METAL CONSTRUCTION ASSOCIATION

Metal Roof Installation Manual

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BUILD LEGACIES METAL

Chapter 4: Panel Types

Chapter Contents

4. Panel Types

A roof panel has two main functions. The first is to provide an environmental barrier to the structure. The second is to add to the structural integrity of the roof system.

In addition to the variety of materials already discussed, metal panels are now available in countless sizes, shapes, and configurations. There are many ways to introduce and study the various types of panels available to an installer. For the purpose of this study, we will categorize and reference panels based on four questions relating to a panel's characteristics:

Orientation – How are the panels laid out and installed directionally on the roof?

Fastening Method – How are panels secured to the structure?

Structural Capabilities – Are the panels designed to support weight and span an open area (structural panels), or do they require a solid deck (non-structural panel)?

Water Shedding Capabilities – What type of water flow do the roof panels normally experience

By studying the panels in this manner, it becomes easier to see ***how*** each component works with all others to form a complete roofing system. It also provides an understanding of ***why*** certain jobs require certain panels, fasteners, or methods to be used.

NOTE

Dividing panel types in this manner makes describing the different characteristics of the panels easier, but over-simplifies the matter. In reality, most of today's metal roof panels share characteristics. The same is true of water standing (hydrostatic) and water shedding (hydrokinetic) seams and applications. Further clarification, explanation, and detail will be covered in Chapter 10, Roofing Design, and Chapter 16, Panel Installation.

4.1 By Orientation

Panels organized by orientation will be either vertically or horizontally oriented when installed.

4.1.1 Horizontal / Modular Panels

Horizontally-oriented panels run perpendicular to the slope of the roof and rake-to-rake on a typical roof. Horizontal orientation of metal roofing had its origins in Bermuda. In order to provide fresh water, metal pans or troughs were installed in tiers across the slope of the roof to divert the clean rainwater into cisterns for storage and use later. This type of roof became known as Bermuda roofing. (Figure 4-1)

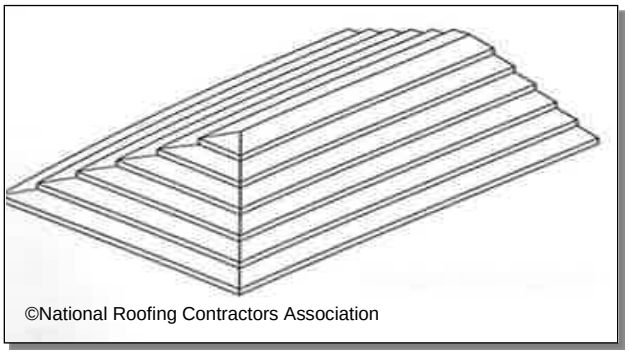

Figure 4-1
Bermuda Type Roofing

Currently, many horizontally-applied metal roof profiles are referred to as Bermuda roofing, even though most are no longer shaped like a trough and collect rain water in cisterns.

Another common type of roof panel which is normally installed horizontally uses a modular panel. Unitized panels do not emphasize the long, narrow, lines of Bermuda roofing, but vary in length from several feet to smaller individual metal tiles, to even smaller individual metal shingles as

shown in Figure 4-2. They are made to simulate the look and texture of traditional roofing materials like asphalt, slate, wood, and clay. Most modular panels are installed horizontally-oriented, similar to their traditional counterparts.

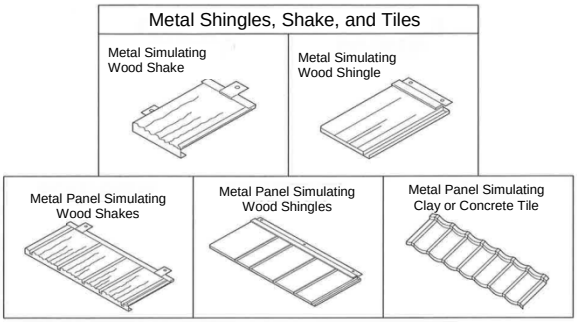

Figure 4-2
Examples of Unitized Metal Panels

4.1.2 Vertical Panels

Metal roof panels which are vertically-oriented normally run from eave-to-ridge, or valley-to-hip. This type of panel is the most common type of metal roof that people envision when they think of a metal roof. Thanks to modern production methods, and on-site roll-formers, individual panels can be up to 40 feet or more in length. This type of panel, more than any other, seems to offer the most variety to the customer. Vertical-type roof panels also present the most variety and challenge to the installer. (Figure 4-3)

Figure 4-3
Vertical Roof Panel Installation

The variety of vertical panels is so great that further divisions are necessary. They can be further defined by their profile configuration, how they are fastened, and what type of side seams they use. Initially, three styles will be investigated: standing seam, through-fastened, and batten seam panels.

4.1.2.1 Standing Seam

A very large category of vertically oriented panels is known as standing seam panels, or standing seam roofs. Often abbreviated as SSP or SSR, this panel type is identified by its adjacent panel edges which are bent up to 90°, then folded over the adjacent panel edge to form a tight joint. Sometimes two folds are used, forming a 360° joint.

Many variations of this seam are shown in Figure 4-4. They all "stand" 90° to the roof surface and raise the panel seam above the roof surface. Depending on the style, the seam stands ¾" to over 3" above the roof surface minimizing the potential for water leakage.

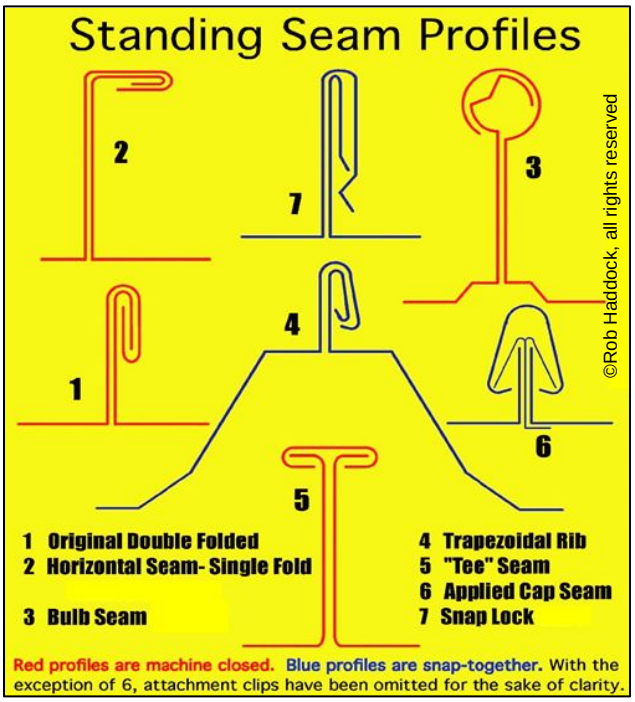

Figure 4-4
Examples of Standing Seam Profiles

The installation of the SSP will vary according to how the panel is made. Installation may involve using a portable seamer (Figure 4-5), a separate seam cap which snaps or slides into place, or an integrated locking system built into each panel. Always read and follow the instructions provided by the manufacturer specific to the type of panel that is being installed.

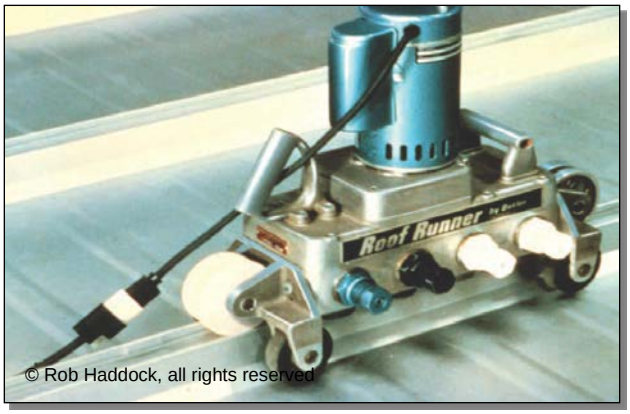

Figure 4-5
Portable Seamer for Standing Seam Panels

4.1.2.2 Through-Fastened

Vertically oriented panels can also be divided by how they are fastened. Through-fastened panels are installed using threaded fasteners with washers. The fastener actually punctures and "goes through" the panel, while the washer provides leakage protection around the hole. These fasteners are external to the panel and are visible after the roof is installed as shown in Figure 4-6.

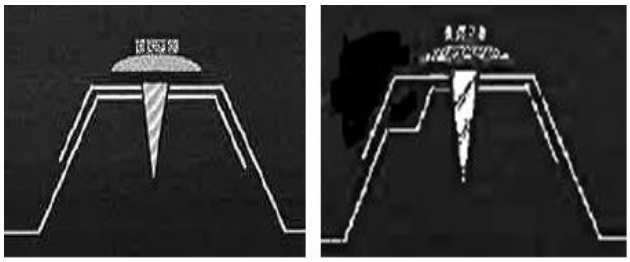

Figure 4-6
Through-Fastened Vertical Panel Installation

Vertically oriented panels can also be installed using other methods. These may involve separate clips, hidden fasteners, and other fastening devices. Fastening methods will be discussed in more detail later in this chapter within Section 4.2.

4.1.2.3 Batten Seam

When metal roofs migrated from the Middle East to Europe, metal roofing profiles adapted to the styles of architecture and climate of Western Europe and Scandinavia. Snow and ice often damaged normal standing seams. Strips of wood were inserted between the adjacent standing edges. These strips support the seam area, increasing the durability of the standing seams, and created a new seam style called the "batten seam," so called because of the wooden batten strip, as shown in Figure 4-7.

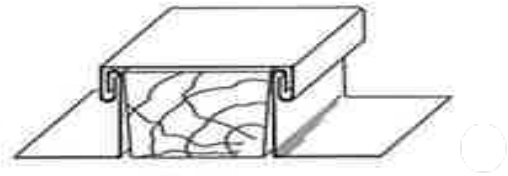

Figure 4-7
Batten Standing Seam with Wooden Batten

A significant addition to the batten joint was the introduction of a separate joining component called the batten cover. This cover fastens or locks, onto the two standing edges and completes the joint. A modern batten joint is shown in Figure 4-8.

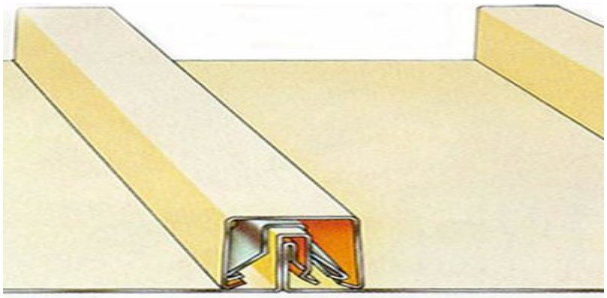

Figure 4-8
Modern Batten Seam with Snap-on Cover
Note – No Wooden Batten

A variation of the batten seam, called the batten roll, uses a raised "lap seam" formed into the panel. There is no separate batten cover. Although this “batten roll” style was developed for lead roofing to provide more gentle radii for this unique material, modern forming techniques also use this style of joint for steel panels. A modern roof using Batten style panels is shown in Figure 4-9.

Figure 4-9
Modern Batten Style Roof

4.2 By Fastening Method

All metal roof panels are fastened to the structure via a combination of fasteners and clips designed just for that purpose. Vertical metal roof panels are sometimes sorted by how they are fastened. Most are secured using one of the fastening methods below:

- Through-fastened
- Hidden or concealed fasteners

Each method uses a combination of standard hand tools, and pneumatic, electric, or battery-powered devices for panel installation.

INSTALLER NOTE

While the ***method*** of installation will be similar, the ***exact*** fastener, clip, spacing, and similar required details may vary between jobs due to design considerations. These design considerations may include such things as roof load, wind and climate considerations, roof substrate and other issues. These issues should be addressed with each particular roof panel manufacturer.

4.2.1 Through-fastened

As mentioned in the previous Section, 4.1.2.2, and shown in Figure 4-6, through-fastened panels are installed using threaded fasteners with washers. The fastener actually punctures and “goes through” the panel, while the washer seals around the hole and provides leakage protection. These fasteners are external to the panel and are still visible after the roof is installed. Through-fastened panels require extra care installing the fasteners to ensure proper sealing, and may have length limitations due to thermal movement.

4.2.2 Hidden or Concealed Fasteners

Another method of fastening panels uses hidden or concealed fasteners. These come in a variety of styles specific to the panel being installed, and any job specific considerations as mentioned previously. Figure 4-10 shows a sampling of available clip styles.

