

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.

3. The FEMA Plan Set may not be applicable to all homes, and use of the plan set may require consultation with a licensed general contractor or design professional.
4. When the FEMA Plan Set is used, full use of all applicable details is recommended, but not required. In cases of voluntary retrofit, when existing conditions make installation of some details infeasible or too costly to perform, partial use of the plan set is encouraged to improve performance as much as practicable.

What is the FEMA Plan Set?

The FEMA Plan Set is a prescriptive, pre-engineered set of plans that can be adapted to retrofit cripple walls and foundation anchorage in wood-frame dwellings. It allows a general contractor or knowledgeable homeowner to draw the layout and specify the work required for installation of plywood bracing and additional foundation anchorage in the crawl space of a home (Figure 2). It is intended to contain all of the necessary supplemental technical information and guidance for preparation of a complete set of plans for submittal to the local building department and for use during construction.

The earthquake strengthening measures specified in the FEMA Plan Set meet the intent of the 2012 *International Existing Building Code* (IEBC), Chapter A3, and the 2013 *California Existing Building Code* (CEBC). Work is focused on the cripple walls in the crawl space area below the first floor. Wood-frame dwellings may have other vulnerable areas or other structural deficiencies that could become damaged in an earthquake. The FEMA Plan Set does not attempt to address all potential deficiencies in a home, and does not eliminate the risk of potential damage in future earthquakes.



Figure 2: Cripple wall with plywood strengthening that was undamaged in the South Napa earthquake. Photo credit: ZFA Structural Engineers.

Is the FEMA Plan Set applicable to your home?

Cripple walls can be vulnerable to earthquake damage, but not all homes with cripple walls require earthquake strengthening. Homes that are already adequately anchored to their foundation, cripple walls that are adequately braced with plywood, and homes located in regions of low seismicity (i.e., away from active earthquake faults), may not need additional work. The FEMA P-50 report, *Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings* (FEMA, 2012), provides a way to determine if a home needs earthquake retrofit. A design professional (such as a licensed engineer) should be consulted if there is any uncertainty in the need for strengthening.

When cripple wall strengthening is needed, the FEMA Plan Set is intended to be generally applicable in a variety of situations. However, to be eligible, a home must meet a series of requirements based on the underlying assumptions used to pre-engineer the plan set. Sheet S0 in the set lists a series of questions under the heading “Eligibility for Use.” If you can answer “yes” to all of these questions, the plan set should be generally applicable for use in your home.

If the FEMA Plan Set is not applicable to your home, a complete project-specific set of construction documents should be developed. Project-specific documents may rely, in part, on the FEMA Plan Set, but must be prepared by a design professional (such as a licensed engineer or architect).

Even when the FEMA Plan Set is determined to be applicable, certain conditions may require consultation with a design professional to modify the prescriptive information contained in the plan set to be fully applicable in your situation. If only isolated locations in your home deviate from the conditions shown in the plan set, a licensed engineer or architect may be able to assist on a limited basis, producing supplemental information for submittal to the building department, rather than a full project-specific set of construction documents.

How is the FEMA Plan Set used?

Adaptation of the FEMA Plan Set to your home is performed by a licensed general contractor (recommended) or by a knowledgeable homeowner. Sheets S0 through S4 of the plan set should be filled out completely,

including a scaled plan of the home and references to applicable details in Sheets D1 through D7. Sheets X1 through X4 provide examples illustrating the use of the plan set. Homeowners should consult their local building department with any questions.

The licensed contractor, or homeowner, submits the completed plan set to the local building department for a building permit. The building department may charge a fee to review the plans for conformance with local building codes. This fee may also cover site inspection services by building department representatives to ensure that the proposed work has been constructed in accordance with the building permit.

The building department may also require Special Inspection, which is on-site testing by an outside, third-party inspector that is hired by the homeowner. Although the FEMA Plan Set identifies conditions requiring Special Inspection, the local building department decides what work does and does not require Special Inspection.

Limited access and clearance in the crawl space below most homes often makes implementation of cripple wall strengthening difficult. For these reasons, it is recommended that a licensed contractor, rather than a do-it-yourself homeowner, perform the work. Since earthquake strengthening work is also specialized, homeowners should seek and engage general contractors who specialize in this type of work. Homeowners are encouraged to consult the contractor licensing board in their state for guidance on hiring a contractor to provide construction services. Many states have laws regulating the types of licenses contractors must hold, insurance requirements, bonding requirements, and liens.

Does your home need everything in the Plan Set?

The scope of work outlined in the FEMA Plan Set is intended to provide a reasonable level of earthquake strengthening for cripple walls and foundation anchorage. This level of strengthening is intended to reduce, but not eliminate, the risk of potential damage in future earthquakes.

Sometimes, the configuration of a home, or an obstruction in the crawl space, may make the installation of some work prescribed in the plan set infeasible, or too costly to perform. In the case of voluntary seismic improvements, partial work is often better than no work at all. Although not recommended, partial implementation of the FEMA Plan Set is encouraged to improve potential earthquake performance as much as practicable. Partial retrofit will result in a reduction in the effectiveness of the seismic strengthening work, and a correspondingly higher risk of potential damage in future earthquakes.

If a decision is made to reduce the scope of the cripple wall retrofit work, the strengthening should be implemented as symmetrically as possible around the perimeter of the crawl space. A licensed engineer or architect should be consulted if there is any uncertainty in an appropriate reduction of scope.

Foundation Requirements

The FEMA Plan Set applies to homes with a continuous concrete perimeter foundation system with or without reinforcement. In the preparation of this plan set, existing foundation systems consisting of stone, concrete masonry units (CMU), or brick masonry have not been addressed. Where an existing foundation system is constructed using a material other than concrete, the plan set is not applicable, and a licensed engineer or architect should be consulted. Application of the plan set also assumes the existing foundation system to be in reasonably good condition. Guidance for evaluating the quality of the existing concrete, along with additional specific requirements for the installation of tie downs or uplift anchors in existing concrete foundations, is provided as part of the plan set.

Limitation of Liability

Earthquake strengthening constructed in accordance with the FEMA Plan Set is intended to reduce the risk of earthquake-related damage to existing residential dwellings with wood-frame cripple walls. The content of this plan set is based on the experience and judgment of practicing engineers and limited research. All circumstances, forms, or types of construction have not necessarily been contemplated in the preparation of this plan set, and it is not possible to control the quality of construction or predict or test all conditions that may occur during an earthquake. No party associated with the preparation of this plan set makes any representation, warranty, or covenant, expressed or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of earthquake strengthening based on this plan set.

Strengthening Adjacent Garage Slabs-On-Grade

The FEMA Plan Set applies to the portions of a home with wood-frame cripple walls below the first floor. Garages, or portions of a home supported directly by concrete slabs-on-grade are not within the scope of the plan set. Although not addressed herein, such areas could also be vulnerable to earthquake damage due to inadequate connection between wood-framing and the slab-on-grade. If the presence of existing anchor bolts within accessible areas of the garage or other areas of the home cannot be verified, or if inadequate anchorage is suspected, homeowners are encouraged to consult with a licensed engineer or architect for recommendations.

Acknowledgements

This Recovery Advisory has been adapted from information originally prepared by many organizations, including the Structural Engineers Association of Northern California (SEAONC), Association of Bay Area Governments (ABAG), California Building Officials (CALBO) Emergency Preparedness Committee, Earthquake Engineering Research Institute-Northern California (EERI-NC), ICC Tri-Chapter, City of San Leandro, City of Seattle, City of Los Angeles Department of Building and Safety, and Simpson Strong-Tie. It was prepared by the Applied Technology Council (ATC) under contract with the Federal Emergency Management Agency. Work was performed by a Project Technical Committee consisting of Colin Blaney (Chair), Thor Matteson, and David L. McCormick, with the assistance of Gayle Klink and Steve R. Patton. Work was reviewed by a Project Review Panel consisting of Kelly Cobeen and Jeffrey E. Taner. Work was overseen by Michael Mahoney (FEMA Project Officer), Anna H. Olsen (ATC Project Manager), and Jon A. Heintz (ATC Program Manager).

Resources and other Useful Links

- CBSC, **2013 California Existing Building Code**, California Code of Regulations, Title 24, Part 10, California Building Standards Commission, Sacramento, California.
- City of Los Angeles Department of Building and Safety, **Earthquake Hazard Reduction in Existing Wood Frame Residential Buildings with Weak Cripple Walls and Unbolted Sill Plates**, Standard Plan Number One, September 2009. http://ladbs.org/LADBSWeb/LADBS_Forms/Publications/anchor_bolting.pdf
- Federal Emergency Management Agency, **FEMA P-50, Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings**, May 2012. <https://www.fema.gov/media-library/assets/documents/92229>
- Federal Emergency Management Agency, **FEMA P-50-1, Seismic Retrofit Guidelines for Detached, Single-Family, Wood-Frame Dwellings**, June 2012. <https://www.fema.gov/media-library/assets/documents/92229>
- ICC, **2012 International Existing Building Code**, Chapter A3, International Code Council, Washington, D.C.
- Project Impact Seattle, **Standard Earthquake Home Retrofit Plan Set**, January 2008. http://www.seattle.gov/dpd/static/get_file/Earthquake%20Home%20Retrofit%20Planset_DPDD017407_LatestReleased.pdf
- Simpson Strong-Tie Company, Inc., **Seismic Retrofit for Residential Wood Frame Cripple Walls and Sill Plate Anchorage**, May 2012. <http://www.strongtie.com/literature/f-plans.html>
- Structural Engineers Association of Northern California, Association of Bay Area Governments, California Building Officials, Northern California Chapter of the Earthquake Engineering Research Institute, Tri-Chapter of the International Code Council, **Standard Plan A (2008): Residential Seismic Strengthening Plan**. <http://seaonc.org/free-publications>

For more information, see the FEMA Building Science Earthquake Program web site at <http://www.fema.gov/earthquake>
If you have any additional questions on FEMA Building Science Publications, contact the helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 1-866-927-2104.

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HOW TO USE THIS PLAN SET

A. Before you begin:

1. Familiarize yourself with the contents of this plan set and the South Napa Earthquake Recovery Advisory FEMA DR-4193-RA2 *Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings*. This plan set is intended for use by a general contractor or homeowner without necessarily having to involve an engineer or architect.
2. Contact your local authority having jurisdiction (AHJ), often known as the Building Department, to understand the building permit application process. Inquire about:
 - a. how many copies of the plans must be submitted
 - b. how much are fees
 - c. which inspections are required
3. The AHJ 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, to determine if this plan set is applicable. A "no" answer to any question disqualifies the home from using this plan set, unless a licensed engineer or architect is involved.
 - a. Question 11 instructions: Visit the referenced website, enter the latitude and longitude for your property, choose 2012 IBC, Site Class D, and Risk Category II from the drop-down menus. Type address, including city and state, into search box on map.

B. Prepare your plans: (See Sheets X1 through X4 for definitions of terms and examples of the notation for submittal to the AHJ.)

1. Draw a scaled plan of the perimeter of the home in the graph 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 which 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- D7.
 - 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 1 on D5 for definition 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.

C. Gather information to complete the plans:

1. Review Technical Notes and Supplemental Technical Notes on Sheets S1 and S2 respectively for guidance on materials and installation for the required work.
2. Review the Detail Sheets included in this plan set (Sheets D1-D7). Note 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).
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 licensed professional engineer or architect approved by the AHJ. See "Purpose" on Sheet S0 for additional information.
4. Using Construction Data on Sheet S3, complete section A: General Home Information. This information will be used to determine which row of information to use in the Earthquake Strengthening Schedule. Additional instructions are included on Sheet S3.
5. Check the box on the corresponding line of the Earthquake Strengthening Schedule that applies to the home. This information provides you with the length of required strengthening and number of anchors and connectors that you will need, per wall line.
6. Using the information from the Earthquake Strengthening Schedule, complete part B: Summary of Work. Additional instructions are included on Sheet S3.
7. Refer to Technical Notes, Sheet S1 for anchor and connector installation instructions. When tie-downs are required, see Supplemental Technical Notes on Sheet S2.

D. Complete your plans:

1. Using the information from the Earthquake Strengthening Schedule, add the following to complete your Foundation and Strengthening Layout Plan:
 - a. Indicate and dimension the length of strengthening required at each wall line, using placement in accordance with Section E of Sheet S1 for plywood (if occurs).
 - b. Identify the details used for the connections as noted above. Indicate the connection type, minimum number of connectors each wall line. Conform to Sections C and D of Sheet S1.
 - c. Identify the detail used for the plywood braced panel. (Sheets D4 or D5).
 - d. Identify the detail used for the tie-down. (Sheet D4).
 - e. Identify the detail used for the top plate splice. (Sheet D7).
 - f. Identify the detail(s) used for notching and/or cutouts. (Sheet D7.)

E. Submit your plans:

1. Submit a permit application and the required number of completed plan sets (Sheets S0 through D7) to the AHJ 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 AHJ to verify that field conditions are consistent with the information provided on the approved plan.
3. Inspection(s) by the AHJ may be required for:
 - a. Foundation Anchor bolts / Anchor Plate installation,
 - b. Blocking installation,
 - c. Plywood braced panel on cripple wall, sheathing and nailing,
 - d. Metal hardware "connectors" installation,
 - e. Tie-downs, and
 - f. Final inspection.
4. Special inspection by a testing agency may be required in conjunction with Note C.1, from Table H-1 on Sheet S2.
5. No work requiring inspection shall be covered until it has been inspected and approved by the Authority Having Jurisdiction (AHJ).

Sheet List

- * 00 Instructions for Use
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- D6 Foundation Replacement Details
- D7 Panel Notching and Top Plate Details
- * X1 Example - Foundation Plan
- * X2 Example - Foundation Plan
- * X3 Example - Cripple Wall Strengthening
- * X4 Example - Strengthening - No Cripple Wall

* Sheet is for instruction and reference only.
Do not submit to the Authority Having Jurisdiction.

ACKNOWLEDGEMENTS

This Plan Set for Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings was funded by the Federal Emergency Management Agency (FEMA) as part of the South Napa Earthquake Recovery Advisory, FEMA DR-4193-RA2. This effort would not have been possible without the prior development of the following documents:

Standard Plan A (2008): Residential Seismic Strengthening Plan (produced by the Structural Engineers Association of Northern California and others); *Earthquake Hazard Reduction in Existing Wood Frame Residential Buildings with Weak Cripple Walls and Unbolted Sill Plates, Standard Plan Number One* (produced by the City of Los Angeles Department of Building and Safety); *Seismic Retrofit for Residential Wood Frame Cripple Walls and Sill Plate Anchorage* (produced by Simpson Strong-Tie); and the *Standard Earthquake Home Retrofit Plan Set* (produced by the City of Seattle under Project Impact).

