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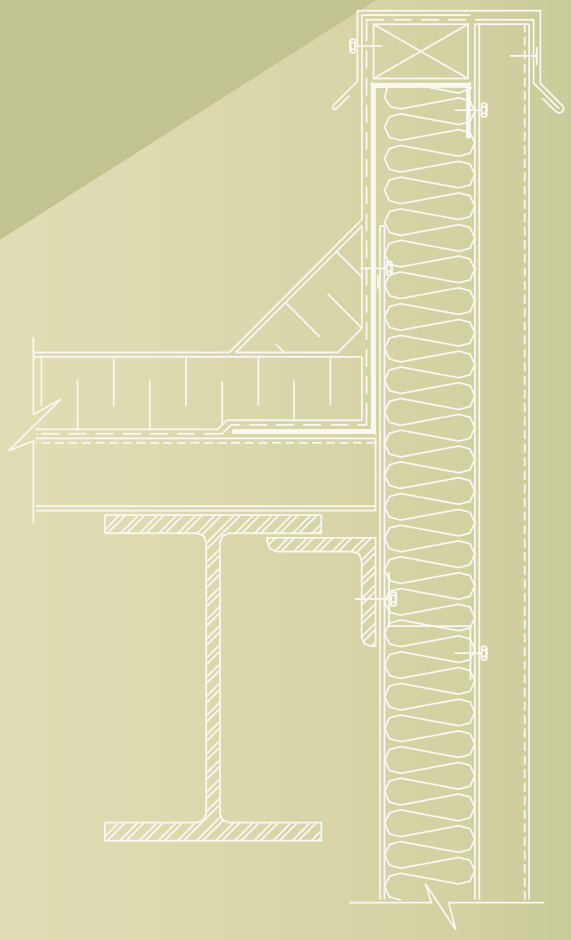
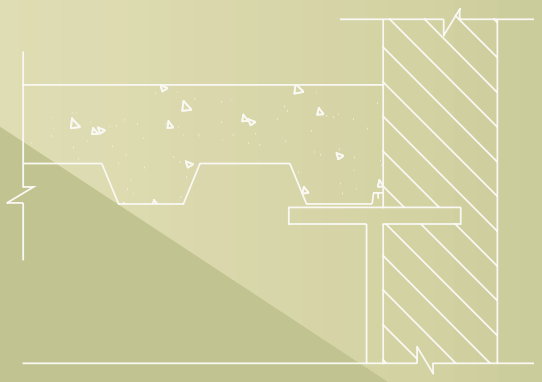
HOW TO SERIES...



Steel Roof Deck and Floor Deck



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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 and floor deck.*

This guide will go through the various stages in the selection of steel deck product, describe the different types of deck products, discuss structural design issues 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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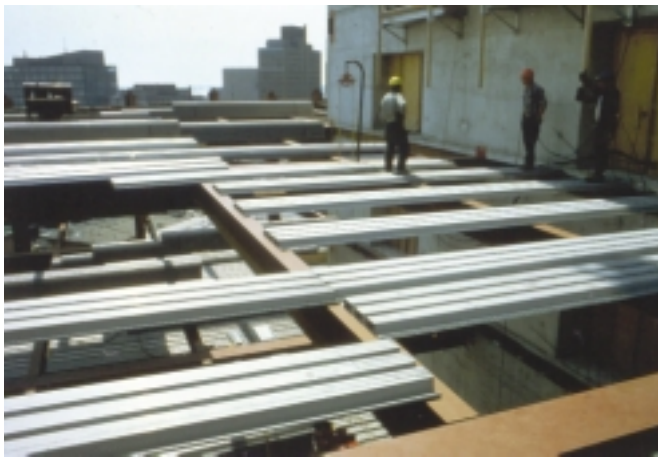
What is Steel Deck ?

There are a wide variety of steel deck products on the market today, basically divided into two categories: roof deck and composite floor deck.