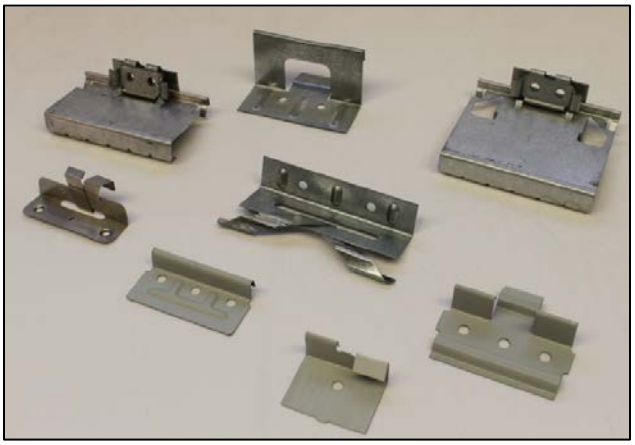

Figure 4-10
Examples of Clips Used For Panel Installation

When properly installed, there are no visible fasteners on the main roof surface except at the eave. This style of installation, as illustrated in Figure 4-11, is often used in commercial and residential installations where a roof’s appearance is a major consideration, in addition to protection from the environment.

4.2.3 Panel to Panel, Side Seam

In addition to fasteners and clips, roof panels require some method to connect or fasten to the other panels making up the roof surface. This is often accomplished by a snap seam or mechanical interlocking connection. During the manufacturing of the panels, certain profiles are formed, and close tolerances held, which enable the panels to be virtually identical in every aspect. When installed properly, the close tolerances allow each panel to snugly "nest" within the profile of the panel next to it. The panels will actually snap into place and provide additional strength and protection.

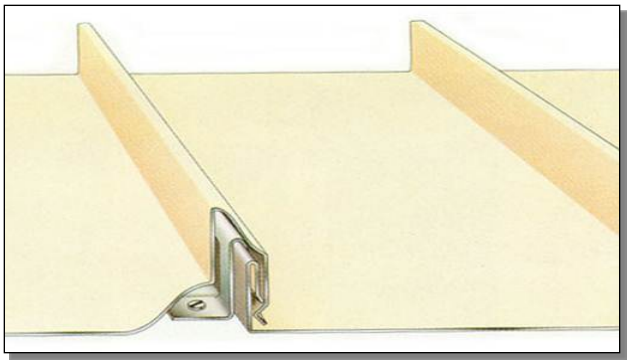

Figure 4-11
A Snap Together Seam Panel

In addition to the snap together seam, many other interlocking methods are used by various manufacturers and product lines. They have many names, and an example is shown in Figure 4-12. Always follow the manufacturer's installation instructions for the panel being installed.

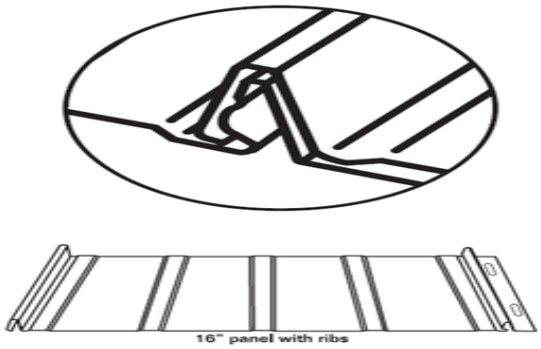

Figure 4-12
Example of Interlocking Side Seam

4.3 By Structural Capabilities

Any study of metal roofing would be incomplete without a knowledge and understanding of the difference between structural and non-structural, panels. In spite of the vast variety of materials, fastening methods, and finishes available, all panels may be classified as structural or non-structural. They are designed to handle entirely different roof loads and often require different substrates, fastener layouts, and other installation techniques.

4.3.1 Structural

In addition to weather protection, a metal roof consisting of structural panels will also provide roof load transfer to the structure. Individual structural panels have superior structural properties allowing them to span greater distances unsupported. They normally do not need a solid substrate for strength or moisture protection (Figure 4-13).

