

## 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
  - Foundation si

The primary purpose  
damage to wood light

This Guideline is  
**EXTREMELY** expensive  
to use. For more  
information go to  
[https://  
bayarearetrofit.com/  
fema-p-1100-icc-1300-  
and-standard-plan-a/](https://bayarearetrofit.com/fema-p-1100-icc-1300-and-standard-plan-a/)

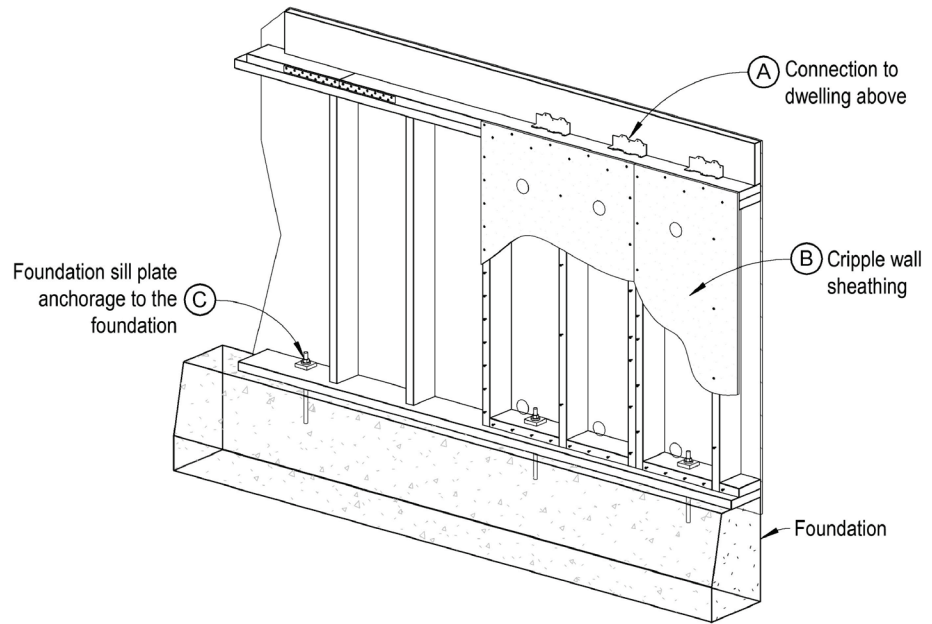


Figure 4.1-1 Example illustration of Configuration A.

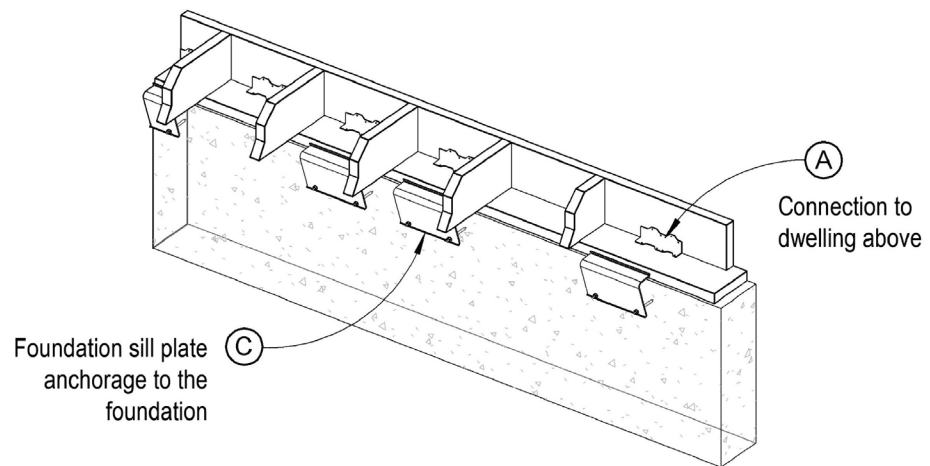


Figure 4.1-2 Example illustration of Configuration B.

#### 4.1.1 Use of this Chapter

In addition to the scope limits of Section 1.8, the dwelling shall comply with all of the eligibility criteria of Table 4.1-1. Where the dwelling is not compliant with one or more of the eligibility statements, assessment and retrofit in accordance with this chapter shall not be permitted.

#### 4.1.2 Vulnerability-Based Assessment and Retrofit Methods

Where a dwelling complies with Section 4.1.1, the dwelling need not be assessed and may be retrofitted in accordance with the prescriptive retrofit provisions of Section 4.4 or the simplified engineered retrofit provisions of Section 4.5 as applicable. If the dwelling does not comply with Section

4.1.1, assessment shall be in accordance with Section 4.3; alternately, assessment is not required if retrofit is to be provided. Where retrofit is required by Section 4.3, retrofit shall be in accordance with Section 4.1.3 or Section 4.1.4.

**Table 4.1-1 Eligibility Criteria for Use of Chapter 4**

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is a detached <i>one- or two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> and assessment and retrofit will occur for each attached <i>townhouse unit (the full townhouse structure)</i> .		
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 and the perimeter walls of the occupied stories (not including porches or other appurtenances) are supported on: <ul style="list-style-type: none"> <li>a. Cripple walls foundation systems (Configuration A), or</li> <li>b. Foundation stem walls or foundations without cripple walls (Configuration B), or</li> <li>c. Post and pier systems to be retrofitted with cripple walls, or</li> <li>d. Cripple wall foundation systems or foundation without cripple walls in combination with a <i>slab-on-ground</i> foundation.</li> </ul>		
4	The dwelling has a continuous <i>perimeter foundation</i> (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 end does not exceed 5 to 1 (horizontal to vertical) or 20%.		

#### **4.1.3 Prescriptive Retrofit**

For dwellings that meet the eligibility criteria of Table 4.1-1 and all of the additional eligibility criteria of Table 4.1-2, retrofit of the non-conforming conditions shall be permitted to use the prescriptive retrofit provisions of Section 4.4.

#### **4.1.4 Simplified Engineered Retrofit**

Where the prescriptive retrofit provisions of Section 4.4 are not used, a simplified engineered retrofit shall be provided in accordance with Section 4.5.

**Table 4.1-2 Additional Eligibility Criteria for Use of Prescriptive Retrofit Provisions of Section 4.4**

Eligibility Criteria		Compliant	Non-Compliant
1	The dwelling is assigned to <i>Seismic Design Category</i> (SDC) B through E in accordance with Section 1.6.		
2	The weight of roofing material shall not exceed 12 psf except where allowed by Section 4.4.10 for one-story crawlspace dwellings with clay tile roofing.		
3	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, except <i>masonry fireplace surrounds</i> not more than 4 inches thick and not more than 100 square feet in area are permitted to exceed this weight.		
5	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.		
6	Floors in each story are at the same elevation, excluding slab-on-ground portions.		
7	The maximum square footage of the dwelling, excluding areas supported on slabs on grade, do not exceed 3,000 square feet for one-story dwellings and 4,000 square feet for two-story dwellings.		
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	There is no indication that an engineered <i>seismic force-resisting system</i> is present in the dwelling (engineered plans, visible <i>tie-down</i> brackets).		

## 4.2 Definitions and Minimum Requirements

The definitions of Chapter 2 are applicable to all assessments and all retrofits designed in accordance with Chapter 4. The minimum requirements of Chapter 3 are applicable to all retrofits designed in accordance with Chapter 4. See Figure 4.4-18 for minimum requirements at existing single and double top plate splices, cutouts at braced wall panels, and allowable notching and reinforcing for cripple wall top plates and studs.

## 4.3 Vulnerability-Based Assessment

### 4.3.1 Scope

The assessment criteria of this section shall be used to determine whether existing foundations, anchorage, cripple walls, and connections are in compliance with the requirements of this chapter. Where they are in compliance with the requirements of this chapter, retrofit is not required. Where they are found to not be in compliance with the requirements of this chapter, retrofit in accordance with Section 4.4, Section 4.5, or a general engineered retrofit is required. The assessment provisions of Section 4.3 shall be permitted to be used provided existing cripple wall heights are 4



feet or less, and first floor framing is supported directly on cripple walls, a foundation sill, or any combination of the two, and where any existing retrofit work to be considered in the assessment obtained a building permit prior to the date of original publication of this prestandard.. Where Section 4.3.2 requires a detailed assessment, this detailed assessment shall be provided in accordance with Section 4.3.3.

In lieu of a detailed assessment, the dwelling may be retrofit in accordance with Section 4.4 or 4.5 as applicable.

#### **4.3.2 Simplified Assessment**

Crawlspace dwellings shall be assessed in accordance with Table 4.3-1. Each existing element listed in Table 4.3-1 and members to which these elements are directly attached, shall be assessed to identify incomplete or inadequate installation, damage, and deterioration that might significantly affect seismic performance. Where this assessment identifies incomplete or inadequate installation, damage or deterioration, the elements shall be deemed not adequate for use. For these conditions, the applicable assessment statement within Table 4.3-1 shall be determined to be false and the indicated compliance step taken. Alternately, a detailed assessment of existing elements in accordance with Chapter 8 may be provided.

The scope of this assessment shall be permitted to be based on the judgment of the evaluator. The findings and documentation of this investigation shall be subject to the approval of the *building official* where required.

**Table 4.3-1 Simplified Structural Assessment for Crawlspace Dwellings**

<b>Item</b>	<b>Existing Configuration</b>	<b>Assessment Statement</b>	<b>Compliance Step if True</b>	<b>Compliance Step if False</b>	<b>Compliance Step if Unknown</b>
1	A	The tallest cripple wall height does not exceed 4 feet.	Proceed to Item 2.	Provide engineered assessment or retrofit of sheathing, anchorage to foundation, and connection to dwelling above.	Not applicable.
2	A, B	Existing concrete foundation condition is adequate for use.	Retrofit of foundation is not required.	Retrofit of foundation is required.	Provide detailed assessment of foundation in accordance with Section 8.1.

**Table 4.3-1 Simplified Structural Assessment for Crawlspaces Dwellings (continued)**

Item	Existing Configuration	Assessment Statement	Compliance Step if True	Compliance Step if False	Compliance Step if Unknown
3	A1	For the cripple wall with foundation system, the connectors to dwelling above are in condition adequate for use and are spaced on average, a maximum of 32 inches on center for a one-story dwelling or 16 inches on center for a two-story dwelling on average along each perimeter wall line.	Retrofit of connectors to dwelling above is not required.	Retrofit of connectors to dwelling above is required.	Provide detailed assessment or retrofit of connectors to dwelling above.
4	B1	For foundations without cripple walls, connectors to dwelling above are in adequate condition and are spaced on average a maximum, 32 inches on center for a one-story dwelling, or 16 inches on center for a two-story dwelling on average along each perimeter wall line.	Retrofit of connectors to dwelling above is not required.	Retrofit of connectors to dwelling above is required.	Provide detailed assessment or retrofit of connectors to dwelling above.
5	A2	The wood structural panel sheathing and nailing are in adequate condition for use and the length provided is at least 50% of the length of each perimeter wall for a one-story dwelling, or at least 70% of the length of each perimeter wall for a two-story dwelling. Wood structural panels shall be attached with 8d common nails spaced 4 inches on center along each edge and 12 inches on center at each intermediate support.	Retrofit of sheathing is not required.	Retrofit of sheathing, anchorage to foundation, and connectors to dwelling above is required.	Provide detailed assessment or sheathing retrofit.
6	A3, B2	Anchor bolts or proprietary anchors are in adequate condition for use and are spaced at 64 inches on center maximum for a one-story dwelling, or 32 inches on center maximum for a two-story dwelling on average along each perimeter wall line.	Retrofit of anchorage to foundation is not required.	Retrofit of anchorage to foundation is required.	Provide detailed assessment or anchorage retrofit.

Note: For configuration illustrations see Figure 4.1-1 and Figure 4.1-2.

#### **4.3.3 Detailed Assessment**

Detailed assessment for foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple top plates below, shall be in accordance with Sections 8.1 through 8.4.

#### **4.3.4 Engineered Assessment**

As an alternate to the detailed assessment requirements of Section 4.3.3 and Sections 8.1 through 8.4, an evaluation by a *registered design professional* can be provided to demonstrate that existing components are in compliance with this prestandard. This evaluation shall utilize all engineering criteria listed in Section 4.5. For guidance, assumptions made in developing the simplified engineered vulnerability-based retrofit in Section 4.5 are listed in the commentary for Section 4.5.

## **4.4 Prescriptive Vulnerability-Based Retrofit**

### **4.4.1 Scope**

Prescriptive retrofit provisions of this section are permitted for use on dwellings and *dwelling units* complying with the eligibility criteria of Table 4.1-1 and Table 4.1-2.

Dwellings identified by Section 4.3 to require foundation retrofit shall comply with Section 4.4.4.

Dwellings identified by Section 4.3 to require foundation sill plate anchorage retrofit shall comply with Section 4.4.5.

Dwellings identified by Section 4.3 to require retrofit of the connection to dwelling above shall comply with Section 4.4.8.

Dwellings identified by Section 4.3 to require retrofit of the cripple wall sheathing shall comply with the requirements of Section 4.4.4 through Section 4.4.10.

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.

All figures referenced in Section 4.4 describing the prescriptive retrofit provisions can be found at the end of Chapter 4.

### **4.4.2 Determination of Seismic Design Category**

The prescriptive vulnerability-based retrofit procedures within Section 4.4 have been developed for dwellings located within Seismic Design Categories (SDCs) B to E. See Section 1.6 for  $S_{DS}$  values for use within this prescriptive procedure based upon the specific *Seismic Design Category*.

### **4.4.3 Determination of Weight Classification**

The prescriptive vulnerability-based retrofit procedures of Section 4.4 have been developed for dwellings using three *weight classifications*: heavy, medium, and light construction. Further, eight weight combinations, based upon the type of exterior and interior wall finishes and roofing materials are assigned to three weight classifications as identified within Figure 4.4-1.

Where interior or exterior finishes vary, a heavier type finish shall be assumed where 25% or more of that finish type exists within the dwelling.

#### **4.4.4 Foundations**

Where identified by Section 4.3 to require retrofit, foundations shall be replaced with continuous perimeter foundations conforming to Figure 4.4-19.

#### **4.4.5 Foundation Sill Plate Anchorage to the Foundation**

Where identified by Section 4.3 to require retrofit, foundation sill plate anchorage shall be retrofitted in accordance with this section. Foundation sill plate anchorage of one of the types listed in Figure 4.4-2 or Figure 4.4-3 shall be provided at each perimeter wall in accordance with Figure 4.4-12 and Figure 4.4-13. The number of anchors per line shall be in accordance with the Earthquake Retrofit Schedules in Figures 4.4-6 through Figure 4.4-11, but not more than 64 inches on center for one-story dwellings and 48 inches on center for two-story dwellings and can be evenly distributed along each wall line.

#### **4.4.6 Cripple Wall Sheathing**

Where identified by Section 4.3 to require retrofit, cripple wall sheathing shall be retrofitted to conform to this section. *Cripple wall clear heights* greater than 7 feet are not permitted and not covered by this chapter. Cripple wall lengths and nailing shall be proportioned in two equal length panels per wall line where possible as indicated in the Earthquake Retrofit Schedules provided in Figure 4.4-6 through Figure 4.4-11 as applicable. Two panels of slightly different lengths can be used where obstructions prohibit equal length walls. If a single panel is used on a wall line instead of two panels, the minimum single panel length shall be two times the two panel length in the schedule reduced by 10%. If more than two panels are used, the total length of the two panels should be increased 10% above the total panel length shown in the schedule. If panels of sufficient length with tie-downs cannot fit in the available wall length provided due to obstructions, the simplified engineering retrofit per Section 4.5 shall apply. In all cases, a fully sheathed wall line is deemed to comply with the bracing requirements within this prestandard.

Cripple walls sheathed with wood structural panels with or without tie-downs shall be provided at each perimeter wall line. Where tie-downs are used, the additional requirements of Section 4.4.7 shall apply. Wood structural panel bracing panels shall be provided in lengths not less than 4 feet. The length of braced panels without tie-downs shall be equal to or exceed twice the height of the cripple wall.

Wood structural bracing panels shall be provided as close to each end of each perimeter wall line as possible.

Where tie-downs are not used, wood structural panel installation shall conform to Figure 4.4-16. Where tie-downs are used, wood structural panel installation shall conform to Figure 4.4-17.

#### **4.4.7 Additional Requirements for Cripple Walls with Tie-Downs**

Where tie-downs are used in conjunction with the Earthquake Retrofit Schedules in Figure 4.4-6 through 4.4-11, the additional requirements of Section 4.4.7.1 shall apply.

##### **4.4.7.1 Existing Foundation Requirements**

Where tie-downs are used, the foundation requirements of Section 4.4.7.2 shall be met. Where these requirements are not met, a new foundation system shall be required in accordance with Section 4.4.4 or engineered retrofit design shall be provided in accordance with Section 4.5.

##### **4.4.7.2 Existing Foundation Visual Verification and Testing Requirements**

Where tie-downs are used in accordance with the Earthquake Retrofit Schedules provided in Figure 4.4-6 through Figure 4.4-11, additional visual verification and testing of the existing foundation system is required to be completed by the owner or general contractor and approved by the building official.

###### **4.4.7.2.1 Visual Verification**

The size of existing foundation systems at the location of new tie-down anchors shall be verified to be at least 15 inches deep (“D”) and 8 inches wide (“W”). The dimension “D” shall be measured from the bottom of footing to the underside of the existing mudsill. The dimension “W” shall be measured from the top outside face of footing to the inside top face of footing as indicated in Figure 4.4-17.

###### **4.4.7.2.2 Existing Foundation Quality Requirements**

Verification of the overall quality of the concrete along any wall line requiring tie-downs shall be made by use of a minimum of two sacrificial torque tests along each wall line where tie-downs are used. These tests shall consist of installing 1/2- or 5/8-inch diameter screw-type bolts into the existing concrete and verifying that a torque value per Table 4.4-1 can be achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company or testing agency hired by the owner and as approved by the building official.

**Table 4.4-1 Foundation Verification Requirements**

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

#### **4.4.7.2.3 Existing Foundation Tension Test Requirements**

Where "With Tie-downs" is specified within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, each adhesive anchor shall be torque tested in accordance with Table 4.4-1. Torques in excess of those shown for adhesive anchors shall not be applied. Tests shall not be performed prior to adequate curing per manufacturer's requirements. Anchors where torque tests fail shall be replaced and re-installed. Where torque tests continue to fail, the existing foundation system shall be replaced locally for a minimum of 30 inches on each side of the proposed tie-down anchor location.

#### **4.4.7.2.4 Adhesive Anchor Installation Verification**

Where "With Tie-downs" is specified within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, installation shall conform to the manufacturer's installation instructions. Items 1 through 10 below shall be performed and verified by the general contractor or owner:

1. Drill all holes to the specified diameter and depth
2. Blow all holes clean of dust with oil-free compressed air for a minimum of 4 seconds
3. Clean all holes with a nylon or steel brush for a minimum of 4 cycles (per manufacturer's instructions)
4. Blow holes clean of dust with oil-free compressed air for a minimum of 4 seconds
5. Check adhesive cartridge expiration date and required minimum temperature for adhesive cure
6. Open cartridge, connect the required nozzle, and install cartridge in dispensing tool
7. Purge out the required amount of adhesive per the manufacturer's instructions prior to filling any holes with adhesive
8. Fill the holes 1/2 to 2/3 full, starting at the bottom of the hole to prevent air pockets and withdraw the nozzle as the hole fills up

9. Insert a clean and oil-free threaded rod turning slowly until the threaded rod contacts the bottom of the hole
10. Do not disturb the threaded rod until adhesive has fully cured. See manufacturer's instructions for cure time required

#### **4.4.7.3 Tie-Down Requirements**

Tie-down requirements shall be as follows:

1. Tie-downs shall be as specified in Figure 4.4-4 and capable of developing 3,075 pounds based upon allowable stress design (ASD).
2. End studs(s) to which tie-downs are installed shall be 3× minimum or double 2× with nailing conforming to Figure 4.4-17.
3. All tie-downs shall use 5/8-inch diameter (A36) threaded rod adhesive-type anchors with minimum embedment per Figure 4.4-17.

#### **4.4.8 Connection to Dwelling Above**

Existing or new rim joists, blocking, and miscellaneous framing members shall be connected to the foundation sill or the top of cripple wall in accordance with Figures 4.4-13, Figure 4.4-14, and Figure 4.4-15, as required within the Earthquake Retrofit Schedules in Figure 4.4-6 through Figure 4.4-11, as applicable.

#### **4.4.9 Additional Requirements for Non-Rectangular Dwellings with "T" or "L" Plan Configurations**

Plan configurations other than rectangular such as "T" or "L" shapes that have offsets in the exterior wall lines, within the crawlspace plan area, greater than 33% of the largest plan dimension shall meet the following requirements in that direction:

- Foundation sill to foundation connections along offset walls shall have a maximum spacing of 32 inches on center.
- 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 inches on center.
- Cripple walls, where they occur, shall be sheathed with new wood structural panels, as specified in Figure 4.4-16 or Figure 4.4-17. The sheathing shall have a minimum length of 90% of the offset wall length.

#### **4.4.10 Special Provisions for One-Story Homes with Clay Tile Roofing**

One story crawlspace dwellings with clay tile that weight up to 20 psf shall be permitted to be strengthened in accordance with the provisions for two-story heavy homes as noted in the applicable Earthquake Retrofit Schedules for an area twice the total area in square feet for any raised portion of the plan area.

### **4.5 Simplified Engineered Vulnerability-Based Retrofit**

#### **4.5.1 General**

Engineered retrofit of foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple wall top plates below shall be in accordance with the ASCE/SEI 7 Section 12.14, Simplified Alternative Structural Design Criteria for Simple Bearing Wall or Building Frame Systems, as amended below. Material design capacities for all components shall be as specified by the adopted building code.

1. The scope of seismic retrofit need only include the foundations, foundation sill plate anchorage to the foundation, cripple wall sheathing, and anchorage of perimeter blocking or rim joists to the foundation sill plate or cripple wall top plates below.
2. ASCE/SEI 7 Section 12.14 shall be modified as described in Table 4.5-1. ASCE/SEI 7 section may either be applicable as written (Y) with or without notes; not applicable (N); or applicable with clarifications noted (M).
3. Cripple wall wood structural panel sheathing and seismic load path shall be designed using a seismic response modification factor,  $R$ , of 4.0.
4. Finish and bracing materials other than wood structural panels (per definitions in Chapter 2) shall not be considered to provide seismic capacity in the crawlspace.
5. The in-plane *load path connections* for anchorage to foundations and anchorage to floor framing above shall be provided at all locations where retrofit cripple wall sheathing is provided. In-plane load path connections shall be designed using load combinations with an overstrength factor,  $\Omega_0$ , of 1.5 in lieu of 2.5 in ASCE/SEI 7 Section 12.14.3.2.



6. Where tie-downs are used in the existing foundation, the registered design professional shall be responsible for evaluating the existing foundation system.

**Table 4.5-1 ASCE/SEI 7 Section 12.14 Application Matrix**

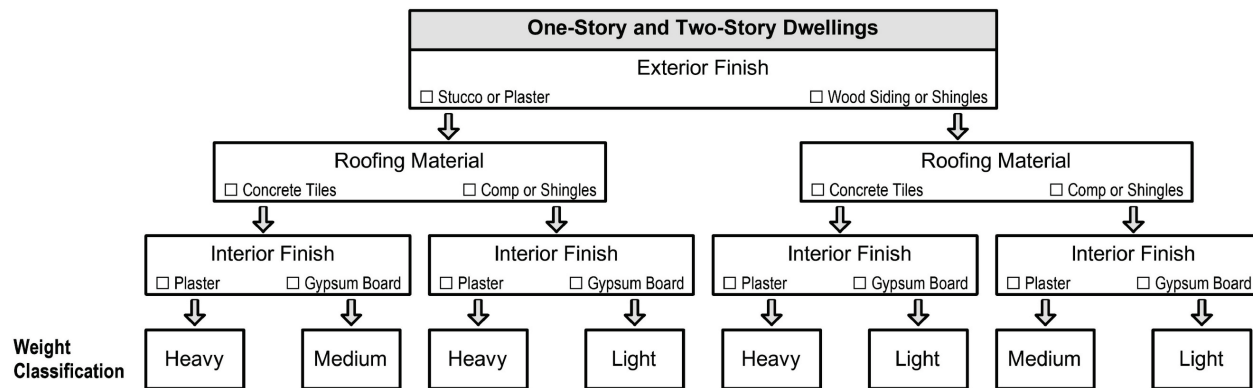
ASCE/SEI 7 Section	Applicability	Notes
12.14.1.1	N	All limitations listed within Items 1 through 12 shall be assumed to comply and ASCE/SEI 7 Section 12.14 is eligible for use
12.14.1.2	Y	
12.14.1.3	M	See Chapter 3 for additional definitions
12.14.1.4	M	Notations as applicable
12.14.2	M	See Section 4.5.1 Item 1
12.14.3	M	See Section 4.5.1 Item 1
12.14.3.1	Y	
12.14.3.2	M	$E_{mh}$ shall be taken as $1.5Q_E$
12.14.4.1	N	
12.14.4.2	N	
12.14.5	M	See Section 4.5.2 Item 2
12.14.6	Y	
12.14.7	N	
12.14.8.1	M	$F = 1.0$ for two-story dwellings
12.14.8.2	Y	
12.14.8.3	Y	
12.14.8.3.1	M	See Section 4.5.2 Item 2
12.14.8.3.2	N	
12.14.8.3.2.1	N	
12.14.8.4	N	
12.14.8.5	N	

#### **4.5.2 Additional Simplifying Assumptions**

The following simplifications shall be permitted to be made in the engineered retrofit design:

1. Where applicable, the unit assembly weights listed in non-mandatory Appendix L of this prestandard are permitted to be used for determination of the seismic base shear.
2. In lieu of a horizontal force distribution in accordance with ASCE/SEI 7 Section 12.14.8, seismic forces may be distributed equally to each exterior wall line in each orthogonal direction, except as follows:

- a. Plan configurations other than rectangular such as “T” or “L” shapes that have offsets in the exterior wall lines, within the crawlspace plan area, greater than 33% of the largest plan dimension in each direction shall have seismic forces distributed to that exterior wall lines based upon rational analysis assuming relative diaphragm in-plane flexibility.
  - b. Where exterior walls of plan configurations other than rectangular such as “T” or “L” shapes have offset walls along the same orthogonal direction offset by less than 33%, the distribution of seismic forces may be assumed to be proportional to the length of each of the exterior wall segments.
3. When designing cripple walls for overturning, in lieu of a more detailed overturning analysis of the entire dwelling, each exterior cripple wall line shall be designed to resist its local overturning moment plus 15 percent of the total overturning moment of the superstructure above. The calculations of forces  $F_R$  and  $F_{2nd}$  (where applicable) can be based upon tributary mass to those levels per ASCE/SEI 7 Section 12.14.13.
4. The allowable tension load at the end of cripple walls braced with wood structural panels can be assumed as follows:
  - a. Where two *post-installed anchor* bolts are installed at each end of cripple walls braced with wood structural panels as indicated in Figure 4.4-16, the allowable tension load may be assumed to have an allowable uplift capacity of 1.5 kips (ASD) provided there is a minimum length to height ratio of 2.0 for the sheathed portion of the cripple wall.
  - b. Where one post-installed anchor bolt and one tie-down anchor are installed at each end of cripple walls braced with wood structural panels as indicated Figure 4.4-17, the end of the wall may be assumed to have an allowable uplift capacity of 3.0 kips (ASD).
5. Soil *site class* may be assumed to be type C if specific site class information is not available.



Weight Classification:

This flowchart is used to determine the general weight classification of your home's construction.

1. Check the box of the material that most closely matches your home's finishes.

2. Note the Weight Classification result for use in the Earthquake Retrofit Schedules.

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.

Figure 4.4-1 Dwelling weight classification by interior and exterior finishes. Sheet S3.



ANCHOR BOLTS			
IMAGE	TYPE	EMBEDMENT DEPTH	
		1/2"Ø	5/8"Ø
	Screw-Type Anchor	4-1/2"	4-1/2"
	Adhesive-Type Anchor	4-1/4"	5"

Figure 4.4-3 Foundation sill anchors. Sheet S3.


TIE-DOWNS			
Supplemental Technical Notes, Sheet S2, Section T			
IMAGE	TYPE	SHEET REF	CAPACITY (ASD)
	Wood Stud to Foundation Tension Tie	SHEET D4	3000#

Figure 4.4-4 Tie-down requirements. Sheet S3.

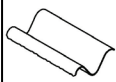

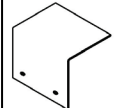
CONNECTORS				
IMAGE	TYPE		SHEET REF	MIN CAPACITY (lbs) ASD
	A	Foundation Sill to Foundation	SHEETS D1 & D2	1530
	B			960
	C			875

Figure 4.4-2 Foundation sill anchors. Sheet S3.


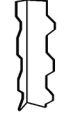



	D	Floor to Cripple Wall or Floor to Foundation Sill	SHEETS D2, D3 & D3.1	565
	E			740
	F			590
	G			445
	H			725

Figure 4.4-5 Floor to cripple wall or foundation sill connectors. Sheet S3.

EARTHQUAKE RETROFIT SCHEDULE (S <sub>DS</sub> = 1.0 Seismic) ONE-STORY																				
Weight Category	Total Area in Square Feet	Mark row that applies <input type="checkbox"/>	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										Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill		
			Cripple Wall Height								Panel Edge Nailing									
			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	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	
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:**

- 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 S4.
- 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.)
- 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.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-6 Earthquake retrofit schedule,  $S_{DS}$  = 1.0, one story. Sheet S3.1-1.

EARTHQUAKE RETROFIT SCHEDULE (S <sub>DS</sub> = 1.2 High Seismic) ONE-STORY																			
Weight Category	Total Area in Square Feet	☑ Mark row that applies	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										Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill	
			Cripple Wall Height								Panel Edge Nailing								
			up to 1'	1'-1" to 2'	2'-1" to 4'-0"		4'-1" to 6'-0"		6'-1" to 7'-0"			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		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
	801 to 1000		6.7"	8.0'	9.3'	6.7"	12.0'	8.0'	12.0'	8.0'	4"	6	9	10	10	7	15	15	19
	1001 to 1200		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
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	10.7'	4"	8	13	14	14	10	21	20	27
	1501 to 2000		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34
	2001 to 2500		14.7'	14.7'	17.3'	14.7'	20.0'	14.7'	21.3'	16.0'	4"	12	19	21	21	15	33	31	41
	2501 to 3000		17.3'	17.3'	18.7'	17.3'	21.3'	17.3'	22.7'	17.3'	4"	14	23	25	25	17	38	37	48
1-Story Medium Construction	up to 800		5.3'	6.7"	9.3'	6.7"	10.7'	8.0'	12.0'	8.0'	3"	6	9	10	10	7	15	15	19
	801 to 1000		6.7"	8.0'	10.7'	6.7"	12.0'	8.0'	13.3'	9.3'	3"	7	11	12	12	8	18	17	23
	1001 to 1200		8.0'	8.0'	10.7'	8.0'	13.3'	9.3'	14.7'	10.7'	3"	8	12	13	13	9	21	20	26
	1201 to 1500		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	15	16	16	11	24	23	31
	1501 to 2000		10.7"	12.0'	14.7'	10.7'	17.3'	13.3'	18.7"	14.7"	3"	12	18	20	20	14	30	29	39
	2001 to 2500		13.3'	13.3'	17.3'	13.3'	20.0'	14.7"	21.3'	16.0'	3"	14	22	24	24	16	36	35	46
	2501 to 3000		14.7"	14.7"	18.7'	14.7"	21.3'	17.3'	22.7"	18.7"	3"	16	25	27	27	19	42	40	53
1-Story Heavy Construction	up to 800		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
	801 to 1000		6.7"	8.0'	10.7'	8.0'	13.3'	9.3'	14.7"	10.7"	2"	8	12	14	13	9	21	20	26
	1001 to 1200		8.0'	9.3'	12.0'	9.3'	14.7"	10.7"	16.0'	12.0'	2"	9	14	16	15	11	24	23	30
	1201 to 1500		9.3'	10.7"	13.3'	10.7"	16.0'	12.0'	17.3'	13.3'	2"	11	17	18	18	13	28	27	36
	1501 to 2000		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
	2001 to 2500		13.3'	14.7"	18.7"	13.3'	21.3'	16.0'	22.7"	17.3'	2"	16	25	28	28	19	43	41	54
	2501 to 3000		14.7"	16.0'	20.0'	16.0'	22.7"	18.7"	25.3'	20.0'	2"	19	29	32	32	22	50	48	63

**Notes:**

- 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 S4.
- 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.)
- 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.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-7 Earthquake retrofit schedule,  $S_{DS}$  = 1.2, one story. Sheet S3.1-2.

EARTHQUAKE RETROFIT SCHEDULE ( $S_{DS}$ = 1.5 Very High Seismic) ONE-STORY																			
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	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									Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill		
			Cripple Wall Height																
			up to 1' Without Tie-downs	1'-1" to 2' Without Tie-downs	2'-1" to 4'-0" Without Tie-downs	With Tie-downs	4'-1" to 6'-0" Without Tie-downs	With Tie-downs	6'-1" to 7'-0" 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		8.0'	8.0'	10.7'	8.0'	12.0'	8.0'	13.3'	9.3'	4"	6	10	10	10	7	16	15	20
	801 to 1000		9.3'	9.3'	12.0'	9.3'	13.3'	9.3'	14.7'	10.7'	4"	7	11	12	12	9	19	18	24
	1001 to 1200		10.7'	10.7'	13.3'	10.7'	16.0'	10.7'	16.0'	12.0'	4"	8	13	14	14	10	22	21	28
	1201 to 1500		12.0'	12.0'	14.7'	12.0'	17.3'	12.0'	18.7'	13.3'	4"	10	16	17	17	12	26	25	33
	1501 to 2000		14.7'	14.7'	17.3'	14.7'	21.3'	16.0'	22.7'	16.0'	4"	13	20	22	22	15	34	32	43
	2001 to 2500		18.7'	18.7'	20.0'	18.7'	24.0'	18.7'	25.3'	18.7'	4"	15	24	27	27	18	41	39	52
	2501 to 3000		21.3'	21.3'	22.7'	21.3'	26.7'	21.3'	28.0'	21.3'	4"	18	28	31	31	21	48	46	60
1-Story Medium Construction	up to 800		6.7'	8.0'	10.7'	6.7'	13.3'	9.3'	13.3'	9.3'	3"	7	11	12	12	9	19	18	24
	801 to 1000		8.0'	9.3'	12.0'	8.0'	14.7'	10.7'	16.0'	10.7'	3"	9	13	15	15	10	22	21	28
	1001 to 1200		9.3'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	3"	10	15	17	17	11	26	25	32
	1201 to 1500		10.7'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	38
	1501 to 2000		13.3'	13.3'	17.3'	13.3'	21.3'	16.0'	22.7'	17.3'	3"	14	23	25	25	17	38	36	48
	2001 to 2500		16.0'	16.0'	20.0'	16.0'	22.7'	17.3'	25.3'	20.0'	3"	17	27	29	29	20	45	43	57
	2501 to 3000		18.7'	18.7'	21.3'	18.7'	25.3'	20.0'	26.7'	21.3'	3"	20	31	34	34	23	53	50	67
1-Story Heavy Construction	up to 800		8.0'	9.3'	12.0'	8.0'	13.3	10.7'	14.7'	10.7'	2"	8	13	14	14	10	22	21	27
	801 to 1000		8.0'	10.7'	13.3'	9.3'	16.0'	12.0'	17.3'	12.0'	2"	10	15	17	17	11	26	25	33
	1001 to 1200		9.3'	12.0'	14.7'	10.7'	17.3'	13.3'	18.7'	13.3'	2"	11	18	19	19	13	30	28	37
	1201 to 1500		10.7'	13.3	16.0'	12.0'	18.7'	14.7'	20.0'	16.0'	2"	13	21	23	23	16	35	34	45
	1501 to 2000		13.3	16.0'	18.7'	14.7'	22.7'	17.3'	24.0'	18.7'	2"	17	26	29	29	20	44	43	56
	2001 to 2500		14.7'	17.3'	21.3'	16.0'	25.3'	20.0'	26.7'	21.3'	2"	20	32	35	34	24	53	51	67
	2501 to 3000		17.3'	20.0'	24.0'	18.7'	28.0'	22.7'	29.3'	24.0'	2"	23	37	40	40	27	62	59	79

**Notes:**

- 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 S4.
- 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.)
- 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.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-8 Earthquake retrofit schedule,  $S_{DS} = 1.5$ , one story. Sheet S3.1-3.

EARTHQUAKE RETROFIT SCHEDULE ( $S_{DS}$ = 1.0 Seismic) TWO-STORY																			
Weight Category	Total Area in Square Feet	<div>Mark row that applies</div> <div><input checked="" type="checkbox"/></div>	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									Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill		
			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"		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"
			Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs									
2-Story Light Construction	up to 1600		8.0'	8.0'	10.7'	8.0'	12.0'	9.3'	13.3'	9.3'	4"	7	10	11	11	8	17	17	22
	1601 to 2000		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	10.7'	4"	8	12	13	13	9	20	19	26
	2001 to 2400		10.7'	10.7'	13.3'	10.7'	14.7'	10.7'	16.0'	12.0'	4"	9	14	15	15	10	23	22	29
	2401 to 3000		12.0'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	13.3'	4"	10	16	18	18	12	27	26	34
	3001 to 4000		14.7'	14.7'	17.3'	16.0'	20.0'	16.0'	21.3'	16.0'	4"	13	20	22	22	15	34	32	43
2-Story Medium Construction	up to 1600		8.0'	9.3'	10.7'	8.0'	13.3'	9.3'	13.3'	10.7'	3"	7	11	12	12	9	19	18	24
	1601 to 2000		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	14.7'	12.0'	3"	9	13	15	15	10	22	22	28
	2001 to 2400		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	3"	10	15	17	17	11	26	25	32
	2401 to 3000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	30	29	39
	3001 to 4000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	17.3'	3"	14	23	25	25	17	38	36	48
2-Story Heavy Construction	up to 1600		9.3'	9.3'	12.0'	9.3'	13.3'	10.7'	14.7'	12.0'	2"	9	14	16	16	11	24	23	30
	1601 to 2000		9.3'	10.7'	13.3'	10.7'	14.7'	12.0'	16.0'	13.3'	2"	11	17	18	18	13	28	27	35
	2001 to 2400		10.7'	12.0'	14.7'	10.7'	16.0'	13.3'	17.3'	14.7'	2"	12	19	21	21	14	32	31	41
	2401 to 3000		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	18.7'	16.0'	2"	14	23	25	25	17	38	37	48
	3001 to 4000		13.3'	16.0'	18.7'	14.7'	21.3'	17.3'	22.7'	18.7'	2"	18	28	31	31	21	48	46	60

**Notes:**

- 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 S4.
- 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.)
- 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.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-9 Earthquake retrofit schedule,  $S_{DS} = 1.0$ , two story. Sheet S3.1-4.



EARTHQUAKE RETROFIT SCHEDULE (S <sub>DS</sub> = 1.2 High Seismic) TWO-STORY																			
Weight Category	Total Area in Square Feet	Mark row that applies <input checked="" type="checkbox"/>	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								Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill			
			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"	Panel Edge Nailing											
			Without Tie-downs	Without Tie-downs	Without Tie-downs	With Tie-downs	Without Tie-downs		With Tie-downs	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		9.3'	9.3'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	4"	8	12	13	13	9	21	20	26
	1601 to 2000		10.7'	10.7'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	4"	9	14	16	16	11	24	23	31
	2001 to 2400		12.0'	12.0'	14.7'	13.3'	17.3'	13.3'	18.7'	14.7'	4"	10	16	18	18	12	28	26	35
	2401 to 3000		14.7'	14.7'	16.0'	14.7'	20.0'	14.7'	20.0'	16.0'	4"	12	19	21	21	14	33	31	41
	3001 to 4000		17.3'	18.7'	18.7'	18.7'	22.7'	18.7'	24.0'	18.7'	4"	15	24	26	26	18	40	39	51
2-Story Medium Construction	up to 1600		9.3'	10.7'	12.0'	9.3'	14.7'	10.7'	16.0'	12.0'	3"	9	14	15	15	10	23	22	29
	1601 to 2000		10.7'	12.0'	13.3'	10.7'	16.0'	12.0'	17.3'	13.3'	3"	10	16	18	17	12	27	26	34
	2001 to 2400		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	3"	12	18	20	20	14	31	29	39
	2401 to 3000		13.3'	14.7'	17.3'	13.3'	20.0'	16.0'	21.3'	16.0'	3"	14	22	24	24	16	36	35	46
	3001 to 4000		16.0'	16.0'	20.0'	16.0'	22.7'	18.7'	24.0'	20.0'	3"	17	27	30	29	20	46	44	58
2-Story Heavy Construction	up to 1600		9.3'	10.7'	13.3'	10.7'	16.0'	12.0'	16.0'	13.3'	2"	11	17	19	18	13	28	27	36
	1601 to 2000		10.7'	12.0'	14.7'	12.0'	17.3'	13.3'	18.7'	14.7'	2"	13	20	22	22	15	34	32	42
	2001 to 2400		12.0'	13.3'	16.0'	13.3'	18.7'	14.7'	20.0'	16.0'	2"	15	23	25	25	17	38	37	49
	2401 to 3000		13.3'	14.7'	18.7'	14.7'	21.3'	17.3'	21.3'	18.7'	2"	17	27	30	29	20	46	44	58
	3001 to 4000		16.0'	17.3'	21.3'	17.3'	24.0'	20.0'	25.3'	21.3'	2"	21	34	37	37	25	57	55	72

**Notes:**

- 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 S4.
- 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.)
- 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.
- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-10 Earthquake retrofit schedule,  $S_{DS} = 1.2$ , two story. Sheet S3.1-5.



EARTHQUAKE RETROFIT SCHEDULE (S <sub>DS</sub> = 1.5 Very High Seismic) TWO-STORY																			
Weight Category	Total Area in Square Feet	<div>☒ Mark row that applies</div>	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									Foundation Sill Anchors					Floor to Cripple Wall or Floor to Foundation Sill		
			Cripple Wall Height						Panel Edge Nailing										
			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	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

**Notes:**

- 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 S4.
- 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.)
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- Any of the connectors listed within a particular group and as shown on sheet S3 may be used for strengthening the particular condition.
- This plan set was developed using the lowest listed manufacturer's capacity within a particular group. Cells marked "NG" on the applicable Earthquake Retrofit Schedule may be found to have an acceptable spacing where an alternate connector is used. Any such substitution can only be made by a Registered Design Professional.
- Foundation sill anchor types A, B, and C should not be used with cripple walls over 2 feet.

Figure 4.4-11 Earthquake retrofit schedule,  $S_{DS}$  = 1.5, two story. Sheet S3.1-6.



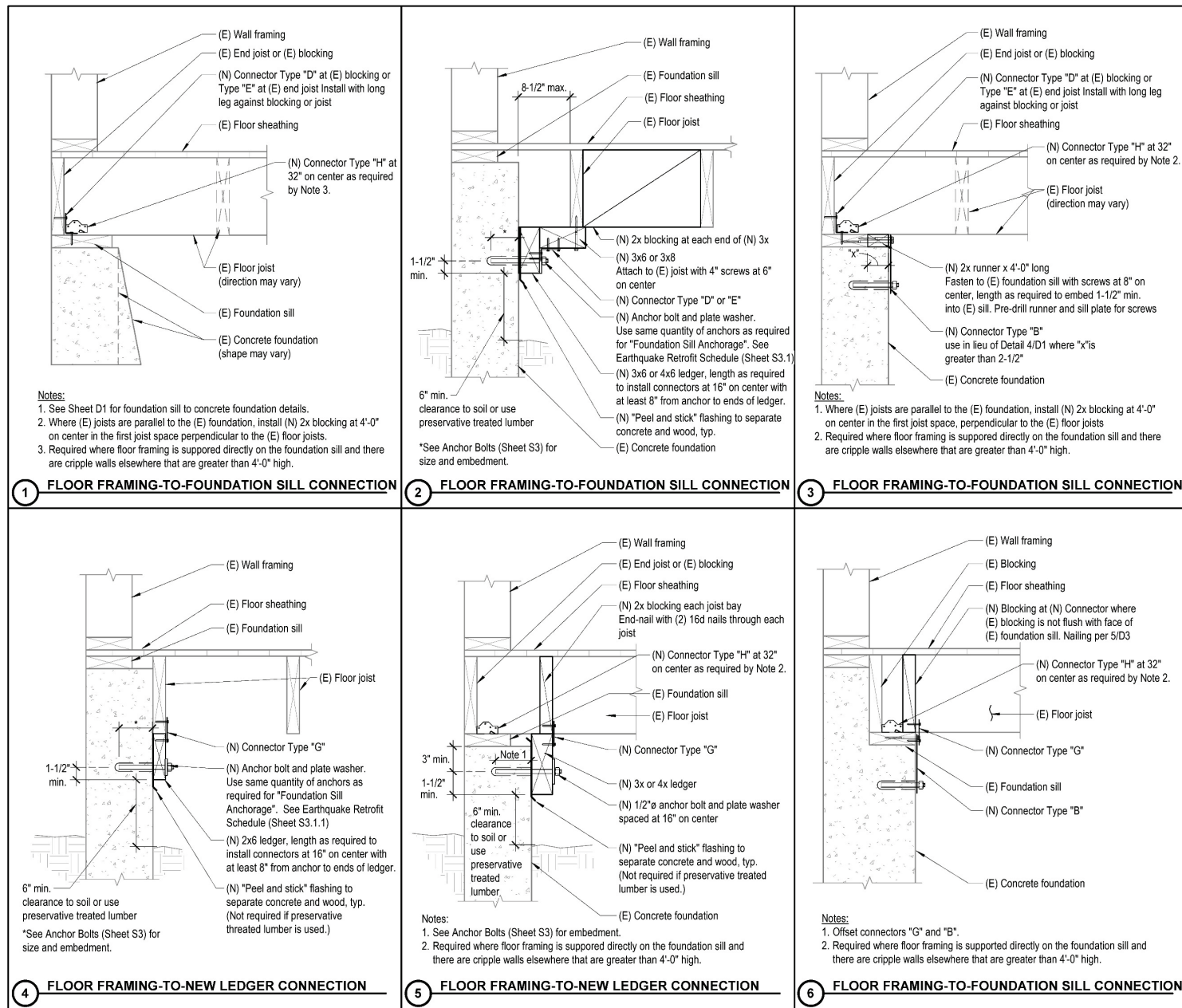


Figure 4.4-13 Floor framing to foundation sill connection details. Sheet D2.

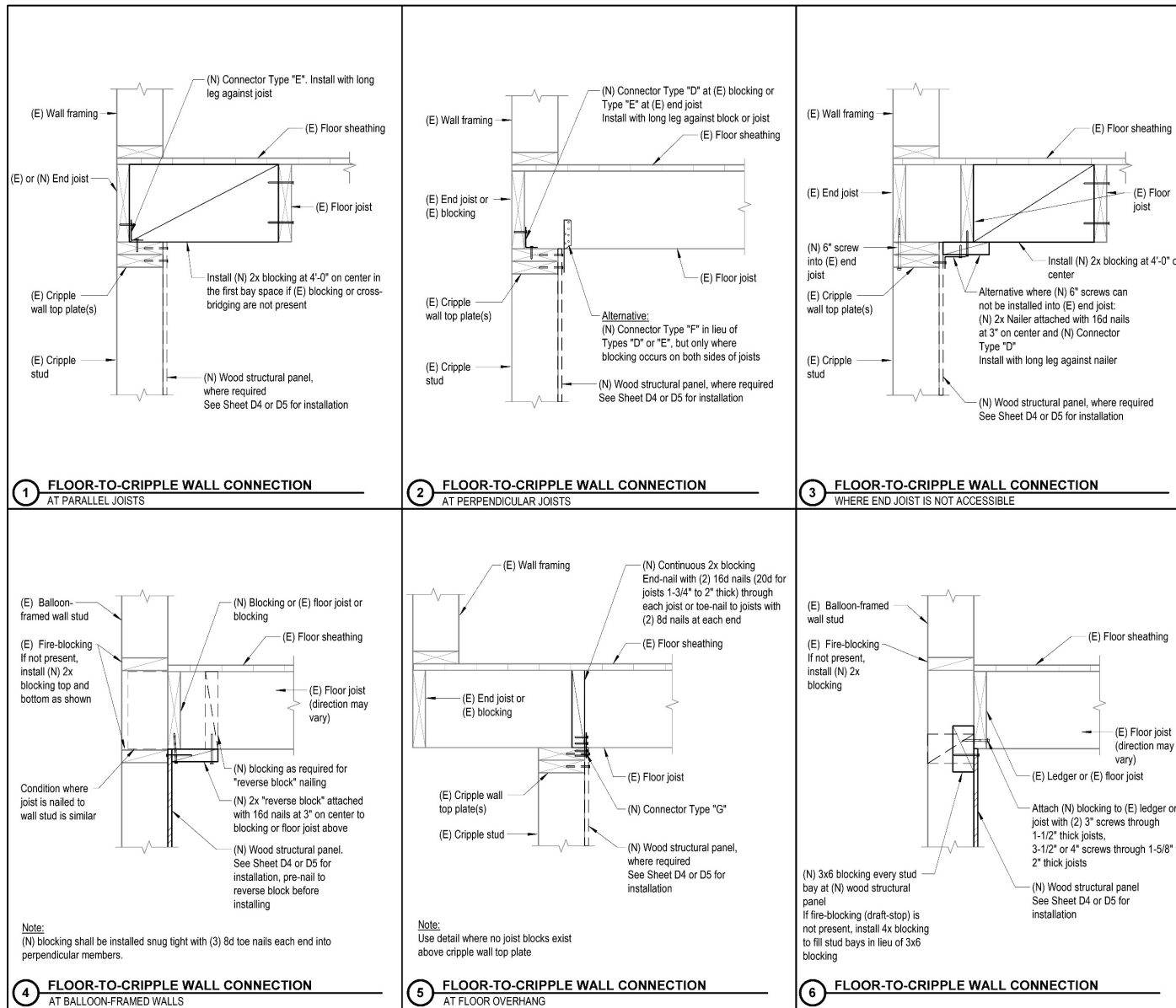


Figure 4.4-14 Floor framing to cripple wall connection details. Sheet D3.

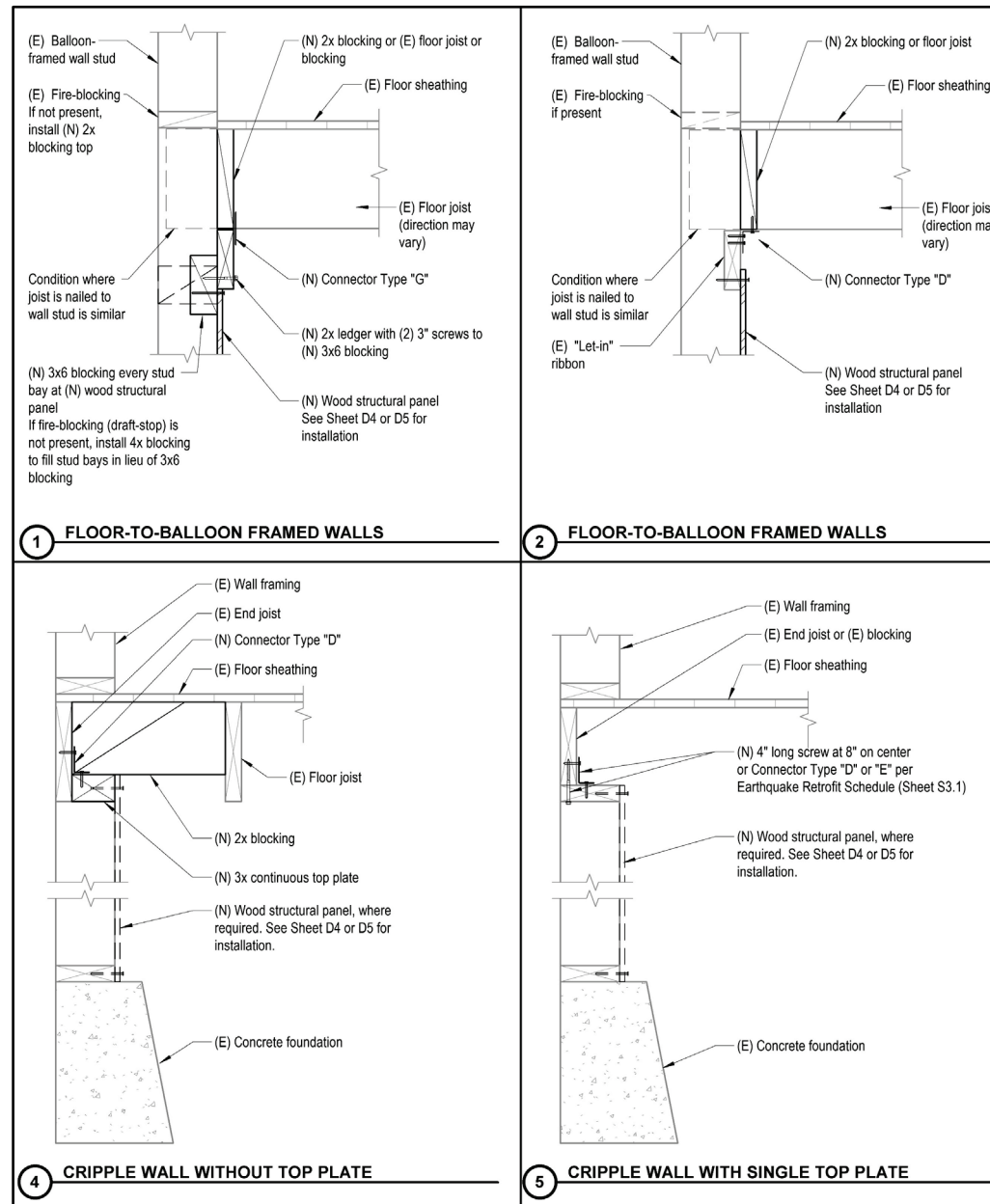


Figure 4.4-15 Floor framing to cripple wall connection details. Sheet D3.1.



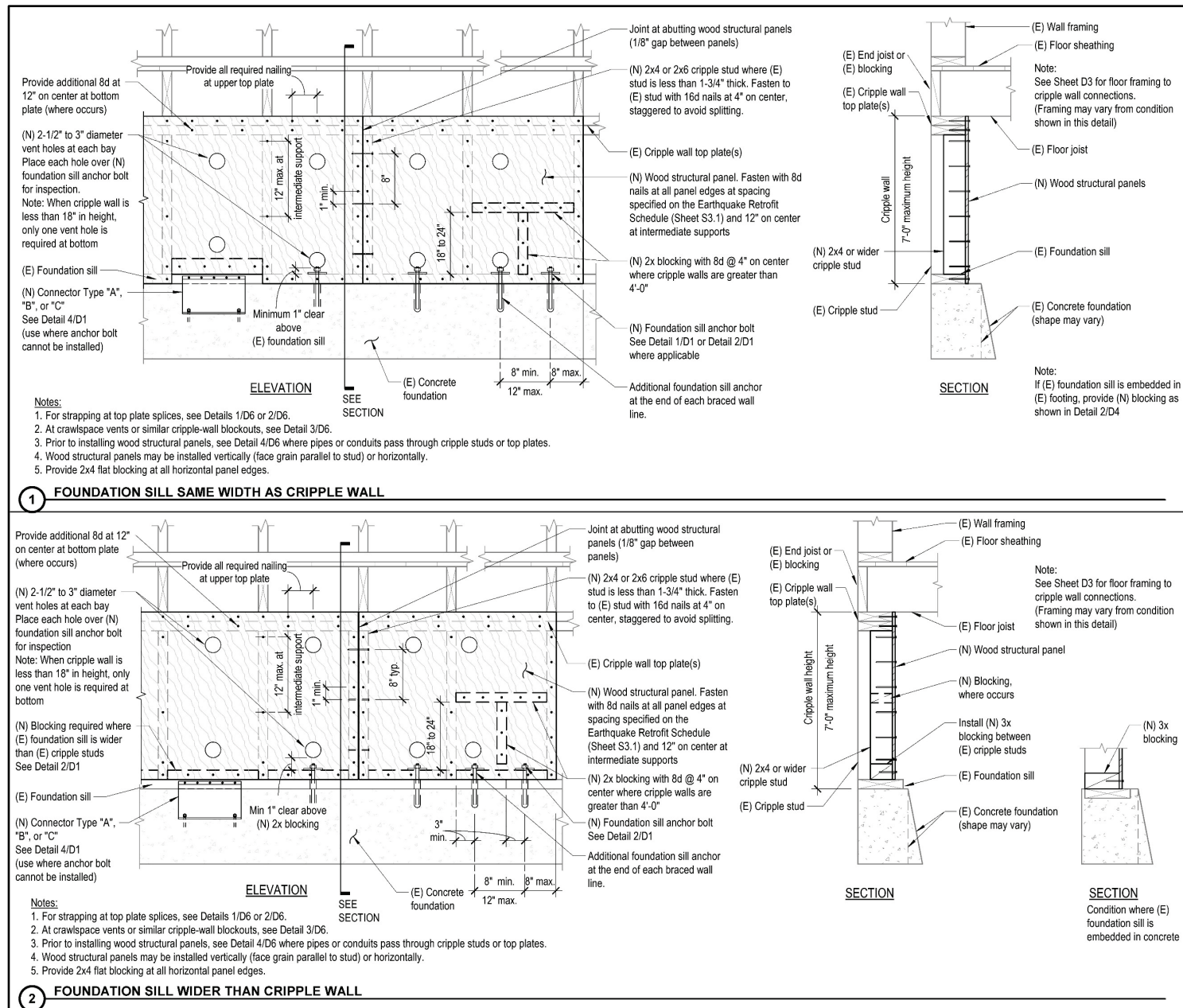


Figure 4.4-16 Wood structural panel installation without tie-downs. Sheet D4.

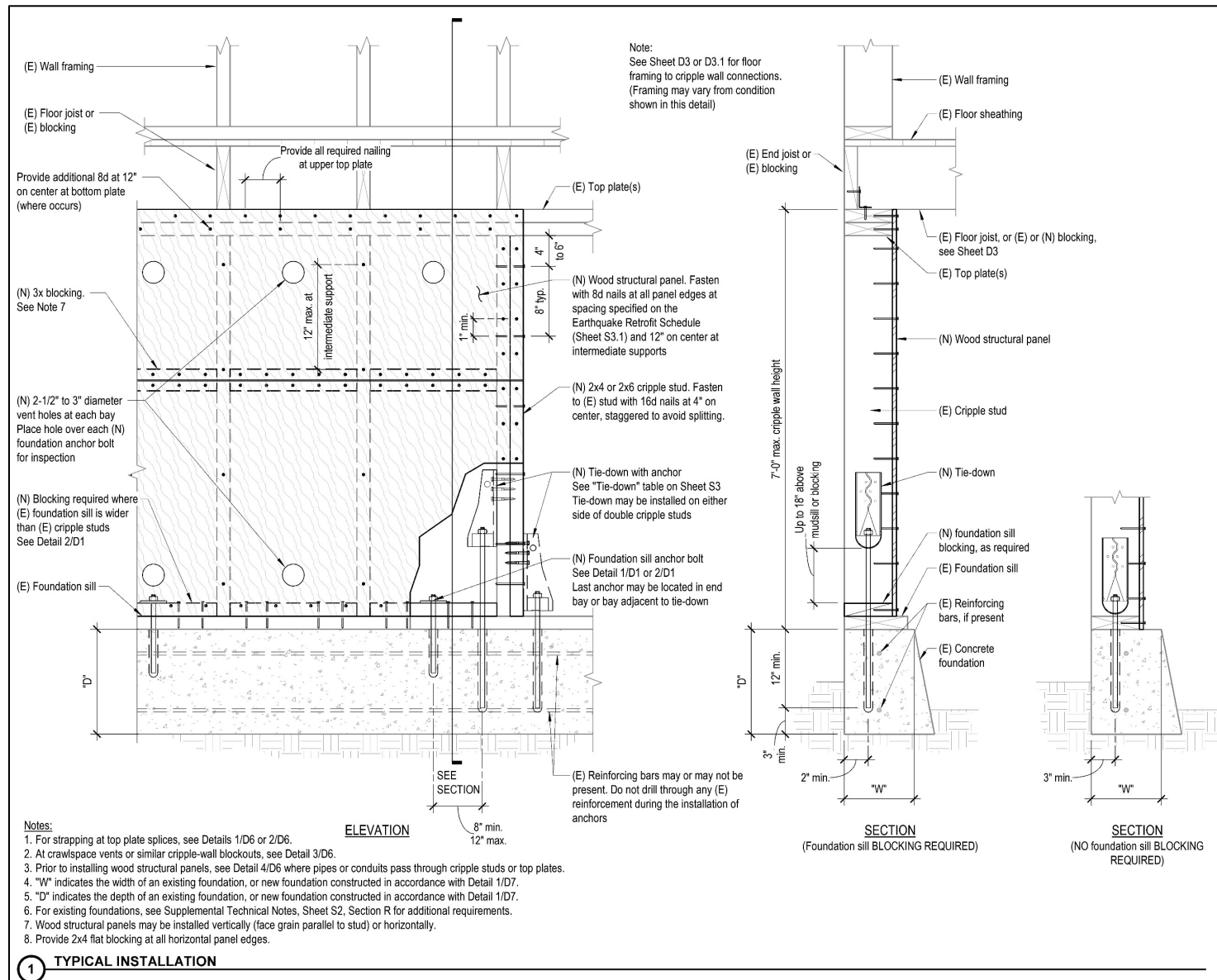


Figure 4.4-17 Wood structural panel installation with tie-downs. Sheet D5.

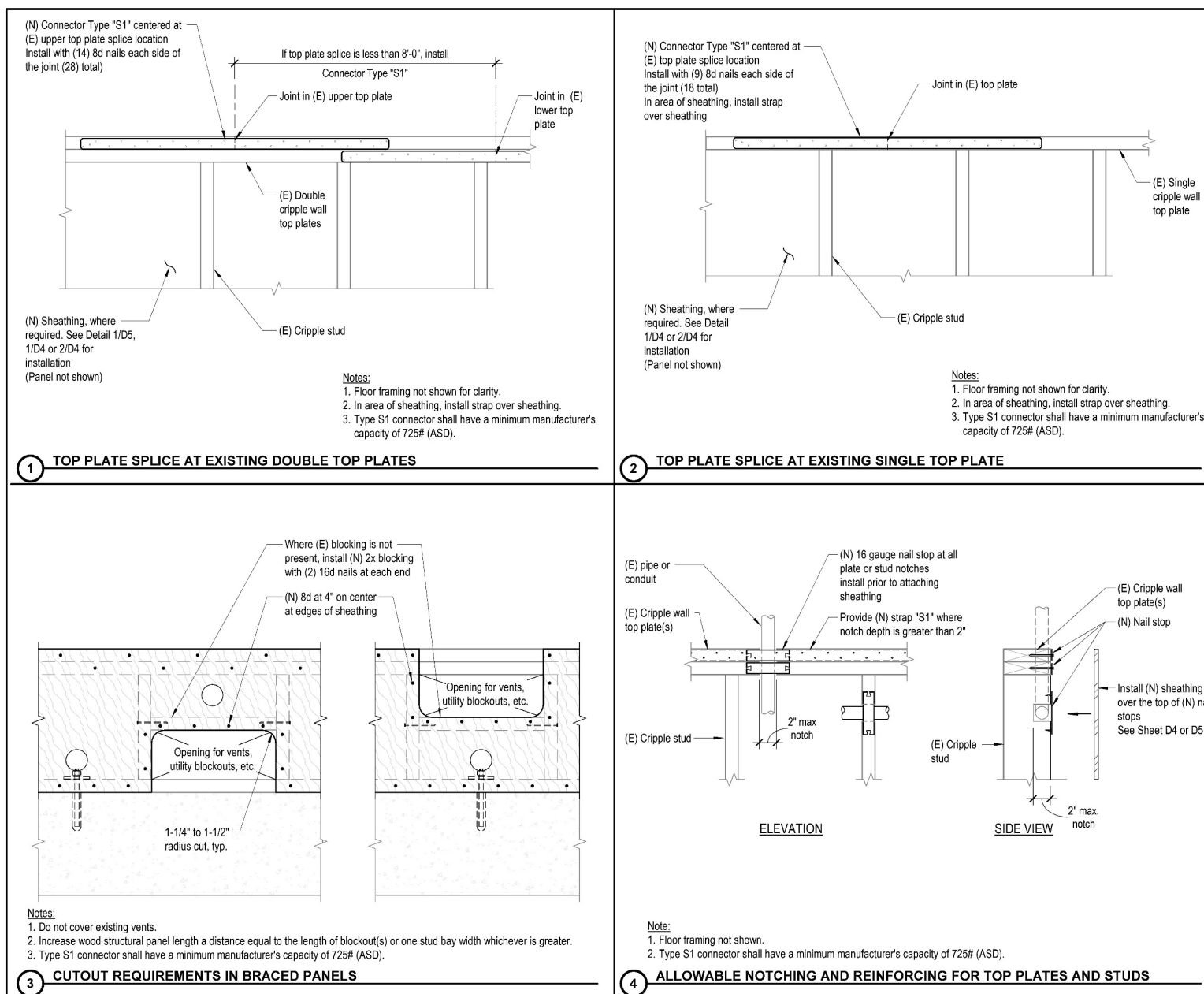


Figure 4.4-18 Vent openings and top plate details. Sheet D6.



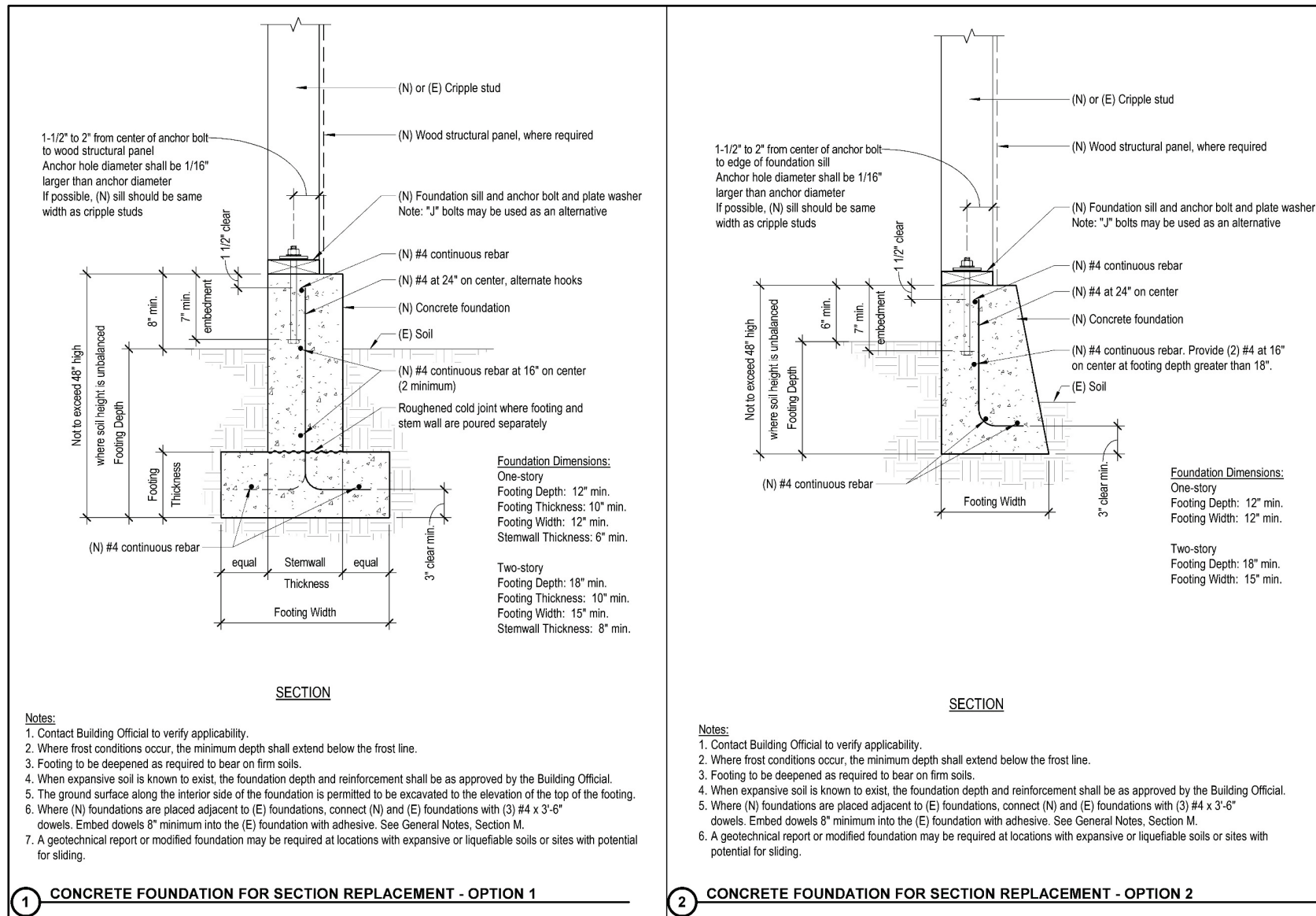


Figure 4.4-19 Foundation replacement details. Sheet D7.