



Metal Roof Installation Manual

Chapter 14: Fasteners

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BUILD LEGACIES
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Chapter 14: Fasteners

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14. INTRODUCTION

Fasteners are a critical component in any metal roof installation. Although the proper fastener is designated by the engineer or designer of the roof system, it is the installer who must actually install it properly. Even the most basic roof system uses hundreds or thousands of fasteners of various sizes, shapes, and styles. Fasteners may appear similar but differ greatly in their performance. Always use the manufacturer's recommended fastener size and type. Doing so protects the design performance of the installation.

The designated fastener is selected based on such factors as the material and thickness of the roof panel, insulation, substrate, and structural members of the roof system. Other factors like wind resistance and roof load are also used in determining the correct fastener for the installation.

Sometimes a fastener substitution must be made. The installer must often select and install an acceptable substitution. The material in this chapter will provide a solid foundation for making a decision which will not compromise the integrity of the roof system.

14.1 Fastener Parts and Installation

Selecting and using the best fastener during the installation makes the installer's job easier and faster, with lower installation torques and faster installation times. The choice of the best fastener also helps by reducing labor costs and improving overall roof system performance.

Today's fasteners save installation time by eliminating steps like drilling, tapping, and sealing by their unique design features. Most of the fasteners the installer uses are a "self" style fastener; self-piercing, self-drilling, self-cutting, and even self-tapping.

A typical metal roof fastener is illustrated in Figure 14-1 and the key areas are identified. These areas will be discussed in light of the installer's normal activities and requirements.

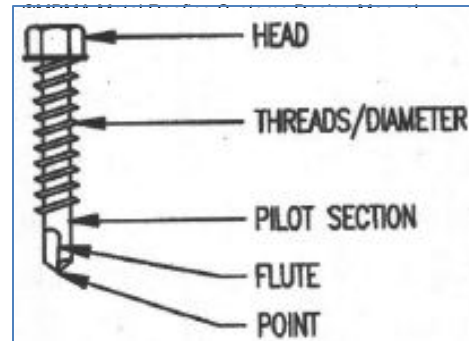


Figure 14-1
Key Areas of a Typical Fastener

14.1.1 Points

The points of the fastener will vary based on their design function. Self-piercing, drilling, and cutting fasteners all have different points and are illustrated in Figure 14-2.

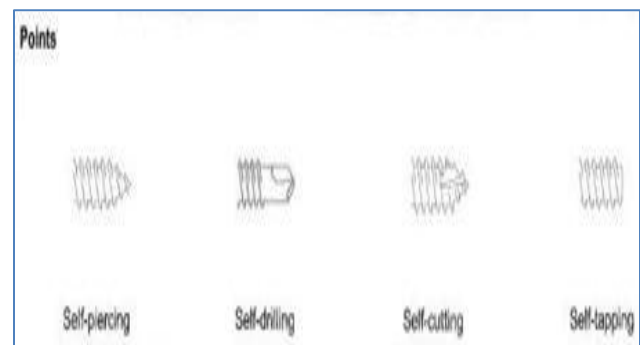


Figure 14-2
Fastener Points

Self-piercing fasteners are used with lighter gauge materials, while self-cutting or self-drilling points are used with thicker gauge and more solid materials, substrates, and structural members. Screw points may be combined with other fastener types. Each manufacturer will have specific combinations best suited for the installation.

14.1.2 Heads

The proper head style ensures stability during driving, proper clamping of materials, and desired finish appearance. Figure 14-3 shows some of the many fastener head styles used in metal roof installations. Heads that are designed as flat, flush, or even countersunk are normally installed as concealed fasteners and covered with other roof members or within narrow spaces. Domed, hex, rounded, or pan-head style fasteners are designed to remain above the fastened member's surface, often exposed to the environment.

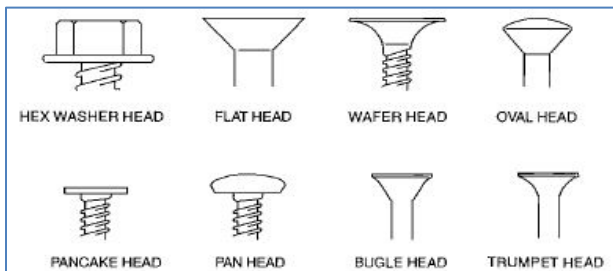


Figure 14-3
Fastener Heads

In roofing applications, many fasteners have some sort of gasket or seal beneath the head surface. When installing a sealed fastener, it is a good practice to visually look at each fastener as it is being connected to the drive bit. Sealed fasteners should not be over-tightened or seal damage and leaking may occur.

14.1.3 Drives

How the fastener is "driven" or "attached" to the system can vary, and new varieties continue to be introduced. Some of the more common drive styles are shown in Figure 14-4. Drives vary from the traditional slotted and Phillips screw styles to elaborate combinations requiring special bits for installation.

Drive formats may be combined with other fastener types discussed in this section.

Certain drive styles are more common to concealed fasteners, while others are typical for through-fastener applications.

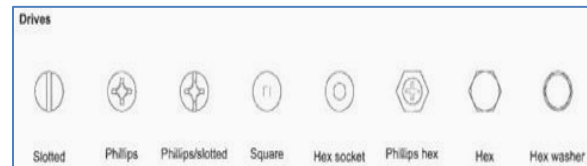


Figure 14-4
Fastener Drives

14.1.4 Threads

The correct choice of thread form and diameter optimizes low installation torque with high pullout strengths. The thread surface is one portion of the fastener which is in direct contact with the material, and provides the transfer of loads, while sustaining the holding pressure for the fastened material. Traditional thread sizes (Figure 14-5) are used, but the strength of the fastener is determined by the selected thread size, along with the fastener diameter, its length, and the fastener material.

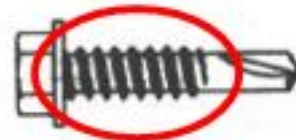


Figure 14-5
Most Fasteners Use Standard Thread Sizes

The fastener is then selected to match the requirements for the specific roof installation and the material to which the fastener is attached. It should be noted that only threads which are actually *engaged* in material are adding value and strength to the system. Any exposed threads which protrude through material, or within a void, are not adding to the holding strength of the fastener.

14.1.5 Diameter and Length

The diameter and length of the fastener, in combination with the thread size and

material, determine its strength. Generally bigger and longer is stronger, but as mentioned in the thread discussion, only the portion of the material in direct contact with other material is significantly adding to the holding strength of the fastener.

14.1.6 Materials and Coatings

The fastener finish provides lubrication during installation, as well as corrosion resistance after installation. The material of the fastener determines the initial fastener strength when all other factors are equal. The fastener material and its coatings are a concern to the installer for another very important reason: compatibility.

Installing fasteners of the wrong material or coating, might not weaken the strength of the roof, but certainly can shorten the life of the roof by dissimilar metal corrosion and staining of the roof materials as shown in Figure 14-6. Material compatibility is explained in more detail in Section 3.6, *Compatibility*, and Section 10.9.3, *Dissimilar Materials*. Check with fastener, roof panel, and substrate manufacturers for corrosion resistance requirements and information.



Figure 14-6

Incorrect Fastener Material Shortens Roof Life

Fasteners for a roof installation are supplied with a variety of coatings. Because of oxidation, carbon steel fasteners have some type of coating (e.g., zinc, proprietary) applied to the fastener. Exposed fasteners, except for unique situations, should always match

the color of the roof panel being installed. Fasteners which do not match the color of the roof panel can create issues like those shown in Figures 14-7 and 14-8. Fasteners of these types are normally ordered directly from the roof panel manufacturer, and in quantities which allow for extras.



Figure 14-7

Wrong Color Fasteners Installed on a Roof Panel



Figure 14-8

Correct Color Fastener Next to Incorrect Fastener
Note – Premature Corrosion on Incorrect Fastener

14.1.7 Substructure

The substructure, its thickness, and its material are prime factors in the selection of an appropriate fastener. Substrate *thickness* primarily affects a fastener's required length, while the substrate *material* factors into the fastener coating, material, size, thread, and point characteristics. For example, a fastener installed into steel deck or a concrete member would not be the same fastener used if the deck were 1" treated wood.

When treated wood *is* the substrate, the following fastener recommendations are suggested:

Recommended Fastener Guide⁽¹⁾

Metal Roof or Wall Cladding Material	Fastener Material								
	Zinc Plated Steel Screws ²	Organic Coated Steel Screws ²	Hot-Dip Galvanized Steel Nails ³ and Screws	Zinc-Alloy Head Steel Screws	Stainless Capped Head Steel Screws	Aluminum	Copper and Copper Alloys	300 Series Stainless Steel	400 Series Stainless Steel
Unpainted Galvanized Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Painted Galvanized Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Unpainted Galvalume Steel	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Painted Galvalume Steel	Yes ⁴	Yes	Yes	Yes	Yes	Yes	No	Yes ⁴	Yes ⁴
Aluminum	No	No	No	No	No	Yes	No	Yes	No
Copper & Copper Alloys	No	No	No	No	No	No	Yes	Yes ⁴	Yes ⁴
Stainless Steel	No	No	No	Yes	Yes	No	No	Yes	Yes
Zinc alloy	No	No	No	No	No	No	No	Yes	Yes

Note 1: Cautionary Guideline: This table serves as a guideline for the selection of fasteners used with metal roofing. The performance of compatible fasteners shown in this table matches the expected life of the metal roof or wall cladding materials. However, in highly corrosive environments such as heavy industrial, coastal marine, high airborne pollutants or salt spray, preservative treated lumber or fire-retardant lumber, the compatibility of certain fasteners with metal roofing or wall cladding materials may be affected. In those types of applications, the manufacturers of the fastener and metal panel will have specific and unique recommendations.

In addition, in the event that certain coating barriers are damaged or scratched through to the substrate there is increased potential for premature corrosion. Care should be taken during installation and during routine maintenance of the panels in order to protect the integrity of the coatings used for metal panels.

Note 2: Screws should be plated/coated per ASTM F1941

Note 3: Nails should be galvanized per ASTM A153

Note 4: Not recommended for coastal and heavy industrial environments

Note 5: Commercial availability of threaded aluminum fasteners is very limited due to their lower torsional, tensile, and shear properties.

Carbon steel, aluminum, and *electroplated* galvanized steel fasteners and connectors should not be used in contact with treated wood. *Hot-dipped* galvanized fasteners generally are acceptable. Stainless-steel fasteners and connectors are recommended for maximum corrosion resistance.

Fasteners with proprietary anti-corrosion coatings may be acceptable for use with treated wood. When considering the use of such proprietary-coated fasteners and connectors, consult the fastener manufacturers for specific information regarding the performances of their products

in treated wood and any precautions or special instructions that may be applicable.

Aluminum fasteners, flashings and accessory products should not be used in direct contact with any treated wood. ACQ-treated wood is not compatible with aluminum. See the Recommended Fastener Guide above for more information.

14.1.8 Installation Key Points

Drill and pierce points can leave a sliver of panel material which, if caught by the washer, may damage the washer, allow water intrusion and premature corrosion.

There are two characteristics a fastener must have for proper installation. It must be straight, and it must be tight, like those illustrated in Figure 14-9.

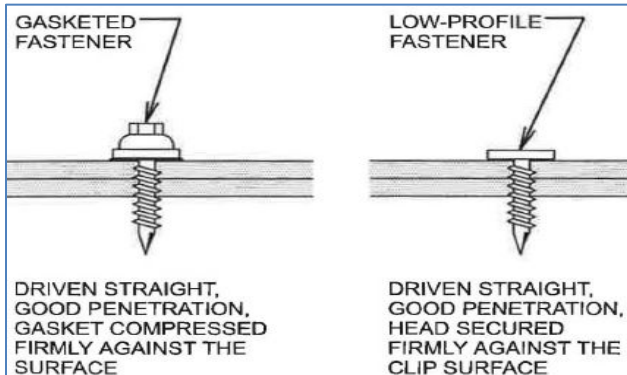


Figure 14-9

Properly Installed Fasteners Are Straight and Tight

When a fastener is not straight, the head does not seat properly to the surface. This results in gaps which may leak and not seal properly. The head of the fastener is also responsible for holding the material in place. When not seated properly, there is less surface and uneven pressure holding the material in place. This creates a weaker connection which may fail at a later time or under additional stresses.

Any fastener can be installed to the improper tightness. Fasteners can be under-tightened or over-tightened. Under-tightened fasteners, like the one shown in Figure 14-10, do not seal properly and are likely to leak. They also do not provide the strength needed to hold the material in place.

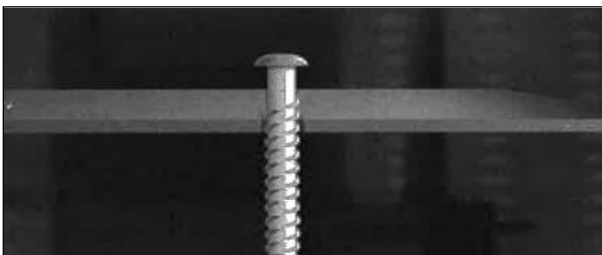


Figure 14-10

Under-Driven Fastener

This allows the material to move when it should remain in place. This additional movement may cause distortion, damage the material, and cause roof failure. Under-tightened fasteners are typically and easily corrected by retightening to the correct tightness.

Over-tightened fasteners present more of a problem and are more difficult to correct. When a fastener is over-tightened, it deforms and often distorts the material it is holding in place. As seen in Figure 14-11, this can create pockets for moisture and water which easily corrode the metal panels and may potentially leak. Over-tightening often over-compresses gaskets and sealant used along with the fastener. This causes less sealing ability around the fastener.



Figure 14-11

Over-Driven Fastener

Note- Distortion and Pocket for Moisture

Correcting over-tightened fasteners is not a matter of simply "untightening", or "loosening," the fastener, because this will create gaps and loss of holding pressure. Replacing over-tightened fasteners may involve additional sealant, a change in gasket, and a different size fastener being used as a replacement. Panel replacement may be necessary if distortion or damage is too severe.

14.1.9 Stripped Fasteners

Fastener technologies are constantly improving. A stripped fastener is a common result of over-tightening. New head and

washer designs make over-tightening almost impossible, but occasional stripping of screws or washer damage is inevitable. Stripped fasteners no longer have the material or the holding pressure present in order to properly secure and seal the area surround the fastener's point of installation. Stripped fasteners must be replaced.

When this happens, the correct remedy is to replace the screw. It is never acceptable to repair such a defect by the surface application of sealant at the screw location. If the problem is merely washer damage, the screw should be replaced with one of like size. If the fastener has stripped, an over-sized screw should be used as a replacement. The installer should have a few over-sized screws at all times when using a screw gun. This will ensure that the remedy is immediately at hand when the mishap occurs, and increases the odds that the fix will be prompt and proper. It is also a good idea to have a few oversized sealing washers on hand, just in case. These can be obtained from the roof manufacturer or most fastener distributors.

14.1.10 Fastener Identification

Installers and others working in the trade often have short names for most fasteners and are often confused when checking Material Lists, Installation Instructions, or the Bill of Materials (BOM) when fasteners are listed. Because of the vast variety of fasteners, many similar in appearance, a standard method of listing fasteners has been established to eliminate confusion. An example is listed in Figure 14-12.

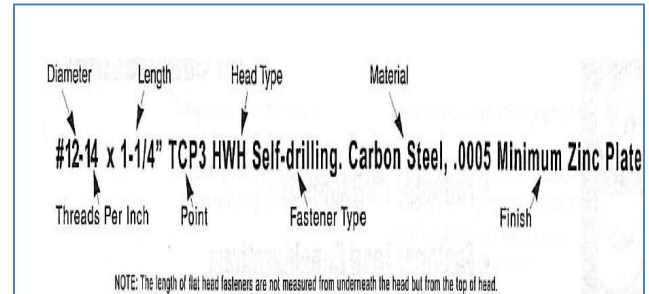


Figure 14-12
Typical Listing Method for Fasteners

This listing identifies each key characteristic of the fastener previously discussed. Additional information is often added, such as a supplier identification number or part number for ordering the fastener. When colored fasteners are identified, a color, initials, or several additional numbers or letters are added to specify the color.

14.2 Fastener Types

The most common types of fasteners used for metal roofing installations are nails, rivets, screws, clips, and cleats. Most installations will use a variety of each of these types of fasteners. However, the *amount* of each type of fastener will vary greatly, based on the type of roof panel being installed.

14.2.1 Nails

Nails are installed by driving the fastener into a substrate, normally wood, by impact, typically with a hammer or powered impact tool. Nails are the most used fastener in asphalt based roofing materials. Nails, like those shown in Figure 14-13, are sometimes used in select metal roof installations, especially for underlayment, slip sheets, and wood substrates. Nails also are frequently used when wood purlins and nailers are installed on the roof system.




	Ring or Annular Shank Nail
	Barbed Shank Nail (smooth)
	Screw Shank Nail

Figure 14-13
Typical Nails Sometimes Used in Metal Roof Installation

14.2.2 Rivets

Rivets, pop rivets, or blind rivets are small non-threaded fasteners with an expandable head for joining light-gauge sheet metal. This type of fastener, like those shown in Figure 14-14, is popular within all sheet metal applications, and provides quick, neat installations. It does, however, require that a hole be drilled through all pieces of material being joined by the fastener.

When installing pop-style rivets, an installer must pay attention to these key fastener dimensions: the drill and rivet diameters, and the "grip" or "pull-up" dimension of the rivet being installed. If either of these dimensions is too great or too small, the joint will not have the strength intended.




	Pop Rivet	sheet metal to sheet metal
	Shear Rivet	sheet metal to sheet metal or purlin
	Nail-in Expansion Fastener	sheet metal to concrete or masonry

Figure 14-14
Rivet Examples

Most standard rivets are not designed to withstand leaks. Special design rivets may be specified which do provide leak protection. The rivet type of fastener does

require a special tool, like the one shown in Figure 14-15, for proper installation. These are normally hand-operated, but pneumatic rivet tools are sometimes used when convenient, and a large amount of rivets must be installed. This tool is discussed and explained in more detail in Section 12.7, *Rivet Gun*.



Figure 14-15
Hand Held Rivet Tool

14.2.3 Screws

Screws of all types are the most used fastener on a metal roof system. The specific type of screw required depends on the type of panel being installed and the material to which it is being fastened. The size and length of the screw will vary, even within the same roof installation. Many of the screws used on a roof installation have seals or gaskets.

Self-piercing screws, sometimes called sheet metal screws, have a very sharp point as seen in Figure 14-16. Designed for fastening lighter gauges of sheet metal, the sharp point easily punctures the material, eliminating the need for drilling.



Figure 14-16
Self-Piercing Screw

Self-drilling screws, also called TEK screws, are similar to sheet metal screws, but with a "drill bit-style" point that drills its own pilot hole. The drill bit end, illustrated in Figure 14-17, is better suited for penetrating and opening thicker gauge sheet metal and other structural material.

Self-drilling screw sizes are available from number 1 through number 5 points. The self-drilling screw sizes are selected based on the combined substrate thickness. The higher the number, the thicker material the drill is designed to penetrate.

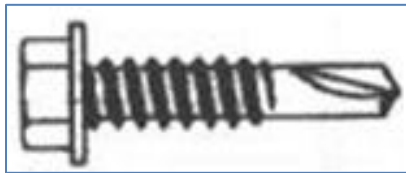


Figure 14-17
Self-Drilling Screw

When fastening with self-drilling fasteners, it is imperative that the screw point has cleared the substrate *before* the threads engage or the drill will actually pull the threads through the substrate faster than it can be drilled, thereby breaking the fastener. This is illustrated in the steps shown in Figure 14-18. The recommended diameter and threads per inch will vary based on the desired fastener performance and substrate thickness.

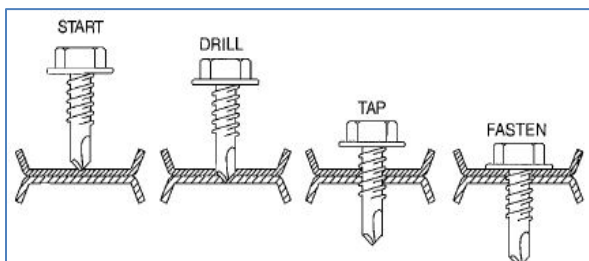


Figure 14-18
Drill Bit Must Clear Substrate Before
Threads Engage

Self-cutting screws (Figure 14-19) are similar to self-piercing and self-drilling screws, but cut, rather than pierce or drill, their own holes.



Figure 14-19
Self-Cutting Screw

Self-tapping screws (Figure 14-20) are designed to cut their own threads into the fastened material and maintain a tight grip between attached materials. True "self-tapping screws," like the middle fastener in Figure 14-19, require a pilot hole for installation; however, self-tapping threads are normally combined with self-piercing, drilling, or cutting points for a versatile fastener which is widely used across the construction industry.



Figure 14-20
Self-Tapping Screws

14.2.4 Clips and Cleats

Clips are normally the fastener used for attaching the roof panel to the substrate or deck on a concealed fastener metal roof system. Clips are also used in a variety of other applications within the roof system. Most clips are designed and supplied by the roof system manufacturer specifically for a single type of roof panel. Common clip examples are shown in Figure 14-21 along with a typical installation. Clips are designed to firmly hold the panel in place, or to allow thermal movement of the panel. Clips may also vary depending on the amount of wind-lift protection required. When clips are used with rigid insulation, a different style clip may be required or bearing plates used for additional support. An example of this type of

installation is shown in Figure 14-22. Note the longer fasteners and baseplates required for each clip.

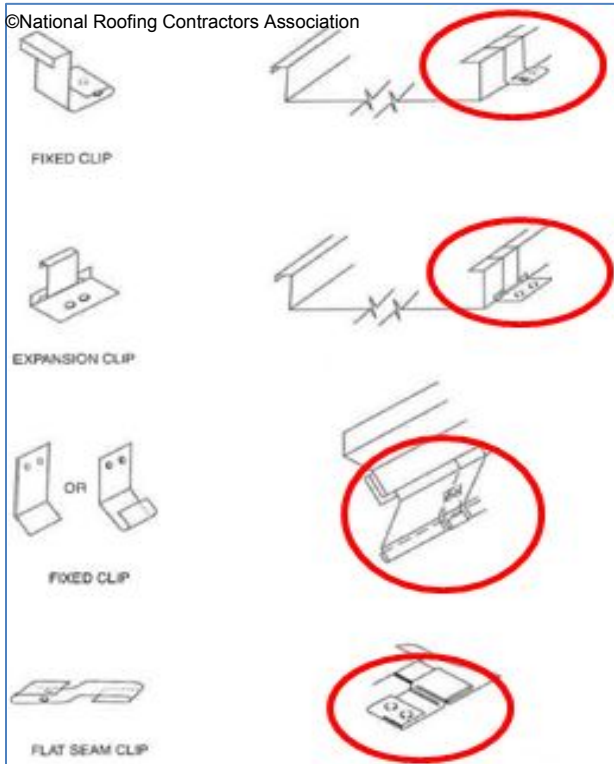


Figure 14-21
Common Clip Styles and Installation

Cleats are also used for fastening roof members, normally along the roof edge and areas of trim, flashing and gutter installations. While clips are smaller, individual fasteners, cleats are normally longer and sometimes formed on-site. Clips may be one-piece or multi-piece fasteners, while cleats are a single formed piece of material. Both clips and cleats are designed to be concealed and are not normally visible after installation. Figures 14-23 and 14-24 illustrate common cleat applications and profiles.

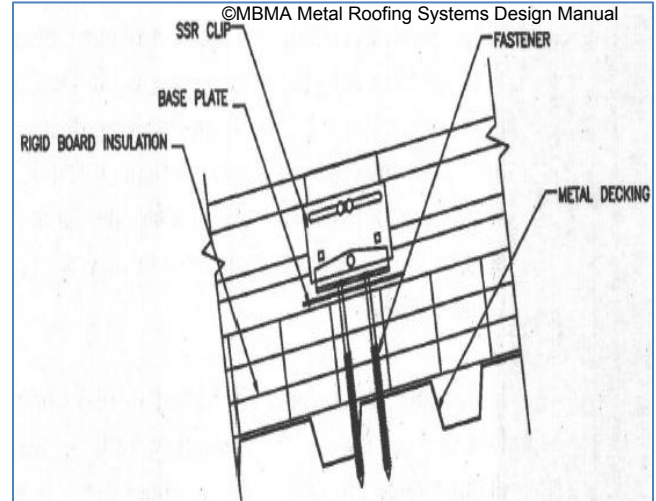


Figure 14-22
Clips Installed Over Rigid Foam May Require Different Fasteners and Base Plates

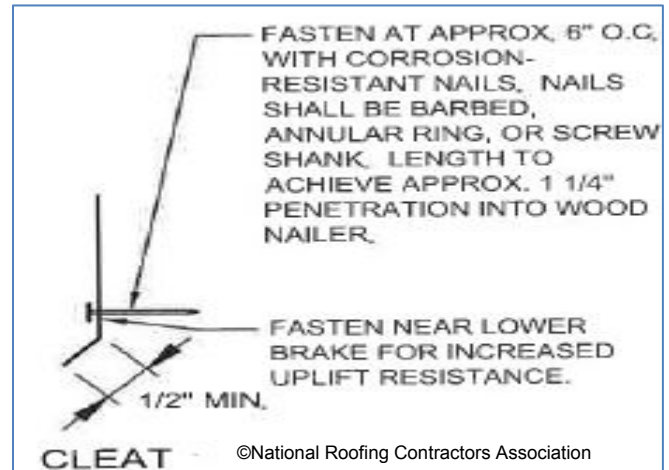


Figure 14-23
Fastening Details of Cleats

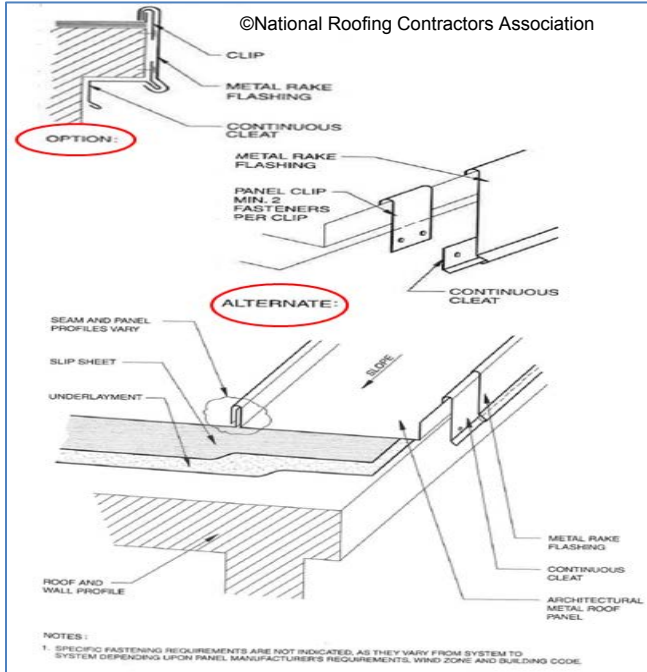


Figure 14-24
Typical Cleat Installation

**Installer Note
Fastener Handling**

Care should always be used when handling the fasteners for a metal roof system. Nails, screws, and rivets are small and are easily dropped. They are often a cause of tire damage on jobsite vehicles, can cause corrosion and staining on the roof surface, and jams in the drainage system.

Clips and cleats are quite strong when properly installed, but are easily bent and damaged before installation on the roof. Stepping on a clip or fastener which has been dropped will likely damage the clip and may dent, or even puncture the roof surface.

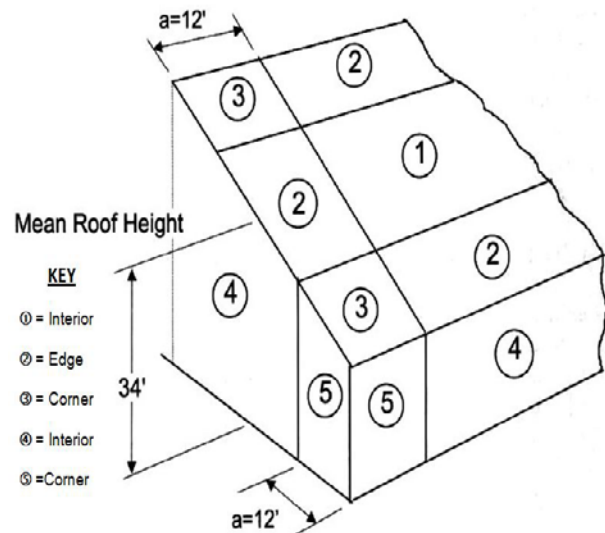
Always give extra attention when handling fasteners, especially where larger quantities, or "handfuls," are being handled at one time.

**14.3 Attaching Panels –
Fastener Spacing and Type**

Before discussing the attachment of specific types of panels, there are several key points to mention which are common to every panel type.

The spacing of fasteners will vary based on several factors. Geographic and weather conditions will determine spacing and type of fastener. A roof that must withstand stronger, even hurricane force winds will have more fasteners, and the fasteners will be installed closer together than on a roof designed for a less forceful environment.

Spacing and fastener types will vary within the roof itself. Certain portions of the roof experience different stress levels and may require additional support. This is illustrated in Figure 14-25 and explained in more detail in Section 10.2, *Uplift*.



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Figure 14-25
Different Roof Areas Experience
Different Uplift Stresses

This is why fasteners along the eaves and ridges often differ from those along panel seams. Side seams along the gable ends will often have more fasteners than those seams

which are mid-roof. Some panels, especially longer panel types, have different fastener patterns at the panel ends than at the mid-panel.

The substrate material and strength (thickness) will also be a factor in the spacing and type of fastener. A roof installed over a thick, solid deck may require fewer, further spaced fasteners than a roof over open spacing. A roof installed over widely spaced structure members is naturally limited in the number, and location, of fasteners which may be installed.

An installer should always follow the manufacturer's recommended instructions for installation methods, and the type, spacing, and location of all fasteners.

14.3.1 Through-Fastened Panels

Attaching through-fastened panels requires additional care during installation because holes must be made through the panel at each fastener location. Each hole has the potential to leak if the correct fastener is not properly installed and sealed. Through-fastened panels normally require fasteners with seals and additional sealant, and additional fasteners along the eaves and lower-end drainage portions of the roof. Typical through-fastened panel installations are shown in Figures 14-26, 14-27 and 14-28.

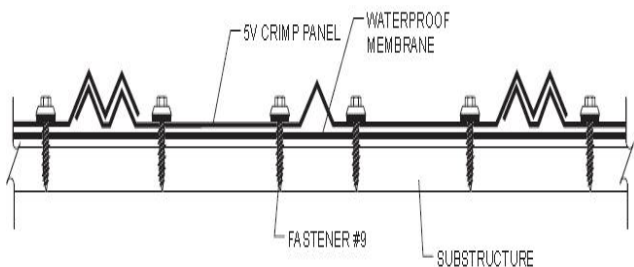


Figure 14-26
Through Panel Fastener Pattern
at Eave and Endlap Locations

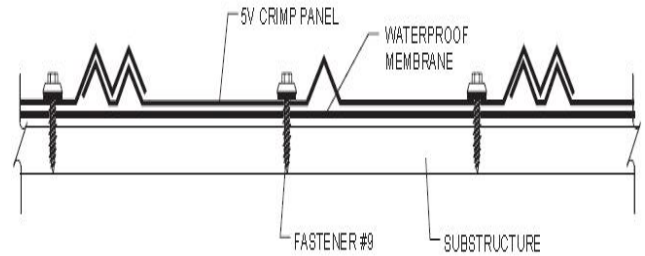


Figure 14-27
Through Panel Fastener Pattern at Mid-Panel
Locations **Note-** Only 3 Fasteners Required

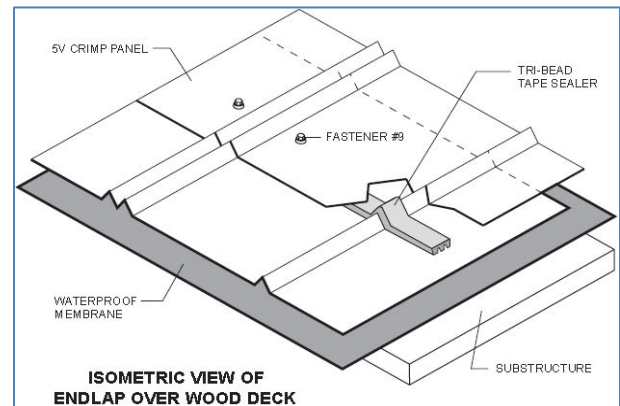
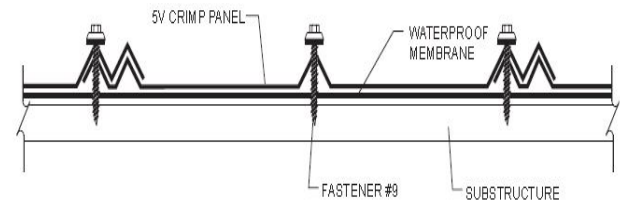


Figure 14-28
Through Panel Fastener Lap Joint

As shown in Figure 14-28, some panels have alternate methods of attachment. It is critical that every installer on the job understands and follows the same method and pattern of panel installation. An installer should not interchange these methods within the same area in order to avoid creating appearance issues.



ALTERNATE FASTENER PATTERN
Figure 14-29
Through Panel Alternate Fastener Pattern
Note – Fasteners Installed at Rib Peaks

Another concern to the installer is that the fasteners of a through-fastened panel roof are highly visible and part of the finished

roof appearance. Any fastener installation errors, such as alignment, color, repairs, or "extra" fasteners, will be visible and could become an issue. Figure 14-30 shows how the wrong color fastener affects the final appearance of the roof. Additionally the wrong fastener material was used, quickly rusted, and stained the roof. Figure 14-31 shows a close up and the correct fastener which should have been installed.

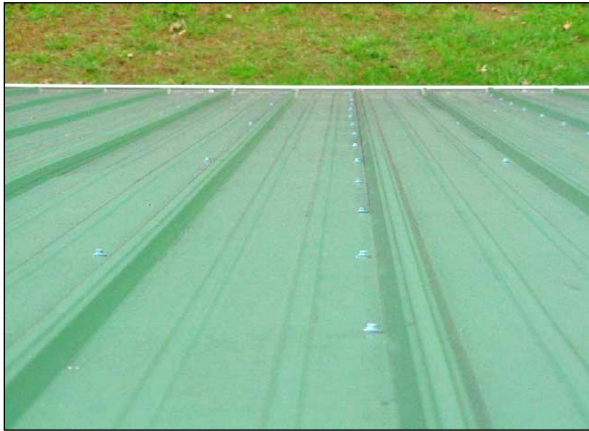


Figure 14-30
Color and Alignment Errors in Fastener Installation are Very Visible



Figure 14-31
Correct Fastener Compared to Installed Fastener

In this method of installation, "neatness counts," and every fastener must present a uniform appearance which "fits" with the entire roof installation.

14.3.2 Concealed Fastener Panels

Attaching concealed fastener panels relies heavily on the use of special clips, cleats and fasteners which are not visible after the roof installation. These are highly dependent on the panel design and profile.

Typical clip installations are illustrated in Figures 14-32 and 14-33. Few, if any, exposed fasteners are used. When necessary, these exposed fasteners are normally limited to the eaves, ridges, or unique areas with special requirements.

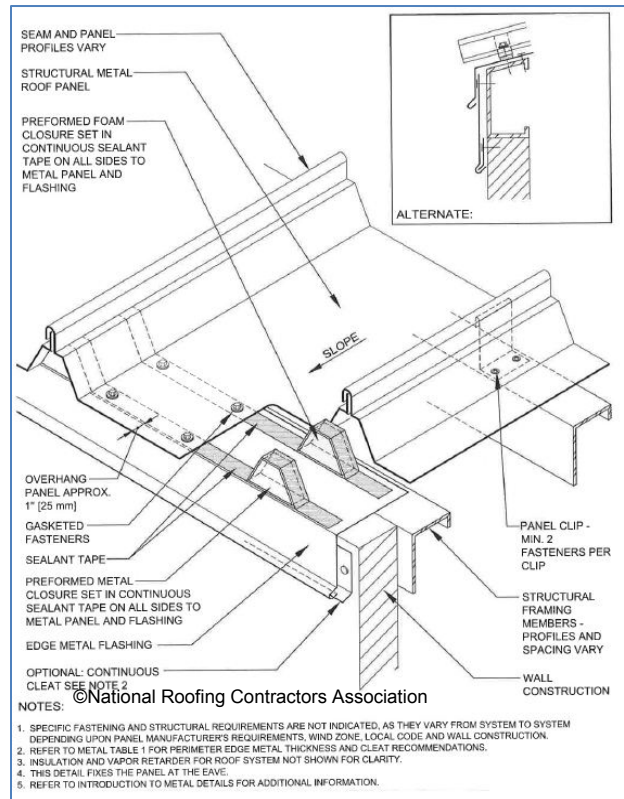


Figure 14-32
Concealed Fastener, Trapezoidal Rib Panel Installation

This type of installation requires additional attention from the installer when sealing the panel and spacing the fasteners. Clips are normally spaced closer together at the panel ends (the eave and ridge areas) and further apart at the mid-section of the panel. Clip spacing may also be different at the

gable ends or where installing a less-than-full-width panel. Different sealing requirements may occur at clip locations due to thermal movement of the panel. Often this type of panel has factory installed sealant at the seams, but still requires additional sealant and proper "marrying" of the sealant. (See Section 13.6.7, *Marrying Sealants at Critical Intersections.*)

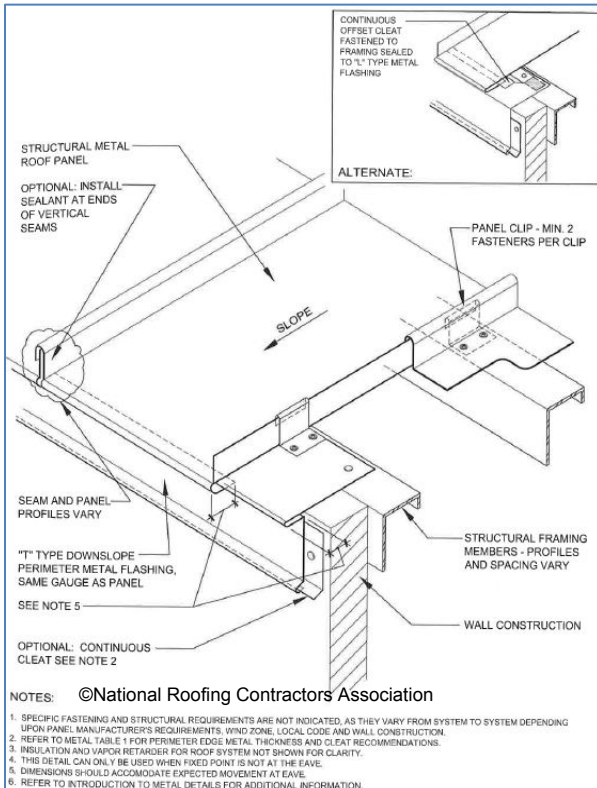


Figure 14-33
Concealed Fastener, Standing Seam Panel Installation

14.3.3 Standing Seam Panels

Standing seam roof (SSR) installations rely heavily on hidden fasteners and clips along the seams, and exposed fasteners along eaves and other locations. The installed clips are often bent and formed along with the panel when the seam is formed, normally by a mechanical seamer. These steps are illustrated in Figure 14-34. An important point for the installer to remember is that the rolled or formed seam normally bonds

and forms the individual panels into one roof membrane, while the purpose of the clips and most of the installed fasteners is to fasten and secure the roof membrane to the structure. Some installations may also require some form of mastic or sealant to be applied between panel seams. While the panel profiles and clip configurations will vary, most standing seam roof panels are installed as illustrated previously in Figures 14-32 and 14-33.

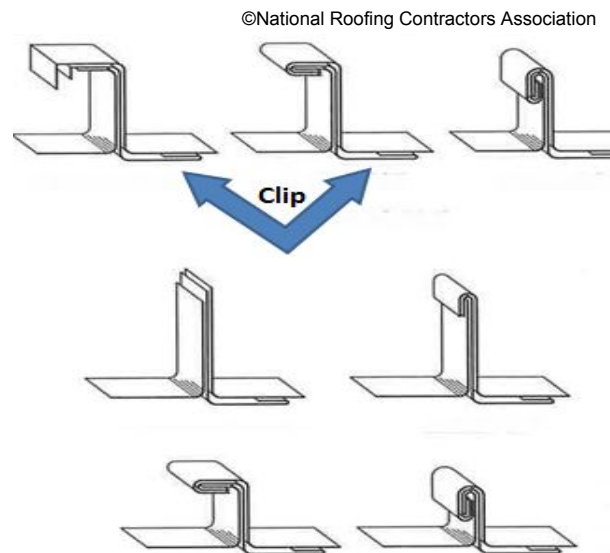


Figure 14-34
When Rolled, the Clip Becomes Part of the Seam

14.3.4 Pre-Drilling Through-Fastened Panels

Extreme care must be used if pre-drilling any roof panel prior to locating the panel in its final position. While pre-drilling panels may save labor time, allow multiple panels to be drilled at once, and maintain identical fastener patterns between panels, careful consideration must be given to the potential problems arising from panel alignment:

- Panel to other panels
- Panel straightness to roof edge
- Panel to structural members (on an open framing system)

