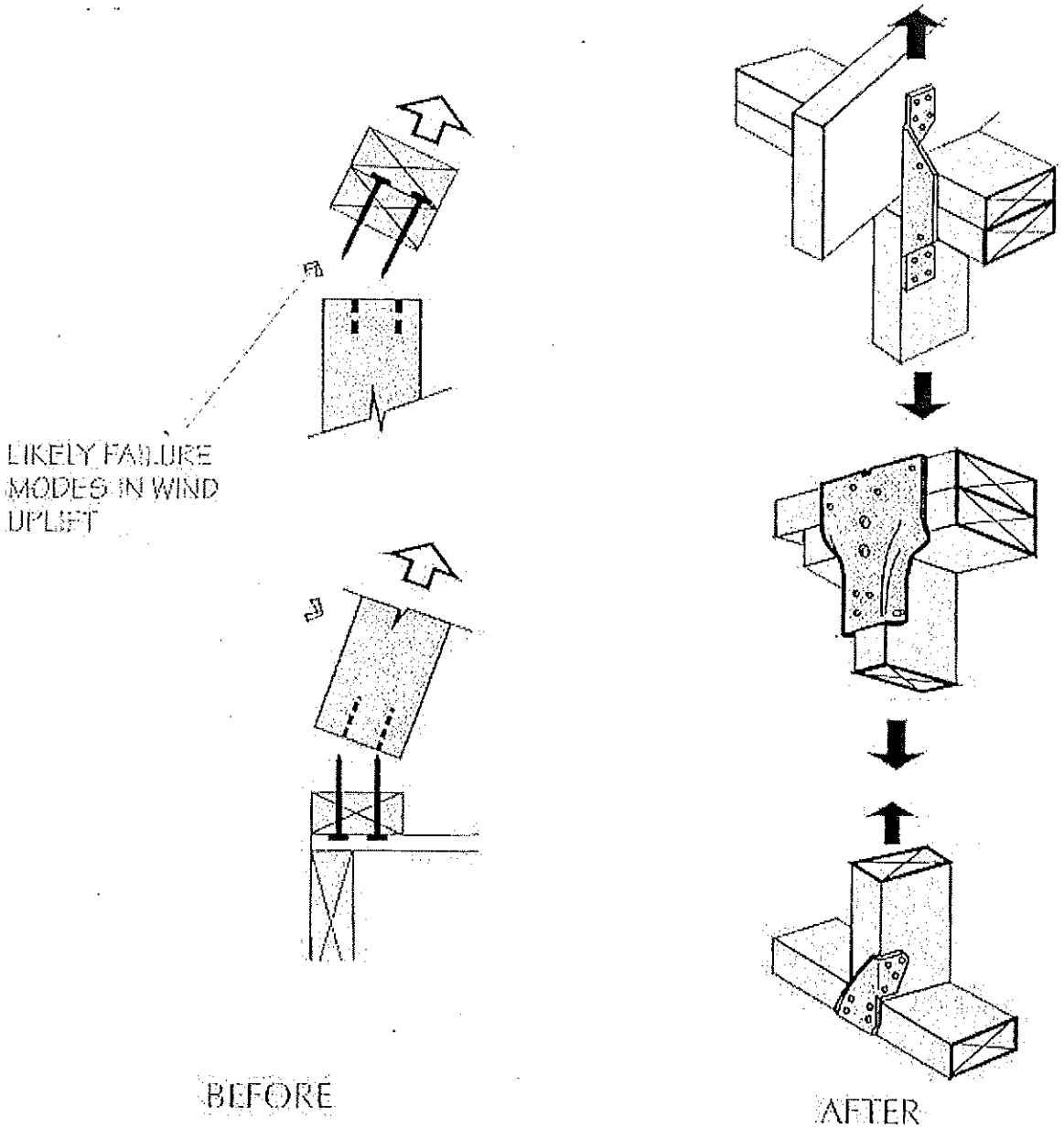
WINDSTORM MITIGATION MANUAL

FOR

LIGHT FRAME CONSTRUCTION

August, 1997



Retrofit Connectors for Existing Residences

There are many existing homes that could benefit from retrofit metal connectors to add resistance capacity for the wind uplift tension chain. Several of the types already shown might be applied to that purpose. However, Some types are already suited to particular elements in the tension chain. Figure 19 illustrates a metal strap tie-down of a floor joist. The strap is used to complete the tension chain when joists are split due to slant nailing or when anchor bolts do not provide enough length into the foundation or where anchor bolts do not exist. The connection is nailed to the floor joist and expansion anchors to the foundation wall. Crawl space homes do not usually have foundations with sufficient weight to resist uplift and may require pouring blocks of concrete at the ends of shear walls to add additional resistance to uplift and incorporate the metal strap.

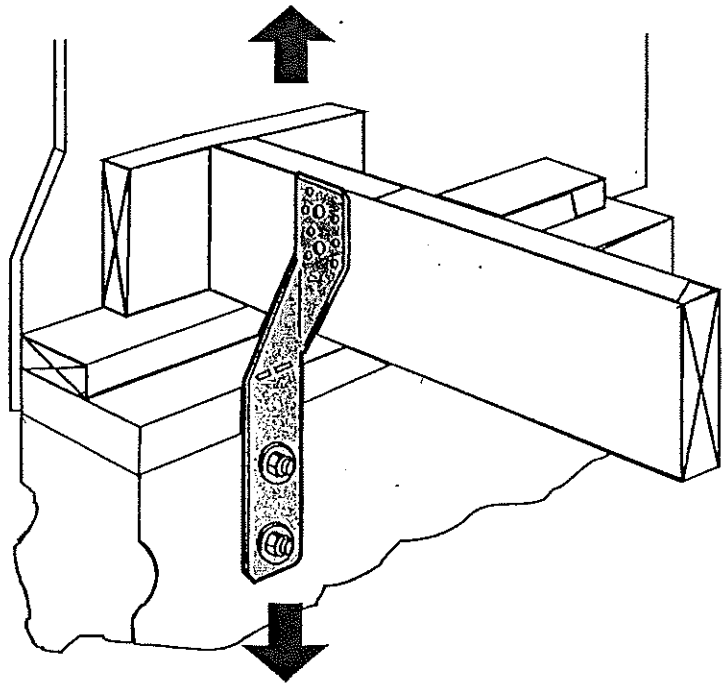


Fig. 19 - FLOOR JOIST TIE-DOWN FOR BASEMENTS OR CRAWL SPACES

The wall studs can be tension tied to the foundation with the detail shown in figure 20. (Next Page). The bolt to the foundation would provide additional capacity if it were an adhesive anchor. This detail is useful in garages that are not internally sheathed with drywall.

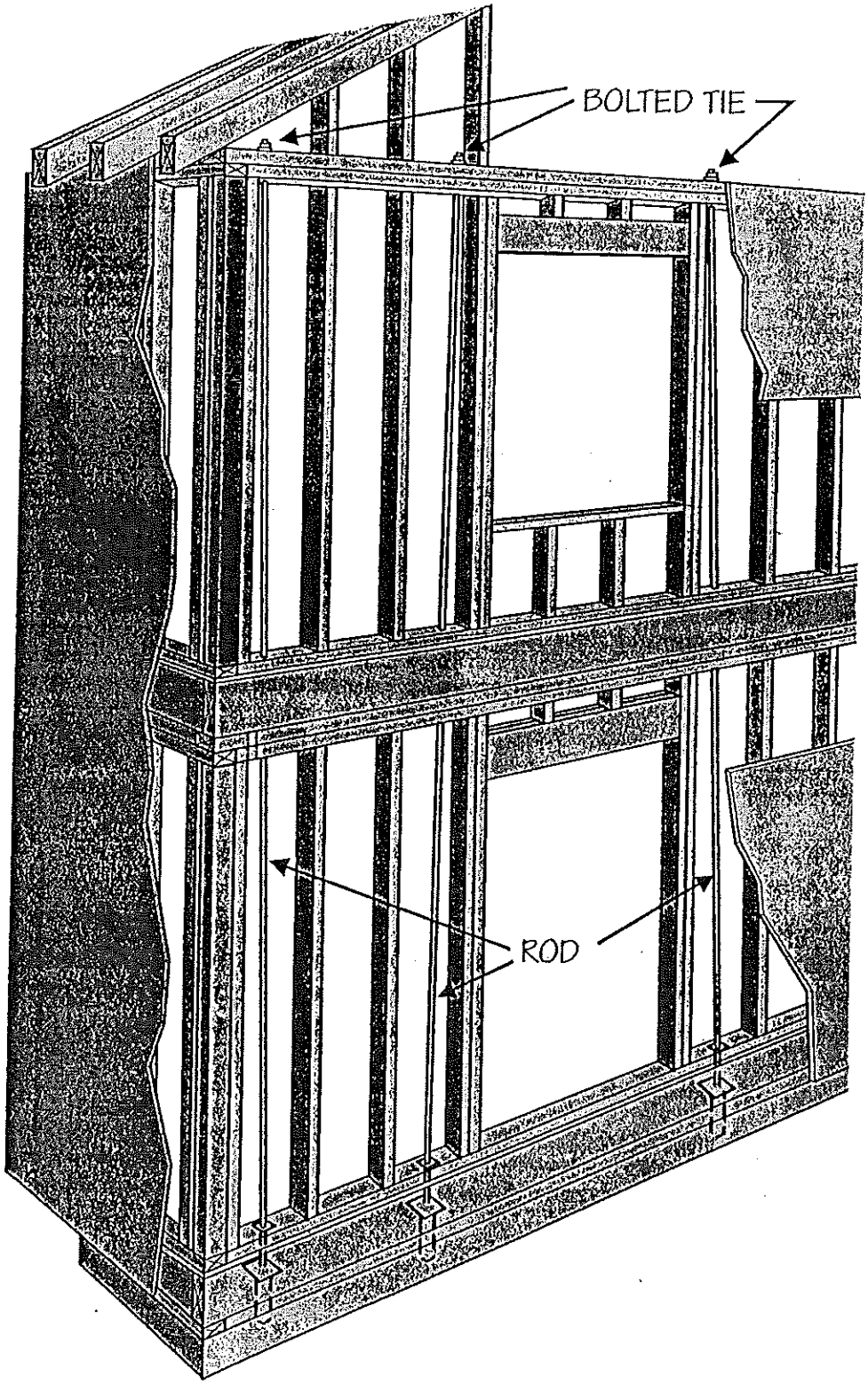


Fig. 18 - TWO-STORY ROD ANCHORAGE SYSTEM

There is a vast array of lightgage metal connectors intended for the purpose of connecting rafters or wood trusses to the double top plate as shown in figure 5.