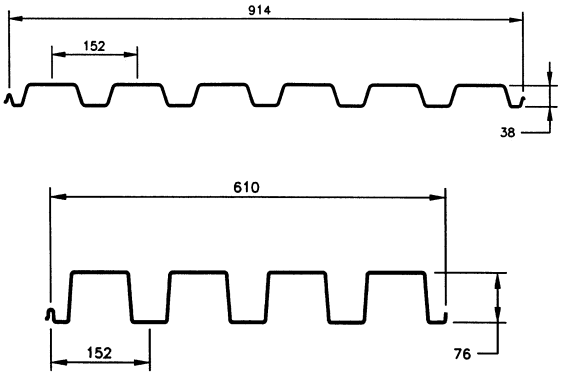
Steel deck is a structural panel element that acts as the surface of a floor or roof. The deck is roll formed from structural quality sheet steel and is engineered to span over joist or purlins. Variations in the thickness, shape and depth of the deck can be utilized to meet a variety of loading conditions and spans. The deck can also be fastened to the supporting structure to enable it act as a diaphragm and provide lateral bracing for the structure.



Deck Types

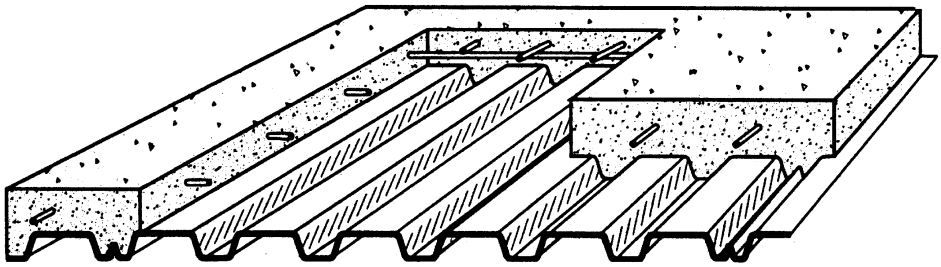
Steel deck assemblies are divided into two categories: roof deck and composite floor deck.

Roof Deck
Steel roof deck is the predominant structural component used in virtually all flat roofs. The deck is a structural panel that spans over roof joist or purlins to provide a flat surface on which to apply the weatherproof roofing. Steel deck is the substrate for most roofing materials such as built-up roofing, membrane roofs or insulated sheet steel roof assemblies. Roof deck has also been used in more unusual configurations that may be sloped or curved.



Typical Roof Deck Profiles

Composite Floor Deck
When steel floor deck was first introduced, it was primarily used as a permanent, or "stay-in-place" form for a reinforced concrete poured in place slab. There were certain advantages in cost and a shorter construction time for this type of concrete formwork over traditional removable formwork. There were some situations, however, where the deck did not have a concrete cover and was the sole load carrying element. The name for this type of deck is *floor deck*, or *non-composite deck*. In the 1960's, floor deck products were developed that incorporated mechanical means of interlocking the concrete and the steel deck. By interlocking the steel deck and the concrete slab, the deck became the positive moment reinforcement in the reinforced concrete slab. In addition, the deck also acted as the formwork for the concrete. The resulting combined section



Typical Composite Floor Slab

has become known as a *composite slab* and the steel deck as a *composite deck*. The plain steel floor deck is no longer produced in any significant quantity in favour of the more efficient composite deck.

Advantages of Steel Deck

Versatility: Steel deck products are available from CSSBI Fabricator member companies in a range of depths (38 to 76 mm, (1-1/2 to 3 in.)) and different rib spacing. Roof deck can also be supplied as acoustical deck with perforations in the web elements to attenuate sound. Steel deck products are available in a variety of thickness to meet most structural requirements. This extensive choice of options makes steel deck applicable to a wide range of projects and structural designs.

High Strength to Weight Ratio: The strength of steel is used with maximum efficiency in the design and fabrication of steel deck, resulting in products with a high strength-to-weight ratio. Consequently, delivery, erection and structural framing costs can be lower than other systems.

Aesthetics: Although steel deck is primarily a structural component, it is visually attractive when left exposed to the interior of the building. With the properly specified prefinished coating, steel deck is easy to maintain, durable and aesthetically pleasing.

All-Weather Construction: Steel deck can be erected in most weather conditions, eliminating the costly delays that can occur with other types of roof systems.

Required Fire Resistance Ratings: ULC and UL fire resistance ratings are available for many standard roof and floor assemblies incorporating steel deck.

Uniform Quality: Through engineering and continuously refined production techniques, CSSBI fabricators produce deck that conforms to explicit industry standards.

Proven Durability: Steel deck has a successful service history of over 60 years, which is indicative of the products durability.

