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.

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.

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.
**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](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](http://www.fema.gov/library).
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);
   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 plans 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 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. Inspect(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).
Purpose

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 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 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 (crawlspace).

3. This plan set for strengthening is intended to be approved by the authority having jurisdiction (AHJ) without requiring additional plans or calculations.

4. When isolated conditions differ from those shown on the plan set, a supplemental engineered solution (including project-specific plans and calculations) shall be developed and shall be issued as an addendum to this plan set.

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 (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.

6. 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 been 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 the Plan Set, nor is any party associated with the preparation of this Plan Set obligated 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.

Eligibility for Use

To determine if a home qualifies, answer the following:

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 11 psf.)
10. Is the difference in cripple wall height between the shortest and tallest walls less than 4’-6”?
11. Is the site seismology less than S1 = 2.34 and S2 = 0.97? (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.
1. All existing concrete, steel anchor bolts, and wood material that will be part of the strengthening work shall be in a reasonably sound condition and free from defects that would substantially reduce the capacity of the material. Any deteriorated material that is replaced or repaired shall comply with the minimum Building Code requirements for new construction. New foundations shall be as detailed on Detail 10E.

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 corrosive interaction of new metallic hardware in contact with preservative treated wood, all new metal fasteners shall be hot-dipped galvanized meeting ASTM A 653 grade G185, or better. Hot-dipped galvanized connectors and fasteners are sufficient. Connectors and fasteners used for any preservative protective treatment installed since 1980 (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 COT/BZ, hot-dipped galvanized connectors and fasteners may be used.

4. 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, termite, etc.). See Note 4 for special precautions which may be required at newer preservative treated foundation sill and other floor framing.

5. The Owner or Contractor shall verify that the existing concrete walls at all areas to receive new anchor bolts are in reasonably good condition. Existence of poor concrete quality would include excessive spalling, large rock pockets, cracks extending completely through the footing greater than 1/4", wide, excessive efflorescence, or the strength concrete cement or mortar easily scrapable with a metal knife or trowel. Strengthening should be avoided in local areas of poor quality. Where these areas cannot be avoided, or where locations of poor quality are widespread, the new anchors should be tested in accordance with Table H-1, Note C.1.

6. All existing under floor ventilation shall be maintained.

7. 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:
   a. one anchor bolt or connector at each end,
   b. 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.

8. 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 plate. Plate washer shall be galvanized per ASTM 153.

9. 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 plate. Plate washer shall be galvanized per ASTM 153.

10. Anchors or connectors outside of required length of strengthening shall be spaced 6" on center minimum along perimeter foundations. Properly seated or connectors where existing anchorage does not exist or does not meet this requirement.

A. GENERAL

B. DESIGN BASIS

C. FOUNDATION CONNECTIONS

1. See Sheet D1 for required connection details.

2. 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:
   a. one anchor bolt or connector at each end,
   b. 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.

3. 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.

4. 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 plate. Plate washer shall be galvanized per ASTM 153.

5. New foundation sill bolts shall have a 3" x 3" x 0.229" plate washer installed between the foundation sill (or blocking) and the plate. Plate washer shall be galvanized per ASTM 153.

6. New foundation sill bolts shall have a 3" x 3" x 0.229" plate washer installed between the foundation sill (or blocking) and the plate. Plate washer shall be galvanized per ASTM 153.

D. FLOOR TO CRIppLE WALL, or FLOOR TO FOUNDATION SILL CONNECTION

1. See Sheets D2 and D3 for required connection details.

2. New connectors required by the Earthquake Strengthening Schedule (Detail 2/S3) 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 those areas along the same wall line.

4. Any deteriorated material that is repaired or replaced shall comply with the requirements of this document. Necessary repairs should be done in accordance with the requirements of this document, and in accordance with the requirements of this document.

5. Predrill sills and ledgers 1/16" larger than anchor diameter to prevent bending and splitting.

6. 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.

7. Where an existing continuous rim joist, end joist, or solid blocking joint. See Detail 2/D7.

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. 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.

10. Anchors or connectors outside of required length of strengthening shall be spaced 6" on center minimum along perimeter foundations. Properly seated or connectors where existing anchorage does not exist or does not meet this requirement.
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 2/5/S). Tie-downs and tie-downs must be used.

2. Where "With Tie-down" (as specified on the Earthquake Strengthening Schedule, Detail 2/5/S) 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 foundation system is required 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.

The quality of the existing foundation system is required 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.

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 18" 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 ADS1572, 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" (A36) threaded rod adhesive-type anchors with minimum embedment per Detail 1/D4.

Table H-1: Verification of Existing Foundation System

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<th>Requirement</th>
<th>Yes or N/A</th>
<th>Signature of Owner or Contractor</th>
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<tbody>
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<td>A.1 The size of the existing foundation is greater than or equal to that specified in Section H, Item 2.</td>
<td>Signature</td>
<td>Owner performing work</td>
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<tr>
<td>B.1 The existing foundation has generally been verified to be in good condition at locations where strengthening was done.</td>
<td>Signature</td>
<td></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 3a. and</td>
<td>Signature</td>
<td></td>
</tr>
<tr>
<td>The quality of the existing foundation is in reasonable 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.</td>
<td>Signature</td>
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Table H-2: Foundation Testing Requirements

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<tr>
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APPLICANT INFORMATION

APPLICANT:

ADDRESS:

PHONE:

PROPERTY ADDRESS:

OWNER:

OWNER'S SIGNATURE

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings

FEMA Plan Set

APRIL 2015

Supplemental Technical Notes
**Construction Data and Earthquake Strengthening Schedule**

**Notes:**
- Length of the wall without tie downs specified in this KIC Metals RFA86/88
- Anchor bolts and Connectors shown in schedule are MANUFACTURER MODEL MANUFACTURER MODEL MANUFACTURER MODEL
- Plywood braced panel may be omitted where cripple wall makes the use of Types "D" or "E" impractical.
- If joists are blocked on both sides and where accessibility existing foundation is suitable and meets criteria.
- Therefore, where possible, longer lengths of uncertainty when dealing with existing foundations, of strengthening where possible. Additional anchors and

### EARTHQUAKE STRENGTHENING SCHEDULE

<table>
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<tr>
<th>Area in Total Floor CONSTRUCTION INFORMATION</th>
<th>MINIMUM TOTAL REQUIRED LENGTH OF STRENGTHENING</th>
<th>FOUNDATION SILL ANCHORAGE</th>
<th>FLOOR TO CRIPPLE WALL</th>
<th>NOTES</th>
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<th>THREE-STORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONE-STORY</td>
<td>TWO-STORY</td>
<td>THREE-STORY</td>
</tr>
</tbody>
</table>

**CONSTRUCTION DATA**

1. **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 down to, but not less than the values listed in the Total Floor Area column of the Earthquake Strengthening Schedule.

2. **CONSTRUCTION DATA**
   - Construction Data and Earthquake Strengthening Schedule

3. **PREPARED BY**
   - S3 Engineering

4. **DATE**
   - APRIL 2015

5. **APPENDIX**
   - FEMA Plan Set

### EARTHQUAKE STRENGTHENING SCHEDULE

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>CONNECTORS</th>
<th>MANUFACTURER</th>
<th>CONNECTORS</th>
<th>TIE-DOWNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simpson Strong-Tie</td>
<td>TYPE A</td>
<td>USP Structural Connectors</td>
<td>PHD150</td>
<td></td>
</tr>
<tr>
<td>Type &quot;A&quot;</td>
<td>Diameter 5/8&quot;</td>
<td>Type &quot;A&quot;</td>
<td>Diameter 5/8&quot;</td>
<td></td>
</tr>
<tr>
<td>Type &quot;B&quot;</td>
<td>Diameter 1/2&quot;</td>
<td>Type &quot;B&quot;</td>
<td>Diameter 1/2&quot;</td>
<td></td>
</tr>
<tr>
<td>Type &quot;C&quot;</td>
<td>Diameter 3/4&quot;</td>
<td>Type &quot;C&quot;</td>
<td>Diameter 3/4&quot;</td>
<td></td>
</tr>
<tr>
<td>Type &quot;D&quot;</td>
<td>Diameter 1&quot;</td>
<td>Type &quot;D&quot;</td>
<td>Diameter 1&quot;</td>
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<tr>
<td>Type &quot;E&quot;</td>
<td>Diameter 1-1/4&quot;</td>
<td>Type &quot;E&quot;</td>
<td>Diameter 1-1/4&quot;</td>
<td></td>
</tr>
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**ANCHOR BOLTS**

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>SCHEDULED DEPT/Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simpson Strong-Tie</td>
<td>3/16&quot;</td>
</tr>
<tr>
<td>KC Metals</td>
<td>3/16&quot;</td>
</tr>
<tr>
<td>USP Structural Connectors</td>
<td>3/16&quot;</td>
</tr>
</tbody>
</table>

**HEAVY CONSTRUCTION**

- Includes any of the following:
  - Steel Frame and Concrete wall
  - Wood-Frame dwellings

**LIGHT CONSTRUCTION**

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

**DEFINITIONS**

- "HEAVY" OR "LIGHT" CONSTRUCTION
  - New Mudsill Anchorage used: (check all that apply)
NEW BLOCKING INSTALLATION

ANCHOR THROUGH FOUNDATION SILL ONLY

ANCHOR THROUGH BLOCKING AND FOUNDATION SILL

FOUNDATION SILL CONNECTORS

<table>
<thead>
<tr>
<th>MATERIAL KEY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
</tr>
<tr>
<td>Bolt</td>
</tr>
<tr>
<td>Block (Connectors attached directly to framing)</td>
</tr>
<tr>
<td>1/4&quot; x 3-1/2&quot; long sinkers</td>
</tr>
<tr>
<td>1/4&quot; x 4&quot; long common</td>
</tr>
<tr>
<td>Screws</td>
</tr>
<tr>
<td>1/4&quot; x 6&quot; long common</td>
</tr>
<tr>
<td>Plywood (Plywood braced panel)</td>
</tr>
<tr>
<td>Plate Washer</td>
</tr>
<tr>
<td>Metal Roof &amp; Siding</td>
</tr>
<tr>
<td>Flashing Tape</td>
</tr>
</tbody>
</table>

**Foundation Sill to Concrete Foundation Connection Details**

- **NEW BLOCKING INSTALLATION**
  - **Align** (E) Foundation sill
  - **FRONT VIEW**
  - **TOP VIEW**
  - **SIDE VIEW**
  - **2-1/2" max.**
  - **5/8" x 1-1/2" sinkers**
  - **2-1/2" max.**
  - **8" max.**

- **ANCHOR THROUGH FOUNDATION SILL ONLY**
  - **2-1/2" max.**
  - **N Plywood braced panel, where required** See Detail 2/53
  - **N Connector Type "A"**
  - **N Foundation sill anchor bolt and plate washer** See Earthquake Strengthening Schedule (Detail 2/53)
  - **N Cripple stud**
  - **N Joint in foundation sill**

- **ANCHOR THROUGH BLOCKING AND FOUNDATION SILL**
  - **2-1/2" max.**
  - **N Plywood braced panel, where required** See Detail 2/53
  - **N 2x blocking See Detail 3/01**
  - **N Foundation sill**
  - **N Joint in foundation sill**
  - **N Concrete foundation** (shape may vary)

- **FOUNDATION SILL CONNECTORS**
  - **Detail used where cripple wall studs are too short to allow drilling for new anchor bolts.**
  - **N Connector Type "A"**
  - **N Joint in foundation sill**
  - **N Concrete foundation** (shape may vary)

**NOTE:**
- **Where "x" = 2-1/2"**, use Connector Type "B" per Detail 3/02
Floor Framing to Foundation Sill Connection Details
Floor Framing to Cripple Wall Connection Details
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.

TYPICAL TIE-DOWN INSTALLATION

Plywood Installation at Plywood Braced Panels with Tie-Downs

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails</td>
<td>8d (8 penny) 0.131&quot; x 2-1/2&quot; long common</td>
</tr>
<tr>
<td></td>
<td>8d (at Connectors attached over plywood)</td>
</tr>
<tr>
<td></td>
<td>8d (at Connectors attached directly to framing)</td>
</tr>
<tr>
<td></td>
<td>10d (10 penny) 0.148&quot; x 3&quot; long common</td>
</tr>
<tr>
<td></td>
<td>10d (at Connectors attached over plywood)</td>
</tr>
<tr>
<td>Screws</td>
<td>Simpson Strong-Tie 1/4&quot; SDS, USP Mitek 1/4&quot; WS &quot;Gold Coat&quot;, or equivalent.</td>
</tr>
<tr>
<td></td>
<td>3&quot; screw 3&quot; long structural wood screw</td>
</tr>
<tr>
<td></td>
<td>4&quot; screw 4&quot; long structural wood screw</td>
</tr>
<tr>
<td></td>
<td>6&quot; screw 6&quot; long structural wood screw</td>
</tr>
<tr>
<td>Plywood</td>
<td>15/32&quot; Structural I, Exposure 1, S-Ply.</td>
</tr>
<tr>
<td></td>
<td>LVL (Laminated Veneer Lumber) Boise-Cascade &quot;VersaLam&quot;, Georgia-Pacific &quot;GP-Lam&quot;, LP &quot;Solid Start&quot;, or equivalent.</td>
</tr>
<tr>
<td></td>
<td>Plywood Installation at Plywood Braced Panels with Tie-Downs</td>
</tr>
<tr>
<td></td>
<td>Plate Washer 4&quot; x 3&quot; square x 0.25&quot; thick.</td>
</tr>
<tr>
<td></td>
<td>Peel &amp; Stick Flashing Tape Fortiflash, Orange Peel-n-Seal, Typar, Tyvek, Vycor, handiWrap. or equivalent.</td>
</tr>
</tbody>
</table>

For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).
Plywood Installation at Plywood Braced Panels without Tie-Downs

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**

- Joint at abutting plywood braced panels (1/8" gap between plywood sheets)
- (E) 2x4 or wider cripple stud where (E) stud is less than 1-3/4" wide
- Fasten to existing stud with two 16d nails at 8" on center
- (E) Cripple wall top plate(s)
- (N) Plywood braced panel
- Fasten with 8d nails at 4" on center at all plywood edges and 12" on center at intermediate supports
- (N) 2-1/2" to 3" diameter vent holes at each bay
- Place each hole over (N) foundation sill anchor bolt for inspection
- (N) Foundation sill anchor bolt (shape may vary)

**FOUNDATION SILL WIDER THAN CRIPPLE WALL**

- Joint at abutting plywood braced panels (1/8" gap between plywood sheets)
- (E) 2x4 or wider cripple stud where (E) stud is less than 1-3/4" wide
- Fasten to existing stud with two 16d nails at 8" on center
- (E) Cripple wall top plate(s)
- (N) Plywood braced panel
- Fasten with 8d nails at 4" on center at all plywood edges and 12" on center at intermediate supports
- (N) 2-1/2" to 3" diameter vent holes at each bay
- Place each hole over (N) foundation sill anchor bolt for inspection
- (N) Foundation sill anchor bolt (shape may vary)

**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.

**Material Key:**

- **Nails:**
  - SS (8 penny) 0.131" x 2-1/2" long common
  - SS (at Connectors) attached over plywood
- **Plywood:**
  - (E) Cripple wall to cripple wall connections.
- **Framing:**
  - (E) Floor joist
  - (N) Vent hole
  - (N) Foundation sill
  - (E) Concrete foundation

**Property Address:**

---

Earthquake Strengthening of Wood-Frame Dwellings

FEMA Plan Set

APRIL 2015

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**MATERIAL KEY:**

- **Nails:**
  - SS (8 penny) 0.131" x 2-1/2" long common
  - SS (at Connectors) attached over plywood
- **Plywood:**
  - (E) Cripple wall to cripple wall connections.
- **Framing:**
  - (E) Floor joist
  - (N) Vent hole
  - (N) Foundation sill
  - (E) Concrete foundation

**Property Address:**
Cripple Walls in Wood-Frame Dwellings

FEMA Plan Set

SECTION

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.

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:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nails</td>
<td>8d (8 penny) 0.131&quot; x 2-1/2&quot; long common</td>
</tr>
<tr>
<td></td>
<td>8d (at Connectors attached over plywood)</td>
</tr>
<tr>
<td></td>
<td>8d (at Connectors attached directly to framing)</td>
</tr>
<tr>
<td></td>
<td>10d (10 penny) 0.148&quot; x 3&quot; long common</td>
</tr>
<tr>
<td></td>
<td>10d (at Connectors attached over plywood)</td>
</tr>
<tr>
<td></td>
<td>10d (at Connectors attached directly to framing)</td>
</tr>
<tr>
<td>Screws</td>
<td>Simpson Strong-Tie 1/4&quot; SDS, GRK 3/8&quot; RSS &quot;Climatek&quot;, USP Mitek 1/4&quot; WS &quot;Gold Coat&quot;, or equivalent.</td>
</tr>
<tr>
<td></td>
<td>3&quot; screw 3&quot; long structural wood screw</td>
</tr>
<tr>
<td></td>
<td>4&quot; screw 4&quot; long structural wood screw</td>
</tr>
<tr>
<td></td>
<td>6&quot; screw 6&quot; long structural wood screw</td>
</tr>
<tr>
<td>Plywood</td>
<td>15/32&quot; Structural I, Exposure 1, 5-Ply.</td>
</tr>
<tr>
<td></td>
<td>Two-story LP &quot;Solid Start&quot;, or equivalent.</td>
</tr>
<tr>
<td>Plate Washer</td>
<td>4 x 3&quot; square x 0.229&quot; thick.</td>
</tr>
<tr>
<td>Peel &amp; Stick Flashing Tape</td>
<td>Fortiflash, Orange Peel-n-Seal, Typar, Tyvek, Vycor, HandiWrap, or equivalent.</td>
</tr>
</tbody>
</table>

Foundation Replacement Details
Where (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.

Opening for vent, flood vent openings, utility blockouts, etc.

1-1/4" to 1-1/2" radius cut, typ.

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.

Notes:
- Floor framing not shown for clarity.
- For Connector types see Earthquake Strengthening Schedule and "Connectors" table (Detail 2/S3).

Notes:
- Floor framing not shown for clarity.

Notes:
- Floor framing not shown for clarity.

Notes:
- Floor framing not shown for clarity.

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- Floor framing not shown for clarity.

Notes:
- Floor framing not shown for clarity.

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- Floor framing not shown for clarity.

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- Floor framing not shown for clarity.

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- Floor framing not shown for clarity.

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- Floor framing not shown for clarity.

Notes:
- Floor framing not shown for clarity.
Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings
FEMA Plan Set

EXAMPLE OF CALCULATING TOTAL STRENGTHENING REQUIREMENTS

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 example chooses to use 1/2" Anchor Bolts and Type "V" Connectors; to determine lengths and quantities.

Wall Line (18'-0" + 20'-0") = 38'-0"

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

Plywood strengthening length must be at least the greater of two times the maximum cripple wall height of 24" or 4'-0" for each section along this wall line.

Example calculation:

a = 20'-0" (Provided 9'-4" + 10'-8" > 20'-0")
b = 20'-0" (Provided 9'-4" + 10'-8" > 20'-0")
c = 20'-0" (Provided 9'-4" + 10'-8" > 20'-0")
d = 20'-0" (Provided 9'-4" + 10'-8" > 20'-0")

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

Detail identifiers may be shown once per wall line except where existing conditions vary and a different detail is used.

Section identifiers showing all plan details associated with each section of the cripple wall line being strengthened.

Detail and sheet numbers will vary based on your conditions.

EXAMPLE OF NOTATION FOR SUBMITTAL TO BUILDING DEPARTMENT

Details shown per wall line. Label the front side of home (street side).

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This sheet is for information and reference only. Do not submit to the Authority Having Jurisdiction.
This example chooses to use 5/8"ø Anchor Bolts, and Type "E" Connectors, to determine lengths and quantities.

- Wall line = 26'-0"  
  - Maximum cripple wall height: 5'-6"
  - Min. required length of strengthening with tie-downs = 21'-4"  
  - (Provided 10'-8" + 10'-8" = 21'-4")
- Wall line = 26'-0"  
  - Maximum cripple wall height = 6'-0"
  - Min. required length of strengthening without tie-downs = 33'-4" on each wall line without tie-downs and 21'-4" for wall lines with tie-downs.

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 plywood braced panels, anchors, and connectors.

MINIMUM REQUIRED LENGTH OF STRENGTHENING USING PLYWOOD BRACED PANELS, ANCHORS, AND CONNECTORS

Wall line = 26'-0"  
- Maximum cripple wall height: 5'-6"
  - Min. required length of strengthening with tie-downs = 21'-4"  
  - (Provided 10'-8" + 10'-8" = 21'-4")

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

Notes:
1. This sheet is for instruction and reference only. Do not submit to the Authority Having Jurisdiction.
2. Plywood braced panels: New plywood installed to a length of cripple wall to provide strengthening.
3. Strengthening: Foundation and/or cripple wall work intended to yield improved performance during an earthquake.
4. Wall line: All wall segments forming the overall building dimension on one side.

Refer to Sheet 00 for additional instructions.
Example - Cripple Wall Strengthening

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.
Required length of strengthening
See Earthquake Strengthening Schedule (Detail 2/S3)

Condition where (E) joist is too close to allow access to mudsill

(E) Rim joist

(N) Connector where minimum number cannot be achieved within the required length of strengthening

(E) Foundation sill

(N) Connector where minimum number cannot be achieved within the required length of strengthening

(N) Connector Type "D" or "E"
See Detail 1/D2

5

Condition where (E) joist is too close to allow access to mudsill

(E) Floor joist

(E) Rim joist or (E) blocking

(N) Connector Type "G"
See Detail 5/D2

(E) Concrete foundation

(N) Anchor bolt
See Detail 5/D2

(N) Ledger
See Detail 5/D2

8" min. and 12" max. edge distance to centerline of bolt

(N) Connector "A", "B", or "C"
See Detail 4/D1

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