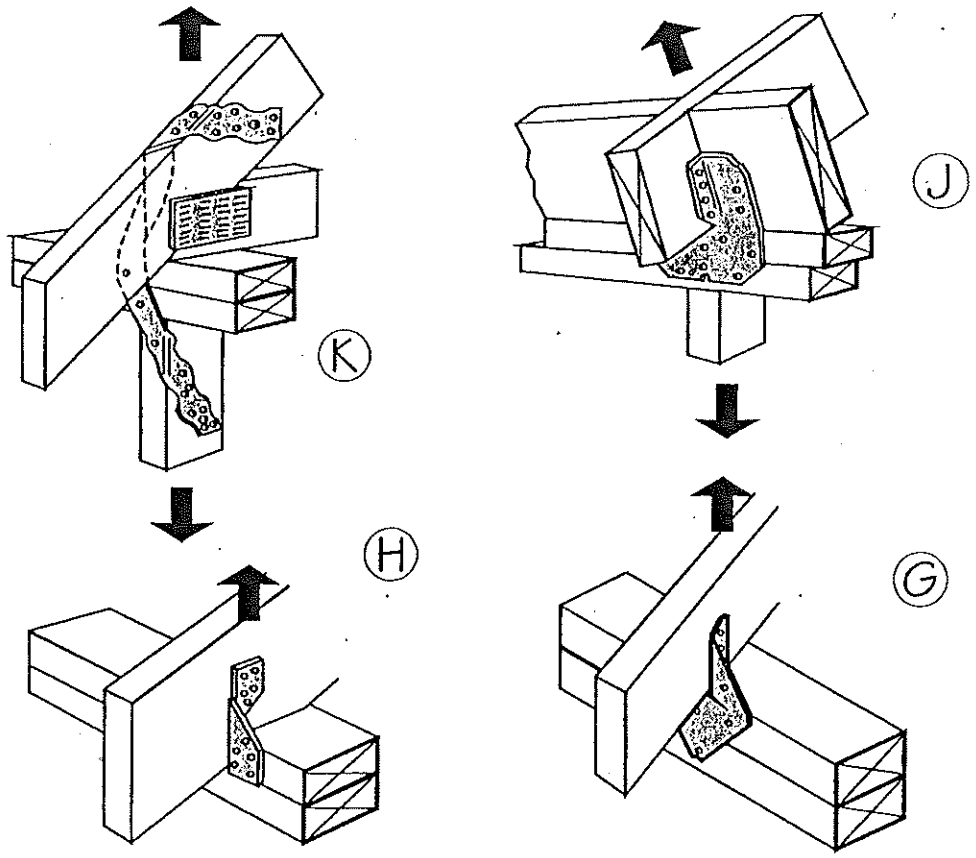


Fig. 5 - RAFTER/TRUSS CONNECTIONS TO DOUBLE PLATE

Metal connector plate types "**G**", "**H**" and "**J**" are basically used when the rafters or trusses ***do not align*** with the wall studs below. These connectors attach to the double top plate directly. Laterally loaded nails again transfer all the wind uplift. Strap connector type "**K**" is used when the studs align with the metal plate connected roof truss. It wraps around and over the truss to avoid nailing into the pressed plate of the truss. The connector types "**J**" and "**G**" are intended primarily for the condition when the rafters create an overhang of the same slope as the rafter.

The variety of connectors illustrated in all these figures only constitute a small number of the possible situations that can be confronted with the use of dimension lumber. Special lightgage metal connectors are available to deal with the "high tech" components illustrated in figure 6 of Chapter 3. The use of solid web "I"

Another approach to completing the wind uplift chain at the stud wall is shown in figure 4 (below). Again another set of lightgage metal connectors is used for a set of different conditions and required tension capacity. This time the strap type "**E**" connects the stud directly to the dimension lumber band board and bypasses the bottom plate. This allows the fabrication of the skeleton stud wall by the typical process of end grain nailing as shown in figure 1 of Chapter 4. Once the wall is erected and the top plate installed, the strap anchor is added. Thus, the nails used to make the stud wall in the traditional way never participate in transferring wind uplift. The straps do all the work and laterally load the nails. The strap anchor at the double top plate (type "**E**", but bent so called type "**F**") is bent over and laterally nailed into the side of the two top plate members.

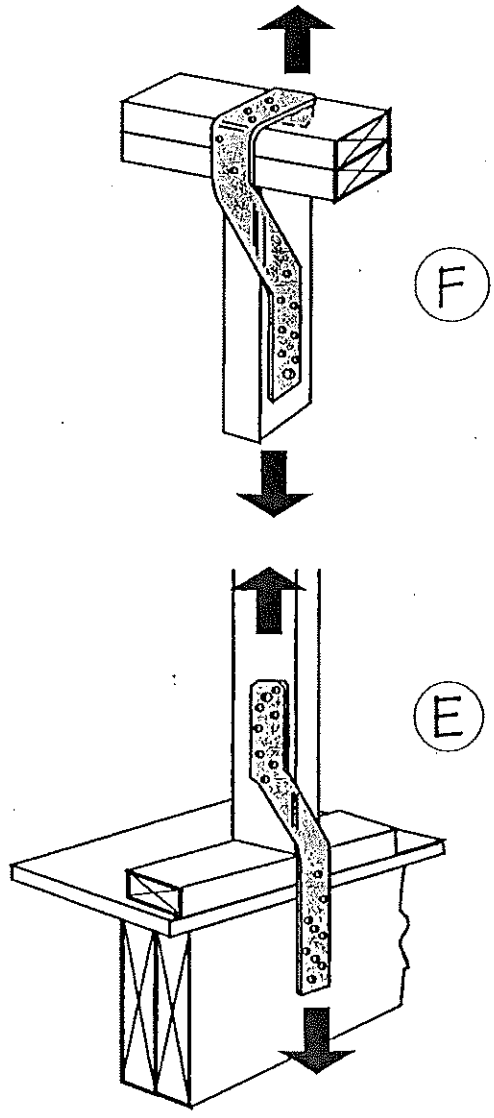


Fig. 4 - STUD TO PLATES - STRAP TIES

The left side of figure 3 (below) utilizes metal connector plate type "**A**" for the bottom plate and a similar type "**B**" for the wider double top plate connection to a typical stud. This approach eliminates the code violation of nails in withdrawal from end grain, described in Chapter 2. Type "**A**" is an ideal connection for situations when the studs do not align with the roof trusses or rafters. The right side of figure 3 illustrates two different types of metal connectors that can also be used to achieve the same purpose. This particular case has a roof rafter in line with the stud and uses connector type "**D**" to basically tie the rafter to the stud and skip past the double top plate. This avoids slant nailing of the rafter and the potential for splits in the wood. The metal connector type "**C**" is used between the bottom plate and stud and properly loads the nails laterally.

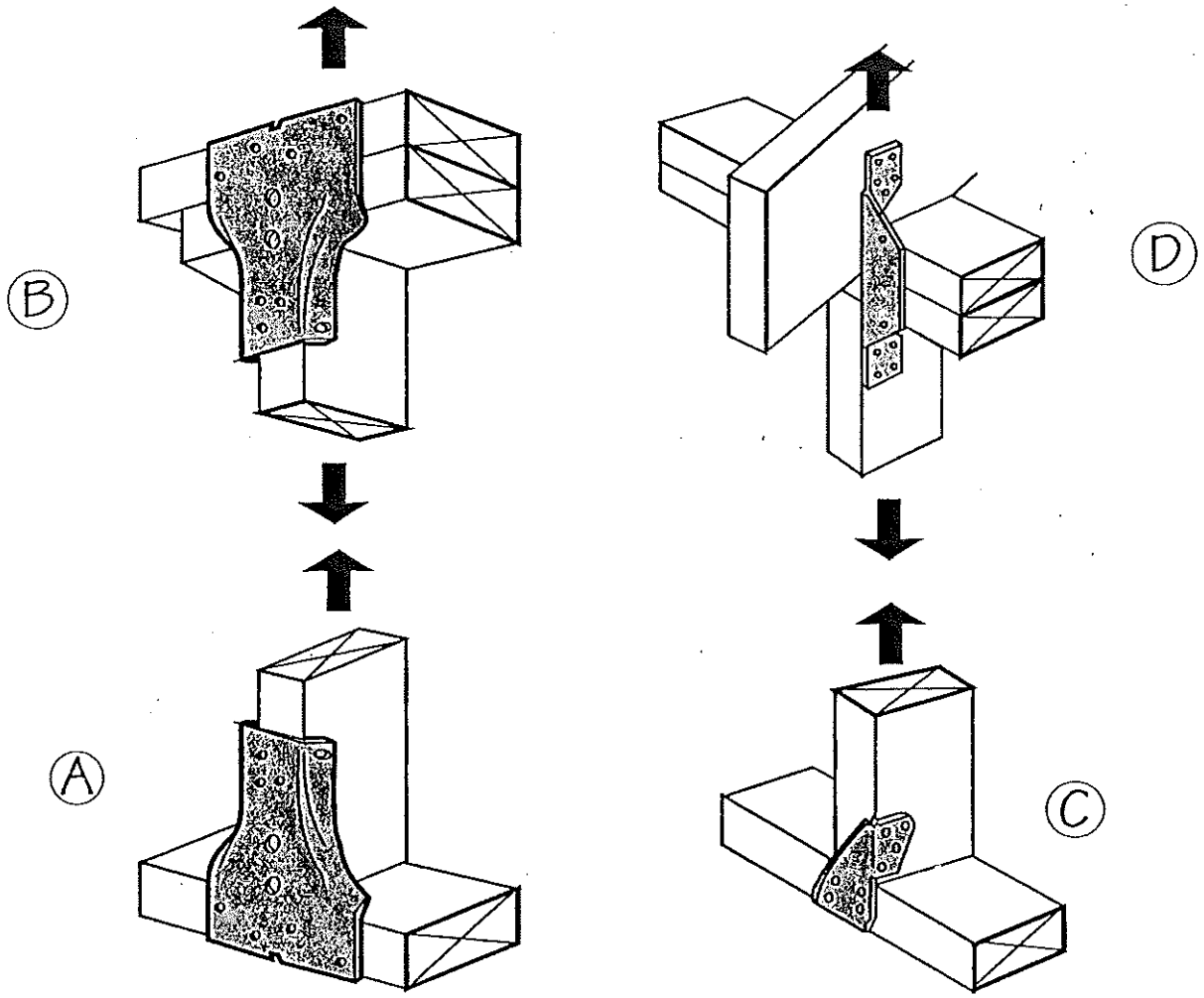


Fig. 3 - STUD TO WOOD PLATES - OPTIONS

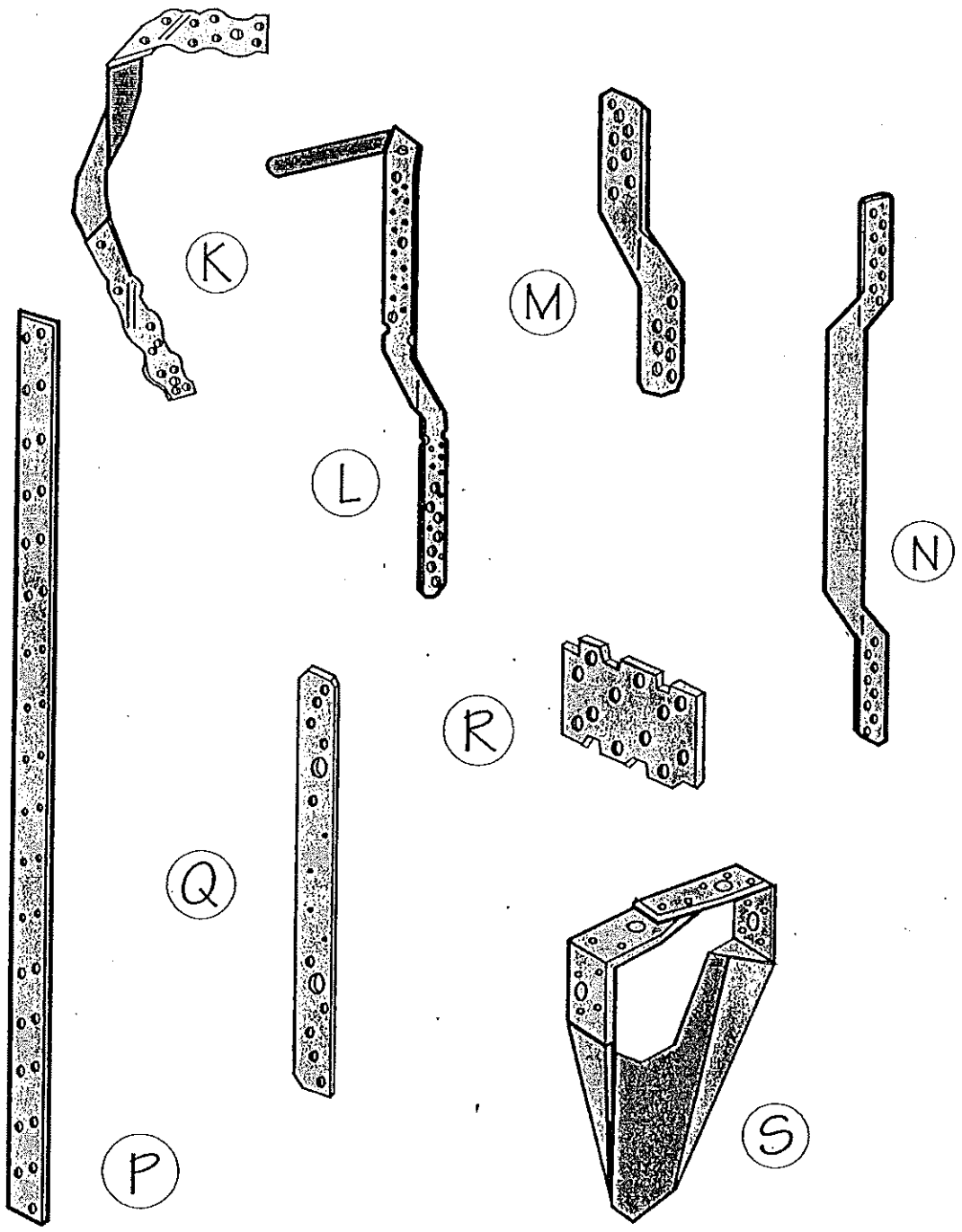


Fig. 2B - TYPICAL METAL CONNECTORS (letters referenced throughout the chapter)

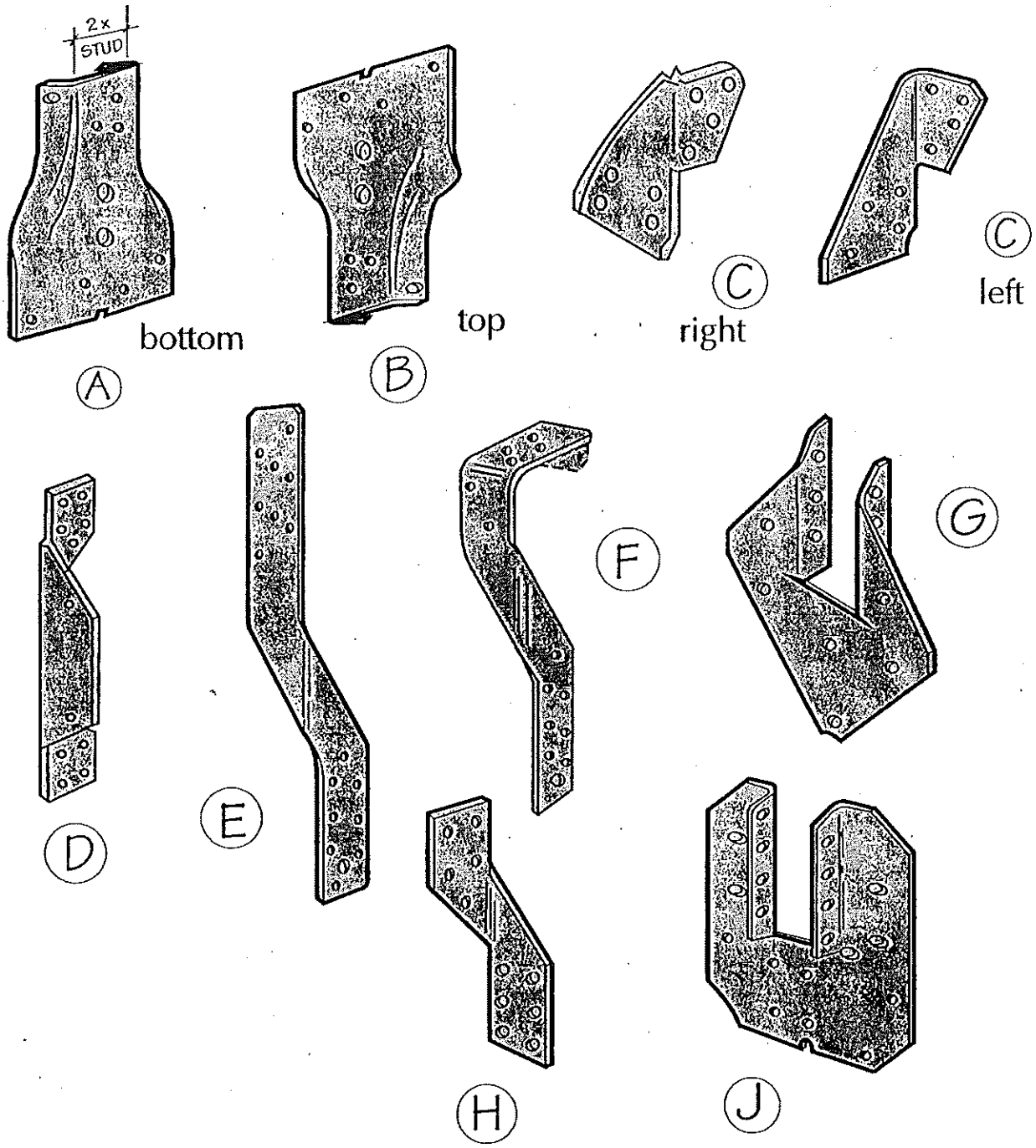


Fig. 2A - TYPICAL METAL CONNECTORS
(letters referenced throughout the chapter)

exterior stud wall areas where non-structural insulation board is used. Note that the pre-formed metal plate acts as a template with pre-drilled holes for nailing the wood parts exactly where they are intended to go. This eliminates nailing too close to an edge, or omitting a nail, since every hole must be filled with a nail.

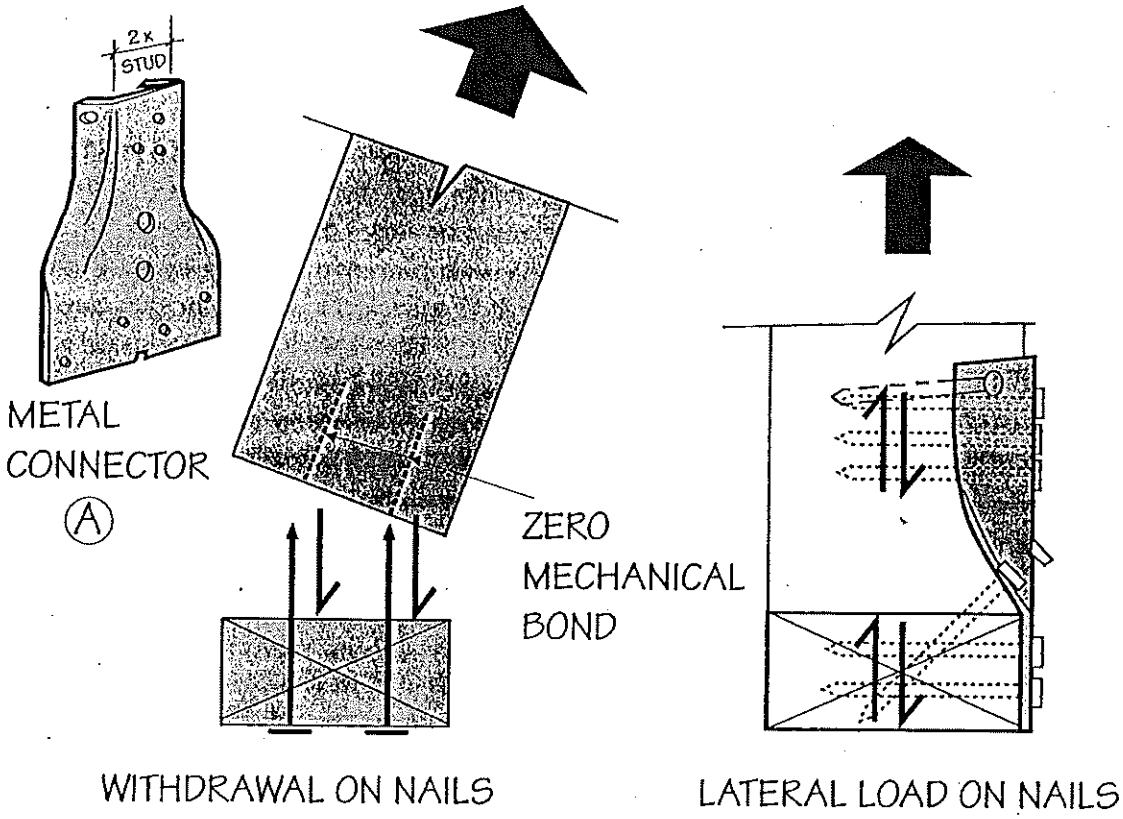


Fig. 1 - PROPER USE OF NAILS / METAL PLATES

There is a vast array of pre-formed lightgage metal plates for an assortment of applications. Yet they all have in common the correct use of nails - always laterally loaded.

Typical Stud Wall and Rafter Connectors

Figure 2A and 2B illustrate just a few of the most common connectors used to properly complete the uplift chain and provide for tension load transfer from roof to mud sill. Each of these metal connectors has a set number of pre-drilled holes, and each one must be filled with the size of nail recommended by the manufacturer. If this procedure is followed, the "allowable" capacity for wind uplift shown in the manufacturer's catalog can be used for design.

General Discussion

The standard residential anchor bolts that can be purchased at any hardware store are 1/2 inch in diameter and either 6 or 8 inches long. This length includes approximately 2 inches of threading at one end and an additional hook length of 2 inches, as shown in figure 12.

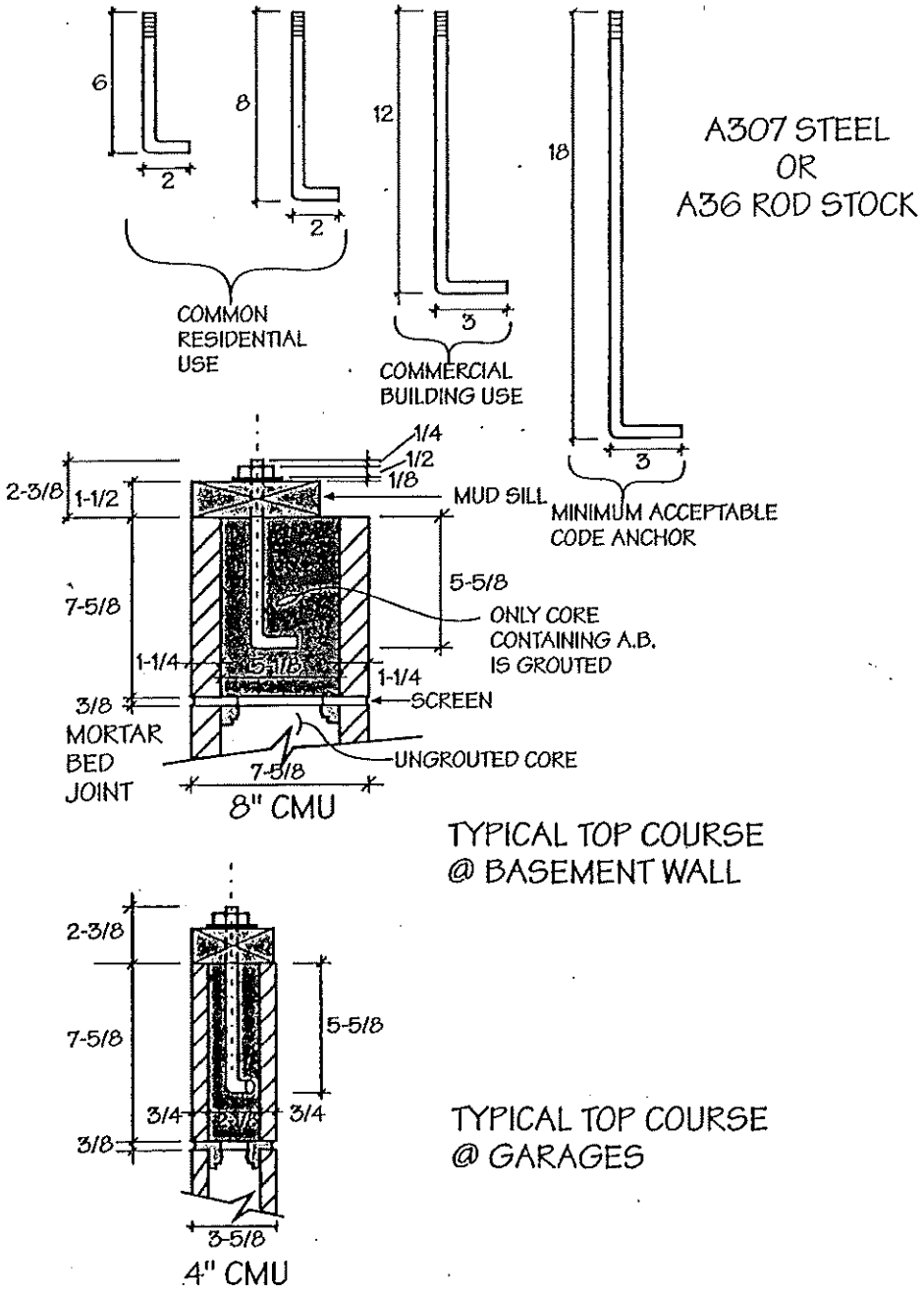


Fig. 12 - ANCHOR BOLT BASICS

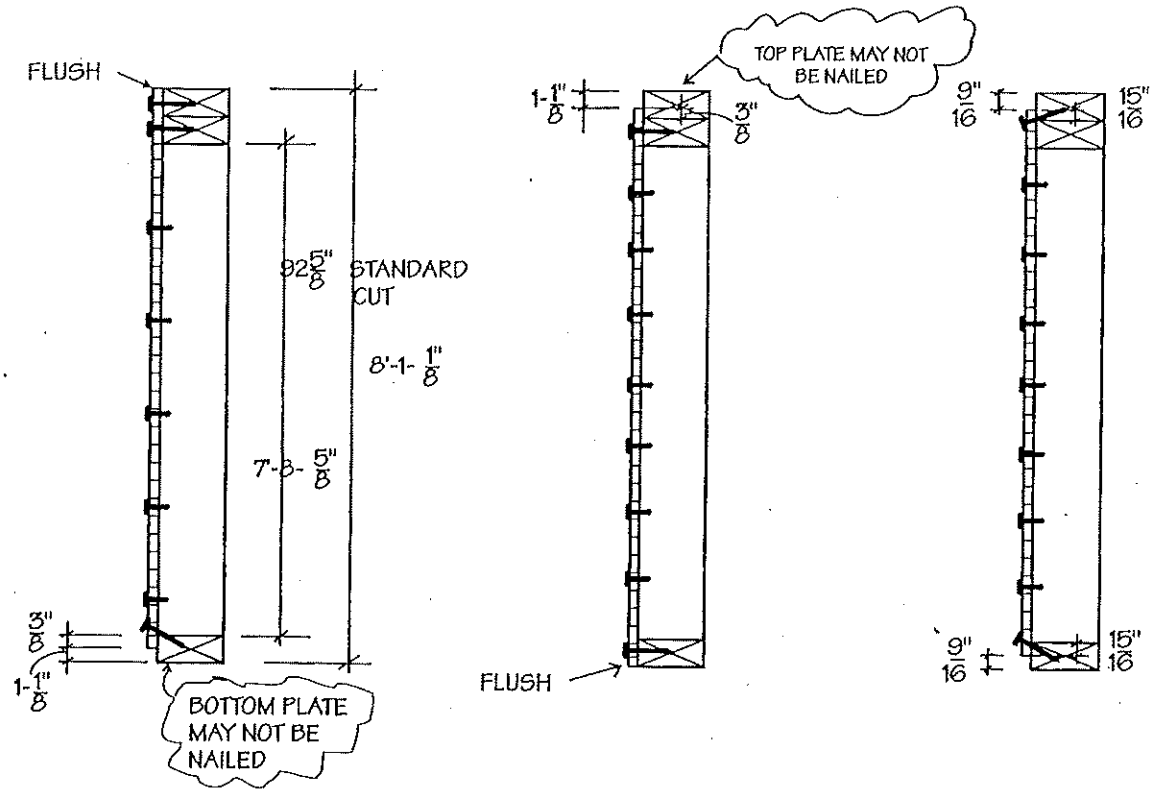


Fig. 11 - PLYWOOD OR OSB BOARD USED TO RESIST UPLIFT

5. Foundation Anchorage. When all the connections of the wind uplift chain are capable of transferring the uplift force from the roof down to the dimension lumber mud sill, the anchor bolts and foundation must complete the uplift resistance chain. The anchor bolts are intended to tie the wood superstructure to the masonry or concrete foundation wall and concrete footing. Sufficient dead load, the gravity weight of the foundation, must be larger than the uplift force to keep the residence from direct uplift and overturning, as illustrated in Chapter 1, figures 10 and 12.