In particular, the authors would like to acknowledge the organizations involved with the development of *Standard Plan A (2008)* including:

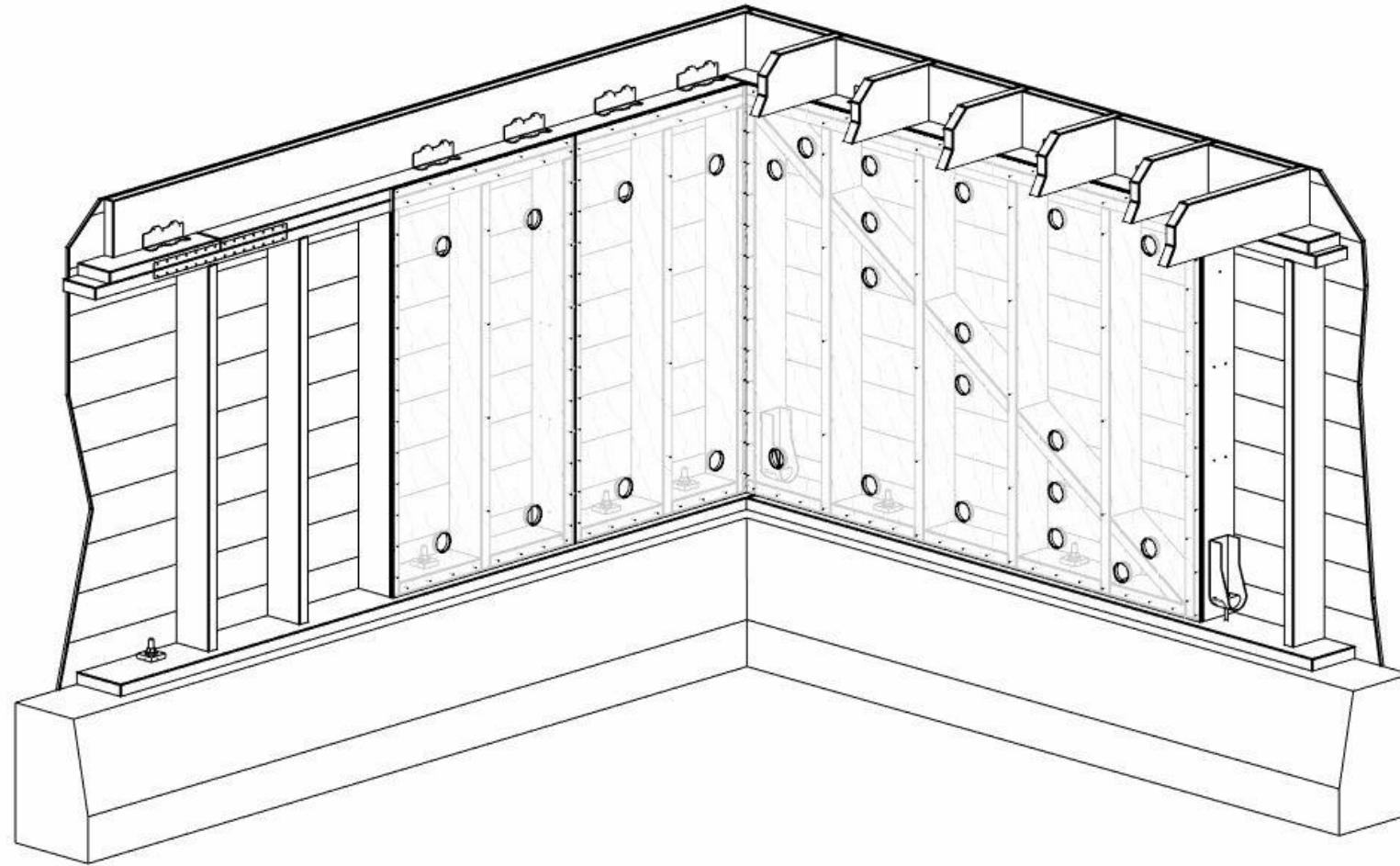
- The Structural Engineers Association of Northern California (SEAONC)
- The Association of Bay Area Governments (ABAG)
- California Building Officials (CALBO) Emergency Preparedness Committee
- Earthquake Engineering Research Institute, Northern California (EERI-NC)
- ICC, TRI-Chapter (East Bay, Peninsula, Monterey Bay)
- The City of San Leandro

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



00



ELIGIBILITY FOR USE

To determine if a home qualifies; answer the following:		YES	NO
1.	Is the home a duplex or a single family residence?		
2.	Is the home two stories or less?		
3.	Are all the floors in each story at the same elevation? (Excluding slabs-on-grade)		
4.	Is the home constructed of wood framing?		
5.	Does the home have a continuous perimeter concrete foundation? (This plan set does not apply to homes supported on foundations of masonry, stone, or brick.)		
6.	Does the home have a crawl space?		
7.	Are all the cripple walls less than seven feet in height? (See Sheet X3 for an example of how to measure a cripple wall height)		
8.	Is all brick or stone veneer covering exterior walls, excluding chimneys, less than four feet in height? (If the home does not have any brick or stone veneer, check "YES")		
9.	Is the weight of the home's roof covering less than 11 pounds per square foot? (Shingle or metal roof coverings are often less than 11 psf; clay or concrete tile roof coverings are often more than 11psf.)		
10.	Is the difference in cripple wall height between the shortest and tallest walls less than 4'-2"? Note that perimeter locations with no cripple wall are to be indentified as zero foot height and included in this comparison.		
11.	Is the site seismicity less than $S_S = 2.34$ and $S_1 = 0.97$? Verify at: http://earthquake.usgs.gov/designmaps/us/application.php See Note A.4a on Sheet 00.		

If you answered "YES" to each of these questions, proceed to Sheet S3.
If you answered "NO" to any of these questions, the home is not eligible to apply this plan set.
See PURPOSE, Note 5.

APPLICANT INFORMATION

APPLICANT: _____

 ADDRESS: _____

 PHONE: _____
 PROPERTY ADDRESS: _____

 OWNER: _____

 OWNER'S SIGNATURE _____

PURPOSE

- The intent of work scope illustrated within these prescriptive drawings is to promote public safety and welfare by reducing the risk of earthquake-related damage to existing wood-framed residential dwellings with a crawl space below the bottom floor. These drawings are intended to improve the seismic performance of residential buildings but will not necessarily prevent earthquake damage, nor make a home "earthquake proof"
- Garages or other portions of the residence built on concrete slabs on grade are not within the scope of this document. However, this plan set does apply to those portions of a dwelling that are adjacent to a portion supported on a slab-on-grade foundation but which have a raised floor framing system (crawl space).
- This plan set for strengthening is intended to be approved by the authority having jurisdiction (AHJ) without requiring additional plans or calculations.
- When isolated conditions differ from those shown on the plan set, a supplemental engineered solution (including project-specific details and calculations) shall be developed and shall be issued as an addendum to this plan set. The project-specific details and calculations must be prepared by a licensed engineer or architect.
- Where conditions fall outside of the scope of this plan set as defined within "Eligibility for Use", or where the AHJ determines that conditions exist that are beyond the prescriptive provisions of this plan set, an alternative engineered solution (including a complete project-specific plans and calculations) shall be developed. The project-specific plan set may rely in part on this plan-set, and may require design by a licensed engineer or architect as required by the AHJ.
- Work performed under permit according to this plan set does not legalize any previous work performed without a permit.

LIMITATION OF LIABILITY

Earthquake strengthening constructed in accordance with this Plan Set is intended to reduce the risk of earthquake-related damage to existing residential dwellings with wood-frame cripple walls. The content of this Plan Set is based on the experience and judgment of practicing engineers and limited research. All circumstances, forms, or types of construction have not necessarily been contemplated in the preparation of this Plan Set, and it is not possible to control the quality of construction or predict or test all conditions that may occur during an earthquake. Neither the Department of Homeland Security, the Federal Emergency Management Agency, the Applied Technology Council, nor the authors of this Plan Set makes any representation, warranty, or covenant, expressed or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of earthquake strengthening based on this Plan Set, nor is any party associated with the preparation of this Plan Set obligated to or liable for actual, incidental, consequential, or other damages to users of the Plan Set, or any other person or entity arising out of or in connection with the use, condition, or performance of earthquake strengthening in accordance with this Plan Set, or the maintenance thereof.

SHEET INDEX

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- D7 Panel Notching and Top Plate Details

ABBREVIATIONS

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

FOR JURISDICTION USE

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



FEMA

S0

A. GENERAL

- All existing concrete, steel anchor bolts, and wood material that will be part of the strengthening work shall be in reasonably sound condition and free from defects that would substantially reduce the capacity of the material. Any deteriorated material that is repaired or replaced shall comply with the minimum Building Code requirements for new construction. New foundations shall be as detailed on Detail 1/D6.
- All metal connectors and hardware shall be installed per manufacturer's instructions and in accordance with the requirements of this document.
- Due to the corrosive interaction of new metallic hardware in contact with preservative treated wood, all new metal fasteners shall be hot dipped galvanized meeting ASTM A153, and new metal connectors shall meet ASTM A 653 class G185, or better.
- New lumber placed in contact with new or existing concrete shall be preservative pressure-treated with Disodium Octaborate Tetrahydrate (commonly known as "DOT") or Sodium Octa-Borate (commonly known as "SBx"). This preservative treatment does not require stainless steel connectors or fasteners. Hot-dipped galvanized connectors and fasteners are sufficient. Connectors and fasteners used for any existing preservative pressure-treated lumber installed since 1990 (such as for prior repairs to termite or decay damage) shall be stainless steel. This includes all concrete anchors, washers, nails, and sheet metal connectors in contact with the treated lumber. Isolation membranes are not adequate. Exception: if definitive evidence is available showing that the lumber was treated with CCA (chromated copper arsenate) or DOT/SBx, hot-dipped galvanized connectors and fasteners may be used.
- The Owner or Contractor shall verify that existing framing conditions and those earthquake strengthening methods shown generally conform to this prescriptive plan set. Special attention should be given to any unique areas which may be present due to recent repairs for damaged conditions (dry rot, termites, etc.) See Note 4 for special precautions which may be required at newer preservative treated foundation sills and other floor framing.
- 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 1/8" wide, excessive efflorescence, or low strength concrete cement or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local area of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors should be tested in accordance with Table H-1, Note C.1.
- All existing under floor ventilation shall be maintained.

B. DESIGN BASIS

- This plan set has been developed in accordance with the 2012 International Existing Building Code (IEBC) and the California Existing Building Code (CEBC), Section A301.3 Alternate Design Procedures, assuming the following:
 - Seismic Design Category D
 - Site Class D
 - Seismic Importance Factor = 1.0
 - Spectral Response Acceleration = $S_s = 2.341g$; $S_1 = 0.973g$
 - Spectral Response Coefficients: $S_d_s = 1.56g$; $S_d_1 = 0.97g$
 - 75% factor per A301.3 of the 2012 IEBC (2013 CEBC)
 - Response Modification Factor, $R = 6.5$
 - Design Base Shear, $V = 0.13W$ (ASD), where W = seismic weight of building.
- Where project site seismic spectral response accelerations exceed values noted above, the home is not eligible to be strengthened according to this plan set and the owner must seek consultation from a licensed architect or engineer to develop a strengthening design.

C. FOUNDATION CONNECTIONS

- See Sheet D1 for required connection details.
- New anchor bolts or connectors required by the Earthquake Strengthening Schedule (Detail 2/S3) shall be installed within the required length of strengthening as follows:
 - one anchor bolt or connector at each end,
 - space remainder of required anchor bolts or connectors as equally as possible, but not more than 32" on center nor less than 8" on center.
- Where the required number of anchors or connectors cannot be achieved within the "MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING" as specified on Sheet S3, anchors or connectors may be placed adjacent and outside of these areas along the same wall line.
- All new foundation sill bolts shall have a 3" x 3" x 0.229" plate washer installed between the foundation sill (or blocking) and the nut. Plate washer shall be galvanized per ASTM 153.
- New bolts shall be a minimum of 1-3/4" from the edges of the foundation sill or ledger, and 8" from the ends of the foundation sill or ledger.
- Pre-drill sills and ledgers 1/16" larger than anchor diameter to prevent splitting. Larger holes are not permitted.
- Existing anchor bolts may not be reliable and should not be considered as meeting the requirements of this plan set within the length of strengthening. The existing anchor bolts may be used to satisfy minimum anchor requirement outside the length of strengthening.
- New foundation sill plates shall be borate treated with Disodium Octaborate Tetrahydrate ("DOT"), Sodium Octa-Borate ("SBx"), or foundation grade redwood.
- Threaded rod for adhesive anchors shall conform to ASTM A36 hot-dipped galvanized or stainless steel. Adhesive or screw type anchors shall be installed per manufacturer's instructions.
- Anchors or connectors outside of required length of strengthening shall be spaced 6'-0" on center minimum along perimeter foundations. Provide new anchors or connectors where existing anchorage does not exist or does not meet this requirement.

D. FLOOR TO CRIPPLE WALL or FLOOR TO FOUNDATION SILL CONNECTION

- See Sheets D2 and D3 for required connection details.
- New connectors required by the Earthquake Strengthening Schedule (Detail 2/S3) shall be installed within the length of required strengthening as follows:
 - one connector at each end, and
 - space remainder of connectors as equally as possible, but not more than 32" on center nor less than 8" on center.
- Where the required number of connectors cannot be achieved within the "MINIMUM TOTAL REQUIRED OF STRENGTHENING" as specified on Sheet S3, anchors of connectors may be placed adjacent and outside of these areas along the same wall line.
- Not more than one connector per existing floor joist bay unless joists are spaced 24" on center.
- Increase length of nails 1/2" when attaching connectors through plywood.
- If splices in double top plates do not have a minimum 48" lap, provide a new metal strap at joint. See Detail 1/D7.
- Existing single top plates shall be reinforced with a metal strap at the joint. See Detail 2/D7.
- Where plate straps occur within a plywood braced panel, the strap shall be placed over the plywood and the plywood nails omitted where the strap is installed.
- Where an existing continuous rim joist, end joist, or solid blocking between joists, does not exist above the perimeter cripple wall or foundation sill, new blocking and/or supplemental connections shall be provided per Sheet D3.
- All blocking shall be installed with two 16d toe nails at each end uno.

E. PLYWOOD BRACED PANEL INSTALLATION

- See Earthquake Strengthening Schedule (Detail 2/S3) for the required length of new seismic strengthening along each wall line.
- Install plywood braced panels at each end of each wall line where possible and space additional panels, as needed, along each wall line.
- Plywood braced panels closest to the ends of wall lines shall be located as near to the ends as practicable. Panels may be located away from the ends of a wall line when existing obstructions or limited clearance necessitate such relocations.
- Plywood braced panels 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.
- The length of each plywood braced panel shall not be less than 48 inches. The length of braced panels 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 panels of the required length. The length of braced panels with tie downs should be equal to or exceed the height of the cripple wall.
- Nails for plywood shall be 8d common x 2-1/2" long with a minimum shank diameter of 0.131" (0.131 x 2-1/2").
- Plywood braced panels shall be 15/32" Structural I rated sheathing, Exposure 1, 5-PLY. (3- or 4-PLY is not acceptable.)
- Maintain a minimum edge distance of 3/8" from center of nail to edges of plywood, studs, or top and sill plates. See Sheet D5 for double stud at plywood joints.
- Do not overdrive, countersink, or otherwise damage the outermost ply when installing nails. A nail is over-driven when it breaks the surface ply. Install one additional nail for each over-driven nail.
- Nails must be firmly embedded in framing behind plywood without causing splitting. Pre-drilling may be appropriate for installing nails in framing and blocking to avoid splitting.

F. NEW FOUNDATIONS

- REINFORCING STEEL
 - Reinforcing steel detailing, fabrication, and placement shall conform to the latest editions of the "International Building Code", Chapter 19; "The Manual of Standard Practice of the Concrete Reinforcing Steel Institute"; and the "Building Code Requirements for Structural Concrete and Commentary", ACI-318; unless noted otherwise.
 - Reinforcing steel shall conform to the following standards: Deformed Bars, #3: ASTM A615, Grade 40 or Grade 60 Deformed Bars, #4 and larger: ASTM A615, Grade 60
 - All bars shall have a minimum "Lap Splice" per Table F-1, unless noted otherwise.
 - Reinforcing spacing given is maximum on center and all reinforcing is continuous unless noted otherwise.
 - All reinforcing steel shall be securely wired and properly supported above ground and away from the form.
 - Do not weld reinforcing steel.
 - Do not field bend reinforcing without equipment to ensure proper bending radiuses.
- CONCRETE
 - The minimum 28 days strength five-sack minimum, 2500psi.
 - Dimensions shown for location of reinforcing are to the face of main bars, ties, etc., and denote clear coverage.
 - Forms shall be properly constructed conforming to concrete surface as shown on the drawings, sufficiently tight to prevent leakage, sufficiently strong and braced to maintain their shape and alignment until no longer needed to support the concrete.
 - Forms and shoring shall not be removed until the concrete has attained sufficient strength to withstand all loads to be imposed without excessive stress, creep, or deflection.
 - All items to be cast in concrete such as reinforcing, dowels, bolts, anchors, pipes, sleeves, etc. shall be securely positioned in the forms before placing the concrete.
 - Bars shall be clean of rust, grease or other materials likely to impair bond. All reinforcing bar bends shall be made cold.

Table F-1		
Reinforcement Lap Splices f'c = 2500psi at 28 days		
Reinforcement Size		
#3	#4	#5
14"	24"	36"

Notes:

- Top reinforcing is horizontal reinforcement that has more than twelve inches of concrete below it.

PROPERTY ADDRESS: _____

**Earthquake Strengthening of
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 FEMA Plan Set**



G. PURPOSE OF SUPPLEMENTAL TECHNICAL NOTES

1. These Supplemental Technical Notes provide guidance for the installation of plywood braced panels that employ tie-downs and existing foundation systems. They are to be used where there is insufficient length to install the specified length of plywood braced panels as specified in the Earthquake Strengthening Schedule (Detail 2/S3) and tie-downs must be used.
2. Where "With Tie-down" (as specified on the Earthquake Strengthening Schedule, Detail 2/S3) is used to determine the amount of strengthening required along each wall length, proof load testing of the installed anchor is required. Special procedures are also required for the installation of the required tie-downs and for installation of the plywood braced panels. See Section H for foundation requirements. See Sheet D4 for tie-down installation details and plywood sheathing requirements.

