2.0
Overview of the Gable End Retrofit Process

How does a gable end retrofit work? A gable end retrofit works by making the wall itself stronger, securely connecting gable ends to the rest of the house and sharing the load imposed by hurricanes over a larger area of the house.

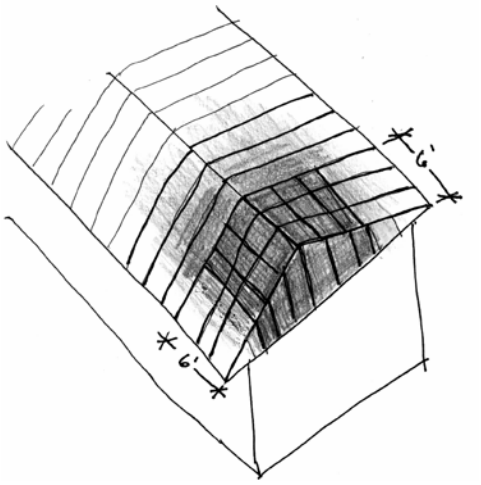

Figure 2.1 The darkest area is the area of the retrofit and so it is the strongest. However, because roof sheathing, especially plywood or OSB, has great capacity to distribute forces over broader areas, via the diaphragm effect, the gable end retrofit really shares its load over a much boarder area as indicated by the progressively lighter shading.

Gable ends have two principal weaknesses: they are not well fastened to the rest of the house, and they can be subject to bending and coming apart. The connections to the rest of the house were discussed above in the section '***What Holds Gable End Walls on Houses****'*.

Retrofitting gable ends entails **two main retrofits**. The first main retrofit involves two sub-retrofits: retrofitting the wall itself to make it stronger, and connecting the gable end wall to the house so it does not get pulled off or get pushed inward. This retrofit is done by connecting the top of the wall to the roof plane structure and the bottom of the wall to the ceiling plane structure. The first main retrofit makes the whole gable end wall above the rectangular wall quite strong. So strong, in fact, it can lend some of its strength to the top of the rectangular wall below. The second main retrofit is the **Wall-to-Wall connection** which involves connecting the gable end wall to the exterior wall below. It is frequently easier to carry out the gable end retrofit step first and then use the horizontal braces installed in that process as a platform of sorts from which to work to tie the two walls together. If the gable end wall is a conventionally framed wall and the wall studs are not connected to the top and bottom framing members using straps or plates (frequently they are just toe-nailed in place), then you will need to install straps or right angle brackets to anchor each of the studs longer than 3' to the upper and lower framing members. If you choose to attach the studs to the top and bottom plates using brackets that have to be nailed to the edge of the top and bottom plates, then you will need to install them before the horizontal braces are installed as the horizontal braces

will block access to the nail holes in the straps. **Figures 9.1 and 10.1** provide examples of typical combinations of gable end wall framing with variations of framing in the wall below. They also illustrate some of the typical bracket installations that can be made to anchor the walls together. You will have a better idea of which to do first after you have looked at the details of the wall-to-wall connection.

Strengthening the gable end wall and connections to the roof framing: **Figures 2.2 and 2.3** illustrate the components involved in strengthening a gable end wall using the L-bent strap method of retrofitting. **Section 6** provides detailed construction instructions for the method shown in those two figures. **Figure 2.2** is a photograph of a completed gable end retrofit taken from an angle that is similar to that drawn in **Figure 2.3**. An important step in strengthening and bracing the gable end is to install 2x4 horizontal braces that butt up against the gable end and extend at least 6' into the interior of the attic. These 2x4s, called **Horizontal Braces**, distribute the loads to the rest of the house. One horizontal brace is placed at the bottom of the wall so it can distribute its share of the wind load applied to the gable end wall to the larger area of the ceiling over the rooms below (the attic floor). Likewise, a horizontal brace at the top of the wall distributes the wind loads applied to the gable end wall to a larger area of the roof structure so that the house can better absorb the forces applied to the gable end. Pairs of horizontal braces are needed at every gable end wall stud wherever the gable end wall framing members are longer than 3-feet.

It is relatively easy to understand that the plane of the roof is strong if the roof sheathing is well secured and stays in place. But it is less obvious that the interior ceiling plane (the drywall or plaster ceilings) is also good at resisting forces applied to the gable end as long as they can be applied over a relatively large area. The horizontal braces are used to transfer the wind forces applied to the gable end into the roof and ceiling planes, and to distribute these forces over a large enough area to avoid local failures of the roof sheathing or ceiling drywall or plaster. These large surfaces perform the function of what engineers call **diaphragms**, transferring loads from one edge of a plane (ceiling or roof in this case) towards the other three edges. In the case of houses, the forces are distributed well beyond the areas immediately adjacent to the gable end wall.

Because existing gable end studs are usually not strong enough, especially where they are installed with their broad faces parallel to the wall, another step in strengthening and bracing the gable end is to attach additional studs next to the existing studs. These **retrofit studs** attach to the studs already in the gable end wall and to the horizontal braces. Not only are studs installed with their broad face parallel to the wall at risk; but, in many houses edge wise studs are not well enough connected to the house at their tops and bottoms. An essential step in strengthening and bracing the gable end is to connect the retrofit studs to the horizontal braces by providing a **tension restraint** to prevent the gable end wall from being pulled off by wind pressure, and by providing a compression mechanism so the gable end wall is restrained from being pushed into the attic. Tension restraint is provided by straps that are fastened around the ends of retrofit studs and to horizontal braces. **Compression restraint** is provided either by

compression blocks or by the ends of horizontal braces depending on which of the two methods to be described later is selected for retrofitting. The method that uses compression blocks is called the **L-bent strap method** and the one that uses the horizontal brace as the compression block is called the **U-bent strap method**. With the completion of these steps, the gable end wall itself is made stronger and the gable end wall is tied to the rest of the house so that it acts as a much stronger unit. These steps will make the gable end about as strong as one in a house built in accordance with today's building code. With this completed at each stud location where the stud is over 3' long, the first main retrofit is done. That leaves making the wall-to-wall connection between the gable end wall and the wall below.

The two main methods of strengthening the gable end wall and its connection to the roof framing: As mentioned above, there are two methods of bending straps. Each has its advantages. Using the L-bent strap method you can install bottom horizontal braces first which has the advantage of giving you a better attic walking surface for the subsequent installation of the upper horizontal braces and then retrofit studs and compression blocks. Whereas in the U-bent strap method one first installs retrofit studs and then the two sets of horizontal braces. The L-bent method does have the disadvantage of requiring the installation of compression blocks that are not required in the U-bent method because horizontal braces perform the compression function. Where there are outriggers extending over the gable end wall, you will notice that horizontal braces installed using the L-bent method will not work. This is a bit hard to explain in writing, but in the attic when you look at this situation, it will become clear that the L-bent strap won't work, but the U-bent strap does. So the U-bent strap's primary application is where there are outriggers with a shortened gable end wall. The expected performance of the methods is identical. The U-bent method costs a little more, but in the scheme of things the difference is not significant. Because of the advantage of having a better walking surface, the L-bent method is preferred. Incidentally, either method can be used at either end of the retrofit studs. This means that where outriggers force you to use U-bent straps, you can still have a better walking surface by using the L-bent method on the attic floor.

Wall-to-Wall connection: One of the essential steps in retrofitting gable ends is to connect the gable end wall to the wall below. This wall-to-wall connection requires connecting the wall below to the reinforced gable end wall above. It is involves installing straps, brackets or screws between the two walls to make a strong connection. It is much less involved than the other main retrofit. A good connection between a strengthened gable end wall and the wall below will do a great deal to prevent the top of wall below from moving in or out. Usually, making a good connection is relatively easy. The connection method depends whether the wall below is concrete block or wood frame, and whether the gable end wall is conventionally framed or is made of a truss. **Section 9** provides detailed construction instructions for making the wall-to-wall connections where the wall below is wood frame. **Section 10** provides similar detailed instructions for making connections on masonry walls.

Figure 2.2 Photograph of completed gable end retrofit using the L-bent strap method – the light colored wood is the lumber added during the retrofit activity

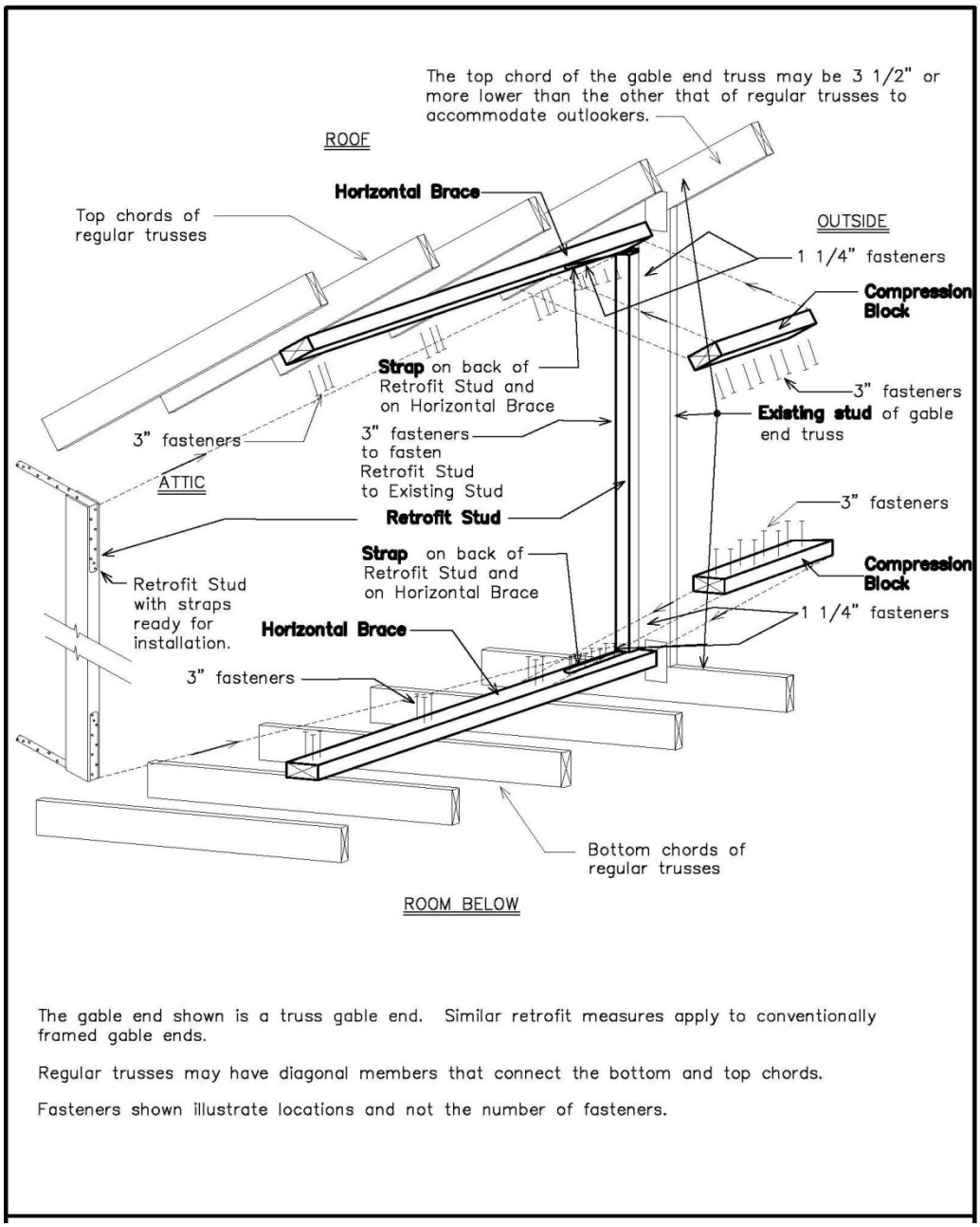

Figure 2.3 Overall drawing showing the concept for strengthening and bracing a gable end wall using the L-bent strap method. You should not get bogged down in studying the details of the drawing. They will be easy to absorb latter.

Figure 6.1on page 25 shows the sequence of steps for making a gable end retrofit using the L-bent method described above.