Metal Roof Installation Manual

Chapter 6: Roof Deck Substructures

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BUILD LEGACIES METAL

Chapter 6: Roof Deck Substructures

Chapter Contents

6. INTRODUCTION

The roof substructure is an integral part of the roof system. It lies just beneath the metal roof panels and serves two primary functions.

First, it acts as a base to which the metal roof material is attached. For metal roofs, the roof substructure secures the fasteners and clips used to hold the panel. Fasteners and clips are attached into the substructure.

Secondly, the roof substructure serves as a structural member, transferring the weight of both live and dead loads to the supporting joists or purlins. Live loads include wind, snow, rain, and moving installation equipment, including foot traffic, which a roof may encounter. Dead loads include HVAC units and the weight of the roof materials including the roof deck itself. Most decks must also act as diaphragms, transferring wind, and other lateral forces, such as seismic movement, to the building's structural frame.

Several additional roof substructure requirements of particular interest to the installer include:

- Providing proper slope for positive drainage. A properly sloped roof should show no evidence of standing water 48 hours after it stops raining.
- As an example, limiting deck deflection to 1/240th of the total span in accommodating the designed, concentrated, or uniform load. This amounts to a deflection of 0.20" for a 300 pound load using a 4 foot span. Deflection limits for common spans are shown in Figure 6-1.
- Accommodating the movement of roof system components, such as thermal expansion and contraction of metal roof panels.
- Two major roof substructure designs are used to perform these functions and meet the requirements mentioned above. They are referred to as open framing and solid deck substrates. Their names reflect their construction characteristics and are detailed below in Sections 6.1, *Open Framing,* and 6.2, *Solid Decking*.

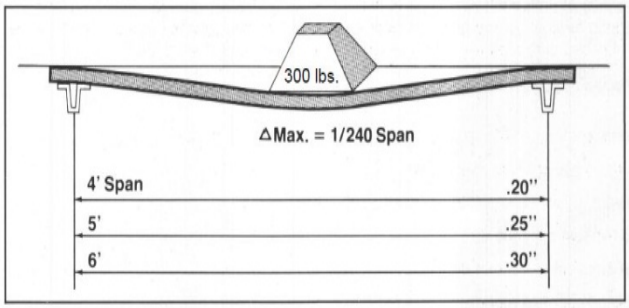

Figure 6-1
Roof Deflection Limits

Installer Note

An installer's main concern with either type of substructure is the substructure surface itself. Each surface must be suitable for the application of the metal roof, and carefully inspected prior to installation. The surface should be smooth, straight, and free of humps and depressions. A solid deck should be swept and clean, free of any fasteners, litter, or debris. The roof sub-structure should be aligned vertically, square. Any surface imperfections will be transferred through the roof panel, and be visible after the roof is installed.

Joist manufacturers routinely build camber into their joists. Camber builds a curvature or "pre-stress" into the joist which "flattens" after there is a load on the joist. Camber that may be appropriate for a floor system supporting relatively heavy dead loads may not be appropriate for roof joists, which support relatively light dead loads. The "hills" and "valleys" created by camber on roof joists (especially on longer spans) may be aesthetically unacceptable and make installation more difficult. For this reason, roof joists using less, or no, camber than the manufacturer's standard amount, are specified and used. If not confirmed, any such errors may not be visible until the roof installation has begun.

6.1 Open Framing

The open frame substrate uses secondary framing members to secure the roof panels and fasteners. Commonly called purlins, bar joists, or similar names, these members may be made from wood or metal. They may be individual pieces of wood (Figure 6-2a), formed steel (Figure 6-2b), or truss-like members built from multiple individual pieces (Figure 6-2c).

Open framing must only be used with structural-style panels whose design is capable of both supporting the weight and spanning the dimensions of the open areas of the job.

Installer Note

Installers must make sure the fasteners used to secure roof panels are correct for *both* the type of panel being used *and* the substrate (metal or wood) used on the job.