Economy and Value: Value is determined by combining initial costs, life-cycle costs, and overall performance. Steel deck assemblies are the best value in roof and floor designs. They combine low cost with top performance.

Sheet Steel Material Selection

All steel deck products have one thing in common: they are fabricated from metallic coated, high quality controlled, sheet steel. Each component of the steel sheet (steel core and coatings) 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.

Table 1 - Sheet Steel Thickness Table

Design Base Steel Thickness		Base Steel plus Metallic Coating Thickness		CSA-S136-94 Under-Tolerance on Metallic Coated Thickness		Minimum Allowable Coated Thickness	
inches	mm	G90 (0.0015")	Z275 (0.040 mm)	inches	mm	G90 inches	Z275 mm
0.105	2.67	0.1065	2.71	0.0045	0.115	0.1020	2.595
0.075	1.91	0.0765	1.95	0.0040	0.105	0.0725	1.845
0.060	1.52	0.0615	1.56	0.0030	0.075	0.0585	1.485
0.048	1.22	0.0495	1.26	0.0025	0.065	0.0470	1.195
0.036	0.91	0.0375	0.95	0.0020	0.050	0.0355	0.900
0.030	0.76	0.0315	0.80	0.0020	0.050	0.0295	0.750

Steel Core: A steel deck 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 properties.

The thickness of the steel core is selected to accommodate the structural requirements. When specifying a product thickness, 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.

All manufacturing is subject to variations, and quality control procedures are in place that specify the tolerance limits. For cold formed steel structural members designed for use in Canada, the CSA –S136 *Standard for Cold Formed Steel Members* governs. This standard specifies the maximum allowable under-tolerance based on the design thickness. Table 1 shows the minimum allowable thicknesses of Z275 (G90) galvanized sheet for the common thicknesses available for steel deck. Minimum thickness for deck with other metallic or paint coatings must take into account the coating thicknesses. Table 2 lists the thickness of common alternative coatings.

Table 2 - Metallic Coating Thicknesses

Coating Designation (Metric)	Thickness (mm)	Coating Designation (Imperial)	Thickness (in)
ZF075	0	A25	0
Z001	0	G01	0
Z180	0.025	G60	0.0010
Z275	0.040	G90	0.0015
AZM150	0.040	AZ50	0.0015
AZM165	0.045	AZ55	0.0018
AZM180	0.050	AZ60	0.0020

Metallic Coatings: It is important that the potential for corrosion of the steel be controlled and not allowed to affect the integrity and strength of the product; therefore, the steel core 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 (Galvalume™ and Galvalume Plus™), zinc (galvanized) and zinc-iron alloy (galvanneal) 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. Under most conditions, a Z275 (G90) zinc coating can typically protect gaps of bare steel or edges up to 1 mm (1/16

inch) in width. A more in-depth description of the cathodic protection process can be found in many engineering materials handbooks.

The aluminum-zinc alloy coating also provides a similar sacrificial and barrier type protection of the steel, as described above. Aluminum-zinc alloy coatings are not recommended for use in contact with fresh concrete, such as in composite deck.

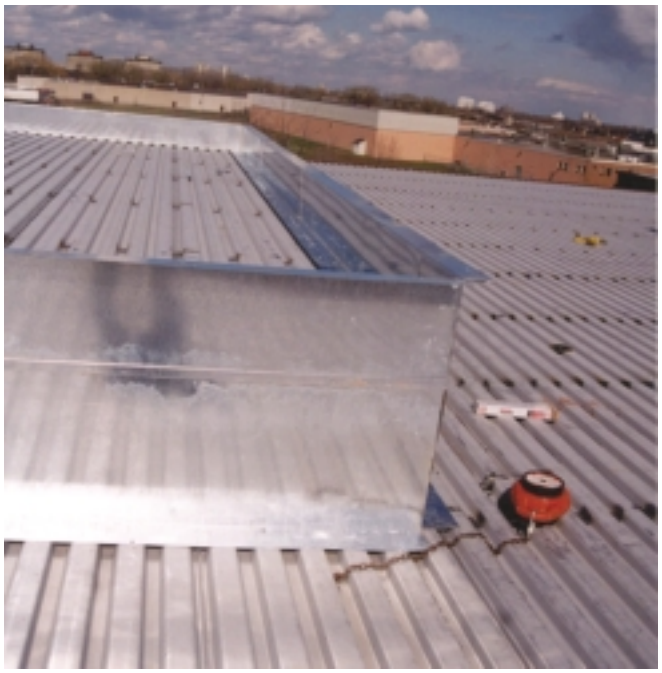
Metallic coatings are applied to steel sheet by the hot-dip process and are offered in a range of coating weights. The most common coating specified for roof and composite deck products is ZF075 (A25) zinc-iron alloy coating. Heavier coatings may be appropriate depending on the environmental conditions.