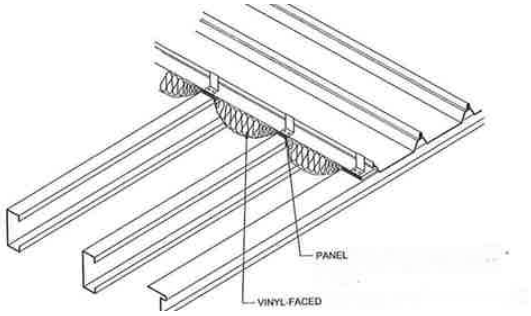

Figure 4-13
Open Substrate for Structural Roof Panels
Note- This Installation Uses Insulation

Most of the strength of the structural panel comes from the addition of formed ribs. These ribs usually run parallel to the length of the panel. Some panel profiles also use horizontal ribs. The rib profile of a typical structural panel will have high, side ribs and may also have lower, stiffening ribs, often referred to as intermediate ribs. The rib shape also affects the strength of the panel. Common rib shapes are vertical, trapezoidal; half round, and wider, flat, low-profile ribs.

The most common design profiles are trapezoidal and vertical leg. Many manufacturers use profiles similar to those shown in Figures 4-14, 4-15, and 4-16.

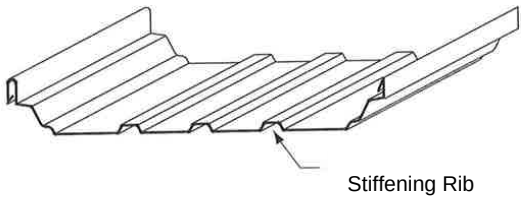

Figure 4-14
Trapezoidal Rib profile

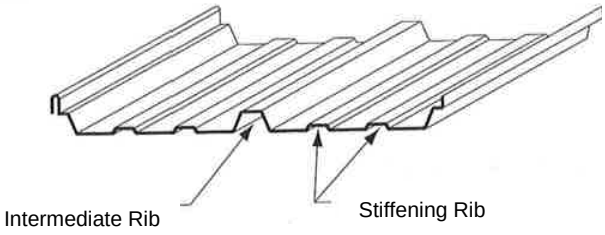

Figure 4-15
Intermediate Rib Profile

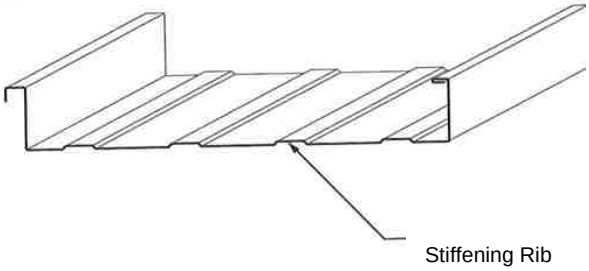

Figure 4-16
Vertical Rib Profile

Minimum slope for structural metal panel roofs can be as low as ¼ inch per foot (1.2°). Always consult the panel manufacturer for recommended minimum roof slope.

It should be noted and understood that, at times, structural steel roof panels are used in places where non-structural, architectural style panels would be acceptable, or normally used. This presents no problem structurally. The opposite, though, is **NOT** true, and cannot be performed. Non-structural, architectural style panels **CAN NOT** be used where structural panels are required. This is explained in the next section.

4.3.2 Non-structural

Non-structural-style metal roof panels are used where appearance, in addition to weather protection, are major considerations in a roof system. Non-structural panel profiles are typically characterized by vertical seams, giving these panels a neat, clean appearance when installed, as shown in Figure 4-17.

Figure 4-17
Architectural Panel Roof System

A solid deck, Figure 4-18, or a support system with very close spacing of its support members, may be required to help support the roof load. Architectural panels may also require more fasteners than structural panels when installed.

Many, though not all, non-structural-style panel systems are considered to be hydrokinetic, or water-shedding, type systems. This will be explained in detail in Section 4.4.1, the next section in this chapter. Because some of these roof system depend on shedding water, the panel joints may not be sealed or have gaskets.

Figure 4-18
Solid Substrate, with Underlayment, For
Installation of an Architectural Panel Roof

Under extreme weather conditions, even properly installed roof systems of this style may leak some moisture. Therefore, most, but not all, non-structural style panels are installed over some form of water-shedding underlayment.

Since this roof style is designed to shed water rapidly, the roof slope needs to be adequate for proper water removal. A slope of 3 inches per foot (14°), or greater, is often specified by the panel manufacturer.