Individual safety must be considered in every type of installation. Open framing installation involves large open areas with no support, and the risk of falling, as well as dropping materials or tools, is greatly increased. This risk applies to those working **on** the roof, as well as those working **beneath** the open spans during roof installation. Additional safety equipment may be required on open framing installations.

6.2 Solid Decking

A solid deck substrate consists of solid sheets, panels, or very closely spaced deck members to which the roof membrane is applied. The deck members may be made of wood, metal, or composite materials. Our focus in this chapter will be on decks made from wood and metal.

Solid decking **must** be used with non-structural style panels. Structural panels do not *require* a solid deck, but *may* be installed over one, if desired.

Solid deck roof designs may or may not have rigid insulation included as part of the installation. Rigid insulation will be discussed later in this chapter and in more detail in Chapter 10, *Roofing Design*.

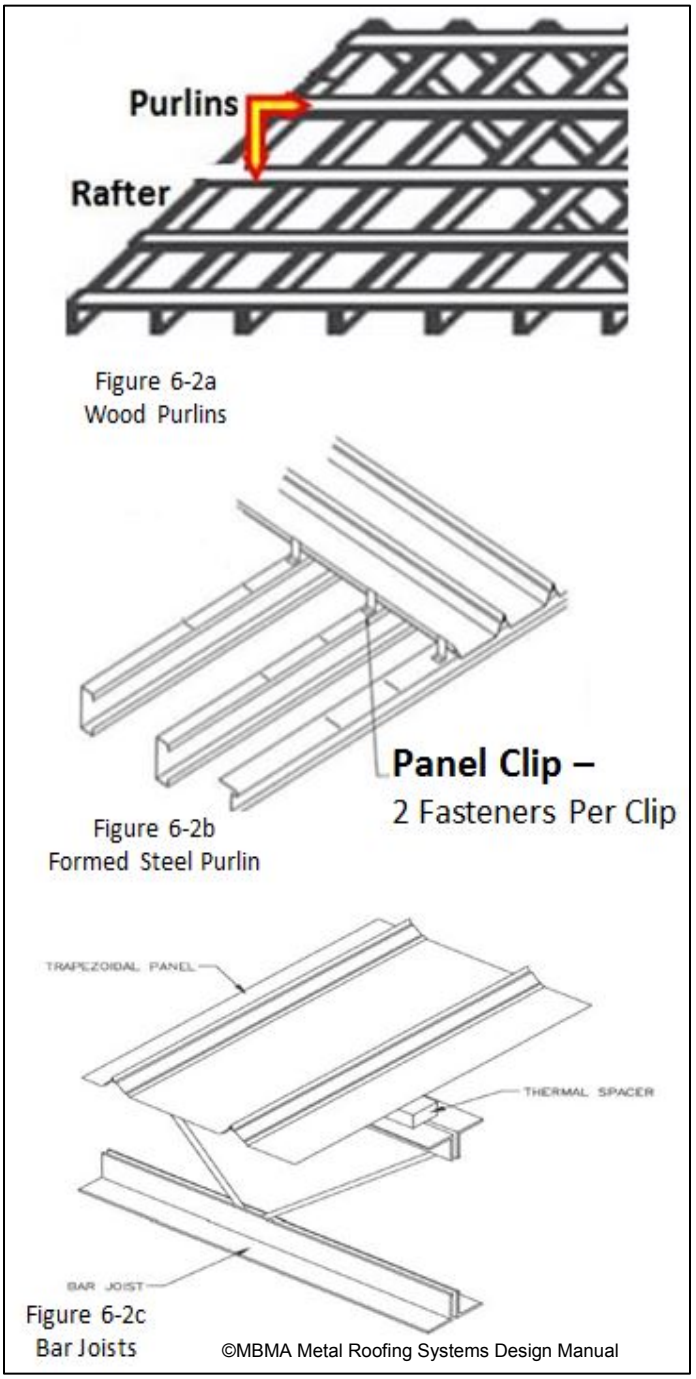

Figure 6-2
Common Open Framing Styles

Underlayment

Some roof deck materials require some sort of underlayment before metal roof panels are installed. Many may require both an underlayment and what is called a slip sheet. Underlayment normally comes in rolls, and is available in a variety of materials as shown in Figure 6-3. Figure 6-4 shows the most commonly used underlayment known as asphalt saturated felt or roofer's felt.

Figure 6-3
A Variety of Underlayment Material Is Available

Underlayment provides a:

- Separation between the roofing panel and the roof deck, or substrate.
- Proper drainage path, normally to the eave, for any water that may leak under the roof panel.
- Level of secondary weather protection.

Figure 6-4
The Most Common Underlayment Is Asphalt Saturated Felt or Roofer's Felt

Underlayment material needs to be supported, and is not used on open framing roof systems.

Most underlayment material is either asphalt, synthetic, or polymer-based. This material tends to grab and stick to a roof's metal panel causing the underlayment to stretch and tear as the panel thermally expands and contracts. Once stretched and torn, the underlayment fails to provide protection to the roof structure. Therefore, some applications may require a slip sheet to be installed on top of the underlayment. A slip sheet provides a surface between the underlayment and the roof panel that allows the roof panel to freely expand and contract without sticking to the underlayment. The slip sheet can be clearly seen in Figure 6-5.

Figure 6-5
A Slip Sheet Is Often Installed Between the Underlayment and the Roof Panel.

If underlayment and slip sheets are used, they should be inspected for proper installation and damage before installing the roof panels. The underlayment and slip sheet can be easily damaged by careless sliding of material, dropped tools, and installer carelessness during panel installation. Installation details will be covered in Chapter 10, *Roof Designs*.

6.2.1 Wood Deck

Wood is a versatile material often used for construction of a solid roof deck. Plywood,

oriented stranded board (OSB), and individual wood planks are different forms that are used as solid roof decks.

Plywood

Plywood is popular for both residential and commercial decking, like the deck in Figure 6-6. All roof deck plywood should be American Plywood Association (APA) rated sheathing.

Figure 6-6
A Plywood Solid Roof Deck Substrate

Most building codes require a label on wood panels, ensuring compliance with the standards set by the Department of Commerce,[1] or the American Plywood Association.[2] It is recommended that wood panels bear the APA trademark and have a smooth surface upon which to install the roof panel. Two different plywood stamps are shown in Figures 6-7a and 6-7b.

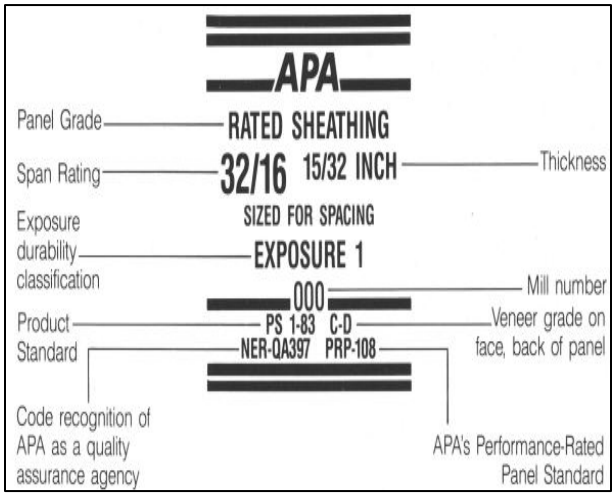

Figure 6-7a
Plywood Stamp Conforming To Department Of Commerce Standard PS 1-83

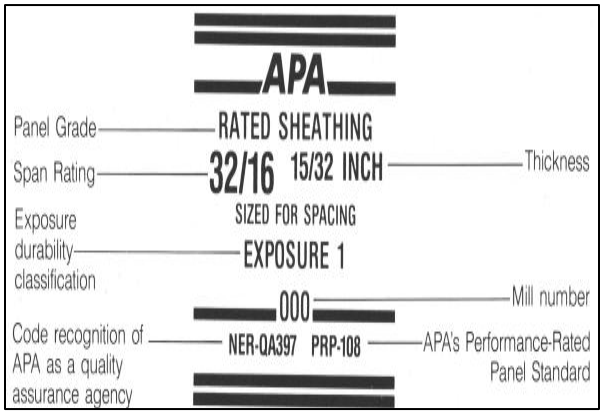

Figure 6-7b
Plywood Stamp Conforming To APA Performance Standard PRP-108

The span rating is of particular interest to anyone making a panel repair or replacement. Both examples in Figure 6-7 are rated 32/16. The left-hand number (32) indicates the maximum center-to-center spacing of supports, in inches, when the panels are installed with the long dimension running across the supports. The right-hand number (16) indicates maximum center-to-center spacing of supports, in inches, when the panels are used as sub-flooring in a double flooring application. In both applications, it is assumed that the panels are continuous and extend over two or more spans.

[1] Standard PS 1-83, all veneer plywood

[2] Performance Standard PRP-108

The minimum thickness of any plywood panel used in a roofing application should be a nominal 15/32", end joints should be staggered, and the correct fasteners should be used for the installation design requirements.

Oriented Strand Board (OSB)

Like plywood, OSB is often used in both residential and commercial applications. Oriented Strand Board is made from rectangular-shaped wood strands which are cross-oriented, compressed, and glued together with waterproof glues. The cross-oriented construction gives OSB material added strength and rigidity in both directions. Any OSB used for roof decking should be APA rated sheathing, and have a minimum thickness of 15/32".

Wood Plank Decks

Individual plank roof decks are typically used where their appearance from *inside* the building is a primary consideration. The boards may be solid lumber or laminated boards. Solid wood boards may have square edges, ship-lapped ends, or tongue and groove edges for installation. Laminated boards often have a tongue and groove edge for installation.

Wood plank decks should have a minimum thickness of one inch. Fastener type and spacing are determined by the design requirements of the individual installation. Any repair or replacement of a wood plank deck should match the original material, fasteners, and fastening pattern as closely as possible. Any variation may affect the deck strength and be visible through the installed metal roof panel.

6.2.2 Metal Deck With, or Without, Rigid Insulation

A solid metal roof deck is constructed from individual formed steel panels. These panels have formed ribs for strength and rigidity. Various rib profiles and sheet gauges are available and are selected to match the design requirements of the roof. Three common profiles are shown in Figures 6-8a, 6-8b, and 6-8c.

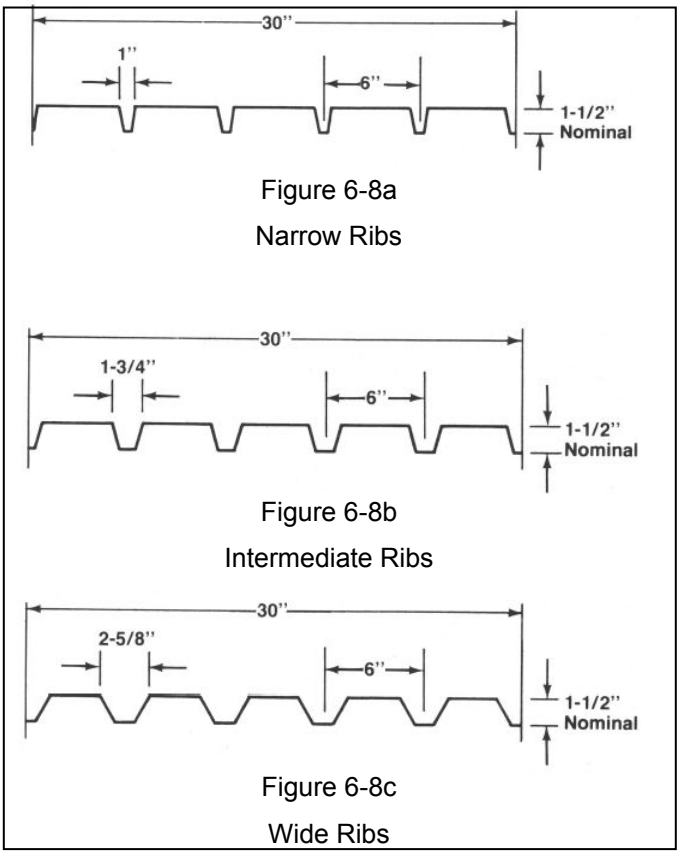

Figure 6-8a
Narrow Ribs

Figure 6-8b
Intermediate Ribs

Figure 6-8c
Wide Ribs

Figure 6-8
Common Rib Profiles

Most recommendations call for a minimum gauge of 22 and a G90 galvanized coating. Metal deck material may be fastened to the support structure by welding where a metal structure is used, or by mechanical fasteners. Weld spacing, fastener type, and spacing are based on the design requirements of the roof and will vary. Welding and metal deck installation also has additional safety and health precautions depending on methods and materials used. Always read and follow applicable warnings, cautions, and advisories.

Rigid Insulation

Rigid insulation is often installed as part of the roof installation. A properly insulated building uses less energy in both heating and cooling. However, insulation does not provide a suitable fastening surface for fasteners; therefore, several methods are used to provide panel support.

Roof panel clips and bearing plates may be used on top of the insulation as shown in Figure 6-9. Note the metal bearing plate on top of the insulation which provides a solid surface for the clip.

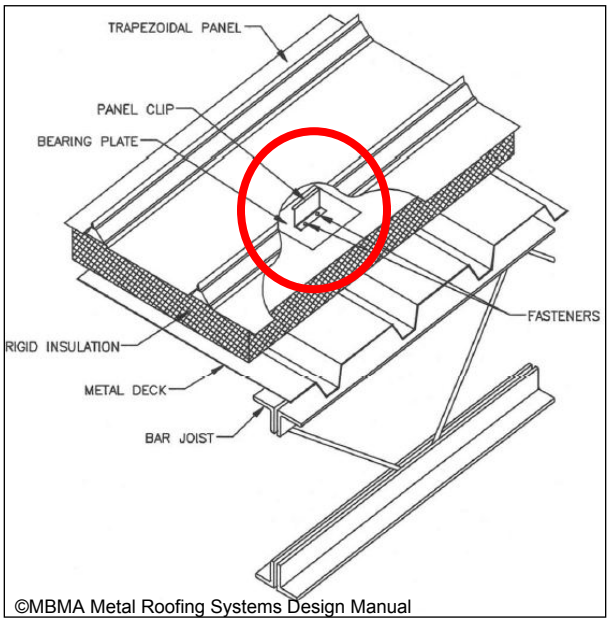

Figure 6-9
Rigid Insulation Using Bearing Plates

Another method uses steel z-shaped purlins between the insulated panels. Figure 6-10 shows how these z-purlins provide a solid surface for fastening the panel clips and fasteners.

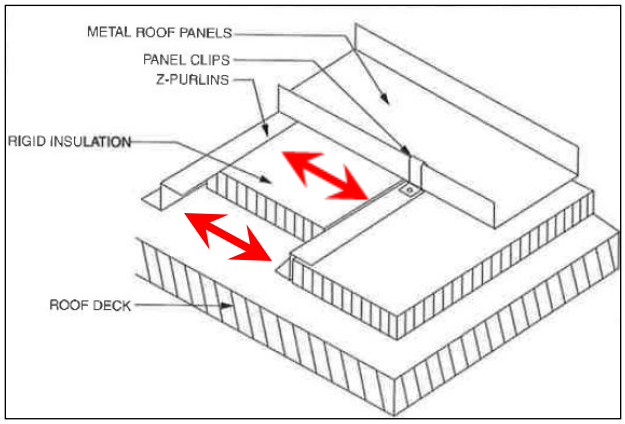

Figure 6-10
Rigid Insulation Using Z Purlins

One method of installing rigid insulation uses purlins or battens between the sheets of insulation. This provides a consistent surface for panel installation.

In summary, the roof deck is the structure to which the metal roof panels are attached. Understanding roof decks is an important key in the proper installation of a metal roof. The type and style of the roof deck will affect fastener selection and spacing, and determine additional steps that an installer may need to perform in order to properly install the roof. Additional items, like underlayment, slip sheets, or insulation, directly affect how an installer performs the work and what specific items to check before roof installation can begin.

Notes: