

Earthquake Retrofit Details

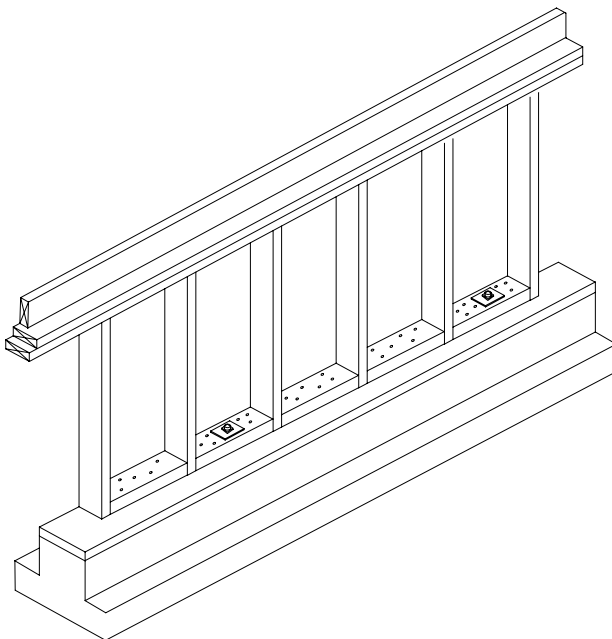
There are two primary connections that must be made in the retrofit shear wall construction of homes with cripple walls. These are the connection of the shear wall to the mudsill and the connection of the shear wall to the floor of the house. Descriptions of these connections can be found in this document.

Connection of Shear Wall to Mudsill

Plywood is used to brace the cripple walls and keep them from collapsing. The best type of plywood to use in retrofit work is 1/2-inch, structural 1, 5-ply plywood. 3-ply plywood of any thickness is not appropriate for seismic retrofit work. On page 10 of the Wood-Frame Subcommittee Findings Report (WFSFR) it says: "The performance of 3-ply construction has raised questions of its ultimate capacity. Horizontal tearing has occurred on some outer face plies above the inner ply seam. Values for all 3-ply panel construction were therefore reduced to 200lbs/ft maximum." Los Angeles uses this rating for 3-ply plywood in its building code.

What this means, as far as Los Angeles is concerned, is that each linear foot of 3-ply plywood can only resist 200 pounds of force, no matter how the shear-wall is built. Shear walls constructed of 1/2 inch thick, structural 1, 5-ply plywood can resist up to 600 pounds per linear foot. What this means is that a shearwall made with structural one plywood can be three times as strong as one made with 3-ply plywood. Since the cost of 3-ply plywood and 5-ply plywood is about the same, it only makes sense to build shear walls with 5-ply plywood.

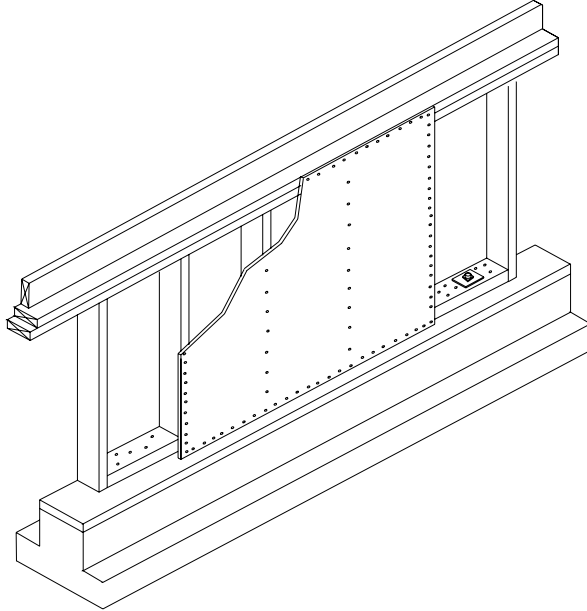
Numerous methods have been devised to attach the plywood to the bolted mudsill. One method uses 2 by 4 blocks that are nailed onto the top of the mudsill. The plywood is then nailed to these blocks. Please see Diagrams 4 and 5 below.



2 x 4 blocks are placed between the upright 2 by 4's and nailed onto the mudsill

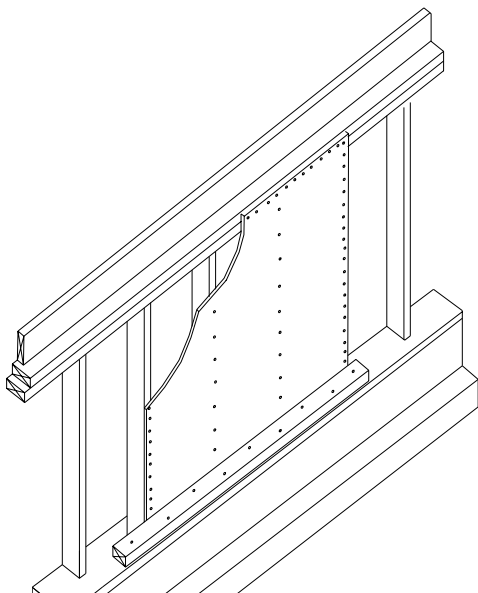
The plywood shear panel is then nailed into the 2 x 4 blocks. This attaches the plywood shear panel to the blocks that are nailed and bolted to the mudsill.

The points of concern when using this method to build a shear wall are:



The blocks tend to split. Most cripple walls are built with upright 2 by 4's placed 16 inches apart. For this reason most of the blocks placed between the studs are only 14 inches long. It is quite easy to split these blocks, if nails are placed within 2 inches of the ends of the blocks. Use of green lumber greatly reduces the risk of splitting. Pre-drilling the nail holes guarantees that the nails will not split the blocks. To get a strong enough connection at least 8 16d commons should be used to attach each block to the mudsill. Use a palm nailer to drive the nails through the blocks.

The blocks are especially prone to splitting when the plywood is nailed to the sides of the blocks. The plywood is usually nailed with 8-penny common nails spaced 3 inches apart. Since the edges of the blocks are especially prone to splitting, nails should not be driven through the plywood within two inches of the edges of the blocks. Pre-drilling for the 8d commons is also an option. Do not use nails that are larger in diameter. The larger the diameter of nail, the higher the likelihood of the nails splitting the blocks. A cripple wall shear panel may look great on the outside, but the bottom of it may be nailed into toothpicks and you won't be able to tell.

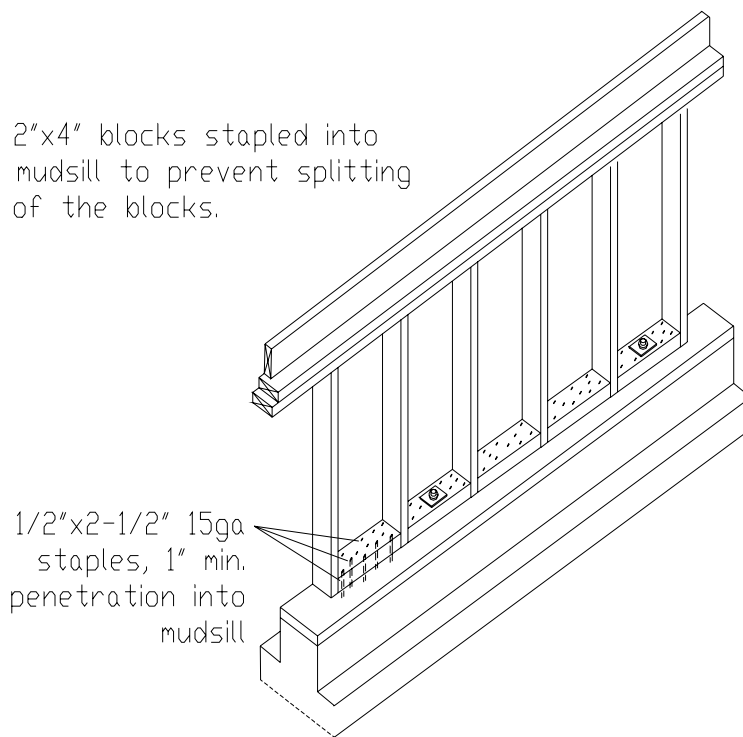


The diagram to the left shows a shear wall made with reverse blocking. The reverse blocking method is quite effective in homes that have wide mudsills. The 2 by 4 reverse-block is nailed to the plywood before the plywood and 2 by 4 are installed on the cripple wall and mudsill.

The diagram to the left, shows the reverse blocking method viewed from the side. Notice that the bolt can be placed through the reverse block. This reduces the number of nails that have to be used to attach the reverse block to the mudsill.

The plywood is nailed to the block with 8d commons 3 inches apart before the shearwall is nailed in place on the cripple wall. It generally works best to push the block against the bottoms of the studs and then nail the block to the mudsill with 12d commons 3 inches on center, slightly staggered. Then nail the plywood to the studs in the normal way.

Another method, shown in the diagram below, uses structural staples to staple the 2 x 4 blocks to the mudsill.

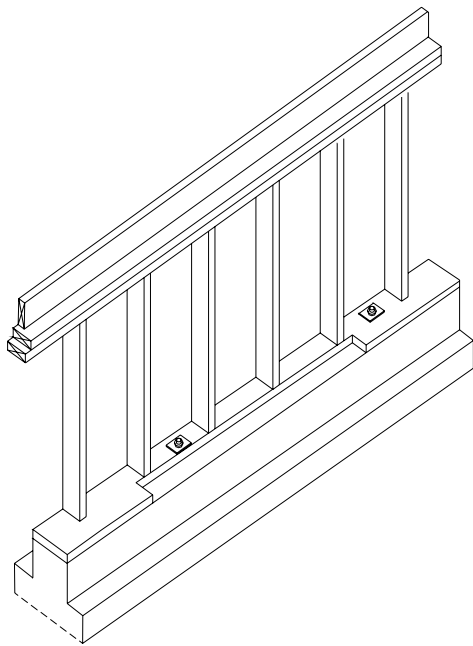


The following items should be considered when using the stapled block method shown above.

- 1) Staples can land quite close to the edge of the 2 by 4 blocks without splitting them. To get the necessary capacity for a strong shearwall at least 15 staples should be installed

in each block. The best staples are 2 ½ inch long 15ga staples. To further prevent splitting of the blocks it is important to staple the plywood onto the sides of the blocks. The best staples for this purpose are 1-1/2 inch long 15ga staples.

The American Plywood Association recommends the use of staples when splitting of framing is a problem. Test reports for stapled shear-walls can be found in American Plywood Association Report 154, May 1993. Page 10 of this report states: “Staples provide a method for developing high design shear values while still using 2 inch nominal framing. The small diameter of the staple legs is not as apt to cause splitting of the framing as are closely spaced large diameter.”



The next method we are going to look at is the flush-cut mudsill method.

In this method, the redwood mudsill is cut flush with the 2 by 4 upright studs with a special saw or with a sawzall

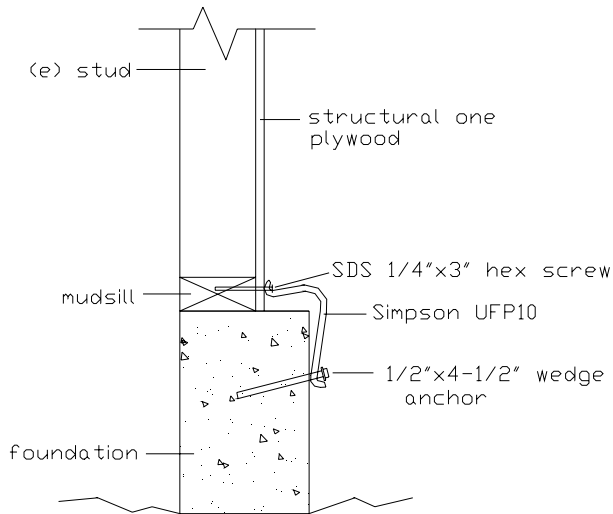
The lower edge of the plywood is then nailed directly into the redwood mudsill where the mudsill has been cut away.

Things to think about with this method are:

Only a contractor with a lot of carpentry experience should attempt flush-cutting a mudsill. It requires proficiency with a sawzall or use of a special flush-cut saw and a high degree of skill.

Any fungus in the lower portion of the mudsill will become apparent once the mudsill is flush-cut. Contractors should closely examine the condition of the redwood mudsill after it is flush-cut.

The next method we will look at involves using the bolting method normally used for homes with low clearance. Sometimes cripple walls are too short to allow the installation of normal bolts. The method used for low clearance shearwalls is shown below:



The only thing that needs to be a concern in this method is the fact that the 1/4 by 3" lag screws will only penetrate the mudsill 2 1/2 inches because the plywood takes up 1/2 of an inch. This means that the bolting strength has been reduced by 16%.

Some variations of this method are shown below:

