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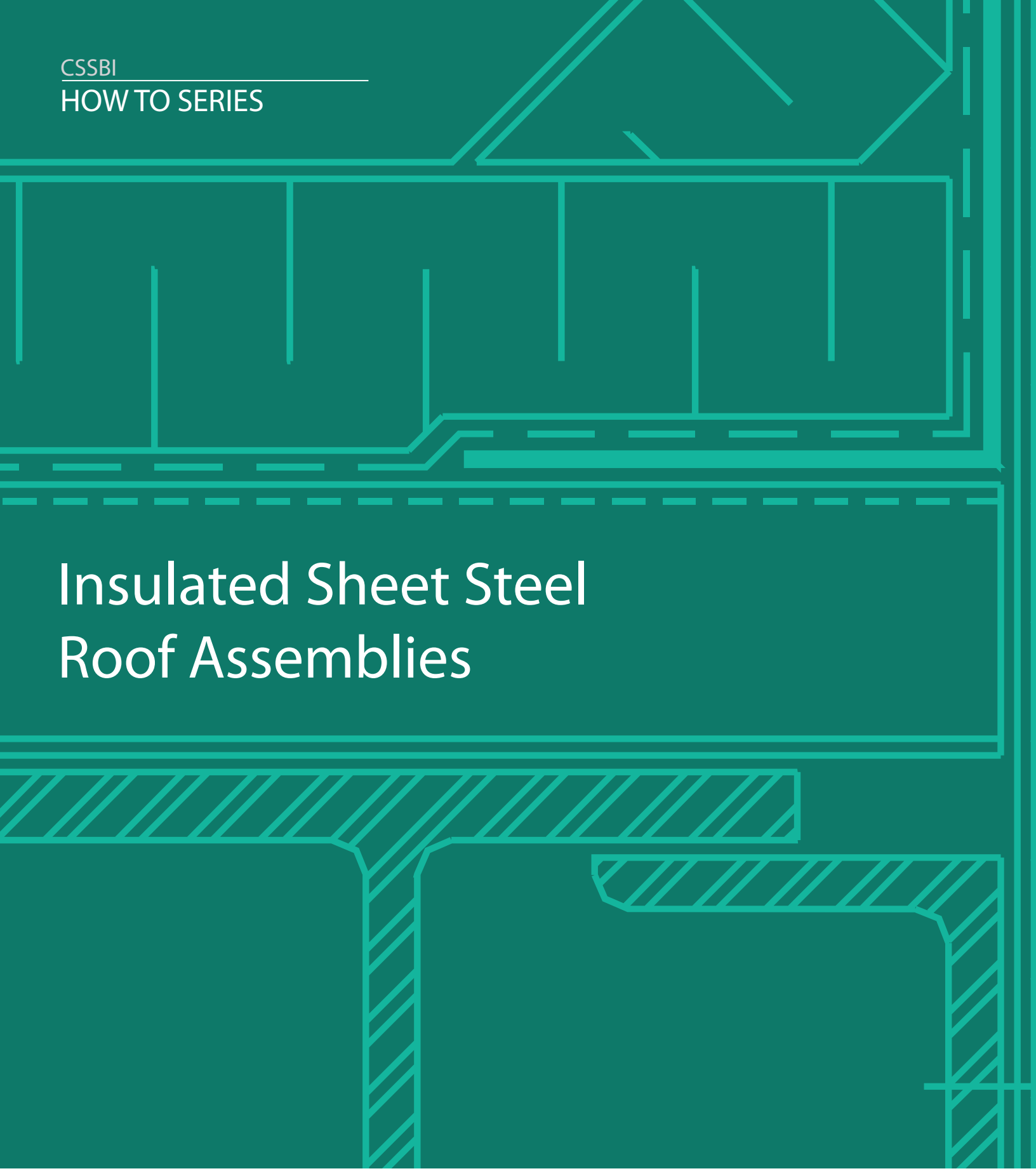
HOW TO SERIES

Insulated Sheet Steel Roof Assemblies



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HOW TO SERIES

Preface

This *How To Series* publication is an educational tool intended to give guidance to anyone specifying sheet steel building products. This particular publication deals with sheet steel roof assemblies for architectural, industrial and commercial applications. It does not address the many residential and agricultural roofing applications for steel. Insulated sheet steel roof assemblies are made up of sheet steel roof cladding, a cavity for insulation, and an interior sheet steel liner sheet or structural deck.

This guide will go through the various stages in the selection of sheet steel roof assembly components, describe the different roofing products, discuss architectural and structural design issues, as well as building science topics and material selection. The purpose is to promote quality construction and effective design solutions. This is a generic guide giving the basic details and should only supplement the specific recommendations or design guidance published by the manufacturer appropriate to their own products. The standard details presented in the Appendix show only those products normally supplied by the sheet steel fabricator. Other suppliers and trades are responsible for collateral material.

The material presented in this publication has been prepared for the general information of the reader. While the material is believed to be technically correct and in accordance with recognized good practice at the time of publication, it should not be used without first securing competent advice with respect to its suitability for any specific application. Neither the Canadian Sheet Steel Building Institute nor its Members warrant or assume liability for the suitability of the material for any general or particular use.

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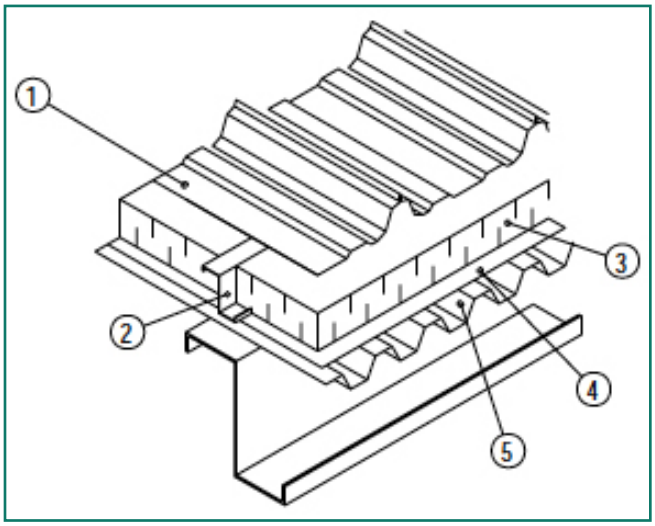
What is an Insulated Sheet Steel Roof Assembly ?

There are a wide variety of insulated sheet steel roof assemblies on the market today. As with traditional low slope membrane roof systems, each sheet steel roofing system is best suited to its own specific applications.

When choosing an insulated sheet steel roof assembly, it is important to look first at the project requirements. The designer must decide if the roof will be steep or low slope, whether solid decking will be used to support the roofing panels, or if the panels will span from one structural member to the next. The designer must carefully consider climatic conditions to which the roof will be exposed, the occupancy or interior conditions so that moisture control and ventilation needs can be properly dealt with, and what type of aesthetic properties the roof must have.



A typical insulated sheet steel roof assembly is one that has the following basic components: (1) exterior roofing sheets and flashings, (2) sub-girts and/or clips, (3) insulation, (4) air/vapour retarder, and (5) a structural decking or substrate. Other systems will have different components specific to their designs.

Why Use Prefinished Sheet Steel?

Sheet steel is a material that is exceptionally durable, yet has the versatility to meet the most demanding and innovative designs.

Prepainted sheet steel is **versatile**. It is available in a wide range of thicknesses and shapes - ranging from shallow corrugated to hidden fasteners, batten and tile styles, and low slope seamed structural profiles. It is easily integrated with other building materials and can be manufactured to meet the loading requirements of any building design.

Prepainted sheet steel is **durable**. Coating systems have been developed and proven over the past 50 years in a diverse range of environmental conditions. Prepainted sheet steel has been successfully incorporated into numerous types of structures across North America, from the extreme climatic fluctuations of the Arctic, to the acid rain environments of heavy industry, and to severe conditions in coastal maritime locations.

Prepainted sheet steel is **colourful**. A rainbow of possibilities allows creative opportunities to design projects with a palette of colours as diverse as the imagination. The choices can seem limitless, providing the ability to design colour into a building so it stands out on the horizon or blends into the neighbourhood. With an adequate order quantity, corporate colours can be matched to establish a client's image or just a touch of colour can be added to heighten the aesthetics of the project.

Prepainted sheet steel is **economical**. It offers the benefits of a lightweight roll formed product allowing structures to be designed using economical components with the added advantage of having the flexibility of incorporating efficient insulation packages into the building envelope. Thanks to the versatility and range of quality prefinished sheet steel profiles, there are steel roof systems available to accommodate any budget. Studies have also shown the life cycle cost benefits of steel roofing.

LIFE CYCLE COSTS OF VARIOUS ROOFING MATERIAL				
Type	**Initial Cost (USD)**	**Life Cycle (Yr)**	**Life Cycle Maintenance (USD)**	**USD/Sq.Ft./Yr**
Asphalt BUR	466,165	13.6	107,638	30.65
Coal Tar BUR	619,074	18.1	107,128	29.15
Modified Bitumen	475,854	17.2	153,886	26.60
PVC	345,712	9.4	109,978	35.22
Adhered EPDM	576,187	17.9	172,468	30.39
Ballasted EPDM	461,473	18.3	117,632	22.99
Mechanically Attached EPDM	495,520	16.8	191,931	29.73
Steel	581,471	22.4	102,671	22.19

System Types

Steel roofing assemblies are traditionally divided into two categories: architectural and structural. These two systems are aimed at different segments of the roofing market and can have substantially different aesthetic and performance demands, as well as different design requirements. Although it is possible for either product to be used in many applications, it is important that the differences between the systems be understood so the correct choice can be made for each project.

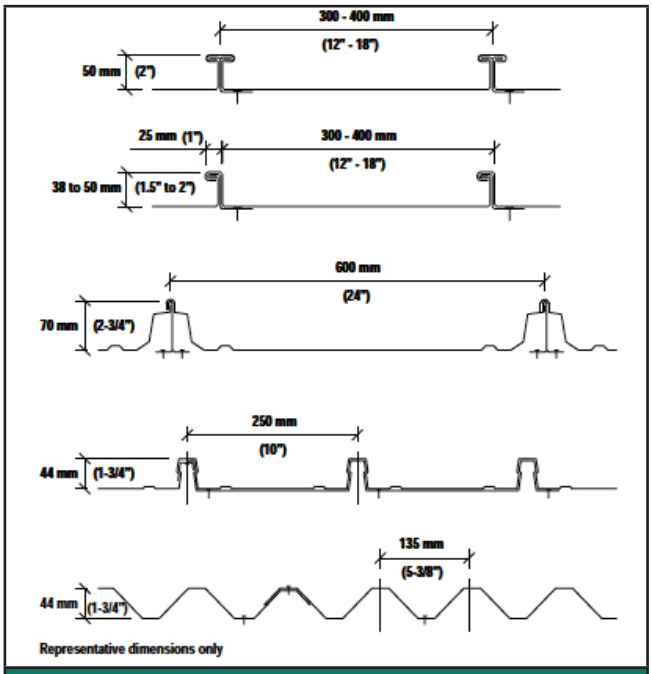


Figure 1: Examples of Structural Panels

The **architectural** type steel roofing system is similar to the traditional **steep-sloped** roof and is primarily a visual product applied over solid sheathing. It is considered to be a water shedding roof system (hydrokinetic) rather than a water barrier (hydrostatic) roof system. **Structural** type steel roof systems may be compared to traditional low slope roof membrane systems because they are designed to carry roof loads, resist moisture infiltration on **low-slope** applications, and can be installed without a solid sheathing substrate.

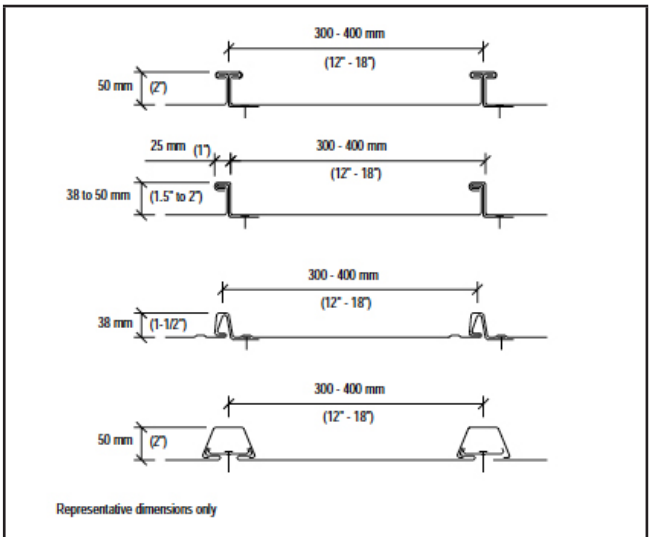


Figure 2: Examples of Architectural Panels

PROFILE AND SEAM CONFIGURATIONS

Sheet steel roofing is available in a variety of widths, cross-sections and seam types as illustrated in the different pictures and sketches throughout this document. The profile is typically roll formed into corrugations, offering a variety of different appearances. The corrugations add structural strength to the panel that is necessary for many applications.

The term "standing seam" is used to refer to many kinds of roofing panels that have a raised vertical seam, which ensures that the panel seams are above the water level. The longitudinal seams between panels and the seaming

techniques vary by application and by manufacturer. Typical mechanically seamed roof profiles are shown in Figures 1 and 2. The standing seam can also be used as an architectural element to highlight the roof aesthetics and accent the building's architecture.

The seaming process varies, and depends on the manufacturer's product. Each panel typically has a male and female rib that interlock. Some panels will use mechanical or hand seamers to roll-form the seam while other products snap together or have a batten clip.

The other common type of roofing profile has a lapped joint between adjacent sheets. A product typical of this type of profile is illustrated in the bottom sketch in Figure 1. There are a wide variety of products that have a variety of lapped side-laps. For low slope applications, i.e. less than 3 in 12, the manufacturers should be consulted for installation advice.

ARCHITECTURAL SHEET STEEL ROOF ASSEMBLIES

Architectural steel roofing assemblies are primarily intended to be visual products, and as such would normally have a minimum slope of about 3 in12 (14°). These systems are designed to shed water rapidly over the surface of the panels. In order for the panel to shed water rapidly, the roof must have an adequate slope. Many architectural panel systems are seamed with a double-interlock method, which perform well on even lower slopes. Architectural steel roofing panels require solid decking for structural support. A separate slip-sheet or an approved underlayment with slip-sheet capabilities is recommended when installing over a continuous solid surface.

The roof panels are usually attached to the deck with a system of individual steel clips or tracks. These are installed at intervals determined by the design wind uplift forces. The clips or tracks also allow the panels some thermal movement longitudinally. Architectural sheet steel roofing panels may be considered alternatives to several other traditional steep-slope roof coverings such as asphalt shingles, wood shingles or shakes, tile and slate.

STRUCTURAL SHEET STEEL ROOF ASSEMBLIES

Structural sheet steel roof assemblies, including seamed and non-seamed types, are designed to resist the passage of water at the joints and laps under hydrostatic pressure. They are versatile systems that can be used on both steep and low-slope applications.

Structural sheet steel roof assemblies have the strength and capability of spanning between structural members such as joists or purlins without being supported by a solid roof deck, and in some configurations do not require an underlayment. These roofs get their strength from heavier thickness of the steel sheet and the incorporation of large, high profile side ribs and pans with intermediate stiffening ribs.

CSSBI recommends 1/4 :12 (1.2°) as the minimum slope for seamed structural sheet steel roof assemblies, and 1 in 12 for through fastened structural sheet steel roof assemblies. Some systems have factory-applied sealant in the standing seams which is compressed during the seaming operation. Structural sheet steel roof systems (with sealed seams) are regarded as an alternative to membrane roofs.

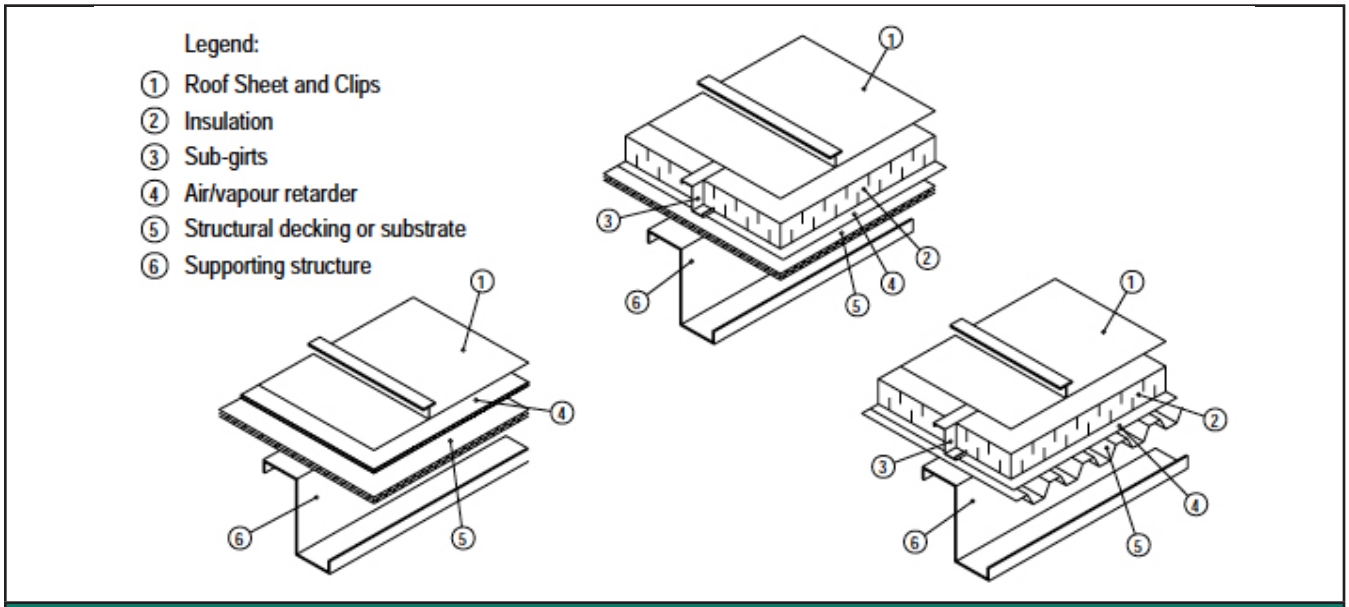


Figure 3: Examples of Architectural Roof Assemblies

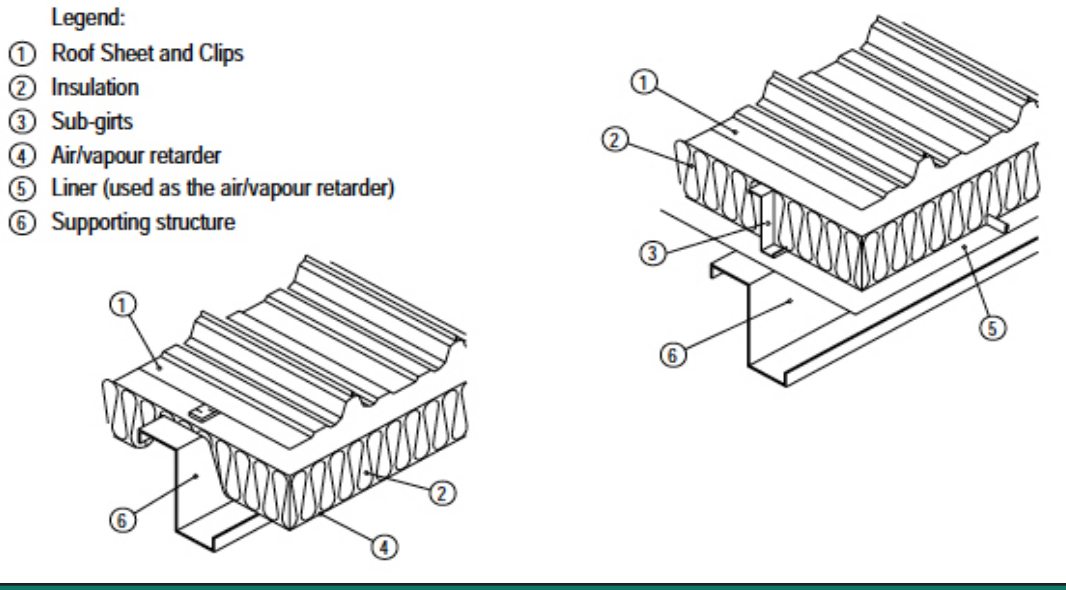


Figure 4: Examples of Structural Roof Assemblies

Material Selection

All sheet steel building products used in a steel roof assembly have one thing in common: they are fabricated from metallic coated, high quality, sheet steel. This material can also be prepainted for additional corrosion protection and enhanced aesthetics. Each component of the steel sheet (steel core, metallic coating, and organic coating) is important to the service life of the finished product. There are a range of steel properties and coatings available that provide flexibility in specifying the appropriate material. It is important to select the coatings to suit the anticipated environmental conditions and budget.

Steel Core: An insulated sheet steel roofing system is an engineered product and must be manufactured from sheet steel with certified structural properties. The data sheets available from the manufacturer will list the relevant material specifications and engineering data. Non-structural elements such as liner sheets, which are not designed as load carrying elements, do not need to meet the strict mechanical properties of the structural elements, but are still produced from quality controlled steel sheet.

The thickness of the steel core of a sheet steel building product is selected to accommodate the structural requirements. **When specifying a product, the decimal thickness must be used. The use of gauge numbers to specify thickness is not recommended since there is no universally accepted relationship between gauge number and minimum thickness.**

Metallic Coatings: To maintain the strength and integrity of the roofing product, the steel substrate must be protected from the environment. The first line of protection for the steel is supplied by the metallic coating, one of the most effective methods of protecting bare steel from corrosion. Both 55% aluminum-zinc alloy and zinc coatings provide a tough, non-porous barrier that does not allow moisture to come in contact with the steel.

Besides acting as a protective barrier, the zinc in the coating overlay is able to "sacrifice" itself to protect the underlying sheet steel if it is exposed, like at a cut edge or a scratch. Sacrificial protection occurs when two dissimilar metals are in electrical contact and are coupled with water and oxygen. A more in-depth description of the cathodic protection process can be found in many engineering materials handbooks.
The 55% aluminum-zinc alloy coating also provides

similar sacrificial and barrier type protection of the steel, as described above.

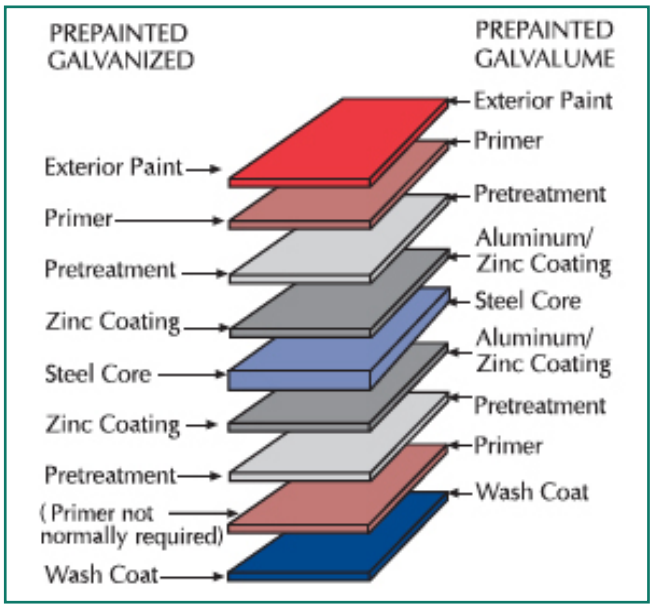
Metallic coatings are applied to steel sheet by the hot dip process and are offered in a range of coating weights. The minimum metallic coatings for exterior applications are Z275 (G90) (galvanized) or AZM150 (AZ50) (55% aluminum-zinc alloy). For interior applications a lighter coating may be appropriate depending on the environmental conditions. The various CSSBI publications have information on recommended coatings that can be used as a selection guide. Refer to the CSSBI web site at **www.cssbi.ca** for an up-to-date list of publications.

For low-slope roofing applications, unpainted 55% aluminum-zinc alloy is a popular construction material by itself. For maximum corrosion protection of architectural roof systems, a paint coating should be added to provide both colour and additional corrosion protection for both zinc and 55% aluminum-zinc alloy metallic substrates. The paint system inhibits water and oxygen from reaching the underlying metallic coated sheet steel, thus effectively arresting the corrosion process.

Prefinished Coatings: Prefinished means the sheet steel has been factory painted before it is roll formed into the cladding shape. Prefinishing is done in a coil-coating process where paint is applied in a precise, multi-step process. The resulting baked-on paint coatings can meet very severe corrosion protection requirements and aesthetic demands.

Prefinished sheet steel is normally supplied with a full paint system on the exposed side and a wash coat on the back side. The wash coat may vary in colour, which is a consideration in single skin applications with no insulation where the back is visible. If colour matching on the back side is required, a colour controlled coating should be specified. Prefinished sheet steel can also be produced with a full paint coat on both sides of the sheet. It is important to note that although different colours can be ordered on either side, the paint system must be the same resin type.

Since the mid-1960's, prefinished sheet steel cladding has demonstrated exceptional durability right across Canada, thanks to a highly efficient combination of materials protecting the steel core. There is a wide selection of systems and colours to suit all applications including commercial, industrial and more prestigious architectural applications, as well as aggressive industrial or marine environments. The fabricator should be consulted for details of the products and colours available.



For colour matching, an actual paint sample of the desired colour is required. It is, however, technically difficult for different production lots of prefinished steel to have perfect colour match, but there are several ways to achieve satisfactory colour matching on a large project:

1. Purchase the entire requirements for the project from one lot if quantity will allow;
2. Clad each roof area with material from the same lot;
3. Insert a new lot at a roof change or break in the building structure to minimize the effect of any possible colour variation.

Deck and Substrates

The most common structural framing and substrates to support sheet steel roof assemblies are steel joist with steel deck, steel joist with plywood decking, wood joists with plywood decking, and cold formed steel purlins with a steel liner sheet. Other types of structural systems are also used, however, this bulletin will only show details for the steel joist and steel deck assemblies. The details given are generic and, in general, apply to any substrate The manufacturer should be consulted for guidance if other substrates are used.

Air/Vapour Retarder

The role of the **vapour retarder** is to stop the migration of moisture from the warm interior, through the roof assembly to the outside. This is important in the Canadian climate where there are many days when the interior temperature is much greater than the exterior. This is significant because the warmer interior air can hold more moisture (i.e. higher relative humidity) than the colder outside air. If this warm, moist air is allowed to migrate towards the cold exterior, it will progressively cool until it reaches its dew point. If the dew point is reached the air can no longer hold the moisture as a vapour and it will begin to condense out as water.

The migration of water vapour through the roof assembly is a very slow process unless it is carried along by air exfiltration. A roof assembly, as one of its many functions, must act as an air barrier. As the name implies, an **air barrier** controls the movement of air from the inside to the outside (or vice versa) of the building enclosure. To maintain healthy indoor air quality, proper air exchange is necessary; however, this exchange process must be controlled properly. The uncontrolled exfiltration of air out through holes in the roof assembly will take with it heat and moisture.

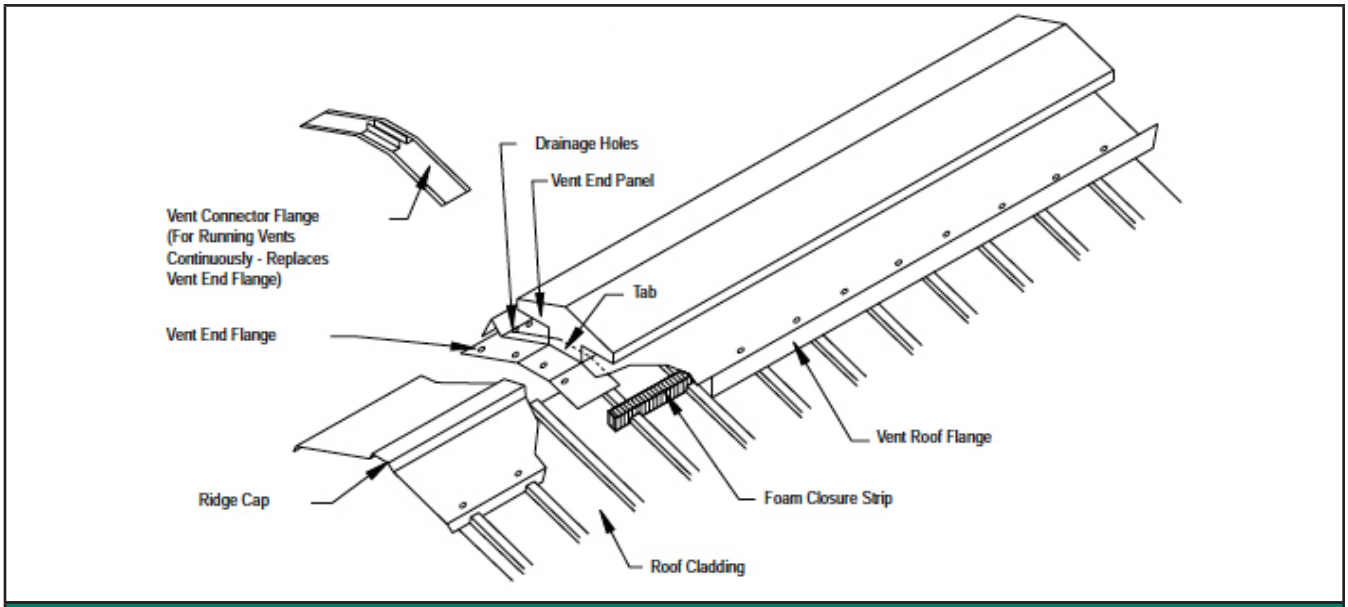
In an insulated sheet steel roof assembly the **underlayment** is designed to act as the air andvapour retarder for the system. The underlayment membranes applied are installed over the substrate with the side and end laps between adjacent sheets carefully sealed. It is very important that the continuity of the underlayment be maintained between the walls, roof and at all corners to maintain the continuity of the air/vapour retarder. In some assemblies gypsum board is installed on the deck substrate before the underlayment. This is an optional element in an insulated sheet steel roof assembly and may not be needed for many underlayment materials. The fabricator should be contacted for guidance.

With some underlayment materials, once they are installed the roof assembly becomes weatherproof. It is possible at this point for the interior work to begin even before the completion of the remainder of the exterior insulated roof assembly.

Insulation

The **thermal resistance** of the roof assembly is another important building science design criteria. The internal sub-girts in the assembly can be varied in depth to accommodate up to 305 mm (12 inches) of insulation or more. Both rigid and semi-rigid insulation is used depending on the assembly type. Semi-rigid insulation is used where the exterior sheet is self-supporting and the load is transferred to the structure through clips and/or subgirts. Rigid insulation is used in architectural roof systems to transfer the load through the insulation to the substrate. In most cases the rigid (board) insulation is laid in the cavity without fastening it to the substrate. For steeper slope applications the manufacturer should be consulted for guidance on fastening requirements.

Thermal bridging issues are mitigated with the application of insulating tape to the flanges of the sub-girts. This breaks the metal-to-metal connection and helps minimize



Low-Profile Ridge Vent

thermal bridging transmission. Other thermal sub-girt systems are available for more demanding applications. Refer to CSSBI B20 *Thermal Transmittance of Insulated Sheet Steel Wall and Roof Assemblies* for details.

Ventilation

In conjunction with carefully sealed air and vapour retarders, a vented air space above the insulation may help to dissipate any accumulation of moisture in the roof cavity. This may be required for applications involving high interior humidity. The drawings should indicate the eave and ridge details and any roof vents required for the movement of ventilation air thought the air space. The roof system manufacturer has fully designed and tested ventilation accessories.

Strength Design

The strength of the roof components are engineered by the manufacturer of the product. Span tables, used to select the proper profile and thickness for the anticipated loads, are available for all roofing profiles.

The purlin spacing can affect the design flexibility and economy of some insulated sheet steel roof assemblies. When a liner sheet is used in the assembly instead of steel deck or structural substrate, the sub-girts must be supported on the purlins. The greater the distance between purlins, the longer the span of roofing, and the stronger the roofing section must be. The stronger sections are those that are deeper, use thicker steel and are generally more expensive.
The steel thicknesses commonly used for the roof sheets are between 0.61 mm (0.024 in) and 0.46 mm (0.018 in). Heavier thicknesses are available for more demanding structural requirements.

One of the advantages of steel roofing is the sheets are manufactured to order for the project, and can be produced in long lengths. It is desirable where practical to use a single sheet from eave to ridge, however, consideration must be given to profile and thickness to accommodate material handling, transportation and erection. The longer lengths require special handling equipment for quality installation. Accommodating the thermal contraction and expansion is an additional design consideration for long sheets.

Fastening Systems

CONCEALED FASTENER SYSTEMS

A concealed fastener roof system uses a clip anchored to the sub-girt or substrate to hold down the roof sheets. There are a variety of clip types used depending on the

manufacturer. Some concealed fastener roof systems have a clip that allows the roof sheets to "float" and accommodate thermal expansion. A standing seam roof system may have the clip rolled into the panel side lap seam during erection. Other systems may use a batten cap to conceal the fastener or clip. The manufacturer of the roofing system will provide the details of their product and the fastening requirements.

EXPOSED FASTENER SYSTEMS

The exposed fastener roof systems use screws through the sheet itself to anchor the sheet to the sub-girt or substrate. The screw heads are exposed and normally colour matched to the roof sheet colour. All exposed fasteners for roof applications must have a neoprene washer under the head to seal the penetration. There are many different types of exposed fastener roofing profiles and systems. The manufacturer will provide the details of the fastening requirements.

Drainage Control

Sheet steel roof systems should employ external drainage systems in a fashion similar to other low and steep slope roof systems. External drainage systems include exterior gutters and downspouts. Internal drainage systems should be avoided.

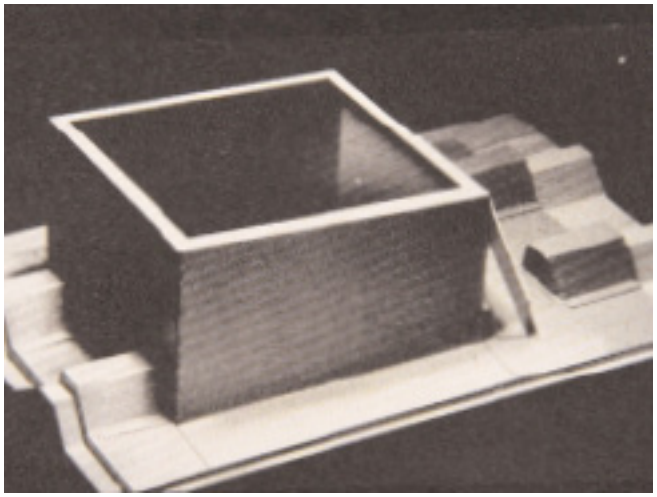
Flashing and Penetrations

While it is recognized that penetrations through the roof assembly will be necessary, the quantity and size should be minimized. The roof cavity should not be used to accommodate services.

Framing and flashing details around penetrations should be clearly shown on the drawings. Manufacturers have standard methods and accessories for handling penetrations and these should be followed. These details will show the proper methods for sealing both the liner and exterior cladding around the penetration. The type and location of flashings and sealants should also be clearly shown on the drawings.

