

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings



FEMA

SOUTH NAPA EARTHQUAKE RECOVERY ADVISORY

FEMA DR-4193-RA2

Purpose and Intended Audience

The August 24, 2014 South Napa earthquake has reinforced past observations that wood-frame dwellings with flexible wood foundation walls (known as cripple walls) and inadequate anchorage (bolting) to the foundation are vulnerable to damage from earthquake shaking (Figure 1). Damage due to vulnerable cripple walls, particularly taller cripple walls, can be significant and costly to repair. In addition, homes with cripple wall damage are usually identified as unsafe to occupy (i.e., “red tagged”). As a result, occupants will be displaced and unable to live in their home until repairs can be performed, adding living expenses to the cost of repairing earthquake damage.



Figure 1: House with cripple walls damaged in the South Napa earthquake. Temporary bracing has been installed to provide stability and prevent collapse. Photo credit: Estructure.

Fortunately, relatively simple and inexpensive measures can be undertaken to mitigate cripple wall vulnerabilities before an earthquake occurs. These include the installation of plywood bracing around the perimeter of the crawl space area and new anchor bolts to improve the attachment between a home and its foundation system. The FEMA Plan Set for Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings (FEMA Plan Set) accompanying this Recovery Advisory is intended to be used as a template for retrofitting common cripple wall and foundation anchorage vulnerabilities throughout California and the United States. It provides a pre-engineered retrofit solution and step-by-step instructions for use by knowledgeable contractors or skilled homeowners in customizing the work for the conditions at a specific home. **Note that building permits are always required when performing the work described in this advisory.**

This Recovery Advisory Addresses:

- Installation of pre-engineered plywood bracing and foundation anchorage details intended to improve the performance of cripple walls in wood-frame dwellings in future earthquakes.
- Information on how and when to use the FEMA Plan Set, and when to engage the services of a design professional.

This Recovery Advisory does not address the repair of cripple walls that have already been damaged in an earthquake, and does not provide a comprehensive evaluation (and retrofit) of all potential seismic vulnerabilities that can be present in a wood-frame dwelling.

Key Issues:

1. This Recovery Advisory and the FEMA Plan Set are applicable to wood-frame dwellings with a crawl space below the first floor and cripple walls up to seven feet (7'-0") in height, among other limitations.
2. Earthquake strengthening measures illustrated in the FEMA Plan Set are intended to reduce, but not eliminate, the risk of potential damage in future earthquakes.

EARTHQUAKE STRENGTHENING SCHEDULE

		GENERAL INFORMATION		MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING (at each wall line)								FOUNDATION SILL ANCHORAGE Technical Notes (Sheet S1), Section C					FLOOR TO CRIPPLE WALL FLOOR TO FOUNDATION SILL Technical Notes (Sheet S1), Section D			
				Total Floor Area in Square Feet	Heavy or Light Construction	See Note 4	Plywood Braced Panels Technical Notes (Sheet S1), Section E								Min. No. of Foundation Connectors or Anchors Along Each Perimeter Wall Line					Min. No. of Connectors Along Each Perimeter Wall Line
		Cripple Wall Height								Type "A"	Type "B"	Type "C"	1/2"ø Bolt	5/8"ø Bolt	Type "D"	Type "E" or "F"	Type "G"			
		0' < 1'	1' < 2'			2' < 4'		4' < 6'										6' < 7'		
		--	Without Tie-downs			Without Tie-downs	With Tie-downs	Without Tie-downs	With Tie-downs									Without Tie-downs	With Tie-downs	
ONE-STORY	800	Heavy	9'-4"	9'-4"	14'-8"	10'-8"	18'-8"	12'-0"	20'-0"	14'-8"	4	6	6	5	4	10	9	10		
	800	Light	8'-0"	8'-0"	14'-8"	8'-0"	18'-8"	10'-8"	20'-0"	12'-0"	3	4	4	4	3	7	6	7		
	1000	Heavy	12'-0"	12'-0"	16'-0"	12'-0"	20'-0"	14'-8"	22'-8"	16'-0"	4	6	7	6	4	12	10	12		
	1000	Light	8'-0"	8'-0"	16'-0"	8'-0"	20'-0"	12'-0"	22'-8"	13'-4"	3	4	5	4	3	8	7	8		
	1200	Heavy	12'-0"	13'-4"	17'-4"	13'-4"	22'-8"	16'-0"	24'-0"	17'-4"	5	7	8	7	5	14	12	13		
	1200	Light	9'-4"	9'-4"	17'-4"	9'-4"	22'-8"	13'-4"	25'-4"	14'-8"	3	5	6	5	3	9	8	9		
	1500	Heavy	16'-0"	16'-0"	18'-8"	16'-0"	24'-0"	17'-4"	28'-0"	20'-0"	6	9	10	8	6	16	14	16		
	1500	Light	10'-8"	12'-0"	20'-0"	12'-0"	25'-4"	14'-8"	28'-0"	17'-4"	4	6	7	6	4	11	10	11		
	2000	Heavy	18'-8"	20'-0"	22'-8"	20'-0"	28'-0"	20'-0"	30'-8"	22'-8"	7	11	12	10	7	20	18	20		
	2000	Light	13'-4"	13'-4"	22'-8"	14'-8"	29'-4"	18'-8"	32'-0"	20'-0"	5	7	9	7	5	14	12	14		
	2500	Heavy	22'-8"	24'-0"	24'-0"	24'-0"	30'-8"	24'-0"	34'-8"	26'-8"	8	13	15	12	8	24	21	24		
	2500	Light	16'-0"	16'-0"	25'-4"	16'-0"	32'-0"	20'-0"	36'-0"	22'-8"	6	9	10	9	6	17	15	16		
TWO-STORY	1500	Heavy	16'-0"	16'-0"	20'-0"	16'-0"	25'-4"	18'-8"	28'-0"	20'-0"	6	9	10	9	6	17	14	16		
	1500	Light	12'-0"	12'-0"	20'-0"	12'-0"	26'-8"	16'-0"	29'-4"	18'-8"	4	6	7	6	4	12	10	12		
	1800	Heavy	18'-8"	18'-8"	21'-4"	20'-0"	28'-0"	20'-0"	20'-0"	22'-8"	7	10	12	10	7	19	17	19		
	1800	Light	13'-4"	13'-4"	22'-8"	13'-4"	28'-0"	17'-4"	32'-0"	20'-0"	5	7	8	7	5	13	12	13		
	2400	Heavy	24'-0"	24'-0"	24'-0"	24'-0"	32'-0"	24'-0"	34'-8"	26'-8"	8	13	15	12	9	24	21	24		
	2400	Light	17'-4"	17'-4"	26'-8"	17'-4"	33'-4"	21'-4"	36'-0"	24'-0"	6	9	11	9	6	17	15	17		
	3000	Heavy	26'-8"	28'-0"	28'-0"	28'-0"	34'-8"	28'-0"	37'-4"	28'-0"	9	15	17	14	10	28	24	27		
	3000	Light	20'-0"	20'-0"	28'-0"	20'-0"	36'-0"	24'-0"	40'-0"	26'-8"	7	11	12	10	7	20	17	20		

– Check the box that applies to the home.

Notes:

1. Anchor bolts and Connectors shown in schedule are minimum required per wall line, placed within the length of strengthening where possible. Additional anchors and connectors may be necessary to meet the requirements of specific details and technical notes.
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 alternate only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
4. Plywood braced panel may be omitted where cripple wall is less than 1'-0" in height. Use length of strengthening for required connectors.

CONNECTORS	
MANUFACTURER	MODEL
TYPE A	
Simpson Strong-Tie	UFP10
TYPE B	
Simpson Strong-Tie	FAP
KC Metals	RFP
TYPE C	
KC Metals	RFA86/88
KC Metals	RFA136/138
USP Structural Connectors	SFA8
TYPE D	
Simpson Strong-Tie	L70
KC Metals	CA70
USP Structural Connectors	AC7
TYPE E	
Simpson Strong-Tie	L90
KC Metals	CA90
USP Structural Connectors	AC9

CONNECTORS	
MANUFACTURER	MODEL
TYPE F (Note 4)	
Simpson Strong-Tie	H10A
KC Metals	HT10A
USP Structural Connectors	RT16A
TYPE G	
Simpson Strong-Tie	LTP4
KC Metals	FAL
USP	MP4F
TYPE S1	
Simpson Strong-Tie	MSTA36
KC Metals	TSA36
USP Structural Connectors	MSTA36
TYPE S2	
Simpson Strong-Tie	ST6236
KC Metals	TS36
USP Structural Connectors	KST234

Note: Manufacturer's model numbers and installation instructions are subject to change. Verify and follow manufacturer's written instructions.

TIE-DOWNS	
Supplemental Technical Notes (Sheet S2), Section I.	
MANUFACTURER	MODEL
Simpson Strong-Tie	HDU2
KC Metals	ADST2
USP Structural Connectors	PHD2A

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

A: GENERAL HOME INFORMATION

Instructions for Section A

Using the home's total square footage, number of stories, and "Heavy" or "Light" construction type; mark the square footage closest to, but not less than the values listed in the Total Floor Area column of the Earthquake Strengthening Schedule.

1. Square footage calculation
 - a. Number of stories above cripple wall / mud sill: _____
 - b. Approximate 1st floor area over crawl space: _____
(Do not include areas built over slab-on-grade.)
 - c. Approximate 2nd floor area over crawl space: _____
(Do not include areas where 1st floor is built over slab-on grade.)Total approximate square footage: _____
(line b + line c)
2. Is the home HEAVY or LIGHT construction? (see below for definition)
Check one: ☐ HEAVY Construction ☐ LIGHT Construction

B: SUMMARY OF WORK

Instructions for Section B

Line 1: Based on the tallest cripple wall of the entire home, write the length indicated in the "Without Tie-downs" column in the space provided. If you have a wall line not long enough to accommodate the indicated length use the "With Tie-downs" column instead. Your home may have some wall lines with and some wall lines without tie-downs.

Line 2: Choose and indicate the type and size of foundation sill anchors to be used. Either 1/2" or 5/8" diameter bolts may be used. Connectors type A, B, or C may be used where there is no cripple wall or the foundation sill is inaccessible.

Line 3: Indicate the types of connectors to be used. The connectors will be determined by your particular framing condition.

Line 4: Check this box if tie-downs are used due to insufficient length of wall lines or obstructions make it impossible to meet the minimum length required in Line 1. Complete Table H-1 on Sheet S2.

1. Required length of strengthening without tie-downs _____ ft per wall line.
Where tie-downs are required: _____ ft per wall line.
2. New Mudsill Anchorage used: (check all that apply)
Bolts: Diameter _____ ☐ Adhesive ☐ Screw
☐ Type "A" Connector ☐ Type "C" Connector
☐ Type "B" Connector
3. Floor Framing Connectors to Mudsill or Top Plate used: (check all that apply)
☐ Type "D" ☐ Type "F"
☐ Type "E" ☐ Type "G"
4. ☐ Check this box if SUPPLEMENTAL TECHNICAL NOTES were used. (Required where tie-downs are used.)

DEFINITIONS - "HEAVY" OR "LIGHT" CONSTRUCTION

HEAVY CONSTRUCTION: Includes any of the following:

Exterior Wall Finishes: Stucco

Roofing: Concrete or clay tiles weighing up to 11 pounds per square foot.

LIGHT CONSTRUCTION: is limited to the following:

Exterior Wall Finishes: Wood panel siding; or similar lightweight board

Roofing: Wood shakes; wood or asphalt shingles; composition roofing; or metal roofing weighing five pounds per square foot or less.

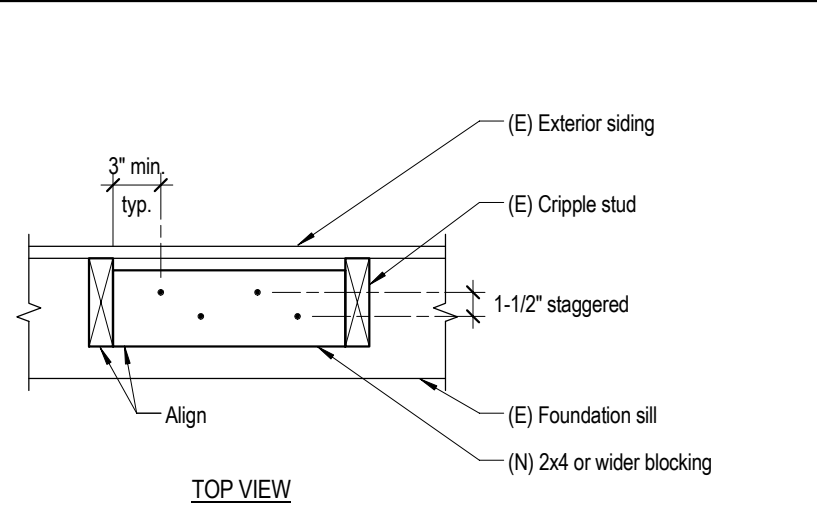
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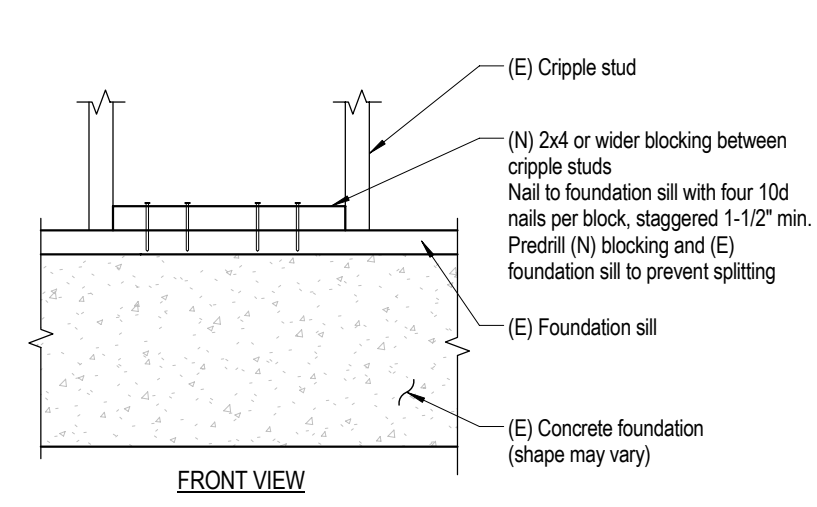
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set



S3

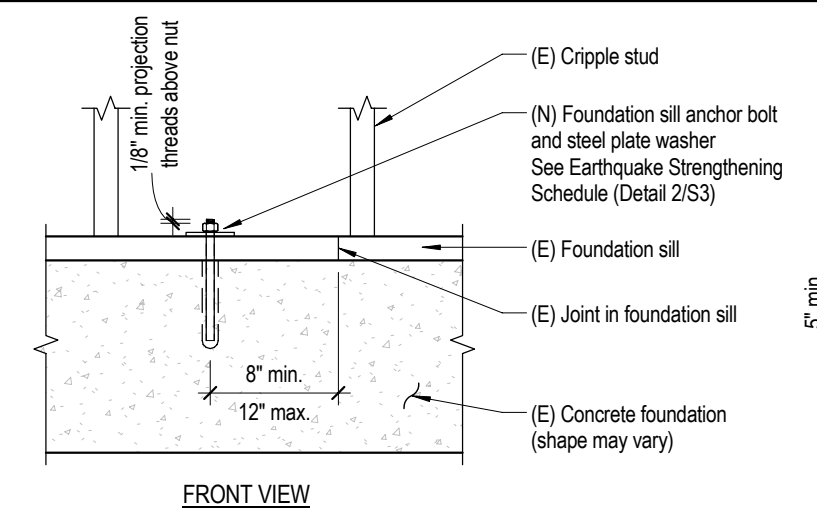


TOP VIEW



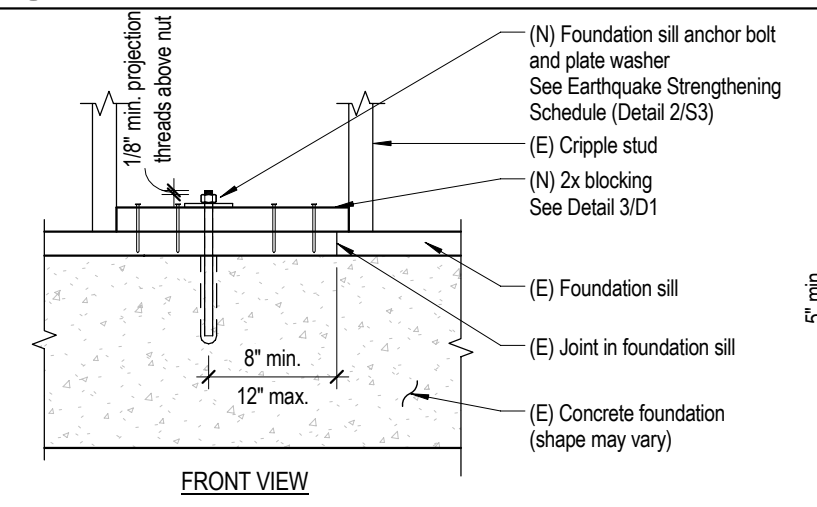
FRONT VIEW

3 NEW BLOCKING INSTALLATION



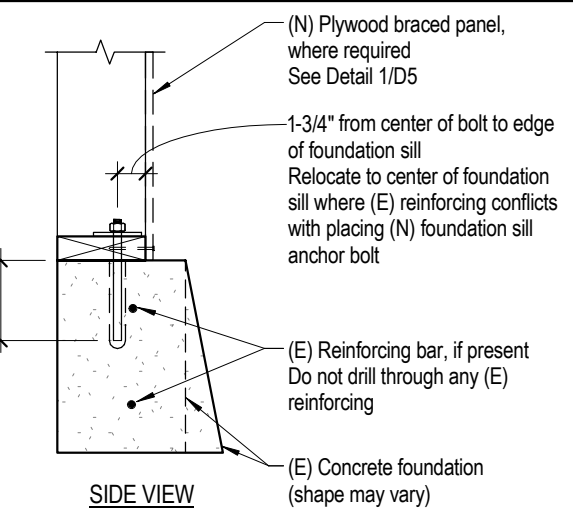
FRONT VIEW

1 ANCHOR THROUGH FOUNDATION SILL ONLY

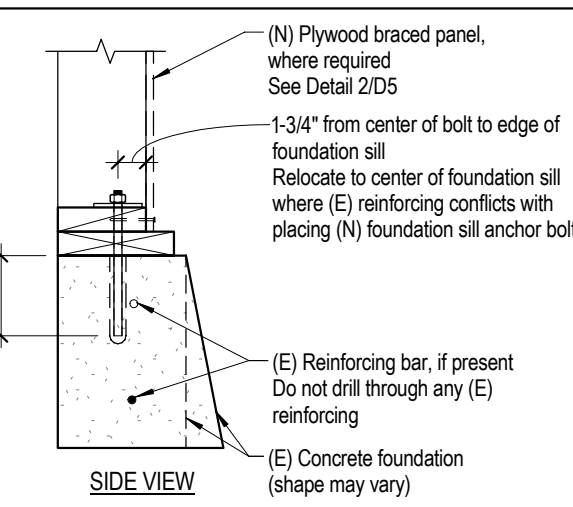


FRONT VIEW

2 ANCHOR THROUGH BLOCKING AND FOUNDATION SILL



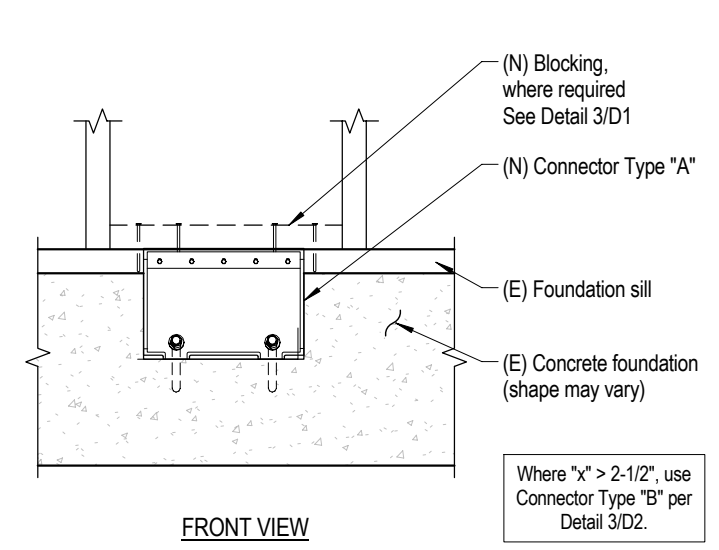
SIDE VIEW



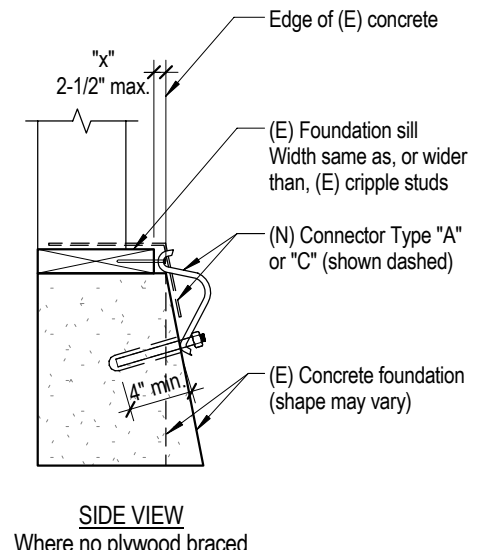
SIDE VIEW

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)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
20d (20 penny)	0.192" x 4" long common
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
Plywood (Plywood braced panel)	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	

PROPERTY ADDRESS: _____

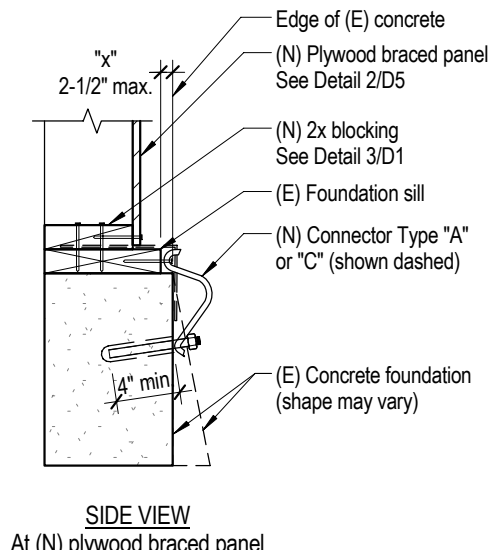


FRONT VIEW



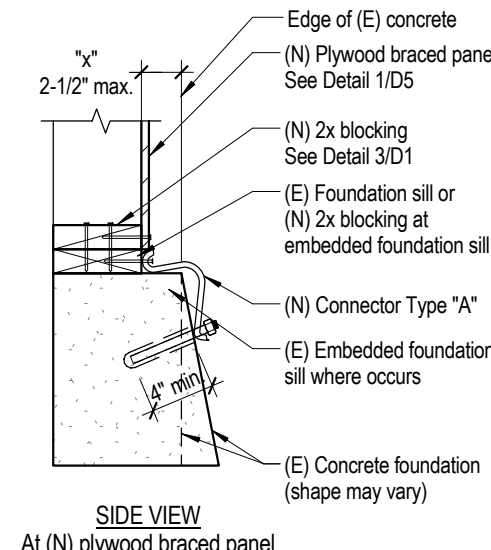
SIDE VIEW

Where no plywood braced panel is required



SIDE VIEW

At (N) plywood braced panel where (E) foundation sill is wider than (E) cripple studs