H. EXISTING FOUNDATION REQUIREMENTS & TESTING

1. Where tie-downs are proposed to strengthen any existing cripple walls, additional visual verification and testing of the existing foundation system is required as noted below prior to commencing any work. Tie-downs can only be used once this verification process has been completed and the size and strength of the existing foundation system has been verified. The Owner or Contractor shall complete Table H-1 which will be reviewed by the authority having jurisdiction. This may require local excavation of soil.
2. The size of existing foundation systems shall be verified to be at least 15" high ("D") and 8" wide ("W") as indicated by Detail 1/D4. The use of pictures to document these conditions is encouraged.
3. The quality of the existing concrete foundation adjacent to the installation of new tie-downs shall be verified by tension tests. This verification shall be achieved by 3a below. Torque tests as specified in 3b below, may be used to verify the anchorage capacity of existing concrete footings where required by Note A.6 on Sheet S1. Also see note A.6 on Sheet S1 for general requirements for existing foundation systems.

a. TENSION TESTS

A minimum of one tension test shall be made along each wall line. If the test is performed on an anchor other than the tie-down, it shall not be more than 16" from the location of a proposed tie-down. These tests shall consist of installing 1/2" or 5/8" diameter threaded rods and adhesive anchors as specified by the applicable manufacturer. Minimum acceptable test values are listed in Table H-2. Tension tests shall be performed by a special inspection company hired by the owner and as approved by the AHJ.

or:

b. TORQUE TESTS

A minimum of two sacrificial torque tests shall be made along each wall line. These tests shall consist of installing 1/2" or 5/8" diameter screw-type bolts into the existing concrete and verifying that a value per Table H-2 can be achieved. Torque tests can be performed either by the owner, a general contractor, or a special inspection company hired by the owner and as approved by the AHJ.

4. The Owner (Owner performing the work) or Contractor shall complete the Table H-1 acknowledging that the existing foundation system has been visually reviewed and tested and conforms to the requirements of this section.

I. TIE-DOWN REQUIREMENTS

1. Tie-downs shall be Simpson HDU2-SDS2.5, KC Metals ADST2, USP Structural Connectors PHD2A, or an equivalent able to withstand an allowable tensile load of 3075 lbs or more, installed per manufacturer's instructions.
2. End studs(s) to which tie-downs are installed, shall be 3x minimum or double 2x. For nailing at double studs, see Sheet D5.
3. All tie-downs shall use 5/8"Ø (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1/D4.

Table H-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 H, Item 2.		_____ Signature
B.1 The existing foundation has generally been verified to be in good condition at locations where strengthening was done.		_____ Signature
C.1 The capacity of the existing anchors have been verified by passing the tension tests specified in Section H, Item 3a. and: The quality of the existing foundation is in reasonably good condition as noted in Note A.6 on Sheet S1. Where the quality of the concrete is questionable, it can be verified by passing the torque tests specified in item Section H, Item 3b or by tension test as specified in Section H, Item 3a.		_____ Signature

Table H-2: Foundation Testing Requirements

	Screw Anchor	Adhesive Anchor
Diameter	Torque (ft-lbs)	Tension Load (lbs)
1/2"	50	900
5/8"	80	1100

APPLICANT INFORMATION

APPLICANT: _____

ADDRESS: _____

PHONE: _____

PROPERTY ADDRESS: _____

OWNER: _____

OWNER'S SIGNATURE _____

**Earthquake Strengthening of
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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				
	Cripple Wall Height																	
	0' < 1'	1' < 2'				2' < 4'	4' < 6'	6' < 7'	Type "A"	Type "B"	Type "C"	1/2"Ø Bolt	5/8"Ø Bolt	Type "D"	Type "E" or "F"	Type "G"		
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
TWO-STORY	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
	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:
- 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.
 - 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 alternate only if joists are blocked on both sides and where accessibility makes the use of Types "D" or "E" impractical.
 - 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 KC Metals	FAP RFP
TYPE C KC Metals KC Metals USP Structural Connectors	RFA86/88 RFA136/138 SFA8
TYPE D Simpson Strong-Tie KC Metals USP Structural Connectors	L70 CA70 AC7
TYPE E Simpson Strong-Tie KC Metals USP Structural Connectors	L90 CA90 AC9

CONNECTORS	
MANUFACTURER	MODEL
TYPE F (Note 4) Simpson Strong-Tie KC Metals USP Structural Connectors	H10A HT10A RT16A
TYPE G Simpson Strong-Tie KC Metals USP	LTP4 FAL MP4F
TYPE S1 Simpson Strong-Tie KC Metals USP Structural Connectors	MSTA36 TSA36 MSTA36
TYPE S2 Simpson Strong-Tie KC Metals USP Structural Connectors	ST6236 TS36 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	HU2
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.

- Square footage calculation
 - Number of stories above cripple wall / mud sill: _____
 - Approximate 1st floor area over crawl space: _____
(Do not include areas built over slab-on-grade.)
 - 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)
- 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.

- Required length of strengthening without tie-downs _____ ft per wall line.
Where tie-downs are required: _____ ft per wall line.
- New Mudsill Anchorage used: (check all that apply)
Bolts: Diameter _____ Adhesive Screw
 Type "A" Connector Type "C" Connector
 Type "B" Connector
- Floor Framing Connectors to Mudsill or Top Plate used: (check all that apply)
 Type "D" Type "F"
 Type "E" Type "G"
- 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.

PROPERTY ADDRESS: _____

Earthquake Strengthening of
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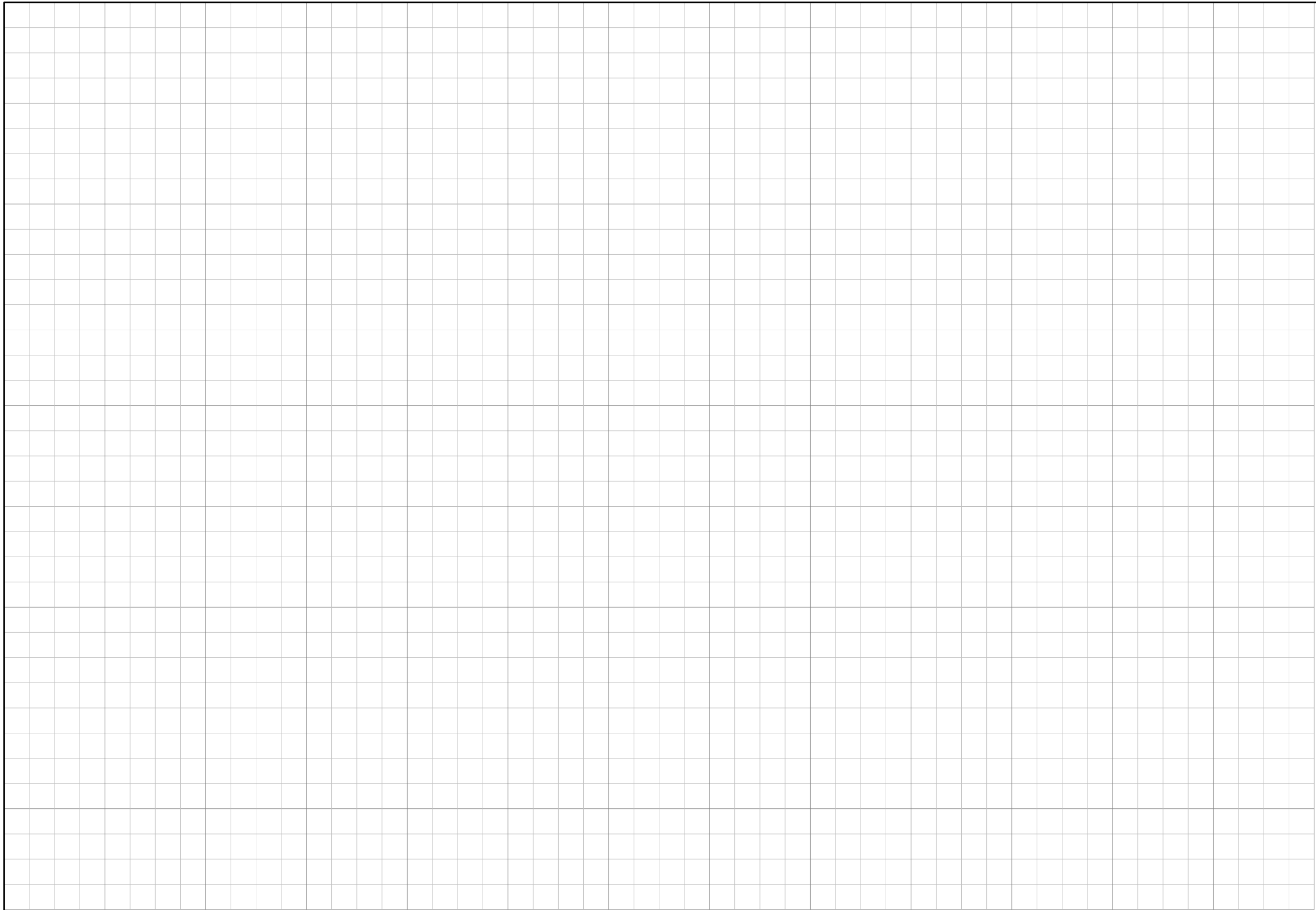


2 EARTHQUAKE STRENGTHENING SCHEDULE

1 CONSTRUCTION DATA

Construction Data and Earthquake Strengthening Schedule

S3



PROPERTY ADDRESS: _____

Earthquake Strengthening of
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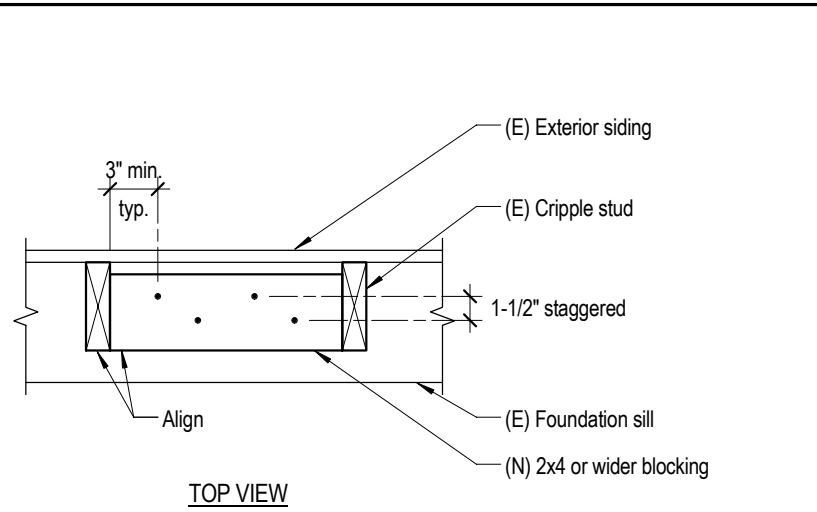


Foundation and Strengthening Layout Plan

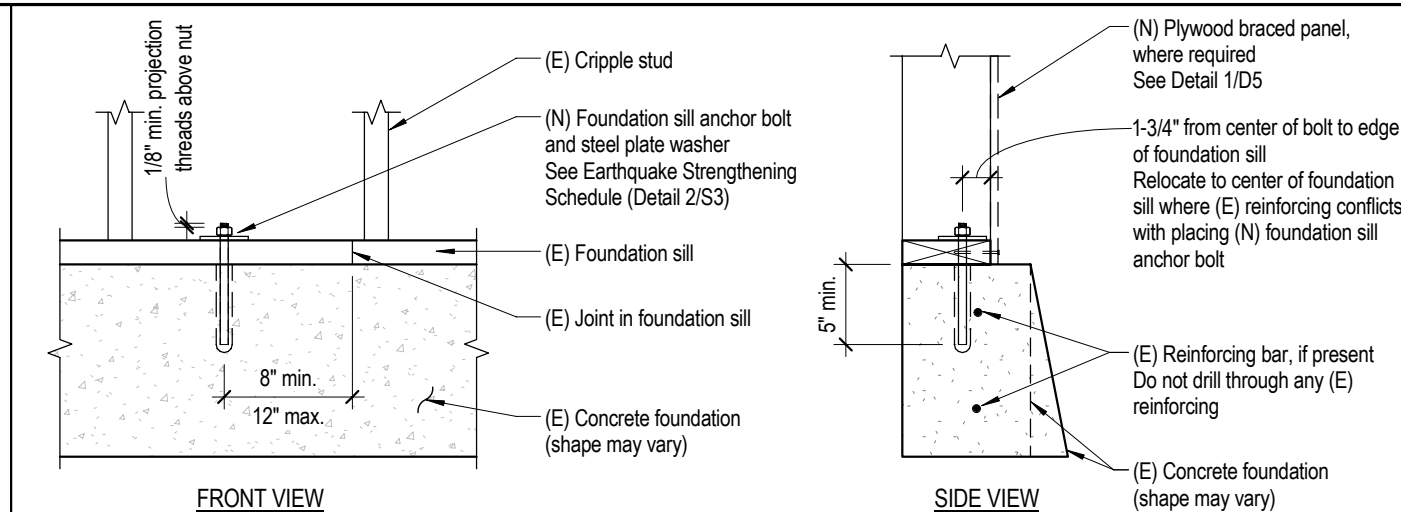
ONE SQUARE = ____ FEET

Show north arrow and indicate street side (front) of home.

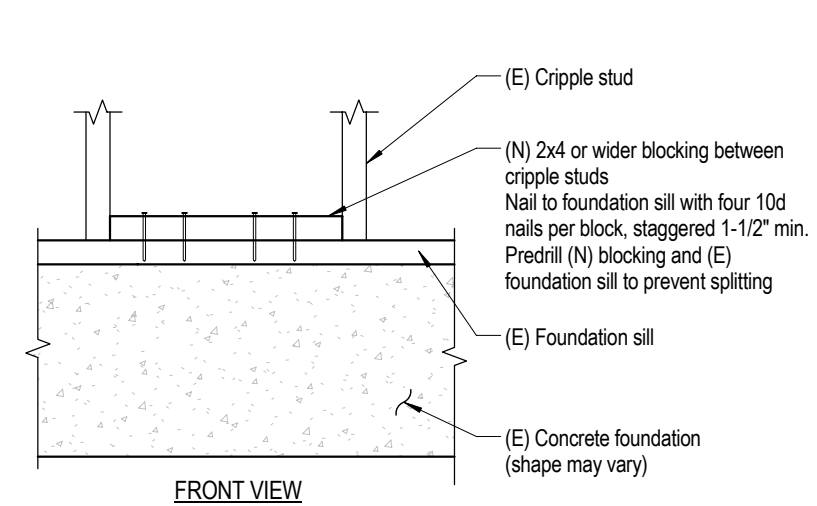
S4



TOP VIEW

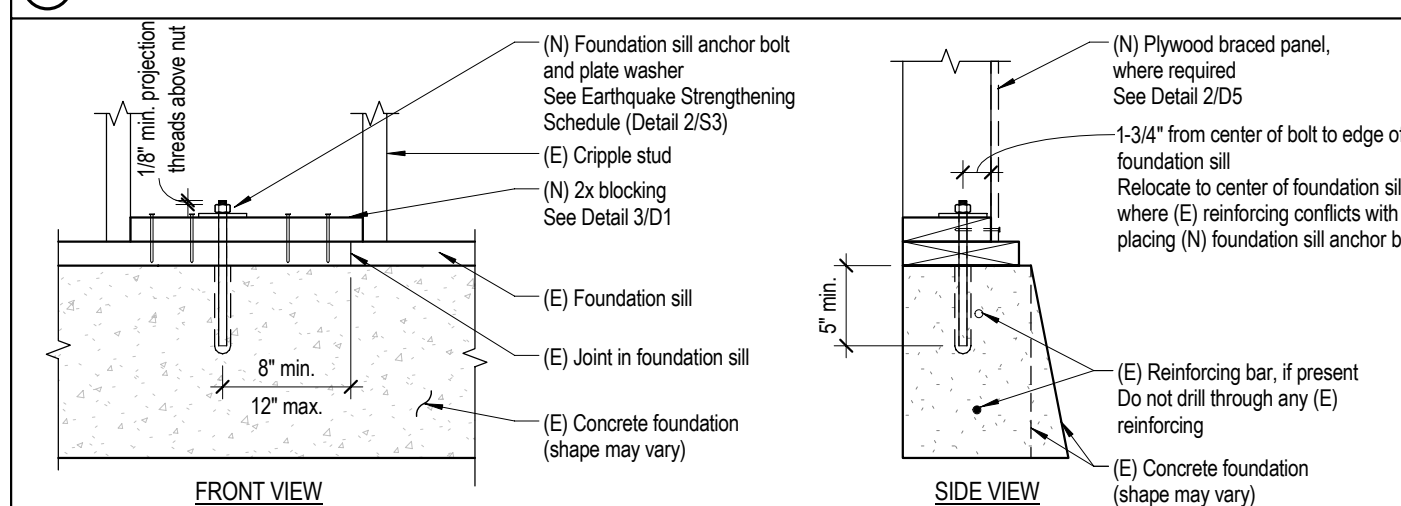


1 ANCHOR THROUGH FOUNDATION SILL ONLY

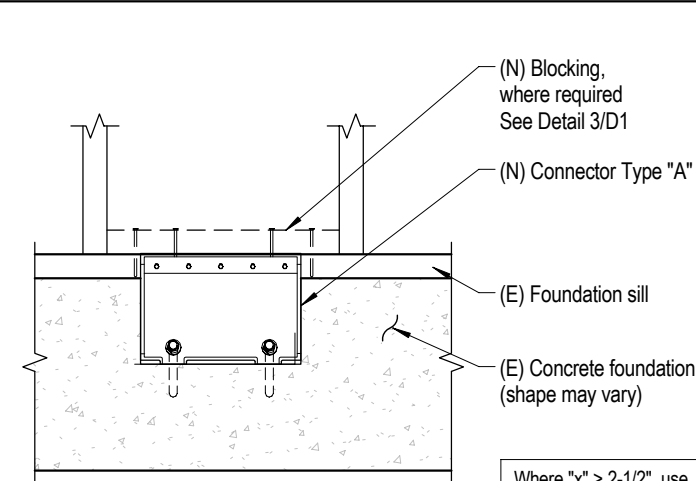


FRONT VIEW

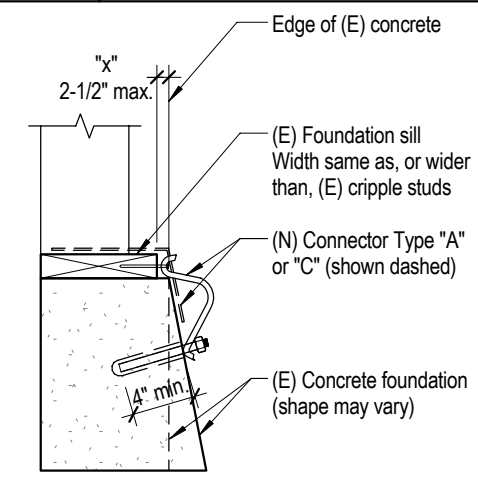
3 NEW BLOCKING INSTALLATION



2 ANCHOR THROUGH BLOCKING AND FOUNDATION SILL

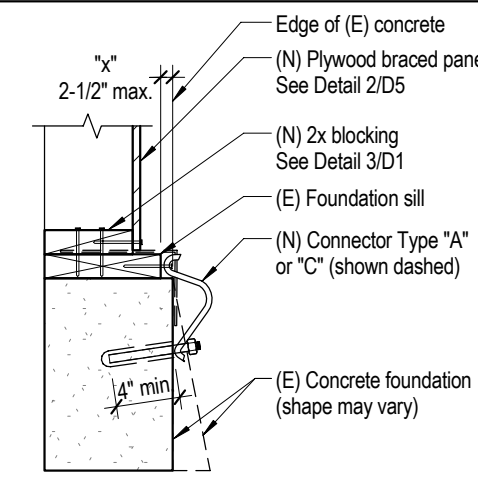


FRONT VIEW



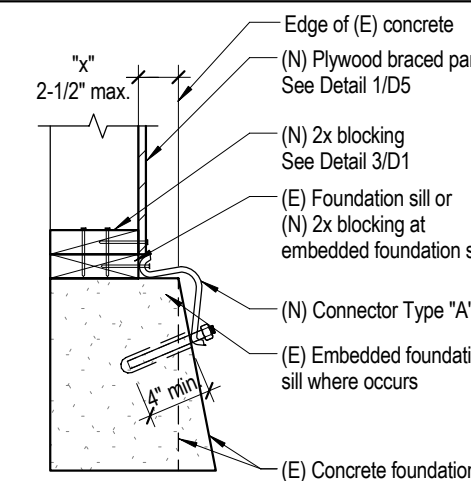
SIDE VIEW

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.

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).	

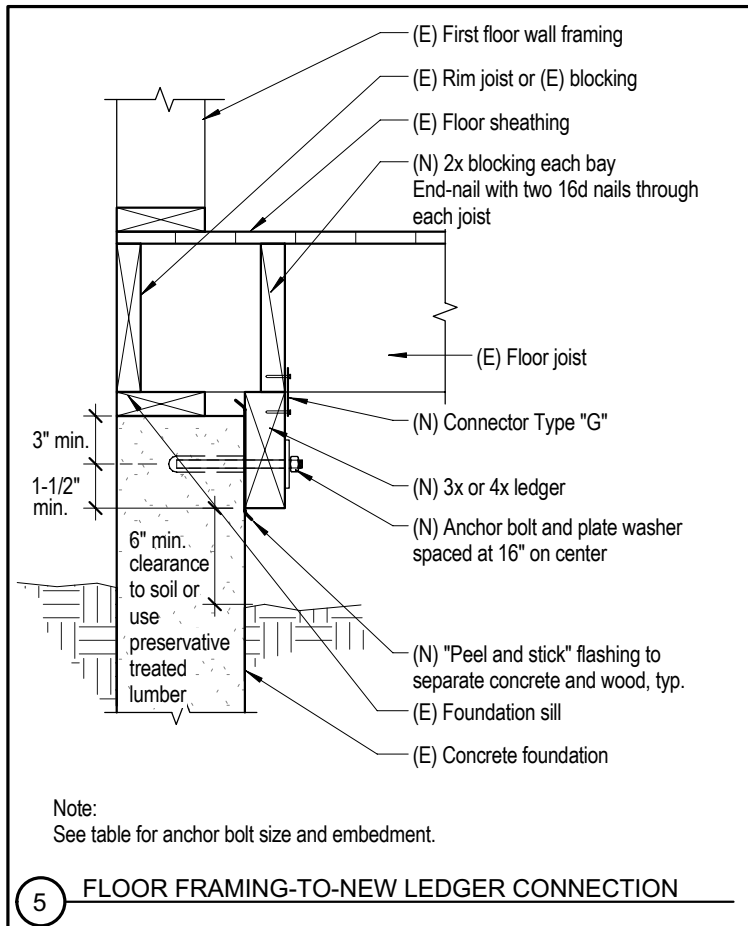
PROPERTY ADDRESS: _____

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

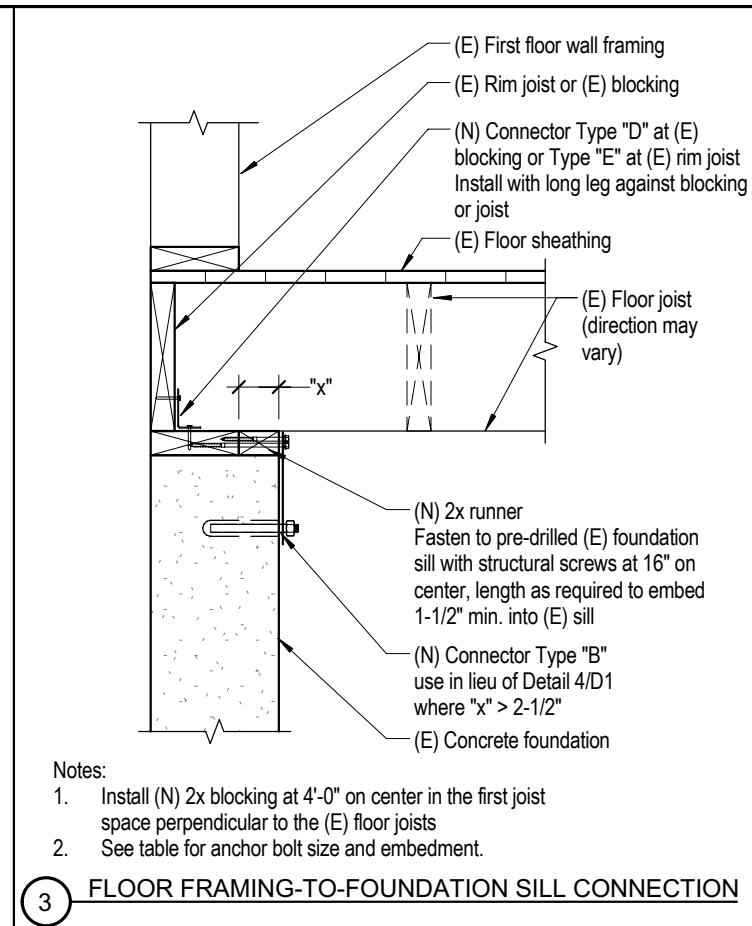


Foundation Sill to Concrete Foundation Connection Details

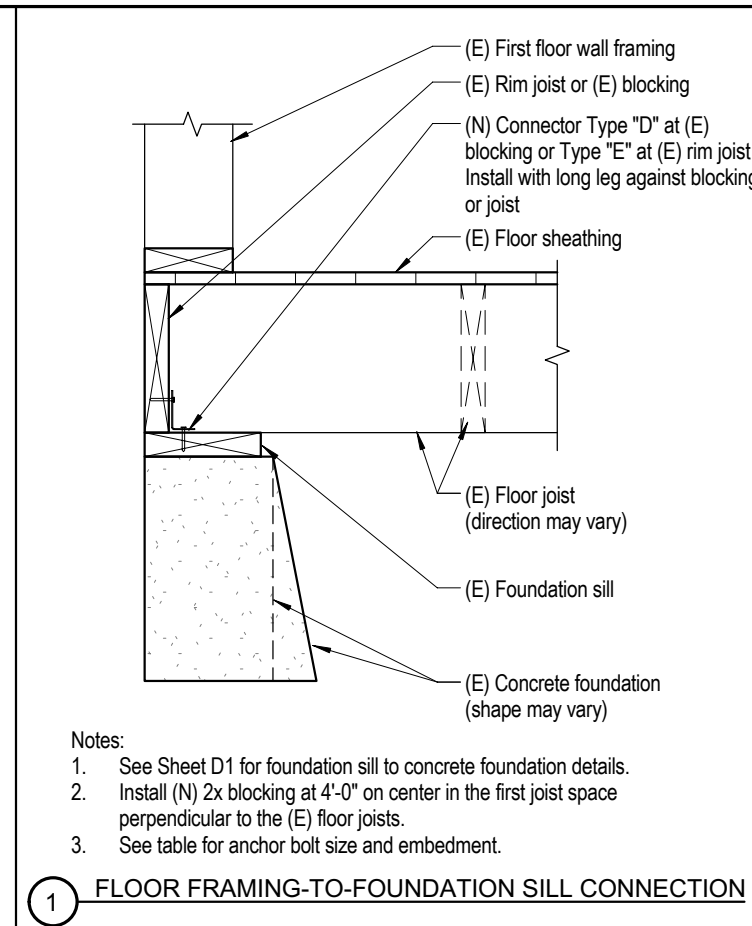
D1



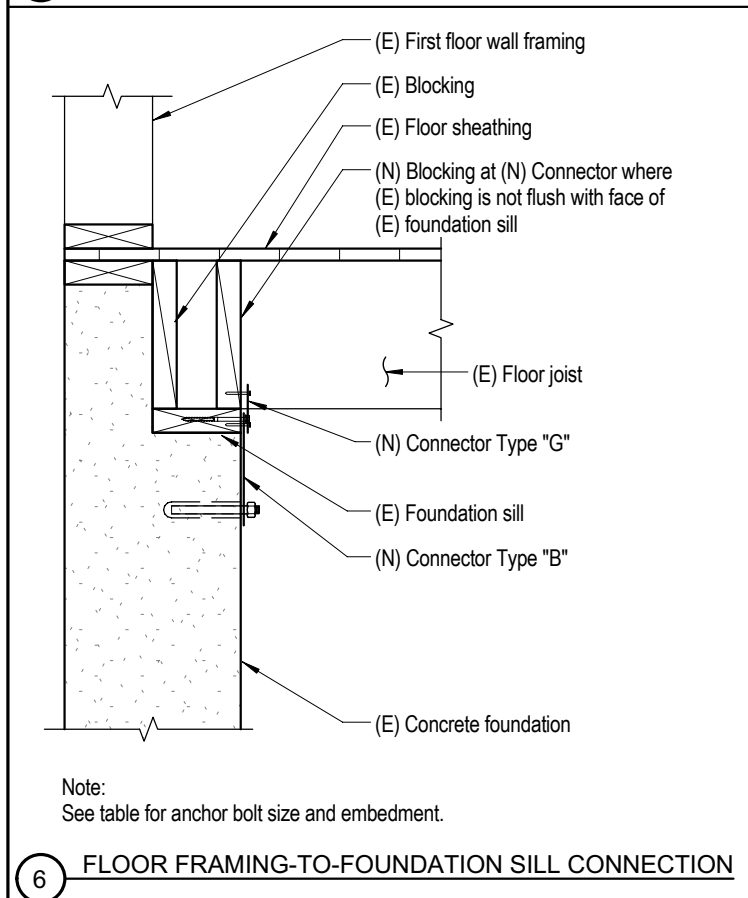
5 FLOOR FRAMING-TO-NEW LEDGER CONNECTION



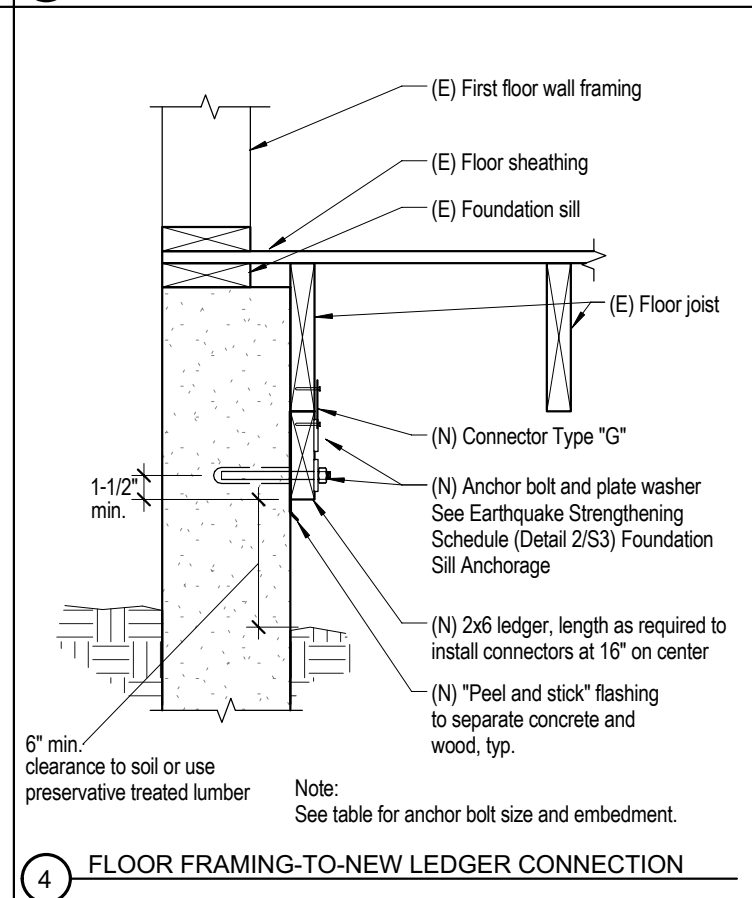
3 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



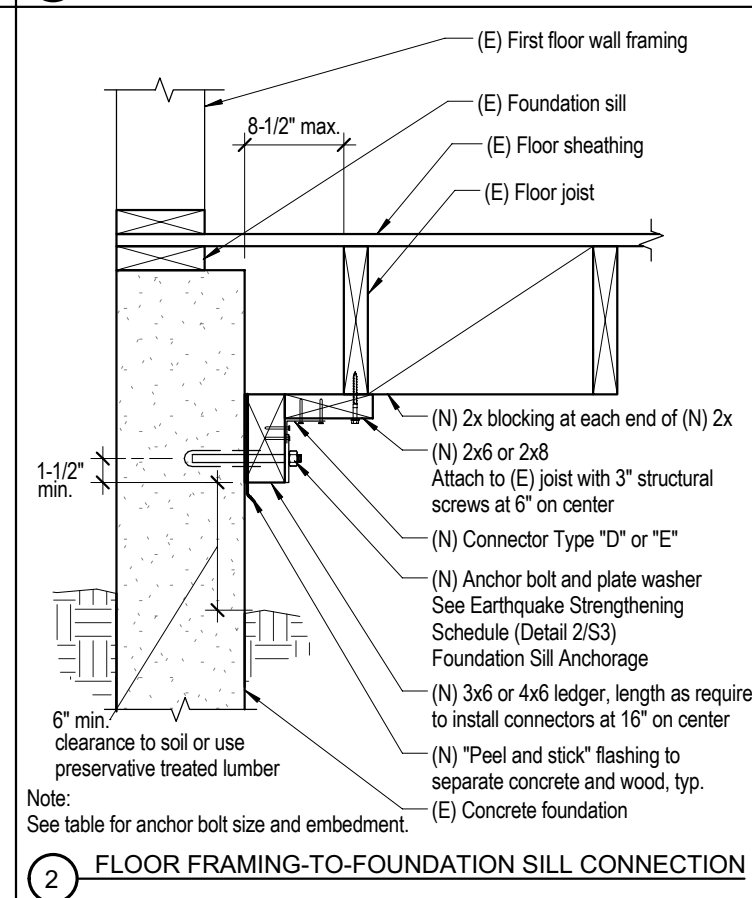
1 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



6 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION



4 FLOOR FRAMING-TO-NEW LEDGER CONNECTION



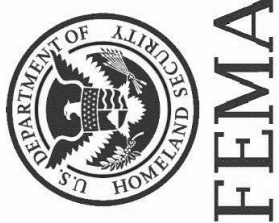
2 FLOOR FRAMING-TO-FOUNDATION SILL CONNECTION

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).	

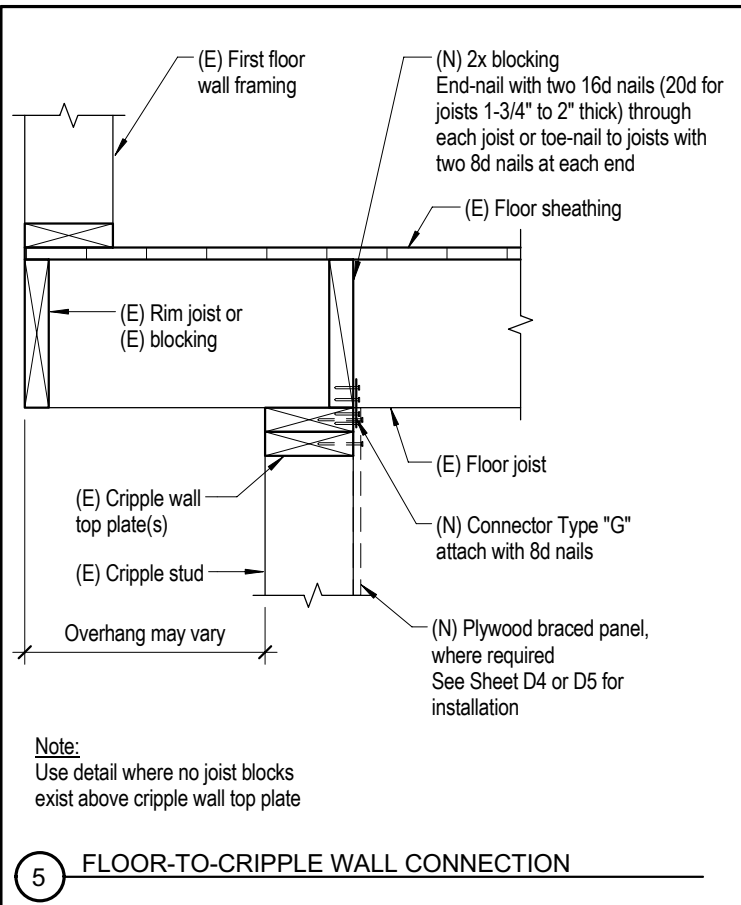
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Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set

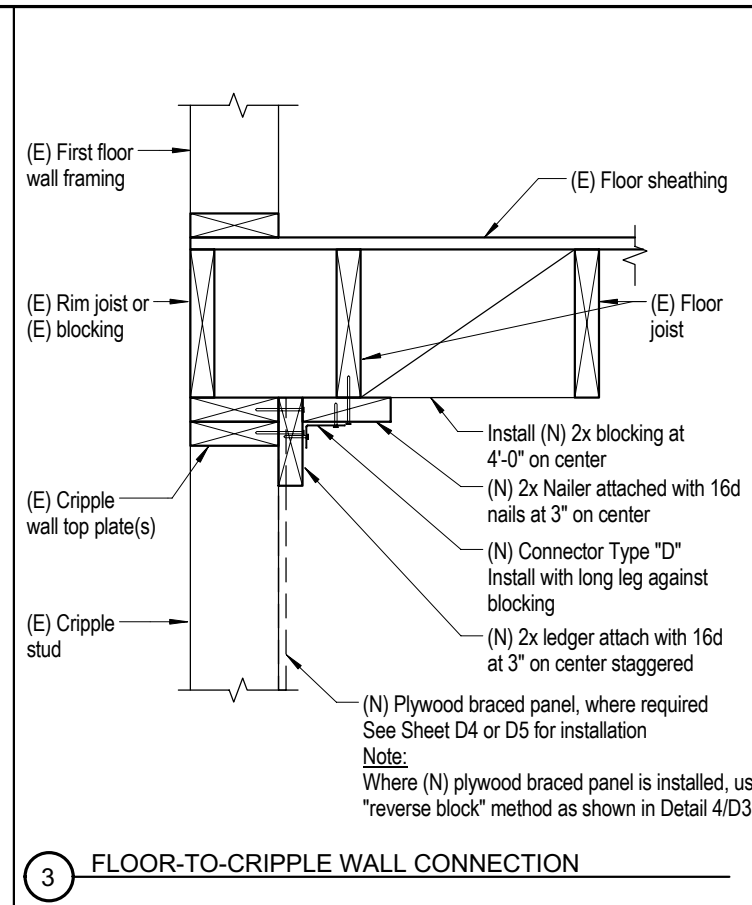


D2

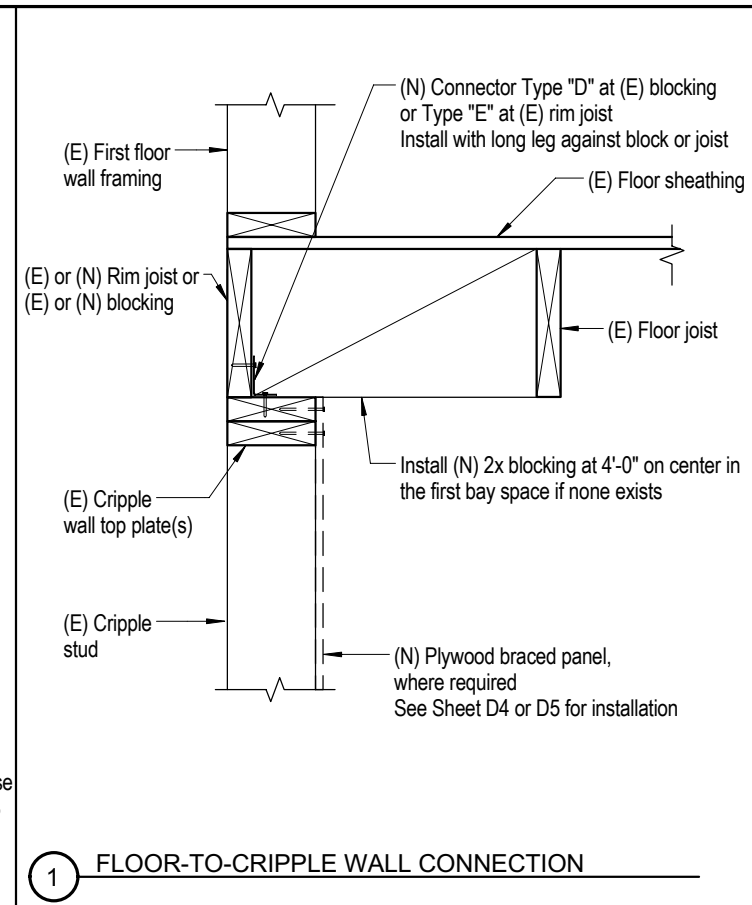
Floor Framing to Foundation Sill Connection Details



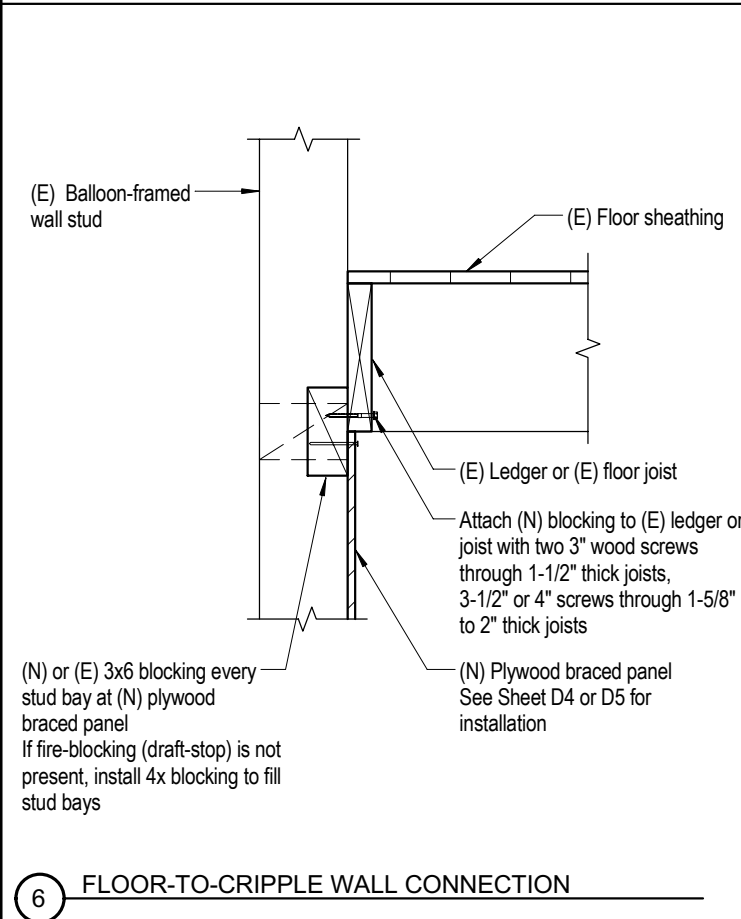
5 FLOOR-TO-CRIPPLE WALL CONNECTION



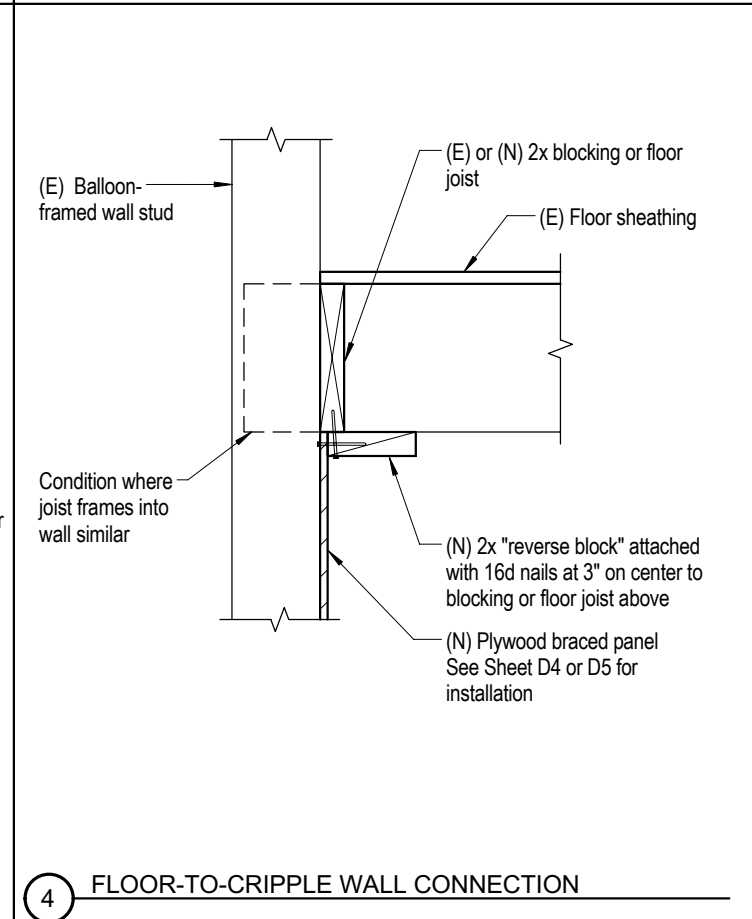
3 FLOOR-TO-CRIPPLE WALL CONNECTION



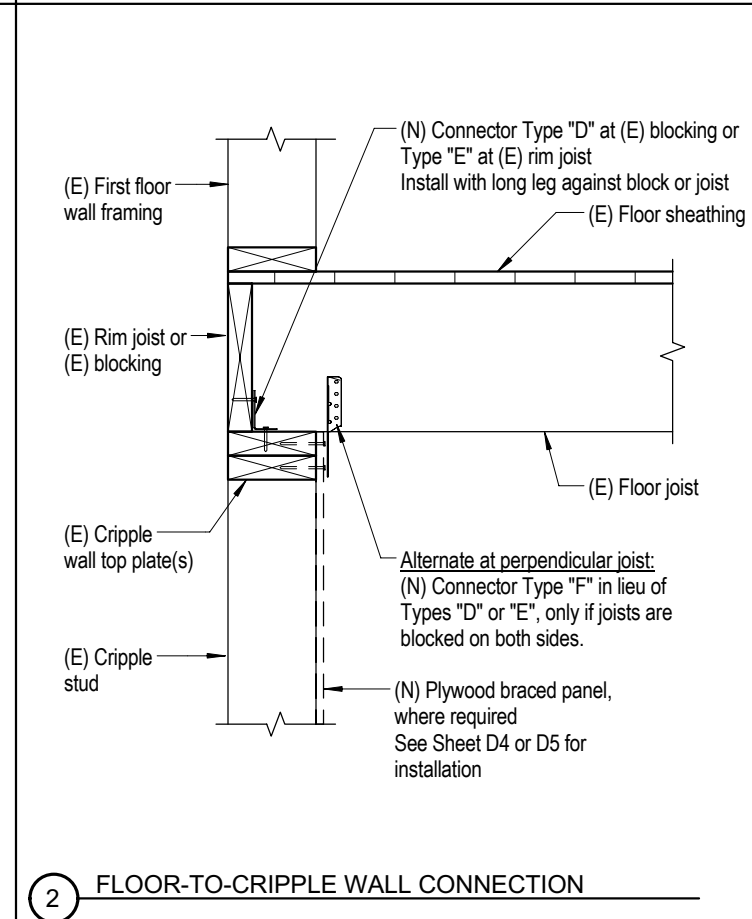
1 FLOOR-TO-CRIPPLE WALL CONNECTION



6 FLOOR-TO-CRIPPLE WALL CONNECTION



4 FLOOR-TO-CRIPPLE WALL CONNECTION



2 FLOOR-TO-CRIPPLE WALL CONNECTION


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).	

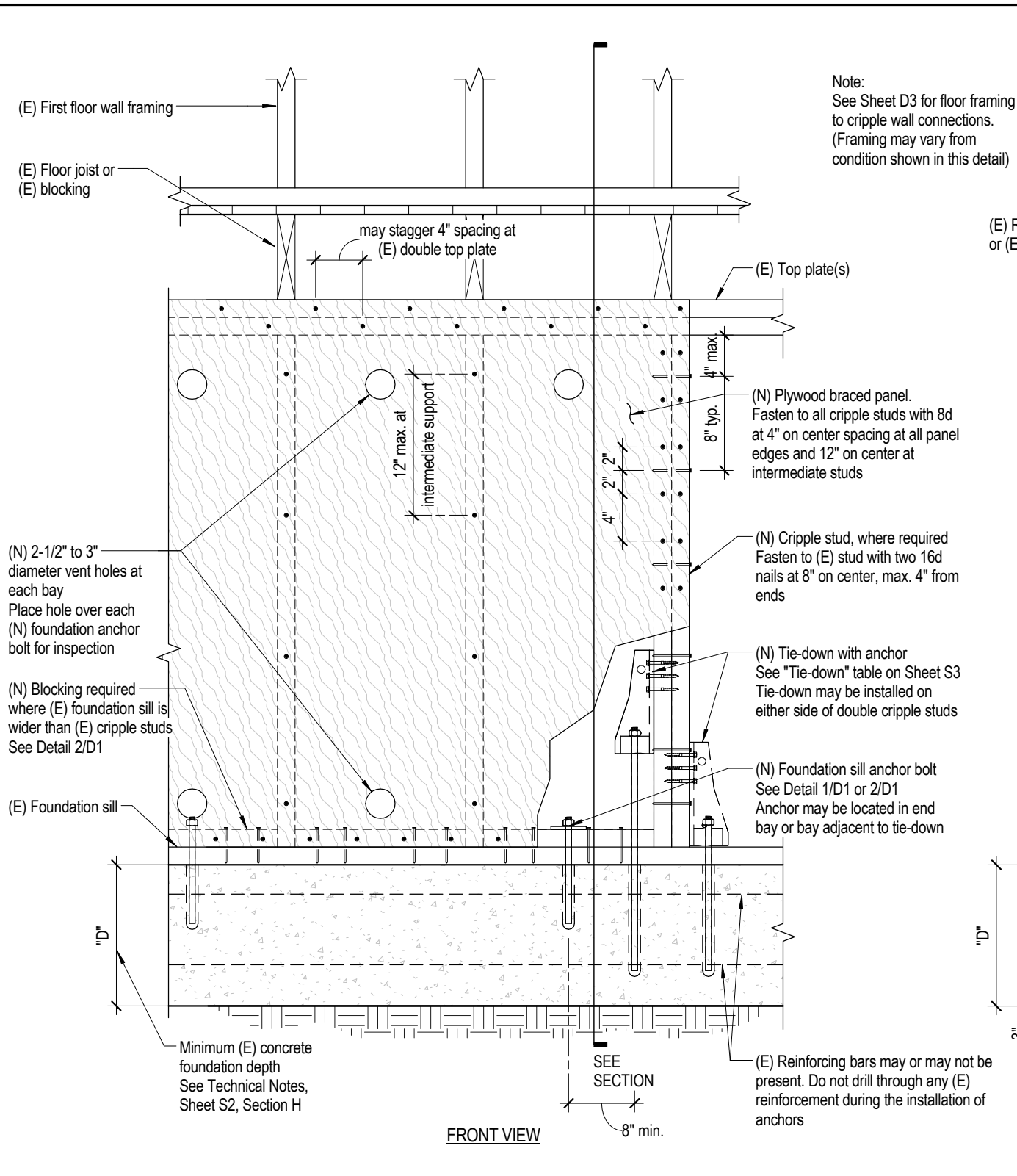
PROPERTY ADDRESS: _____

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

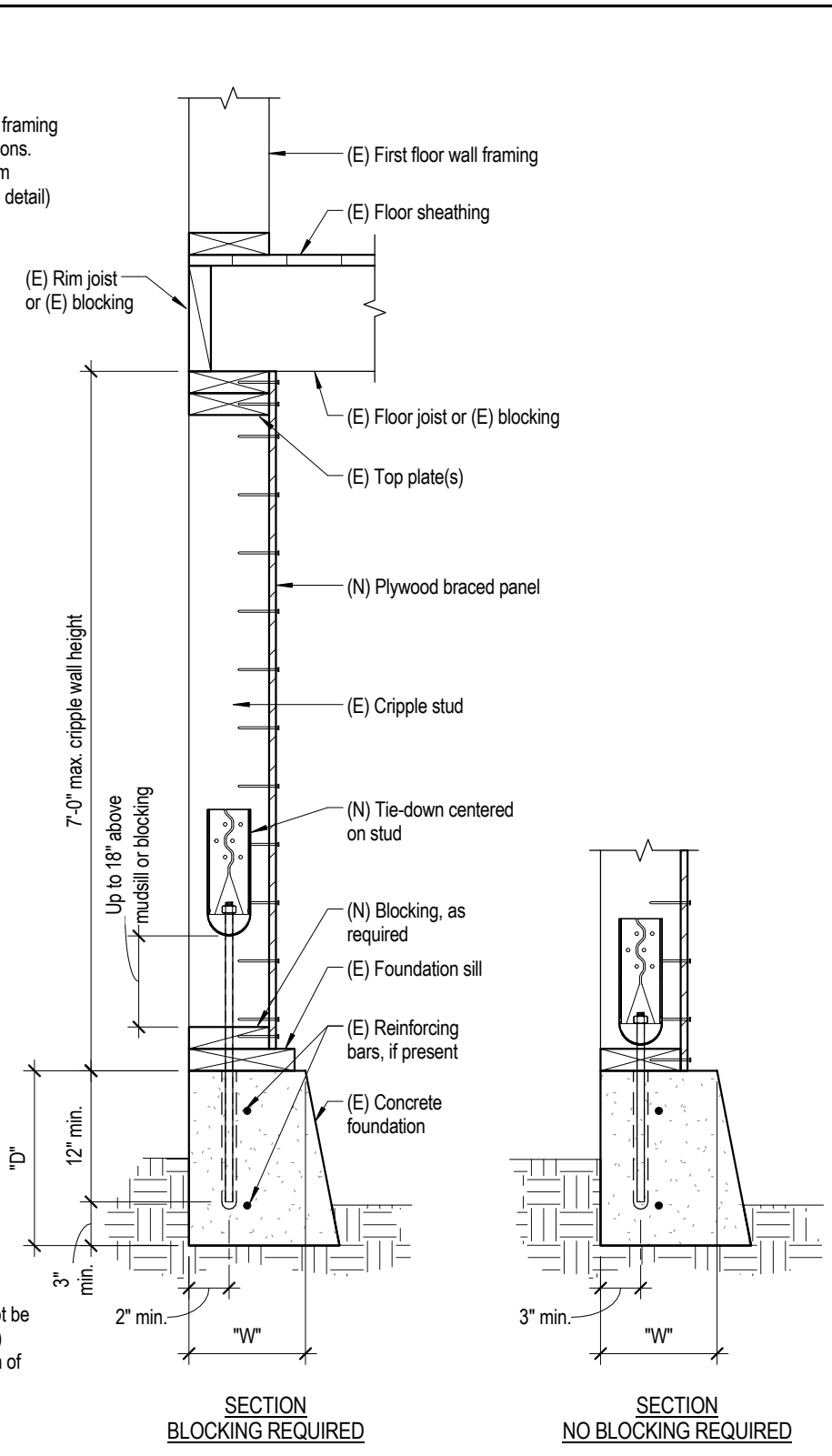


D3

Floor Framing to Cripple Wall Connection Details



Note:
See Sheet D3 for floor framing to cripple wall connections. (Framing may vary from condition shown in this detail)



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**

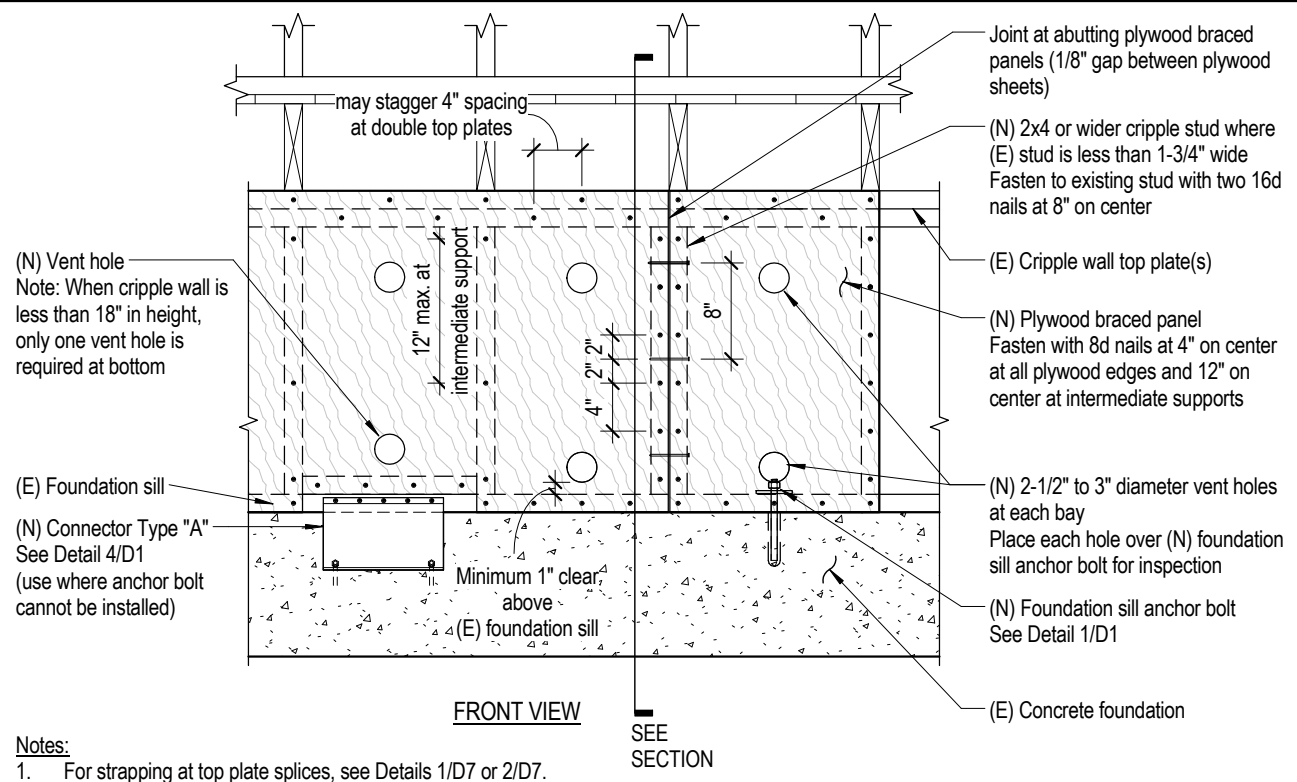
- Notes:
- For strapping at top plate splices, see Details 1/D7 or 2/D7.
 - At crawlspace vents or similar cripple-wall blockouts, see Detail 3/D7.
 - Prior to installing plywood, see Detail 4/D7 where pipes or conduits pass through cripple studs or top plates.

1 TYPICAL TIE-DOWN INSTALLATION

Plywood Installation at Plywood Braced Panels with Tie-Downs

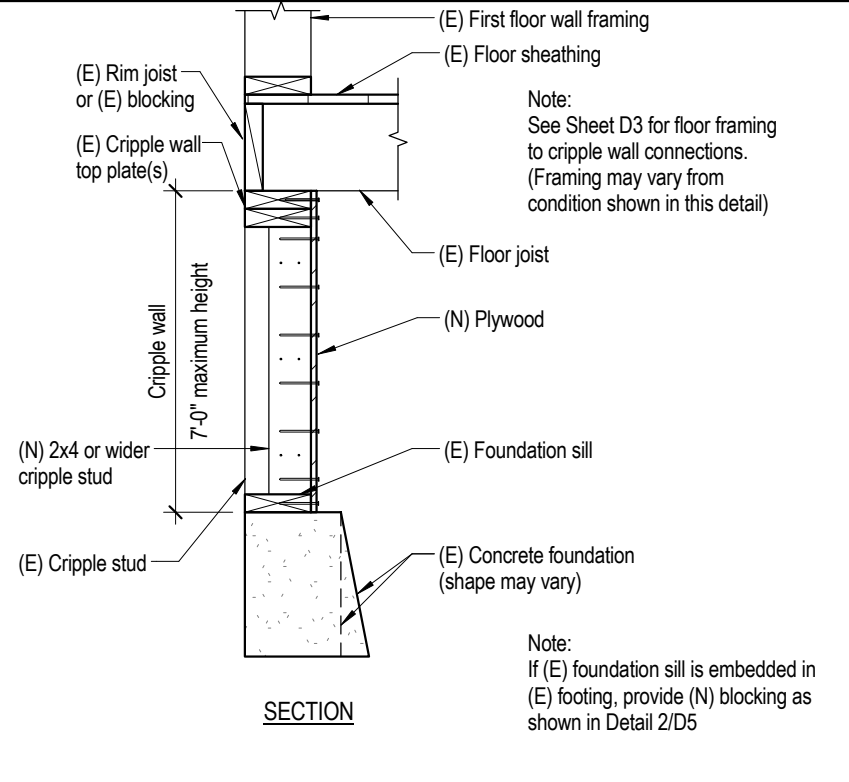


D4



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

1 FOUNDATION SILL SAME WIDTH AS CRIPPLE WALL



- (N) Blocking required where (E) foundation sill is wider than (E) cripple studs See Detail 2/D1

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

2 FOUNDATION SILL WIDER THAN CRIPPLE WALL

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).	

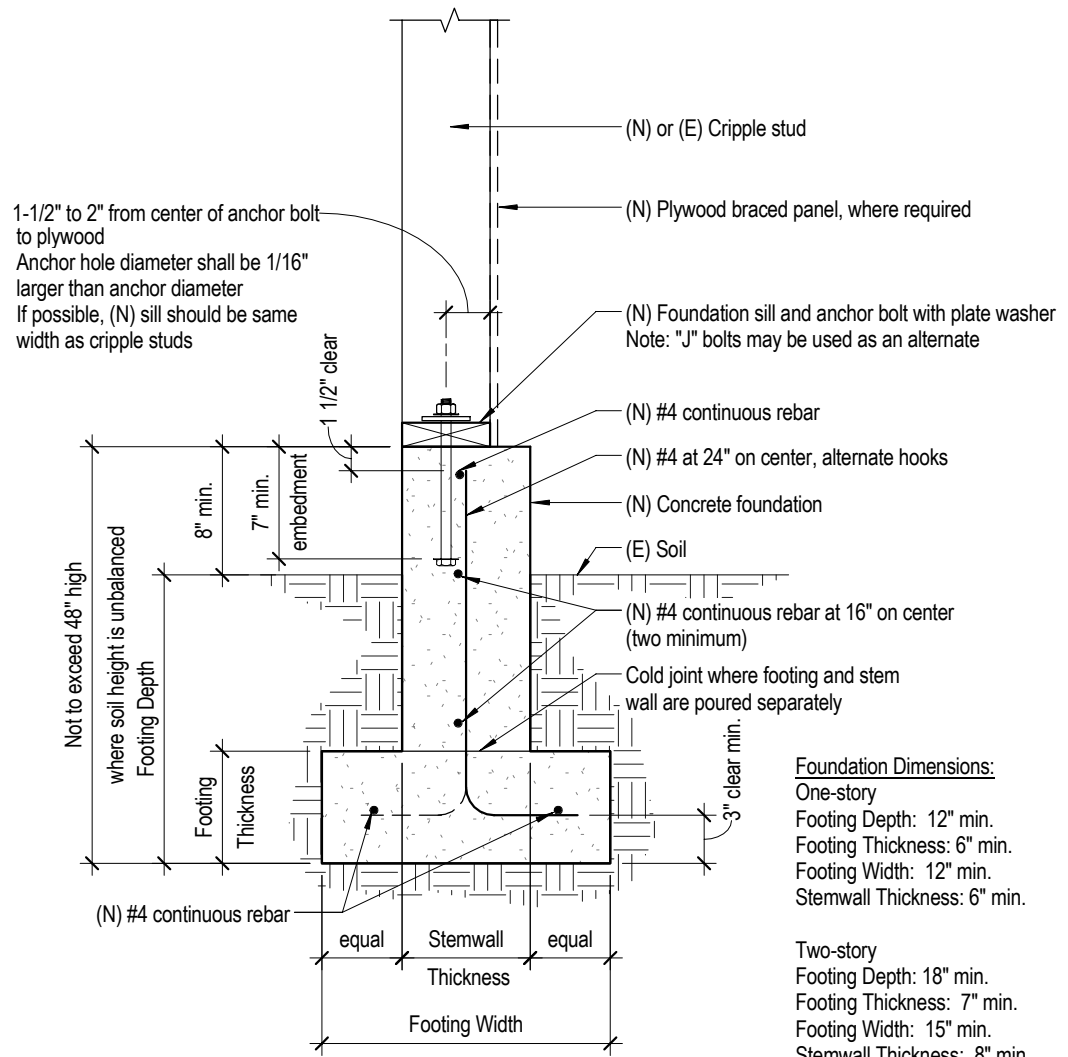
PROPERTY ADDRESS: _____

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



Plywood Installation at Plywood Braced Panels without Tie-Downs

D5



1-1/2" to 2" from center of anchor bolt to plywood
 Anchor hole diameter shall be 1/16" larger than anchor diameter
 If possible, (N) sill should be same width as cripple studs

Foundation Dimensions:
 One-story
 Footing Depth: 12" min.
 Footing Thickness: 6" min.
 Footing Width: 12" min.
 Stemwall Thickness: 6" min.
 Two-story
 Footing Depth: 18" min.
 Footing Thickness: 7" min.
 Footing Width: 15" min.
 Stemwall Thickness: 8" min.

Notes:

1. Contact AHJ 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 AHJ.
5. The ground surface along the interior side of the foundation may 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 three #4 x 3'-6" dowels. Embed dowels 8" minimum into the (E) foundation with adhesive.
7. A soils 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

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.

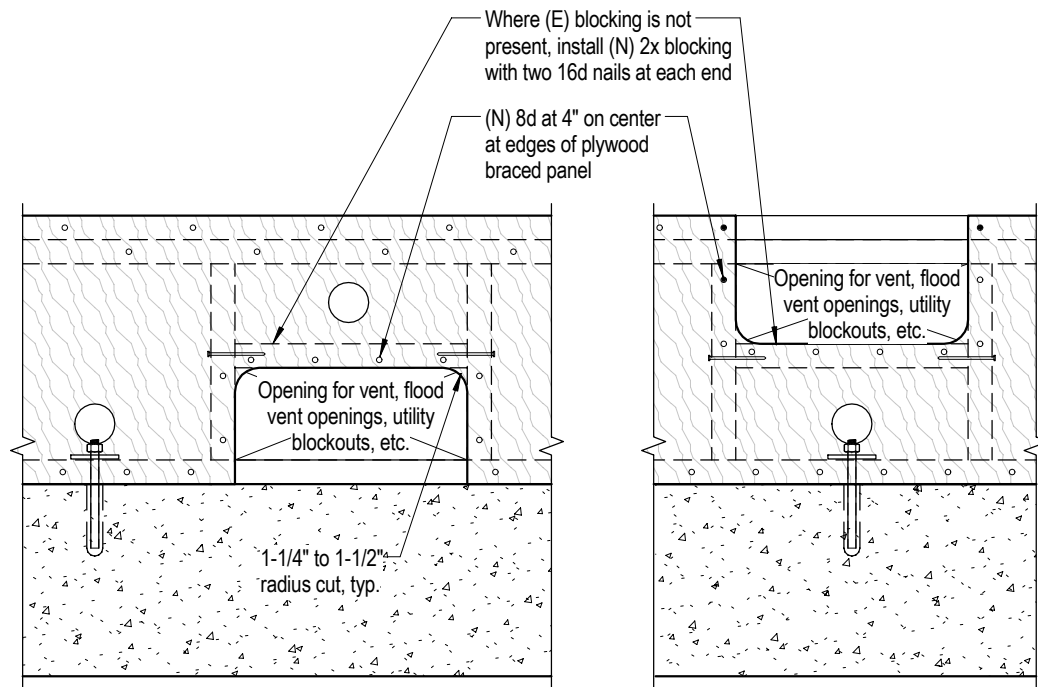
PROPERTY ADDRESS: _____

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



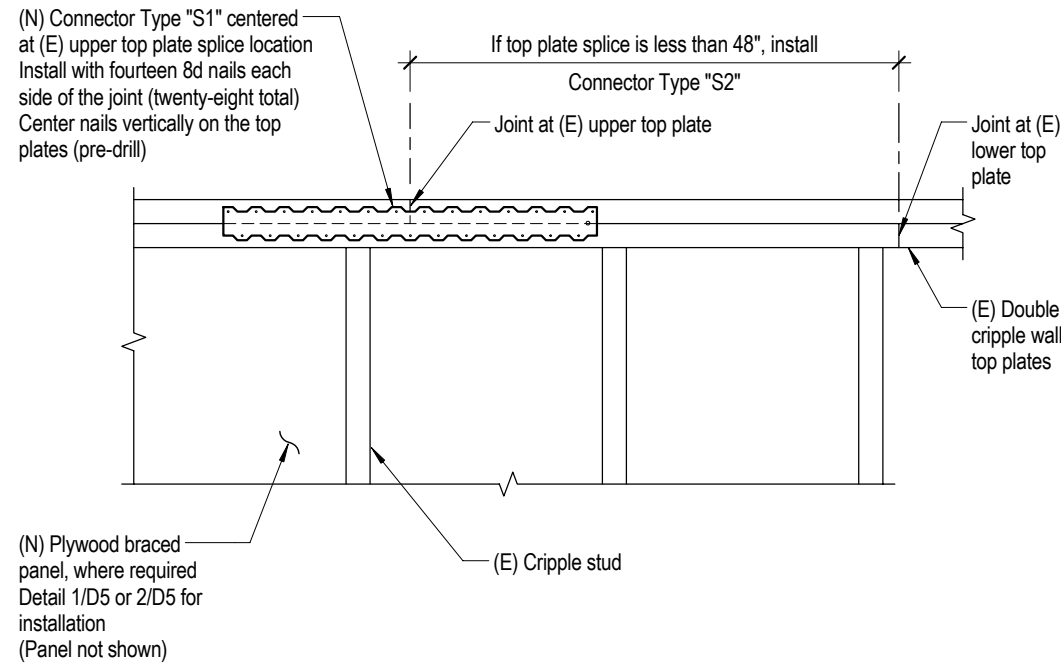
D6

Foundation Replacement Details



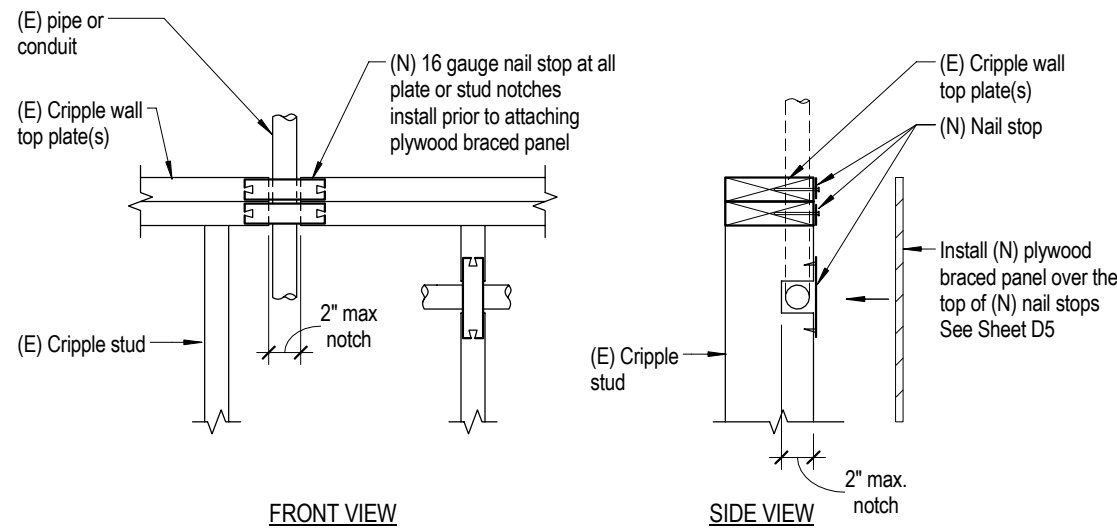
- Notes:
- Do not cover existing vents.
 - Increase plywood braced panel length a distance equal to the length of blockout(s) or one stud bay width whichever is greater.

3 CUTOUT REQUIREMENTS IN PLYWOOD BRACED PANELS

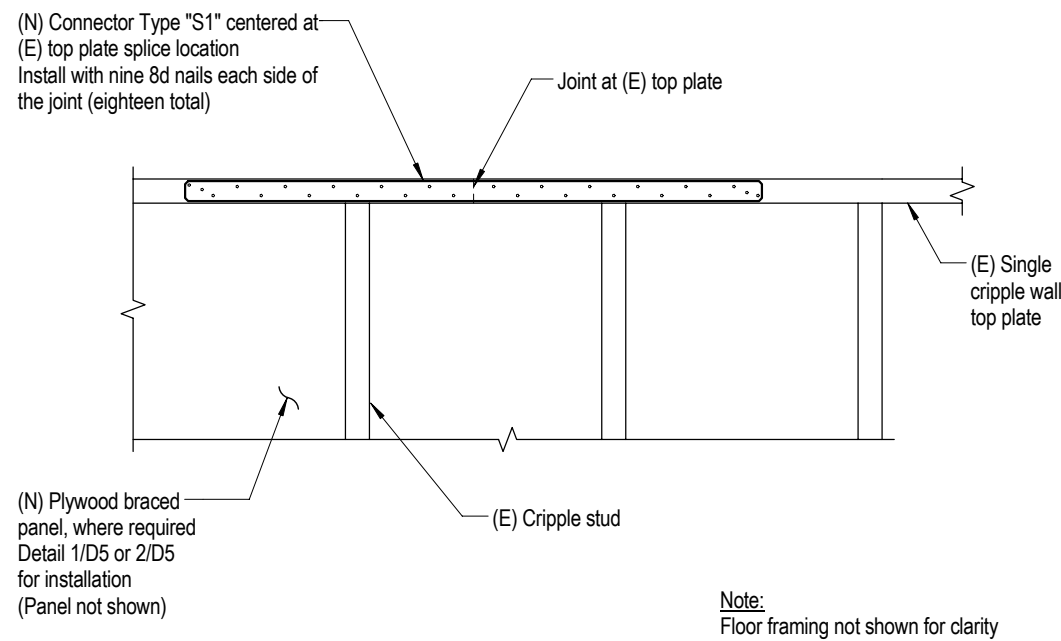


Note:
Floor framing not shown for clarity

1 TOP PLATE SPLICE AT EXISTING DOUBLE TOP PLATES



4 ALLOWABLE NOTCHING AND REINFORCING FOR TOP PLATES AND STUDS



Note:
Floor framing not shown for clarity

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).

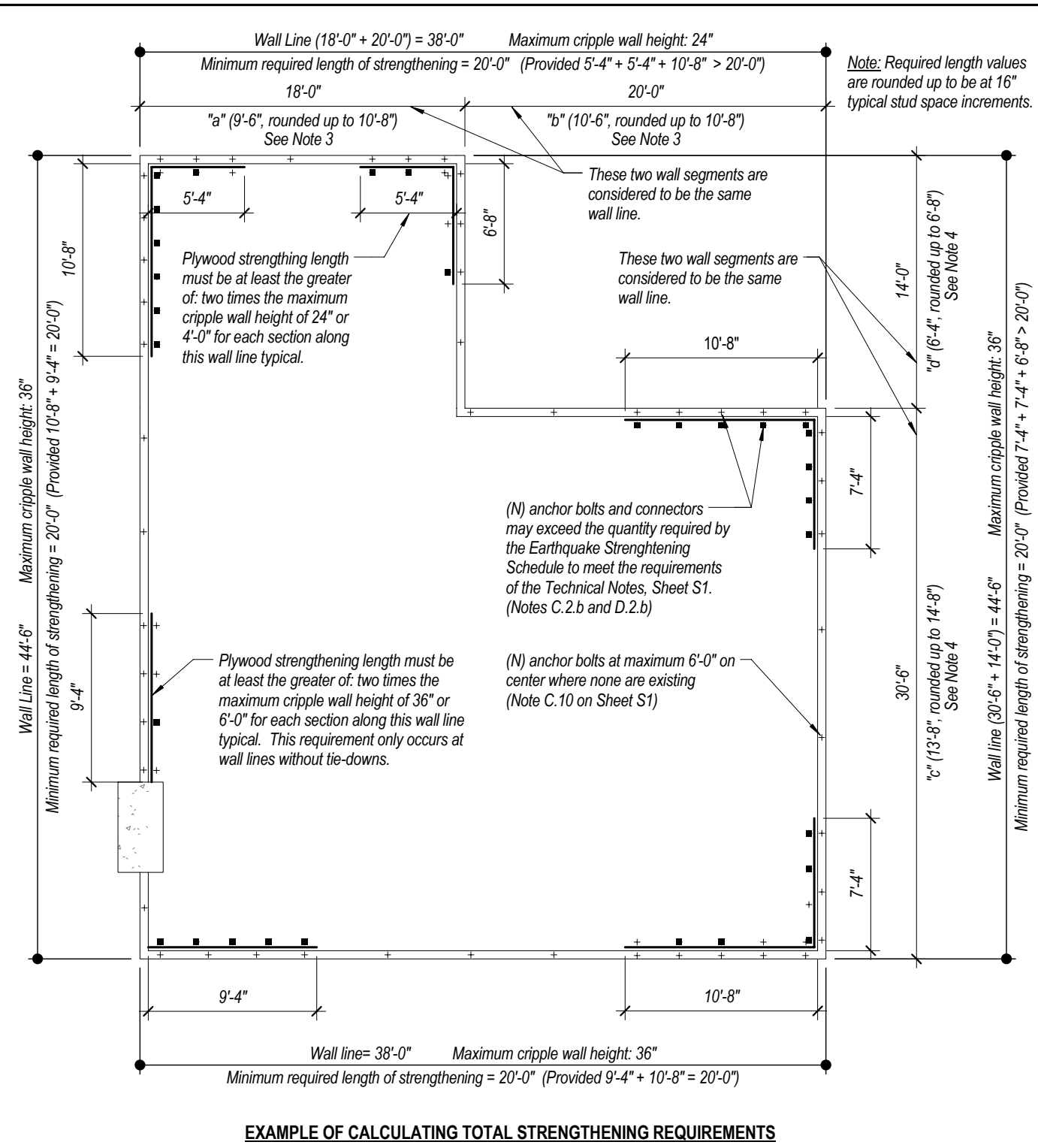
PROPERTY ADDRESS: _____

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

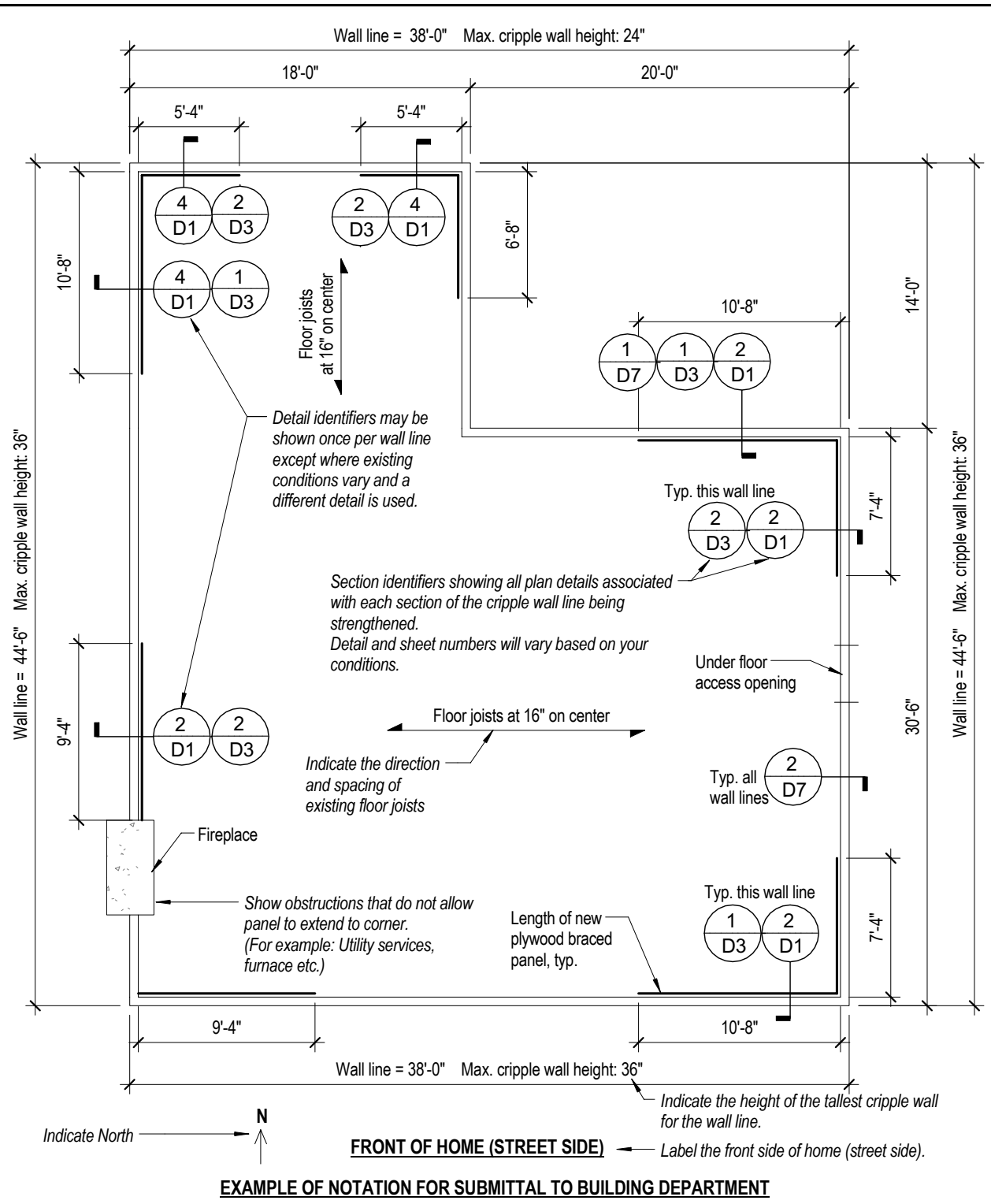


Panel Notching and Top Plate Details

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

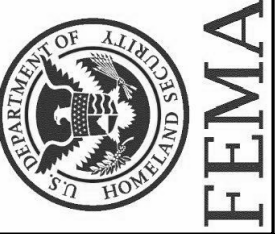
Example - Foundation Plan

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

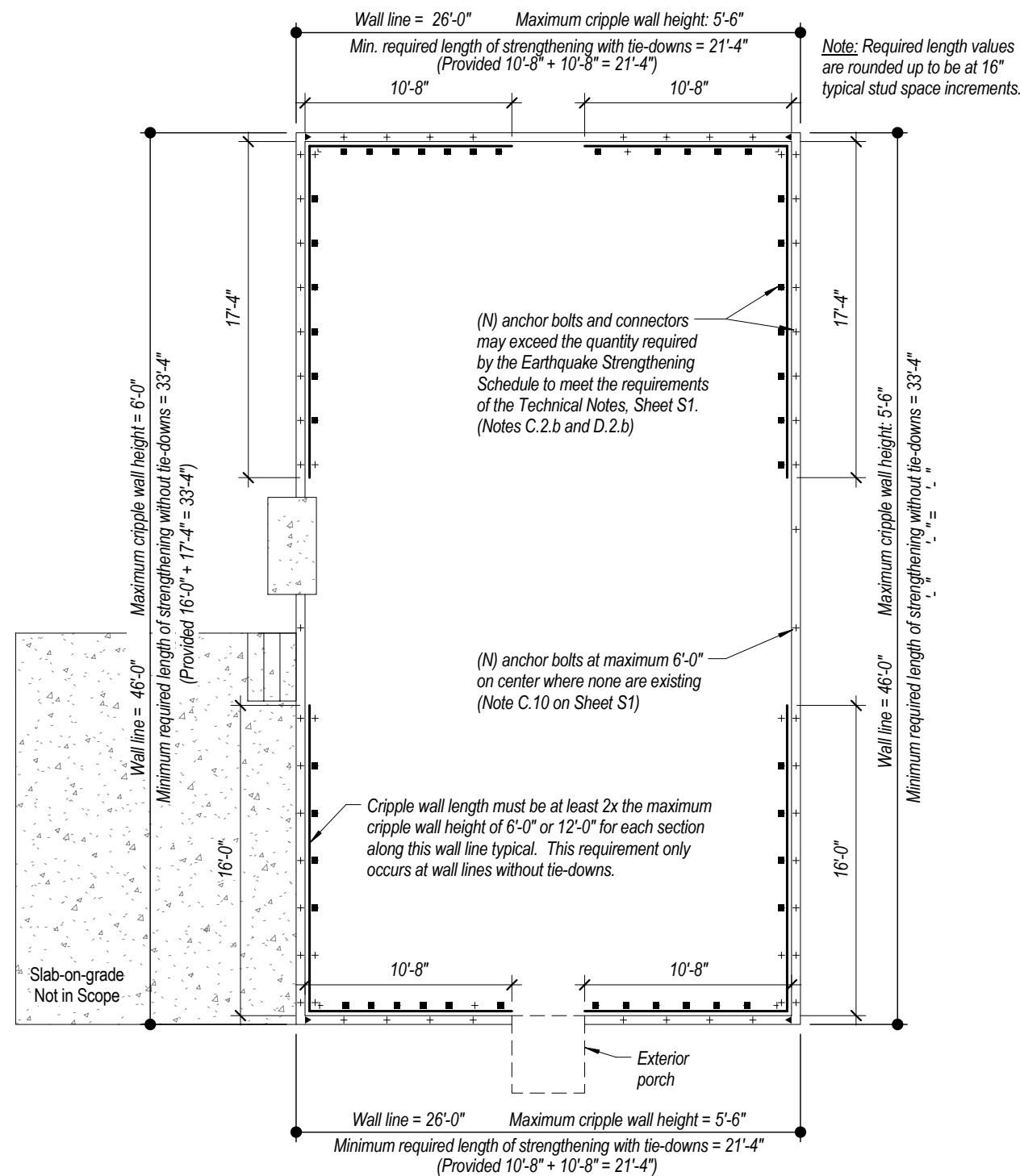
- Definitions**
- Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
 - Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
 - Wall line: All wall segments forming the overall building dimension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

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

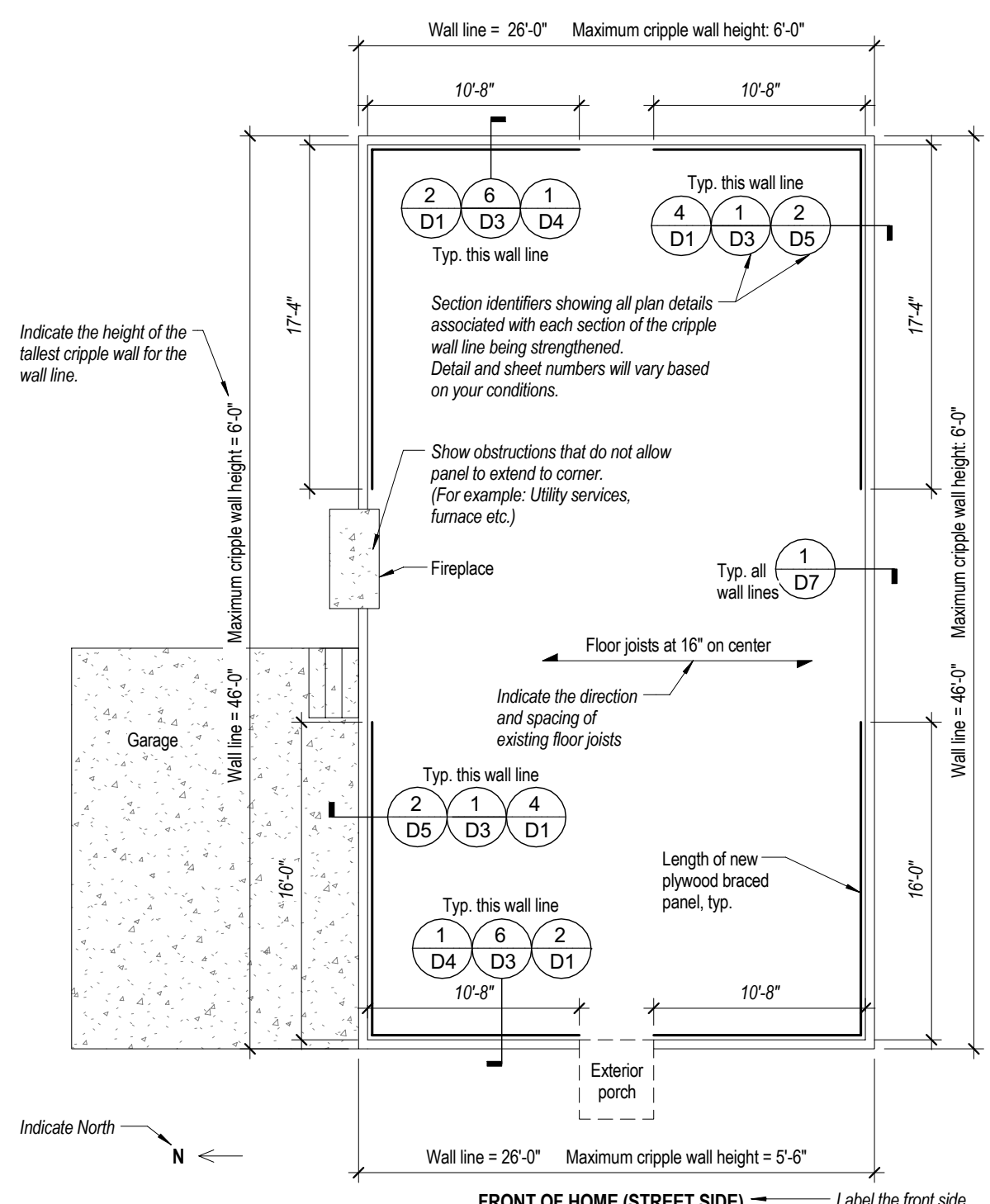
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings FEMA Plan Set



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

Example - Foundation Plan

- Notes:**
1. Plan shows typical notation. Instructional notes are in *italics* and should not be included on submittal drawing. Refer to Sheet 00 for additional instructions.
 2. 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.

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



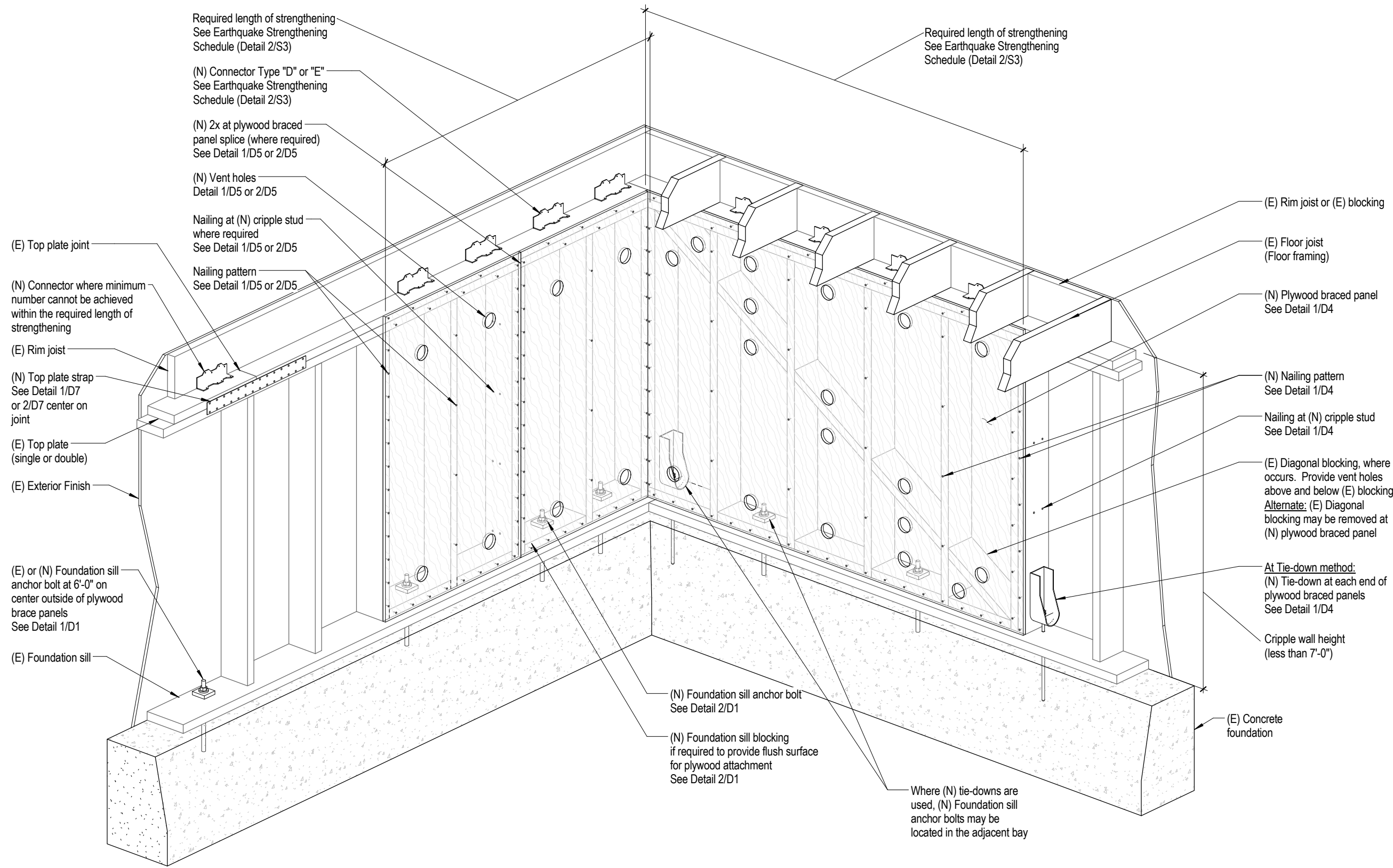
X2

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

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



X3



- 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.

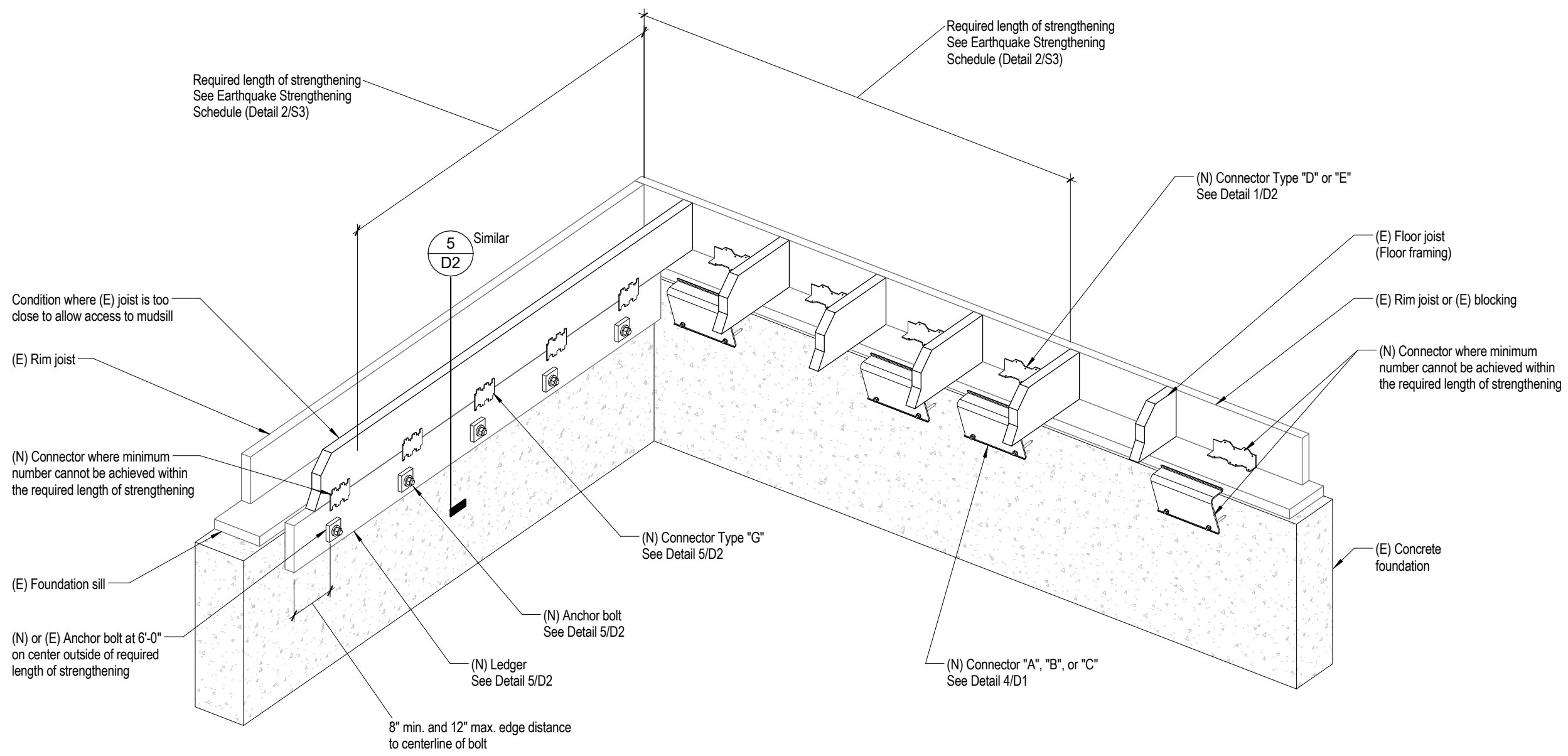
Example - Cripple Wall Strengthening

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