



## Seismic Retrofit Guide

Improve Your Home's Earthquake Resistance



## PLEASE READ

**Purpose of this document:** This Seismic Retrofit Guide is designed to promote public safety and welfare by reducing the risk of earthquake induced damage to existing homes. The following guidelines are prescriptive minimum standards based on the 2006 International Existing Building Code and are intended to improve the seismic performance of homes, but will not necessarily prevent earthquake damage. These guidelines only apply to homes with crawl spaces and cripple walls. They address reinforcing the cripple wall, but not the stories above. For conditions other than those shown in the following drawings, a structural engineer or other qualified designer should be consulted. Before starting any work, check with your building department for local building requirements, which may include stricter standards than those prescribed here.

The information in this guide is intended to show how Simpson Strong-Tie products should be installed. It is not intended for use by designers. Designers should refer to the current Simpson *Wood Construction Connectors* catalog for loads and other critical design information.

# Why Should I Retrofit My Home?

**D**uring an earthquake, the strength of a home is put to the test. Ground forces try to tear the home apart and in many cases, cause severe damage. If you live in an area prone to earthquakes, it's important that the structural frame of your home is strong enough to absorb an earthquake's energy (see Continuous Load Path, page 4). Fortunately, advances in structural engineering, lessons learned from past earthquakes and research performed by the scientific community have paved the way for the development of new construction techniques that better equip homes to withstand an earthquake. Local and regional building codes now require all new homes to meet these higher construction and safety standards.

Since many existing homes were constructed prior to the development of these newer code requirements, a retrofit may be necessary to increase structural safety. A retrofit adds bracing and reinforcement to strengthen the critical connections within a home. A home that has been retrofitted is able to resist much greater earthquake forces and has a lower risk of being damaged.

Upgrading a home to the latest building code standards, however, is not always practical for most older homes. This type of upgrade would require the homeowner to hire a licensed structural engineer and a specialty contractor to perform a detailed structural evaluation. This evaluation would include the removal of many finish materials, such as sheetrock, stucco, siding, etc., to examine the construction of the home.

Fortunately, there are less intrusive ways to retrofit older homes and improve their structural safety and performance during an earthquake. Simpson Strong-Tie is the leader in structural product solutions that increase the strength and safety of homes. Our products are used to connect and secure the structural frame of a house.

In 2003, Simpson opened a research laboratory to better understand how earthquakes, high winds and other natural disasters affect building performance. The lab's state-of-the-art testing equipment can recreate the magnitude of such earthquakes as the 1989 Loma Prieta quake in California, which measured 6.9 on the Richter



scale. The testing and research being conducted is helping to advance product development and improve building design and safety.

Simpson Strong-Tie is committed to helping homeowners understand how to strengthen their homes for earthquakes and other natural disasters. This guide is designed to help you understand the basic principles of a home retrofit and provide step-by-step instruction on ways to strengthen your home for the next big earthquake.

## Reasons to Retrofit:

- Your home will have a better chance of surviving the next big earthquake and with less property damage and loss of life.
- Retrofitting your home may lower earthquake insurance premiums and deductibles.
- Strengthening your home can add resale value.

***A home that has been retrofitted is able to resist much greater earthquake forces and has a lower risk of being damaged.***

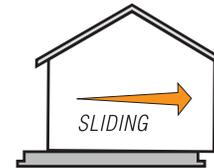
# Earthquake Basics

Before you begin a retrofit project, it's important that you are familiar with the basic principles of home construction and how earthquakes impact your home.

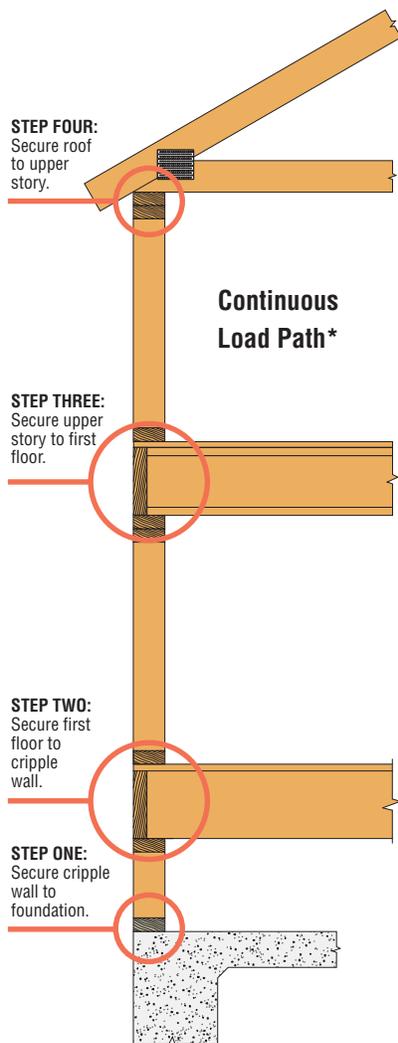
## Earthquake Basics: Lateral and Uplift Forces

During an earthquake, a home experiences two types of forces: lateral forces and uplift forces. Lateral (or shear) forces are horizontal forces that result in back and forth (side to side) movement, also known as racking. Lateral forces can shake the house and weaken its frame and cause it to slide off the foundation. Uplift forces are vertical forces that result in up and down movement. Uplift forces can cause the house to overturn and lift off the foundation.

Using a continuous load path throughout the home strengthens the entire structure and helps it to resist lateral and uplift forces.



**How Earthquake Forces Affect A Home**



## Earthquake Basics: Continuous Load Path

Building codes now require homes to meet higher structural design standards, including the use of a “continuous load path.” This method of construction involves creating a series of solid connections throughout the home. These connections are created by using a system of wood framing, metal connectors, fasteners (like nails and screws) and shearwalls.

These connections are critical during an earthquake. A continuous load path redistributes external forces from an earthquake by transferring these forces from the frame of the house to the foundation. A home is more likely to withstand an earthquake and stay intact when each part of the house is connected together.

In general, houses built within the last 20 years, should have been constructed with a continuous load path. To verify this, you can hire a professional contractor or structural engineer to perform a structural evaluation on your house. When hiring a design professional, you want to make sure they are licensed and have a good reputation. You should ask for references and check with the Better Business Bureau.

*\*Note: This Seismic Retrofit Guide does not attempt to create a continuous load path within a home, but provides practical solutions to reinforce your home.*

# Do I Need to Retrofit My Home?

There are certain types of homes that are more likely to need a retrofit than others. A quick analysis of your home can help determine if your home fits that criteria.

## 1. Am I living in an area prone to earthquakes?

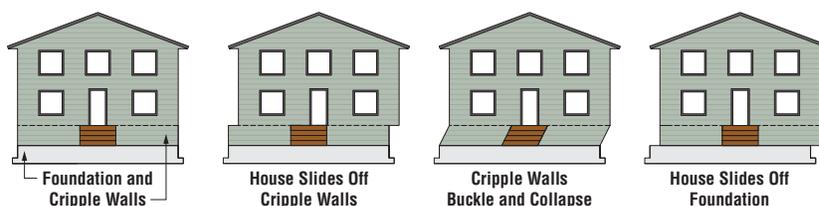
There are geographic areas that are considered high seismic regions. These seismic areas are based on the likelihood of an earthquake occurring and its severity. The easiest way to find out if you are living in a high seismic area is to call your local building department and ask if you are in Seismic Zone 3 or 4 (for California residents) or Seismic Design Category D, E or F. These designations are assigned to regions with high seismic potential.

## 2. Was my home built within the last 20 years?

As a general rule of thumb, homes built within the last 20 years were designed to conform to stricter building codes and will be better equipped to resist the force of an earthquake. Homes built prior to that timeframe are typically more vulnerable to earthquake damage.

## 3. Is my home built on a raised foundation?

If your house is not built directly on a concrete slab, chances are it's built on a raised foundation. This means the home was built on a system of posts, beams and "cripple walls" (cripple walls are short wood-framed walls running underneath and around the perimeter of the house). These homes typically have crawl spaces underneath them. They are susceptible to damage because the supporting structure under the house may not have been built to resist seismic forces and thus is considered a weak area. Past earthquakes have shown these areas are highly susceptible to structural failures as shown in the illustration below.



## 4. Is my home built on a hillside?

Homes built on a hillside typically have raised foundations and crawl spaces as those described above and can experience similar failures. However, these failures tend to be more severe because the posts and cripple walls supporting the home are built at different heights due to the uneven terrain.

## 5. Is there living space above my garage?

Garages are vulnerable areas in a house due to the large garage door opening. Because of this large opening, the narrow walls on either side of the garage door must be designed to resist earthquake forces. This is extremely important if there is a living space above the garage because these rooms add weight that the garage must support. Current building codes require that these narrow walls be specially designed to resist earthquake forces. Older homes, however, typically did not address this issue and are more vulnerable to damage during an earthquake as shown in the illustration.

**If you live in an older home with a living space above the garage or on a hillside, you'll need to consult with a licensed structural engineer for design solutions.**



# Conduct Your Own Survey

Once you have identified that there is a potential need to retrofit your home, you should then conduct your own inspection and evaluate the structural integrity of your home. Hiring a professional to help with this evaluation is recommended, but not required. Since home retrofits are not mandatory, building departments typically do not require the use of an engineer, architect or a licensed contractor as long as the home falls within certain prescriptive parameters (Note: you should contact your building department to make sure there are no special requirements). The building code does provide construction details for retrofitting the supporting perimeter walls of the crawl space. With the right tools, a motivated homeowner can do this themselves. However, before getting out the hammer and nails, you must access your crawl space and evaluate the following items:

1. Is the top of the crawl space perimeter wall properly attached to the floor system?
2. Are the crawl space perimeter walls too tall?
3. Are the interior columns attached properly to the beams they are supporting?
4. Are the bottom plates of the crawl space perimeter walls properly attached to the foundation?
5. Are the crawl space perimeter walls reinforced with plywood or oriented strand board (OSB) panels?

*Note: It's important when you evaluate your crawl space to check existing lumber and new wood framing materials for decay and rot. When wood is exposed to moisture, it can rot and possibly weaken the wood structure. If you suspect wood decay, you'll need to contact a licensed structural engineer and/or contractor for design solutions.*

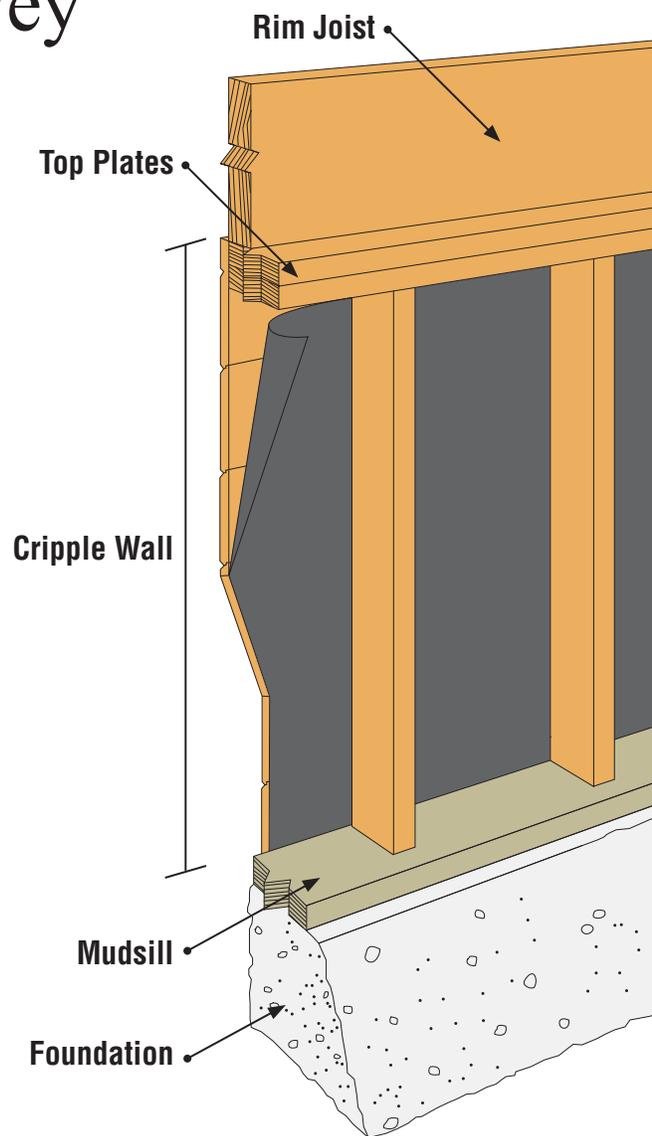
## 1. Is the top of the crawl space perimeter wall properly attached to the floor system?

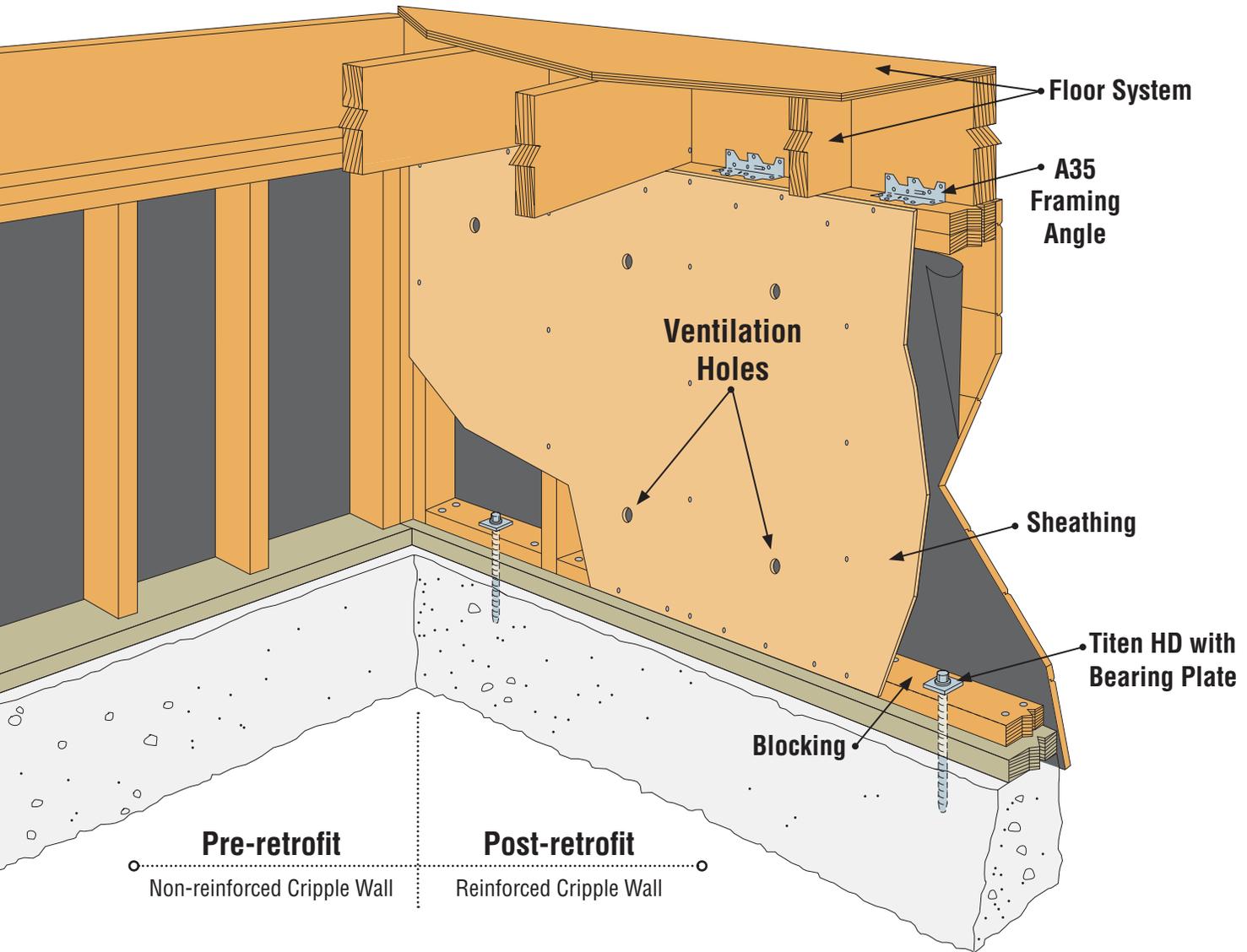
On top of the crawl space wall rests the floor system. Around the outside of the floor system and the perimeter wall system is what is known as the rim joist. The rim joist should be attached to the top of the wall with metal connectors. The connectors should be located approximately 16 inches on center.

## 2. Are the crawl space perimeter walls too tall?

In order to use this retrofit guide, the perimeter walls of your home must not be too tall. To determine this, you need to measure the distance from the top of the concrete foundation to the top of the perimeter wall (or the bottom of the floor system). In certain cases, an engineer must design your retrofit solution, these include:

- If your home is one or two stories and the perimeter wall height is greater than 4 feet at any point
- If your home is three stories and the perimeter wall height at any point is greater than 14 inches
- If your home is more than three stories





**3. Are the interior columns attached properly to the beams they are supporting?**

Often there are interior columns supporting the floor system (not shown above, see page 16). The tops of these columns should be attached to the floor beams with a metal connector.

**4. Are the bottom plates of the crawl space perimeter walls properly attached to the foundation?**

Building codes require that 5/8-inch diameter anchor bolts should be placed at certain locations to prevent the home from sliding off of the foundation. According to the code, anchor bolts must be located within 12 inches from the end of each plate line and no more than 6 feet on center for one and two-story homes. The bolts should have a bearing plate between the top of the sill plate and the nut. The bolts should be undamaged and rust-free.

**5. Are the crawl space perimeter walls reinforced with plywood or OSB panels?**

Perimeters walls must be reinforced to prevent the house from falling over during an earthquake. This is typically done by installing plywood or OSB sheathing panels on the outside of the walls. Older homes often did not use this type of sheathing. Instead siding boards were used, but not attached to prevent failures. The building codes recommend the installation of 1/2-inch plywood or OSB panels to the inside face of the walls in strategic locations to strengthen the perimeter walls.

# I Know I Need to Retrofit My Home, How Do I Get Started?

Now that you have identified the areas of your home that may need reinforcing, this next section addresses how you can do the work yourself.

Before you begin your retrofit project, you'll need to determine whether or not your home has cripple walls. Cripple walls are the short wood-framed walls running underneath and around the perimeter of your house. These walls are constructed on top of the foundation and are generally 12 to 30 inches high, but can be as high as 12 feet when located on a hillside.

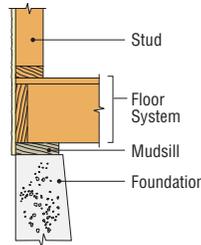
Start by answering the following questions:

- Does your house have a cripple wall between the foundation and floor framing?
- If your house has a cripple wall, how tall is it?
- If your house has a cripple wall, is the mudsill wider than the studs?

Based on your answers, you can then follow one of the retrofit scenarios listed below. Please see the page numbers referenced under each step for specific how-to instructions.

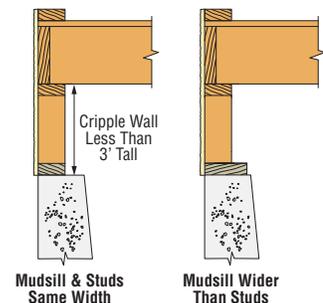
## NO CRIPPLE WALL

Step 1	Step 2	Step 3
Install UFP Foundation Plates Page 11	Install A35 Shear Angles Page 15	Install AC Post Caps Page 16



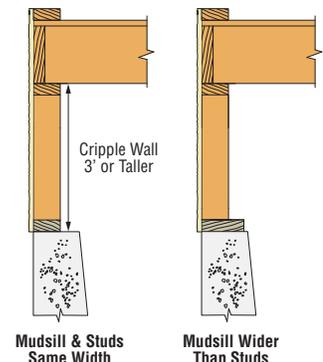
## CRIPPLE WALL LESS THAN 3 ft TALL

Cripple Wall Height	Step 1	Step 2	Step 3	Step 4	Step 5
Mudsill & Studs Same Width	Install Sheathing Page 13	Install UFPs Page 11	Install A35 Shear Angles Page 15	Install AC Post Caps Page 16	—
Mudsill Wider Than Studs	Install Blocking Page 12	Install Sheathing Page 13	Install UFPs Page 11	Install A35 Shear Angles Page 15	Install AC Post Caps Page 16



## CRIPPLE WALL 3 ft TO 4 ft TALL

Cripple Wall Height	Step 1	Step 2	Step 3	Step 4	Step 5
Mudsill & Studs Same Width	Install Titen HDs & BPs Page 10	Install Sheathing Page 13	Install A35 Shear Angles Page 15	Install AC Post Caps Page 16	—
Mudsill Wider Than Studs	Install Blocking Page 12	Install Titen HDs & BPs Page 10	Install Sheathing Page 13	Install A35 Shear Angles Page 15	Install AC Post Caps Page 16

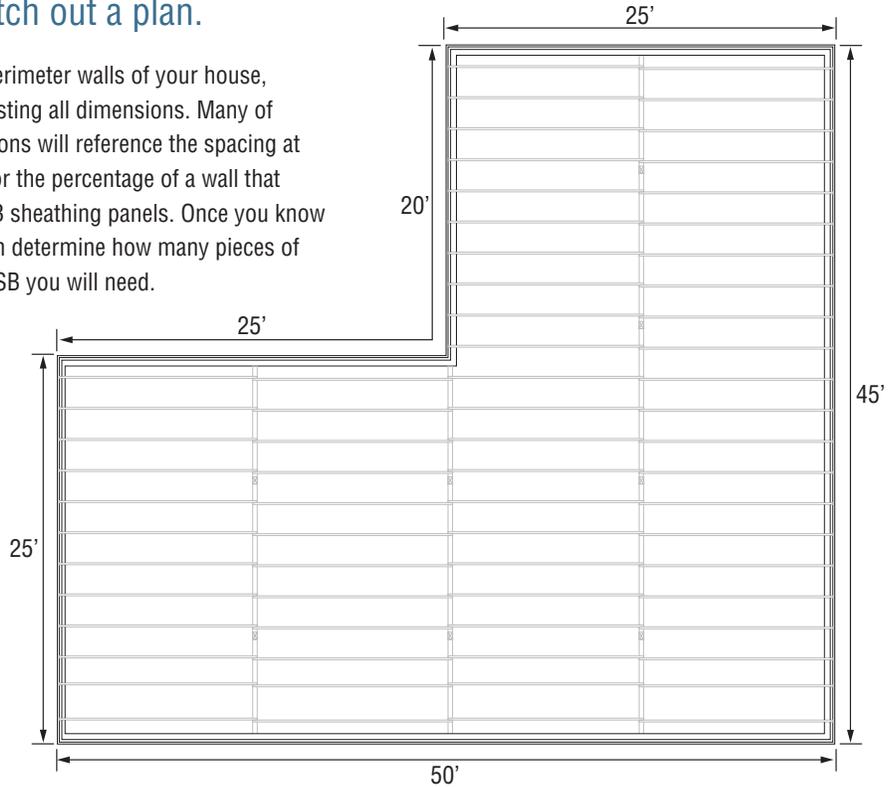


Note: If your cripple wall is taller than 4 ft., please contact an engineer.

# Sketch A Plan

Once you've determined the steps to take, next you'll need to sketch out a plan.

Start by making an outline of the perimeter walls of your house, showing where the studs are and listing all dimensions. Many of the directions in the following sections will reference the spacing at which hardware must be installed or the percentage of a wall that must be covered with plywood/OSB sheathing panels. Once you know the dimensions of the walls you can determine how many pieces of hardware or how much plywood/OSB you will need.



**Palm Nailer**



**Rotohammer Drill**



## Tools Needed for Retrofitting

Tool	Purpose
Measuring Tape	Measuring walls, spacing, lumber
Circular Saw	Cutting plywood and 2x lumber
Rotohammer Drill	Drilling into concrete
Carbide Tipped Drill Bits (1/2" & 5/8" diameter)	For use with rotohammer (bit must share compatible shank type with rotohammer)
Socket Wrench or Impact Wrench with 15/16" Socket	Installing Titen HDs
Drill with 3/8" driver attachment	Driving SDS screws for UFP installation
Hammer	Installing A35 angles in areas with clearance
Hammer or Nail Gun	Nailing off sheathing and installing blocking
Palm Nailer (optional)	Installing nails in sheathing or A35 angles and blocking in areas with little vertical clearance
Air Compressor	Required for nail gun or palm nailer, also handy for cleaning dust out of holes for Titen HD
Chalk Line	Marking nail lines on sheathing
3" Hole Saw Drill Bit	Drilling ventilation holes in sheathing

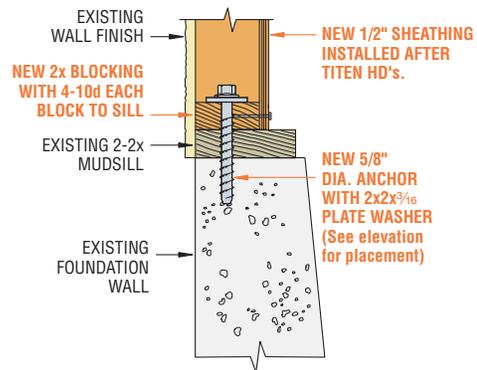
*Note: Tools such as rotohammers and air compressors are commonly available at tool rental centers. For an explanation of technical terms and symbols, please reference the glossary on pages 17 and 18.*

# Installing the Titen HD to Anchor the Mudsill

The Titen HD is a screw anchor that is used to anchor the mudsill to the foundation. It's easy to install with just a few tools.

## Installation Details

- Anchor diameter:  $\frac{5}{8}$  in.
- Drilled hole depth: See table for embedment depth
- Anchor length: This will be determined by the thickness of the mudsill. See table.
- Anchor spacing: 6 ft. on center (o.c.) for one and two-story homes
- Washer: A 2 in. by 2 in. by  $\frac{3}{16}$  in. thick steel plate washer (sold separately) is required in seismic areas (Simpson Bearing Plate model BP $\frac{5}{8}$ -2 fulfills this requirement.)

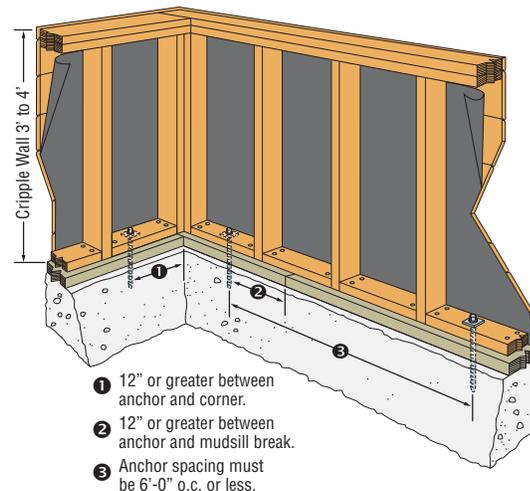


**Anchoring Mudsill to Foundation with Titen HD**

**Table 1 | Determining Titen HD Length**

Mudsill Thickness <sup>1</sup> (in)	Hole Depth in Foundation <sup>2</sup> (in)	Titen HD Model No. (Size)
1½	5	THD62600H (5/8" x 6")
2	4½	THD62600H (5/8" x 6")
2½	4½	THD62612H (5/8" x 6½")
3	5½	THD62800H (5/8" x 8")
3½	5	THD62800H (5/8" x 8")

Note: 1. Mudsill may be single thickness or double if blocking is required for sheathing purposes.  
2. Minimum required embedment for the Titen HD in this application is 3¾". Hole depths above have been adjusted for available anchor sizes.



- 1 12" or greater between anchor and corner.
- 2 12" or greater between anchor and mudsill break.
- 3 Anchor spacing must be 6'-0" o.c. or less.

## Instructions

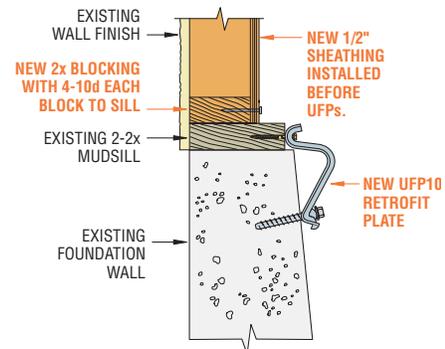
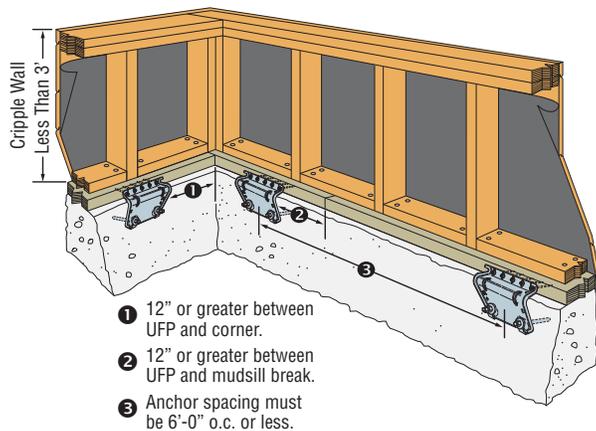
1. Starting at each corner of the foundation, mark where each anchor will be installed. Make the first mark 12 inches from the corner (end of the mudsill). From that point, measure and mark for each anchor every 6 feet, with no anchor being further than 12 inches from the break between two pieces of mudsill. If you need to adjust this spacing to account for a break in the mudsill or corner, reduce the spacing between anchors.
2. Using a rotohammer drill (with a  $\frac{5}{8}$ " diameter bit) drill down through the center of the mudsill (or mudsill and blocking) into the top of the concrete foundation to the appropriate embedment depth shown in Table 1. (Note: Embedment is the depth of the hole from the top of the concrete, not the top of the mudsill.)
3. Clean the concrete dust from the hole using compressed air.
4. Insert the Titen HD into the hole, with the square washer in place, and drive the anchor into the hole using a socket wrench with a  $\frac{15}{16}$ " socket. Drive the anchor until it and the plate washer are snug against the mudsill.
5. Repeat around the perimeter of the foundation.

# Installing the Universal Foundation Plate (UFP)

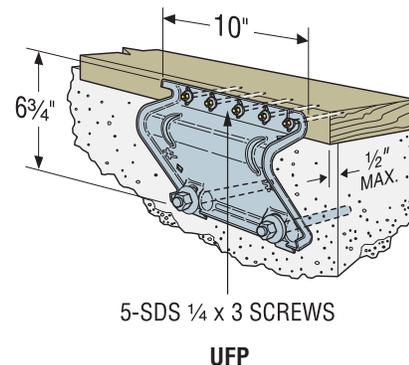
The UFP is a retrofit foundation plate that allows the cripple wall to be anchored to the foundation from the side. This allows the product to be used in applications where minimal vertical clearance exists.

## Installation Details

- Foundation Plate: Model UFP10
- Fasteners to mudsill: (5) - Simpson SDS ¼ x 3 screws (included with the UFP10)
- Anchors to foundation: (2) - ½ in. by 5 in. Titen HD anchors
- Hole depth in foundation: 4¼ in.
- Foundation plate spacing: 6 ft. on center (o.c.)



Anchoring Mudsill to Foundation with UFP



## Instructions

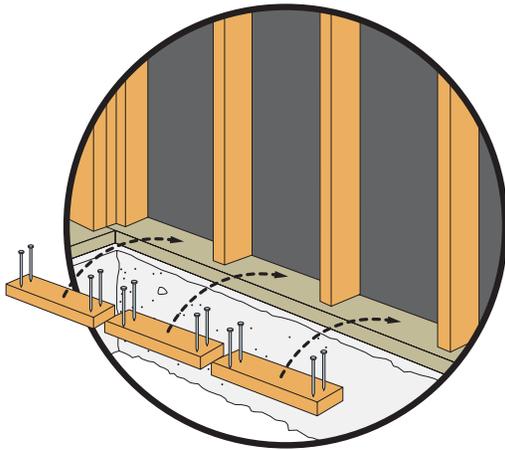
1. Starting at each corner of the foundation, mark where each plate will be installed. Make the first mark 12 inches from the corner (end of the mudsill). From that point, measure and mark for a UFP every 6 feet, with no plate being further than 12 inches from the break between two pieces of mudsill. If you need to adjust this spacing to account for a break in the mudsill or corner, reduce the spacing between plates.
2. Place the UFP against the bottom of the cripple wall and foundation so that it aligns correctly (as shown in the diagram above). Using a hammer, drive the SDS screws into the side of the mudsill (or through the sheathing into the mudsill).
3. Using a rotohammer drill with a ½" diameter bit, use the UFP as a template and drill holes in the foundation 4 inches deep. (Note: Embedment is the depth of the hole from the face of the concrete, not the face of the UFP.)
4. Clean the concrete dust from the hole using compressed air.
5. Insert the Titen HD through the UFP and drive the anchor into the hole using a socket wrench with a ¾" socket. Drive the anchor until it is snug against the UFP.
6. Repeat around the perimeter of the foundation.

# Installing Blocking

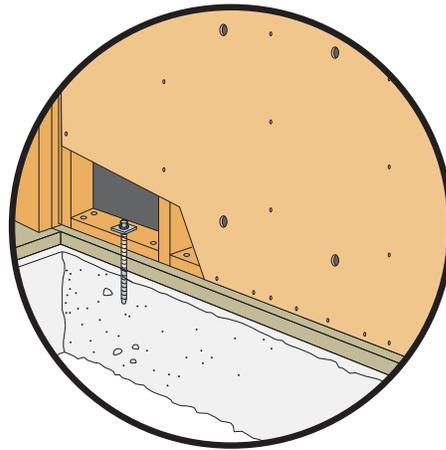
In applications where the mudsill is wider than the cripple wall studs, blocking will need to be installed on top of the mudsill to provide a nailing surface for the sheathing. In order for sheathing to strengthen the cripple walls, it needs to be properly nailed on all four sides.

## Installation Details

- Material: 2x material equal in width to existing studs
- Nailing: (4) - 10d nails per block
- See page 14 for instructions on determining how much blocking/sheathing your house will need and where it will be located.



**Cripple Wall Prior to “Blocking” Retrofit**



**Cripple Wall with Blocking**

## Instructions

1. Measure the space between cripple wall studs and count the number of “stud bays” (the area between two studs) that will be covered with sheathing (see page 14 for instructions).
2. Cut the appropriate number of blocks. (Cut blocking appropriately for a tight fit.)
3. Place the block in the stud bay on top of the mudsill, so that the interior edges of the block lines up with the inside edge of the cripple wall stud.
4. Nail the block to the mudsill with four 10d nails per block.
5. Repeat for each stud bay until all bays to receive sheathing have blocking.

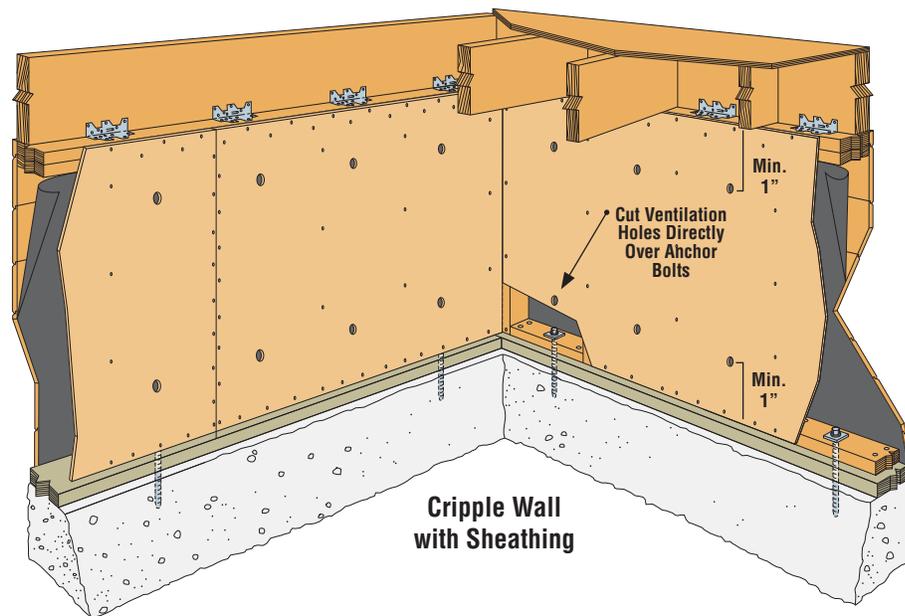
*Note: Although not necessary, if you decide to use pressure-treated wood to provide blocking, you'll need to select connectors and fasteners with the proper protective coating. Pressure-treated wood is more corrosive than non-treated lumber. The application and type of pressure-treated wood you use will help determine the connector and fastener coating. For more information, visit [www.strongtie.com](http://www.strongtie.com) and click on Corrosion.*

# Installing Sheathing

Nailing sheathing onto the inside of cripple walls is required to strengthen the cripple walls under your house. Correct nailing during installation is crucial to the walls' performance.