SIDE VIEW

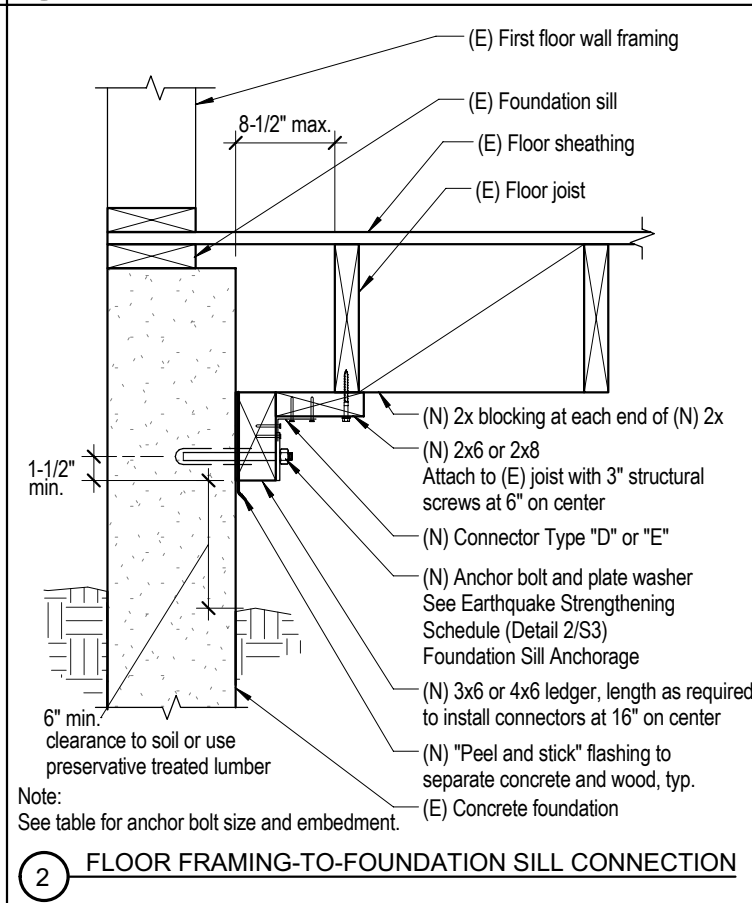
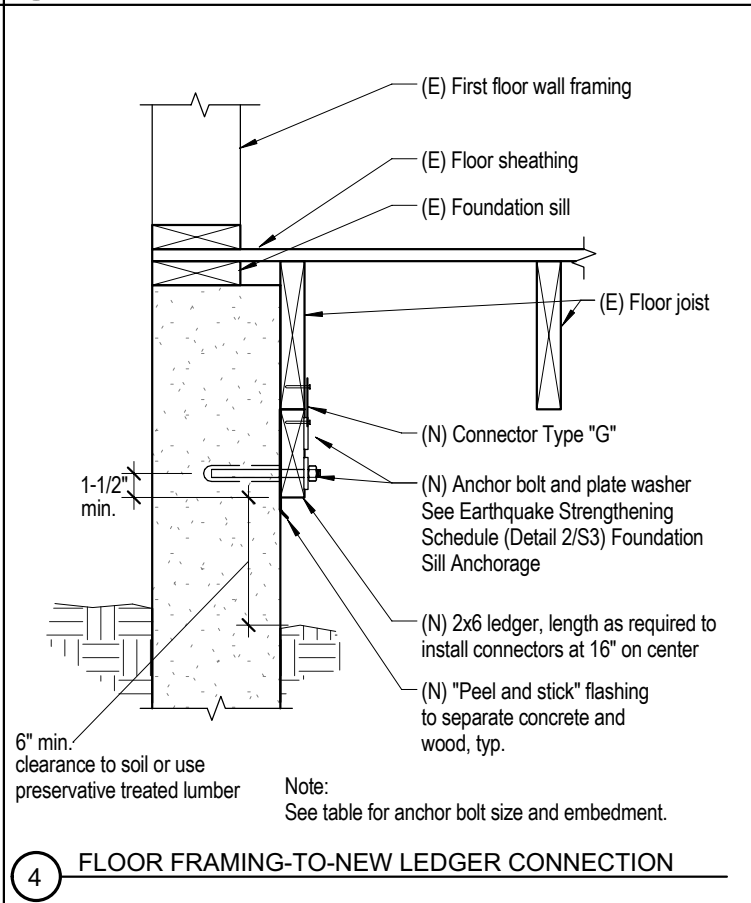
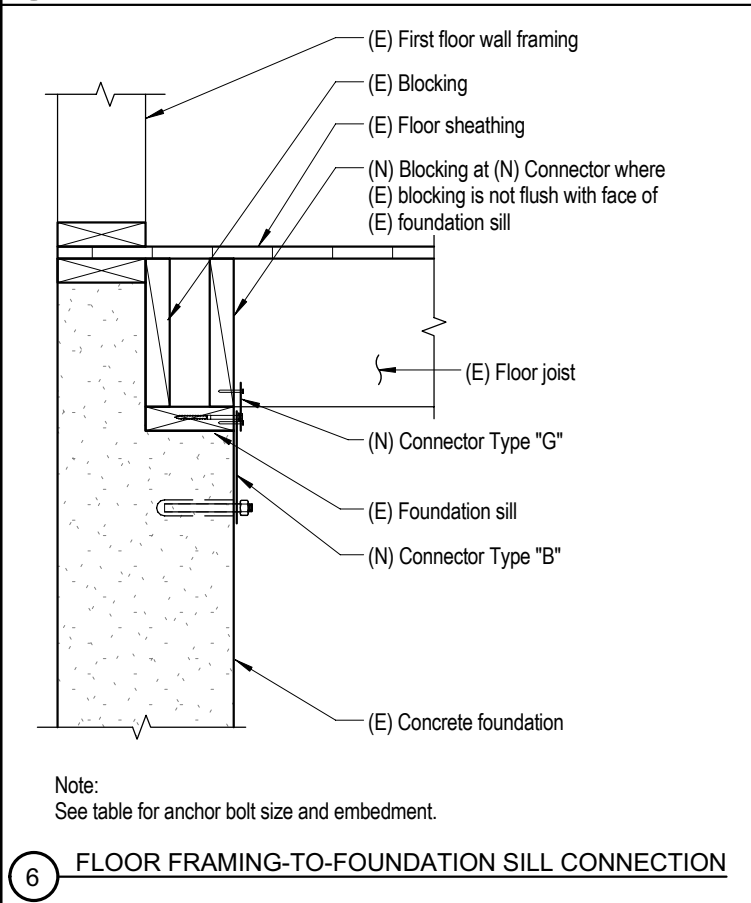
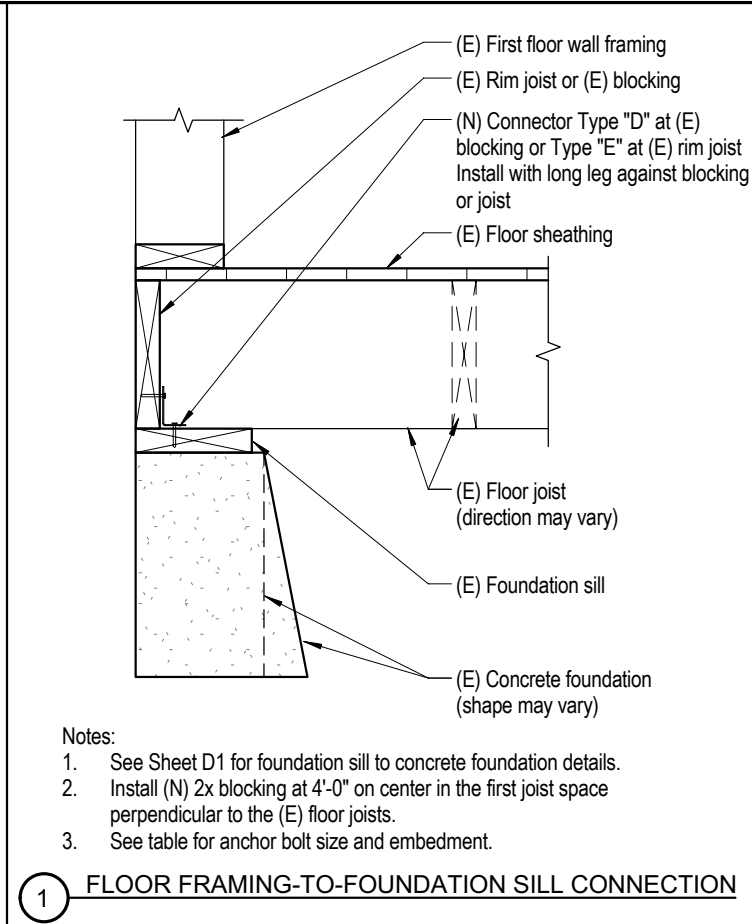
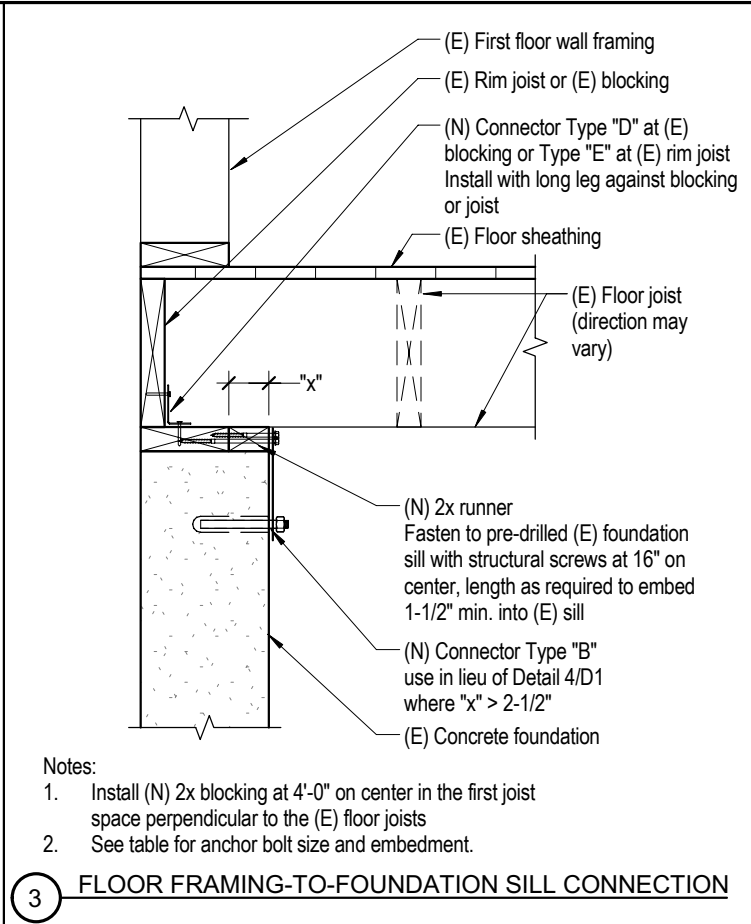
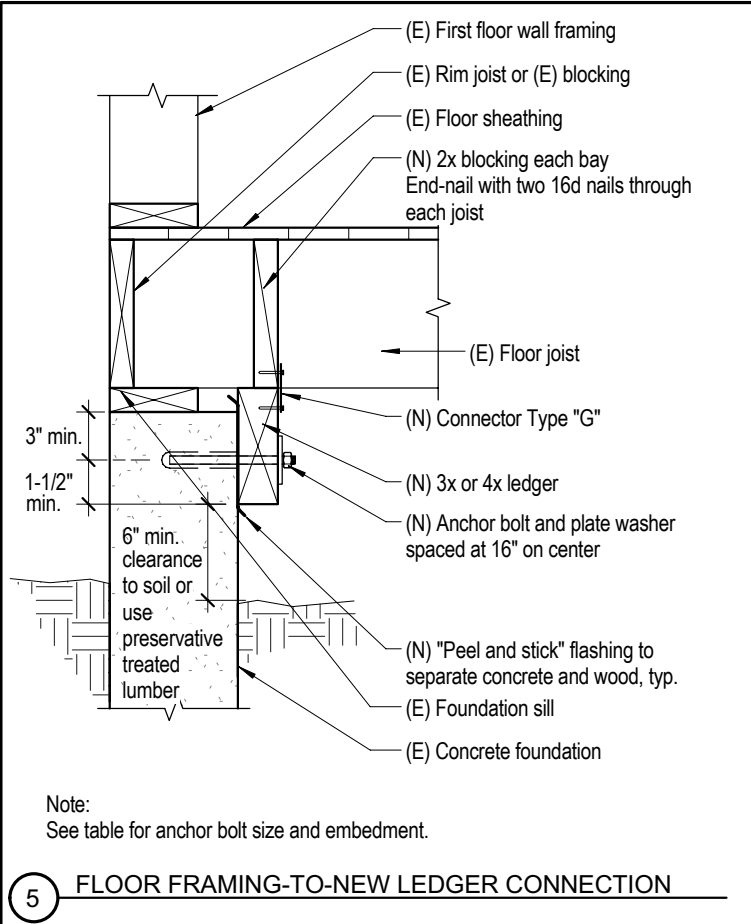
At (N) plywood braced panel where (E) foundation sill is same width as (E) cripple studs

4 FOUNDATION SILL CONNECTORS
Detail used where cripple wall studs are too short to allow drilling for new anchor bolts.

Foundation Sill to Concrete Foundation Connection Details

Earthquake Strengthening of
Cripple Walls in
Wood-Frame Dwellings
FEMA Plan Set

D1



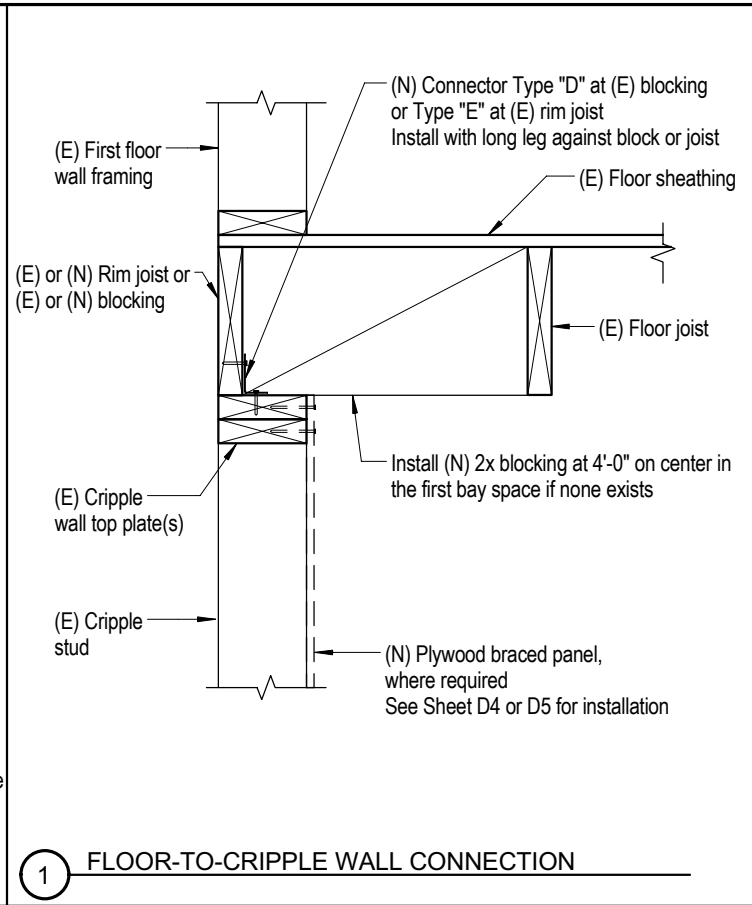
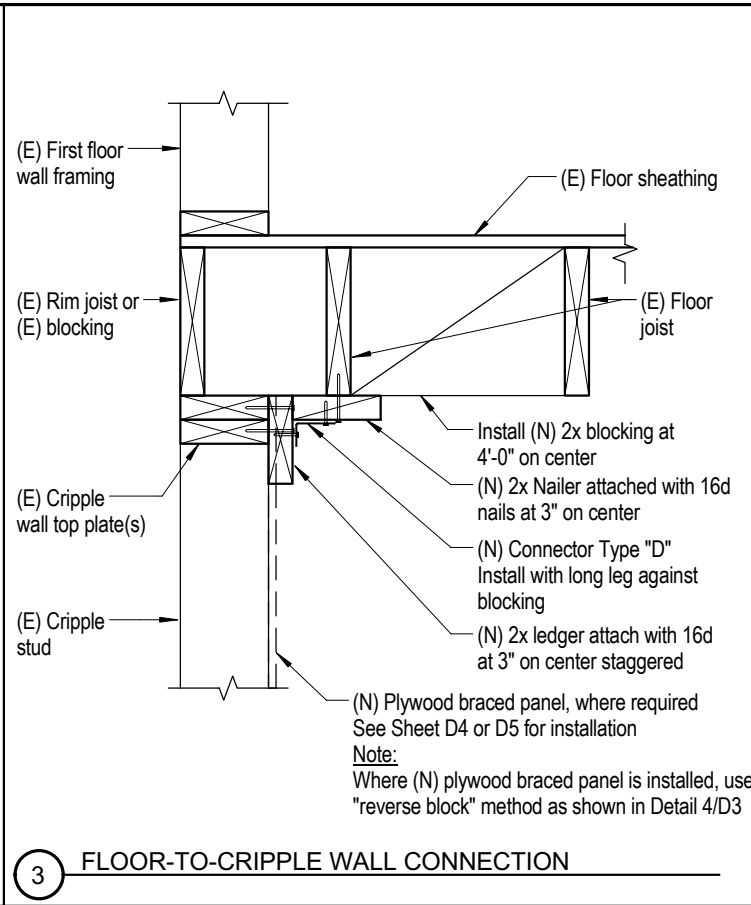
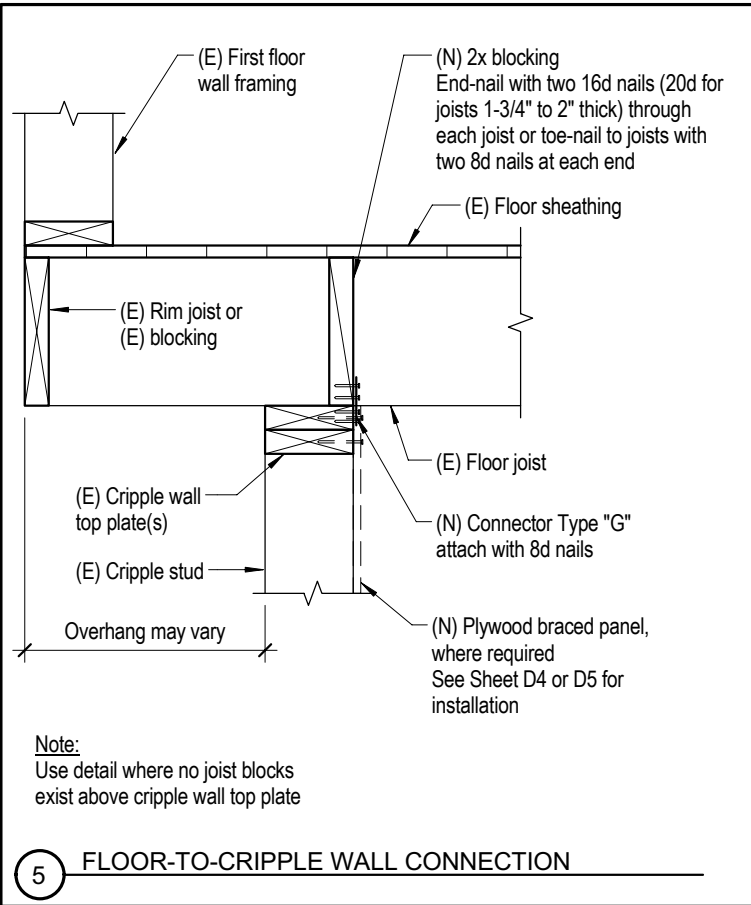
MATERIAL KEY:	
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:	
Term	Description
Nails	
8d (8 penny)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
20d (20 penny)	0.192" x 4" long common
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
Plywood (Plywood braced panel)	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	

PROPERTY ADDRESS: _____

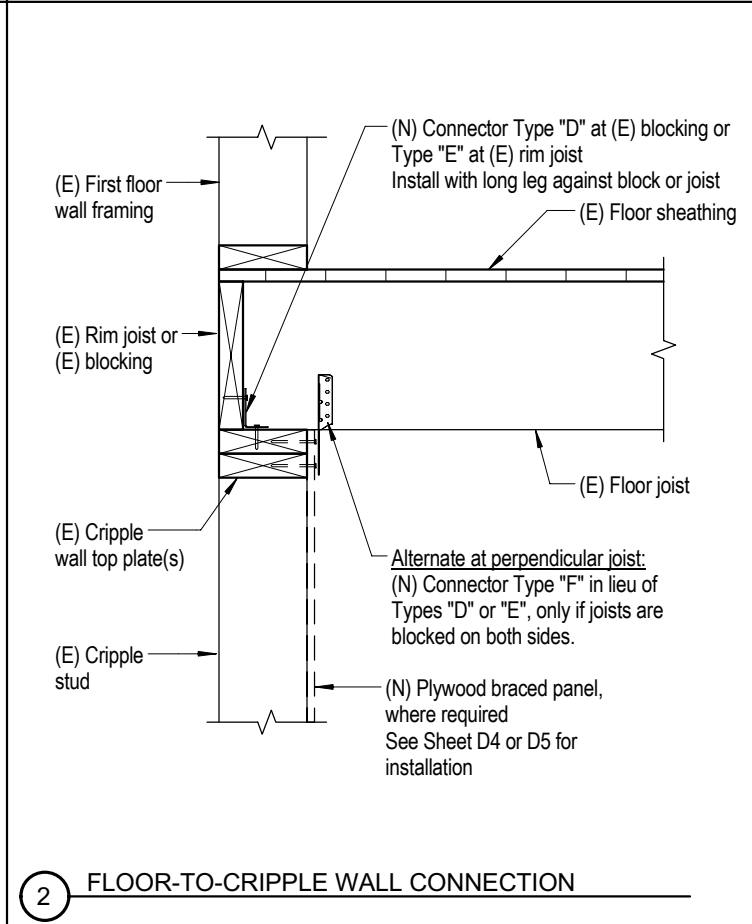
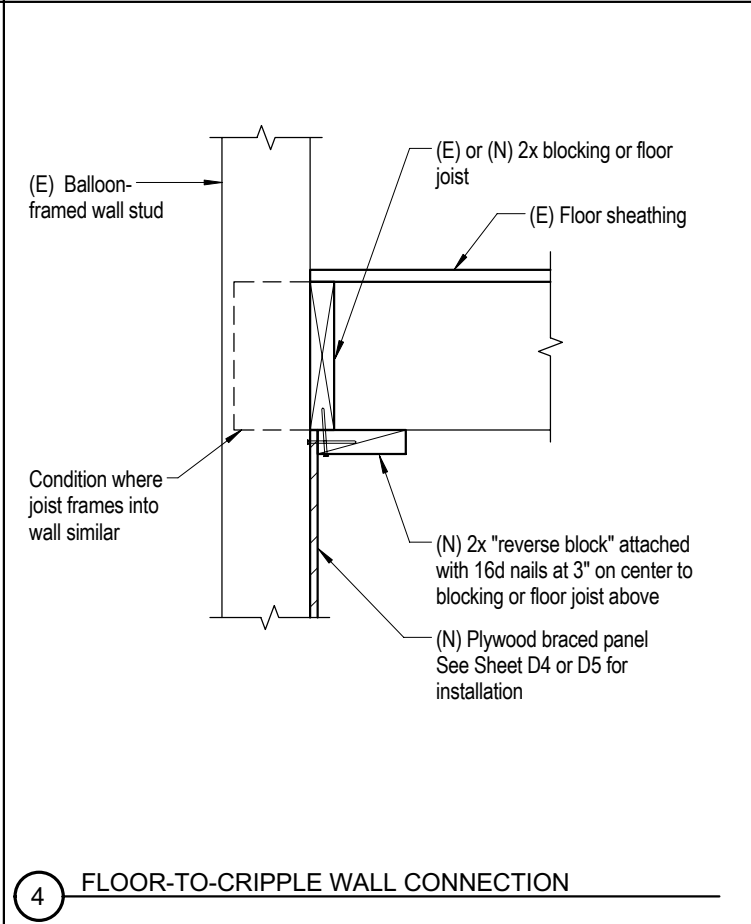
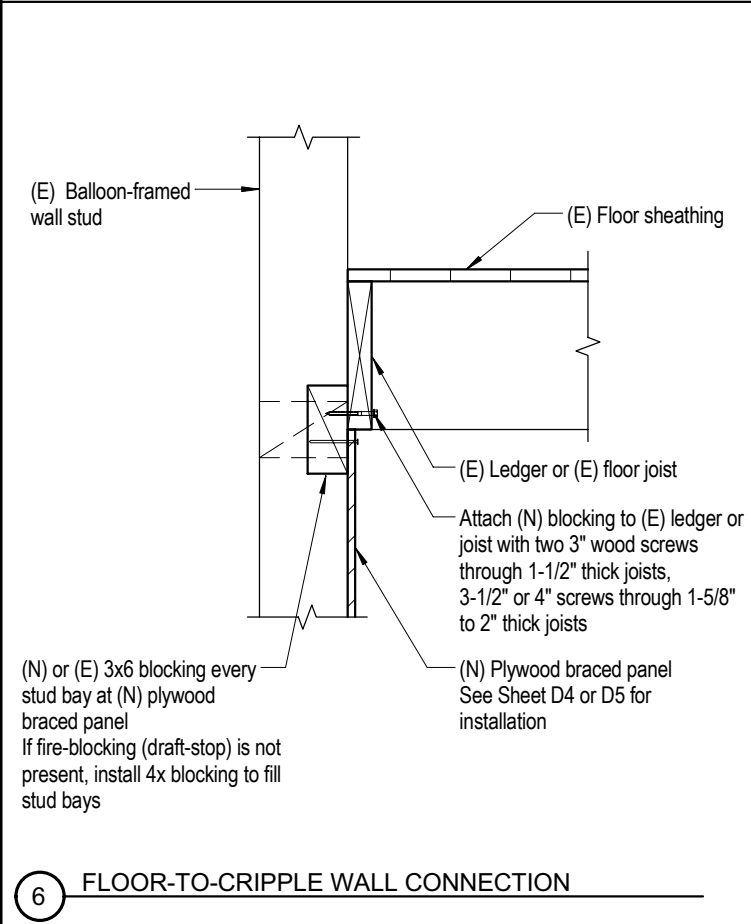
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set

D2

Floor Framing to Foundation Sill Connection Details



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)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
20d (20 penny)	0.192" x 4" long common
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
Plywood (Plywood braced panel)	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	



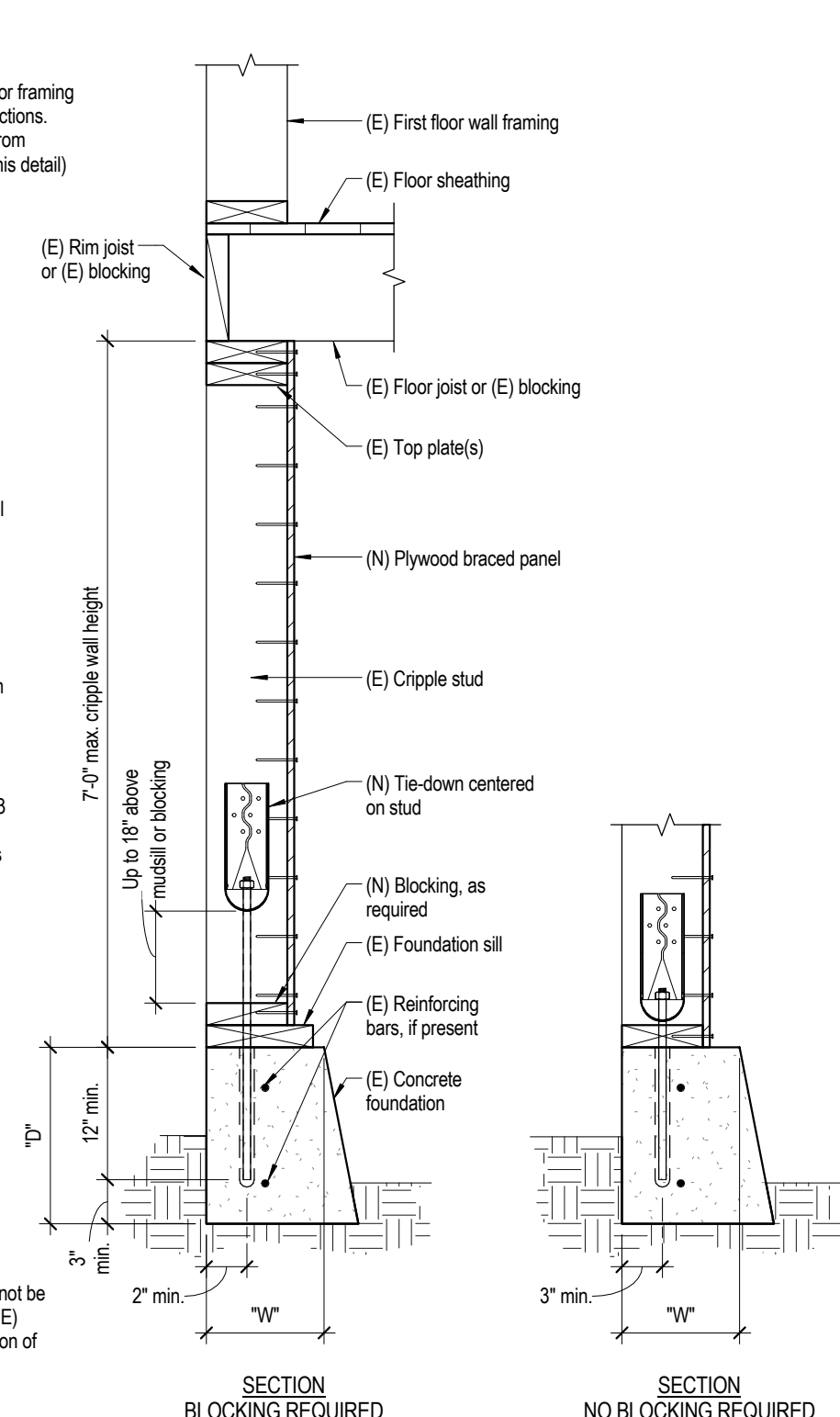
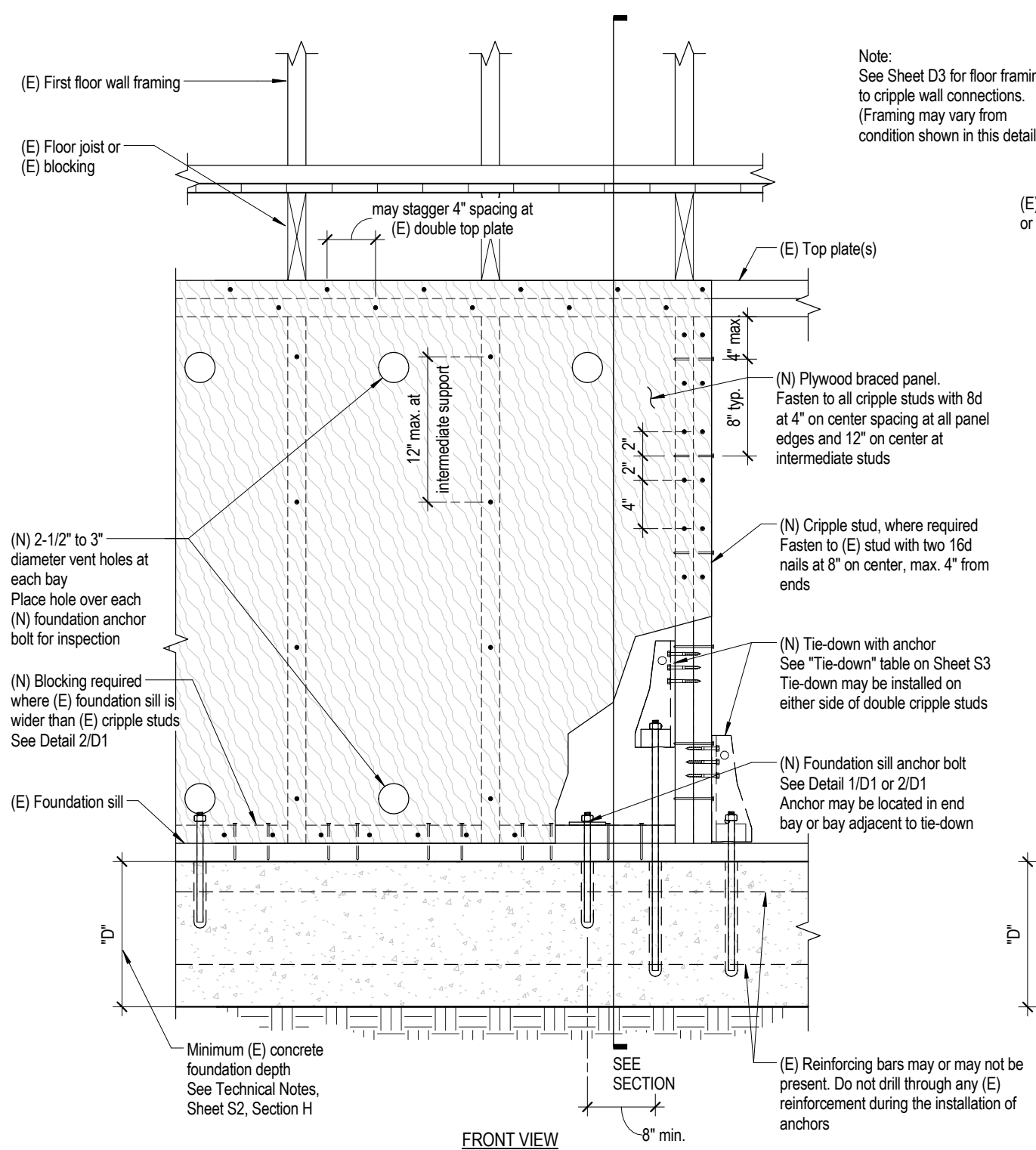
PROPERTY ADDRESS: _____

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set

 **FEMA**

D3

Floor Framing to Cripple Wall Connection Details



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)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
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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
Plywood (Plywood braced panel)	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	

PROPERTY ADDRESS: _____

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set



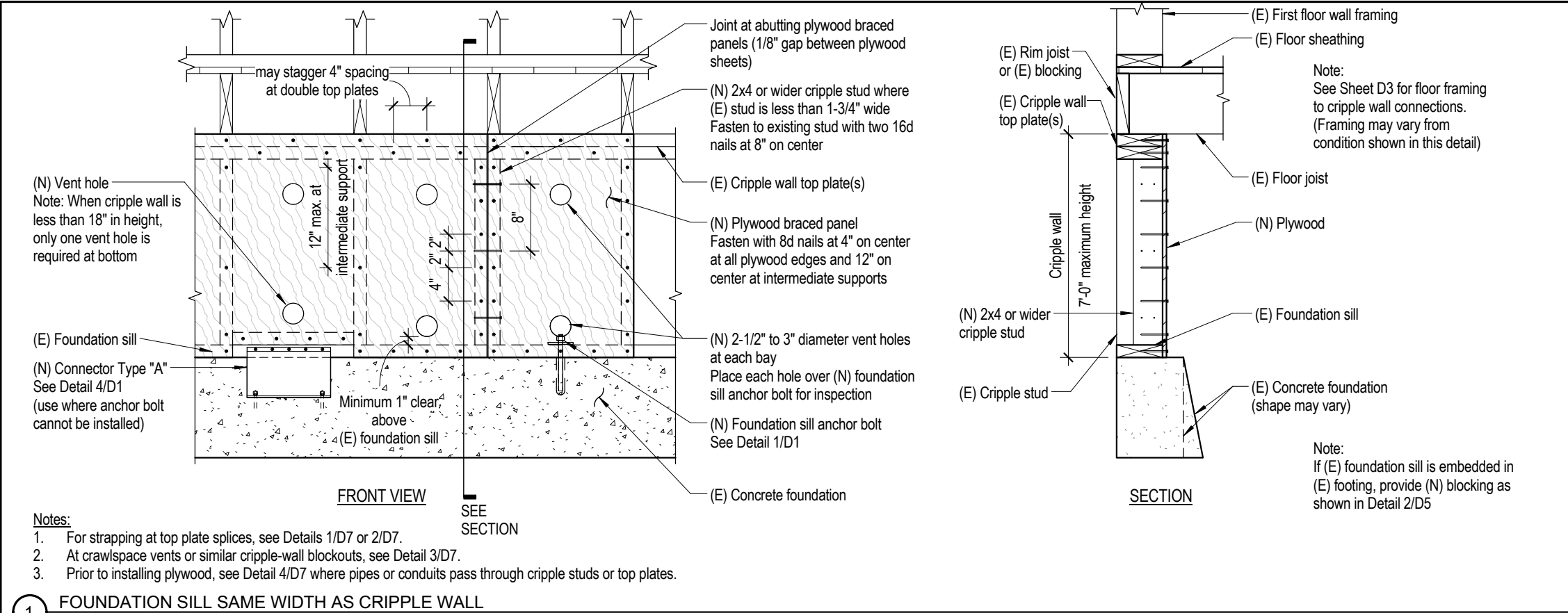
FEMA

D4

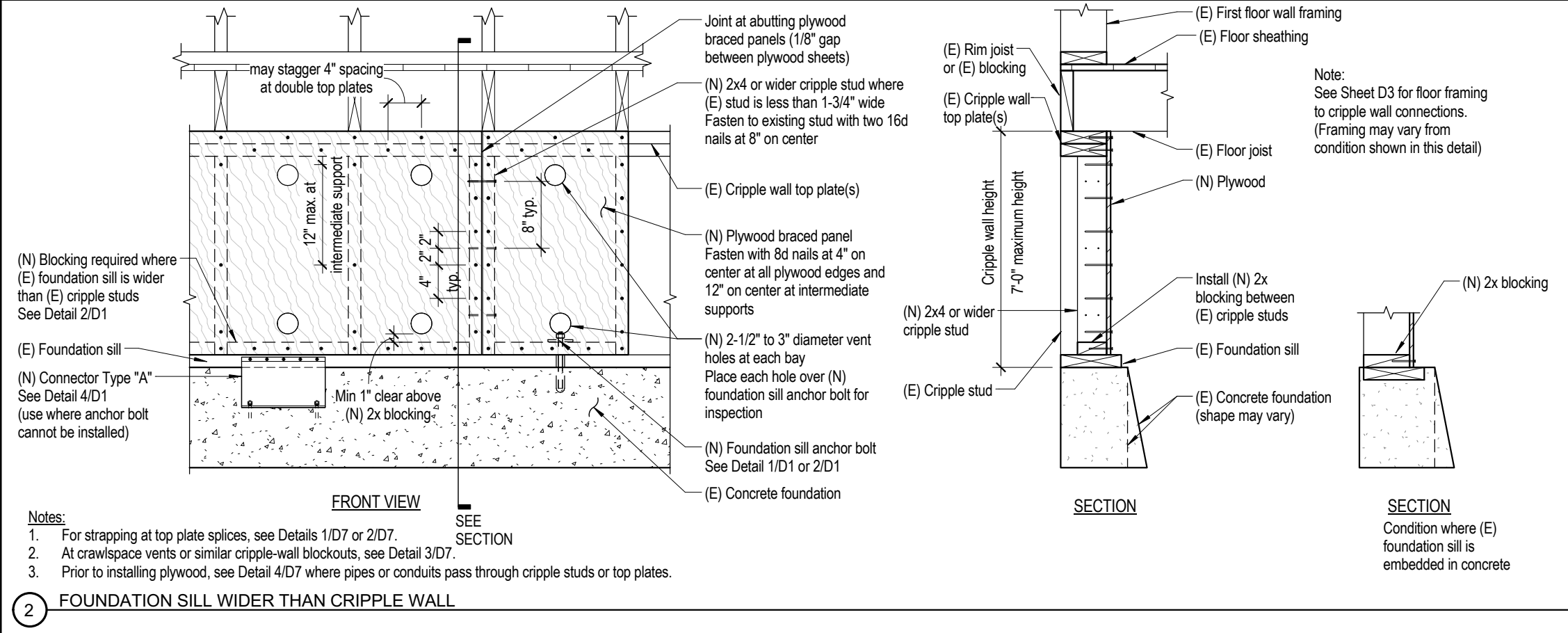
- Notes:
- For strapping at top plate splices, see Details 1/D7 or 2/D7.
 - At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D7.
 - Prior to installing plywood, see Detail 4/D7 where pipes or conduits pass through cripple studs or top plates.

1 TYPICAL TIE-DOWN INSTALLATION

Plywood Installation at Plywood Braced Panels with Tie-Downs



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)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
20d (20 penny)	0.192" x 4" long common
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Plywood (Plywood braced panel)	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	



Plywood Installation at Plywood Braced Panels without Tie-Downs

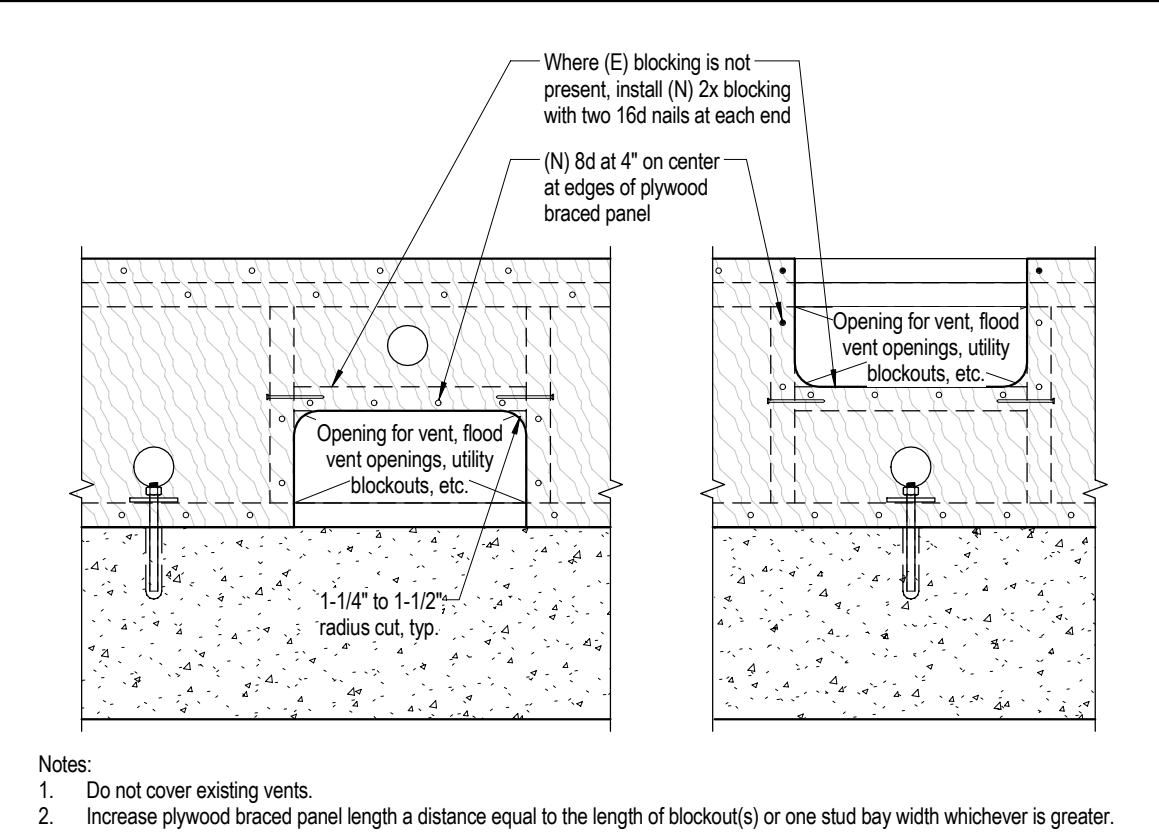
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Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set

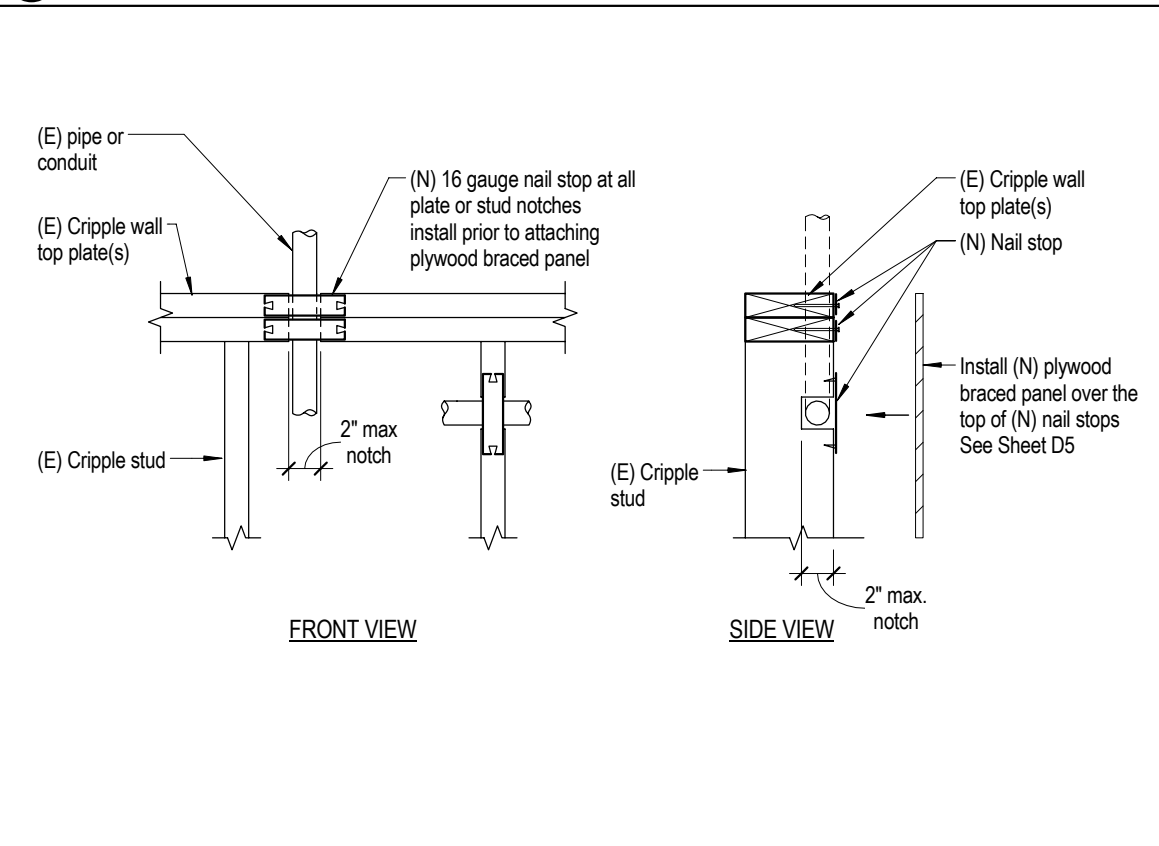
**FEMA**

D5

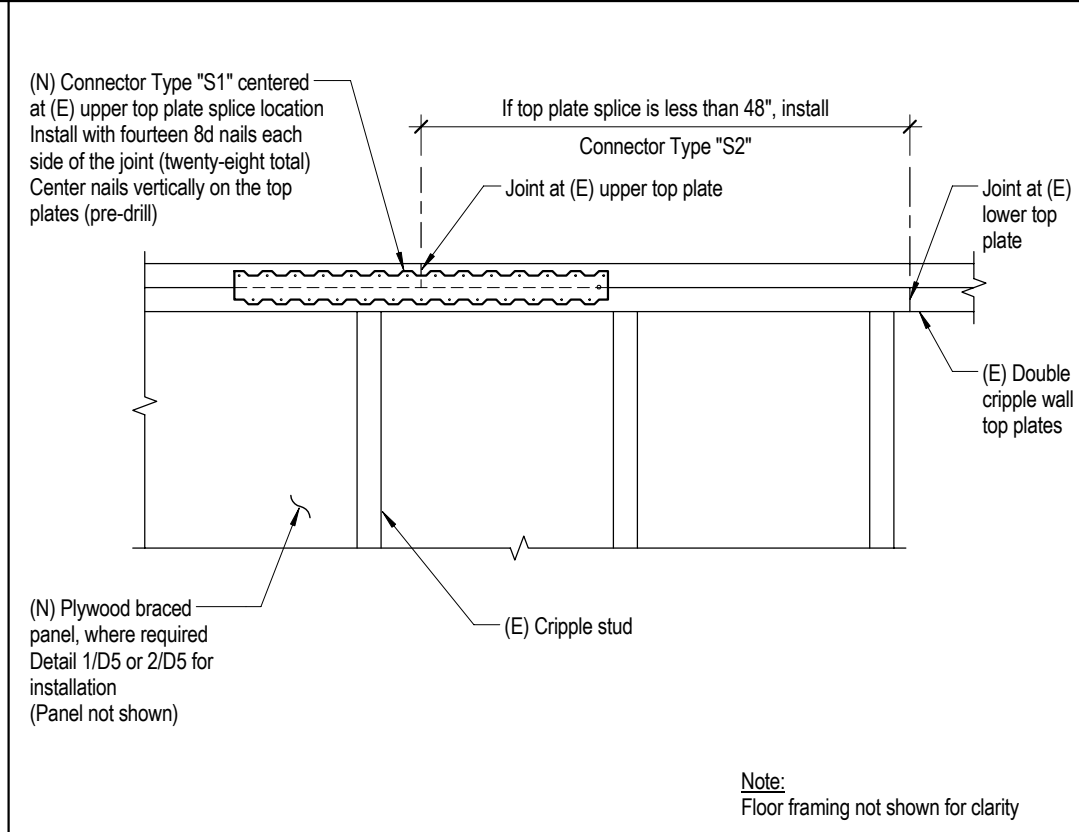
APRIL 2015



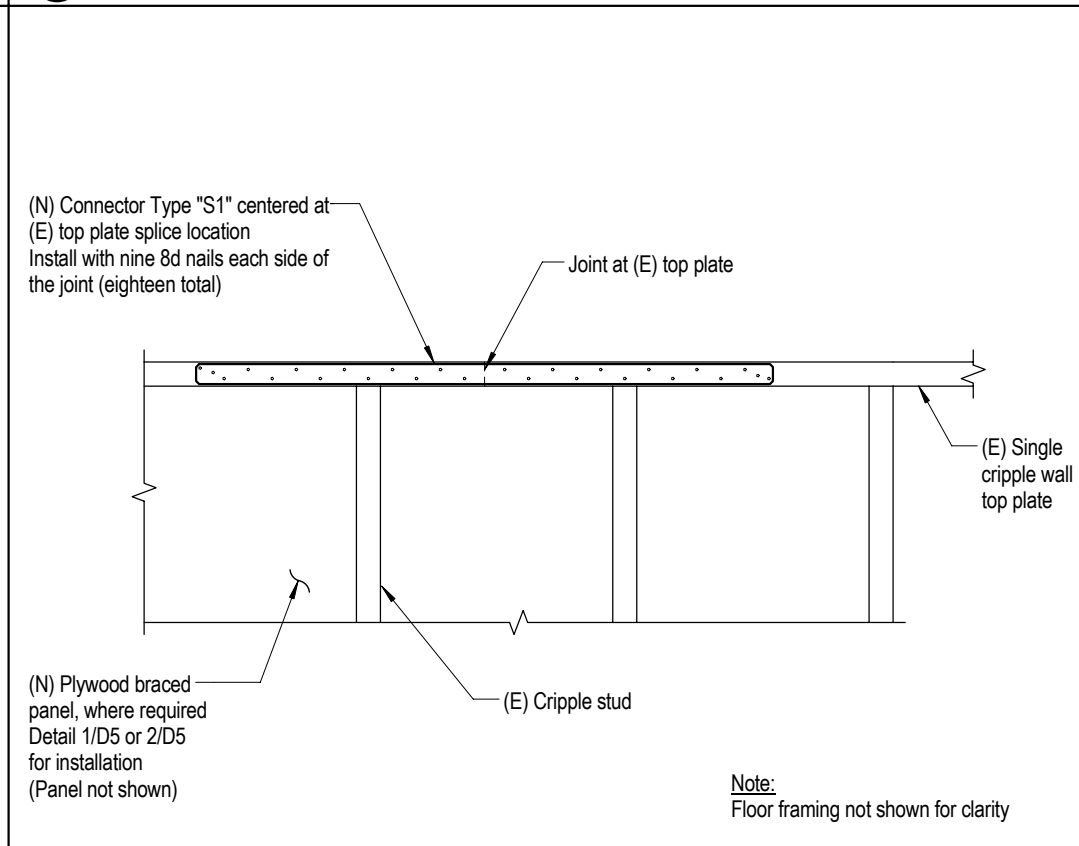
3 CUTOUT REQUIREMENTS IN PLYWOOD BRACED PANELS



4 ALLOWABLE NOTCHING AND REINFORCING FOR TOP PLATES AND STUDS



1 TOP PLATE SPLICE AT EXISTING DOUBLE TOP PLATES



2 TOP PLATE SPLICE AT (E) SINGLE TOP PLATE

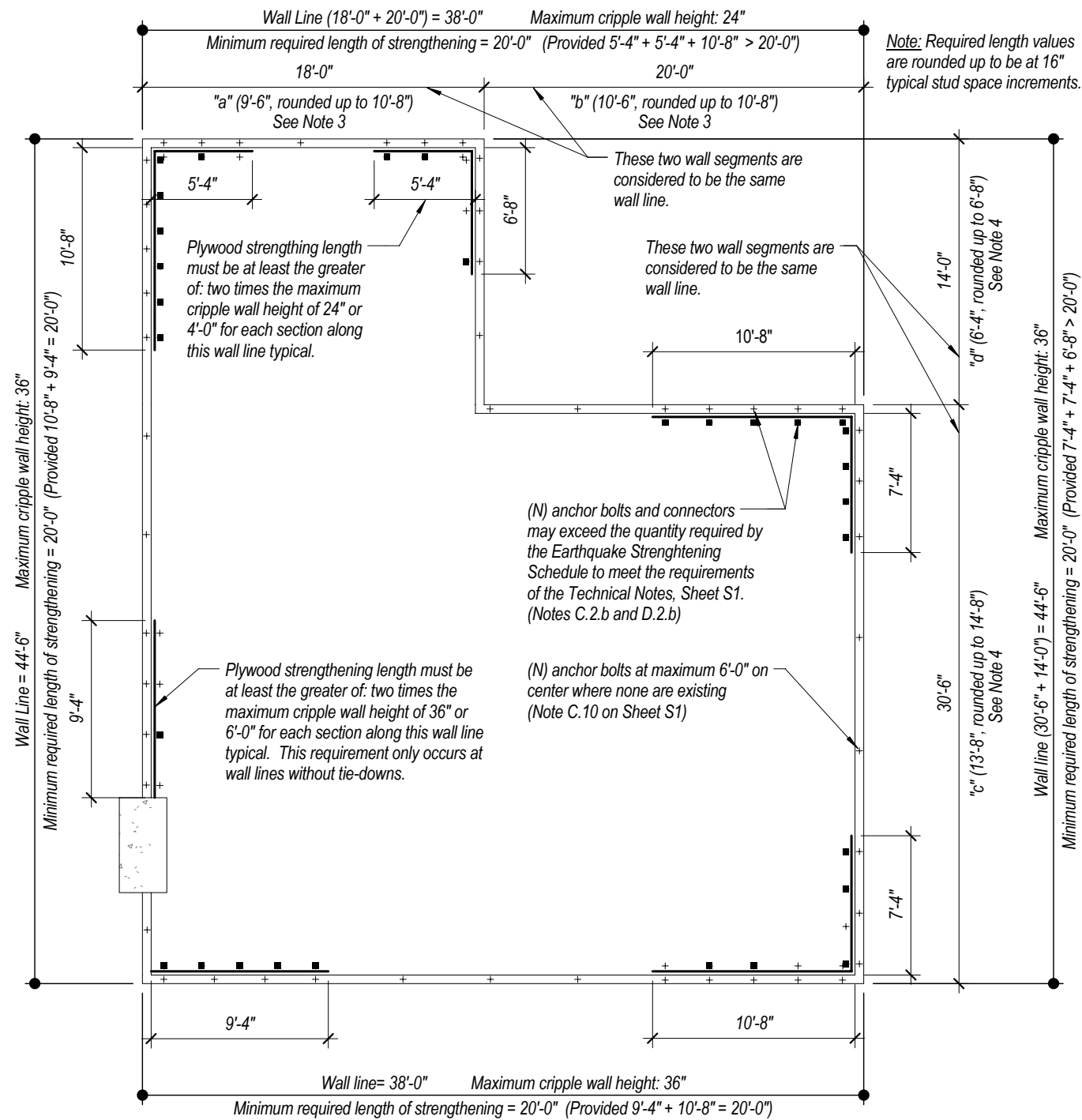
MATERIAL KEY:	
Below is a key to common call-outs in the details. Unless specified otherwise in the details, use the sizes and materials as follows:	
Term	Description
Nails	
8d (8 penny)	0.131" x 2-1/2" long common
8d (at Connectors attached over plywood)	0.131" x 2-1/2" long common
8d (at Connectors attached directly to framing)	0.131" x 1-1/2" long
10d (10 penny)	0.148" x 3" long common
10d (at Connectors attached over plywood)	0.148" x 3" long common
10d (at Connectors attached directly to framing)	0.148" x 1-1/2" long
16d (16 penny)	0.162" x 3-1/2" long sinkers
20d (20 penny)	0.192" x 4" long common
Screws	
3" screw	3" long structural wood screw
4" screw	4" long structural wood screw
6" screw	6" long structural wood screw
Plywood (Plywood braced panel)	
	15/32" Structural I, Exposure 1, 5-Ply.
LVL (Laminated Veneer Lumber)	
	Weyerhaeuser "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, Tyvar, Tyvek, Vycor, HardieWrap, or equivalent.
For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).	

PROPERTY ADDRESS: _____

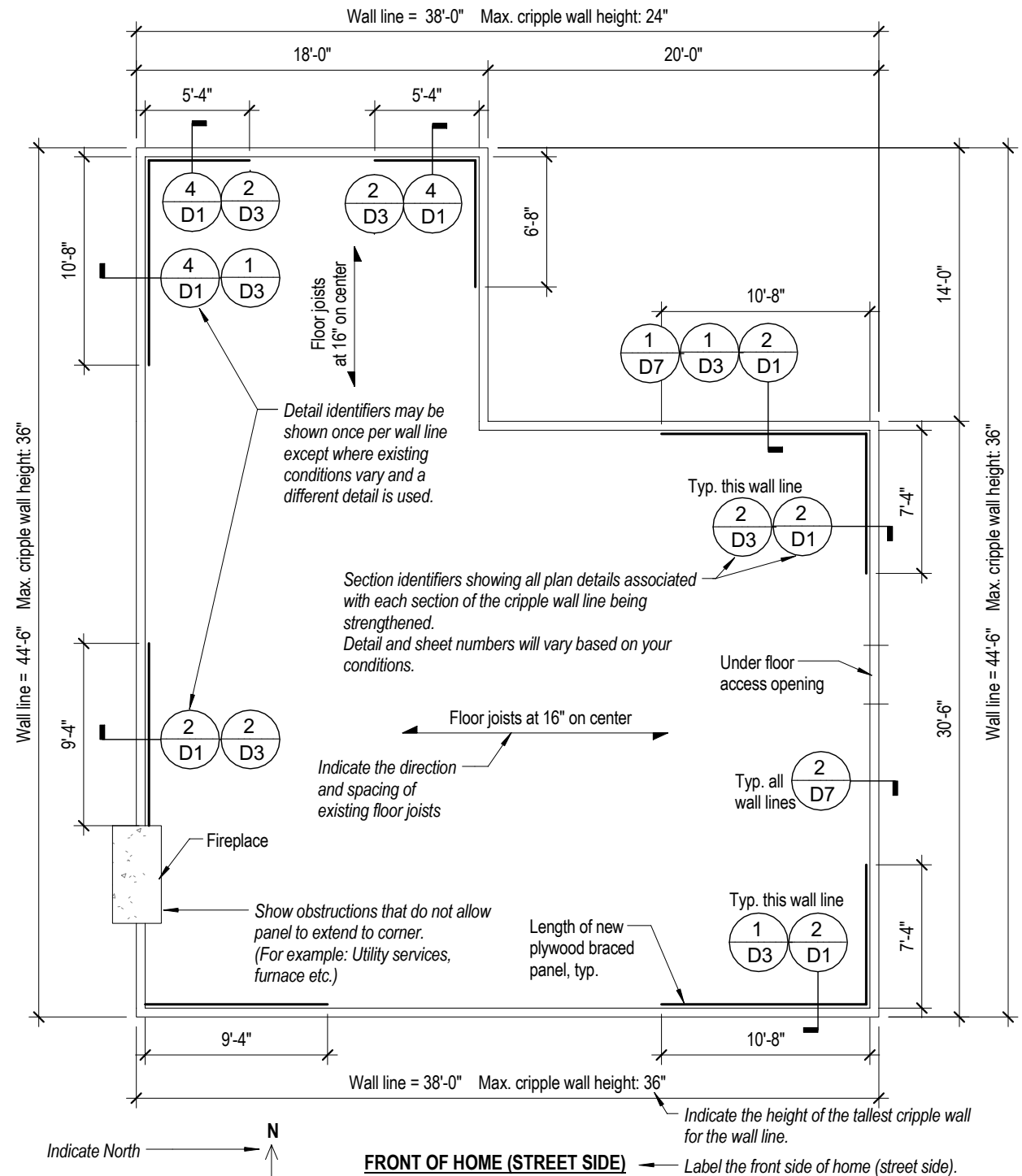
Earthquake Strengthening of
Cripple Walls in
Wood-Frame Dwellings
FEMA Plan Set

**FEMA**

D7



EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS



EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

This sample is a 1407 square foot, one-story home of "Light" construction. The wall lines of this home allow enough length to use plywood braced panels without tie-downs. The row for 1500 square feet on Earthquake Strengthening Schedule Sheet S3 was used to determine the needed length of 20 feet on each wall line (no tie-down). This example chooses to use 1/2"Ø Anchor Bolts, and Type "E" Connectors; to determine lengths and quantities.

Key:

- Minimum required length of strengthening using plywood braced panels, anchors, and connectors
- Foundation sill anchor bolt or connector
- Floor framing connector

Example - Foundation Plan

Notes:

- Plan shows typical notation. Instructional notes are in *italics* and should not be included on submittal drawing. Refer to Sheet 00 for additional instructions.
- Detail Number (Homeowner or Contractor to choose most appropriate detail)
Sheet Number
- Sample calculation. Approximate length of strengthening required for segments "a" and "b" use 16" increments:
 $a = 20'-0" \left(\frac{18'}{18'+20'} \right) \approx 9'-6"$ $b = 20'-0" \left(\frac{20'}{18'+20'} \right) \approx 10'-6"$
- Sample calculation. Length of strengthening required for segments "c" and "d":
 $c = 20'-0" \left(\frac{30'-6"}{30'-6"+14'} \right) \approx 13'-8"$ $d = 20'-0" \left(\frac{14'}{30'-6"+14'} \right) \approx 6'-4"$

Plywood braced panels:

Strengthening:

Wall line:

Definitions

New plywood installed to a length of cripple wall to provide strengthening.

Foundation and/or cripple wall work intended to yield improved performance during an earthquake.

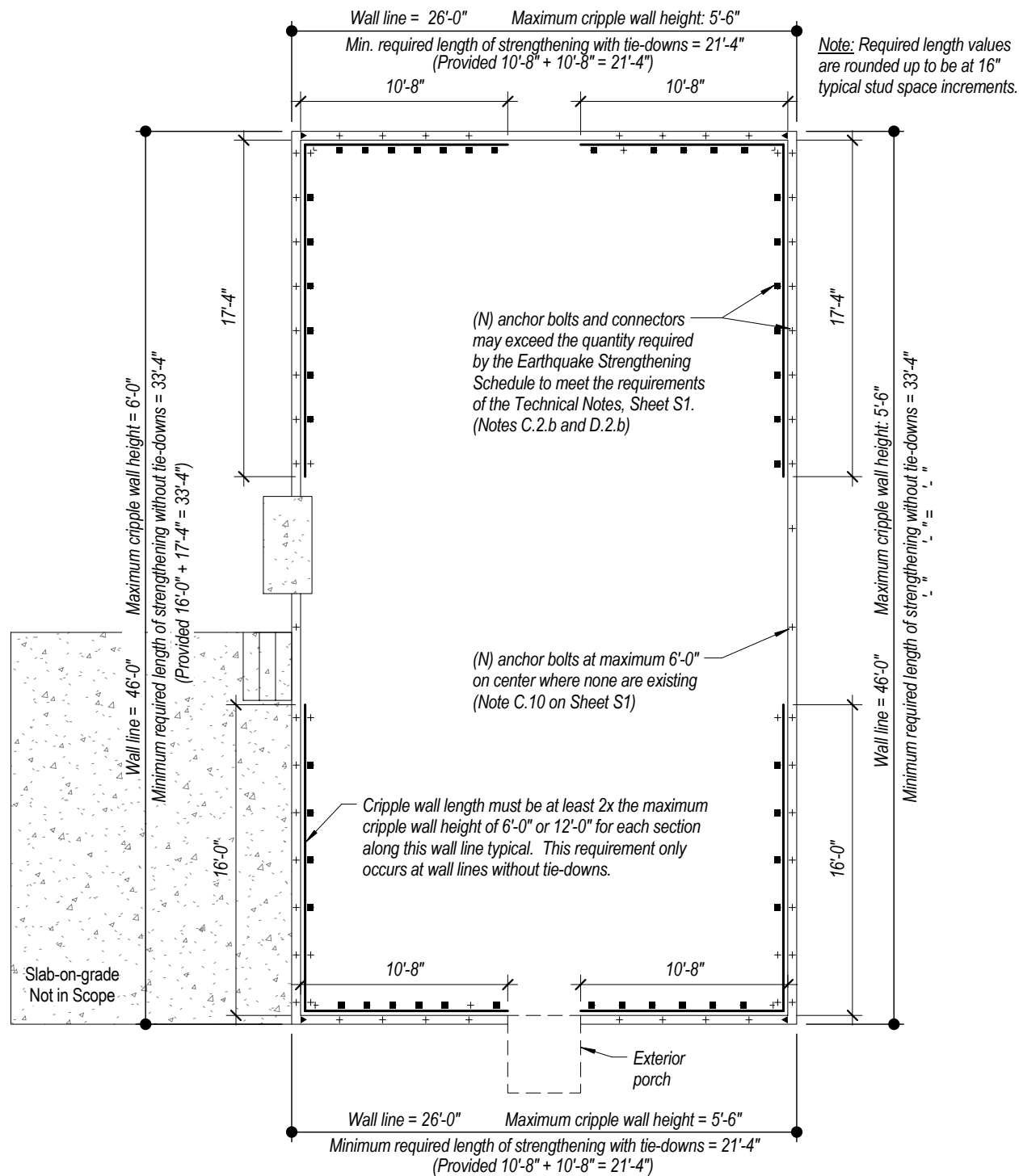
All wall segments forming the overall building dimension on one side.

This sheet is for instruction and reference only.
Do not submit to the Authority Having Jurisdiction.

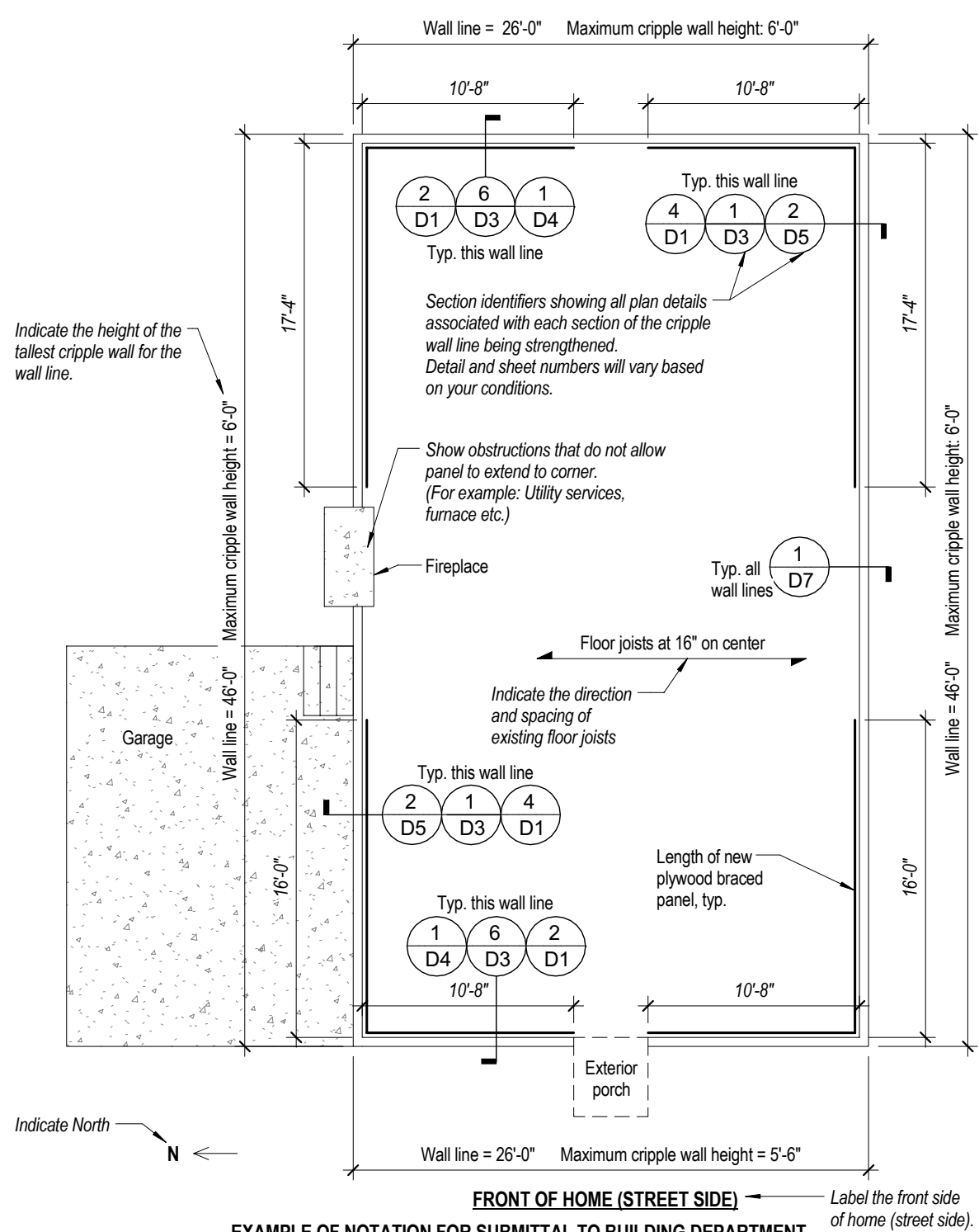
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set



X1



EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS



EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

This sample is a 2392 square foot, two-story home of "Light" construction. (Excludes porch). Not all wall lines of this home allow enough length to use plywood braced panels without tie-downs, therefore plywood braced panels both with and without tie-downs will be used. The row for 2400 square feet in the Earthquake Strengthening Schedule Sheet S3 was used to determine the needed length of 33'-4" on each wall line without tie-downs and 21'-4" for wall lines with tie-downs. This example chooses to use 5/8" Anchor Bolts, and Type "E" Connectors, to determine lengths and quantities.

Key:

Minimum required length of strengthening using plywood braced panels, anchors, and connectors

- Foundation sill anchor bolt or connector
- Floor framing connector
- Tie-down

Notes:

- Plan shows typical notation. Instructional notes are in *italics* and should not be included on submittal drawing. Refer to Sheet 00 for additional instructions.

- Detail Number (Homeowner or Contractor to choose most appropriate detail)
 Sheet Number

Definitions

- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
- Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
- Wall line: All wall segments forming the overall building dimension on one side.

Example - Foundation Plan

This sheet is for instruction and reference only.
 Do not submit to the Authority Having Jurisdiction.

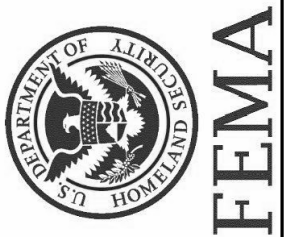
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set



X2

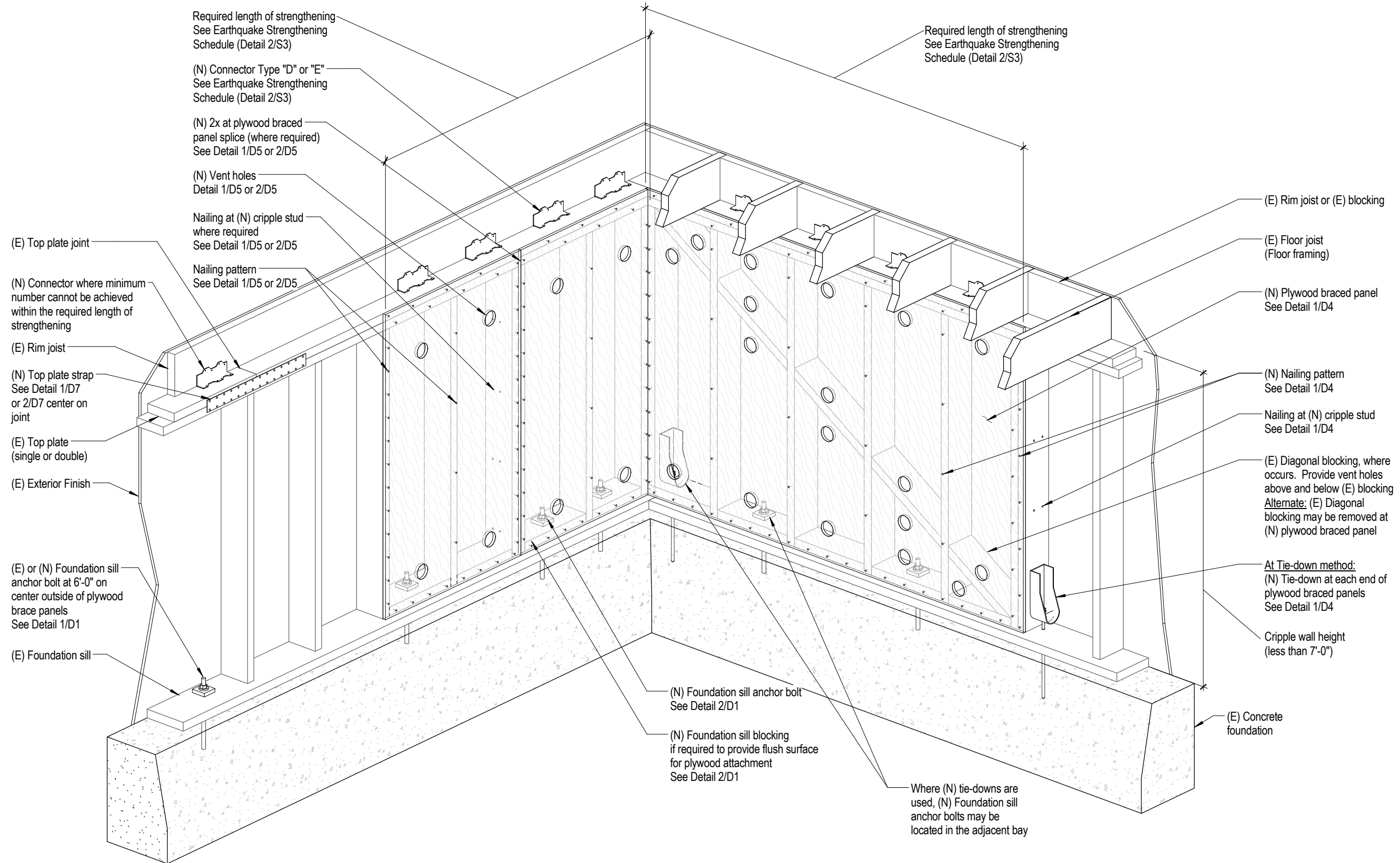
This sheet is for instruction and reference only.
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Earthquake Strengthening of
Cripple Walls in
Wood-Frame Dwellings
FEMA Plan Set



X3

APRIL 2015



- Notes:
1. This detail is to show an example of cripple wall that has gone through an earthquake retrofit and to identify terms and details used in this plan set.
 2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
 3. This view is looking from the interior of the crawl space.

Definitions

- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
- Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
- Wall line: All wall segments forming the overall building dimension on one side.

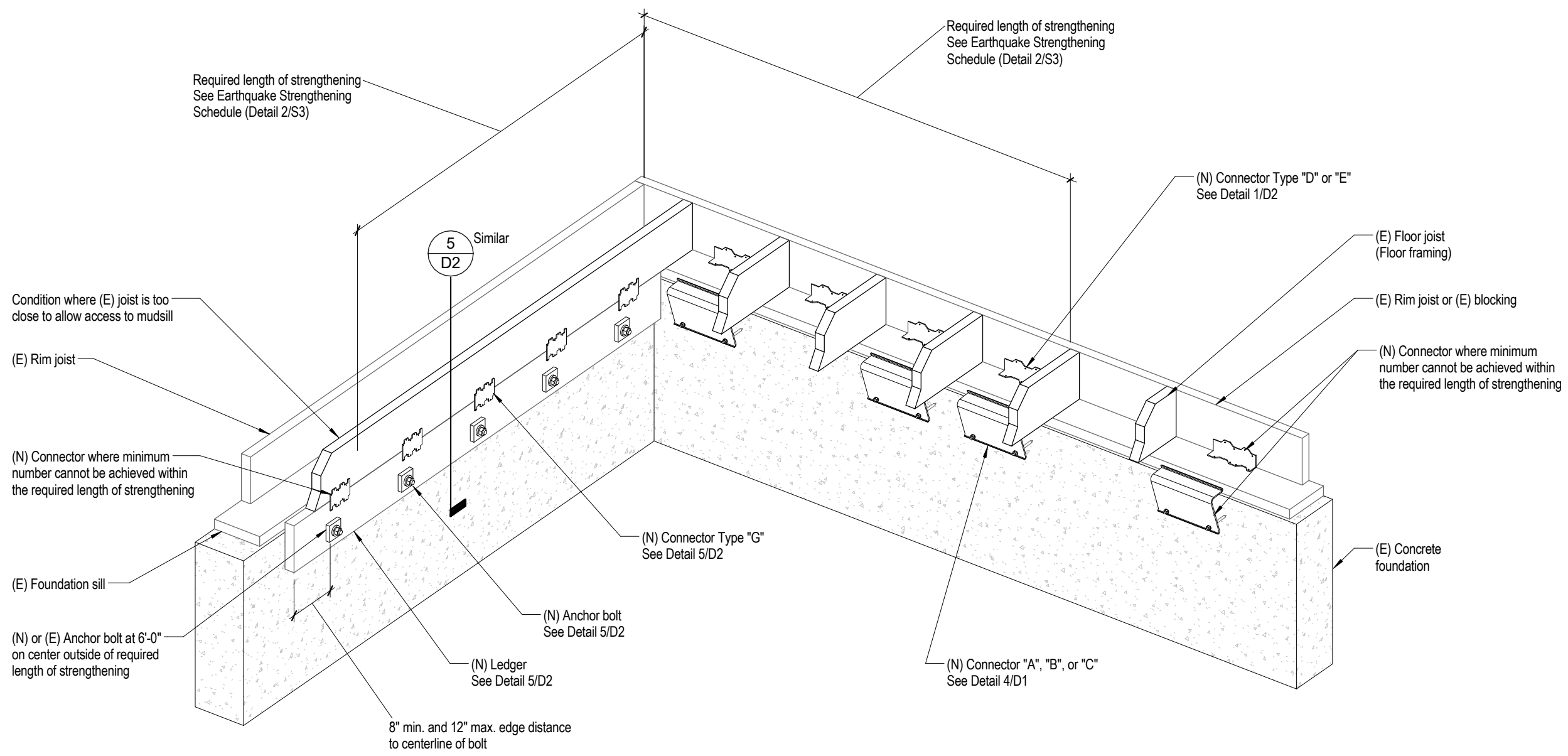
Example - Cripple Wall Strengthening

This sheet is for instruction and reference only.
Do not submit to the Authority Having Jurisdiction.

Earthquake Strengthening of
Cripple Walls in
Wood-Frame Dwellings
FEMA Plan Set



X4



- Notes:
1. This detail is to show an example of an earthquake retrofit where there is no cripple wall, and to identify terms and details used in this plan set.
 2. This detail is not intended to supersede requirements contained in the specific installation details on Sheets D1 through D7.
 3. This view is looking from the interior of the crawl space.

Definitions	
Plywood braced panels:	New plywood installed to a length of cripple wall to provide strengthening.
Strengthening:	Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
Wall line:	All wall segments forming the overall building dimension on one side.

Example - Strengthening - No Cripple Wall