Penetrations may be required by other trades (e.g. the mechanical contractor) but should be co-ordinated with the metal roofing contractor to ensure that these penetrations do not compromise the integrity of the roofing assembly.

Some penetrations like high temperature pipes and heat emitting devices require special consideration such as minimum insulation clearance and special sealing details. The roofing manufacturer should be consulted for guidance.



It is desirable to raise roof top mechanical equipment above the surface of the exterior cladding on legs that transfer the load directly to the structural members. The designer should consider the effects of thermal expansion and contraction around the penetrations. The manufacturer should be consulted for recommendations.

Large rectangular penetrations should be flashed with curbs that have deflectors to channel drainage and eliminate standing water upstream of the penetration. Reinforcement of the roof openings around penetrations may be necessary to maintain the structural integrity of the roof system and to facilitate sealing. Where reinforcement is required, it should be clearly shown on the drawings.

Snow Management

The management of snow on the roof of a building is an important design consideration, particularly for sloping metal roofs. There are many misconceptions about the proper means of managing snow and the merits of snow retention devices, often called snow guards. It is good practice to anticipate snow sliding off a roof and design accordingly. Here are some points to consider:

- "Drop zones" should be planned where snow coming off the roof can land without harming pedestrians, landscape or other buildings.
- One function of a snow guard or snow fence is to break up the mass of sliding snow. This will reduce the chances of damage from a large solid block of snow falling off the roof.

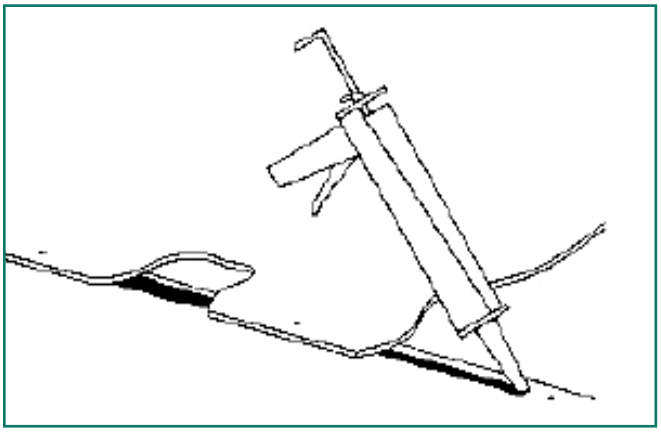
- Deflectors can be installed over doorways to direct sliding snow away from walkways.
- Fascia and gutters should not project above the roof surface or they will get damaged from sliding snow.
- Snow guards need to be designed and placed to meet the anticipated snow loads. There are a number of different types of snow guards commercially available that have different structural capacities.
- Consult the snow guard manufacturer for specific advice.

Caulking and Sealants

Caulking and sealants are an integral part of the weather/air/vapour protection systems used in conjunction with mechanical fasteners. Their primary function is to seal joints, thereby maintaining the integrity of the different barriers. Careful choice of caulking and sealants of suitable quality is important and the selection should be shown on the drawings. There are many different types of sealants with different properties and performance expectations. The manufacturer's details should clearly indicate where and what caulking is required. Field-applied sealants are typically supplied in tube form, but some are also available in a semi-cured tape form. For some liner sheets, the sealant in the side lap is factory applied.

APPLYING SEALANTS

Proper application of caulking and sealants is important and must follow the manufacturers' recommendations. Where components have been pre-caulked by the manufacturer it is important to verify this caulking and to repair skips, gaps and damaged area before installing the component.



After the sealant is extruded, the joint should be finished as soon as possible. This is to prevent premature curing, which could cause poor bonding to the second surface. When placing the sealant, care must be taken not to entrap air. Always lay the bead of sealant so that it covers the fastener hole in a continuous line, when compressed, the sealant positively seals the fastener.

Caulking or sealant tapes used correctly under suitable conditions will do an excellent job. For the tape to make a positive seal, it is important that the initial thickness of

the tape is greater than the gap between the components of the finished joint. However, some types may be difficult to compress within a joint, especially during cold weather. This could result in a possible loose joint later. Installation of the tape must follow the contour of the profile to ensure complete coverage.

Design Considerations

STRUCTURAL LOADS

The structural design of the roof system is done by the manufacturer who will publish data sheets for their profiles. These data sheets will specify the maximum spans or loads that the roof assembly is designed to carry. Many roof assemblies are designed as systems, taking into consideration the strength of the roof sheets, clips, sub-girts, fasteners and supports acting together. Consequently, it is important that all of the components of the assembly be supplied by the same manufacturer. If there is any question about the loads to be carried, or the capacity of the assembly, contact the manufacturer.

WIND UPLIFT

Wind across the roof will cause some areas of uplift, or suction. Designing for wind uplift is important and the roof system manufacturers have several approved systems. There are a number of test standards in use today, the most common being UL (Underwriters' Laboratories), FM (Factory Mutual) and ASTM (Association for Standards and Materials). If the project requires the roof assembly to meet one of these standards, check with the manufacturer for additional information.

THERMAL EXPANSION AND CONTRACTION

The expansion and contraction of sheet steel takes place with temperature changes and can cause problems for the roof system if this movement is not accommodated. Expansion and contraction can cause flashings to become distorted and may lead to roof leaks and make the roofing system more prone to future storm damage.

The roofing designer must consider thermal movement as it relates to panel-to-panel connections, panel-to-structure connections, panel–to-flashing connections, and flashing-to-structure connections.

Differential thermal expansion and contraction will result from one of the following reasons:

1. Different materials have different coefficients of thermal expansion
2. Some components may be subjected to a greater degree of temperature change
3. Movement of the two materials may be in different directions
4. Different colours have different reflective properties

Movement along the length of the panel, from the ridge to the eave, is an important concern with most standing seam roof systems. Horizontal movement is less of an issue because the panel width is relatively small and any thermal movement can be accommodate by flexing of the sheet.

Panel movement along the length of the sheet is generally not a concern if the panels are short. Fastening clips and flashings can accommodate some of the thermal movement by rolling or flexing. Long panel lengths, on the other hand, can have significant movement depending on the temperature change. Clips must be either designed to allow the panel to slide back and forth, or the clips must accommodate the movement by flexing, rolling or sliding. With an expansion clip, the base portion of the clip is fastened to the structure and the upper portion that is attached to the panel is allowed to slide or "float".

Where to fix the panel is a design consideration that must be well thought out. Panels may be fixed at the eave, at the midpoint, at the ridge or at a line of penetrations. The location should be a horizontal point shared in common by all panels so the movement is consistent from one panel to the next. Particular attention should be paid to accommodating the expected thermal movement around penetrations.

The amount that a panel can move as a result of thermal expansion and contraction can be calculated by multiplying the coefficient of thermal expansion by the maximum length of the panel from where it is fixed, and multiplied by the expected temperature change. The coefficient of thermal expansion for typical sheet steel is 11.7×10^{-6} per °C.

Example: A panel 10m long is installed during the summer at 20°C. The expected extreme range in temperature is from -40°C to +30°C. However, the roof sheets can be expected to heat up considerably in summer due to the sun and may reach a surface temperature of +60°C. The change in length is calculated as follows:

Contraction
$(11.7 \times 10^{-6})(-40\text{-}20°C)(10{,}000mm) = 7.0$ mm

Expansion
$(11.7 \times 10^{-6})(60\text{-}20°C)(10{,}000$ mm$) = 4.7$ mm

Re-roofing

Re-roofing of existing structures can be done very successfully using sheet steel assemblies. The variety of roofing types, colours and profiles provides the designer with a number of choices to fit most design criteria. Re-roofing of existing flat built-up or single ply roofs is a natural application for sheet steel assemblies. The steel roof offers many years of trouble free service and can be installed directly over the existing roof often without any modifications to the existing structure. A steel re-roof can also be designed as an architectural feature to enhance the look of the building, or a low-slope roof can be installed that cannot be distinguished from the original flat roof.

With the wide variety of sheet steel roofing systems available, there are numerous considerations a designer must keep in mind when looking at a re-roofing project. One of the first areas of consideration involves tear-off versus re-cover:

- Will the existing structure withstand the weight of a new framing system or sheet steel roof assembly in addition to the building code loads?
- Can the existing roof penetrations be flashed in a watertight manner? Can the existing curbs be extended to accommodate proper flashings?
- Is additional insulation needed?
- Can proper ventilation under the roofing sheet be achieved if needed?
- Does the existing substrate provide adequate anchorage for the fasteners needed to connect the new roof?
- Does the existing roof drain adequately or should the slope be increased?
- Will the aesthetics of the building be improved with the addition of a new sheet steel roof?
- Is there moisture trapped within the existing roof assembly? If moisture is present does it contain atmospheric contaminants that could lead to the premature deterioration of the assembly?
- Can the building owner allow a complete tear-off or will the removal process interfere with interior operations and production?

Additional considerations involve the type of roof deck and the existing framing system:

- Is the roof deck used as an exposed ceiling where no fastener penetration is desired?
- Are there any historic preservation by-laws in the area?
- Will water run-off from the new roofing panels stain the exterior wall?
- Is there a local by-law requiring controlled flow roof drainage?
- Does the roof structure need to be re-engineered to comply with current building codes?
- If the ballast is being removed from the existing roof, is this a sufficient reduction in weight to accommodate the installation new roofing system without changes to the structure?

The roofing fabricator should be contacted for advice on the design and selection of an appropriate re-roofing system.

Related Information

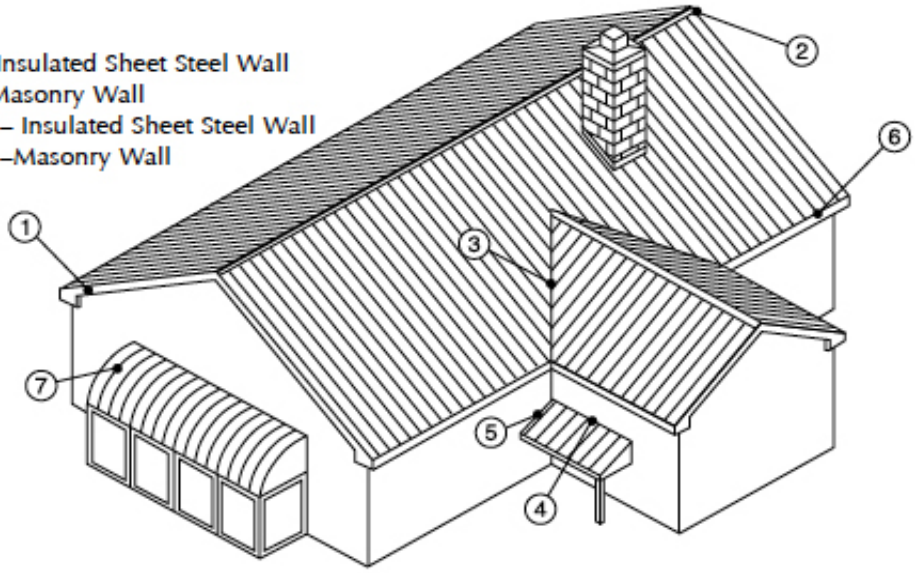
The CSSBI has a number of publications on various topics related to sheet steel building products. For complete list, contact the CSSBI or visit our web site at *www.cssbi.ca*.

Appendix - Detail Drawings

The following sections and details are representative of the basic components of insulated sheet steel roof assemblies and demonstrate the function each detail is required to perform. Every CSSBI Manufacturer Member and roofing applicator may provide you with details slightly different than those shown in this document that recognizes their particular products or practice. The function of each detail is to provide a roof assembly that is structurally sufficient, thermally responsive to the building's design, and properly sealed for weather tightness. In all cases good building science practices should be followed. For additional information on details not shown, consult a CSSBI Manufacturer Member.

The overall building layout shown below indicates the location of the detail areas covered by the individual detail drawings. In some instances there will be more than one detail drawing shown to give some options. These are representative details and not the only correct way of installing insulated sheet steel roof assemblies.

(1A) Gable End – Insulated Sheet Steel Wall
(1B) Gable End – Masonry Wall
(2A) Ridge – Expansion
(2B) Ridge – Fixed
(3) Valley
(4A) Roof to Wall Perpendicular – Insulated Sheet Steel Wall
(4B) Roof to Wall Perpendicular –Masonry Wall
(5A) Roof to Wall Parallel to Sheet – Insulated Sheet Steel Wall
(5B) Roof to Wall Parallel to Sheet –Masonry Wall
(6A) Eave – Standard Eave
(6B) Eave – Eave with Gutter
(7) Curved Panels

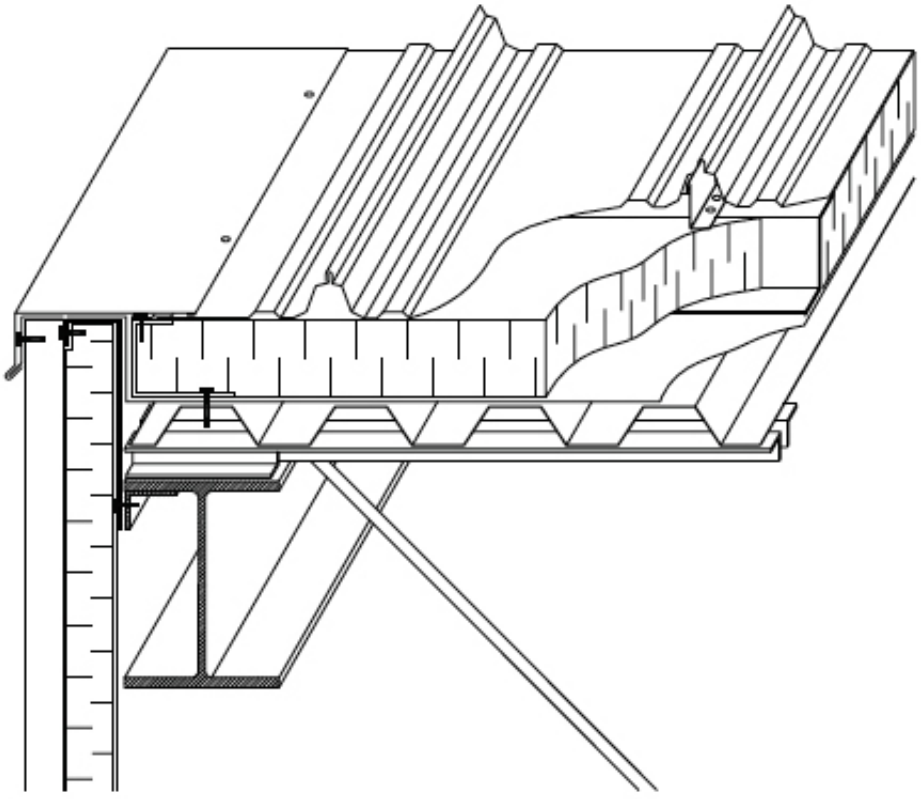


Detail 1A: Gable End - Insulated Sheet Steel Wall
Installation/Assembly Notes:

a) Wait until the wall assembly and steel deck are in place before proceeding.
b) Apply the air/vapour retarder membrane on top of the steel deck. Make sure the membrane is continuous and goes up over top of the wall.
c) Fasten the U-channel to the steel deck along the gable edge wall.
d) Align and fasten the sub-girts to the steel deck.
e) Lay the insulation in place between the sub-girts.
f) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations and attach the hold-down clip on top of the U-channel.
g) Trim the last sheet adjacent to the gable edge to the correct width. Fasten the hold-down clip to the U-channel, making sure that the edge of the roof sheet is secure.
h) Align and install the remaining roof sheets, connecting the side laps to the clips where required. For exposed fastener profiles screw through the roof sheet directly into the sub-girts and U-channel.
i) Apply a bead of caulking along the edge of the roof sheet.
j) Engage the cap flashing in the clip fixed to the wall cladding. Stitch screw the cap flashing to the roof sheet.

Specifier/Designer Notes:

- Periodically check to make sure the sheets are square to the gable edge and adjust if necessary. Trim the edge of the last sheet to fit the area.
- Pre-drill holes in the roof sheets for exposed fastener panels to ensure a straight fastener pattern. Clean any filings off the sheet before installation.
- Cap flashings are fabricated by the roofer from flat sheet material of the same thickness as the exterior cladding. The roofer purchases this material from the siding contractor unless otherwise specified.
- Special attention must be taken to ensure the air/vapour retarders of the various trades (roofer and cladding installer) are sealed together to ensure a continuous seal of the building envelope.

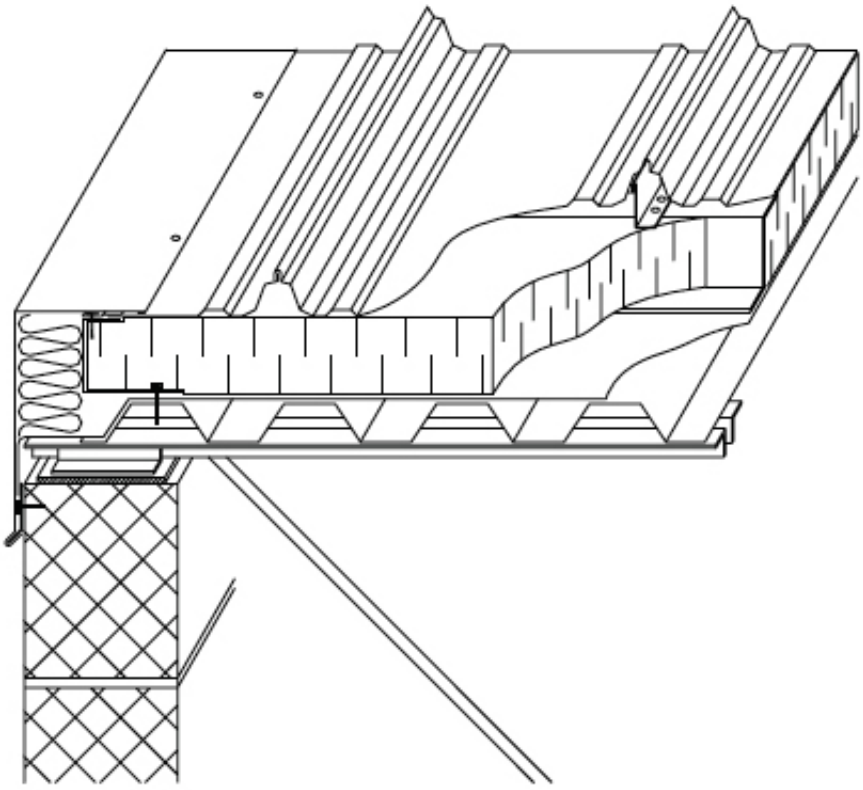


Detail 1B: Gable End - Masonry Wall
Installation/Assembly Notes:

a) Wait until the masonry wall and steel deck are in place before proceeding.
b) Apply the vapour retarder membrane on top of the steel deck. Make sure the membrane is continuous and goes up and over the top of the masonry wall.
c) Fasten the Z-girt to the steel deck along the gable edge wall.
d) Align and fasten the sub-girts to the steel deck.
e) Secure the insulation in place between the sub-girts.
f) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations and attach the hold-down clip on top of the U-channel.
g) Trim the last sheet adjacent to the gable edge to the correct width. Fasten the hold-down clip to the U-channel, making sure that the edge of the roof sheet is secure.
h) Align and install the remaining roof sheets, connecting the side laps to the clips where required. For exposed fastener profiles screw through the roof sheet directly into the sub-girts and U-channel.
i) Apply a bead of caulking along the edge of the roof sheet.
j) Engage the cap flashing in the clip fixed to the masonry wall. Stitch screw the flashing to the roof sheet.

Specifier/Designer Notes:

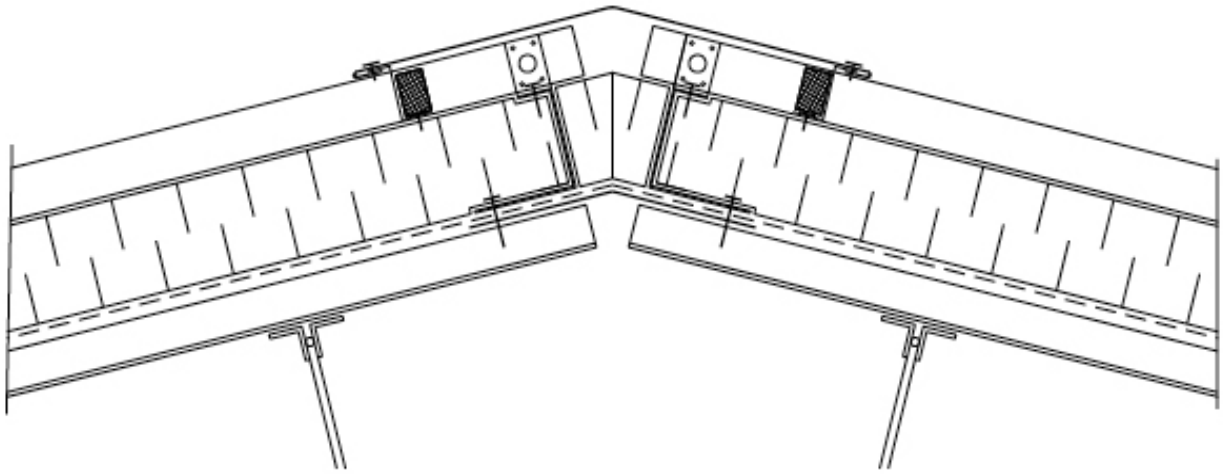
- Periodically check to make sure the sheets are square to the gable edge and adjust if necessary. Trim the edge of the last sheet to fit the area.
- Pre-drill holes in the roof sheets for exposed fastener panels to ensure a straight fastener pattern. Clean any filings off the sheet before installation.
- Cap flashings are fabricated by the roofer from flat sheet material of the same thickness as the exterior cladding. The roofer purchases this material from the siding contractor unless otherwise specified.
- Special attention must be taken to ensure the air/vapour retarders of the various trades (roofer and cladding installer) are sealed together to ensure a continuous seal of the building envelope.



Detail 2A: Ridge - Expansion
Installation/Assembly Notes:

a) Wait until the steel deck from both sides of the ridge are fastened in place before proceeding.
b) Install a sheet metal flashing over the ridge, screwed to each deck.
c) Apply the vapour retarder membrane on top of the ridge. Make sure the membrane is continuous.
d) Fasten U-channels along the edge of the two sloping decks.
e) Align and fasten the sub-girts to the steel deck.
f) Secure the insulation in place between the sub-girts.
g) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
h) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
i) Screw metal closures onto roof sheets.
j) Fix foam closure in place with a line of caulking.
k) Install the ridge cap, screwing into metal closures.

Specifier/Designer Notes:
The roof sheet must be detailed to accommodate thermal expansion either at the ridge or eave. This detail allows the roof sheets to expand/contract at the ridge, therefore the eave detail must be fixed.

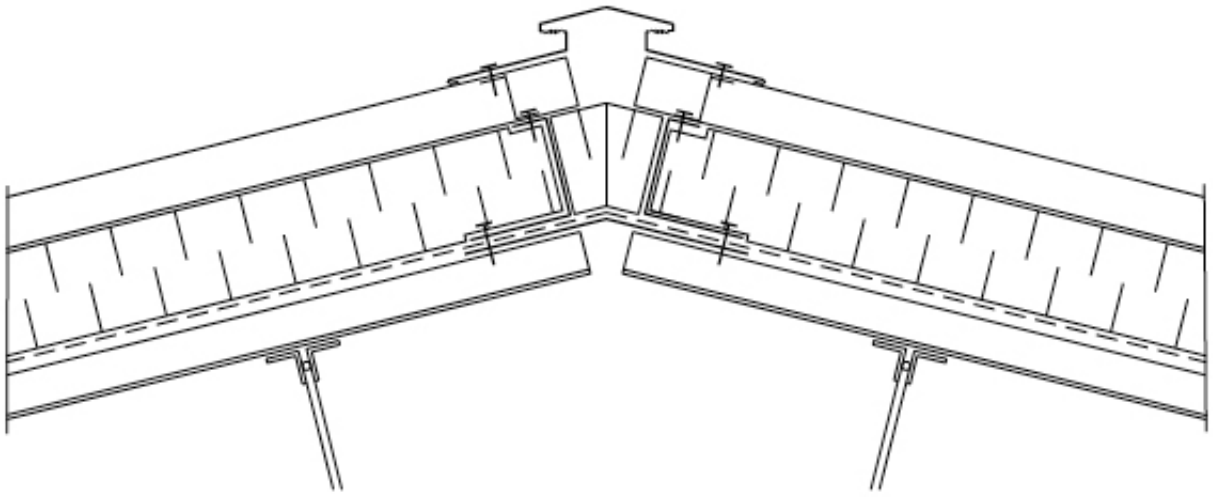


Detail 2B: Ridge - Fixed
Installation/Assembly Notes:

a) Wait until the steel deck from both sides of the ridge are fastened in place before proceeding.
b) Install a sheet metal flashing over the ridge, screwed to each deck.
c) Apply the vapour retarder membrane on top of the ridge. Make sure the membrane is continuous.
d) Fasten U-channels along the edge of the two sloping decks.
e) Align and fasten the sub-girts to the steel deck.
f) Secure the insulation in place between the sub-girts.
g) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
h) Align and install the roof sheets, connecting the side laps to the clips or tracks. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
i) Metal closures are screwed through the cladding into the U-channel.
j) Install the ridge cap, screwing into closure channels.

Specifier/Designer Notes:

- This detail shows a vented ridge flashing designed to provide positive ventilation to the insulation cavity of the roof assembly through the ribs of the roofing sheet up to the ridge.
- Thermal expansion and contraction of a floating roof sheet must have one point along the sheet's length "fixed" to the structure, either at the ridge, the eave or at a point in the middle of the sheet. This detail has the roof sheets fixed at the ridge, therefore the eave detail must be allowed to expand/contract.



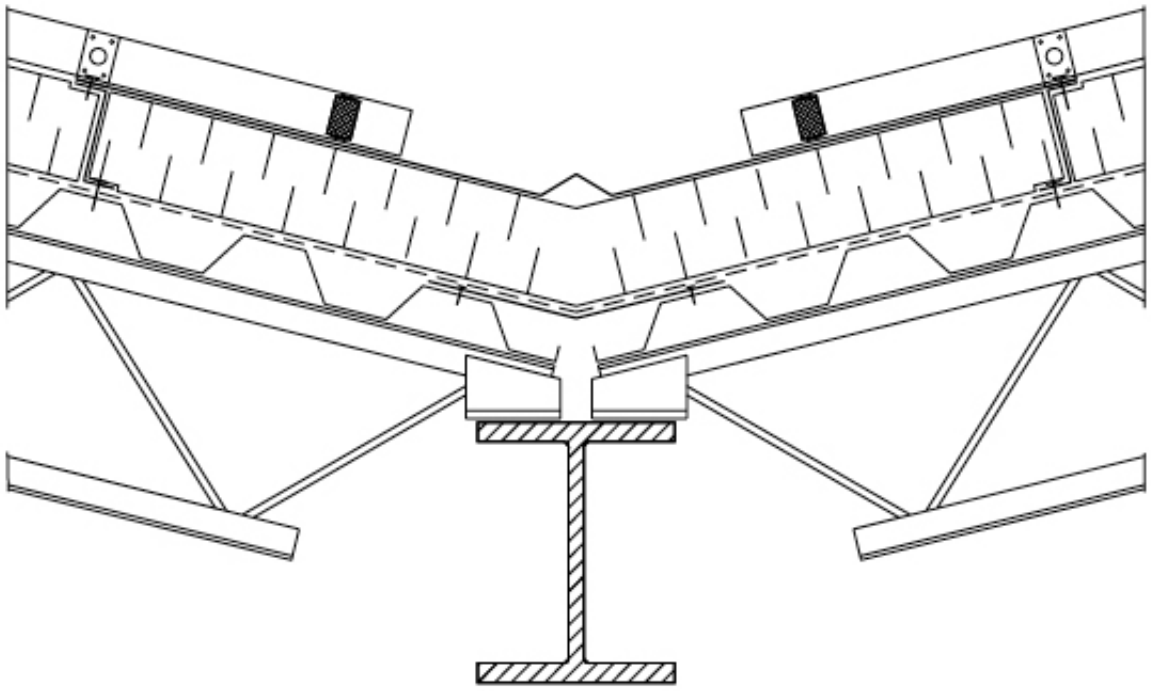
Detail 3: Valley

Installation/Assembly Notes:

a) Wait until the steel deck from both sides of the valley are fastened in place before proceeding.
b) Install a sheet metal flashing over the valley, screwed to each deck.
c) Apply the vapour retarder membrane over the valley, making sure the membrane is continuous.
d) Align and fasten the sub-girts to the steel deck.
e) Secure the insulation in place between the sub-girts.
f) Install valley flashing and screw into sub-girts.
g) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
h) Trim roof sheets to the proper angle and install, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
i) Install a pre-formed foam closure or field-cut foam pieces (at skew cut areas) to fill the voids in the roof sheets. Fix closures in place with a line of caulking.

Specifier/Designer Notes:

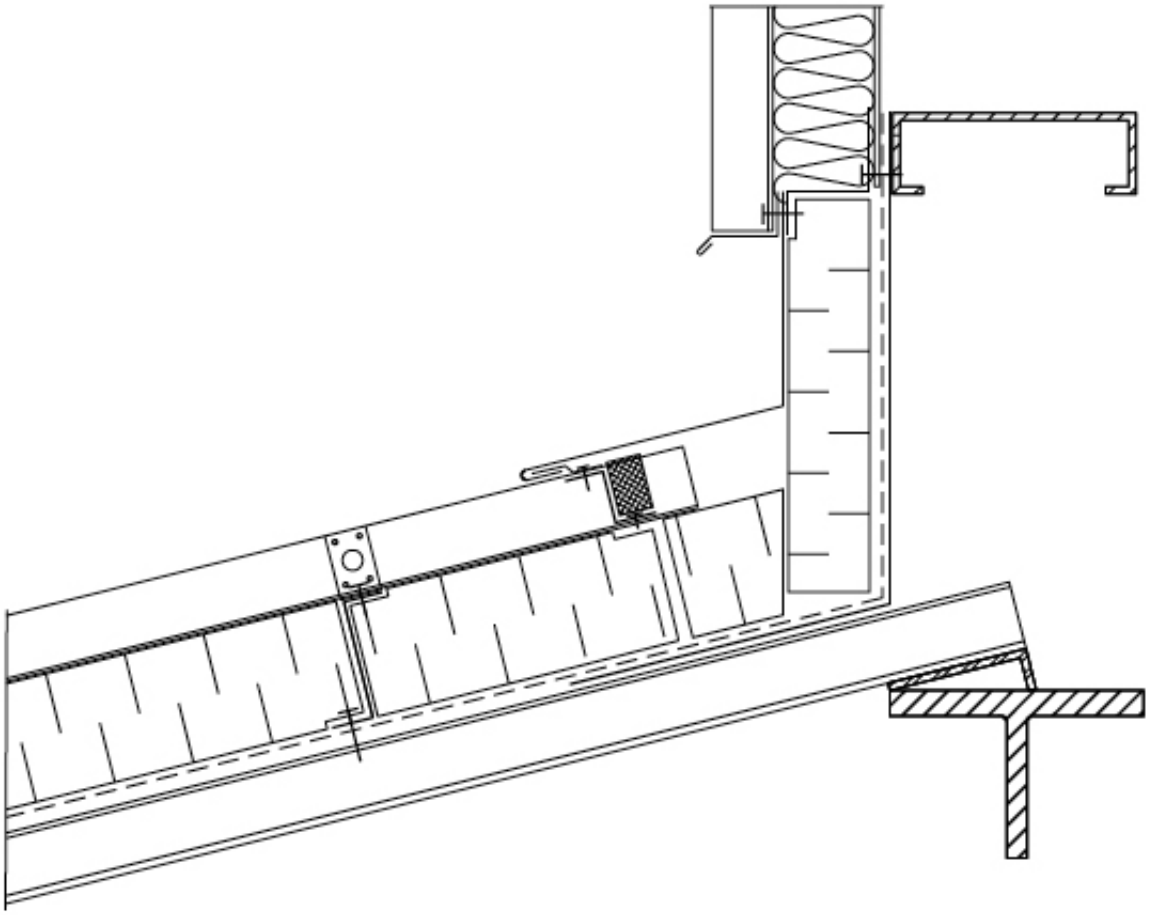
The flow of water or sliding snow must be considered when detailing a valley detail. On low to medium slopes, a simple valley gutter flashing may be used. On medium to steep sloped roof applications, a "V" ridged valley gutter flashing (as shown) will help deflect the water flow down the gutter to the eave. For control of sliding snow, refer to the Snow Management discussion.



Detail 4A: Roof to Wall Perpendicular to Sheet - Insulated Sheet Steel Wall
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Install a sheet metal flashing from the deck to the first wall girt, fastening to both.
c) Apply the vapour retarder membrane over the deck and flashing up to the first wall girt. Make sure the membrane is continuous and stays in place until the wall liner sheet can be installed.
d) Align and fasten the sub-girts to the steel deck.
e) Secure the insulation in place between the sub-girts.
f) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
g) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
h) Metal closures are screwed through the cladding into the roof sheet. Attach hold-down clips to the metal closure.
i) When the wall assembly is being constructed, insulate the corner, install the corner flashing by engaging it into the hold-down clips and screw it to the wall sub-girt.

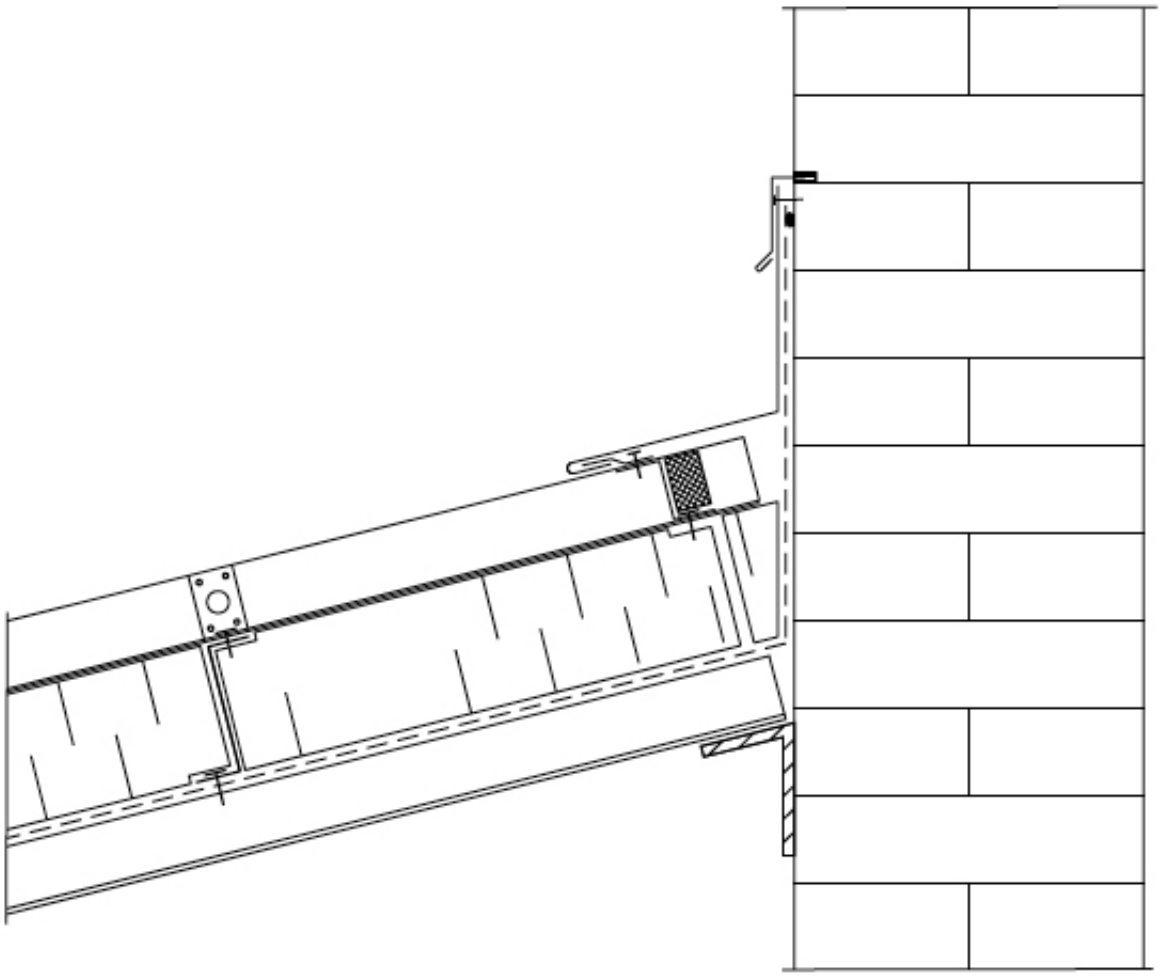
Specifier/Designer Notes:
This detail shows a sliding type installation where the roofing and wall cladding are allowed to expand/contract.



Detail 4B: Roof to Wall Perpendicular to Sheet - Masonry Wall
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Apply the vapour retarder membrane over the deck and up the masonry wall. Make sure the membrane is continuous and glue to the masonry until the wall flashings can be installed.
c) Align and fasten the sub-girts to the steel deck.
d) Secure the insulation in place between the sub-girts.
e) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
f) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
g) Metal closures are screwed through the cladding into the U-channel. Attach hold-down clips to the metal closure. Fix foam closure in place with a line of caulking.
h) Install the wall flashing, engaging it in the hold-down clips and fastening it to the masonry wall.
i) Reglet to be cut in the masonry wall by others. Seal the counter flashing in the masonry wall reglet with caulking. Ensure that the counter flashing overlaps the wall flashing by at least 2 in. (50 mm).

Specifier/Designer Notes:
This detail, similar to Detail 4A is designed to provide expansion / contraction control for the roof sheet.

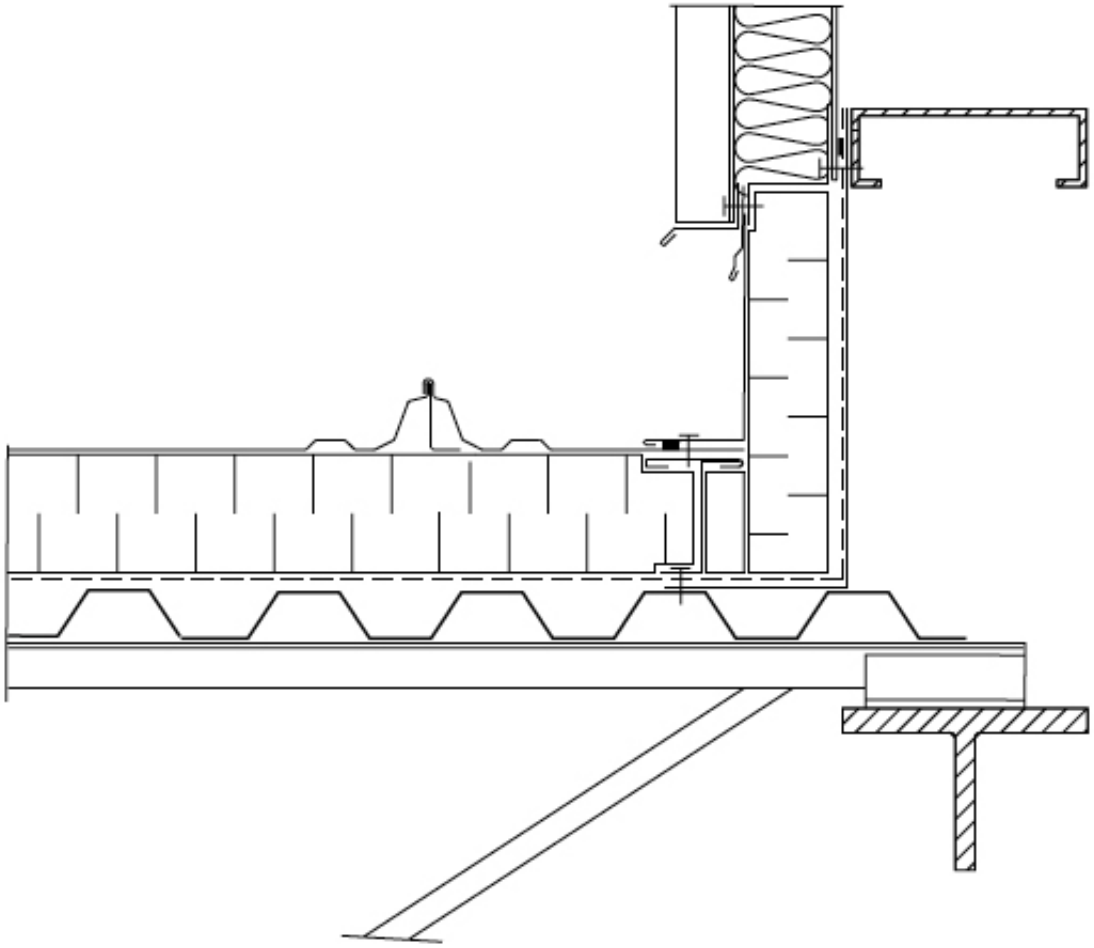


Detail 5A: Roof to Wall Parallel to Sheet - Insulated Sheet Steel Wall
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Install a sheet metal flashing from the deck to the first wall girt, fastening to both.
c) Apply the vapour retarder membrane over the deck and flashing up to the first wall girt. Make sure the membrane is continuous and stays in place until the wall liner sheet can be installed.
d) Align and fasten the sub-girts to the steel deck.
e) Secure the insulation in place between the sub-girts.
f) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
g) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts. Trim the last sheet adjacent to the wall to the correct width.
h) Fit the sliding clip over the flange of the sub-girt adjacent to the wall.
i) When the wall assembly is being constructed, insulate the corner.
j) Lay a bead of caulking along the sheet cut edge
k) Install the corner flashing by fastening it to the roof sliding clip.

Specifier/Designer Notes:

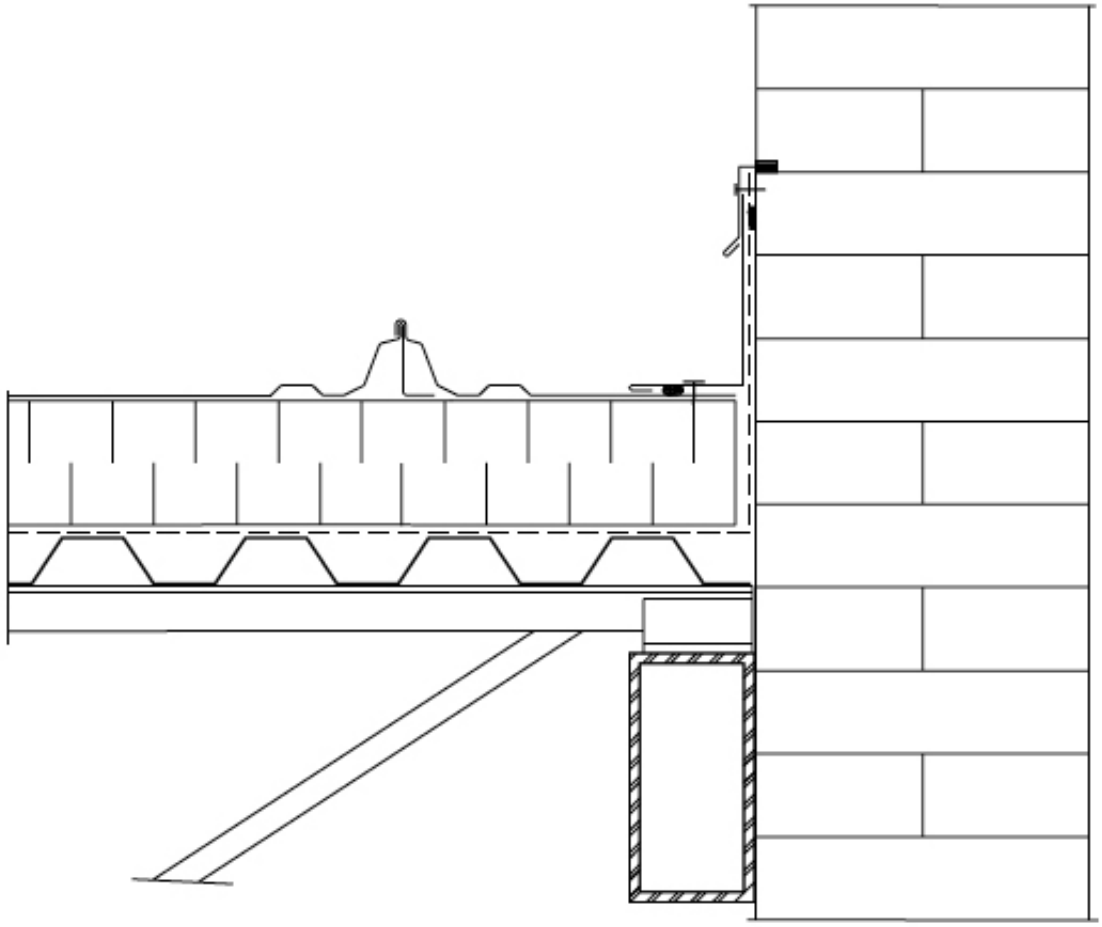
The roof sheet will expand and contract due to thermal expansion. This movement must be controlled at the junctions of the roof and wall connections to prevent a failure of the connection. Flashings between the horizontal (sloped) roof and the vertical wall must be designed to allow for this movement.



Detail 5B: Roof to Wall Parallel to Sheet - Masonry Wall
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Apply the vapour retarder membrane over the deck and up the masonry wall. Make sure the membrane is continuous and glue to the masonry until the wall flashings can be installed.
c) Align and fasten the sub-girts to the steel deck.
d) Secure the insulation in place between the sub-girts.
e) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
f) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts. Trim the last sheet adjacent to the wall to the correct width.
g) Lay a bead of caulking along the sheet cut edge.
h) Install the wall flashing, screwing it to the roof sheet.
i) Reglet to be cut in the masonry wall by others. Seal the counter flashing in the masonry wall reglet with caulking. Ensure that the counter flashing overlaps the wall flashing by at least 2 in. (50 mm).

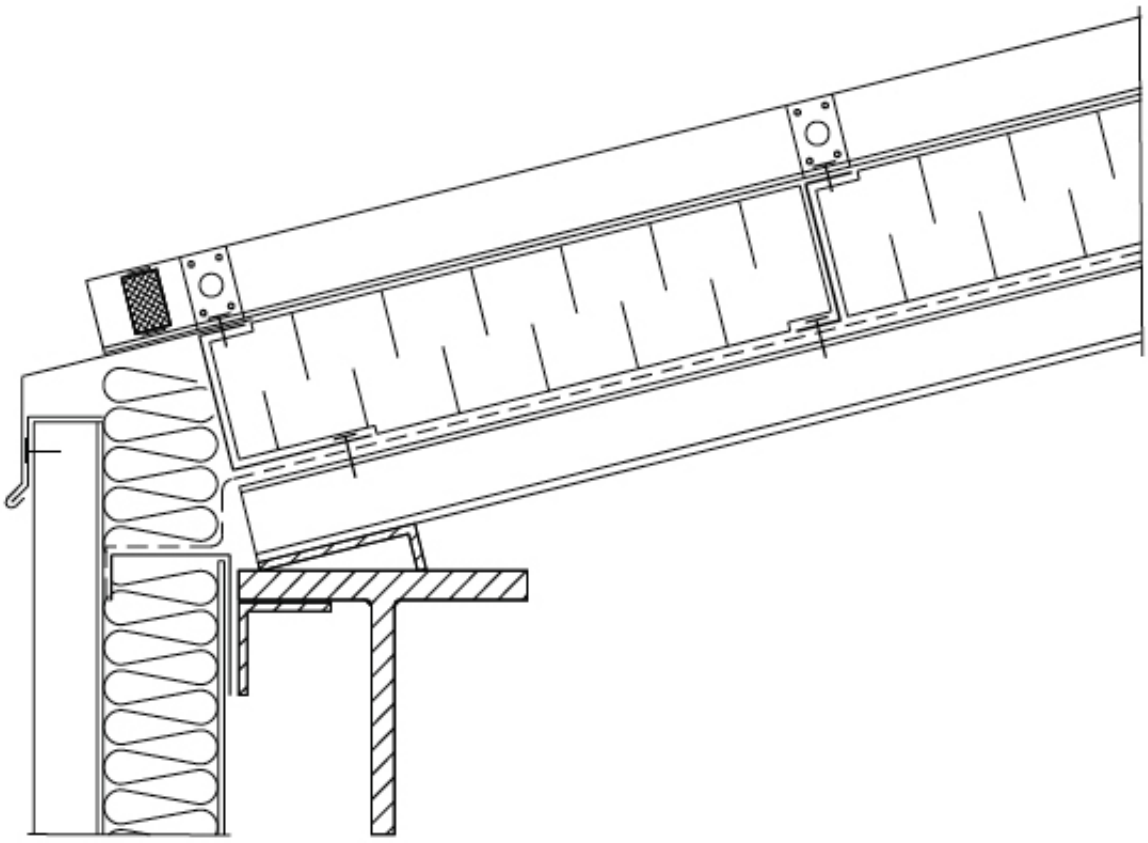
Specifier/Designer Notes:
The roof sheet will expand and contract due to thermal expansion. This movement must be controlled at the junctions of the roof and wall connections to prevent a failure of the connection. Flashings between the horizontal (sloped) roof and the vertical wall must be designed to allow for this movement.



Detail 6A: Eave - Standard Eave
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Apply the vapour retarder membrane over the deck and flashing down over the top of the wall. Make sure the membrane is continuous and stays in place until the wall exterior sheet can be installed.
c) Fasten the U-channel near the bottom edge of the sloping deck.
d) Align and fasten the sub-girts to the steel deck.
e) Secure the insulation in place between the sub-girts.
f) Install the eave flashing, fastening it to the U-channel.
g) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
h) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
i) Foam closures are fixed in the roof sheets with a bead of caulking.
j) When the wall assembly is being constructed, insulate the corner.

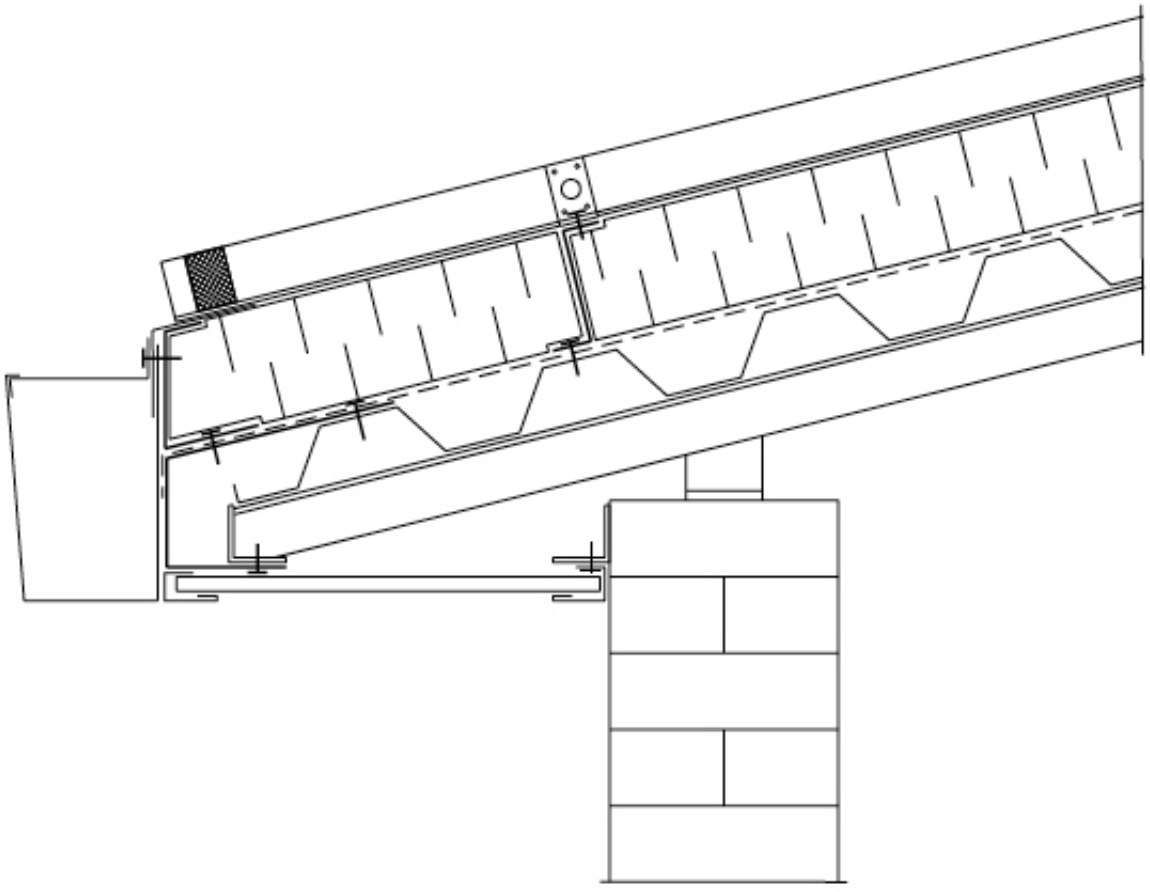
Specifier/Designer Notes:
Like the ridge detail, the eave detail must be designed to accommodate thermal expansion or hold the roof sheet in a fixed position. This detail shows a roof sheet held into place using a thermal expansion clip fastened to the sub-girt system. Therefore the ridge or the upslope end of this sheet must be fixed into place.



Detail 6B: Eave - Eave with Gutter
Installation/Assembly Notes:

a) Wait until the steel deck is in place before proceeding.
b) Install the eave support by fastening it to the deck and the supporting structure.
c) Apply the vapour retarder membrane over the deck and eave support down over edge of the eave. Make sure the membrane is continuous and stays in place until the gutter can be installed.
d) Fasten the U-channel near the bottom edge of the eave support.
e) Align and fasten the sub-girts to the steel deck.
f) Secure the insulation in place between the sub-girts.
g) Install the eave flashing and gutter, fastening it to the U-channel.
h) For hidden fastener profiles, attach the clips to the sub-girts at the specified spacing and locations.
i) Align and install the roof sheets, connecting the side laps to the clips. For exposed fastener profiles screw through the roof sheet directly into the sub-girts.
j) Foam closures are fixed in the roof sheets with a bead of caulking.
k) Finish off the soffit area.

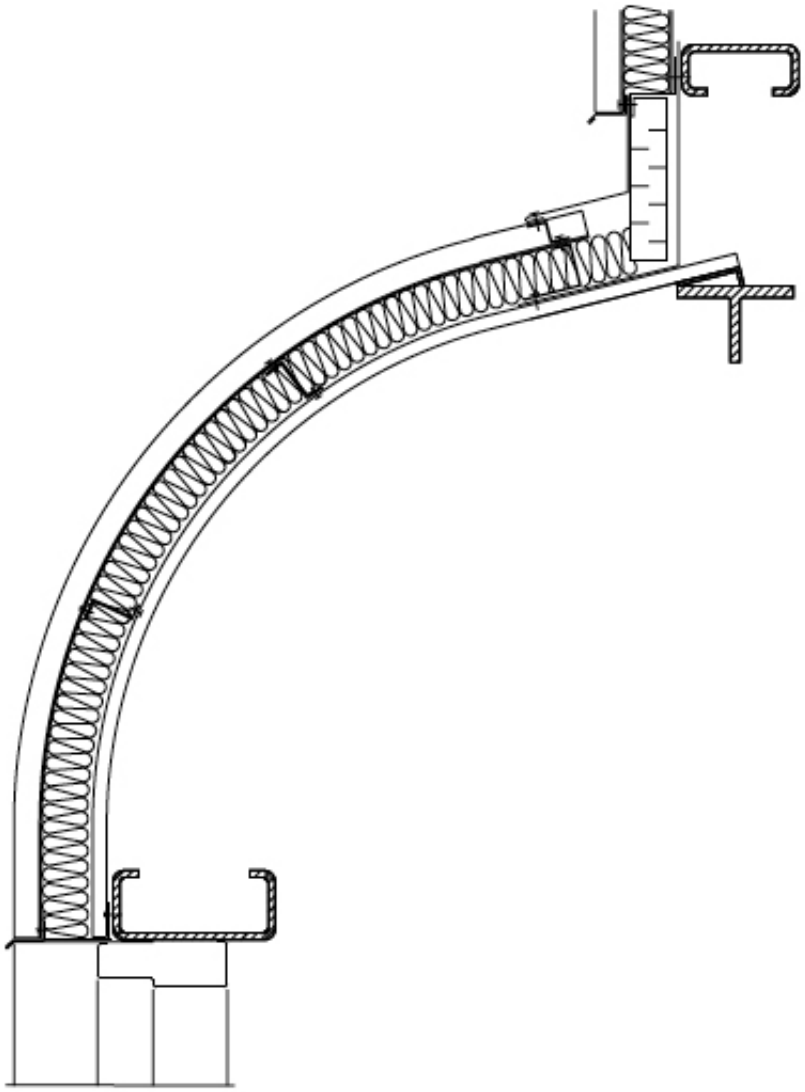
Specifier/Designer Notes:
Like the ridge detail, the eave detail must be designed to accommodate thermal expansion or hold the roof sheet in a fixed position. This detail shows a roof sheet held into place using a thermal expansion clip fastened to the sub-girt system. Therefore, the ridge or the upslope end of this sheet must be fixed into place.



Detail 7: Curved Panels
Installation/Assembly Notes:

a) Install the curved interior liner sheet, fastening it to the structural support at the top and the wall girt at the bottom.
b) Install a sheet metal flashing from the deck to the first upper wall girt, fastening to both.
c) Apply the vapour retarder membrane over the liner, making sure it is continuous from the upper wall girt to the lower wall girt, and stays in place until the wall assemblies can be installed.
d) Fasten the U-channel near the top of the curved liner.
e) Install a drip flashing and fasten the U-channel near the bottom of the curved liner.
f) Secure the insulation in place.
g) Align and install the roof sheets, screwing through the roof sheet directly into the upper and lower U-channels.
h) Metal closures are screwed through the cladding into the upper U-channel.
i) When the upper wall assembly is being constructed, insulate the corner, install the corner flashing by fastening it to the roof closure channels and wall sub-girt.

Specifier/Designer Notes:
There are different types of curved panels systems with varying framing requirements. Consult the product manufacturer for details.



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