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Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

Purpose and Intended Audience

The August 24, 2014 South Napa earthquake (FEMA DR-4193) 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.

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. It was republished in 2019 to incorporate comments received from the California Building Officials (CALBO) and update references.

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 2016 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.

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.

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


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.

To order publications, contact the FEMA Distribution Center:
Call: 1-800-480-2520
(Monday–Friday, 8 a.m.–5 p.m., EST)
Fax: 240-699-0525
E-mail: FEMA-Publications-Warehouse@fema.dhs.gov
Additional FEMA documents can be found electronically in the FEMA Library at http://www.fema.gov/library.
A. Before you begin:
1. Familiarize yourself with the contents of this plan set and the South Napa Earthquake Recovery Advisory FEMA P-1024/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 a Civil or Structural 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. fees
   b. how many copies of the plans must be submitted
   c. which inspections are required
   d. whether or not a Civil or Structural Engineer, or Architect is required to develop and submit plans and calculations.
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 on Sheet S0, to determine if this plan set is applicable. A "no" answer to any question disqualifies the home from using this plan set, unless a licensed engineer or architect is involved.
   a. Question 11 website instructions:
      f. Label the street side (front) of the home.
      e. An arrow pointing to North.
      d. Dimensions for each length of perimeter wall segment and overall dimensions of wall lines.
   b. Question 12 website instructions:
      f. Identify the details used for notching and/or cutouts. (Sheet D7.)
      e. Identify the details used for the top plate splice. (Sheet D7).
      c. Identify the details used for the plywood braced panel. (Sheets D4 or D5).
   c. Question 13 website instructions:
      a. The location of any obstructions along the perimeter of the foundation that make the strengthening work difficult or impossible such as fireplaces, water heaters, utilities, etc. These areas should be avoided when laying out the required strengthening work.
   d. Whether or not a Civil or Structural Engineer, or Architect is required to develop and submit plans and calculations.
   e. Which inspections are required
   f. Whether or not a Civil or Structural Engineer, or Architect is required to develop and submit plans and calculations.

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 that make the strengthening work difficult or impossible such as fireplaces, water heaters, utilities, etc. These areas should be avoided when laying out the required strengthening work.
   b. The foundation sill to concrete foundation connection (Sheet D1).
   c. The floor framing to foundation sill connection (Sheet D2). or
   d. The floor framing to cripple wall connection (Sheet D3).
   e. Dimensions for 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.
2. 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.
3. 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.
4. Using the information from the Earthquake Strengthening Schedule, complete part B: Summary of Work. Additional instructions are included on Sheet S3.
5. Refer to Technical Notes, Sheet S1 for anchor and connector installation instructions. When ties-downs are required, see Supplemental Technical Notes on Sheet S2.

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. The floor framing to cripple wall connection (Sheet D3).
3. Determine the framing 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. While working on the application, you will need to ensure that:
   a. The foundation sill to concrete foundation connection (Sheet D1).
   b. The floor framing to foundation sill connection (Sheet D2). or
   c. The floor framing to cripple wall connection (Sheet D3).
   d. Dimensions for 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.
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 ties-downs are required, see Supplemental Technical Notes on Sheet S2.

D. Complete your plans:
1. Using the information from the Earthquake Strengthening Schedule on Sheet S3, add the following to complete your Foundation and Strengthening Layout Plan on Sheet S4:
   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 occurring).
   b. Identify the details used for the connection as noted above. Include the connection type, minimum number of connectors each wall line. Conform to Sections C and D of Sheet S1.
   c. Identify the details used for the plywood braced panel. (Sheets D4 or D5).
   d. Identify the details used for the tie-down. (Sheet D4).
   e. Identify the details used for the top plate splice. (Sheet D7).
   f. Identify the details 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 shall be required in conjunction with Note C.1, from Table H1 on Sheet S2.
5. No work requiring inspection shall be covered until it has been inspected and approved by the Authority Having Jurisdiction (AHJ).
1. 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".

2. 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 is applicable to portions of a residence with a raised floor framing system (crawlspace) that are adjacent to the portions built on concrete slabs on grade.