4.4 By Water Shedding Capabilities

There are two types of roof systems based on their water shedding ability: hydrokinetic and hydrostatic. As referred to in Sections 4.4.1 and 4.4.2, metal roof panels are also identified in this manner.

Before looking at these two systems individually, the potential problem of roof leakage needs to be addressed. Metal does not leak. Any leakage in a metal roof can usually be traced to four root causes: penetration, improper installation, design deficiencies, and extreme weather events. Penetration may be intentional, such as a through fastener or roof vent, or it may be accidental, such as panel damage. Improper installation, causing gaps and twists, missing sealant, loose fasteners, and similar installer errors may cause leakage. Sometimes a metal roof leaks even though it is properly designed and installed. This may happen from extreme weather events, problems with roof-mounted equipment, and other uncontrollable factors which cause the roof to experience conditions outside of its designed range of protection.

4.4.1 Hydrokinetic, or Water Shedding

The word hydrokinetic is comprised of two parts: "hydro" meaning water and "kinetic" pertaining to movement. Hydrokinetic roof panels are designed to shed moving water. Panels and joints are designed to direct water away from potential areas of leakage, as can be seen in Figure 4-19.

Figure 4-19
Hydrokinetic Roofs Are Designed to Deal with Moving Water, Often in Large Volumes

Hydrokinetic roof panels perform best when used in steep roof applications, and a primary consideration of this style roof (steep roof) is appearance. Within the industry, the terms "steep roof," "hydrokinetic roof," and "architectural roof" are often used interchangeably (Figure 4-20). Many of these panels are also considered non-structural panels.

Figure 4-20
The Terms Hydrokinetic Roof, Steep Roof, and Architectural Roof Are Often Used Interchangeably

An installer needs to remember that such panels and roof systems are not designed for areas of slow-moving water, or roof areas prone to flooding. Additional protection may be needed in areas prone to ice damming and snow build-up, or areas where different roof surfaces meet, such as valleys. Details of this additional protection will be covered in later chapters especially Chapter 10, Roof Design.

4.4.2 Hydrostatic, or Water Resistant

The word hydrostatic is comprised of two parts: "hydro" meaning water and "static" pertaining to fluids not in motion. Panels, joints, and seams are designed to prevent slow-moving water from entering the area protected by the roof.

Hydrostatic installations must consider a panel's weathertightness, as well as its water shedding ability. This style roof is common to large industrial and commercial roof projects as shown in Figure 4-21.

Figure 4-21
Hydrostatic, Low-Slope Roofs Must Address Slow-Moving Water Issues

"Low slope metal roof systems" are sometimes called "hydrostatic metal roof systems." This makes sense since "low slope," in a roofing context, means *very* low slope, nearly flat. A roof of this style is designed and installed to handle large volumes of slow-moving water under normal conditions.

During low slope, hydrostatic installations, special attention is given to seams and joints, valleys, and areas around roof mounted equipment and projections. Often these installations involve more sealant, gaskets, and fasteners than other roof types, since joints and seams may be submerged at times. Slow-moving water also adds pressure to the roof surface which may force moisture past seals, joints, and areas that would normally repel moving water. Proper installation will minimize drainage and leakage problems like those shown in Figure 4-22. These issues will be detailed within Chapter 10, *Roof Design*.

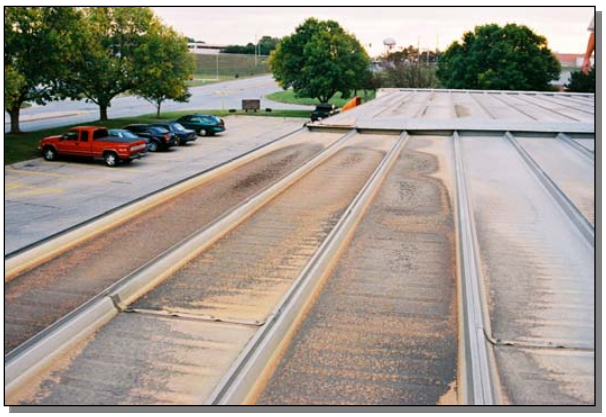

Figure 4-22
Special Attention Must Be Given During Installation to Avoid Drainage Problems

Notes: