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Roof-to-Masonry-Wall Connections

In older houses with masonry walls it is common to find a 2x8 lumber plate that is bolted or strapped flat like a plate to the top of the masonry wall. The trusses or rafters are then connected to this plate. In older homes the connection may be made using 2 or 6 16d nails in a toe nail configuration. In more wind resistant construction, metal straps were used. Aside from the inadequacy of toe nails, one of the greater risks is the inadequacy of the attachment of the plate to the top of the wall. Usually, the bolts anchoring plates to the wall are too far apart, they do not project high enough so that washers and nuts can be placed on the bolts without gouging out some of the plate, and the washers are too small.

In newer houses, the plates are omitted and straps are embedded directly into the top of the concrete wall (in a bond or tie beam) and the trusses and rafters will be set directly on the walls with a metal plate or some other sort of moisture barrier between the top of the wall and the wood. At one time, it was considered sufficient to use straps on every other truss or rafter. Other risk factors include missing nails in the straps and nails that are undersized. Today, houses built to high wind standards have every truss or rafter anchored with a strap. In addition, the straps wrap over trusses or rafters and are secured with the properly number and size nails. A checklist to help you evaluate your roof-to-wall connections if you have a masonry house along with some guidance on the implications of what you find is available by clicking on [Masonry Wall Checklist](#).



Despite the fact that the photo indicates every truss is strapped, this strap between the top of a masonry wall and the truss is a demonstration of a poor installation. Straps should never be bent sideways before attaching to the truss or rafter. This roof can be lifted up a couple of inches before the strap really becomes effective in holding the roof down. Loose connections allow movement that makes it easier for varying wind loads to tear apart the connection. Also note that the shiners indicate that the sheathing was stapled on.

[\(click image for larger version\)](#)

Retrofitting Roof-to-Wall Connections in Masonry Houses:

There are several ways to gain access to the roof-to-wall connections in masonry houses. One possible way is to gain access through the eave area (which may be

exposed or through the soffit which is the flat surface at the eaves that forms a sort of ceiling where the roof overhangs the exterior wall). Another way is to gain access to this connection when the house is being re-roofed. Finally, access can be gained by removing interior wall and ceiling material along the outside walls.

Wind forces on roofs are greatest at the outside corners of houses. Consequently, for gable end roofs the most important roof-to-wall connections are those within 6 to 8 feet of the outside corners. Although the forces occur at the same place on hip roofs, the roof structure is such that it is the very corner truss or rafter (called the jack) that needs to be well connected. The jack goes at 45 degrees towards the interior from the corner where its other end is connected to a girder truss or rafter. The girder spans across the house and has a high wind load applied to it because of the jack and several other trusses or rafters being connected to it. The result is that the most important retrofit measures for hip roofs are to connect jacks to corners and both ends of girders to the sidewalls.

Evaluation:

In the vast majority of cases plates will not be connected well enough to the tops of walls. To be adequately connected the plates must have:

- 1/2" diameter (or larger diameter) anchor bolts holding plates on
- Bolts must be spaced no farther apart than 48",
- Bolts must be within 12" of ends of plates
- Bolts must extend up high enough that washers and nuts are installed without the plate being gouged out

General Connection Retrofit Measure:

If a 2x8 plate is present, there are two approaches. One is to strengthen the plate's anchorage and then connect trusses or rafters to it and the other is to connect the rafters or trusses using fasteners that are long enough to go through the plate and anchor directly into the top of the masonry wall. In most cases it will be far easier and cheaper to connect to the top of wall without having to go to the additional step of trying to adequately secure plates to the tops of walls and then connecting trusses or rafters to plates. Ignoring the plate means it just becomes a big fat washer of not much value. That is fine.

The handiest connector available that can be used to connect trusses and rafters to the top of walls, whether just to lumber plates or to the tops of masonry walls, are right angle gusset brackets. These connectors are not available at most home supply stores, but are available at lumber suppliers to contractors. The HGA is made for application to wood walls whereas the HGAM is made for application to masonry. Both the HGA and HGAM are supplied with four 1/4" diameter by 1-1/2" long special wood screws to connect to the sides of trusses or rafters. The HGA is supplied with four 1/4" diameter by 3" long special wood screws for installing through two top plates whereas the Simpson HGAMs are supplied with four 1/4" diameter 2-3/4" long concrete screws and the USP HGAMs are supplied with four 1/4" diameter 1-3/4" long special concrete screws. If you are going through the top plate, you will need to get longer 1/4" diameter masonry screws since they have to pass through the 1-1/2" plate and then extend at least 1-3/4" into the top of the masonry wall if the connection is into the concrete in the middle of the bond beam. If the brackets are being installed directly on top of the masonry wall, the shorter concrete screws can be advantageous if rebar in the bond/tie beam is

close to the top surface of the wall.

Installation Hints: Using a hammer drill will make drilling into solid concrete faster whereas drilling into the walls of concrete blocks can easily be done with an ordinary drill. Be sure to use 1/4" diameter drill bits. Do not ream out the holes and be sure to make the holes a bit deeper so that any drill dust at the bottom of the hole will not prevent the screws from being fully embedded. In some applications a right angle drill would be a handy tool to have. When placing the special wood screws into the sides of trusses, it is likely that the screws hit a truss plate. Screwing through a truss plate is acceptable, it only presents a problem with getting the screw started so drill a starter hole 3/16" or 1/4" in diameter just through the plate, but only through the plate and not into wood. A way to make the masonry screw installation easier is to use a battery powered drill to drive the screws into the pre-drilled holes. If you are using a hammer drill, switch off the hammer drill option. The battery powered drill will give you a better feel for how hard it is to drive the screw than a corded drill. This may help you avoid stripping the threads or twisting off the head of the screw.

Connection of the 2x8 plate: If the only weakness is the size of the washers and the bolts are long enough, replace the accessible washers with the square ones made for bottom plates that are 1/8" thick and 3" square. They are available with slotted holes for the bolts. Suitable washers include Simpson BPS and BP and USP HBPS/LBPS and BP/LBP. These washers have holes sized for 5/8" diameter bolts whereas the bolts you are most likely to find holding your plates on are only 1/2". Consequently, it would be good practice to reuse the 1/2" washers by placing them on top the 3" washers provided the bolts are long enough to allow the nut to be fully engaged so that the bolt top is at least flush with the top of the nut when you tighten it down.

Connectors on Exterior or Interior Walls: One can fasten connectors to the sides of trusses or rafters and to the side of the wall. Two types of connectors make this easy. One is a saddle connector and the other is a twist strap. The masonry fasteners for these connectors are installed through the walls of the block and into the concrete core of the bond beam. Consequently, the masonry screws used to connect to the sides of the bond beam should be at least 2-3/4" long.

Retrofitting by Accessing from the Soffit Areas:

It may be possible to gain access to the roof-to-wall connection by removing the soffit panels. When you gain access this way, you have two choice of how to connect trusses or rafters to the walls. In most cases using HGAMs will be easiest, but using a connector that is attached to the face of a masonry wall will also provide a good connection, especially in situations where the connector would be hidden by being above the soffit. If soffits are not present and you have exposed rafter tails, the part of connectors on walls can be painted over or a frieze board can be placed over them. In some circumstance a good solution would be to use pre-finished boards like synthetic trim boards. Alternatively one could paint frieze boards a trim color (i.e. a contrasting color to the walls) in order to minimize painting the rest of the wall. Two kinds of connectors lend themselves to this with one being a saddle type and the other a twist strap as mentioned above. They typically fasten to the face of trusses or rafters in a location where that part of the connector is not readily apparent and the other part of the connector extends down the wall

to be secured to the face of the wall.

Retrofitting by Accessing from the roof:

When your house is being re-roofed, there is a great opportunity to retrofit the roof-to-wall connection with minimal additional cost. The approach is to remove roof sheathing over the exterior wall at the eaves in areas where you want to reinforce the connections. Sheathing can be removed as whole sheets which then have to be replaced because usually they will be too damaged to be reused or one can make access holes in the sheathing above the wall at truss or rafter locations. Cutting holes in plywood or OSB sheathing is easy. The cut out pieces should be saved and reinstalled. The Florida building code provides a prescriptive method for reattaching the cut out pieces. It is quoted below.

"Holes shall be deemed adequately repaired if a patch of paneling is installed with no gap greater than 1/2 inch (12.7 mm) between the patch and the existing sheathing and if the patch is supported using one of the following methods.

1. Solid 1 1/2 inch (38 mm) lumber shall fully support the patch and shall be secured to the existing sheathing with #8 by 1 1/4 inch (32 mm) screws spaced a minimum of 3 inches (76 mm) around the perimeter with screws a minimum of 3/4 inch (19 mm) from the near edge of the hole. The patch shall be secured to the lumber with #8 by 1 1/4 inch (32 mm) screws spaced on a grid no greater than 6 inches by 6 inches (152 mm by 152 mm) with no fewer than two screws.

2. Holes that extend horizontally from roof framing member to adjacent roofing framing member that are less than or equal to 7 inches (178 mm) wide along the slope of the roof shall be supported by minimum of 2 by 4 lumber whose face is attached to each roofing framing members using a minimum of two each 3-inch (76 mm) long fasteners (#8 screws or 10d common nails) connecting the two. The patch shall have attached to its bottom running horizontally a minimum 2 by 4 either flat wise or on edge secured with #8 × 1 1/4 inch (32 mm) screws a maximum of 4 inches (120 mm) on center and no more distant from the end of the added lumber than 3 inches (76 mm). The patch shall be secured with two #8 × 1 1/4 inch (32 mm) screws to each support member."

When holes are cut for access to the roof-to-wall connection, then right angle gusset brackets (such as Simpson or USP HGAM) can be installed from the top using the method describe above.

The following specific guidelines were developed for the Florida Building Commission to support a mandate by the State Legislature that requires houses valued at more than \$300,000 to include some roof-to-wall retrofits as part of a re-roofing project.

Prescriptive method for gable roofs on a masonry wall: Unless it is possible to verify through non-destructive inspection or from plans prepared by a design professional that the roof structure is anchored at least as well as outlined below, access shall be provided to a minimum of 6-feet of framing members, measured from the corner, along the exterior wall on each side of each gable end. Wherever a strap is missing or an existing strap has fewer than four fasteners on each end, approved straps, ties or right angle brackets with a minimum uplift capacity of 500 lbs shall be installed that connect each rafter or truss to the top plate below or directly to the masonry wall using approved

masonry screws that will provide at least a 2-1/2 embedment into the concrete or masonry. When the straps or right angle brackets are attached to a wood sill plate, the sill plate shall be anchored to the concrete masonry wall below. This anchorage shall be accomplished by installing 1/4-inch diameter masonry screws (each with a supplementary 1/4-inch washer) having sufficient length to develop a 2-1/2 inch embedment into the concrete and masonry. These screws shall be installed within 4-inches of the truss or rafter on both sides of each interior rafter or truss and on the accessible wall side of the gable end truss or rafter.

Prescriptive method for hip roofs on a masonry wall: Unless it is possible to verify through non-destructive inspection or from plans prepared by a design professional that the roof structure is anchored at least as well as outlined below, access shall be provided at a minimum to the hip rafter, to the hip girder and to one rafter/truss on each side of the hip girder at each corner of the hip roof. The hip rafter, the hip girder and the rafters/trusses adjacent to the hip girder that are not anchored with a strap having at least four fasteners on each end, shall be connected to the concrete masonry wall below using approved straps or right angle gusset brackets with a minimum uplift capacity of 500 lbs. Adding fasteners to existing straps shall be allowed in lieu of adding a new strap provided the strap is manufactured to accommodate at least 4 fasteners at each end. The straps or right angle gusset brackets shall be installed such that they connect each rafter or truss to the top plate below or directly to the masonry wall using approved masonry screws that will provide at least a 2-1/2 embedment into the concrete or masonry. When the straps or right angle gusset brackets are attached to a wood sill plate, the sill plate shall be anchored to the concrete masonry wall below. This anchorage shall be accomplished by installing 1/4-inch diameter masonry screws (each with supplementary 1/4-inch washer) with sufficient length to develop a 2-1/2 inch embedment into the concrete and masonry. These screws shall be installed within 4-inches of the truss or rafter on both sides of each interior rafter or truss and on the accessible wall side of the gable end truss or rafter.

Retrofitting by Accessing from the Inside of Your House:

You can also gain access to the roof to wall connection from the inside of your home if you are willing to remove wallboard and ceiling material along the outside walls. The picture shown below is from a retrofit project where the roof-to-wall connections were retrofitted from the inside of the house. It uses the twist strap method which is one of two methods discussed above in the little section titled "Connectors on Exterior or Interior Walls."



Example of a roof-to-wall connection on a masonry home performed from the inside of the house.

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