Metallic coatings are susceptible to staining if they become wet in a nested condition. This is caused when moisture is trapped between bundled sheets from rain, snow or condensation. Storage stain will change the appearance of zinc/iron coatings to a dark grey colour and after prolonged wet exposure the surface could turn to a reddish brown colour as moisture reacts with the surface iron. The surface of zinc coatings will turn to a white rust appearance. The stain is the result of a surface reaction and does not impede the protective properties of the coating. The stain is only cosmetic and superficial and the metallic coating can be painted if required. Storage stain can be prevented if the bundles are kept dry, such as by covering the bundles with a tarp to protect the panels from the elements. If bundles should become wet from condensation or rain, separate the panels to promote drying.

The CSSBI publishes 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 and order form.

Paint Coatings: There are situations where a paint coating is also added to the sheet steel. For example, roof deck applications that are exposed to the interior and are post-painted, or applications in corrosive industrial environments where extra corrosion protection is needed. Sheet steel is available prefinished or it can be post-painted after erection.

Prefinished means the sheet steel has been painted before it is roll formed into the final 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.



There is a wide selection of paint 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.

Post painting involves painting the deck after erection and is common in structures where the deck is visible. The deck and supporting joists can be post-painted all one colour. It is very important to select the proper paint systems for this application to ensure a good bond between the metallic coated deck and the paint.

Sheet steel painted with a primer alone is not recommended for deck applications without a metallic coating

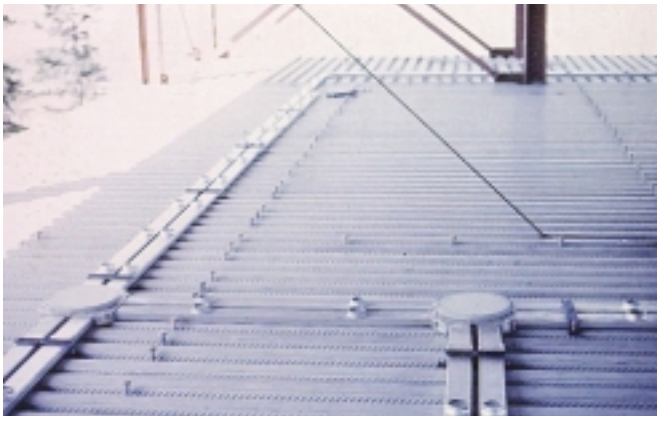
Design and Specification

Design of Steel Roof Deck
The manufacturer and design of steel roof deck is covered by CSSBI Standard 10M *Standard for Steel Roof Deck*. This standard specifies the minimum material properties, manufacturing tolerances, erection and structural design. This standard can be called up by reference in job specifications.

Design of the Composite Deck as a Form
The manufacturer and design of composite steel deck is covered by CSSBI Standard 12M S*tandard for Composite Deck*. This standard specifies the minimum material properties, manufacturing tolerances, erection and structural design. This standard can be called up by reference in job specifications.

Testing of Composite Slabs
A composite slab behaves like a reinforced concrete slab, but the nature of the bond between the steel deck and the concrete can only be determined by test. Every manufacturer of a composite deck product will have carried out a series of tests to develop the design parameters for their product. Tests must be conducted on each deck profile, concrete type, concrete thickness and metallic coating type, covering the available range of steel thicknesses and shear spans. The test method and the method of analysing the data is specified in the CSSBI publication S2 *Criteria for the Testing Composite Slabs*.

Design of Composite Slabs
The composite slab test program will provide the manufacturer with the ultimate strength of the particular deck profiles. The design of the composite slab as part of a structure must consider additional limits states such as shear and deflection. How these varied limits states are handled is covered in the CSSBI publication S3 *Criteria for the Design of Composite Slabs*.



Structural Loads
The structural design of the roof or floor deck 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 deck is designed to carry, as well as other parameters like web crippling capacity and deflection limit states.

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

Diaphragm Design
One of the benefits of a steel deck is its capacity to act as a structural diaphragm. If the deck is adequately attached to the supporting structure and adjacent sheets are attached together, the combined unit can carry significant in-plane shear forces. The steel deck shear diaphragm can be incorporated into the structure to transfer lateral loads (wind, earthquake) to the vertical shear walls or braced bays. Utilizing this capacity of the deck can in many cases eliminate the need, and cost, of discrete horizontal bracing. Information on the design of the steel deck diaphragms can be found in CSSBI B13 *Design of Steel Deck Diaphragms*.

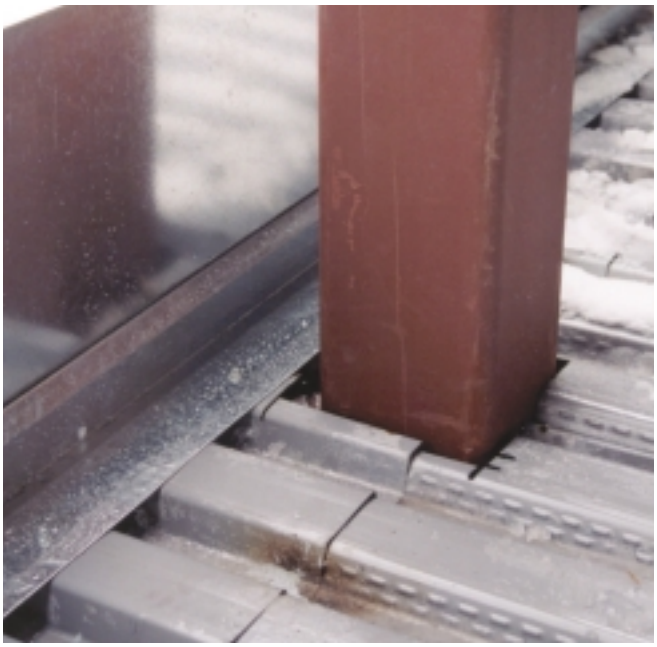
Guide Specifications
Guide specifications are provided in CSSBI 10M and CSSBI 12M for roof deck and composite deck products. These specifications can be adopted by reference or modified as appropriate for a particular job.

Fastening Systems

The connection of the deck to the structure can be made using a number of structural fastening systems. The most common fastening methods are arc spot welding, sheet metal screws and pneumatic or powder actuated pins. The design of these connections is governed by the applicable design standard (i.e. CSA-S136) and is an important consideration if the deck is required to act as a shear diaphragm or is expected to resist significant uplift loads. The CSSBI standards S10 and S12 specify the following minimum fastening:

- Steel roof deck units shall be adequately fastened to structural supports. The maximum spacing of fastenings along bearing supports shall be 400 mm or 2 flute spacings, whichever is the lesser. Arc spot welds shall have a 20 mm nominal top diameter. At side lap locations, welds to the structural supports can be adjusted in shape to fit the available space. Welders shall be qualified for deck welding by the Canadian Welding Bureau.
- End laps shall be not less than 50 mm and shall be formed over supports.
- Side laps of adjacent units shall be mechanically fastened, or for thicknesses greater than 0.91 mm may be welded using 25 mm welds. The fastener spacing shall not exceed 900 mm for roof deck or 600 mm for composite deck. Closer spacing may be required for diaphragm action, as determined by design.
- Where steel roof deck is welded in place, the steel deck surface shall be immediately inspected, and all topside areas where the metallic coating has been burned by welding shall be covered by a suitable primer, applied according to the primer manufacturer's instructions.

The requirements for other types of fasteners (i.e. pins, button punching) must be provided by the fastener manufacturer. Welding should not be used to attach steel



deck that is made from prefinished material, since this will damage the paint coating around the weld area. Other types of mechanical fasteners should be used. Consult the deck manufacturer.

Flashing and Reinforcement

Flashing details around penetrations and along the perimeter should be clearly shown on the drawings. Manufacturers have standard methods and accessories for handling penetrations and transitions that should be followed. The type and location of flashings and accessories should also be clearly shown on the drawings. The drawings in the Appendix illustrate some typical flashings.

