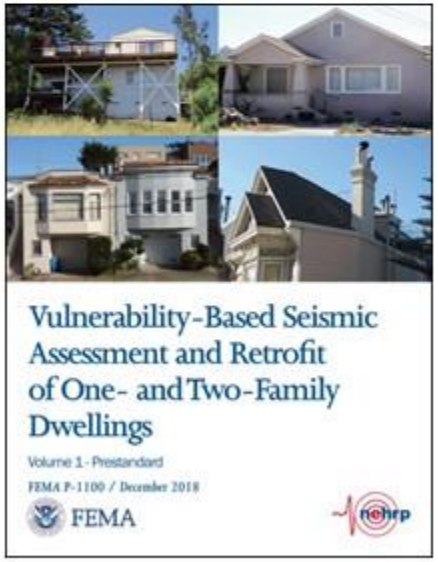
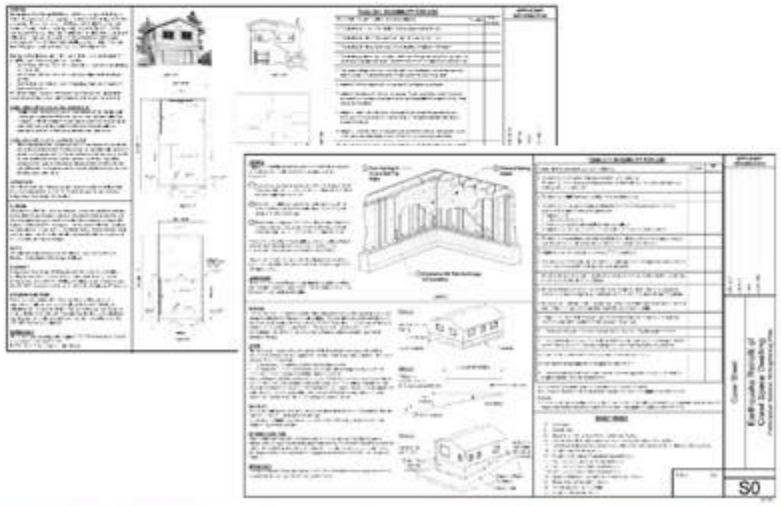
OSSPAC Meeting
March 10th, 2020

FEMA P-1100

Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

March 10th, 2020





Colin Blaney S.E.
Buehler

Learning Objectives

Develop an overall understanding of the FEMA P-1100 Prestandard and related documents.

Learn why we believe it will be a valuable resource for seismic mitigation

Agenda

- Prestandard purpose, scope, and documents
- Why vulnerability-based, and what's covered
- Looking ahead, next steps
- Performance objective
- Introduction to evaluation and retrofit methods
- Prescriptive and simplified engineering retrofits
- Leveraging prescriptive solutions
- Permitting and building department approval
- Introduction to (Ch.4, 5, 6 and 7)
- Preview of updates to FEMA 530

Acknowledgements

Three year plus project

Funding provided by

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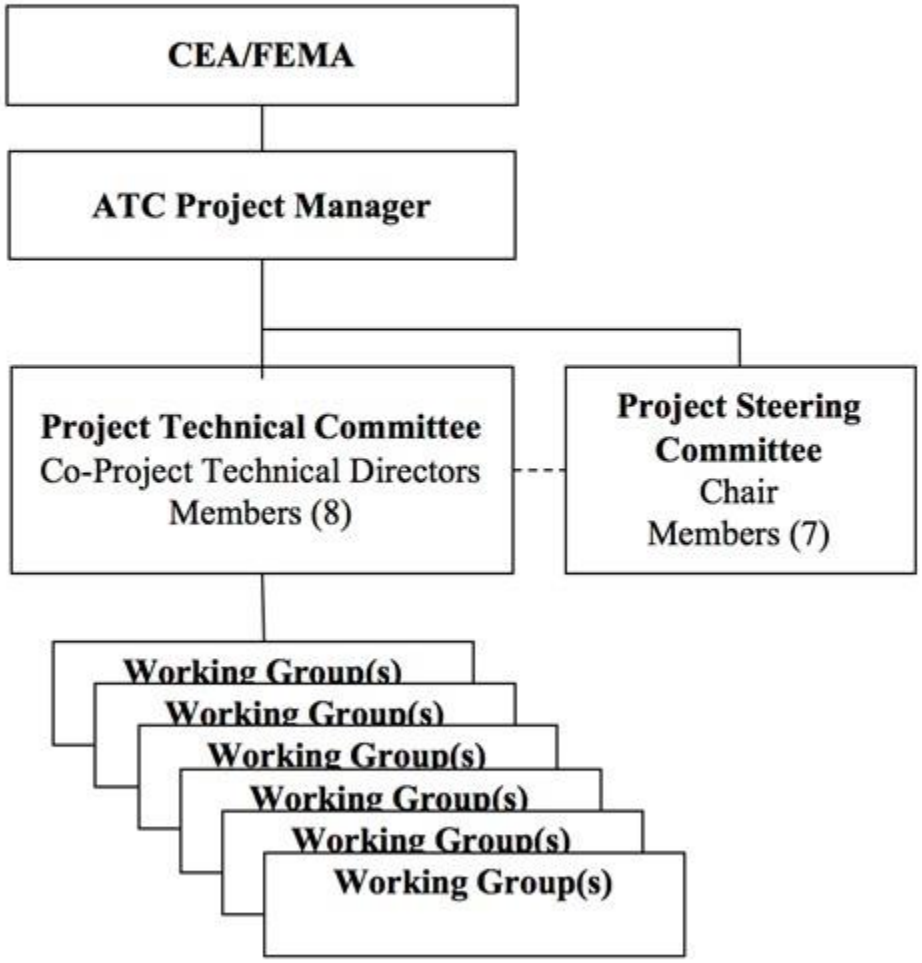

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Why a Prestandard for One and Two-Story Residential Buildings?

- Most Common Type of Dwelling in the United States
- There continues to be well known vulnerabilities that have repeatedly led to significant damage and dwellings being uninhabitable

Purpose

To provide a simple and systematic procedure to identify and retrofit known vulnerabilities in wood light-frame dwellings.

Use of the provisions is anticipated to improve earthquake performance but is not intended to prevent earthquake damage.

Scope

- One and two-story wood light-framed dwellings
- Town houses and single family dwellings divided into multiple dwelling units (R-3)
- Seismic Design Category (SDC) B through E

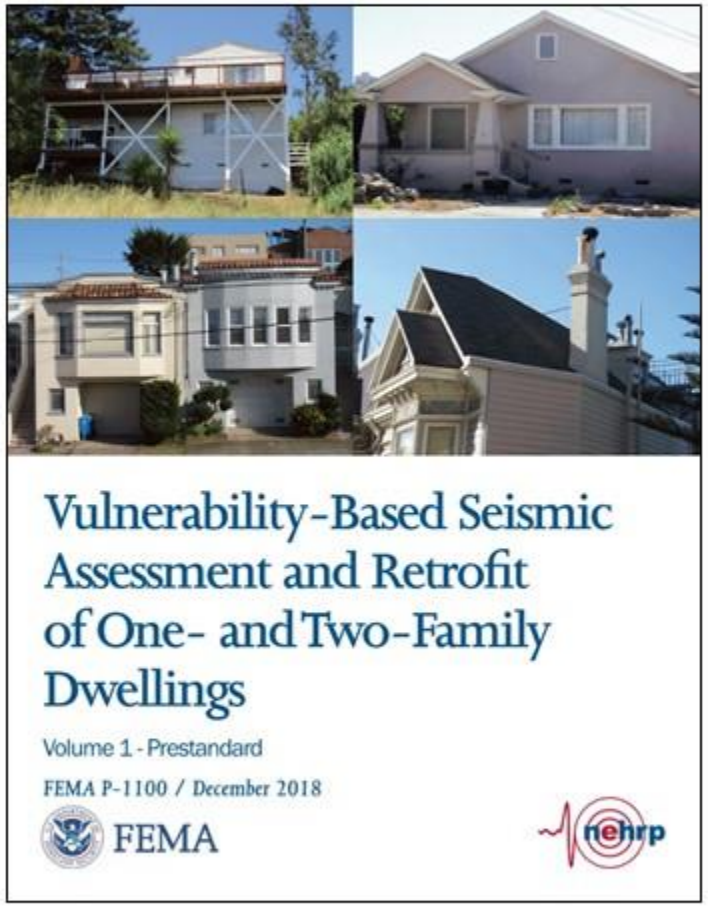
What is Vulnerability-Based?

- Focused on the critical risk
- Not intended to directly address other possible deficiencies

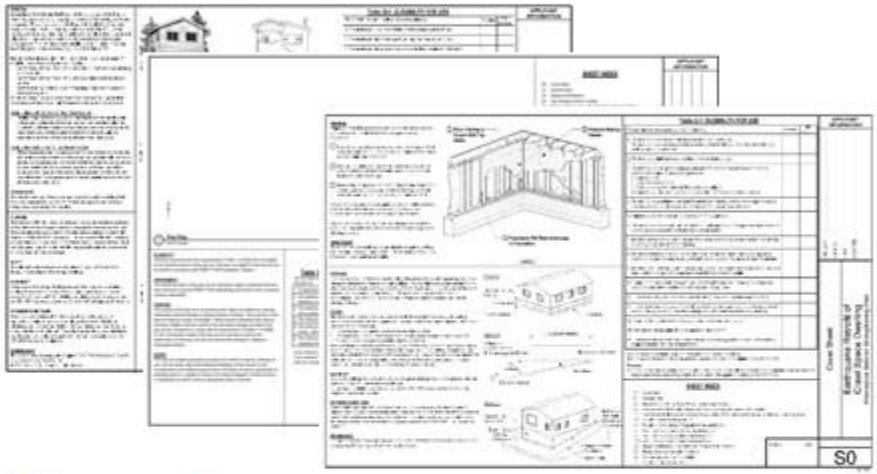
What's Included

- Crawlspace dwellings
- Living space over garage
- Hillside homes
- Chimneys and masonry surrounds
- Combinations!

Available Documents



VOLUME 1 - Prestandard



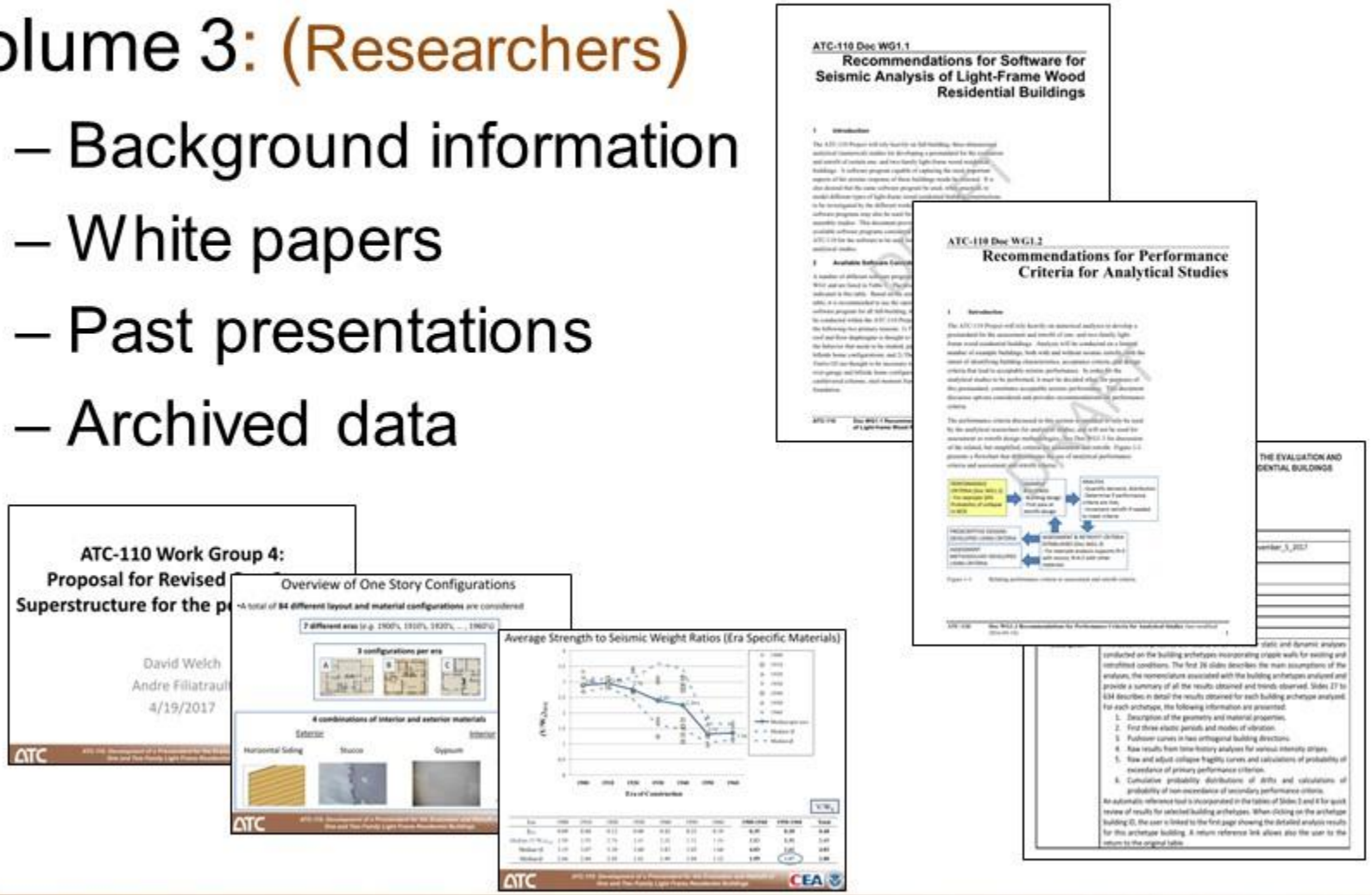
- Plan sets
- General Contractor training materials
- Engineering implementation tool.
- Design examples

VOLUME 2 – Implementation Material (Summer 2019)

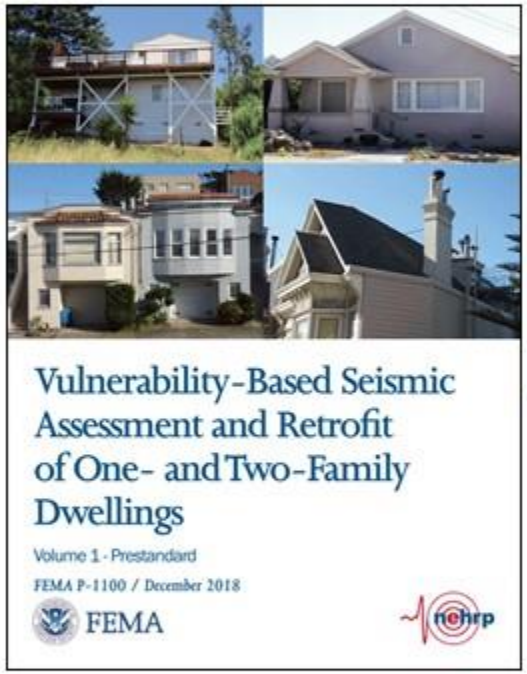
Under Development

Volume 3: (Researchers)

- Background information
- White papers
- Past presentations
- Archived data

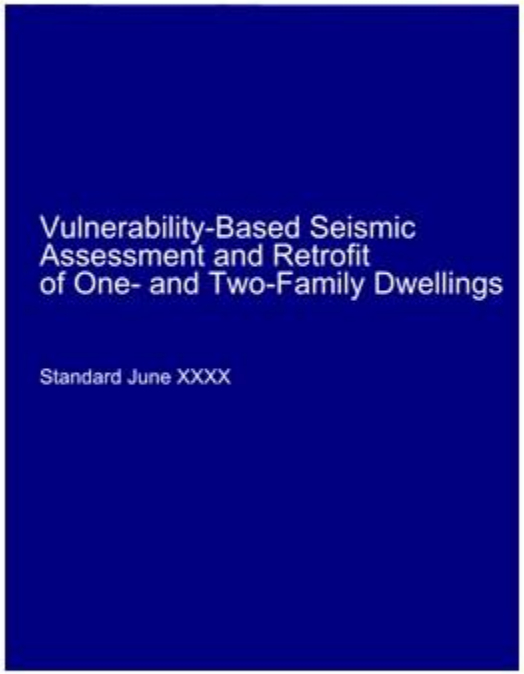


Looking Ahead



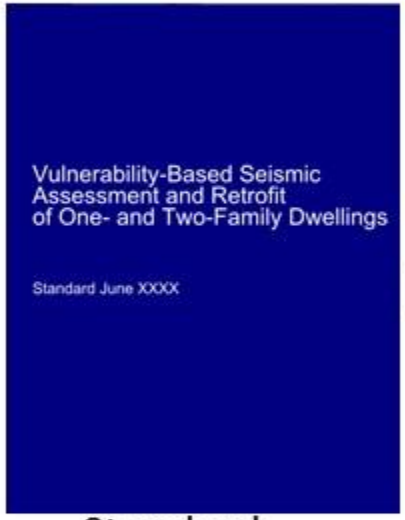
Prestandard

ANSI-Approved Consensus Standard's Process



Standard

Looking Ahead



Standard

Code

[BS] 301.1.4.2 Compliance with reduced International Building Code-level seismic forces. Where seismic evaluation and design is permitted to meet reduced *International Building Code* seismic force levels, the criteria used shall be in accordance with one of the following:

1. The *International Building Code* using 75 percent of the prescribed forces. Values of R, Ω_0 and C_d used for analysis shall be as specified in Section 301.1.4.1 of this code.
2. Structures or portions of structures that comply with the requirements of the applicable chapter in Appendix A as specified in Items 2.1 through 2.5 and subject to the limitations of the respective Appendix A chapters shall be deemed to comply with this section.

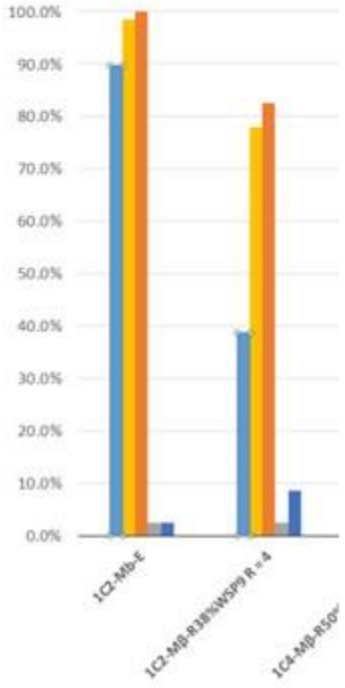
   2.1. The seismic evaluation and design of unreinforced masonry bearing wall buildings in Risk Category I or II are permitted

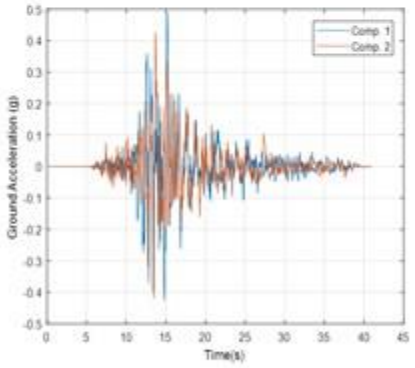
Ch.4: Crawlspace Dwellings
Ch.5: Living Space over Garage
Ch.6: Hillside Homes
Ch.7: Masonry Chimney….

~~Appendix A3~~
New Resource
New Resource
New Resource

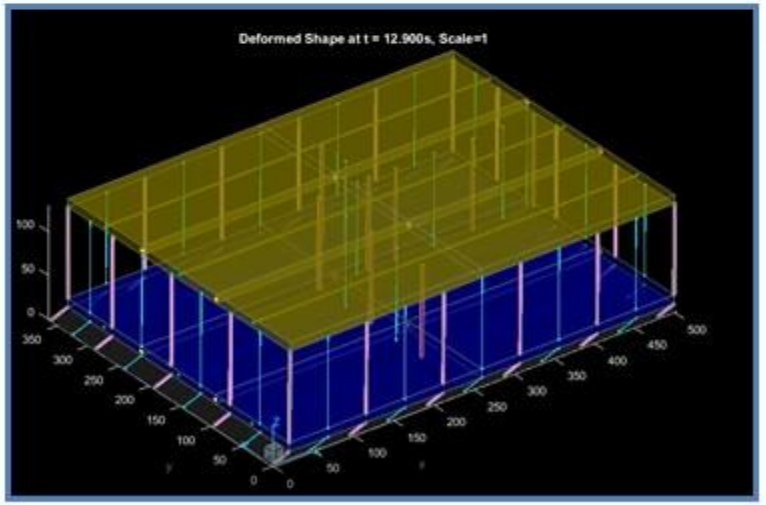
Performance Objective

- Probability of Collapse
  - Approximately 10%-20% under the Maximum Considered Earthquake



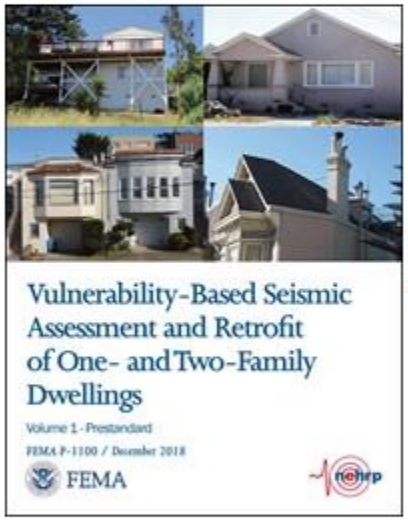


Kobe, Japan 1995 (Shin-Osaka station): MCE Level



1 Story ,2ft CW w/ Horizontal Siding- Existing

Prestandard- Big Picture



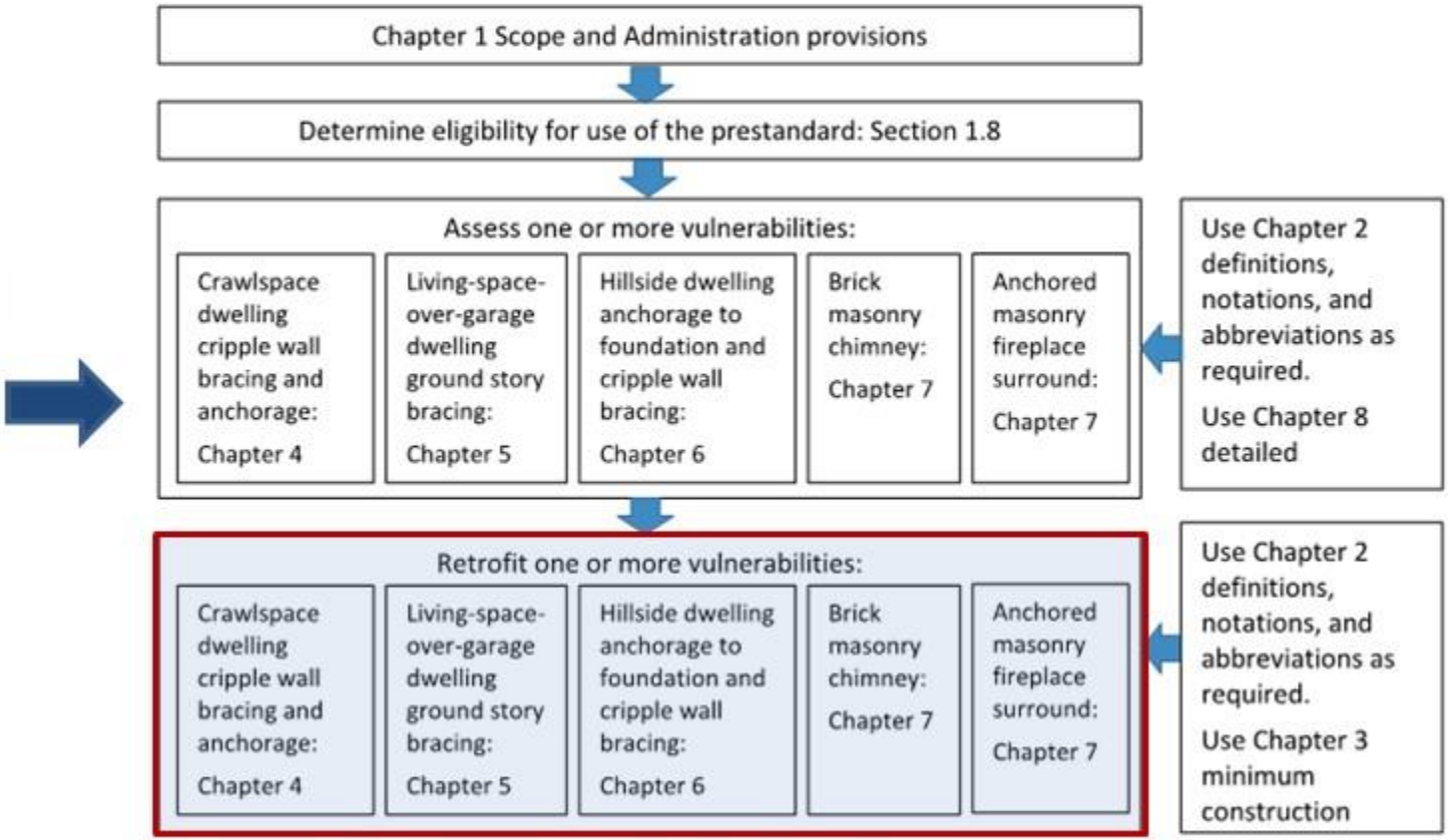


Figure C.1.4-1 Flowchart of intended use of prestandard provisions.

Assessment & Retrofit

Assessment Methods

- Simplified vulnerability-based assessment
- Detailed vulnerability-based assessment
- Engineered vulnerability-based assessment
- General engineered assessment

Retrofit Methods

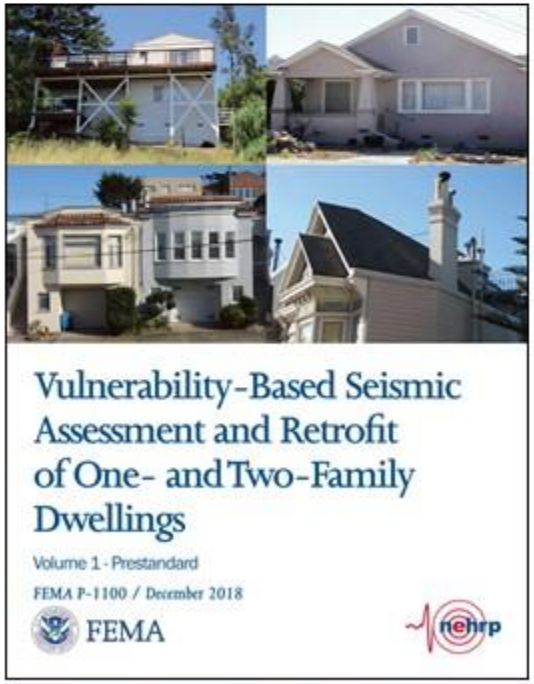
- Prescriptive vulnerability-based retrofit
- Simplified engineered vulnerability-based retrofit
- General engineered retrofit

FEMA P-1100 Prestandard

Chapter 1: Scope and Administration

Chapter 2: Definitions

Chapter 3: Minimum Construction Provisions



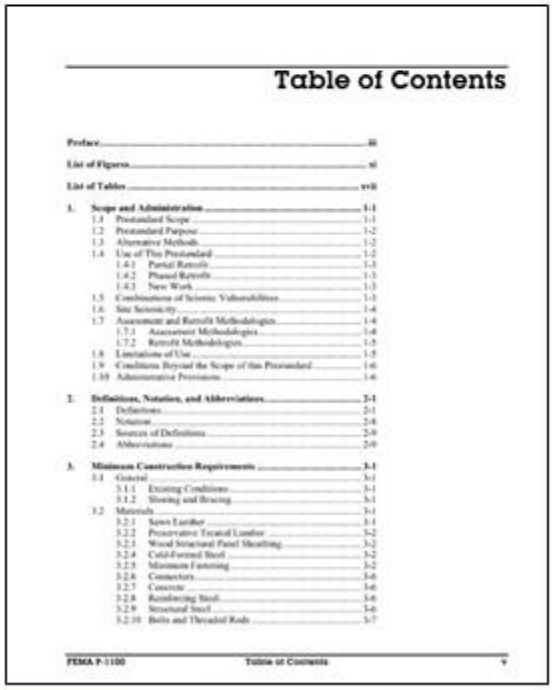


Table of Contents

FEMA P-1100 Prestandard

Chapter 4 thru 7: Assessment and Retrofit Provisions

- Crawlspace Dwellings
- Living-Space-Over-Garage Dwellings
- Hillside Dwellings
- Masonry Chimneys and Fireplace Surrounds

Chapter 8: Detailed Assessment Checklists

Commentary:

What is a Prescriptive Retrofit?

- Engineering is embedded
- Intended to apply to a wide range of dwelling but has limitations
- Prescriptive procedures include many assumptions which leads to some conservatism.

What Retrofits can be Done Prescriptively?

- Crawlspace Dwellings
- Living Space over Garage
- Chimneys
- **Plan Sets**
  - Implementation tool that includes instructions, commentary and other useful information
  - Deemed to comply with Prestandard

When is a Design Professional Needed?

- When actual conditions fall outside of prescriptive assumptions

Table C-1: ELIGIBILITY FOR USE

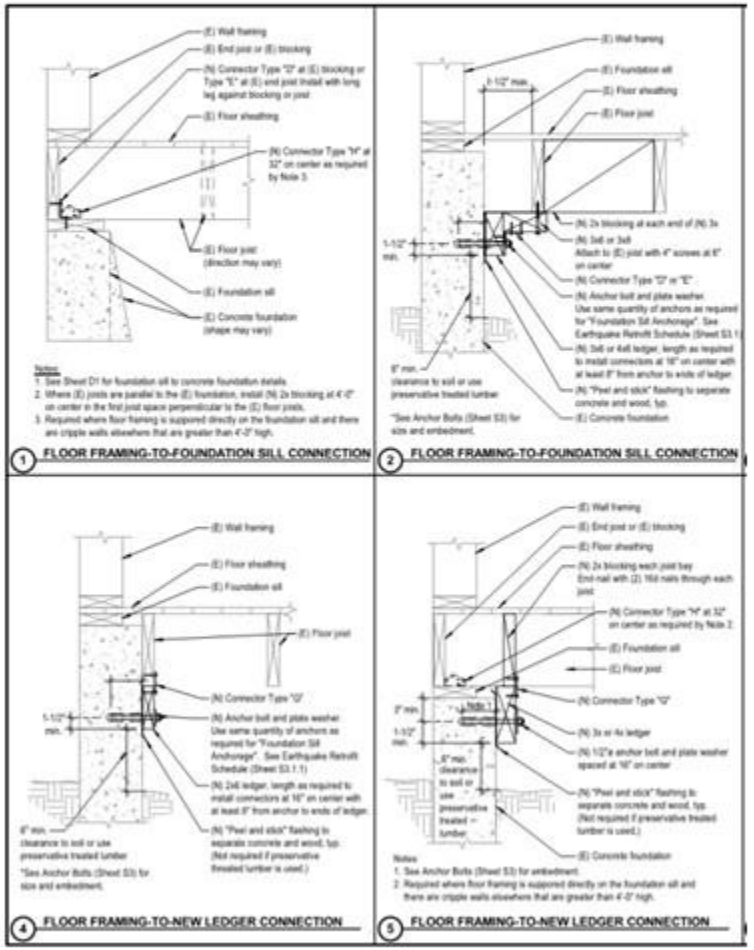
To determine if a home qualifies; answer the following:	Compliant	Non-compliant
1. The dwelling is a one-or two-family detached structure or townhouse. The dwelling unit is a townhouse and assessment and retrofit will occur for all attached townhouse dwelling units at the same time.	✓	
2. The dwelling is a wood light-frame dwelling that is two stories or less.	✓	
3. The dwelling is a crawlspace dwelling as defined in Chapter 2 of FEMA P-1100 Prestandard and the perimeter (not including porches or other appurtenances) is supported on: a. Cripple walls, or b. Foundation stem walls, or c. Post and pier systems to be retrofitted with cripple walls, or d. Cripple walls or foundation stem walls in combination with a slab on grade foundation.	✓	
4. The dwelling has a continuous perimeter foundation (not including porches or other appurtenances), concrete stem walls or will be retrofitted to have a continuous perimeter foundation.	✓	
5. Cripple walls, where they occur, do not exceed 7'-0" in clear height.	✓	
6. The maximum slope as measured from the top of foundations along one edge of the home to the other another does not exceed 5 to 1 (horizontal to vertical) or 20%.	✓	
7. Weight of roofing material shall not exceed 12 psf except for one-story crawlspace dwellings with clay tile roofing as described in footnote 1 below.	✓	
8. Weight of exterior wall finish shall not exceed 10 psf., except that masonry wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.	✓	
9. Weight of interior wall finish shall not exceed 8 psf, except that veneer fireplace surrounds of not more than 4" thick and of up to 100 square feet of vertical surface are permitted to exceed this weight.	✓	
10. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.	✓	
11. Floors in each story are at the same level and not split level, excluding slab on grade portions	✓	
12. The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3000 square feet for one story dwellings and 4,000 square feet for two-story dwellings.		✓
13. No part of the foundations is constructed of unreinforced masonry or stone.	✓	
14. Clear floor to ceiling heights at any occupied level does not 9'-0".		✓
15. There is no indication that an engineered seismic force-resisting system is present in the dwelling (engineered plans, visible tie-down brackets).	✓	

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Noncompliant" to any of these questions the home is not eligible to apply this plan set, unless a Registered Design Professional addresses the non-compliant issues in accordance with P-1100 FEMA Prestandard, Section 4.5, Differing Conditions.

Footnote:
1. One story crawl-space dwellings with clay tile that weigh up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy construction as noted in the applicable Earthquake Retrofit Tables.

When is a Design Professional Needed?

– When retrofit details provided <u>are not</u> compatible with actual construction.

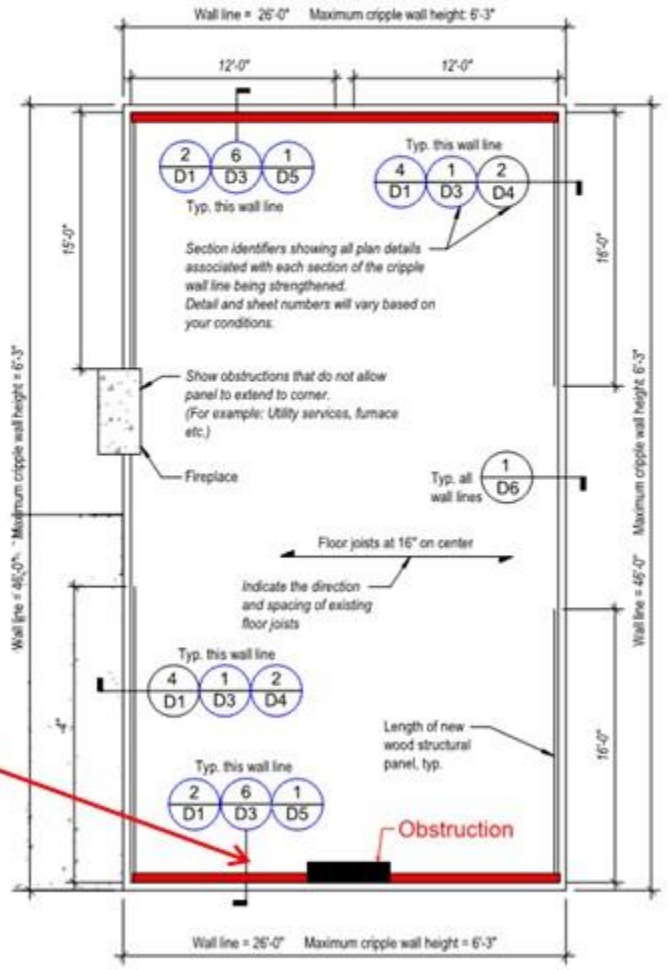


When is a Design Professional Needed?

– Where the prescriptive solutions do not fit

EARTHQUAKE RETROFIT SCHEDULE (S_{DS} = 1.5 Very High Seismic) TWO-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line								Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length							
			Wood Structural Panels								⑥ Foundation Sill Anchors					⑦ Floor to Cripple Wall or Floor to Foundation Sill		
			④ Cripple Wall Height															
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"									
			Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"	Type "E" or "F"	Type "G"
2-Story Light Construction	up to 1600		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	15	17	17	11	26	25	32
	1601 to 2000		13.3'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	4"	11	18	20	19	13	30	29	38
	2001 to 2400		14.7'	16.0'	17.3'	16.0'	21.3'	16.0'	22.7'	17.3'	4"	13	20	22	22	15	34	33	43
	2401 to 3000		18.7'	18.7'	20.0'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	41	39	51
	3001 to 4000		22.7'	22.7'	22.7'	22.7'	26.7'	24.0'	28.0'	24.0'	4"	19	30	33	33	22	50	48	64
2-Story Medium Construction	up to 1600		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	11	17	18	18	13	28	27	36
	1601 to 2000		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	20	22	22	15	33	32	42
	2001 to 2400		13.3'	14.7'	18.7'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	37	48
	2401 to 3000		16.0'	17.3'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	29	29	20	45	43	58
	3001 to 4000		20.0'	20.0'	22.7'	20.0'	26.7'	21.3'	28.0'	22.7'	3"	21	34	37	37	25	57	54	72
2-Story Heavy Construction	up to 1600		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45
	1601 to 2000		13.3'	14.7'	17.3'	14.7'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	19	42	40	53
	2001 to 2400		14.7'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	18.7'	2"	18	28	31	31	21	48	46	61
	2401 to 3000		16.0'	18.7'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72
	3001 to 4000		18.7'	21.3'	25.3'	20.0'	28.0'	24.0'	29.3'	25.3'	2"	27	42	46	46	31	71	68	90



Prescriptive assumptions are listed within the Prestandard commentary

Leveraging Prescriptive Solutions

4.4 Prescriptive Vulnerability-Based Retrofit

4.4.1 Scope

Where a dwelling's actual conditions require modification of the vulnerability-based prescriptive retrofit solutions identified within this section, additional or modified details may be generated by a registered design professional and used to supplement the prescriptive procedures of this section. These supplemental details shall be stamped and signed by a registered design professional and *approved* by the building official.

Permitting and Building Department Approval

- Compliance with the Prestandard requires approval by the Building Official.
- Building Official has discretion over similar conditions.
- Visual Inspections required for foundation anchor bolts, installation of blocking, plywood, metal hardware and any tie-downs

Permitting and Building Department Approval

- Self-certification required where tie-downs are required.
- Torque tests used as indicator of concrete quality and installation.

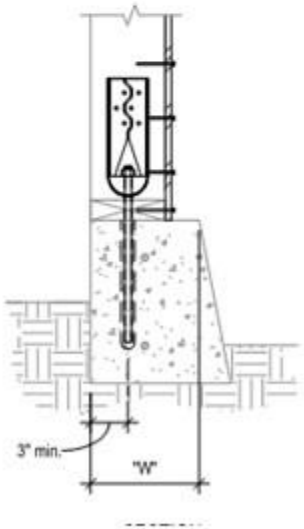
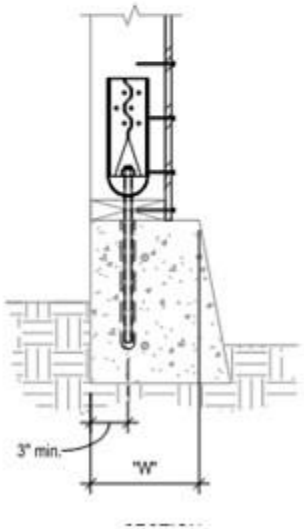


Table R-1: Verification of Existing Foundation System		
Requirement	**Yes or N/A**	**Signature of Owner or Contractor** (Owner performing work)
A.1 The size of the existing foundation is greater than or equal to that specified in Section R, Item 1.		Signature
B.1 The existing foundation has been verified to be in generally good condition at planned tie-down locations as specified in Section R, item 3.		Signature
C.1 The capacity of each new tie-down anchor has been verified by passing the torque tests specified in Table R2.		Signature
D.1 All adhesive anchors were installed per the manufacturer's instructions per the minimum steps as noted in Section T.		Signature

Table C-1 : FR-2ıdation Verification Requirements		
	Screw Anchor	**Adhesive Anchor**
Diameter ø	Torque (ft-lbs)	Torque (ft-lbs)
1/2"	35	15
5/8"	50	20

Permitting and Building Department Approval

– No testing of tie-downs for crawlspace dwellings



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Chapter 4
Crawlspace Dwellings

Chapter 4 Crawlspace Dwellings

Chapter 4

Vulnerability-Based Assessment and Retrofit of Crawlspace Dwellings

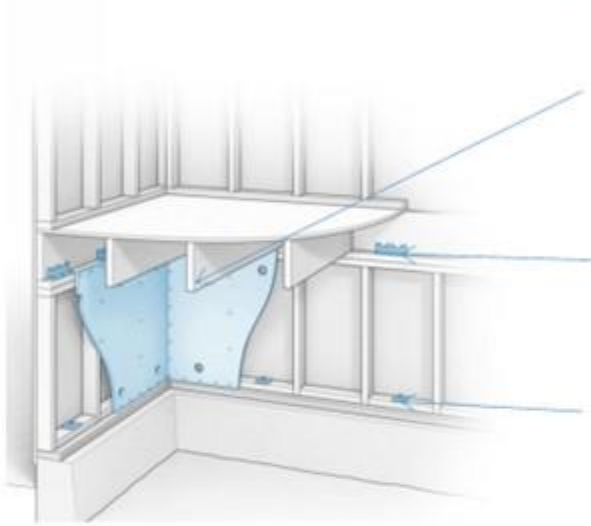
4.1 General

This chapter contains provisions for vulnerability-based assessment and retrofit of wood light-frame *crawlspace dwellings* supported on a raised *cripple wall* and foundation systems (Figure 4.1-1, Configuration A) or supported directly on a foundation system (Figure 4.1-2, Configuration B). Where both occur in a single dwelling, dwellings shall be assessed for both Configuration A and Configuration B. Vulnerabilities addressed by this chapter are:

- At cripple walls and foundation systems (Configuration A)
  - Connection to the framing above (A)
  - Cripple wall sheathing (B)
  - *Foundation sill plate* anchorage to the foundation (C)
- At foundation *stem walls* or foundations without cripple walls (Configuration B)
  - Connection to the dwelling above (A)
  - Foundation sill plate anchorage to foundation (B)

The primary purpose of this chapter is the reduction of earthquake-induced damage to wood light-frame crawlspace dwellings.

Crawlspace Dwellings
Major Components



Add new plywood or orientated strand board sheathing to the inside face of the existing cripple wall studs. The amount necessary will vary based upon an actual home's size and construction

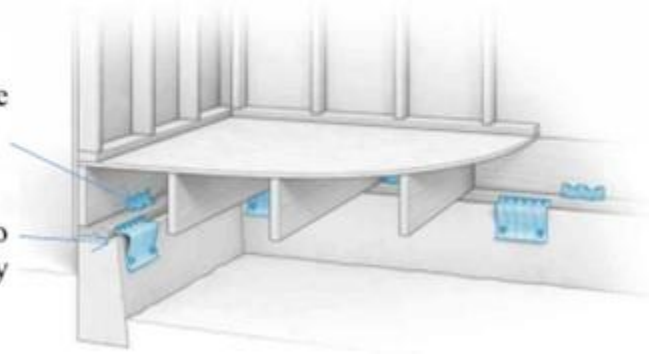
Add new framing anchors to connect the first level floor to the top of the cripple wall

Add new anchors bolts to connect the existing foundation sill to the existing foundation

Condition where cripple walls exist

Add new framing anchors to connect the first level floor to the top of the foundation sill

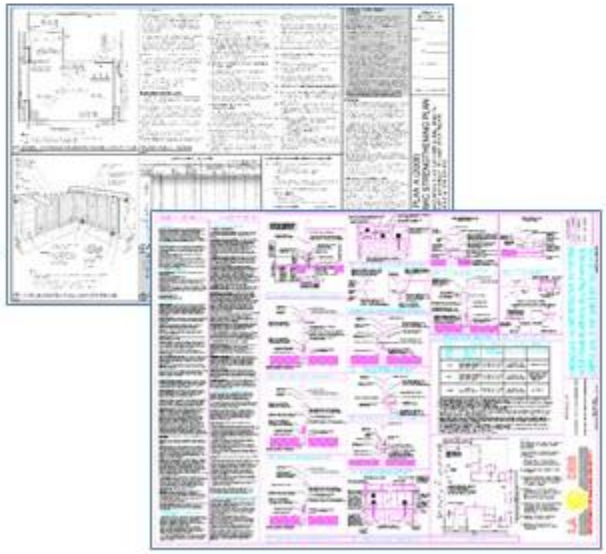
Proprietary anchors may be required where it is impractical to install new anchor bolts vertically

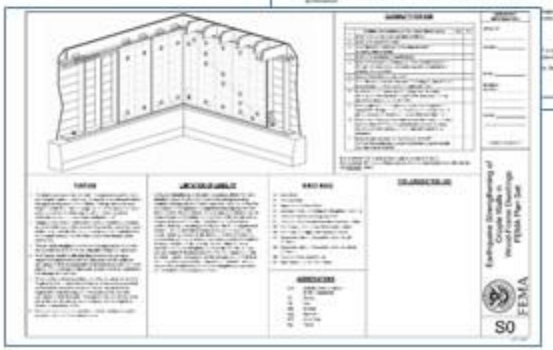


Condition where floor framing rest directly on the footing or stem wall

Crawlspace Dwellings
Previous Work

- IEBC A3
- Standard Plan A, LA plan set, FEMA Plan Set, Seattle Plan Set, others……





Crawlspace Dwelling Retrofitting Unanswered Questions

- What seismic retrofit criteria was needed to achieve performance goals?
- If we strengthen cripple wall, will damage propagate up? (zero sum game)

Overarching Retrofit Design Criteria

- Develop Prestandard using best available tools
- Simplified engineering approach
- Prescriptive retrofits derived from engineering criteria
- Cripple wall collapses do not pose a large LS risk

Overview of Plan Set- Eligibility

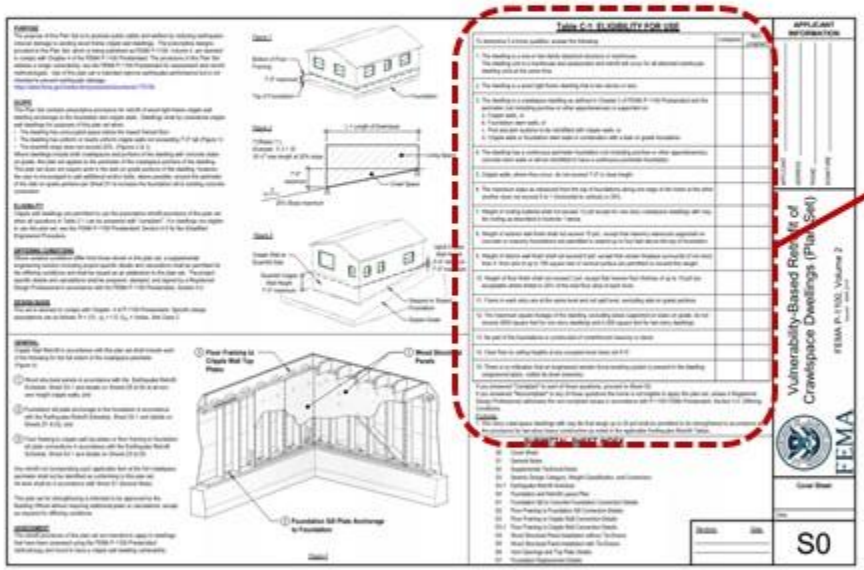


Table C-1: ELIGIBILITY FOR USE

To determine if a home qualifies; answer the following:	Compliant	Non-compliant
1. The dwelling is a one-or two-family detached structure or townhouse. The dwelling unit is a townhouse and assessment and retrofit will occur for all attached townhouse dwelling units at the same time.	✓	
2. The dwelling is a wood light-frame dwelling that is two stories or less.	✓	
3. The dwelling is … perimeter (not in… a. Cripple walls, b. Foundation s… c. Post and pier… d. Cripple walls	✓	
4. The dwelling has a continuous perimeter foundation (not including porches or other appurtenances), concrete stem walls or will be retrofitted to have a continuous perimeter foundation.	✓	
5. Cripple walls, where they occur, do not exceed 7'-0" in clear height.	✓	
6. The maximum slope as measured from the top of foundations along one edge of the home to the other another does not exceed 5 to 1 (horizontal to vertical) or 20%.	✓	
7. Weight of roofing material shall not exceed 12 psf except for one-story crawlspace dwellings with clay tile roofing as described in footnote 1 below.	✓	
8. Weight of exterior wall finish shall not exceed 10 psf., except that masonry wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.	✓	
9. Weight of interior wall finish shall not exceed 8 psf, except that veneer fireplace surrounds of not more than 4" thick and of up to 100 square feet of vertical surface are permitted to exceed this weight.	✓	
10. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limited to 25% of the total floor area of each level.	✓	
11. Floors in each story are at the same level and not split level, excluding slab on grade portions.	✓	
12. The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3000 square feet for one story dwellings and 4,000 square feet for two-story dwellings.	✓	
13. No part of the foundations is constructed of unreinforced masonry or stone.	✓	
14. Clear floor to ceiling heights at any occupied level does not 9'-0".	✓	
15. There is no indication that an engineered seismic force-resisting system is present in the dwelling (engineered plans, visible tie-down brackets).	✓	

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Noncompliant" to any of these questions the home is not eligible to apply this plan set, unless a Registered Design Professional addresses the non-compliant issues in accordance with P-1100 FEMA Prestandard, Section 4.5, Differing Conditions.

Footnote:
1. One story crawl-space dwellings with clay tile that weigh up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy construction as noted in the applicable Earthquake Retrofit Tables.

Do you belong in Ch.4 and Prestandard?

Prescriptive Versus Engineered Retrofit

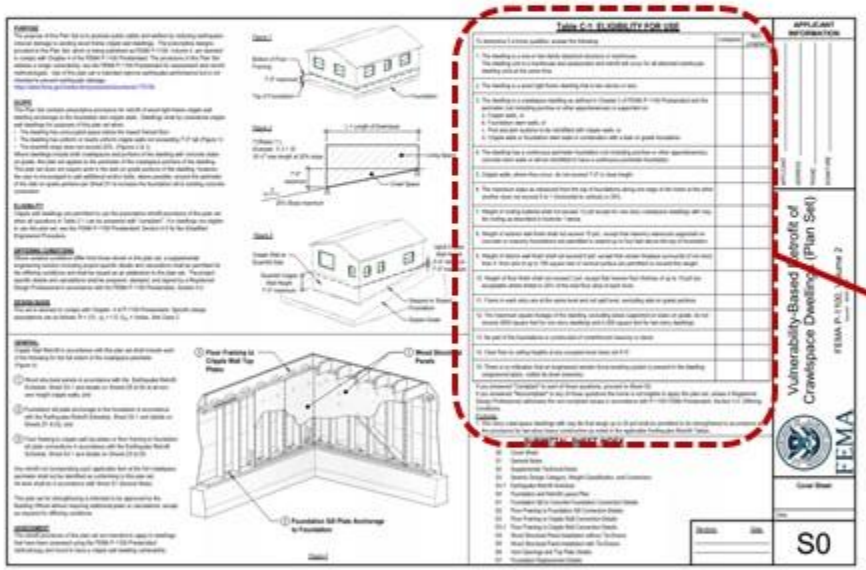


Table C-1: ELIGIBILITY FOR USE

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1. The dwelling is a one-or two-family detached structure or townhouse. The dwelling unit is a townhouse and assessment and retrofit will occur for all attached townhouse dwelling units at the same time.	✓	
2. The dwelling is a wood light-frame dwelling that is two stories or less.	✓	
3. The dwelling is a crawlspace dwelling as defined in Chapter 2 of FEMA P-1100 Prestandard and the perimeter (not including porches or other appurtenances) is supported on: a. Cripple walls, or b. Foundation stem walls, or c. Post and pier systems to be retrofitted with cripple walls, or d. Cripple walls or foundation stem walls in combination with a slab on grade foundation.	✓	
4. The dwelling has a continuous perimeter foundation (not including porches or other appurtenances), concrete stem walls or will be retrofitted to have a continuous perimeter foundation.	✓	
5. Cripple walls, where they occur, do not exceed 7'-0" in clear height.	✓	
6. The maximum slope as measured from the top of foundations along one edge of the home to the other another does not exceed 5 to 1 (horizontal to vertical) or 20%.	✓	
7. Weight of roofing material shall not exceed 12 psf except for one-story crawlspace dwellings with clay tile roofing as described in footnote 1 below.	✓	
8. Weight of exterior wall finish shall not exceed 10 psf., except that masonry wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.	✓	
9. Weight of interior wall finish shall not exceed 8 psf, except that veneer fireplace surrounds of not more than 4" thick and of up to 100 square feet of vertical surface are permitted to exceed this weight.	✓	
10. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable whe	✓	
11. Floors in each	✓	
12. The maximum exceed 3000 sq	✓	
13. No part of the foundations is constructed of unreinforced masonry or stone.	✓	
14. Clear floor to ceiling heights at any occupied level does not 9'-0".	✓	
15. There is no indication that an engineered seismic force-resisting system is present in the dwelling (engineered plans, visible tie-down brackets).	✓	

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Noncompliant" to any of these questions the home is not eligible to apply this plan set, unless a Registered Design Professional addresses the non-compliant issues in accordance with P-1100 FEMA Prestandard, Section 4.5, Differing Conditions.
Footnote:
1. One story crawl-space dwellings with clay tile that weigh up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy construction as noted in the applicable Earthquake Retrofit Tables.

Can you use a prescriptive approach?

Prescriptive Design- Plan Set

A. Before you begin:

1. This plan set is intended for use by a general contractor or homeowner without necessarily having to involve a Registered Design Professional.
2. Contact your local Building Official, often known as the Building Department, to understand the building permit application process. Inquire about:
   a. fees,
   b. how many copies of the plans must be submitted, and
   c. which City inspections are required, see F.3 below.
3. The Building Official may also be able to assist with assessing the applicability of this plan set to a home. See Eligibility For Use, Sheet S0.
4. Complete the Eligibility For Use questionnaire on Sheet S0, to determine if this plan set is applicable. A "no" answer to any question disqualifies the home from using this plan set, unless a Registered Design Professional is involved.

B. Determine your Seismic Design Category (SDC) and Weight Classification:

1. See Sheet S3 and determine the Seismic Design Category (SDC) and Weight Classification for the dwelling. This information will be used to determine which S3.1 sheet is applicable. Note that there are three unique S3.1 sheets for one-story dwellings with differing S_{DS} values and three similar sheets for two-story dwellings. Only one Sheet S3.1 will be applicable to any given dwelling and included within the set of drawings used for submission to the Building Official.

C. Prepare your plans:

1. Draw a scaled plan of the perimeter of the home in the graph layout area provided on Sheet S4, Foundation and Strengthening Layout Plan. Your plan should include the following:
   a. The location of any obstructions along the perimeter of the foundation that make the strengthening work difficult or impossible such as fireplaces, water heaters, utilities, etc. These areas should be avoided when laying out the required strengthening work.
   b. An arrow to indicate the direction of the span of your floor joists plus the spacing such as "floor joists at 16" on center." This will be helpful when selecting the appropriate details shown on Sheets D1 - D6.
   c. Indicate the height of the tallest cripple wall for each wall line. The minimum required length of strengthening along each wall line will be based, among other variables, on this height. See the sections in Details 1 and 2 on Sheet D4 for measurement of "cripple wall height."
   d. Dimensions for each length of perimeter wall segment and overall dimensions of wall lines.
   e. An arrow pointing to North.
   f. Label the street side (front) of the home.
   g. See Sheet S4-ex for an example of a plan sheet submittal and Sheets X1 and X2 for additional examples and instructions of how certain items, such as length of bracing at building offsets are calculated.

D. Gather information to complete the plans:

1. Review General Notes on Sheets S1 and S2 for guidance on materials and installation for the required work.
2. Review the Detail Sheets included in this plan set (Sheets D1-D7). Locate the details that most substantially match a home's framing conditions. Not all details or sheets will apply. As a minimum, you should have one detail each for:
   a. The foundation sill to concrete foundation connection (Sheet D1); and
   b. The floor framing to foundation sill connection (Sheet D2); or
   c. Floor framing to cripple wall connection (Sheet D3 and/or Sheet D3.1).
3. Differences in existing conditions from those illustrated on the details that result in changes to these drawings will need to be reviewed by a Registered Design Professional. See "Purpose" on Sheet S0 for additional information.
4. Once you have chosen the correct (applicable) S3.1 sheet, follow the instructions provided to determine the amount and type of earthquake retrofitting required along each perimeter wall line. Once Steps 1 through 7 are completed, document the results within the Retrofit Table as explained in Step 8.
5. Refer to Supplemental Technical Notes on Sheet S2 where tie-downs are required.

E. Complete your plans:

1. Using the information from the Earthquake Retrofit Schedule on Sheet S3.1, add the following to complete your Foundation and Strengthening Layout Plan on Sheet S4:
   a. Indicate and dimension the total length of braced wall sections required at each wall line.
   b. Identify the details used for the connections as noted in D.2 above. Indicate the connection type and the minimum number of connectors for each wall line. Conform to Sections L and M of Sheet S1.
   c. Identify the details used for the wood structural panel. (Sheets D4 or D5).
   d. If tie-downs are used, identify the details used. (Sheet D5).
   e. Identify the detail used for the top plate splice. (Sheet D6).
   f. Identify the details used for notching and/or cutouts. (Sheet D6.)

F. Submit your plans:

1. Submit a permit application and the required number of completed plan sets (Sheets S0 through D7) to the Building Official for review. Photographs of the foundation sill, cripple wall, and floor framing conditions may assist the review process.
2. Before starting work, the permit holder may be required to schedule a preconstruction inspection with the Building Official to verify that field conditions are consistent with the information provided on the approved plan.
3. Inspection(s) by the Building Official may be required for:
   a. Foundation Anchor bolts / Anchor Plate installation,
   b. Blocking installation,
   c. Wood structural panel on cripple wall, sheathing and nailing,
   d. Metal hardware "connectors" installation,
   e. Tie-downs, and
   f. Final inspection.

FEMA Package Sheet List

01*	Instructions for Use
S0	Cover Sheet
S1	General Notes
S2	Supplemental Technical Notes
S3	Seismic Design Category, Weight Classification, and Connectors
S3.1**	Earthquake Retrofit Schedule - Sds 1.0, One-Story
S3.1**	Earthquake Retrofit Schedule - Sds 1.2, One-Story
S3.1**	Earthquake Retrofit Schedule - Sds 1.5, One-Story
S3.1**	Earthquake Retrofit Schedule - Sds 1.0, Two-Story
S3.1**	Earthquake Retrofit Schedule - Sds 1.2, Two-Story
S3.1**	Earthquake Retrofit Schedule - Sds 1.5, Two-Story
S4	Foundation and Retrofit Layout Plan
S4-ex*	Example of Foundation and Strengthening Layout Plan
D1	Foundation Sill to Concrete Foundation Connection Details
D2	Floor Framing to Foundation Sill Connection Details
D3	Floor Framing to Cripple Wall Connection Details
D3.1	Floor Framing to Cripple Wall Connection Details
D4	Wood Structural Panel Installation without Tie-Downs
D5	Wood Structural Panel Installation with Tie-Downs
D6	Vent Openings and Top Plate Details
D7	Foundation Replacement Details
X1*	Example - Foundation Plan (Dwelling without tie-downs)
X2*	Example - Foundation Plan (Dwelling with tie-downs)
X3*	Example - Cripple Wall Strengthening
X4*	Example - Strengthening - No Cripple Wall

* - Sheet for reference only. Do not submit to the Building Official.
** - Only one "S3.1" sheet will be submitted to Building Official.

This sheet is for instruction and reference only.

Do not submit to the Building Official.

Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2

Revised MAR 2019

FEMA

Instructions for Use

01

Prescriptive Design- Plan Set

PURPOSE
The purpose of this Plan Set is to promote public safety and welfare by reducing earthquake-induced damage to existing wood-frame cripple wall dwellings. The prescriptive designs provided in this Plan Set, which is being published as FEMA P-1100, Volume II, are deemed to comply with Chapter 4 of the FEMA P-1100 Prestandard. The provisions of this Plan Set address a single vulnerability; see the FEMA P-1100 Prestandard for assessment and retrofit methodologies. Use of this plan set is intended improve earthquake performance but is not intended to prevent earthquake damage.
https://www.fema.gov/media-library/assets/documents/175158

SCOPE
This Plan Set contains prescriptive provisions for retrofit of wood light-frame cripple wall dwelling anchorage to the foundation and cripple walls. Dwellings shall be considered cripple wall dwellings for purposes of this plan set when:
- The dwelling has unoccupied space below the lowest framed floor.
- The dwelling has uniform or nearly uniform cripple walls not exceeding 7'-0" tall (*Figure 1*).
- The downhill slope does not exceed 20%. (*Figures 2 & 3*).

Where dwellings include both crawlspaces and portions of the dwelling with concrete slabs-on-grade, this plan set applies to the perimeter of the crawlspace portions of the dwelling. This plan set does not require work in the slab-on-grade portions of the dwelling. However, the user is encouraged to add additional anchor bolts, where possible, around the perimeter of the slab-on-grade portions per Sheet D1 to increase the foundation sill to existing concrete connection.

ELIGIBILITY
Cripple wall dwellings are permitted to use the prescriptive retrofit provisions of this plan set when all questions in Table C-1 can be answered with "compliant". For dwellings not eligible to use this plan set, see the FEMA P-1100 Prestandard, Section 4.5 for the Simplified Engineered Procedure.

DIFFERING CONDITIONS
Where isolated conditions differ from those shown in this plan set, a supplemental engineering solution including project-specific details and calculations shall be permitted for the differing conditions and shall be issued as an addendum to this plan set. The project specific details and calculations shall be prepared, stamped, and signed by a Registered Design Professional in accordance with the FEMA P-1100 Prestandard, Section 4.5.

DESIGN BASIS
This set is deemed to comply with Chapter 4 of P-1100 Prestandard. Specific design assumptions are as follows: R = 3.0; Ω_0 = 1.5; S_{DS} = Varies, Site Class C

Figure 1

Figure 2

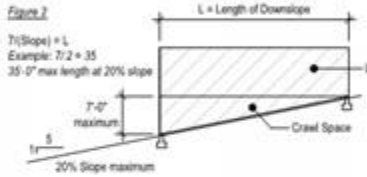
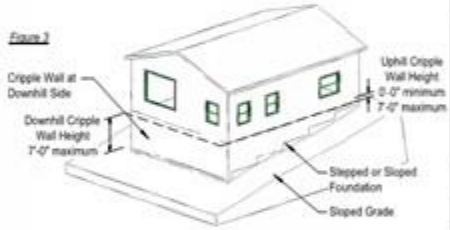


Figure 3



GENERAL
Cripple Wall Retrofit in accordance with this plan set shall include each of the following for the full extent of the crawlspace perimeter (*Figure 4*):

(1) Wood structural panels in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D5 & D4 at all non-zero height cripple walls, and

(2) Foundation sill plate anchorage to the foundation in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D1 & D2, and

(3) Floor framing to cripple wall top plates or floor framing to foundation sill plate connections in accordance with the Earthquake Retrofit Schedule, Sheet S3.1 and details on Sheets D3 & D5.

Any retrofit not incorporating each applicable item at the full crawlspace perimeter shall not be identified as conforming to this plan set.
All work shall be in accordance with Sheet S1 General Notes.

This plan set for strengthening is intended to be approved by the Building Official without requiring additional plans or calculations, except as required for differing conditions.

ASSESSMENT
The retrofit provisions of this plan set are intended to apply to dwellings that have been assessed using the FEMA P-1100 Prestandard methodology and found to have a cripple wall dwelling vulnerability.

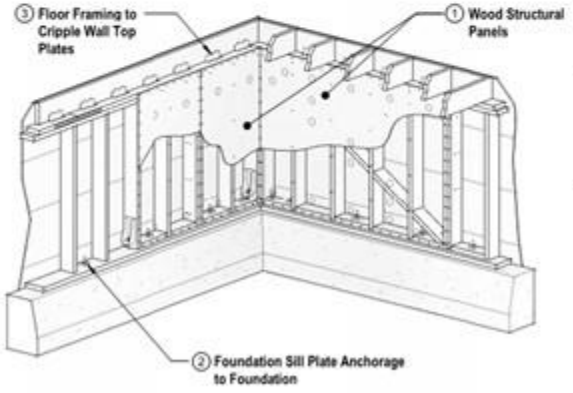


Figure 4

Table C-1: ELIGIBILITY FOR USE

To determine if a home qualifies, answer the following:	Compliant	Non-compliant
1. The dwelling is a one-or two-family detached structure or townhouse. The dwelling unit is a townhouse and assessment and retrofit will occur for all attached townhouse dwelling units at the same time.		
2. The dwelling is a wood light-frame dwelling that is two stories or less.		
3. The dwelling is a crawlspace dwelling as defined in Chapter 2 of FEMA P-1100 Prestandard and the perimeter (not including porches or other appurtenances) is supported on: a. Cripple walls, or b. Foundation stem walls, or c. Post and pier systems to be retrofitted with cripple walls, or d. Cripple walls or foundation stem walls in combination with a slab on grade foundation.		
4. The dwelling has a continuous perimeter foundation (not including porches or other appurtenances), concrete stem walls or will be retrofitted to have a continuous perimeter foundation.		
5. Cripple walls, where they occur, do not exceed 7'-0" in clear height.		
6. The maximum slope as measured from the top of foundations along one edge of the home to the other another does not exceed 5 to 1 (horizontal to vertical) or 20%.		
7. Weight of roofing material shall not exceed 12 psf except for one-story crawlspace dwellings with clay tile roofing as described in footnote 1 below.		
8. Weight of exterior wall finish shall not exceed 10 psf., except that masonry wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.		
9. Weight of interior wall finish shall not exceed 8 psf, except that veneer fireplace surrounds of not more than 4" thick and of up to 100 square feet of vertical surface are permitted to exceed this weight.		
10. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limted to 25% of the total floor area of each level.		
11. Floors in each story are at the same level and not split level, excluding slab on grade portions		
12. The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3000 square feet for one story dwellings and 4,000 square feet for two-story dwellings.		
13. No part of the foundations is constructed of unreinforced masonry or stone.		
14. Clear floor to ceiling heights at any occupied level does not 9'-0".		
15. There is no indication that an engineered seismic force-resisting system is present in the dwelling (engineered plans, visible tie-down brackets).		

If you answered "Compliant" to each of these questions, proceed to Sheet S3.
If you answered "Noncompliant" to any of these questions the home is not eligible to apply this plan set, unless a Registered Design Professional addresses the non-compliant issues in accordance with P-1100 FEMA Prestandard, Section 4.5, Differing Conditions.

Footnote:
1. One story crawl-space dwellings with clay tile that weigh up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy construction as noted in the applicable Earthquake Retrofit Tables.

SUBMITTAL SHEET INDEX

Revision: Date:

APPLICANT INFORMATION
APPLICANT:
ADDRESS:
PHONE:
SIGNATURE:

Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2
Second Edition | MAR 2019

FEMA

Cover Sheet

Date:

S0

Prescriptive Design- Plan Set

A. CODE

1. All work not otherwise specified shall conform to the locally adopted version of the building code or residential code. Contractor shall comply with all locally adopted building codes and ordinances.

B. GENERAL

1. The contractor is responsible for maintaining a safe job site and complying with relevant state and/or federal OSHA standards. Contractor is responsible for the means and methods for accomplishing the work shown in this plan set, including any shoring and bracing of existing construction as required to safely install new work. Exercise caution working around existing utilities, locate underground utilities before excavating, and arrange for temporary disconnection of utilities if necessary.
2. All existing under floor ventilation and access shall be maintained.

C. EXISTING CONDITIONS

1. Contractor shall confirm that existing conditions match plans and details prior to start of work.
2. Contractor shall verify that existing concrete, anchor bolts, wood framing, and other materials that will become part of the work or to which retrofit construction is attached is in reasonably sound condition and free of defects that would substantially reduce the capacity of the material. Where possible, damaged or deteriorated elements shall be repaired in place or supplemented with new elements. Otherwise damaged or deteriorated members shall be replaced. Repair or replacement shall be in accordance with the adopted building or residential code.
3. The Owner or Contractor shall verify that the existing concrete within all areas to receive new anchor bolts are in reasonably good condition. Examples of poor concrete quality would include excessive spalling, large rock pockets, cracks extending completely through the footing greater than 1/4" wide (not closer than 6'-0" on center on average), or low strength concrete cement or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local areas of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors shall be torque tested in accordance with Table C-1.

Table C-1 : Foundation Verification Requirements

	Screw Anchor	Adhesive Anchor
Diameter ø	Torque (ft-lbs)	Torque (ft-lbs)
1/2"	35	15
5/8"	50	20

D. NOTCHING, BORING AND CUTTING

1. Do not cut, bore or notch structural members except as shown in these drawings or as specifically permitted by the building inspector. Exception: Notching and boring of framing shall be permitted as per Chapter 6 of the International Residential Code (IRC)
2. When drilling in concrete, do not drill through existing reinforcing steel. If reinforcing steel is hit during drilling, move a minimum of one inch and drill relocated hole. Fill original hole with non-shrink grout.

E. CONCRETE

1. Concrete shall have a strength of not less than 3000 psi at 28 days (design based on 2500 psi). Concrete mixed on site shall be mixed and placed in accordance with the manufacturer's instructions using potable water.

F. REINFORCING STEEL (REBAR)

1. Reinforcing steel shall confirm to ASTM A615- Grade 40 or 60, ASTM A706, or ASTM A996 Type R.
2. Reinforcing steel bend radii and other rebar detailing shall be in accordance with Concrete Reinforcing Steel Institute.
3. Minimum concrete cover over reinforcing steel.
   a. Concrete cast against and permanently exposed to soil: 3 inches
   b. Formed concrete exposed to weather: 2 inches
   c. Concrete not exposed to weather or in contact with soil: 1-1/2 inch
   d. Reinforcing steel lap splice lengths:

	No. 4	No. 5
• Horizontal bars with more than 12 inches concrete below:	32 inches	42 inches
• Other bars:	24 inches	32 inches

G. STRUCTURAL STEEL

1. Structural steel W-sections, plate, bar and miscellaneous steel shall be ASTM A36, A992 or A572. Welding shall comply with AWS D1.1 requirements using prequalified welding procedures. All welding shall be conducted by welders certified for the materials and welding procedures used.
2. Bolts shall conform to ASTM A-307. Threaded rods shall conform to ASTM A-36.

H. FASTENERS

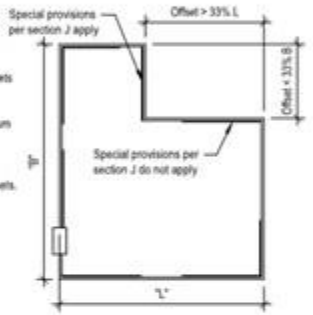
1. General
   a. All bolts, nails, and other fasteners in contact with preservative-treated wood or exposed to weather shall be hot-dip galvanized or stainless steel.
2. Nails
   a. Unless otherwise noted, all nails specified are to be common nails.
   b. Special care is required when installing nails in existing framing. Where required to avoid splitting of framing, predrill to 75% of nail shank diameter.
   c. Fasteners for wood structural panel sheathing shall be full length 6d common nails (0.131" x 2.1/2"). Drive sheathing nail head flush with face of sheathing.
   d. Do not overdrive, countersink, or otherwise damage the outermost ply when installing nails. A nail is over-driven when it breaks the surface ply. Where nails are overdriven to the point that the veneer is fractured, add one new nail for every (2) overdriven nails. Space new nails between existing.
3. Anchor Bolts
   a. Predrill bolt holes to not more than 1/16th inch larger than bolt or anchor bolt to be placed.
   b. At locations of braced wall sections, provide new anchor bolts between 8 and 12 inches from each end of each section of foundation sill plate, and at an on-center spacing as required by the Earthquake Retrofit Schedule. Existing anchor bolts shall not be used to meet this requirement.
   c. Provide steel plate washers 0.229 x 3 x 3 inch minimum at all anchor bolts. Centerline of washer should be 1-1/2" to 2" from face of sheathing.
   d. Anchor bolts shall be a maximum spacing of 64" on center for one-story dwellings and 48" on center for two-story dwellings along the entire portion of all exterior walls.
   e. For braced wall sections without tie-downs, provide two of the required anchor bolts within 8" of each end and one additional anchor bolt at each end as noted on Sheet D4.
   f. For braced wall sections with tie-downs, provide one additional anchor bolt within 8" minimum and 12" maximum at each end as noted on Sheet D5.

I. WOOD STRUCTURAL PANEL SHEATHING

1. Wood structural panels shall be all veneer, conforming to US voluntary Product Standard PS-1, Exposure I or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
2. Oriented Strand Board (OSB) shall conform to US Voluntary Product Standard PS 2 with an exposure rating of Exposure 1 or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
3. Provide 1/8-inch minimum gap at all sheathing panel ends and edges.
4. Maintain a minimum edge distance of 3/8" from center of nail to edges of sheathing, studs, or top and sill plates. See Sheet D4 for double stud at sheathing panel joints.
5. Braced wall sections closest to the ends of wall lines shall be located as near to the ends as practicable. Braced wall sections may be located away from the ends of a wall line when existing obstructions or limited clearance necessitate such relocations.
6. Braced wall sections along the length of a wall line should be nearly equal in length and should be nearly equal in spacing where possible. Using increments of existing stud spacing is expected.
7. The length of each braced wall section shall not be less than 48 inches. The length of braced wall sections without tie-downs should be equal to or exceed twice the height of the cripple wall. Exceptions are permitted when obstructions do not allow braced wall sections of the required length.

J. ADDITIONAL REQUIREMENTS FOR NON-RECTANGULAR DWELLINGS WITH "T OR "L" PLAN CONFIGURATIONS

1. Plan configurations other than rectangular such as "T" or "L" shapes that have offsets in the exterior wall lines, within the crawl space plan area, greater than 33% of the largest plan dimension shall meet the following requirements in that direction:
   a. Foundation sill to foundation connections along offset walls shall have a maximum spacing of 32" on center.
   b. Floor joist to foundation sill and floor joist framing to the top of cripple wall connections along offset walls shall have a maximum spacing of 16" on center.
   c. Cripple walls, where they occur, shall be sheathed with new wood structural panels. The sheathing shall have a minimum length of 90% of the offset wall length.



K. FRAMING

1. Framing shall be Douglas Fir-Larch, or an approved species having a greater or equal specific gravity.
2. Framing in contact with foundations or exposed to weather shall be preservative treated in accordance with AWPA U1 (Commodity Specification A, Use Category 4B). Field treat all cuts, bores and notches per AWPA M-4.

L. CONNECTOR DEVICES

1. Connectors shall be pre-engineered pre-manufactured devices, approved by the building official and installed in accordance with the manufacturer's instructions.
2. Connectors protected from weather shall be provided with a minimum of G90 zinc coating in accordance with ASTM A653. Connectors exposed to weather or in contact with preservative treated wood shall be provided with a minimum hot-dip galvanized coating or G185 coating in accordance with ASTM A653, and fasteners conforming to ASTM A153.
3. Connector devices shall be of the type and size specified in these drawings.
4. Connectors required by the Earthquake Retrofit Schedule shall be installed equall along the length of each wall line or within the length of the braced wall panel(s).
5. Connector spacing may not be less than 8" on center.
6. Where the minimum number of connectors cannot be achieved within the length of the wood structural panel bracing, anchors or connectors may be placed outside of, but as close as possible to, the area with wood structural panels.
7. Increase nail or screw length 1/2-inch minimum when installing connectors over wood structural panels.

M. ADHESIVE ANCHORS

1. Post-installed anchors shall be installed in accordance with the manufacturer's installation instructions.
2. Adhesive anchors shall be Simpson Strong-Tie SET-XP, HILTI RE 500 SD, CIA GEL 7000C, or approved equivalent.
3. Concrete screws shall be Simpson Strong-Tie Titen HD, KC Metals Kwik-HUS-EZ, or Powers Fasteners Wedge-Bolt, or approved equivalent.

N. PERMITS

1. All work required by this plan set shall be permitted through the building department.

O. INSPECTIONS

1. Contractor shall coordinate with the building inspector to ensure that work is accessible for building department inspections, and shall correct noncompliant work as identified by the inspector.

P. SPECIAL INSPECTIONS

1. Special inspection by a third party inspector is not required for the following:
   a. Concrete or reinforcing steel for foundations. Design is based on an ultimate concrete strength of 2500 psi or less.
   b. Installation of cast-in-place or post-installed anchor bolts.
   c. Installation of adhesive anchors for tie-down devices, provided that each anchor is torque-tested in accordance with Table R-2, Sheet S2.
   d. Nailing of wood structural panel shear walls, provided a building department inspection is performed.

APPLICANT: _____

PROPERTY ADDRESS: _____

Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2

Issued: MAR 2019

FEMA

General Notes

Date:

S1

Prescriptive Design- Plan Set

Seismic Design Category (SDC)

1. The first factor taken into consideration when determining the appropriate amount of earthquake strengthening is the anticipated level of seismic shaking or S_{DS} value with is directly related to the Seismic Design Category (SDC).

2. To find the appropriate SDS value, which is either 1.0, 1.2, or 1.5, you must first determine your Seismic Design Category (SDC) by clicking the link below.

   a. In your internet browser go to http://www.atcouncil.org/fema-p-1100
   b. Click on one of the five (5) geographic areas listed to find your location on the appropriate map.
   c. Locate your SDC (SDC A-SDC E) by the color contour shown on the map which corresponds to the % g values shown.
   d. For SDC A-D_1, use S_{DS} = 1.0.
   e. For SDC D_2, use S_{DS} = 1.2 unless the site class can be determined as A, B, or D, in which case use S_{DS} = 1.0.
   f. For SDC E, use S_{DS} = 1.5

   Note: where your location is on, or close to, the border of two SDC's, it is prudent to choose the higher value.

3. Make a note of the appropriate S_{DS} value. It will be used together with the number of stories the dwelling has to determine the appropriate Earthquake Retrofit Schedule (Sheet S3.1) to use in preparing and submitting the plans.

4. You will only use one of the following six Earthquake Retrofit Schedule Sheets. Do not submit the unused S3.1 sheets to the Building Official.

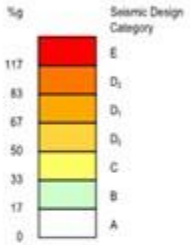
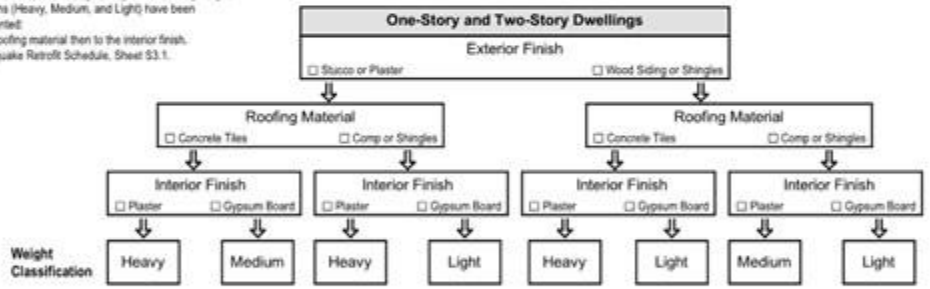


Figure 1. SDC versus %g

Weight Classification

The next factor used to establish the appropriate amount of earthquake strengthening is the dwelling weight. For the purposed of this plan set, three weight classifications (Heavy, Medium, and Light) have been established as described below. Using the flowchart presented:
1. Start with the exterior finish and move progressively to roofing material then to the interior finish.
2. Note the weight classification result for use in the Earthquake Retrofit Schedule, Sheet S3.1.

Specific notes for exterior, interior and roof coverings:
1. The "wood siding or shingles" exterior finish category also includes finishes of similar weight, including but not limited to fiber-cement and aluminum siding.
2. The "comp or shingles" roofing material category also includes roofing materials of similar weight, including but not limited to roll roofing, built-up felt roofing, single-ply membrane roofing, and metal roofing.
3. The "gypsum board" interior finish category also includes wall finish materials of similar weight, including but not limited to wood board or panel siding.
4. The exterior finish, roofing material and interior finish categories are intended to be identified based on the predominant materials used in construction. Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of the heavier finish type exists within the dwelling.



Connectors

1. Manufacturer's model numbers and installation instructions are subject to change. Verify and follow manufacturer's written instructions.
2. Connector images are general in nature only. Individual manufacturer's connectors may vary.
3. Any of the connectors listed within a particular group may be used for strengthening the particular condition.
4. This plan set was developed using the lowest listed manufacturer's capacity within a particular group.
5. Where connectors listed within the applicable Earthquake Retrofit Schedule will not fit within a particular wall line due to limitations in length, alternate connectors may be substituted but shall be designed or selected by a registered design professional and approved by the Building Official.

CONNECTORS

IMAGE	MANUFACTURER	MODEL	CAPACITY
	TYPE A Simpson Strong-Tie USP Structural Connectors	URFP SRC	1530# 1450#
	TYPE B Simpson Strong-Tie KC Metals USP Structural Connectors	FRFP RFP SRCP	1065# 960# 1570#
	TYPE C Simpson Strong-Tie KC Metals KC Metals USP Structural Connectors	FRFP RFA86/88 RFA136/138 SFA8	1065# 725# 1145# 875#
	TYPE D Simpson Strong-Tie KC Metals USP Structural Connectors	L70 CA70 AC7	740# 565# 725#
	TYPE E Simpson Strong-Tie KC Metals USP Structural Connectors	L90 CA90 AC9	925# 740# 905#
	TYPE F (Note 3) Simpson Strong-Tie KC Metals USP Structural Connectors	H10A HT10A RT16A	590# 590# 800#
	TYPE G Simpson Strong-Tie KC Metals USP Structural Connectors	LTP4 FAL MP4F	600# 445# 660#
	TYPE H Simpson Strong-Tie KC Metals USP Structural Connectors	L30 CA30 A3	250# 275# 590#
	TYPE S1 Simpson Strong-Tie KC Metals USP Structural Connectors	MSTA36 TSA36 MSTA36	2050# 2075# 2065#

ANCHOR BOLTS

MANUFACTURER	MODEL	EMBEDMENT DEPTH	
		1/2"ø	5/8"ø
SCREW-TYPE Simpson Strong-Tie KC Metals Powers Fasteners	Titen HD Kwik-HUS-EZ Wedge-Bolt	3-1/2" 4-1/2" 3-3/8"	3-1/2" n/a 3-3/8"
ADHESIVE Simpson Strong-Tie Hilti USP Structural Connectors	Threaded Rod with: SET Adhesive HIT-HY 200 CIA GEL 7000C	4-1/4" 2-3/4" 2-3/4"	5" 3-1/8" 3-1/8"

TIE-DOWNS

Supplemental Technical Notes, Sheet S2, Section T

IMAGE	MANUFACTURER	MODEL	CAPACITY (ASD)
	Simpson Strong-Tie KC Metals USP Structural Connectors	HDU2 ADST2 PHD2A	3075# 4275# 3215#

Note: Tie-down capacities listed above are ASD and based on manufacturer's data. The allowable ASD capacity used for development of this plan set has been reduced to 3000# based on anchorage to existing foundation systems. Tie down anchors must be installed per detail 1/D5.

APPLICANT: _____

PROPERTY ADDRESS: _____

Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2

Issued: MAR 2019

FEMA

Seismic Design Category, Weight Classification, and Connectors

Date:

S3

Prescriptive Design- Plan Set

EARTHQUAKE RETROFIT SCHEDULE (S_{DS}= 1.0 Seismic) ONE-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line: Wood Structural Panels; ④ Cripple Wall Height: up to 1' Without Tie-downs	up to 1' With Tie-downs	1'-1" to 2' Without Tie-downs	1'-1" to 2' With Tie-downs	2'-1" to 4'-0" Without Tie-downs	2'-1" to 4'-0" With Tie-downs	4'-1" to 6'-0" Without Tie-downs	4'-1" to 6'-0" With Tie-downs	Panel Edge Nailing	Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length: ⑥ Foundation Sill Anchors: Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	⑦ Floor to Cripple Wall or Floor to Foundation Sill: Type "D"	Type "E" or "F"	Type "G"
1-Story Light Construction	up to 800	☐	5.3'	5.3'	8.0'	5.3'	9.3'	5.3'	9.3'	6.7'	4"	4	7	7	7	5	11	10	14
	801 to 1000	☐	6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16
	1001 to 1200	☐	6.7'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	14	19
	1201 to 1500	☐	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22
	1501 to 2000	☐	9.3'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2001 to 2500	☐	12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	35
	2501 to 3000	☐	14.7'	14.7'	16.0'	14.7'	18.7'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	32	31	40
1-Story Medium Construction	up to 800	☐	5.3'	6.7'	8.0'	5.3'	9.3'	6.7'	10.7'	6.7'	3"	5	8	8	8	6	13	12	16
	801 to 1000	☐	5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	14	19
	1001 to 1200	☐	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	3"	7	10	11	11	8	17	17	22
	1201 to 1500	☐	8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	20	20	26
	1501 to 2000	☐	9.3'	10.7'	13.3'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	10	15	17	17	11	25	24	32
	2001 to 2500	☐	10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	3"	12	18	20	20	14	30	29	38
	2501 to 3000	☐	12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	21	23	23	16	35	34	45
1-Story Heavy Construction	up to 800	☐	5.3'	6.7'	8.0'	5.3'	10.7'	6.7'	10.7'	8.0'	2"	6	9	10	10	7	15	14	18
	801 to 1000	☐	6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	2"	7	10	11	11	8	17	17	22
	1001 to 1200	☐	6.7'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	10.7'	2"	8	12	13	13	9	20	19	25
	1201 to 1500	☐	8.0'	9.3'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	2"	9	14	15	15	11	24	23	30
	1501 to 2000	☐	9.3'	10.7'	14.7'	10.7'	16.0'	12.0'	17.3'	13.3'	2"	11	18	19	19	13	30	29	38
	2001 to 2500	☐	10.7'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	36	34	45
	2501 to 3000	☐	12.0'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	2"	16	25	27	27	18	41	40	53

Notes:

1. Anchor bolts and Connectors shown in the Earthquake Retrofit Schedule are the minimum required per wall line, placed within the length of strengthening where possible and spaced as equally along each wall line as possible. Note that one additional anchor is required at the end of each braced wall panel per Sheet D4.
2. Tie-downs: If your foundation meets the criteria, you may choose the tie-down option to decrease the required length of strengthening. This may be required where the length of the wall without tie-downs specified in this schedule is longer than can be accommodated by existing conditions. However, there is a level of uncertainty when dealing with existing foundations, therefore, where possible, longer lengths of strengthening, without tie-downs, are preferred. (See Supplemental Technical Notes, Sheet S2 to verify the existing foundation is suitable and meets criteria.)
3. Connector Type "F" should be used as an alternative only if joists have blocking on both sides and where accessibility makes the use of Types "D" or "E" impractical.
4. Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
5. This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Required number of connectors on the Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be designed or specified by a Registered Design Professional.
6. Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

INSTRUCTIONS

1. Locate the section that matches your home's construction. Use the flowchart on Sheet S3 to determine "Construction-Type Weight".
2. Find the home's Total Floor Area in the schedule, this number should be at least as large as the number listed below. Do not use a smaller number, even if it is closer.
   a. Approximate 1st floor area over crawl space: _____ (Do not include areas built over slab-on-grade.)
3. Check the box that matches your home's construction type, number of stories, and total floor area. You will use information in this row of the schedule to determine length of wood structural panels, nailing requirements, quantities of hardware, etc.
4. Measure the maximum height of the cripple wall along each wall line of the house.
5. Determine the length of wood structural panel bracing required. The columns contain the length of required bracing, depending on the height of the cripple wall. The length of bracing is given for cripple wall heights of zero to 1', 1' to 2', 2' to 4', 4' to 6', and 6' to 7'. Furthermore, choices are given for bracing without tie-downs and with tie-downs. If the cripple wall height changes along the length of the wall, use the tallest height to determine the required bracing length. Follow the row across from the total floor area that you checked for your home (in Step 2) to find the bracing length for the cripple wall height on each side of the house.
6. Determine the number of Foundation Sill Anchors required. The columns show the number of anchors required, depending on whether you use Types A through C, or 1/2"ø or 5/8"ø anchor bolts. (ø = diameter of the bolts.) See Sheet S3.
7. Determine the number of Floor to Cripple Wall or Foundation Sill connectors. The columns indicate how many framing connectors are required, depending on whether you use Types D, E, F, or G. See Sheet S3.
8. Complete the Retrofit Summary for your project. Fill in the lengths found in ⑤. Check the boxes for the anchor and connector types you plan to use. The length of new cripple wall sheathing should be distributed along a wall line either in one full length or in a maximum of two panel lengths of approximately equal length. If you intend to use tie-downs, check the box for tie-downs for each wall line where use is intended. Check the box on line 4, and read the Supplemental Technical Notes for additional information. Where the length of required panel does not fit within the available length, the dwelling must have an engineered solution. Alternately, if 95% of the length along any particular wall can be sheathed, then that wall line shall be considered acceptable and an engineered solution is not required.

⑧ RETROFIT SUMMARY

BRACING, ANCHORS, CONNECTORS, AND TIE-DOWNS

1. Required length of strengthening per wall line: (check box if tie-downs will be used on that line)
   North Wall _____ft ☐ with tie-downs East Wall _____ft ☐ with tie-downs
   South Wall _____ft ☐ with tie-downs West Wall _____ft ☐ with tie-downs
2. New Foundation Sill Anchorage to be used: (check all that apply)
   Bolts: Diameter_____ ☐ Adhesive ☐ Screw
   ☐ Type "A" Connector ☐ Type "C" Connector
   ☐ Type "B" Connector
3. Floor Framing Connectors (to Foundation Sill or to Top Plate) to be used: (check all that apply)
   ☐ Type "D" ☐ Type "F"
   ☐ Type "E" ☐ Type "G"
4. ☐ Check this box if tie-downs and the SUPPLEMENTAL TECHNICAL NOTES will be used.

APPLICANT: _____

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Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2

Issued: MAR 2019

FEMA

Earthquake Retrofit Schedule

S_{DS} = 1.0 One-Story

Date:

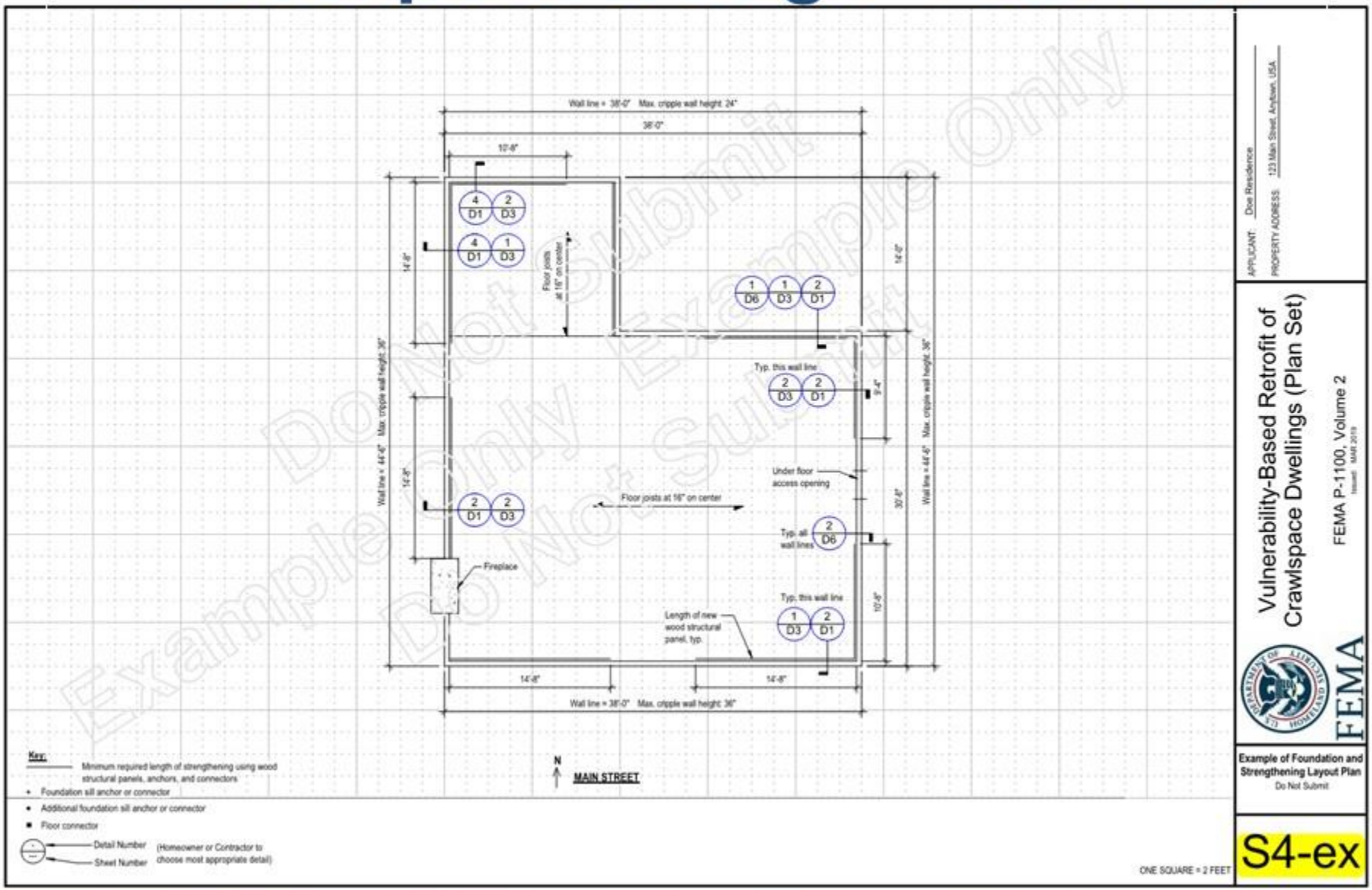
S3.1

Prescriptive Design- Plan Set

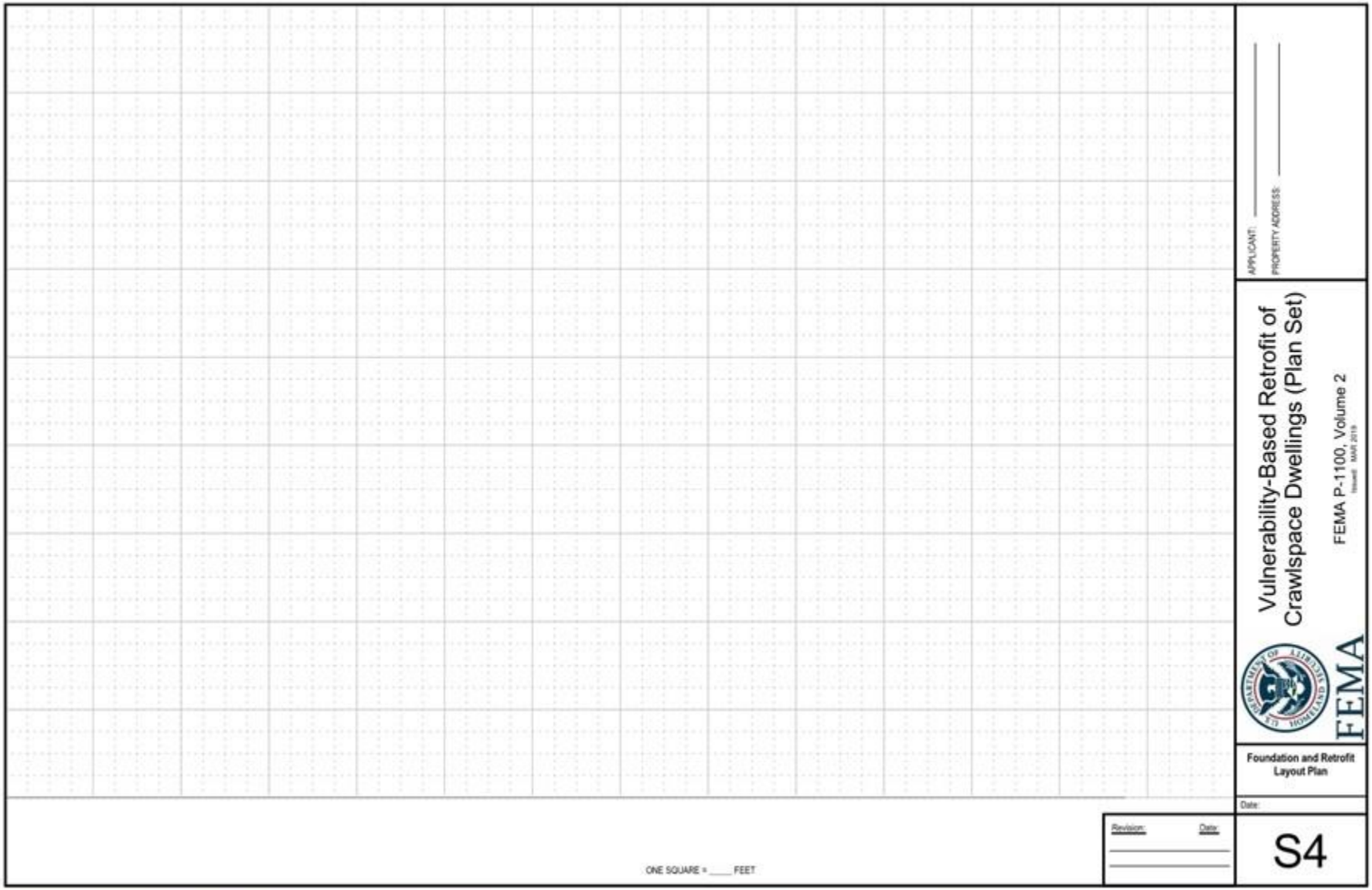
EARTHQUAKE RETROFIT SCHEDULE (S_{DS}= 1.0 Seismic) ONE-STORY

① Weight Category	② Total Area in Square Feet	③ Mark row that applies ☒	⑤ Length Each of Two Braced Wall Sections Required Along Each Perimeter Wall Line — Wood Structural Panels — ④ Cripple Wall Height									Number of Foundation Connectors or Anchors at Each Perimeter Wall Line Assume Distributed Along Length							
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"			⑥ Foundation Sill Anchors					⑦ Floor to Cripple Wall or Floor to Foundation Sill		
			Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Panel Edge Nailing	Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"	Type "E" or "F"	Type "G"
1-Story Light Construction	up to 800		5.3'	5.3'	8.0'	5.3'	9.3'	5.3'	9.3'	6.7'	4"	4	7	7	7	5	11	10	14
	801 to 1000		6.7'	6.7'	8.0'	6.7'	10.7'	6.7'	10.7'	8.0'	4"	5	8	8	8	6	13	12	16
	1001 to 1200		6.7'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	14	19
	1201 to 1500		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	13.3'	9.3'	4"	7	11	12	12	8	18	17	22
	1501 to 2000		9.3'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2001 to 2500		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	35
	2501 to 3000		14.7'	14.7'	16.0'	14.7'	18.7'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	32	31	40
1-Story Medium Construction	up to 800		5.3'	6.7'	8.0'	5.3'	9.3'	6.7'	10.7'	6.7'	3"	5	8	8	8	6	13	12	16
	801 to 1000		5.3'	6.7'	9.3'	6.7'	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	14	19
	1001 to 1200		6.7'	8.0'	9.3'	6.7'	12.0'	8.0'	12.0'	9.3'	3"	7	10	11	11	8	17	17	22
	1201 to 1500		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	20	20	26
	1501 to 2000		9.3'	10.7'	13.3'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	10	15	17	17	11	25	24	32
	2001 to 2500		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	3"	12	18	20	20	14	30	29	38
	2501 to 3000		12.0'	13.3'	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	3"	13	21	23	23	16	35	34	45

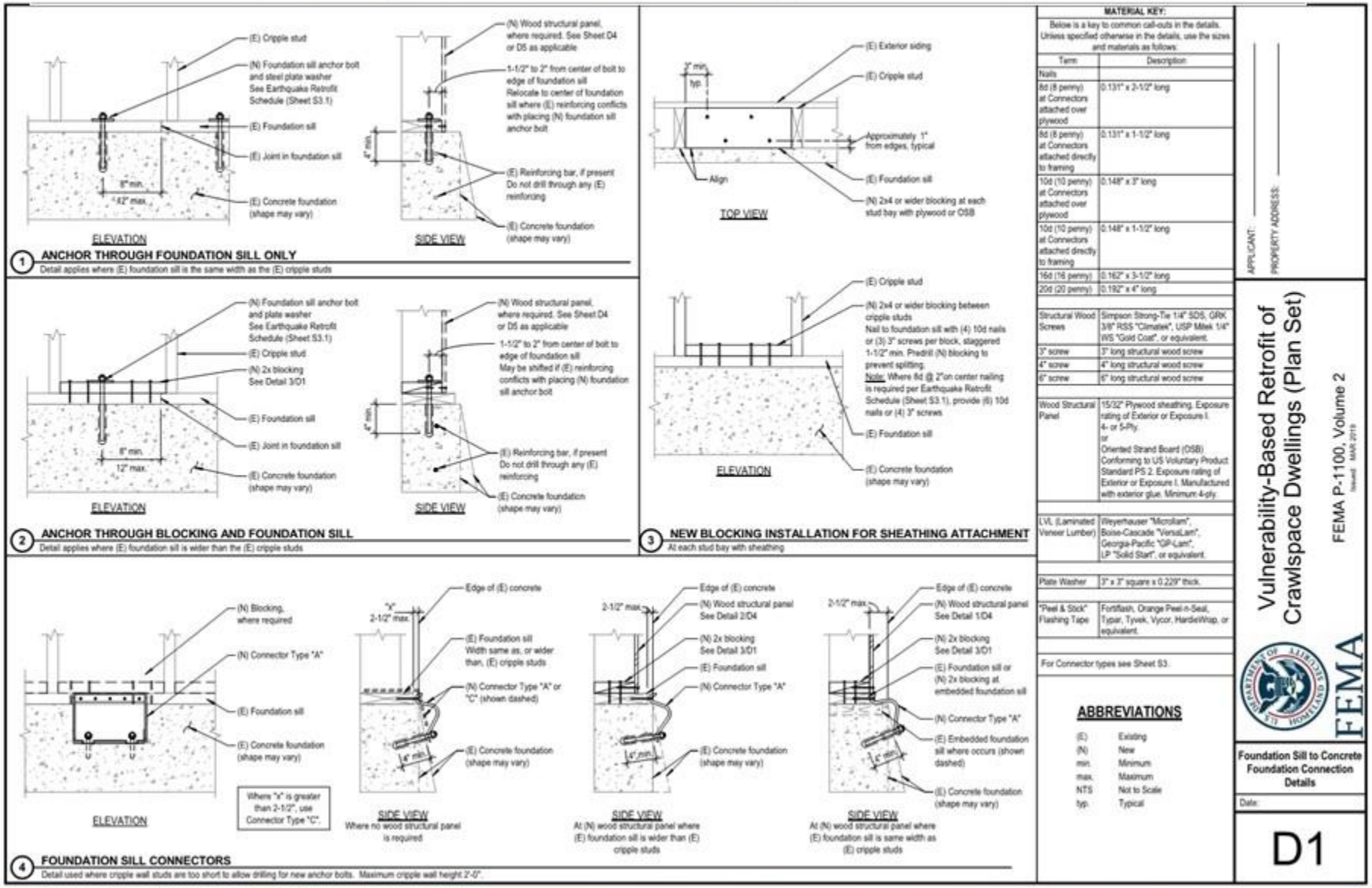
Prescriptive Design- Plan Set



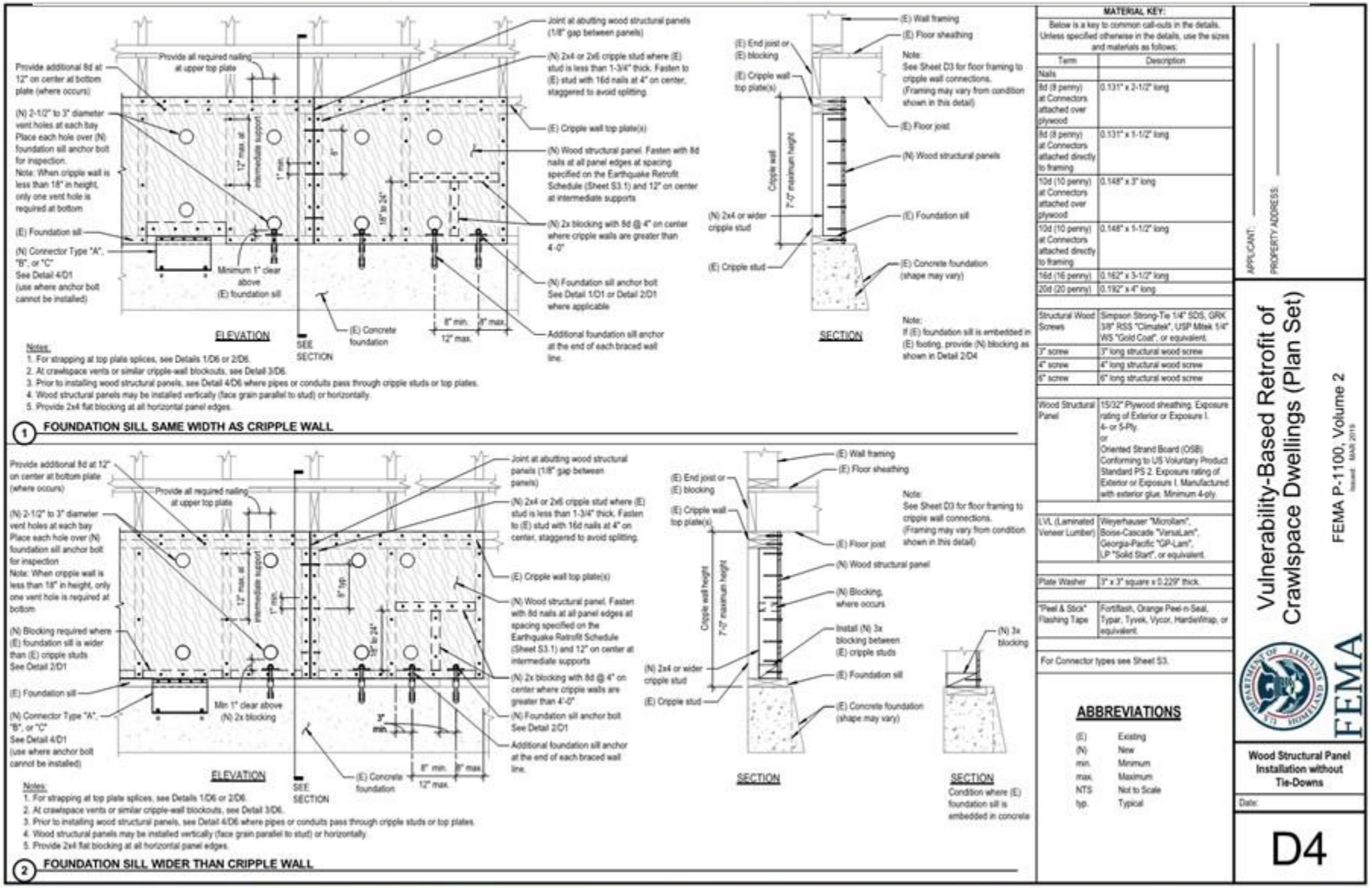
Prescriptive Design- Plan Set



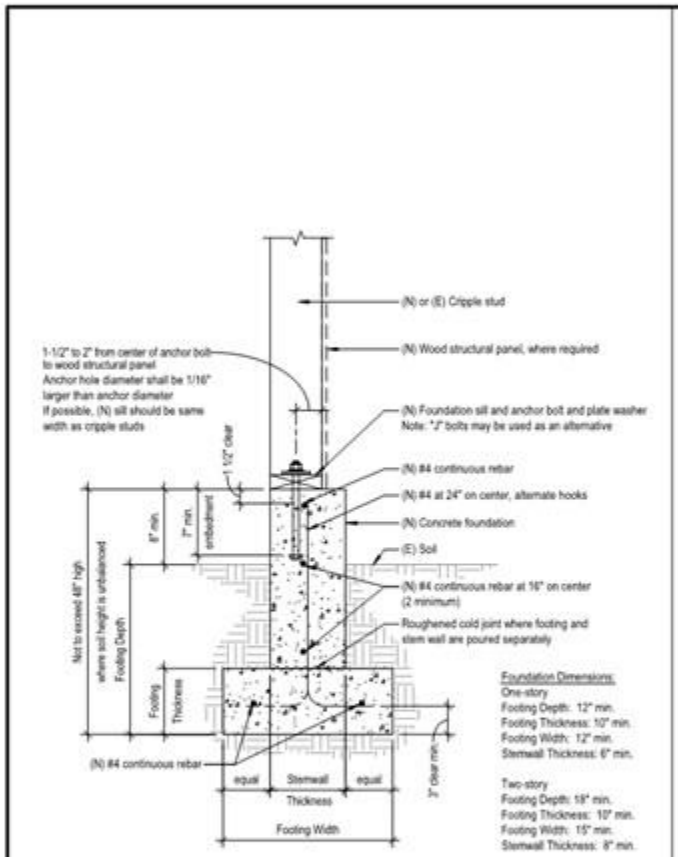
Prescriptive Design- Plan Set



Prescriptive Design- Plan Set



Prescriptive Design- Plan Set



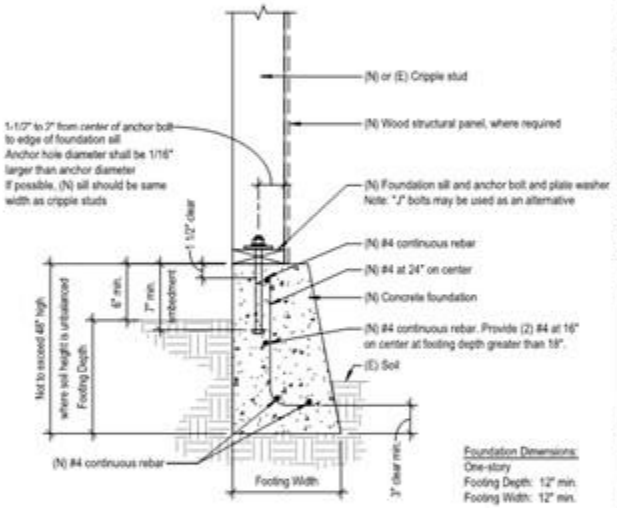
Foundation Dimensions:
One-story
Footing Depth: 12" min.
Footing Thickness: 10" min.
Footing Width: 12" min.
Stemwall Thickness: 6" min.

Two-story
Footing Depth: 18" min.
Footing Thickness: 10" min.
Footing Width: 15" min.
Stemwall Thickness: 8" min.

SECTION

Notes:
1. Contact Building Official to verify applicability.
2. Where frost conditions occur, the minimum depth shall extend below the frost line.
3. Footing to be deepened as required to bear on firm soils.
4. When expansive soil is known to exist, the foundation depth and reinforcement shall be as approved by the Building Official.
5. The ground surface along the interior side of the foundation is permitted to be excavated to the elevation of the top of the footing.
6. Where (N) foundations are placed adjacent to (E) foundations, connect (N) and (E) foundations with (3) #4 x 3'-6" dowels. Embed dowels 8" minimum into the (E) foundation with adhesive. See General Notes, Section M.
7. A geotechnical report or modified foundation may be required at locations with expansive or liquefiable soils or sites with potential for sliding.

1 CONCRETE FOUNDATION FOR SECTION REPLACEMENT - OPTION 1



Foundation Dimensions:
One-story
Footing Depth: 12" min.
Footing Width: 12" min.

Two-story
Footing Depth: 18" min.
Footing Width: 15" min.

SECTION

Notes:
1. Contact Building Official to verify applicability.
2. Where frost conditions occur, the minimum depth shall extend below the frost line.
3. Footing to be deepened as required to bear on firm soils.
4. When expansive soil is known to exist, the foundation depth and reinforcement shall be as approved by the Building Official.
5. Where (N) foundations are placed adjacent to (E) foundations, connect (N) and (E) foundations with (3) #4 x 3'-6" dowels. Embed dowels 8" minimum into the (E) foundation with adhesive. See General Notes, Section M.
6. A geotechnical report or modified foundation may be required at locations with expansive or liquefiable soils or sites with potential for sliding.

2 CONCRETE FOUNDATION FOR SECTION REPLACEMENT - OPTION 2

MATERIAL KEY:

Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:

Term	Description
Nails	
8d (8 penny) at Connectors attached over plywood	0.131" x 2-1/2" long
8d (8 penny) at Connectors attached directly to framing	0.131" x 1-1/2" long
10d (10 penny) at Connectors attached over plywood	0.148" x 3" long
10d (10 penny) at Connectors attached directly to framing	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long
20d (20 penny)	0.192" x 4" long
Structural Wood Screws	Simpson Strong-Tie 1/4" SDS, GRK 3/8" RSS "Climatek", USP Mitek 1/4" WS "Gold Coat", or equivalent.
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Wood Structural Panel	15/32" Plywood sheathing. Exposure rating of Exterior or Exposure I. 4- or 5-Ply. or Oriented Strand Board (OSB) Conforming to US Voluntary Product Standard PS 2. Exposure rating of Exterior or Exposure I. Manufactured with exterior glue. Minimum 4-ply.
LVL (Laminated Veneer Lumber)	Weyerhauser "Microllam", Boise-Cascade "VersaLam", Georgia-Pacific "GP-Lam", LP "Solid Start", or equivalent.
Plate Washer	3" x 3" square x 0.229" thick.
"Peel & Stick" Flashing Tape	Fortiflash, Orange Peel-n-Seal, Typar, Tyvek, Vycor, HardieWrap, or equivalent.

ABBREVIATIONS

(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

APPLICANT:
PROPERTY ADDRESS:

Vulnerability-Based Retrofit of Crawlspace Dwellings (Plan Set)

FEMA P-1100, Volume 2

Issued: MAR 2019

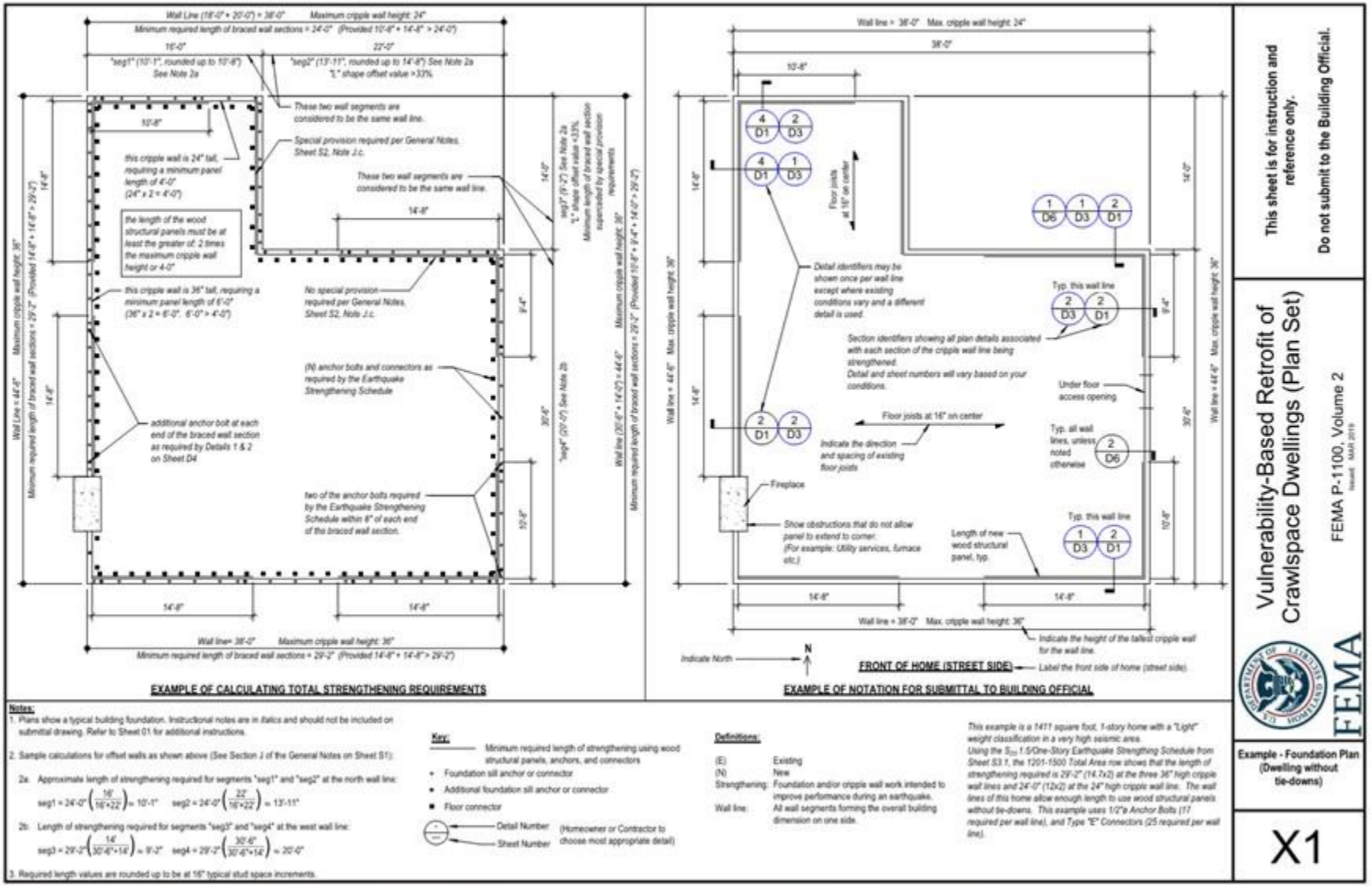
FEMA

Foundation Replacement Details

Date:

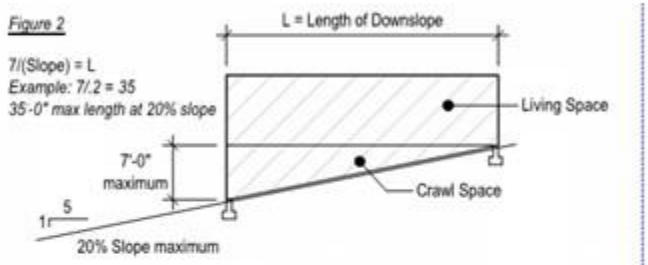
D7

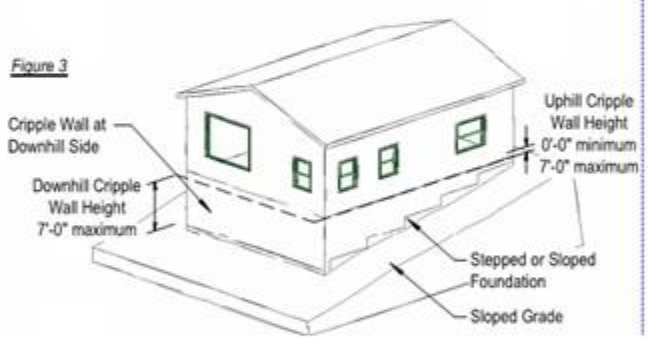
Prescriptive Design- Plan Set



Crawlspace Dwelling
What's Makes P-1100 Different?

- Assessment provisions
- Cripple walls up to 7'-0"
- Prescriptive plans for SDS of 1.0, 1.2, 1.5 (SDC B-E)
- One-story heavy clay tile
- Simplified engineering criteria
- Provisions to leverage prescriptive designs





Prescriptive Design Assumptions

- Prescriptive design will not cover all conditions
- Lots of assumptions were necessary- conservative
- Assumptions listed in commentary section C4.6
- Engineers can leverage prescriptive design and plan sets

C.4.6 Commentary Only: Prescriptive Vulnerability-Based Retrofit Assumptions

The following section lists all significant assumptions used for the development of the prescriptive retrofit approach developed within this prestandard. This includes all provisions and figures within Section 4.4, as well commentary in Section C.4.4. The intent of listing the assumptions here is so that a registered design professional can assess whether modification of these assumptions could benefit any particular home that may require engineering work. The assumptions are as follows:

- The roof slope was taken as 6:12 for weight calculations. If the roof of the particular building has a lesser slope, the building may be lighter than the building used in the prescriptive calculations.
- Gable walls are assumed to exist on the shorter side of the building.
- The interior partition length was taken as 80% of the exterior wall length for weight calculations for all floor levels. If the particular building has fewer partitions, it may be lighter than the building used in the prescriptive calculations.
- Unit weights in non-mandatory Appendix L were used for weight calculations. If different building materials are used in the particular building, it may be lighter or heavier than the building used in the prescriptive calculations. For heavy and light second floor construction 2 psf and 1 psf, respectively, were included for tile (this represents 33% and 17% coverage with 6 psf for tile). For all first floor construction, 2 psf was used. If no floor tile or 100% floor tile exists in the particular building, the floor weights for the particular building will be lighter or heavier than the building used in the prescriptive calculations.

Chapter 5
Living-Space Over Garage

Chapter 5 Living Space over Garage (LOG) Dwellings

Prestandard-Eligibility for Use

Table 5.1-1 Eligibility Criteria for Use of Chapter 5

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached *one-* or *two-family dwelling* or the dwelling is a unit in a *townhouse* and assessment and retrofit will occur for each attached townhouse unit (the full *townhouse structure*).		
2	The dwelling is of wood *light-frame construction* and has a maximum of story above the garage story.		
3	The dwelling is a *living-space-over-garage* dwell…		
4	The dwelling perimeter (not including po… appurtenances) is supported on continuous concrete found…, concrete *stem walls* or thickened slab edge footings.		
5	The lower (garage) level floor is constructed of a conventionally reinforced concrete slab on ground (or at least the portion of the floor that bounds the garage).		

Can use Chapter 5

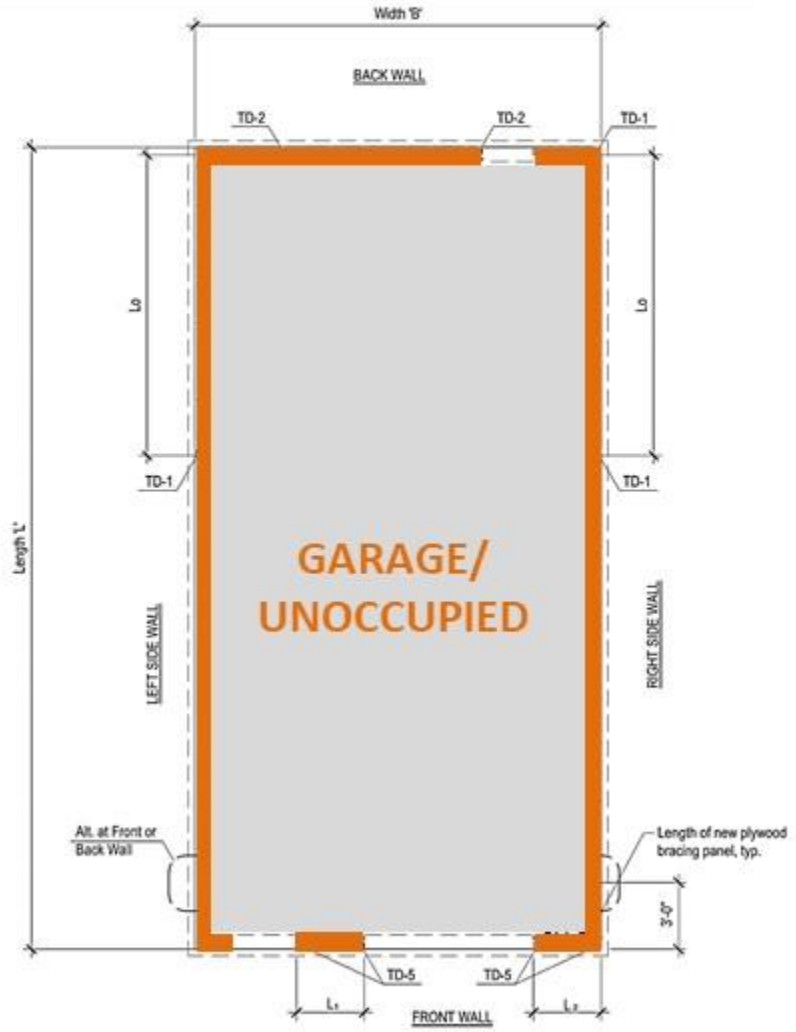
Prescriptive-Eligibility for Use

Table 5.1-2 Additional Eligibility Criteria for Use of Prescriptive Retrofit Provisions (Section 5.4)

Scoping Statement		Compliant	Non-Compliant
1	The dwelling is located within *Seismic Design Category* (SDC) B through E as noted in Section 1.6.		
2	The weight of roofing material shall not exceed 12 psf (measured on slope).		
3	The weight of exterior wall finish shall not exceed 10 psf, except veneer wainscots supported on concrete or masonry foundations that are permitted to extend up to four feet above the top of foundation.		
4	Weight of interior wall finish shall not exceed 8 psf, ex… place surrounds not more than 4 inches thick… …quare feet in area are permitted to exceed thi…		
5	Weight of floor fini… …cept that heavier floor finishes of up to 10 psf are ac… …ited to 25% of the total floor area of each level.		
6	Floors in each story are at the same level, excluding slab on ground portions.		
7	The building area (determined in Section 5.4.4) shall not exceed 2,000 square feet.		
8	No part of the foundations is constructed of unreinforced masonry or stone.		
9	Clear floor to ceiling heights at any occupied level do not exceed 9 feet.		
10	The aspect ratio of the full depth of the dwelling at the lowest level to width of the garage (plan length to plan width) shall not be greater than 2 ½ to 1. See commentary Section C5.4.4.		

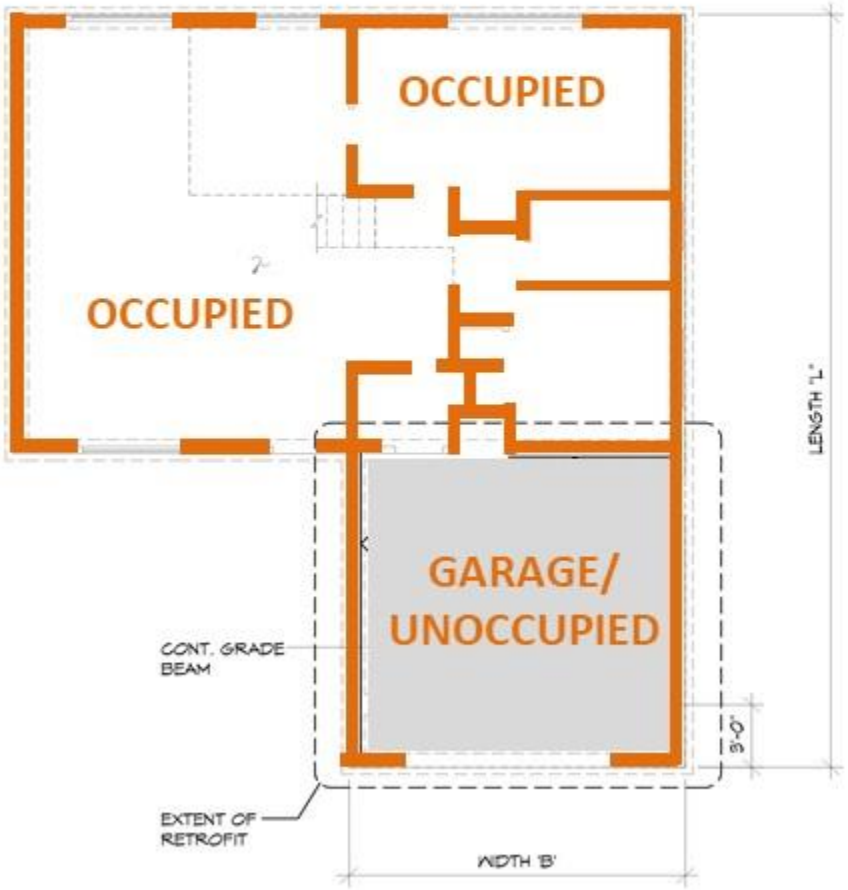
Prescriptive Design Appropriate

What Dwellings are Included?



What Dwellings are Included?

What Dwellings are Included?



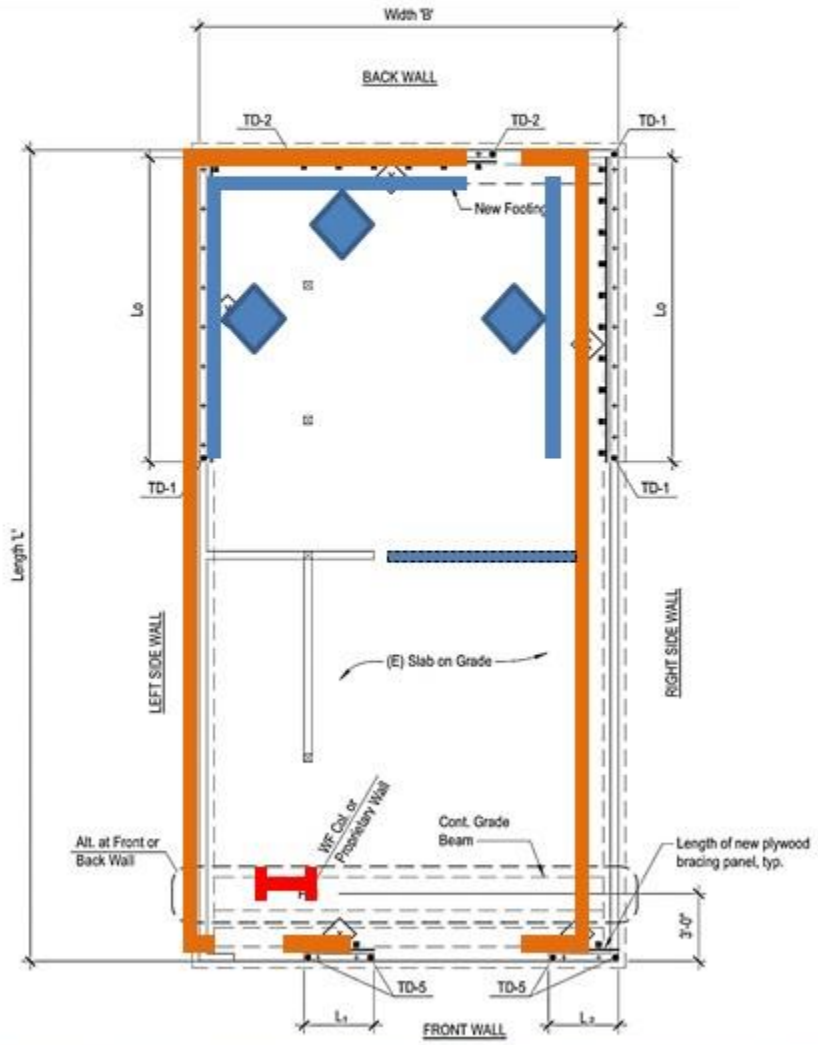
Overarching Retrofit Design Criteria

- Prescriptive retrofit provisions derived from engineering criteria plus assumptions
- Collapses at the ground floor does pose a large LS risk

Retrofit Preview

Add vertical elements and load path connections

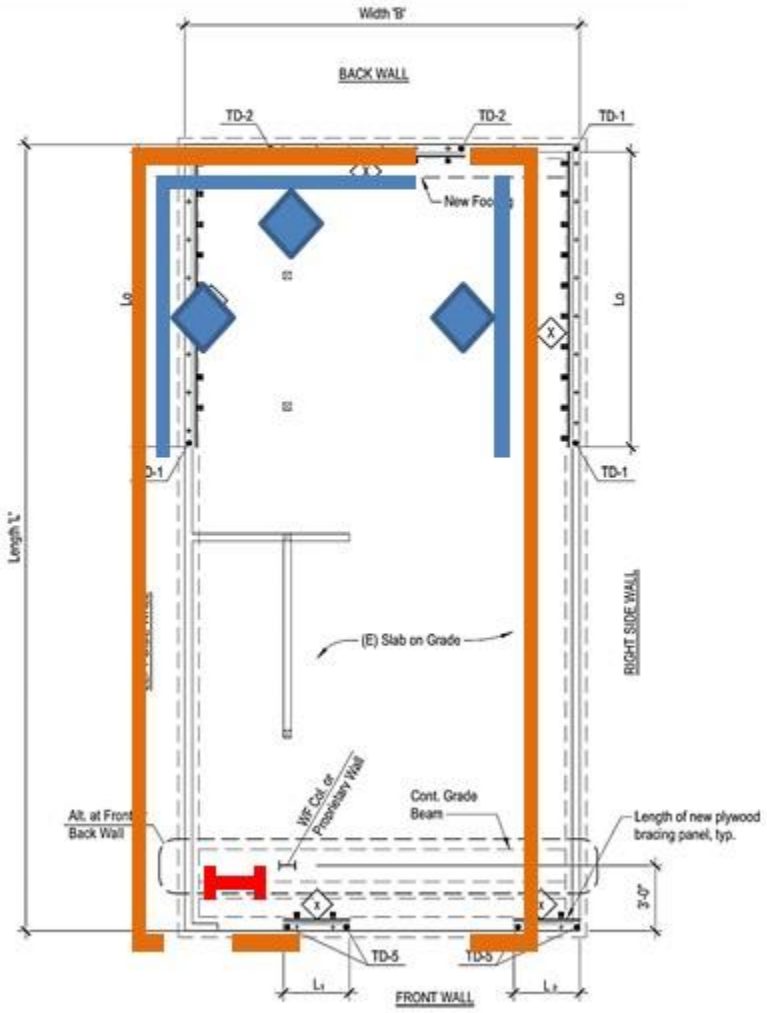
– Locations of element:
  - Front of garage
  - Back of garage
  - Side walls



Retrofit Preview

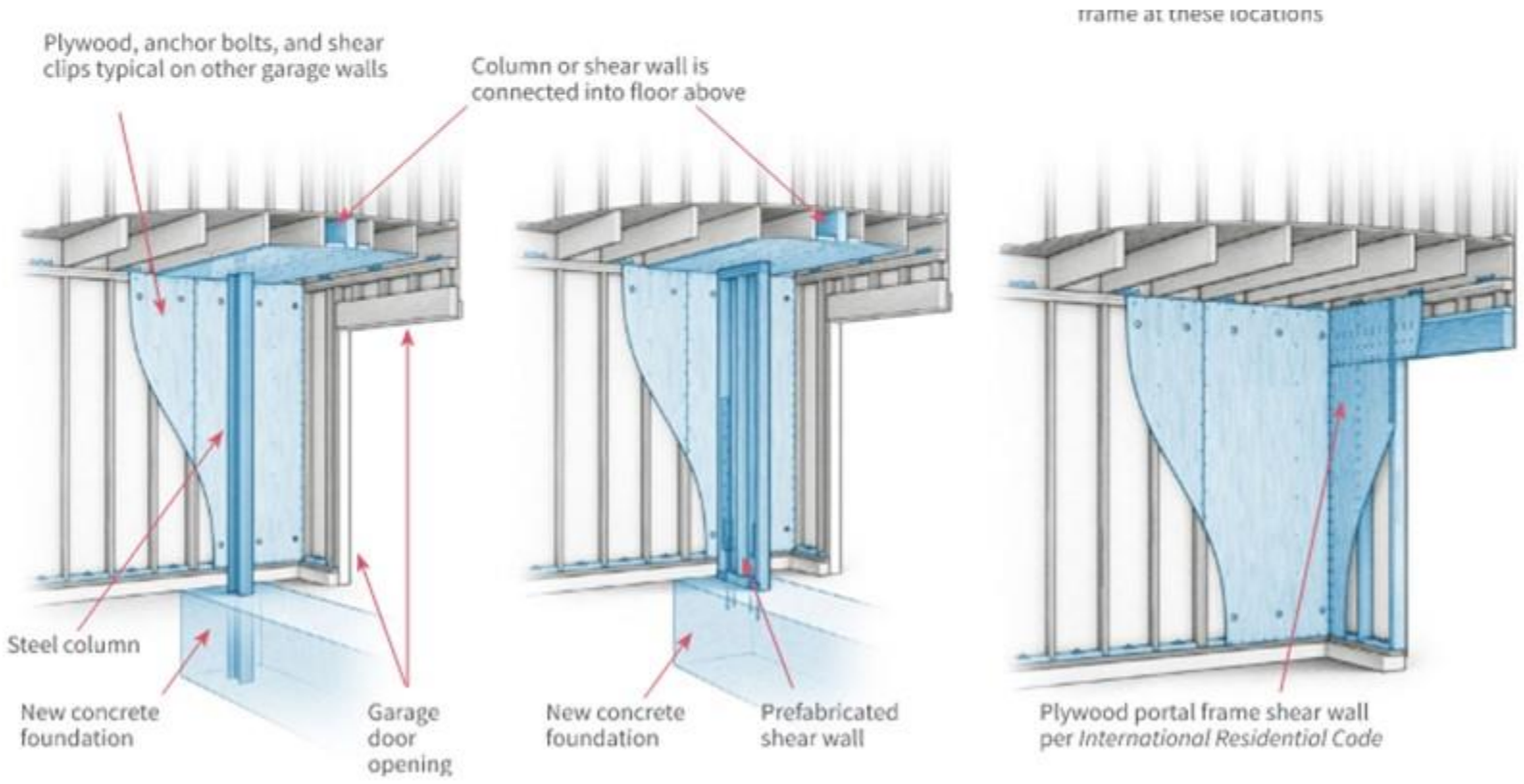
Types of elements:

- Steel retrofit column
- Proprietary shear wall
- Wood structural panel shear wall

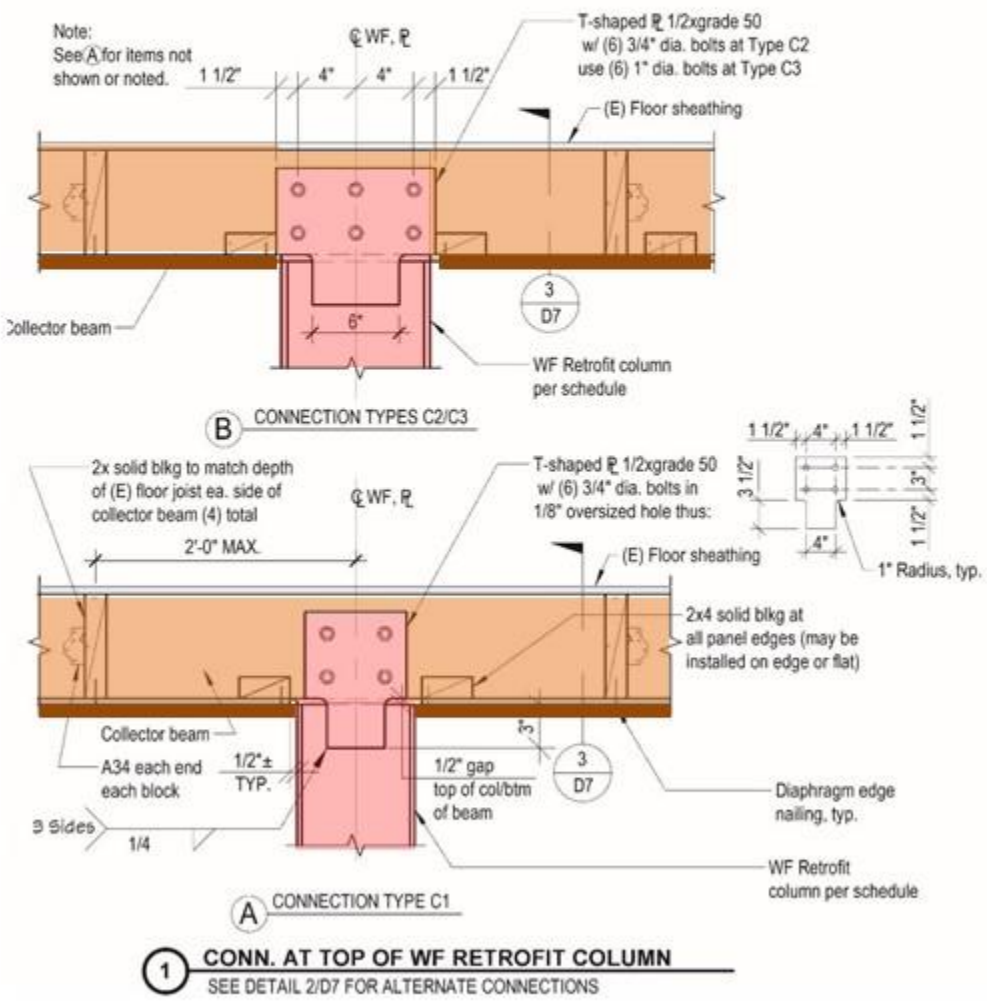


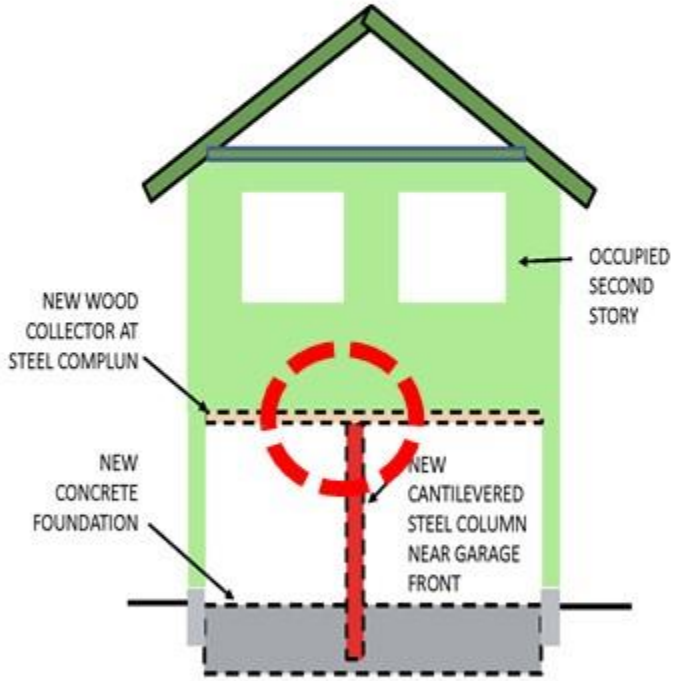
Retrofit Preview

– Required strengthening limited to connections for load path into and out of elements,

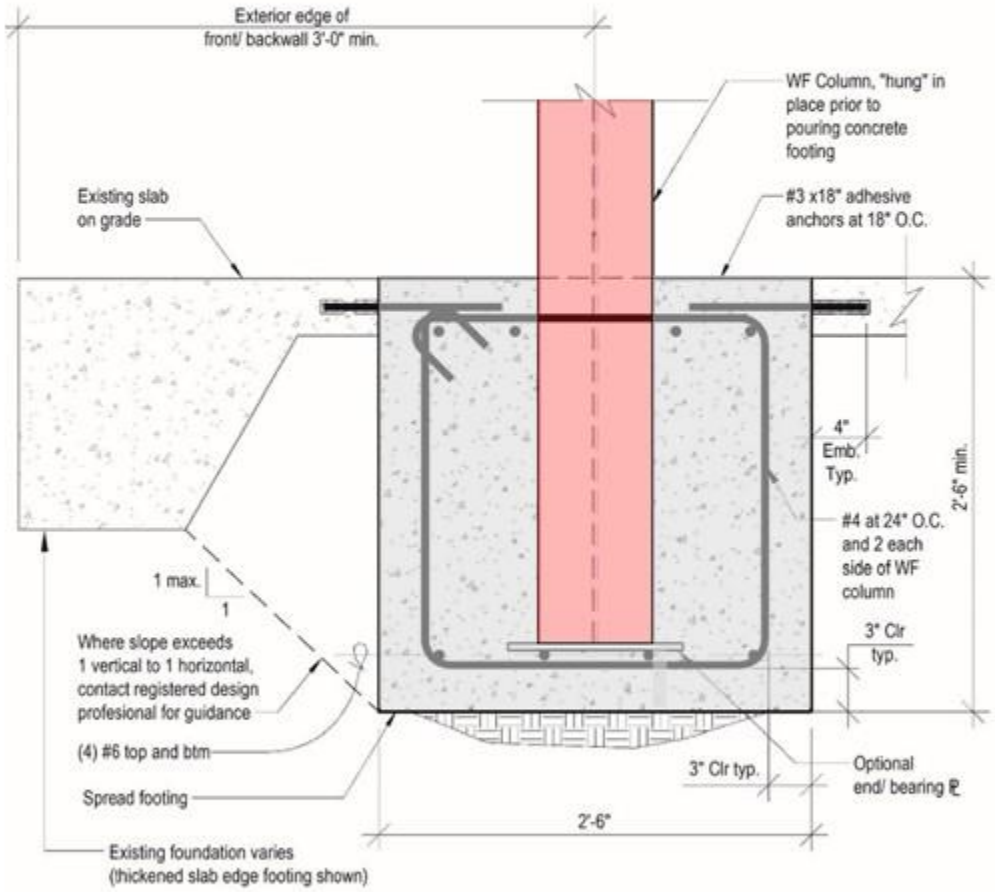


Steel Retrofit Column

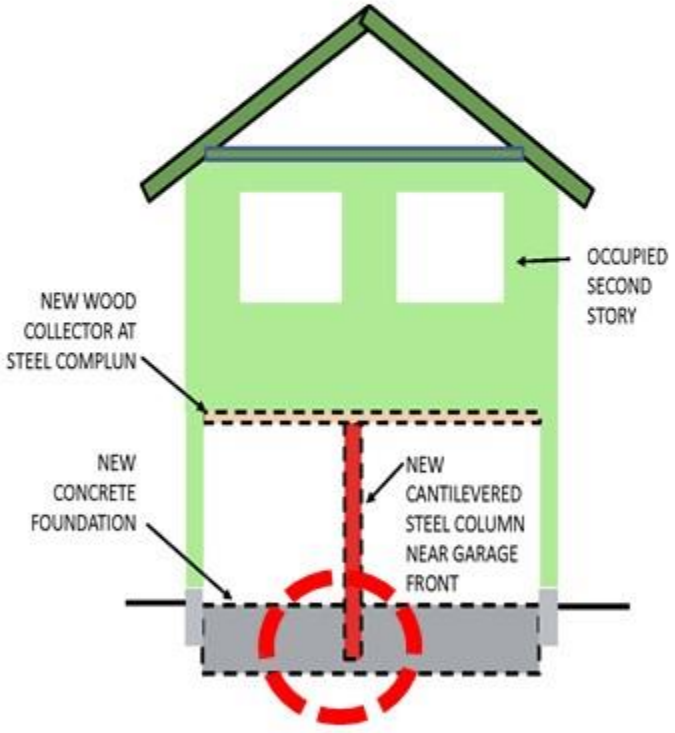




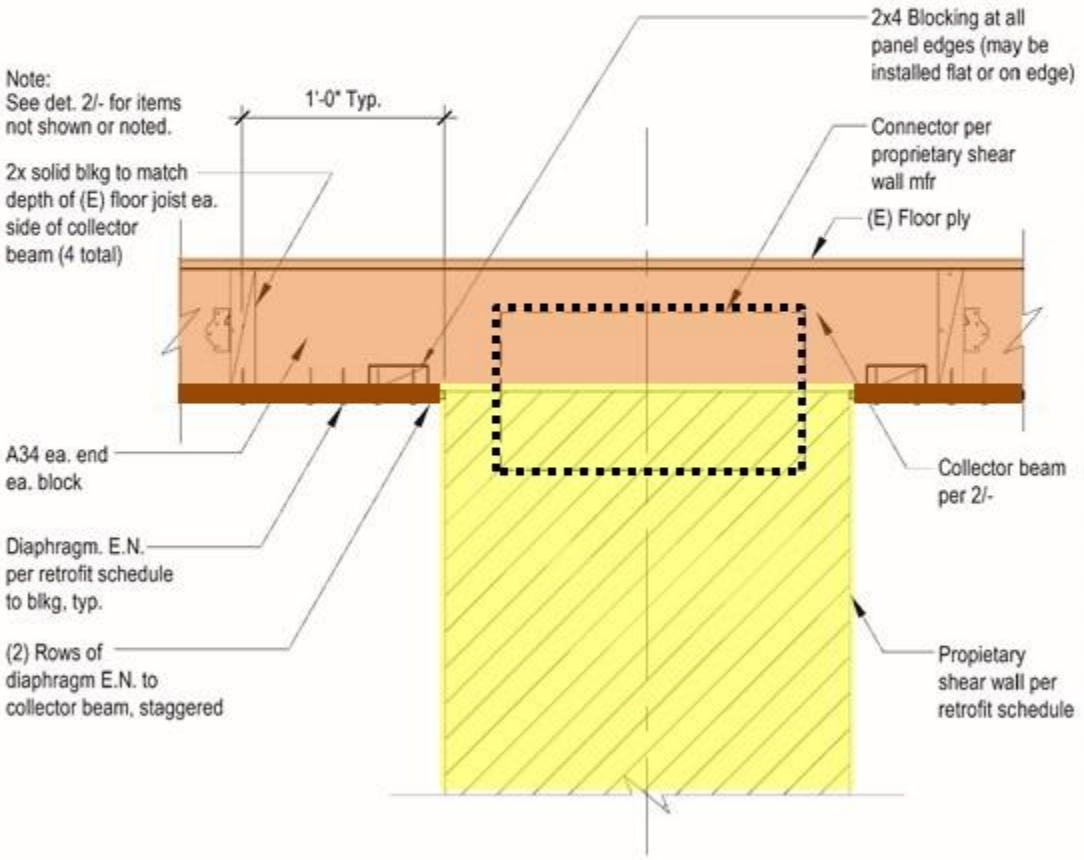
Steel Retrofit Column

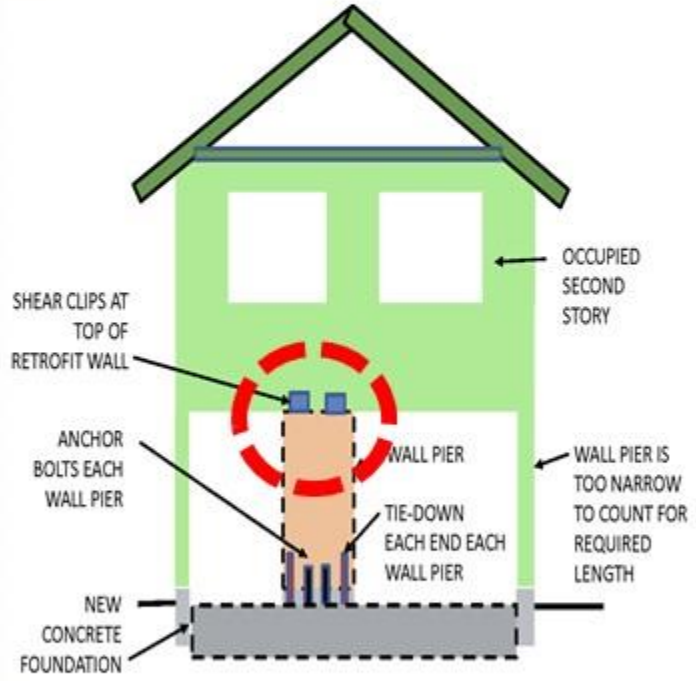


1 FOOTING AT NEW RETROFIT COLUMN



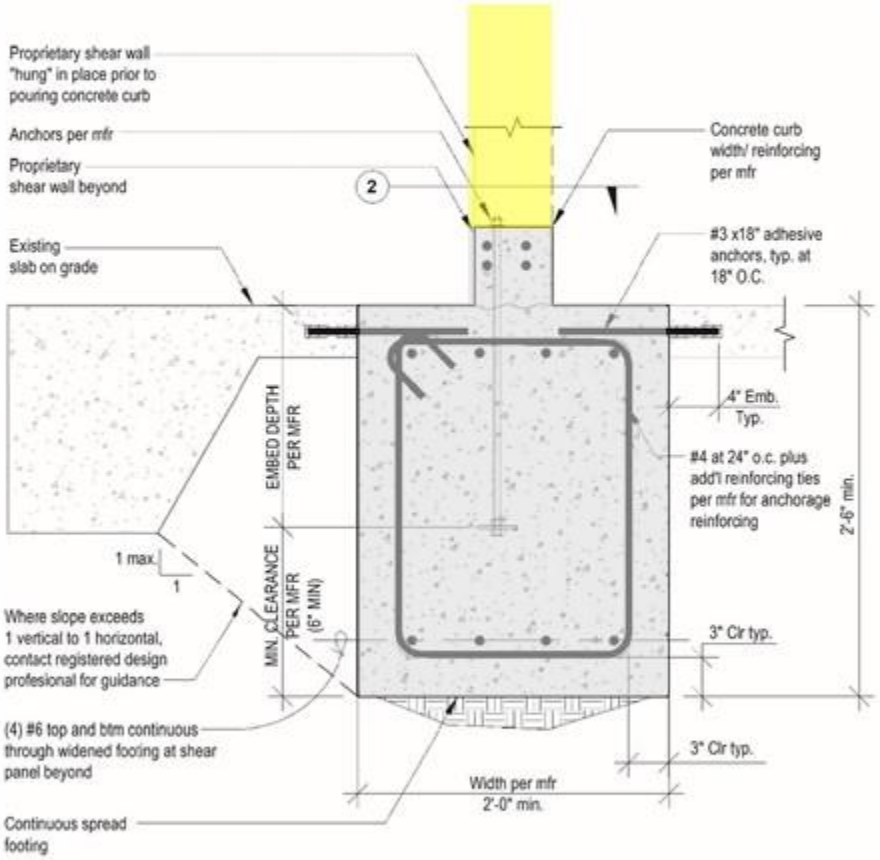
Proprietary Shear Walls



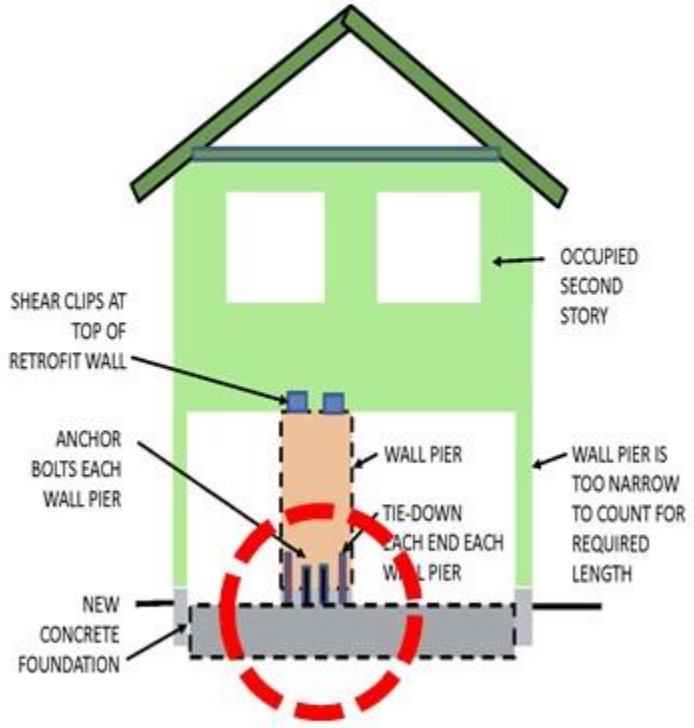


1 **FLOOR CONN. AT PROPRIETARY SHEAR WALL**
FLOOR FRAMING PARALLEL TO GARAGE FRONT

Proprietary Shear Walls



1 CONT. FOOTING/ GRADE BEAM AT PROPRIETARY



Prescriptive Design- Plan Set

GENERAL

Living-Space-Over-Garage Dwellings include several types of dwellings in which living space occurs over a garage or a portion of the dwelling constructed as a garage. This term captures the dwellings in which all of the living space occurs at an upper level over a garage story, as seen in Figure 1. In this dwelling type the garage story may be unfinished and still used as a garage and utility area, or may have been partially or fully converted to a *ground story residential unit*. This term also captures dwellings where a portion of an upper level living space occurs over the garage, as seen in Figure 2.

Earthquake Retrofit Schedules in this plan set include a variety of options for retrofitting each of these configurations, including:

- Wood Structural Panel Shear Walls, with a single length of shear wall along a given wall line;
- Wood Structural Panel Shear Walls, with two sections of shear wall per wall line;
- Retrofits including Steel Columns or Proprietary Shear Walls options for front and back walls.

For Ground Story Bracing in *Living-Space-Over-Garage* Dwellings retrofit in accordance with this plan set, retrofit elements shall be provided as follows:

Configurations without a Ground Floor Residential Unit

- Dwelling does not have a *ground story residential unit*, the retrofits shall include bracing elements at the dwelling front, back and side walls (See Figures D-3). Bracing elements at the side walls are to be wood structural panel shear walls; bracing elements at the front and back walls are permitted to be of any of the bracing element types listed above

Configurations with a Ground Floor Residential Unit

- Where the existing dwelling has a *ground story residential unit*, the retrofits shall include bracing elements at the garage front and side walls, and walls separating the garage use from the residential use (See Figures 4 and 5). Bracing elements at the front wall are permitted to be of any of the bracing element types in listed above. Bracing elements at the side walls and wall separating the garage use from the residential-use are to be wood structural panel shear walls.

ASSESSMENT

The retrofit provisions of this plan set are intended to apply to dwellings that have been assessed using the FEMA P-1100 methodology and found to have a Living-Space-Over-Garage Vulnerability.

PURPOSE

The purpose of this plan set is to promote public safety and welfare by reducing earthquake-induced damage to existing Living-Space-Over-Garage dwellings. The prescriptive designs provided in this plan set are deemed to comply with Chapter 5 of the FEMA P-1100 Prestandard. The provisions this plan set address a single vulnerability; see the FEMA P-1100 Prestandard for assessment and retrofit methodologies. Use of this plan set is anticipated to improve earthquake performance but is not intended to prevent earthquake damage.

SCOPE

This plan set provides prescriptive provisions for retrofit of Ground Story Bracing in Living-Space-Over-Garage Dwellings.

ELIGIBILITY

Living-Space-Over-Garage Dwellings are permitted to use the prescriptive retrofit provisions of this Plan Set when all questions in Table 1 can be answered with "compliant". For Dwellings not eligible to use this plan set, see the FEMA P-1100 Prestandard, section 5.5 for the Simplified Engineered Procedure.

DIFFERING CONDITIONS

Where isolated conditions differ from those shown in this plan set, a supplemental engineering solution including project-specific details and calculations shall be permitted for the differing conditions and shall be issued as an addendum to this plan set. The project specific details and calculations shall be prepared by a licensed architect or engineer in accordance with the FEMA P-1100 Prestandard, Section 5.5.

DESIGN BASIS

This set is deemed to comply with Chapter 5 of ATC 110 Prestandard. Specific design assumptions are as follows:

R = 5.0; Ω_o = 1.5; S_{DS} = Varies Site Class C

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

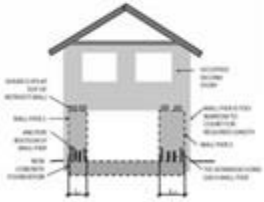


Figure 6
(2 sections of wall option shown)

TABLE 1: ELIGIBILITY FOR USE

To determine if a home qualifies, answer the following:	Compliant	Non-Compliant
1. The dwelling is a one or two-family detached structure or the dwelling is a unit in a townhouse and assesment and retrofit will occur for each attached to townhouse.		
2. The dwelling is a wood light-frame dwelling and has a maximum of one story above the garage story.		
3. The dwelling is a living-space-over-garage dwelling as defined in Chapter 2 FEMA P-1100 prestandard		
4. The dwelling perimeter (not including porches or other appurtenances) is supported on continuous concrete foundations, concrete stem walls for thickened slab edge footings.		
5. The lower (garage) level floor is constructed of a conventionally reinforced concrete slab on grade (or at least the portion of the floor that bounds the garage).		
6. Weight of roofing material shall not exceed 12 psf (measure on slope).		
7. Weight of exterior wall finish shall not exceed 10 psf, except that veneer wainscots supported on concrete or masonry foundations are permitted to extend up to four feet above the top of foundation.		
8. Weight of interior wall finish shall not exceed 8 psf, except that masonry fireplace surrounds of not more than 4' thick and of up to 100 square feet are permitted to exceed this weight.		
9. Weight of floor finish shall not exceed 5 psf, except that heavier floor finishes of up to 10 psf are acceptable where limted to 1/3 of the total floor area of each level.		
10. Floors in each story are at the same level and not split level, excluding slab on grade portions.		
11. The home floor area, calculated as "B" times "L", as defined in figures 3, 4 or 5 shall not exceed 2,000 sqare feet.		
12. No part of the foundations is constructed of unreinforced masonry or stone.		
13. Clear floor to ceiling heights at any occupied level does not exceed 9'-0".		
If you answered "Compliant" to each of these questions, proceed to Sheet S3. If you answered "Non-compliant" to any of these questions, the home is not eligible to apply this plan set.		

SHEET INDEX

(•) Retrofit schedules sheet #'s listed above (sheets S3.1-1.0 thru S3.6-1.0) are for S_{DS} = 1.0 only. See sheet S3, Figure 2 for sheet numbers for Earthquake Retrofit Schedules for S_{DS}=1.2 and S_{DS}=1.5

Revision: Date:

APPLICANT INFORMATION

APPLICANT:
ADDRESS:
PHONE:
SIGNATURE

Cover Sheet

Vulnerability-Based Retrofit of Living-Space-Over-Garage Dwellings
FEMA P-1100 Plan Set

FEMA

S0

MARCH 2019

Chapter 6
Hillside Homes

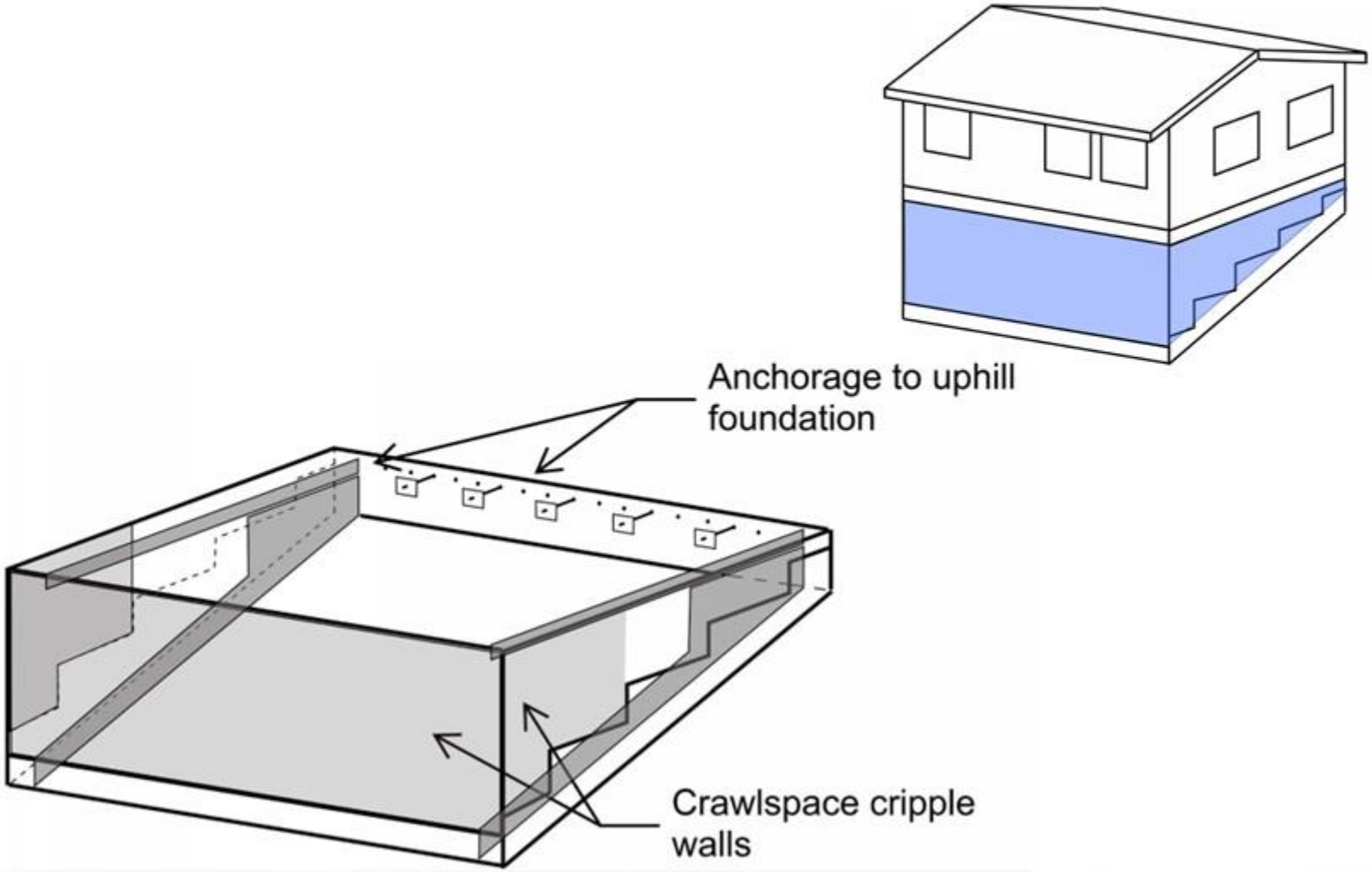
Chapter 6 Hillside

Why Retrofit?

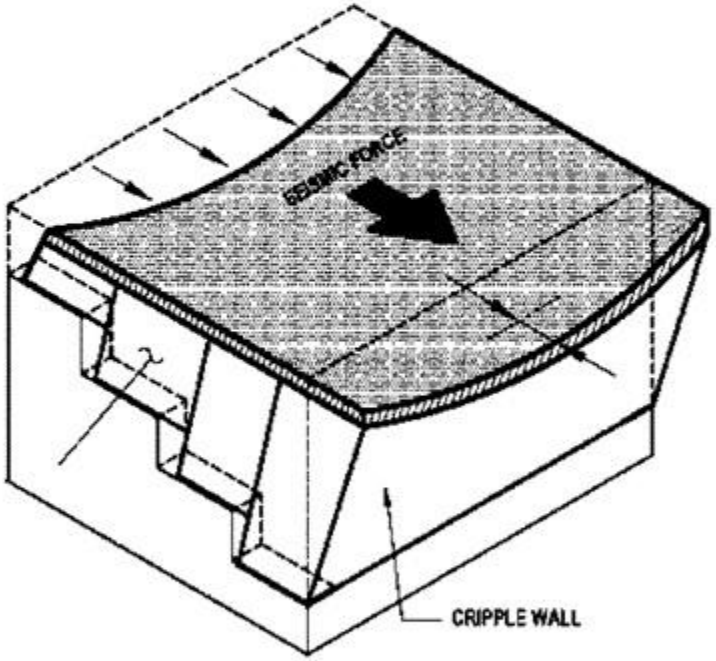
Overarching Retrofit Design Criteria

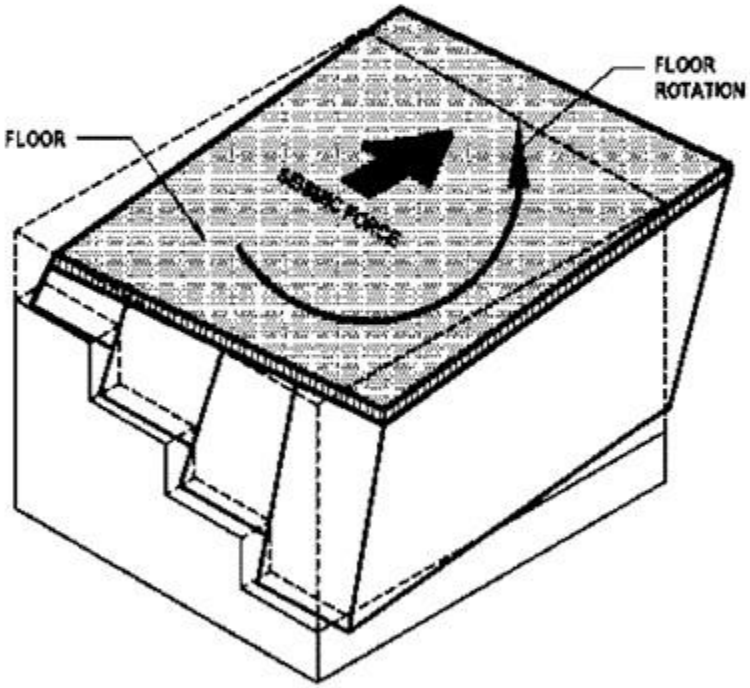
- No prescriptive solutions available
- Collapses at the crawlspace level does pose a large LS risk

Hillside Homes-What Included



Seismic Issue





Prestandard-Eligibility for Use

Table 6.1-1 Eligibility Criteria for Use of Chapter 6 (continued)

Eligibility Criteria		Compliant	Non-Compliant
3	The dwelling is two stories or less above the base-level diaphragm.		
4	The dwelling is of wood *light-frame construction*.		
5	Existing perimeter walls below the base-level diaphragm are of wood light-frame construction, or a combination of wood light-frame and concrete construction.		
6	Existing perimeter walls below the base-level diaphragm are supported on a continuous concrete foundation or will be retrofit to be supported on a continuous foundation. Continuous foundation includes continuous perimeter spread footing with stem w… continuous grade beams or t… on pier or caisson f… continu…		
7	The clea… does not … pace stud wall		
8	The site slope as measured along the sides of the dwelling, starting from the highest uphill point to the lowest downhill point exceeds 1 to 5 (vertical to horizontal).		
9	The *base-level diaphragm* is of wood light-frame construction and is entirely in one plane without vertical offsets, such as a step in the floor or *split level*.		
10	The garage is detached from the dwelling.		
11	The exterior framed walls immediately above the uphill foundation sit directly above the uphill foundation for not less than 75% of the uphill foundation length.		
12	No masonry *chimney* is attached to the side of the dwelling, extends through the dwelling, or sits on any floor level of the dwelling.		

Can use Chapter 6

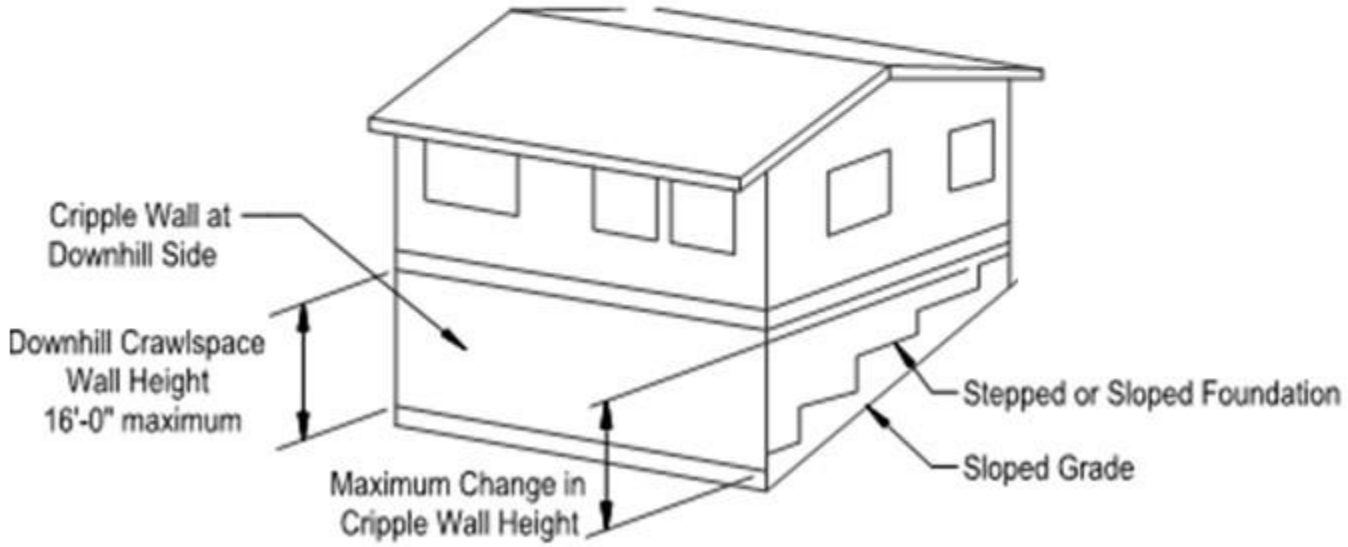
Prestandard-Eligibility for Use

- One- or two-family detached
- Wood light frame
- Unoccupied area below lowest framed floor

Prestandard-Eligibility for Use

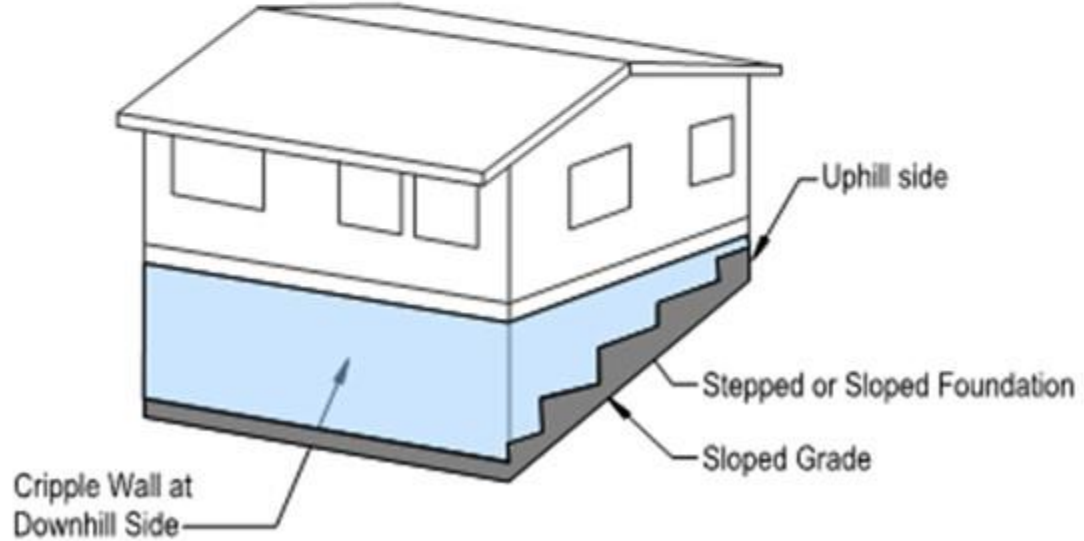
– Min. 7 foot downhill crawlspace wall height (Max. 16 feet)

– Grade slope exceeds 1:5



Prestandard-Eligibility for Use

- Perimeter crawlspace walls are wood or concrete stem walls
- Perimeter crawlspace walls are supported on a continuous concrete foundation **or** foundation will be added

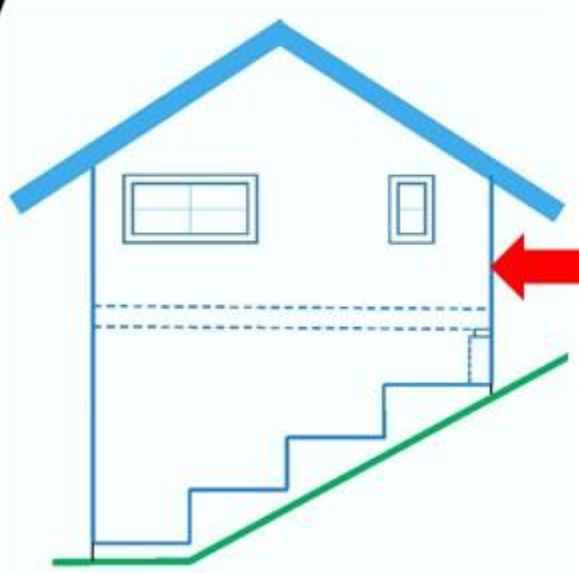


Prestandard-Eligibility for Use

- Max. one or two stories above base-level diaphragm
- Base-level diaphragm is wood framed and in single vertical plane (no steps)

Prestandard-Eligibility for Use

- Exterior framed walls above the uphill foundation sit directly above foundation for at lease 75% of uphill length
- No attached garage
- No masonry chimney



What Dwellings are Included?

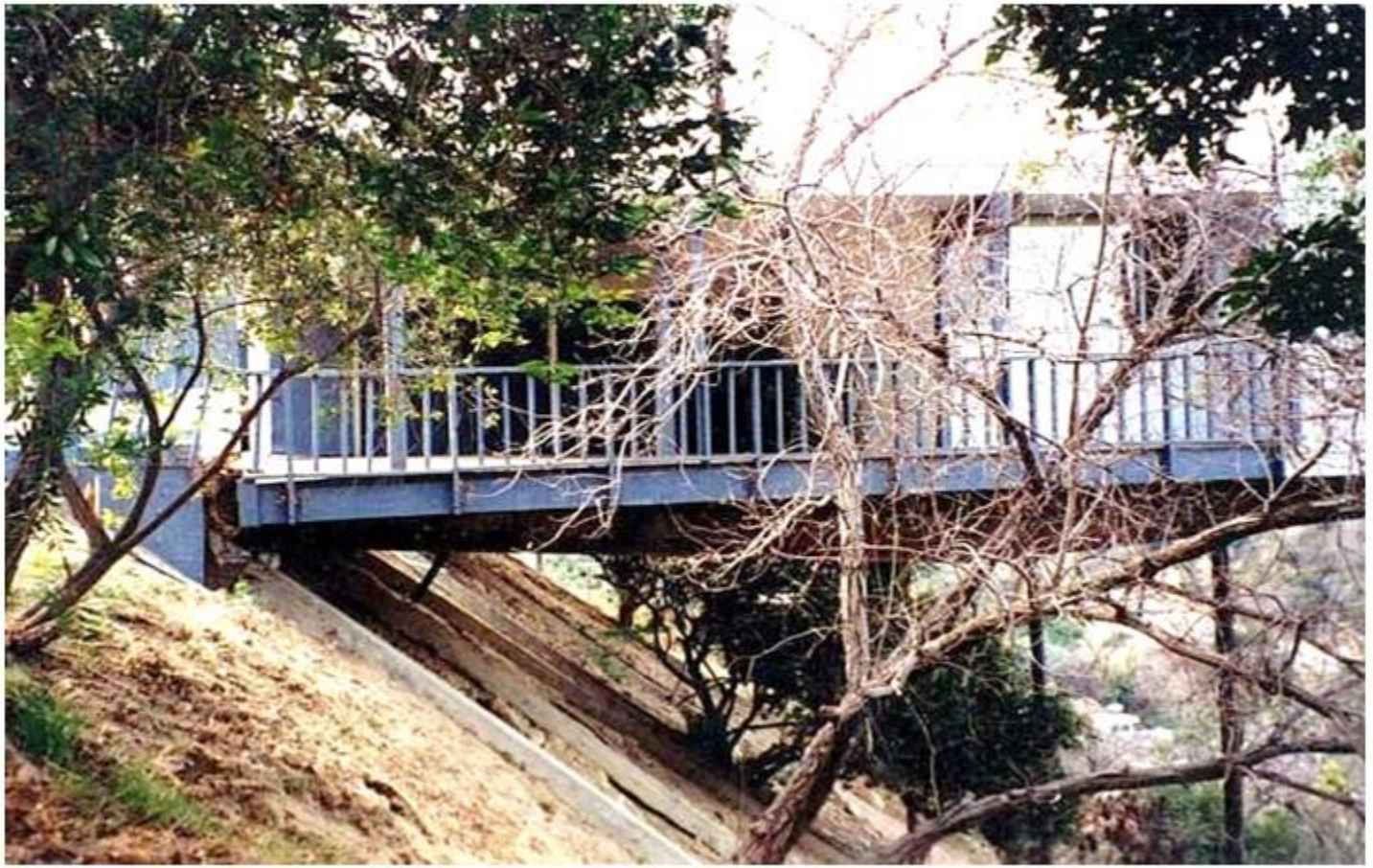
INCLUDED

INCLUDED

What Dwellings are Included?

DEPENDS ON RETROFIT

What Dwellings are Included?

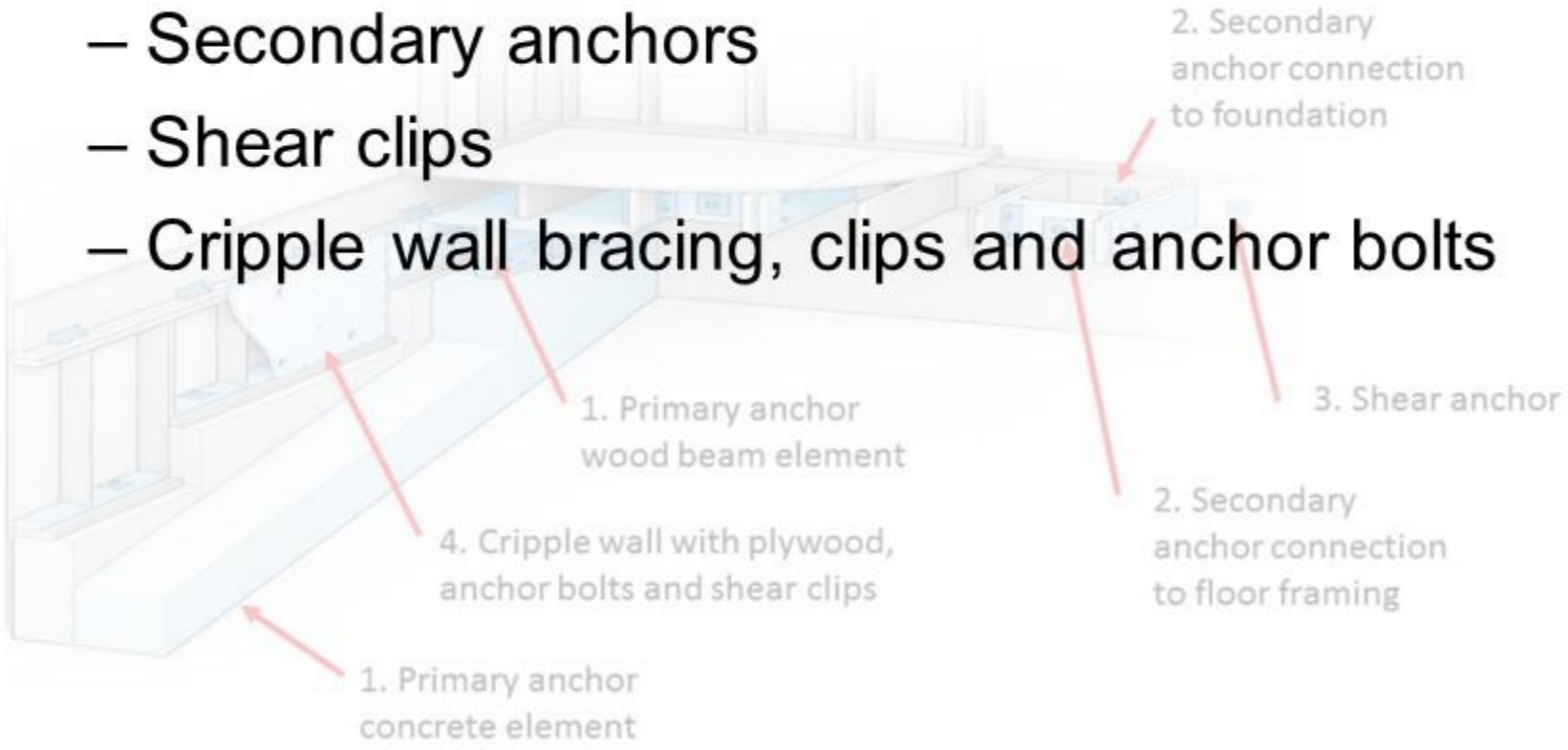


DEPENDS ON RETROFIT

Simplified Engineered Methodology

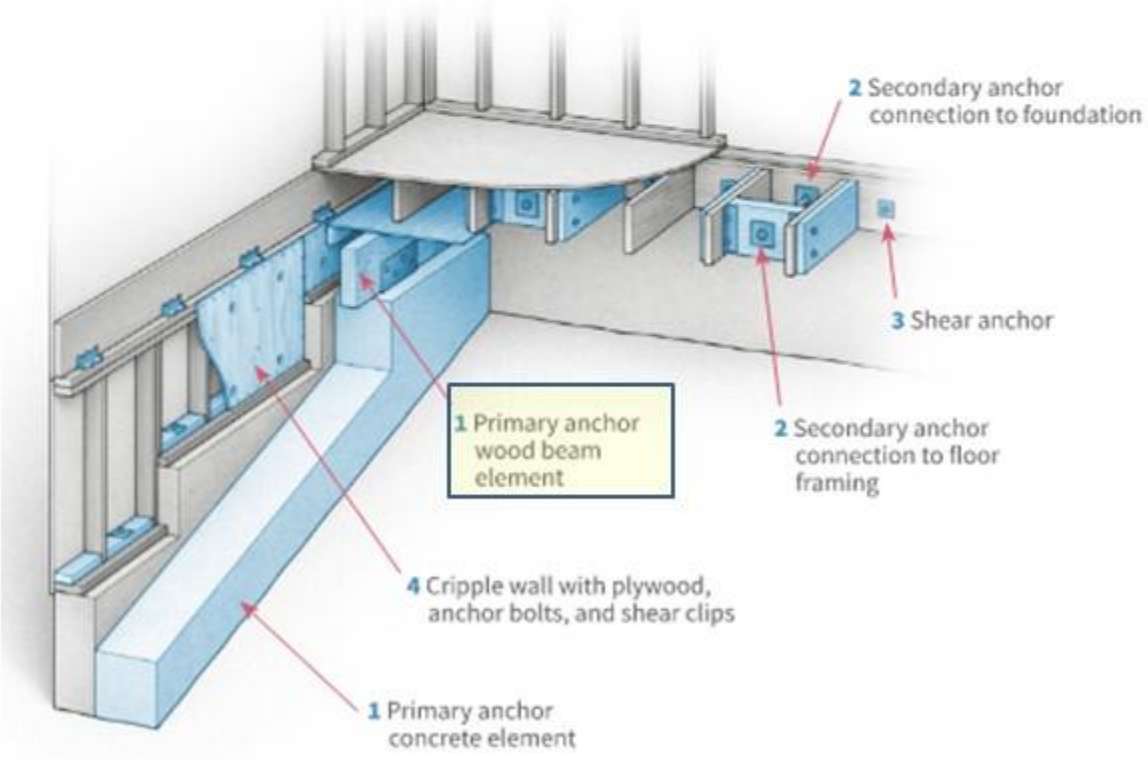
Vulnerability-based approach limited to:

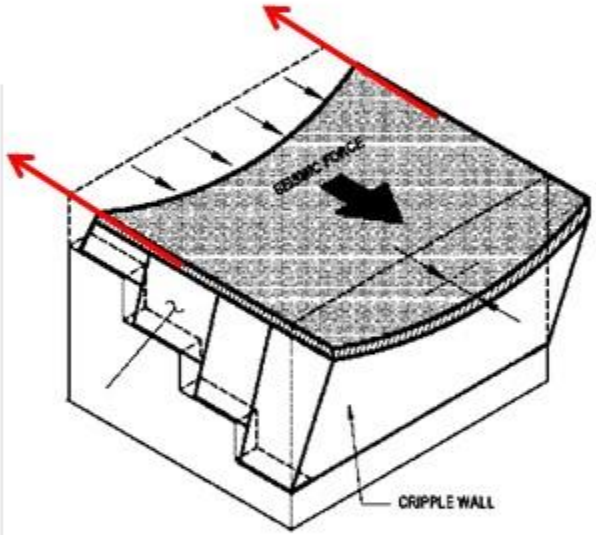
- Primary anchors
- Secondary anchors
- Shear clips
- Cripple wall bracing, clips and anchor bolts



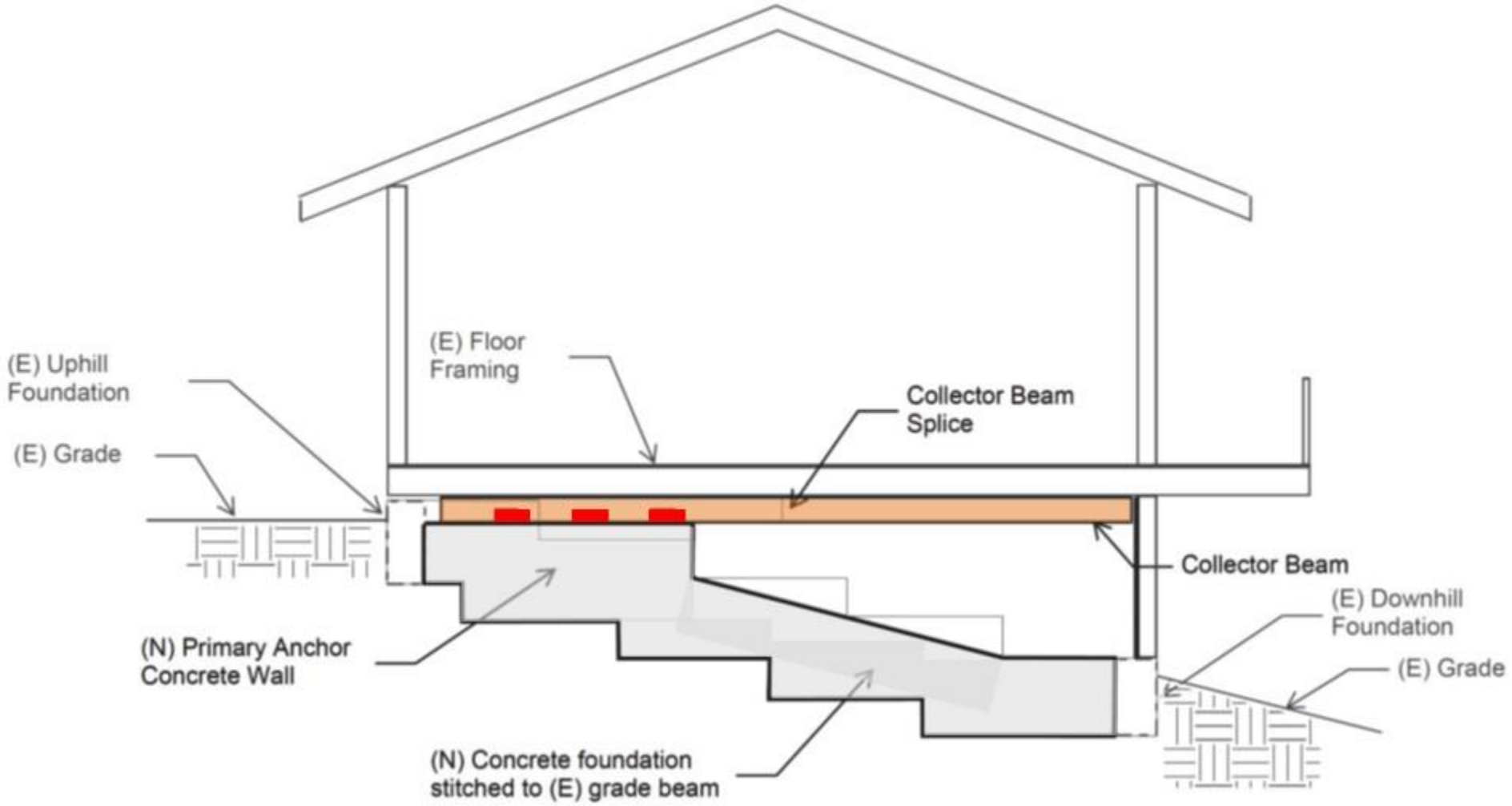
Simplified Engineered Methodology

Primary anchors



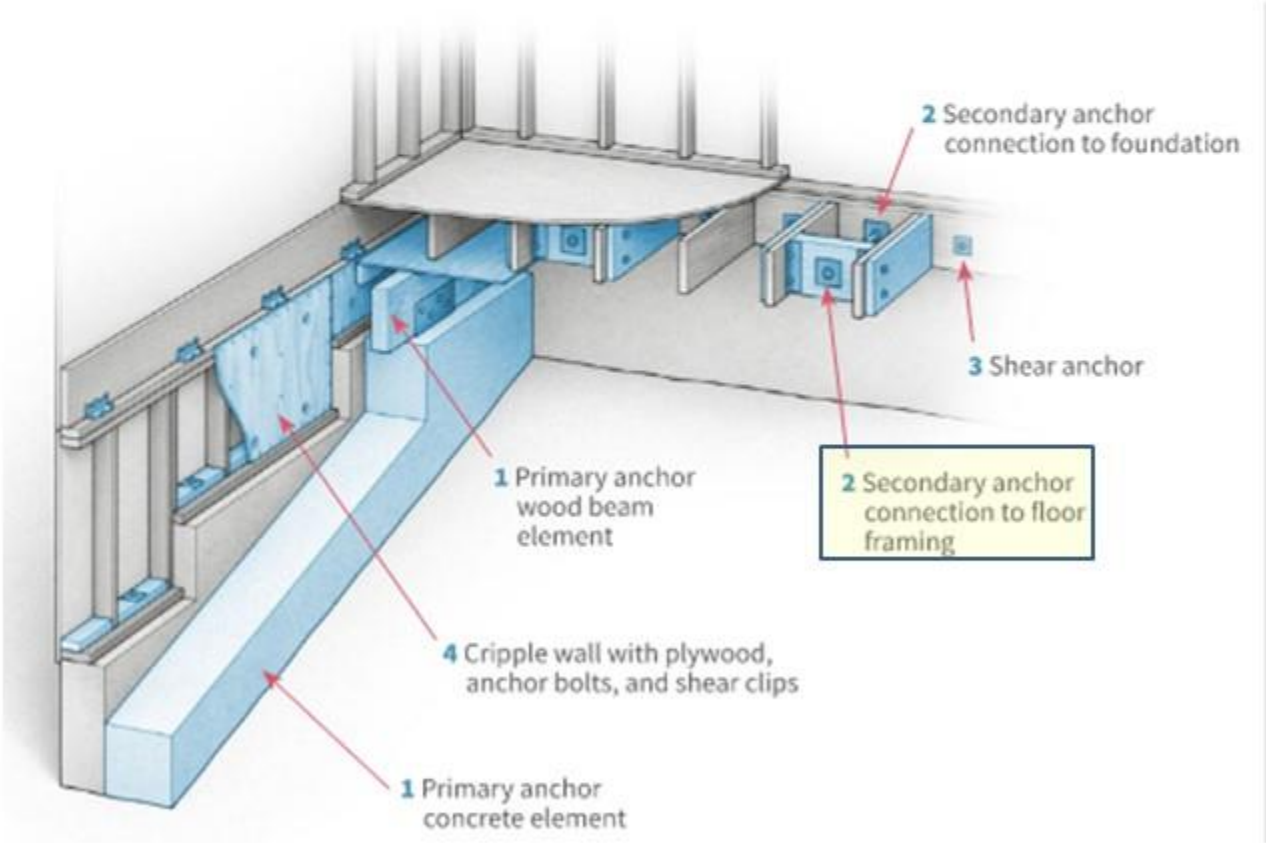


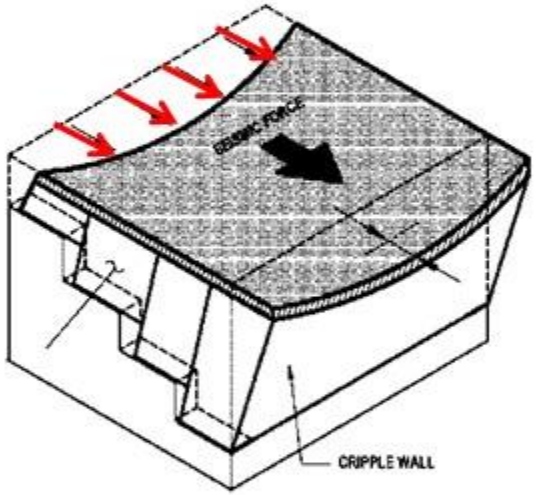
Primary Anchors



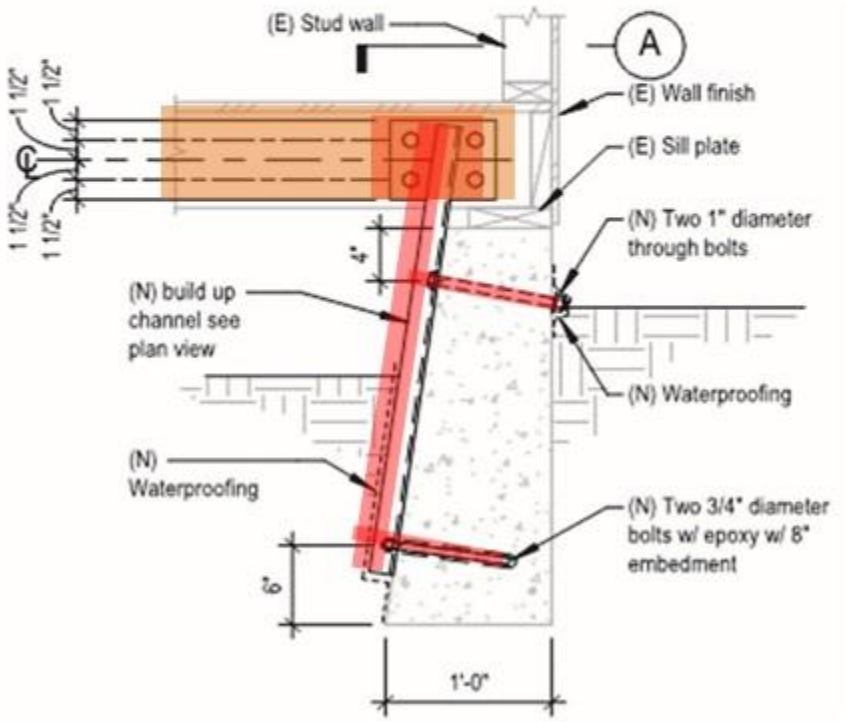
Simplified Engineered Methodology

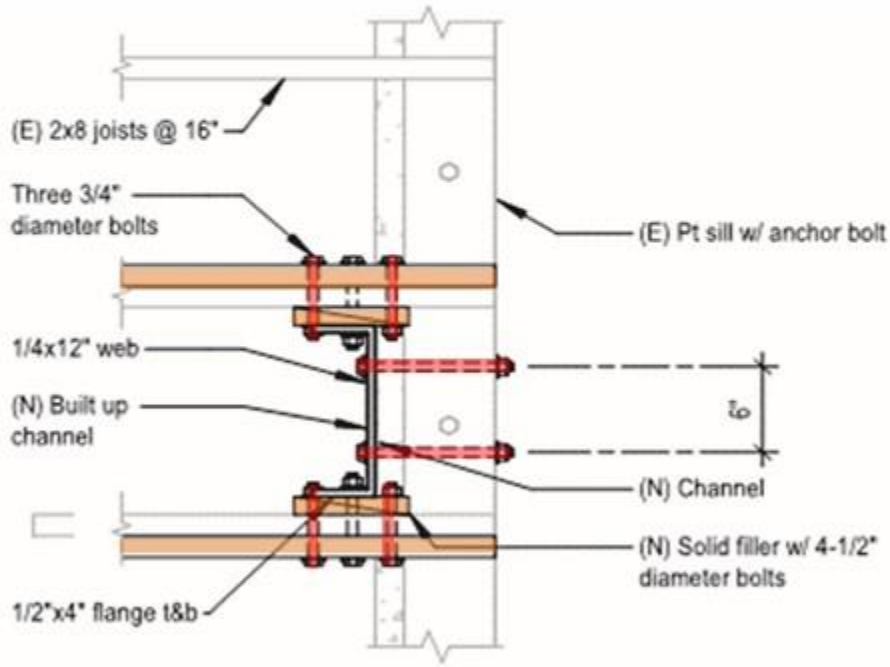
Secondary anchors





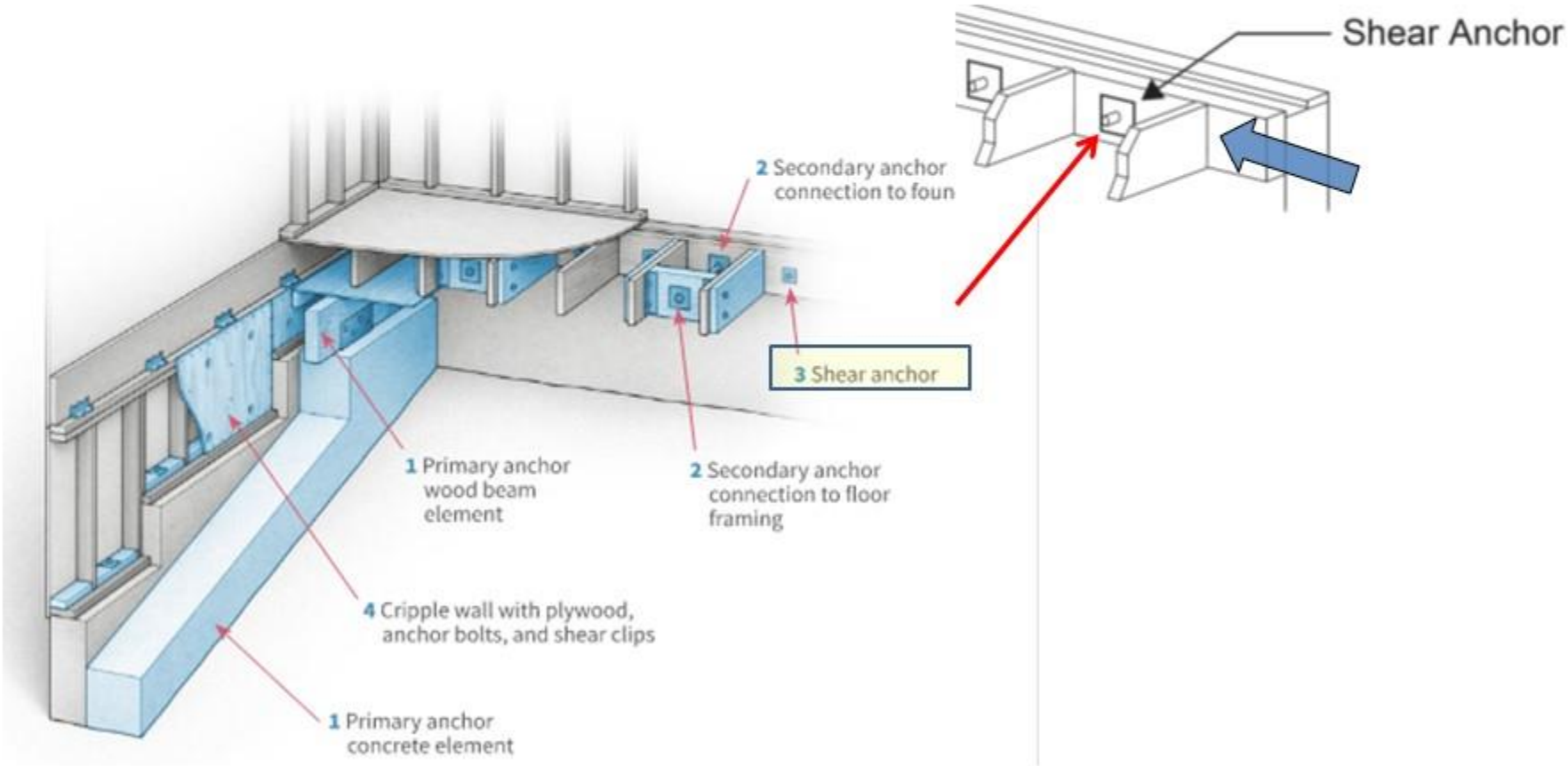
Secondary Anchors





Simplified Engineered Methodology

Shear anchors



Chapter 7
Chimneys and Fireplace Surrounds

Chapter 6 Masonry Chimney's and Fireplace Surrounds

Prestandard-Eligibility for Use

Table 7.1-1 Eligibility Criteria for Use of Prescriptive Chimney Retrofit Provisions (Section 7.4)

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached *one-* or *two-family dwelling* or the dwelling is a unit in a *townhouse*.		
2	The dwelling is a wood light-frame dwelling that is three stories or less above grade plane.		
3	The chimney is constructed of solid brick masonry.		
4	The chimney's largest plan dimension is not more than 40 inches.		
5	The chimney is either an *interior chimney*, or an *exterior chimney* engaging only one exterior wall (i.e. not at the dwelling corner).		

Simplified Assessment Chimney

Table 7.3-1 Simplified Structural Assessment for Masonry Chimneys

Item	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance step if Unknown
1	Interior brick masonry chimneys of single-story dwellings that extend no more than twice the least plan dimension of the chimney above the roof, have no portion more than 6 feet tall that is not enclosed by full-height, finished walls on at least three faces, and whose greatest plan dimension does not exceed 40 inches.	Retrofit of chimney is not required.	Provide detailed assessment or retrofit of chimney.	Provide detailed assessment or retrofit of chimney.
2	Chimneys constructed on or after January 1, 1995.	Retrofit of chimney is not required.	Provide detailed assessment or retrofit of chimney.	Provide detailed assessment or retrofit of chimney.

Simplified Assessment Fireplace Surround

Table 7.3-2 Simplified Structural Assessment for Masonry Fireplace Surrounds

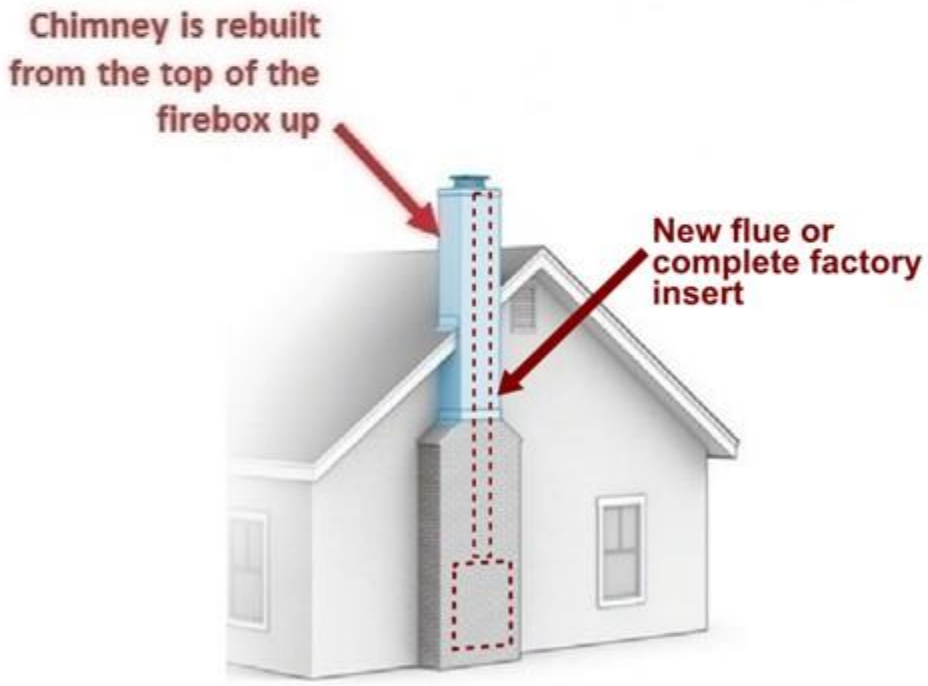
Item	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance step if Unknown
1	Masonry surrounds that extend vertically less than 4 feet above the finished floor or horizontally less than 3 feet from the edge of the *firebox*, OR	Retrofit of masonry surround is not required.	Provide detailed assessment or retrofit of masonry surround.	Provide detailed assessment or retrofit of masonry surround.
2	Masonry surrounds constructed on or after January 1, 1995.	Retrofit of masonry surround is not required.	Provide detailed assessment or retrofit of masonry surround.	Provide detailed assessment or retrofit of masonry surround.

Chimney Retrofit Options Exterior

Remove chimney to just above firebox and cap or reconstruct or…

Chimney Retrofit Options Exterior

…reuse firebox and install new flue or complete new factory insert



Chimney Retrofit Options Interior

Remove chimney to just above roof, floor or ceiling and cap or…

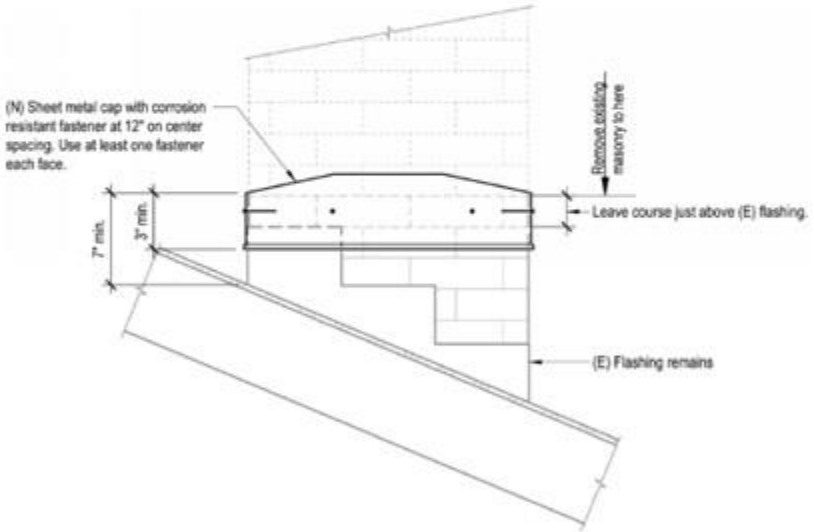


Figure 7.4-1 Capping of chimney removed to roof level (similar to chimney removed to top of firebox).

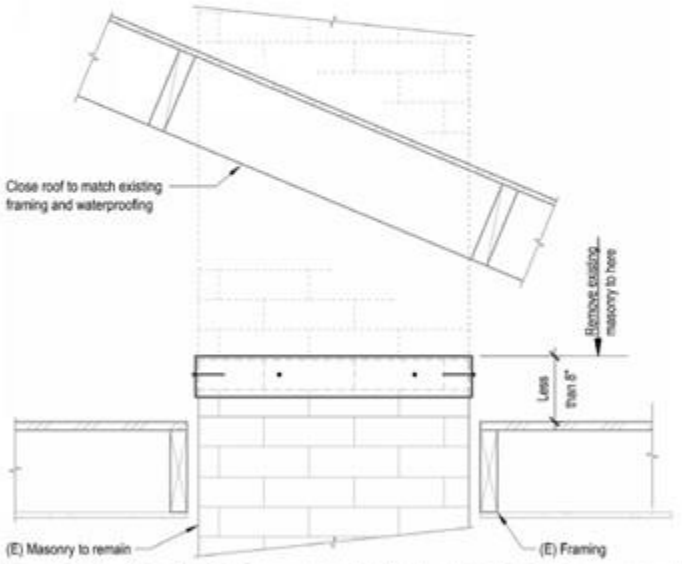
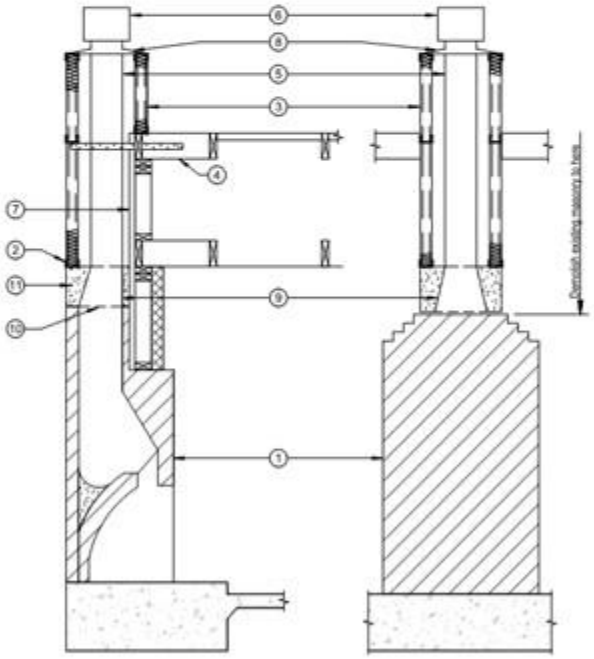
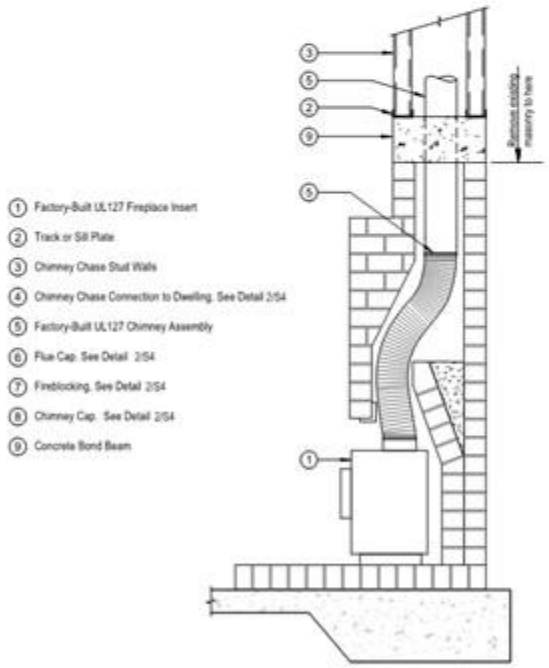


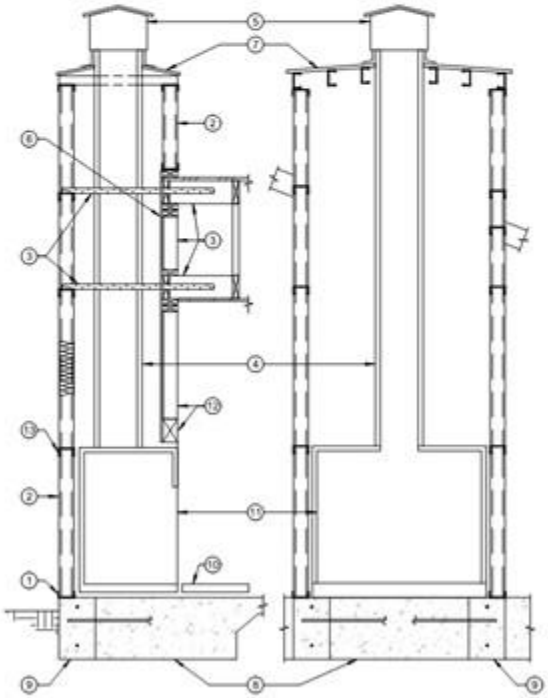
Figure 7.4-2 Capping of chimney removed to floor level (similar to chimney removed to ceiling level).

Chimney Retrofit Options
Interior

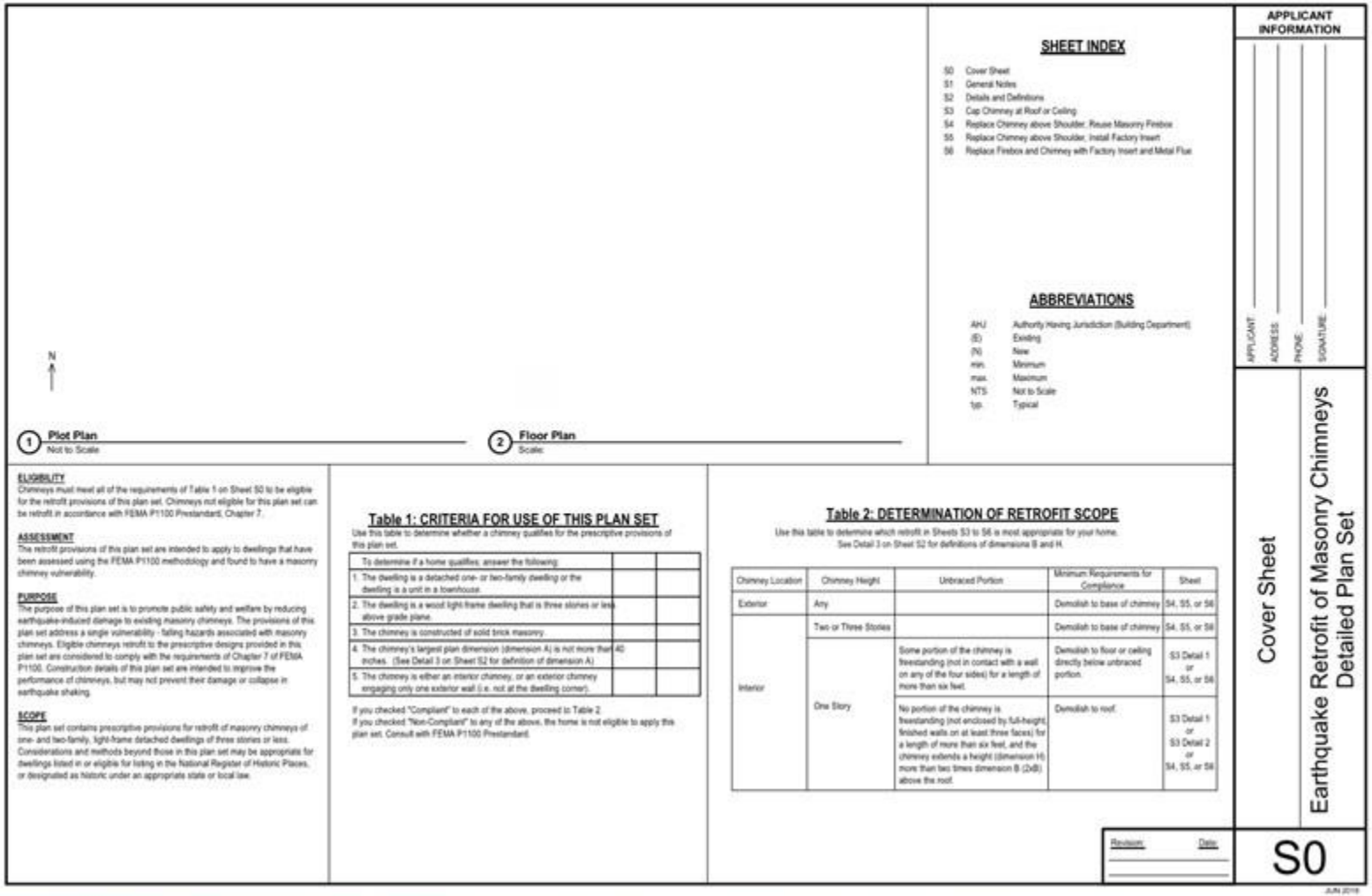
Reuse masonry firebox and install new flue or complete factory insert or reconstruct







Chimney Retrofit – Plan Set



SHEET INDEX

ABBREVIATIONS

AHJ	Authority Having Jurisdiction (Building Department)
(E)	Existing
(N)	New
min.	Minimum
max.	Maximum
NTS	Not to Scale
typ.	Typical

N

1 **Plot Plan** Not to Scale

2 **Floor Plan** Scale:

APPLICANT INFORMATION

APPLICANT

ADDRESS

PHONE

SIGNATURE

ELIGIBILITY
Chimneys must meet all of the requirements of Table 1 on Sheet S0 to be eligible for the retrofit provisions of this plan set. Chimneys not eligible for this plan set can be retrofit in accordance with FEMA P1100 Prestandard, Chapter 7.

ASSESSMENT
The retrofit provisions of this plan set are intended to apply to dwellings that have been assessed using the FEMA P1100 methodology and found to have a masonry chimney vulnerability.

PURPOSE
The purpose of this plan set is to promote public safety and welfare by reducing earthquake-induced damage to existing masonry chimneys. The provisions of this plan set address a single vulnerability - falling hazards associated with masonry chimneys. Eligible chimneys retrofit to the prescriptive designs provided in this plan set are considered to comply with the requirements of Chapter 7 of FEMA P1100. Construction details of this plan set are intended to improve the performance of chimneys, but may not prevent their damage or collapse in earthquake shaking.

SCOPE
This plan set contains prescriptive provisions for retrofit of masonry chimneys of one- and two-family, light-frame detached dwellings of three stories or less. Considerations and methods beyond those in this plan set may be appropriate for dwellings listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

Table 1: CRITERIA FOR USE OF THIS PLAN SET

Use this table to determine whether a chimney qualifies for the prescriptive provisions of this plan set.

To determine if a home qualifies, answer the following:		
1. The dwelling is a detached one- or two-family dwelling or the dwelling is a unit in a townhouse.		
2. The dwelling is a wood light-frame dwelling that is three stories or less above grade plane.		
3. The chimney is constructed of solid brick masonry.		
4. The chimney's largest plan dimension (dimension A) is not more than 40 inches. (See Detail 3 on Sheet S2 for definition of dimension A)		
5. The chimney is either an interior chimney, or an exterior chimney engaging only one exterior wall (i.e. not at the dwelling corner).		

If you checked "Compliant" to each of the above, proceed to Table 2.
If you checked "Non-Compliant" to any of the above, the home is not eligible to apply this plan set. Consult with FEMA P1100 Prestandard.

Table 2: DETERMINATION OF RETROFIT SCOPE

Use this table to determine which retrofit in Sheets S3 to S6 is most appropriate for your home. See Detail 3 on Sheet S2 for definitions of dimensions B and H.

Chimney Location	Chimney Height	Unbraced Portion	Minimum Requirements for Compliance	Sheet
Exterior	Any		Demolish to base of chimney	S4, S5, or S6
Interior	Two or Three Stories		Demolish to base of chimney	S4, S5, or S6
	One Story	Some portion of the chimney is freestanding (not in contact with a wall on any of the four sides) for a length of more than six feet.	Demolish to floor or ceiling directly below unbraced portion.	S3 Detail 1 or S4, S5, or S6
		No portion of the chimney is freestanding (not enclosed by full-height, finished walls on at least three faces) for a length of more than six feet, and the chimney extends a height (dimension H) more than two times dimension B (2xB) above the roof.	Demolish to roof.	S3 Detail 1 or S3 Detail 2 or S4, S5, or S6

Revision: Date:

Cover Sheet

Earthquake Retrofit of Masonry Chimneys
Detailed Plan Set

S0

JUN 2016

Thank You

EXTRA SLIDES

Performance Objective

- Primary (Probability of Collapse)
  - Approximately 10%-20% under the Maximum Considered Earthquake
- Secondary:
  - Indicator of level of repair – Probability of exceeding 0.75% drift at 0.4 MCER
  - Indicator of safety for continued occupancy – Probability of exceeding 1.5% drift at 2/3 MCER

Appendix B

FEMA P-530 Presentation by Colin Blaney

OSSPAC Meeting
March 10th, 2020

FEMA P-530
Earthquake Safety at Home

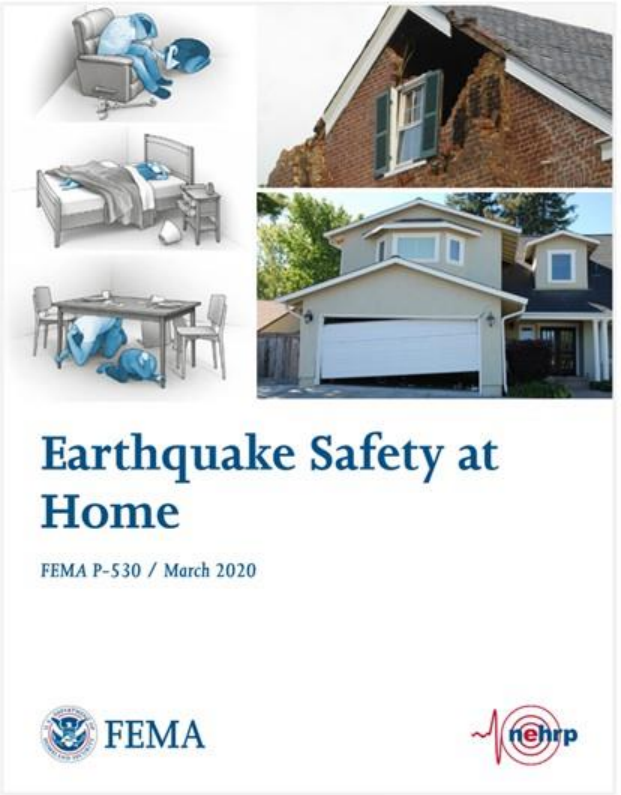
Prepare, Protect, Survive, Respond, Recover and Repair

Colin Blaney S.E.
BUEHLER
Project Technical Director

Audience

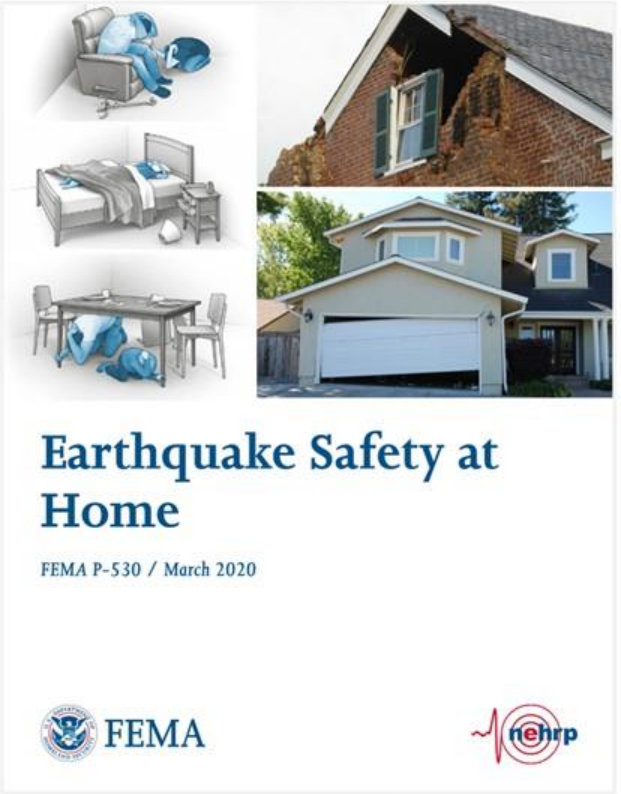
Written for homeowners, renters, families and anybody who travels to earthquake country

https://www.fema.gov/media-library/assets/documents/186094



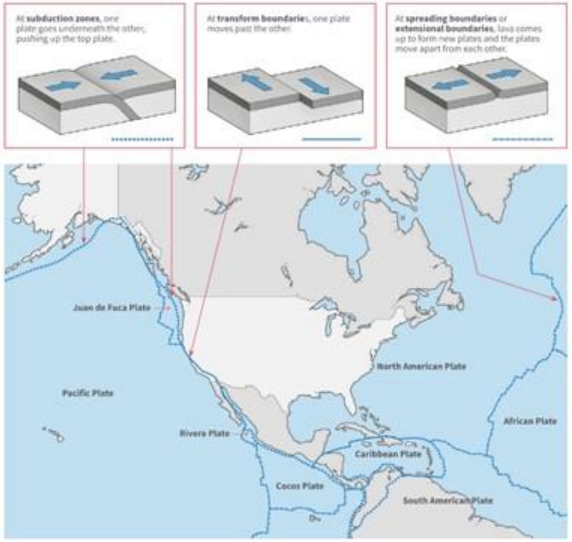
Project Vision

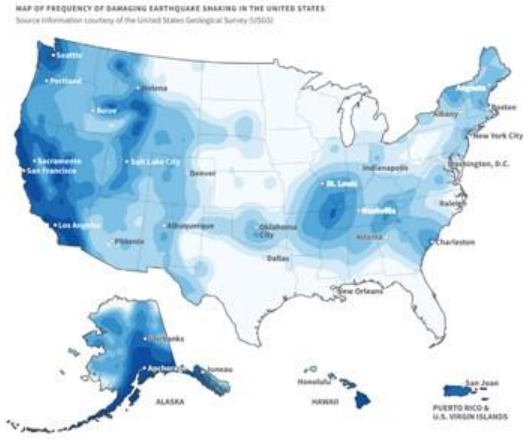
Comprehensive national guide to earthquake safety at home

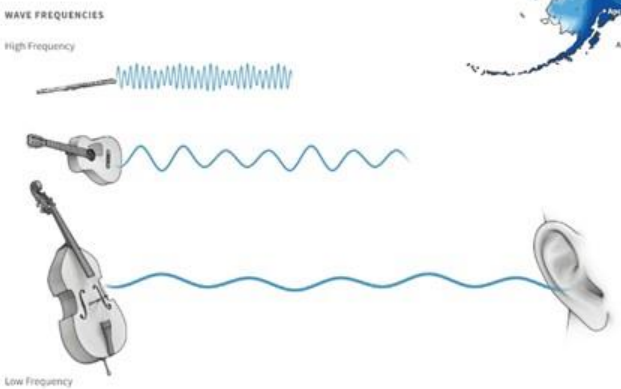


Project Vision

Include introduction on earthquake basics and region-specific facts

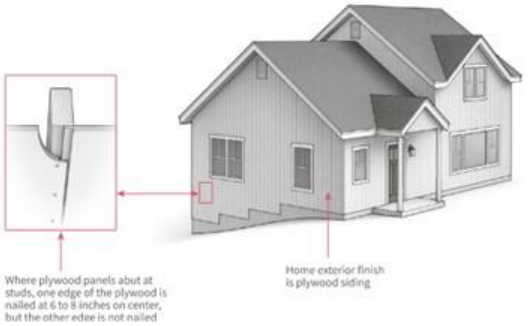


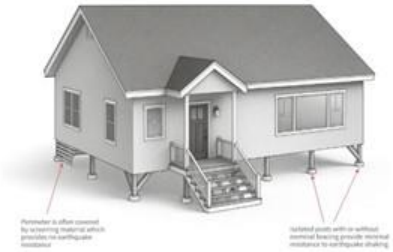


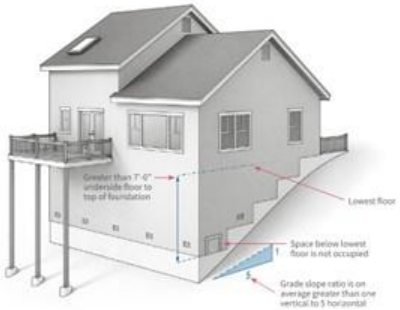


Project Vision

Identify and provide guidance for common structural (seismic) vulnerabilities

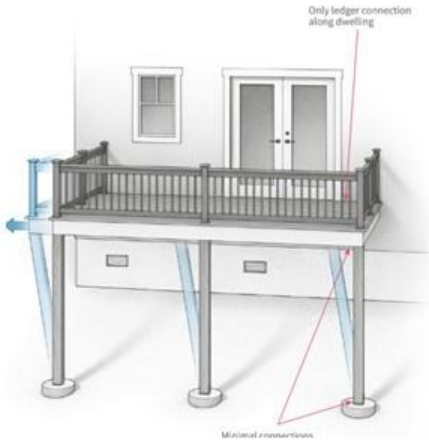


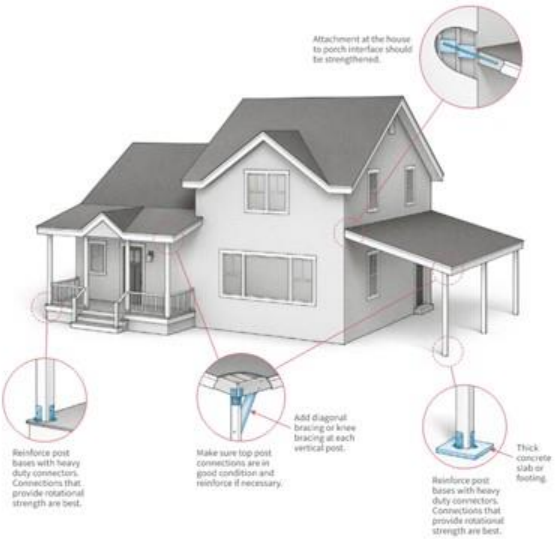


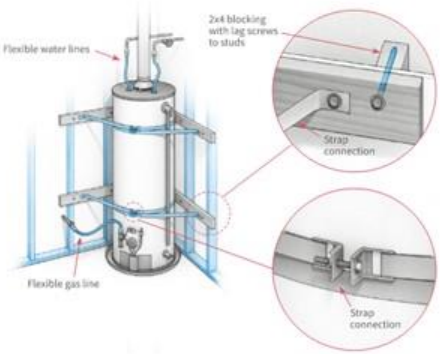


Project Vision

Address other home hazards

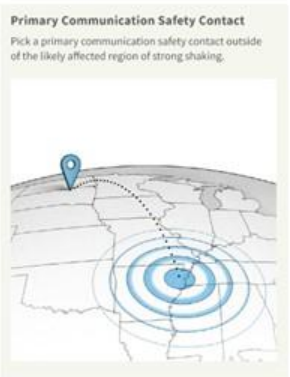


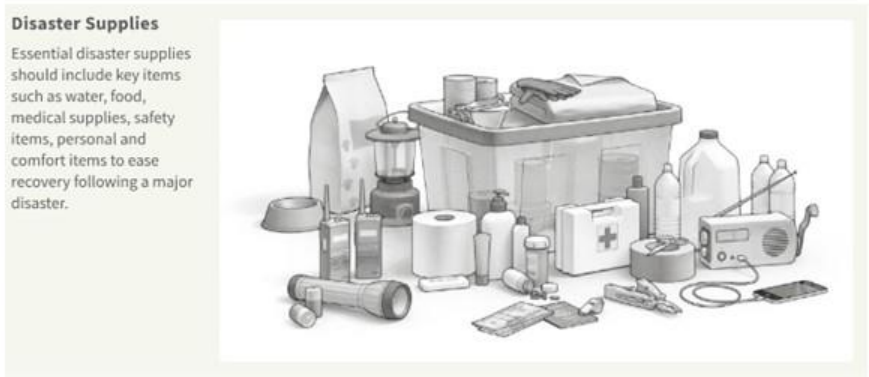




Project Vision

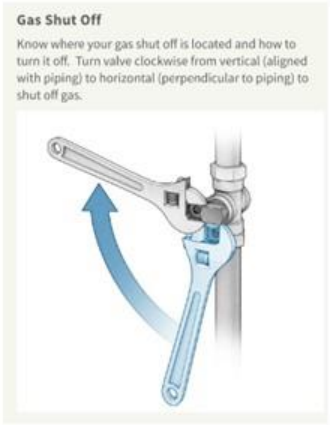
Include actionable advice on earthquake preparation, survival, response, recovery and repair

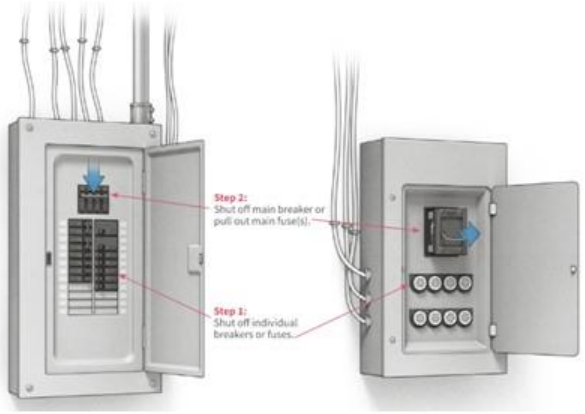




Project Vision

Develop simple, easily digestible messages and powerful graphics





Project Vision

Create sections in a logical order but such that they could be distributed independently after disasters

Earthquakes Across America

Understanding Earthquake Basics and Your Risk

Prepare

Securing Your Space, Making a Plan, and Organizing Your Disaster Supplies

Protect

Identifying and Addressing Your Vulnerabilities

Survive

Knowing What to Do During and Immediately after the Earth Shakes

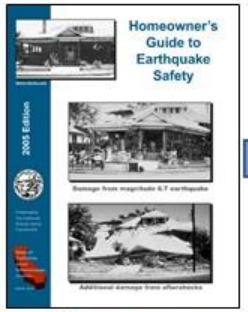
Respond

Getting Back in Your Home - The First Few Days

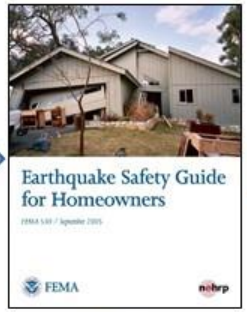
Recover and Repair

Restarting Utilities and Repairing Damage

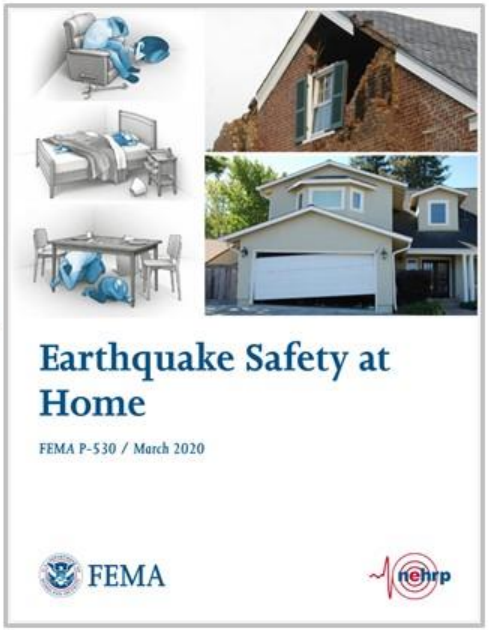
Primary Influencers

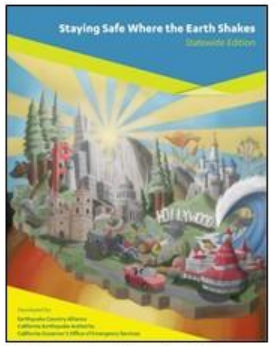


California Seismic Safety Commission
2005

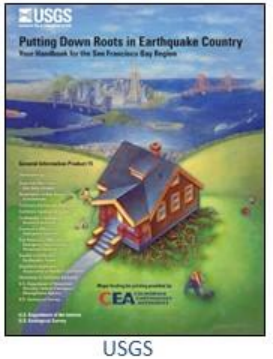


FEMA
2005



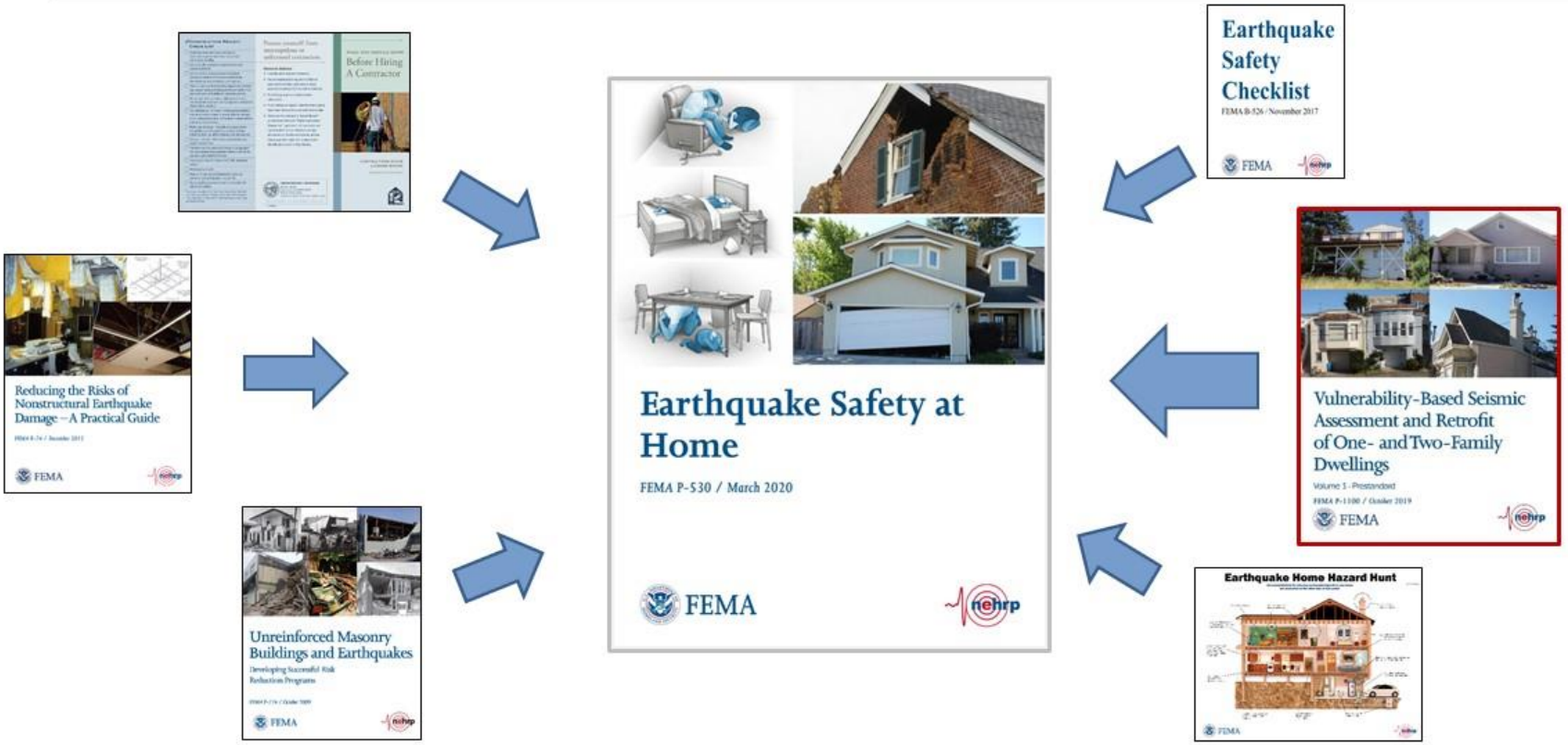


Earthquake County Alliance
California Earthquake Authority
CalOES

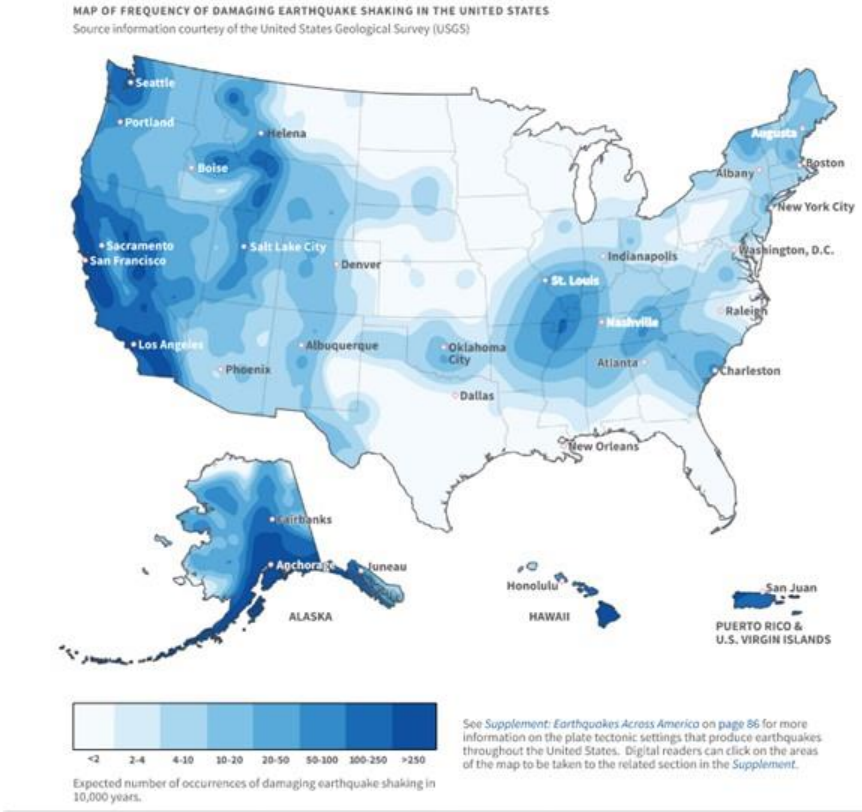


USGS
California Earthquake Authority

Secondary Influencers



Earthquakes Across America



See *Supplement: Earthquakes Across America* on page 86 for more information on the plate tectonic settings that produce earthquakes throughout the United States. Digital readers can click on the areas of the map to be taken to the related section in the *Supplement*.

Prepare

Securing Your Space, Making a Plan, and Organizing Your Disaster Supplies

Prepare

No cost, low cost, higher cost tasks

Plan essentials, post-event communication and reunification plan

Risk at Home!

There are many contents within a home that present a potentially significant risk to your safety during and following a major earthquake. The image below shows interior damage following the 1994 Northridge Earthquake that occurred in California.

PHOTO COURTESY OF WISS, JANNEY, ELSTNER

Primary Communication Safety Contact

Pick a primary communication safety contact outside of the likely affected region of strong shaking.

Disaster Supplies

Essential disaster supplies should include key items such as water, food, medical supplies, safety items, personal and comfort items to ease recovery following a major disaster.

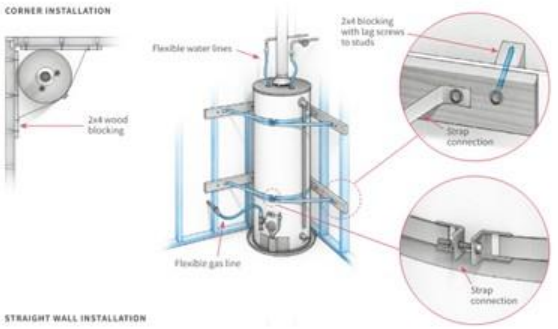
Protect

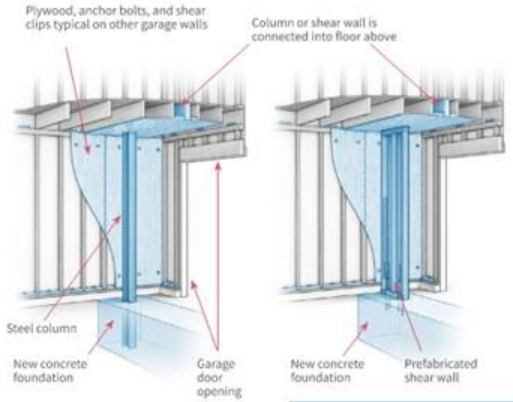
Identifying
and Addressing
Your Vulnerabilities

Protect

Earthquake Strengthening Projects

Retrofit Project	Page	Do-it-yourself	Contractor may be required	Design professional may be required	"Off-the-shelf" or prescriptive solutions available
SMALL PROJECTS					
Restrain Free-Standing Water Heater	28	•	•		•
Anchor Elevated Decks, Porches, Trellises, and Carports	30	•	•	•	
MEDIUM PROJECTS					
Strengthen Weak Cripple Walls and Anchor Floors	34	•	•	•	•
Strengthen Improperly Nailed Plywood Siding	36	•	•		
LARGE PROJECTS					
Strengthen Hillside Home Anchorage to Foundations	38		•	•	
Strengthen Garage in Living-Space-over-Garage Homes	40		•	•	•
Brace Homes Supported on Post and Piers	42		•	•	•
Strengthen Homes with Unreinforced Masonry Walls	44		•	•	
Strengthen Unreinforced Stone or Masonry Foundations	46		•	•	
Retrofit Masonry Chimneys	48		•	•	•





Survive

Knowing What to Do During and Immediately after the Earth Shakes

Survive

Drop, Cover, and Hold On!

When the building begins to shake, the immediate actions to take for your safety are:

For earthquake protective actions for people with mobility disabilities, see page 57.

GRAPHIC COURTESY OF EARTHQUAKE COUNTRY ALLIANCE AND SOUTHERN CALIFORNIA EARTHQUAKE CENTER

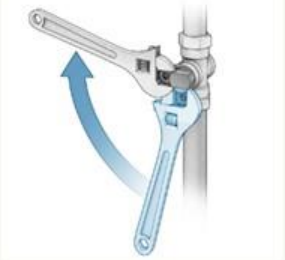
HTTPS://WWW.SHAKEOUT.ORG

Outdoors

Move away from the exterior walls of your home to an open area to prevent building elements, such as glass, chimneys, stone or masonry veneer siding, and parapets from falling on you.

Gas Shut Off

Know where your gas shut off is located and how to turn it off. Turn valve clockwise from vertical (aligned with piping) to horizontal (perpendicular to piping) to shut off gas.



Respond

Getting Back in Your Home - The First Few Days

Respond

Home Safety Checklist Summary

Potentially Damaged Area or Condition	Page	OK	Needs Attention	Resolved	Notes
Gas	62				
Propane or Other Fuel Tanks	62				
Masonry Chimneys	63				
Masonry Walls and Parapets	64				
Solar Panels	64				
Manufactured (Mobile) Homes	65				
Electrical	66				
Water Leaks	67				
Masonry Veneer Detachment	68				
Racked and Leaning Walls, Gaps, Stuck Doors and Windows	69				
Sewer Lines	70				
Glass	70				
Water Heaters	71				
Small Appliances	71				
Furniture and Home Contents	72				
Wall Damage	73				

Wall Damage

☐ OK

☐ Needs Attention

○ Resolved

Check interior and exterior wall finish materials, such as stucco, gypsum board, and plaster, for cracks greater than ⅛-inch wide and several feet long. Check for bulging or buckling finish material, or detachment of finish material from the walls (finish material moves when pushed on or gaps between framing and finish material are detectable).

If Occurs:

Request a home safety evaluation (see page 74). Where none of the exterior doors are operable, do not occupy home until doors are made operable and the home safety evaluation has occurred. Where one or more doors remain operable, the home can be occupied, but damage and required repairs should be evaluated by an insurance professional or design professional (architect or engineer). This finish material damage is an indicator that repair of damage may require more than just patching and painting.

Significant cracking of wall finish materials.
PHOTOS OF DAMAGE TO WALL FINISH MATERIALS FROM ANCHORAGE EARTHQUAKE. COURTESY OF JANISE RODGERS, AVAILABLE AT WWW.EERI.ORG, LAST ACCESSED 8/3/19

Repair and Recover

Hiring a Contractor

A contractor offering to provide services should be able to provide the firm's contractor's license number. You should be able to confirm that the license is valid and current online or by phone.

Hiring an Architectural or Engineering Firm

An architectural or engineering firm offering to provide services should be able to provide the license or registration number of the architect or engineer having oversight of the work. You should be able to confirm that the license is valid and current online or by phone. If you are not working directly with the person whose name appears on the registration, you are encouraged to contact them by phone to ensure that they are knowledgeable regarding the services being provided.

Building Permits

A building permit will need to be obtained for any repair work beyond painting and similar maintenance activities.

Acknowledgements

Mike Mahoney- FEMA
Andrew Herseth- FEMA
Jon Heintz-Applied Technology Council
Ayse Hortacsu- Applied Technology Council
Zahraa Saiyed- Project Management Consultant
Kelly Cobeen- Wiss, Janney, Elstner
Michael Griffin- CCS Group. Inc.
Dr. Lucy Jones – Center for Science and Society
Christopher Mills- Christopher Mills Illustrations
Christina Zagara- Creative Engagement Solutions, LLC
Carol Singer- Carol Singer Design
Mark Benthien- Southern California Earthquake Center
Fred Turner- Alfred E. Alquist Seismic Safety Commission

Questions