## Installation Details

- Material: ½ in. thick plywood or OSB
- Nailing: 8d common nails
  - Every 4 inches on center (o.c.) into the studs at the edges of the panel
  - Every 12 inches o.c. into the studs
- See page 14 for instructions on determining how much blocking/sheathing your house will need and where it will be located.



## Instructions

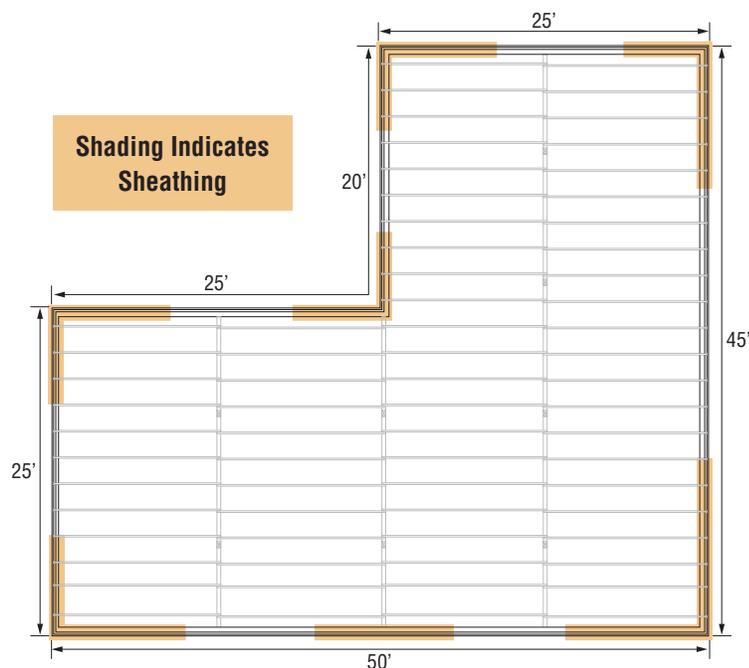
1. Consulting your sheathing plan, measure the height and length of each sheathing run to verify dimensions. Measure from the outside edges of the two end studs in the run to determine overall length. Measure from the top of the foundation to the top of the cripple wall top plate to determine sheathing panel height. (Note: Seams between panels must occur over a stud.)
2. Cut plywood/OSB to size. A chalk line is helpful for making straight lines on the sheathing to ensure cuts are straight.
3. Once the pieces are cut, put them in place to verify fit. On the outside face of the sheathing, mark where the center of each stud will be underneath. Using a chalk line, mark a line to show you where to nail in order to hit the center of the stud. For situations where two pieces of sheathing are joining over a stud, measure in 1/4" from the edge of each piece of sheathing and mark a line down each panel. This will show you where to nail each panel in order to hit the stud under the seam.
4. Nail the sheathing in place driving an 8d common nail every 4 inches o.c. around the edges, and every 12 inches o.c. in the center of the panel. When nailing into a double top plate or nailing seams between panels, follow a staggered nailing pattern (as shown in the diagram).
5. Drill two 3" diameter holes in the sheathing for each stud bay (the space between two studs) for ventilation (see diagram above for hole placement). If the cripple wall is less than 18" tall, only one hole is required.

# How Much Blocking and/or Sheathing Do I Need?

Before you begin cutting lumber for blocking and/or sheathing, you will need to determine how much sheathing your house will require and where to install it. The guidelines are as follows:

- One-story house: 50% of the length of each cripple wall must be sheathed.
- Two-story house: 75% of the length of each cripple wall must be sheathed
- The sheathing on any one wall can be installed in multiple runs in order to accommodate pipes, ductwork, etc. However, the length of any single run of sheathing must be equal to twice the height of the cripple wall onto which it will be installed. Example: The cripple wall is 3' tall, so no run of sheathing can be less than 6' long.
- There must be sheathing at each corner running in each direction. Once again: Multiplying the cripple wall height by 2 equals minimum length of sheathing run. Example: If your cripple wall is 3' tall, you'll need 6' of continuous sheathing at each corner running in each direction.
- No runs of sheathing can be more than 25' apart from center to center.

Using these guidelines, look at the sketch of the outline of your foundation/cripple walls and determine where you need to put sheathing to satisfy the guidelines above. Each sheathing run must begin on a stud and end on one so that the ends can be properly nailed off. Any seams between pieces of sheathing must also occur over a stud for nailing purposes. It is a good idea to go underneath your house to verify that you will be able to install sheathing per your plan.

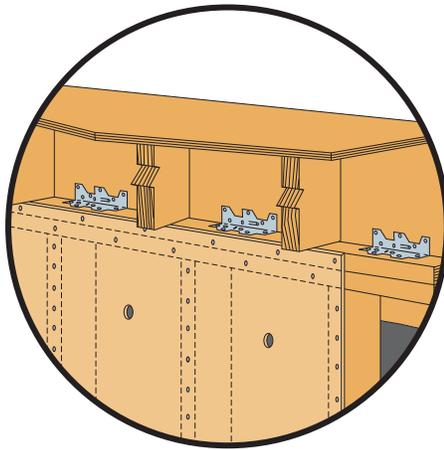


# Installing A35 Shear Angles

Now that you have anchored the cripple wall to the foundation, you need to reinforce the connection between the cripple wall and the floor system. This is accomplished by installing A35 framing angles between the top plate of the cripple wall and the rim joist/blocking of the floor system.

## Installation Details

- Framing angle: Model A35
- Fasteners: (12) - 8d x 1 ½ in. nails
- Spacing: 16 inches o.c.



**A35 Framing Angles Connect the Cripple Wall to the Floor System**

## Instructions

1. Starting at one corner of the house, measure and mark every 16 inches along the top plate of the cripple walls. If you need to adjust this spacing to account for a break in the top plate or corner, reduce the spacing between angles.
2. Place the A35 at the corner between the top plate and the rim joist or blocking.
3. Install the nails using either a hammer or palm nailer.

*Note: A palm nailer will greatly increase the speed and ease of installing nails into the cripple wall top plate.*

# Installing AC Post Caps

Once the perimeter of the house has been secured, the connection between beams and posts in the middle of the floor should be retrofitted as well. The AC Post Cap is a unique two-piece solution that addresses a variety of lumber sizes.

## Installation Details

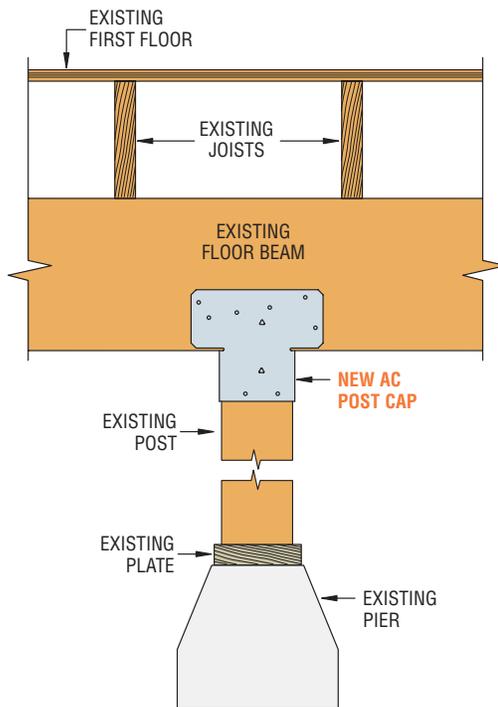
- Based upon the dimension of the post, select the correct model AC Post Cap. You will need 2 caps per post to beam connection.

## Instructions

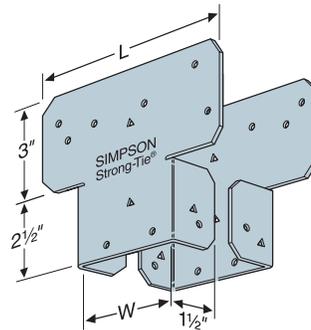
- Place the AC onto the post to beam intersection and fill all round nail holes with 16d common nails.
- Repeat for the other side of the connection.

**Table 2 | AC Sizes / Fastener Data**

Model No.	Post Width (in)	Fasteners
AC4	3½	Post: 8- 16d Nails
AC4R	4	
AC6	5½	Beam: 12- 16d Nails
AC6R	6	



**Typical Interior Post Detail**



**AC Post Cap**

# Glossary of Retrofit Terms

## **Anchor Bolt**

Anchor bolts are used to secure the mudsill to the foundation. An anchor bolt is a metal rod, usually with a threaded end, that is set in concrete and is embedded in the foundation or post-installed in existing concrete (see Titen HD).

## **(Metal) Connectors**

Connectors are steel components that connect the frame of the house together. Connectors are used where two pieces of framing material meet. They are designed to strengthen a home and increase its ability to resist earthquakes, high winds and other forces.

## **Crawl Space**

Crawl space refers to the space beneath a home, typically 18 to 48 inches high that is supported by short wood-framed walls known as cripple walls.

## **Cripple Walls**

Cripple walls are short wood-framed walls between the first floor and foundation. They run underneath and around the perimeter of a house. These walls are constructed on top of a home's foundation and are generally 12 to 30 inches high, but as high as 12 feet when located on a hillside. Cripple walls are vulnerable to earthquake damage and should be properly braced and bolted to the foundation.

## **Fasteners**

Fasteners typically refer to nails, screws, bolts or anchors. Fasteners are used in conjunction with connectors to join framing materials together.

## **Foundation**

A foundation is the block wall, concrete wall or concrete slab a house sits on.

## **Joist (Rim Joists, Floor Joists)**

Joist refers to the wood members that make up part of the floor system of a house. Rim joists run along the perimeter of the floor system.

## **Lateral Forces**

Lateral forces are horizontal forces acting to move a home from side to side.

## **Load**

Load is an engineering term that refers to the weight of the material that is to be supported. The allowable load is the maximum design load that can be imposed on a connector or an anchor.

## **Mudsill (Wood Sill or Sill Plate)**

A mudsill is the wood frame that attaches to the top of the foundation and to the floor system above. The mudsill should be properly bolted to the foundation.

## **OSB/Plywood Sheathing**

OSB and plywood sheathing are panels made from wood or fiber materials that are applied to the outer studs, joists, and rafters of a home to strengthen the structure.

## **Post (Column)**

A post is a load-bearing vertical wood member.

## **Retrofit**

A retrofit adds additional bracing, anchoring or any improvement to a home.

# Glossary of Retrofit Terms (continued)

## Shearwall

A shearwall is a reinforced wall in a home that has been engineered to help resist the lateral forces that are caused by an earthquake. Shearwalls are commonly built by hand on the construction site by attaching wood sheathing and holdown connectors to a section of the wood framing, and then bolting them to the foundation. Pre-manufactured shearwalls are also available, which are typically narrower than site-built walls and offer more design flexibility.

## Stud

A stud is a vertical wood member in the framework of a wall for supporting framing and finishing materials.

## Titen HD

The Titen HD is a high-strength screw anchor that is used to bolt the mudsill to the foundation. (It's installed in existing concrete by drilling a hole and driving in the anchor with a wrench.)

## UFP

The Universal Foundation Plate (UFP) is a metal connector that connects the mudsill to the foundation. It is used when cripple walls are less than 3 feet tall or the mudsill is slightly offset from the foundation.

## Uplift Forces

Uplift forces are vertical forces acting to lift a home.

## Ventilation Holes

Ventilation holes are circular holes that are cut into sheathing to help prevent the wood from decay and rot. Proper ventilation is important when installing new sheathing onto the inside of cripple walls. To determine the size and placement of ventilation holes, see page 13.

### General Technical Symbols & Abbreviations

Symbol/ Terminolgy	Description
”	Inches (in.)
'	Feet (ft.)
<b>o.c.</b>	on center
<b>2x</b>	Refers to 2x4, 2x6, 2x8, etc.

## Retrofit Solutions You Can Do Yourself



**UFP Installation, Anchoring the Mud sill to the Foundation**  
(see page 11)

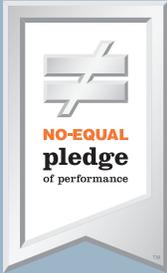


**Titen HD, Anchoring the Mud sill to the Foundation**  
(see page 10)



**AC Post Cap Installation, Connecting Post to Floor Beam**  
(see page 16)

*To learn more about earthquakes and home retrofit solutions, visit [www.strongtie.com](http://www.strongtie.com) and click on “For Your Home.”*



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