3. This plan set for strengthening is intended to be approved by the authority having jurisdiction (AHJ) without requiring additional plans or calculations. The project-specific plan set, and may require design by a licensed engineer or architect as required by the AHJ.

4. When isolated conditions differ from those shown on the plan set, specific details 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.

5. 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 by a licensed Civil or Structural Engineer (including a complete project-specific plans and calculations) shall be developed. The project-specific plan set may include in part this plan set, and may require design by a licensed engineer or architect as required by the AHJ.

6. Work performed under permit according to this plan set does not legalize any previous work performed without a permit. Chimneys and water heaters are not included in the scope of this plan set.

PURPOSE

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 condition, or performance of earthquake strengthening in accordance with 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, nor 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.

LIMITATION OF LIABILITY

APPLICABLE INFORMATION

APPLICANT

APPLICANT:

PROPERTY ADDRESS:

OWNER'S SIGNATURE:

SHEET INDEX

FOR JURISDICTION USE

S0  Cover Sheet
S1  Technical Notes
S2  Supplemental Technical Notes
S3  Construction Data and Earthquake Strengthening Schedule
S4  Foundation and Strengthening Layout Plan
S5  Foundation Sills to Concrete Foundation Connection Details
S6  Floor Framing to Foundation Sill Connection Details
S7  Floor Framing to Cripple Wall Connection Details
S8  Plywood Installation at Plywood Braced Panels with Tie-Downs
S9  Plywood Installation at Plywood Braced Panels without Tie-Downs
S10  Foundation Replacement Details
S11  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

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 condition, or performance of earthquake strengthening in accordance with 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, nor 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.
A. GENERAL

1. 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 requirements of the 2015 International Existing Building Code (IEBC) or, if applicable, the 2016 California Existing Building Code (CEBC). New foundations shall be as detailed on Detail 1108.

2. All metal connectors and hardware shall be installed per manufacturer's instructions and in accordance with the requirements of this document.

3. Due to the corroded interaction of new metallic hardware in contact with preservative treated wood, all new metal fasteners shall be hot-dipped galvanized per ASTM A353. New metal connectors shall meet ASTM A 653 class G853, or better.

4. New lumber placed in contact with new or existing concrete shall be preservative pressure treated with Dinokap Ozone Barite (commonly known as "DOT") or Sodium Octa-Borate (commonly known as "SOB"). 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/SOB, hot-dipped galvanized connectors and fasteners are permitted to be used.

5. 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 that may be present due to recent repairs for damaged conditions (dry rot, termite, etc.). See Note 4 for special precautions that may be required at newer preservative treated foundation sills and other floor framing.

6. The Owner or Contractor shall verify that the existing concrete footing and/or walls at all locations to receive new anchor bolts and tie-down anchors are in reasonably good condition. Examples of poor concrete quality would include excessive spalling, large rock pockets, and/or 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 areas of poor quality. Where these local areas cannot be avoided, or where locations of poor quality are widespread, the new anchor bolts should be located in an area consistent with Table A.1, Note C1.

7. All existing under floor ventilation shall be maintained.

B. DESIGN BASIS

1. This plan set has been developed in accordance with the 2015 International Existing Building Code (IEBC) and the 2016 California Existing Building Code (CEBC), Section A301.3 Alternative Design Procedures, as shown on the drawings.

2. Seismic Design Category D Site Class D

3. Seismic Importance Factor = 1.0

4. Message 0.070

5. 75% factor per A301.3 of the 2015 IEBC (2016 CEBC)

6. Response Modification Factor, R = 6.0

7. Design Base Shear, V = 1.035g (ASD), where W = seismic weight of building.

8. If 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. See #1 of "Eligibility for Use on Sheet S0 for additional information.

C. FOUNDATION CONNECTIONS

1. See Sheet D1 for required connection details.

2. New anchor bolts or connectors required by the Earthquake Strengthening Schedule (Detail 253) shall be installed within the length of required strengthening as follows:

   a. one connector at each end, and

   b. space remainder of connectors as equally as possible, but not more than 32" on center nor less than 8" on center.

3. Where the required number of connectors cannot be achieved within the "MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING" as specified on Sheet S3, anchors of connectors may be placed adjacent and outside of these areas along the same wall line.

4. Not more than one connector per existing floor joist bay until unless joists are spaced 34" on center.

5. Increase length of nails 1/2" when attaching connectors through plywood.

6. If plywood in double top plates does not have a minimum 48" lip, provide a new metal strap at joint. See Detail 1071.

7. Existing single top plates shall be reinforced with a metal strap at the joint. See Detail 2CD.

8. 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.

9. Where existing continuous rim joint, end joint, or solid blocking between joists, does not exist above the perimeter cripple wall or foundation sill, new blocking and/or supplemental connectors shall be provided per Sheet D3.

10. All new blocking shall be installed snug tight with three 8d nails each end into perpendicular member.

11. All new rim joists shall be installed with 8d at 16" on center into top plates.

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

1. See Sheets D2 and S3 for required connection details.

2. New connectors required by the Earthquake Strengthening Schedule (Detail 253) shall be installed within the length of required strengthening as follows:

   a. one connector at each end, and

   b. space remainder of connectors as equally as possible, but not more than 32" on center nor less than 8" on center.

3. Where the required number of connectors cannot be achieved within the "MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING" as specified on Sheet S3, anchors of connectors may be placed adjacent and outside of these areas along the same wall line.

4. Not more than one connector per existing floor joist bay until unless joists are spaced 34" on center.

5. Increase length of nails 1/2" when attaching connectors through plywood.

6. If plywood in double top plates does not have a minimum 48" lip, provide a new metal strap at joint. See Detail 1071.

7. Existing single top plates shall be reinforced with a metal strap at the joint. See Detail 2CD.

8. 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.

9. Where existing continuous rim joint, end joint, or solid blocking between joists, does not exist above the perimeter cripple wall or foundation sill, new blocking and/or supplemental connectors shall be provided per Sheet D3.

10. All new blocking shall be installed snug tight with three 8d nails each end into perpendicular member.

11. All new rim joists shall be installed with 8d at 16" on center into top plates.

E. PLYWOOD BRACED PANEL INSTALLATION

1. See Earthquake Strengthening Schedule (Detail 253) for the required length of new seismic strengthening along each wall line.

2. Install plywood braced panels at each end of each wall line where possible and space additional panels, as needed, along each wall line.

3. Plywood braced panels closest to the ends of wall lines shall be near as to the ends of panels shall 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 the Joists should be equal to or exceed the height of the cripple wall.

4. Plywood braced panels along the length of a wall line shall be nearly equal in length and shall be nearly equal in spacing where possible. Using increments of existing stud spacing is acceptable.

5. The length of each plywood braced panel shall not be less than 46" inches. The length of braced panels without beams 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 the Joists should be equal to or exceed the height of the cripple wall.

6. Nails for plywood shall be 8d common x 2 1/2" long with a minimum shank diameter of 0.131" (3 x 1/2 x 1.25). Exception: 0.131 x 2.5/6" 2.

7. Plywood braced panels shall be 1/2" Structural I rated sheathing, Exposure 1, 5, F.V., or preferably preferred wood species with the minimum edge distance of 3/8" from center of nail to edges of plywood, studs, or top and sill plates. See Sheet D5 for new double studs at plywood joints.

8. Do not overdrive, counterdrive, or otherwise damage the fastener ply when installing nails. A nail is over-driven when it breaks the surface ply. Install one additional nail for each over-driven nail.

9. Nails shall be firmly embedded in framing behind plywood without causing splitting. Predrilling may be appropriate for installing nails in framing and blocking to avoid splitting.
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 testing of the installed anchor is required. Additional procedures are required for the installation of the required tie-downs and for installation of the plywood braced panels as follows:
   a. See Section H for foundation requirements.
   b. 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 systems 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 10" 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, are permitted to 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 testing of the installed anchor is required. Additional procedures are required for the installation of the specified length of plywood braced panels as follows:
   a. See Section H for foundation requirements.
   b. See Sheet D4 for tie-down installation details and plywood sheathing requirements.

Table H-1: Verification of Existing Foundation System

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes or N/A</th>
<th>Signature of Owner or Contractor (Owner performing work)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 The size of the existing foundation is greater than or equal to that specified in Section H, Item 2.</td>
<td>N/A</td>
<td>Signature</td>
</tr>
<tr>
<td>B.1 The existing foundation has generally been verified to be in reasonably good condition at locations where strengthening was done.</td>
<td>N/A</td>
<td>Signature</td>
</tr>
<tr>
<td>C.1 The capacity of the existing anchors have been verified by passing the tension tests specified in Section H, Item 2a.</td>
<td>N/A</td>
<td>Signature</td>
</tr>
<tr>
<td>C.2 The capacity 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 in reasonably good condition or questionable, it can be verified by passing the torque tests specified in Section H, Item 3a.</td>
<td>N/A</td>
<td>Signature</td>
</tr>
</tbody>
</table>

Table H-2: Foundation Testing Requirements

<table>
<thead>
<tr>
<th>Screw Anchor</th>
<th>Adhesive Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>Torque (ft-lbs)</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>50</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>80</td>
</tr>
</tbody>
</table>

I. TIE-DOWN REQUIREMENTS

1. Tie-downs shall be Simpson HDU2-SD5S2.5, KC-Metals ADST2, USP Structural Connectors P2H2A, or an equivalent able to withstand an allowable tensile load of 3075 lbs or more, installed per manufacturer’s instructions.

2. End studs to which tie-downs are installed, shall be 3x minimum or double 2x. For nailing at double studs, see Sheet D5 and D4 where applicable.

3. All tie-downs shall use 5/8 (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1/D4.
EARTHQUAKE STRENGTHENING SCHEDULE

1. Square footage calculation
   a. Number of stories above cripple wall / foundation sill:__________
      (Do not include areas built over slab-grade.)
   b. Approximate 1st floor area over crawl space:__________
      (Do not include areas where 1st floor is built over slab-grade.)
   c. Total approximate square footage:__________

2. Roofing: Concrete or clay tiles weighing up to 11 pounds per square foot.
   Exterior Wall Finishes: Stucco

3. Roofing: Wood shakes; wood or asphalt shingles; composition roofing; or metal roofing
   Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
   or other noncombustible finishes asper local code requirements.

4. Roofing: Wood shakes; wood or asphalt shingles; composition roofing; or metal roofing
   Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
   or other noncombustible finishes asper local code requirements.

5. EXPERIMENTAL MATERIALS: Use only with supplemental technical notes.

6. Tie-downs: Use only with supplemental technical notes.

7. New Foundation Sill (Mud Sill) Anchorage used: (check all that apply)
   a. Adhesive
   b. Screw
   c. Type “A” Connector
   d. Type “B” Connector
   e. Type “C” Connector

8. New Foundation Sill (Mud Sill) Anchorage used: (check all that apply)
   a. Adhesive
   b. Screw
   c. Type “A” Connector
   d. Type “B” Connector
   e. Type “C” Connector

9. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
   Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
   or other noncombustible finishes asper local code requirements.

10. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.

11. Roofing: Concrete or clay tiles weighing up to 11 pounds per square foot.
    Exterior Wall Finishes: Stucco

12. Roofing: Concrete or clay tiles weighing up to 11 pounds per square foot.
    Exterior Wall Finishes: Stucco

13. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.

14. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.

15. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.

16. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.

17. Roofing: Metal roofing; asphalt shingles; composition roofing; or metal roofing
    Exterior Wall Finishes: Wood panel siding; stucco; vinyl siding;
    or other noncombustible finishes asper local code requirements.
Foundation and Strengthening Layout Plan

ONE SQUARE = ____ FEET

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

REVISED AUG 2019
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

Property Address:

FEMA Plan Set

Material Key:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plywood (embedded panel)</td>
<td>5/8&quot; Structural, Exposure 1, Veneer Lumber</td>
</tr>
<tr>
<td>Plywood (framing panel)</td>
<td>1/2&quot; Structural Exposure 1, Veneer Lumber</td>
</tr>
</tbody>
</table>
| Sheet Notes | 1. For Foundation Connections, see Sheet S1, Technical Notes, Section C.  
2. For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2.203). |

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails To Nailing</td>
<td>8d (8 penny) 0.131&quot; x 1-1/2&quot; long common</td>
</tr>
<tr>
<td>Nails To Framing</td>
<td>8d (8 penny) 0.131&quot; x 1-1/2&quot; long common</td>
</tr>
<tr>
<td>Nails To Foundation Sill</td>
<td>10d (10 penny) 0.148&quot; x 3&quot; long</td>
</tr>
<tr>
<td>Nails To Foundation Sill</td>
<td>10d (10 penny) 0.148&quot; x 3&quot; long</td>
</tr>
<tr>
<td>Structural Wood Screw</td>
<td>3/8&quot; RSS &quot;Climatek&quot;, USP Mitek &quot;Gold Coat&quot;, or equivalent.</td>
</tr>
<tr>
<td>10d Structural Wood Screw</td>
<td>10d (10 penny) 0.148&quot; x 1&quot; long</td>
</tr>
<tr>
<td>8d Structural Wood Screw</td>
<td>8d (8 penny) 0.131&quot; x 1&quot; long</td>
</tr>
<tr>
<td>6d Structural Wood Screw</td>
<td>6d (6 penny) 0.119&quot; x 1&quot; long</td>
</tr>
<tr>
<td>4d Structural Wood Screw</td>
<td>4d (4 penny) 0.095&quot; x 1&quot; long</td>
</tr>
<tr>
<td>3&quot; X 3&quot; Square X 0.229&quot; Thick Steel Plate Washer</td>
<td>3&quot; X 3&quot; square x 0.229&quot; thick</td>
</tr>
<tr>
<td>Flashing Tape</td>
<td>Fortiflash, Orange Peel-n-Seal, Typar, Tyvek, Vycor, HardieWrap, or equivalent.</td>
</tr>
<tr>
<td>Typical Tiedown</td>
<td>1/4&quot; WS &quot;Gold Coat&quot;, or equivalent.</td>
</tr>
<tr>
<td>Typical Tiedown</td>
<td>1/4&quot; RSS &quot;Climatek&quot;, USP Mitek &quot;Gold Coat&quot;, or equivalent.</td>
</tr>
</tbody>
</table>

New Blocking Installation

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

Anchor Through Blocking and Foundation Sill

Detail applies where (E) foundation sill is wider than the (E) cripple studs.

Anchor Through Foundation Sill Only

See Detail 3/D1 equivalent.

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

Foundation Sill anchor bolt and Steel plate washer

See Earthquake Strengthening Schedule (Detail 2.203)

1/4" from center of bolt to edge of foundation sill

Anchor Through Foundation Sill Only

Foundation sill anchor bolt and plate washer

See Earthquake Strengthening Schedule (Detail 2.203)

1/4" from center of bolt to edge of foundation sill

Foundation sill anchor bolt and Steel plate washer

See Earthquake Strengthening Schedule (Detail 2.203)

1/4" from center of bolt to edge of foundation sill

Foundation sill anchor bolt attached over framing

See Detail 3/D1

See Detail 1/D5

See Detail 2/D5

Sheet Notes:

1. For Foundation Connections, see Sheet S1, Technical Notes, Section C.

2. For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2.203).

Revised Aug 2019

D1
Floor Framing to Cripple Wall Connection Details

1. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (E) 3x6 blocking with three 8d toe nails each end
   - (N) 2x blocking with three 8d nails each end
   - (N) Connector Type "D" at (E) blocking or Type "E" at (E) rim joist

2. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (N) 2x blocking with three 8d nails each end at 4'-0" on center in the first bay space if none exists
   - (N) 2x ledger attach with 16d at 3" on center staggered
   - (N) Plywood braced panel where required See Sheet D4 or D5 for installation
   - Note: See Sheet D4 or D5 for installation

3. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (N) 2x "reverse block" attached with 16d nails at 2" on center to blocking or floor joist above
   - (N) Plywood braced panel See Sheet D4 or D5 for installation
   - Note: See Sheet 2/03 where joist framing is perpendicular to (E) cripple walls.

4. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (N) 2x blocking or floor joist with three 8d nails each end
   - (N) 2x ledger attach with 16d at 3" on center staggered
   - (N) Plywood braced panel See Sheet D4 or D5 for installation
   - Note: See Sheet 2/03 where joist framing is perpendicular to (E) cripple walls.

5. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (N) 2x blocking or floor joist with three 8d nails each end
   - (N) 2x ledger attach with 16d at 3" on center staggered
   - (N) Plywood braced panel See Sheet D4 or D5 for installation
   - Note: See Sheet 2/03 where joist framing is perpendicular to (E) cripple walls.

6. **FLOOR-TO-CRIPPLE WALL CONNECTION**
   - (N) 2x blocking or floor joist with three 8d nails each end
   - (N) 2x ledger attach with 16d at 3" on center staggered
   - (N) Plywood braced panel See Sheet D4 or D5 for installation
   - Note: See Sheet 2/03 where joist framing is perpendicular to (E) cripple walls.

*Note: Use detail where no joist blocks exist above cripple wall top plate.*

**MATERIAL KEY:**
- Screws: Phillips pan head 4 X 4" RSS, #8 "Cor-Ten", USP Mitek 4" WD "Gold Coat", or equivalent.
- Nail: 10d 0.148" x 3" long common
- Nail: 10d (10 penny) 0.148" x 3" long common
- Nail: 8d (8 penny) 0.131" x 2-1/2" long common
- Nail: 8d (8 penny) 0.131" x 2-1/2" long common
- Nail: 6d (6 penny) 0.131" x 2-1/2" long common
- Nail: 4d (4 penny) 0.131" x 2-1/2" long common
- Nail: 3d (3 penny) 0.131" x 2-1/2" long common
- Nail: 2d (2 penny) 0.131" x 2-1/2" long common
- Nail: 1d (1 penny) 0.131" x 2-1/2" long common

**APPLICANT:**
- D3

**PROPERTY ADDRESS:**
- FEMA Plan Set

**REVISED AUG 2019**
- Cripple Walls in Frame Dwellings
- Earthquake Strengthening of Wood-Frame Dwellings
- FEMA Plan Set
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

Plywood Installation at Plywood Braced Panels with Tie-Downs

Notes:
1. For stopping at top plate splice, see Details 1D7 or 2D7.
2. At crawlspace vents or similar cripple wall blockouts, see Detail 3D7.
3. Prior to installing plywood, see Detail 4D7 where pipes or conduits pass through cripple studs or top plates.
4. *"w" indicates the width of an existing foundation or new foundation constructed in accordance with Detail 1D6. For existing foundations, see Sheet S2, Note G.2 for additional requirements.

TYPICAL TIE-DOWN INSTALLATION

Material Key:
- **APPLICANT:**
  - Wood Frame
  - Wood Frame Dwellings
  - Foundation Walls
  - Foundation Walls

**Sheet Notes:**
1. For Plywood Braced Panel Installation, see Sheet S1, Technical Notes, Section E.
2. For Tie-Down Requirements, see Sheet S3, Supplemental Technical Notes, Section I.
3. For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2S3).

**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:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8d (8 penny)</td>
<td>0.13&quot; x 2-1/2&quot; long common</td>
</tr>
<tr>
<td>10d (10 penny)</td>
<td>0.148&quot; x 3&quot; long common</td>
</tr>
<tr>
<td>16d (16 penny)</td>
<td>0.162&quot; x 4&quot; common</td>
</tr>
<tr>
<td>18d (18 penny)</td>
<td>0.192&quot; x 4-1/2&quot; long common</td>
</tr>
<tr>
<td>Screws</td>
<td>Simpson Strong-Tie 1/4&quot; SDS, GRK</td>
</tr>
<tr>
<td>Nails</td>
<td>8d (8 penny) 0.131&quot; x 2-1/2&quot; long common</td>
</tr>
<tr>
<td></td>
<td>10d (10 penny) 0.148&quot; x 3&quot; long common</td>
</tr>
<tr>
<td></td>
<td>16d (16 penny) 0.162&quot; x 4&quot; common</td>
</tr>
</tbody>
</table>

**Notes:**
- See Sheet S2 for floor framing to cripple wall connections. (Framing may vary from condition shown in this detail).
- Blocking required where (E) stud is less than 1-3/4" thick. Fasten to (E) stud with 16d nails at 4" on center, staggered to avoid splitting. Begin nailing 4" to 6" from ends of studs.
- Blocking, as required.
- Concrete foundation
- Rebar, if present
- Reinforcing bars may or may not be present. Do not drill through any (E) reinforcement during the installation of anchors.
- Minimum (E) concrete foundation depth
- See Technical Notes, Sheet S2, Section H

**Curtailment:**
- Section (N)
- (E) Floor sheathing
- (E) Reinforcing bars, if present
- (E) Concrete foundation
- (E) Top plate(s)
- (E) Floor joist or (E) blocking, see Sheet D3
- (N) Plywood braced panel
- (N) Tie-down centered on stud
- (N) Blocking, as required
- (N) Foundation sill anchor bolt
- See Detail 1D1 or 2D1
- Anchor may be located in and bay or bay adjacent to tie-down
- 2x4 or 2x6 cripple stud
- See "Tie-down" table on Sheet S3
- Foundation sill anchor bolt
- See Detail 3D7, Supplemental Technical Notes, Section I.
- Anchor may be located in and bay or bay adjacent to tie-down
- Double top plate
- See Sheet D3 for floor framing to cripple wall connections. (Framing may vary from condition shown in this detail).
- Blocking required where (E) stud is less than 1-3/4" thick. Fasten to (E) stud with 16d nails at 4" on center, staggered to avoid splitting. Begin nailing 4" to 6" from ends of studs.
- Blocking, as required.
- Concrete foundation
- Rebar, if present
- Reinforcing bars may or may not be present. Do not drill through any (E) reinforcement during the installation of anchors.
- Minimum (E) concrete foundation depth
- See Technical Notes, Sheet S2, Section H

**TYPICAL TIE-DOWN INSTALLATION**
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

**Plywood Installation at Plywood Braced Panels without Tie-Downs**

**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.

**Foundation Sill Same Width as 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
  - Notes:
    - 8d (8 penny) 0.131" x 2-1/2" long common
    - 10d (10 penny) 0.148" x 3" long common
    - 11d (11 penny) 0.157" x 3-1/2" long common
    - 16d (16 penny) 0.192" x 4" long common
    - Screws
      - Engineered Mating pairs 1-1/4" 1/4" 0.222" x 3/8" 1/4" 0.222" x 3/8" "Concrex", USP Mil-Std 131 1/4" x 3" "Gold Coat", or equivalent.
      - 3" Screw 3" long structural wood screw
      - 4" Screw 4" long structural wood screw
      - 5" Screw 5" long structural wood screw
    - Nails
      - 8d (8 penny) 0.131" x 2-1/2" common
      - 10d (10 penny) 0.148" x 3" common
      - 16d (16 penny) 0.192" x 4" common
    - Screws
      - Engineered Mating pairs 1-1/4" 1/4" 0.222" x 3/8" 1/4" 0.222" x 3/8" "Concrex", USP Mil-Std 131 1/4" x 3" "Gold Coat", or equivalent.
      - 3" Screw 3" long structural wood screw
      - 4" Screw 4" long structural wood screw
      - 5" Screw 5" long structural wood screw
    - Nails
      - 8d (8 penny) 0.131" x 2-1/2" common
      - 10d (10 penny) 0.148" x 3" common
      - 16d (16 penny) 0.192" x 4" common

**APPLICABLE PROPERTY CODES:**
- FEMA Plan Set
- S1, Technical Notes, Section E.

**APPLICANT:**
- Earthquake Strengthening of Cripple Walls in Wood
- FEMA Plan Set

**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
  - Notes:
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

FEMA Plan Set

APPLICANT: 
PROPERTY ADDRESS: 

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 is permitted to be excavated to the elevation of the top of the footing. 
6. Where (N) foundations are placed adjacent to (E) foundations, connect (N) and (E) foundations with three #4 x 3' 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. 

| Notes: | 
|---|---|
| 1. For New Foundations, see Sheet S1, Technical Notes, Section F. | 
| 2. For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 253). | 

CONCRETE FOUNDATION FOR SECTION REPLACEMENT
Material Key:

- (E) blocking is not present, install (N) 2x blocking with two 16d nails at each end.
- (N) 8d at 4" on center at edges of plywood braced panel.
- (E) Cripple wall top plates.

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

Cutout Requirements in Plywood Braced Panels:

- Opening for vent, flood vent openings, utility blockouts, etc.
- 1/4" to 1-1/2" radius cut, typ.

Top Plate Splice at Existing Double Top Plates:

- (E) Connector Type "S1" centered at (E) upper top plate splice location. Install with fourteen 8d nails each side of the joint (twenty-eight total). Center nails vertically on the top plates (pre-drill). (Condition not shown).
- If top plate splice is less than 48", install (E) Connector Type "S2" (Condition shown).
- Joint at (E) upper top plate.
- Joint at (E) lower top plate.
- (E) Cripple stud.
- (E) Double cripple wall top plates.
- (E) Plywood braced panel where required. Detail 1/205 or 2/205 for installation. (Panel not shown).

Top Plate Splice at (E) Single Top Plate:

- (E) Connector Type "S1" centered at (E) top plate splice location. Install with nine 8d nails each side of the joint (eighteen total). Joint at (E) top plate.
- (E) Single cripple wall top plate.
- (E) Plywood braced panel where required. Detail 1/205 or 2/205 for installation. (Panel not shown).

Notes:
- Floor framing not shown for clarity.

Allowable Notching and Reinforcing for Top Plates and Studs:

- Plywood (Plywood braced panel).
- LVL (Laminated Veneer Lumber).
- Plate Washer.
- Flashing Tape.

Sheet Notes:
1. For Strapping Requirements, see Sheet S1, Technical Notes, Section D, Notes 6, 7, & 8.
2. For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/33).
Example - Foundation Plan

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. This example chooses to use 1/2" anchor bolts and Type "E" Connectors, to determine lengths and quantities.

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

Example of Calculating Total Strengthening Requirements

Note: Required length values are rounded up to be at 16" typical stud space increments.

Minimum required length of strengthening = 20'-0" (Provided 5'-4" + 5'-4" + 10'-8" = 20'-0")

For each section along this wall line, (N) anchor bolts at maximum 6'-0" on center where none are existing

Wall Line: All wall segments forming the overall building dimension on one side. Indicate the direction and spacing of establishing floor joists.

Wall Line = 38'-0" Max. cripple wall height: 36" 9'-4" 10'-8" 11'-6" 12'-0"

Minimum required length of strengthening = 20'-0" (Provided 9'-4" + 10'-8" = 20'-0"

These two wall segments are considered to be the same wall line.

These two wall segments are considered to be the same wall line.

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

Key:
- (N) anchor bolts and Type "B" Connectors, to determine lengths and quantities.
- Minimum required length of strengthening using plywood braced panels, anchors, and connectors
- Foundation sill anchor bolt or connector
- plywood braced panel, typ.
- Floor framing connector
- Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

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.

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" × 9'-6" = 9'-6"  b = 20'-0" × 10'-8" = 10'-8"

4. Sample calculation. Length of strengthening required for segments "c" and "d":
   c = 20'-0" ÷ (18' ÷ 14") = 13'-8"  d = 20'-0" ÷ (24' ÷ 14") = 8'-4"

Plywood braced panels: 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.
This 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. This 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
- Tie-down

**Notes:**
1. Plan shows typical notation. Instructional notes are in italics and should not be included on submittal drawing. Refer to Sheet 03 for additional instructions.
2. Detail Number (Homeowner or Contractor to choose most appropriate detail)

**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.
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.

Example - Cripple Wall Strengthening

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.

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

Example - Strengthening - No Cripple Wall

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.