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

Reinforcement of the deck openings around penetrations may be necessary to maintain the structural integrity of the deck. Where reinforcement is required, it should be clearly shown on the drawings.

- For openings up to 150 mm across the flutes, no reinforcement is necessary provided that not more than two vertical webs are removed.
- For openings over 150 mm to 300 mm across the flutes, provide not less than a 50 x 50 x 6 mm angle reinforcement to frame across each side of the opening in a direction perpendicular to the flutes. The angles shall be welded to at least two flutes on each side of the opening. Alternatively, reinforcing

shall be provided based on a structural analysis of the loads involved.

- For openings over 300 mm to 450 mm across the flutes, provide suitable reinforcement based on a structural analysis of the loads involved.

Erection

All erection work, including field welding, shall be the responsibility of the Erector. Erectors shall be qualified in accordance with CSA Standard W47.1 *Certification of Companies for Fusion Welding of Steel Structures.* Welders shall be qualified for deck welding by the Canadian Welding Bureau.

Steel deck units shall be placed, and adjusted to final position, on the supporting structure before being permanently fastened thereto. If structural supports are not in proper alignment, the problem shall be reported to the General Contractor in order that the necessary correction can be made before proceeding with the work. The width of the bearing supports must be at least equal to the depth of the deck. Steel deck units shall be adequately fastened to structural supports.

All steel deck being hoisted to the working level shall be adequately banded and carefully slung employing steel wire rope and using a choker type sling or multi-lift beams. All bundles shall be tag lined during the ascent of the hoisting operation. Bundles shall be placed so as to avoid overloading the supporting structure.

All steel deck sheets, after being laid and aligned, shall be properly secured in place prior to leaving the jobsite at the end of a working day. All steel deck cuttings, strapping, packaging material, and other debris pertaining to steel deck shall be removed from the roof area and lowered to the ground at the completion of each working day.

Any damage or alterations by others to the steel deck, including that due to construction loads applied at any time, shall not be the responsibility of the Erector or the Fabricator.

Related Information

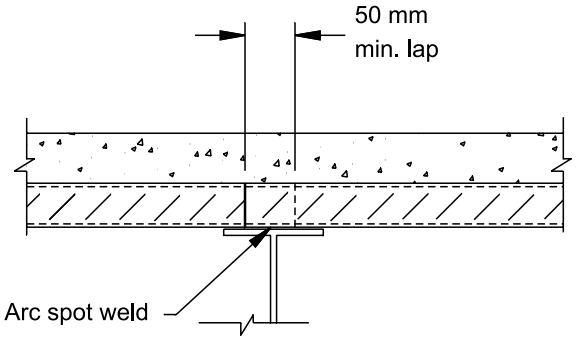
The CSSBI has a number of publications on various topics related to sheet steel building products. For complete list, contact the CSSBI or visit our web site at www.cssbi.ca.

Appendix

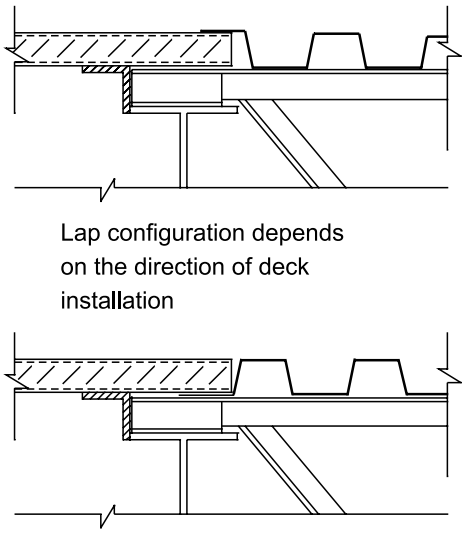
Detail Drawings

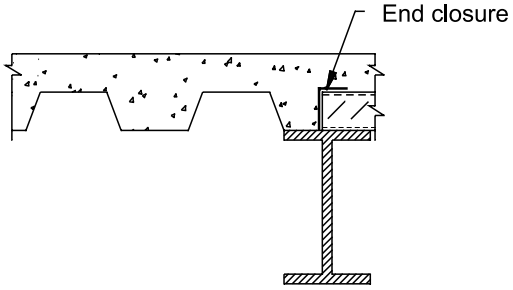
The following sections and details are representative of the basic components of insulated sheet steel roof and floor deck assemblies. Every CSSBI steel deck Fabricator Member may provide you with details slightly different than those shown in this document that recognizes their particular products or practice. The function of each detail is to provide an assembly that is structurally sufficient, and practical. In all cases good building science practices should be followed. These are representative details and not the only correct way of installing insulated sheet steel deck. For additional information on details not shown, consult a CSSBI Fabricator Member.

Detail 1: Typical Lap Joint

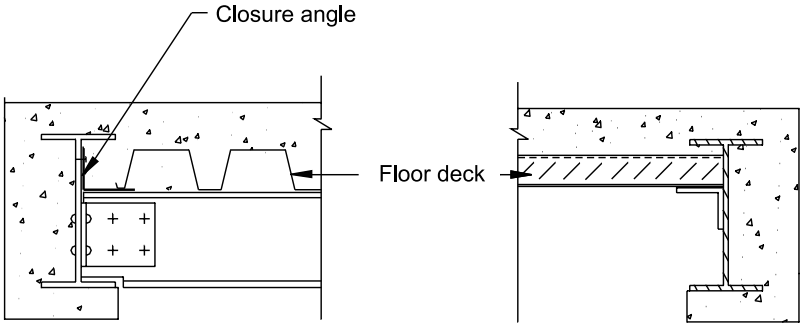


Detail 2: Change in Direction

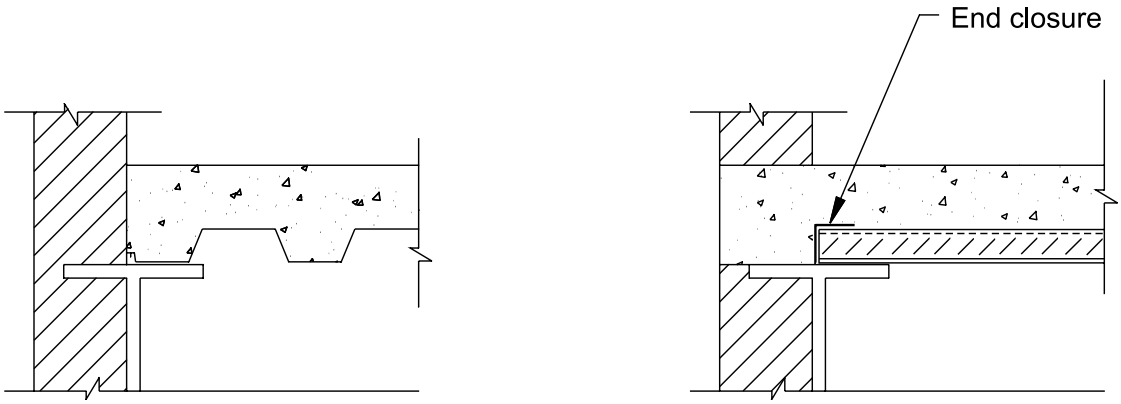




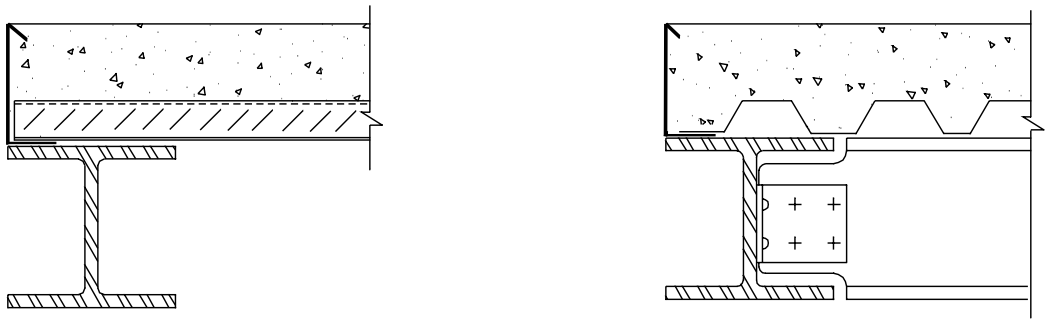
Detail 3: Side Condition – Beam at Lower Level Than Girder



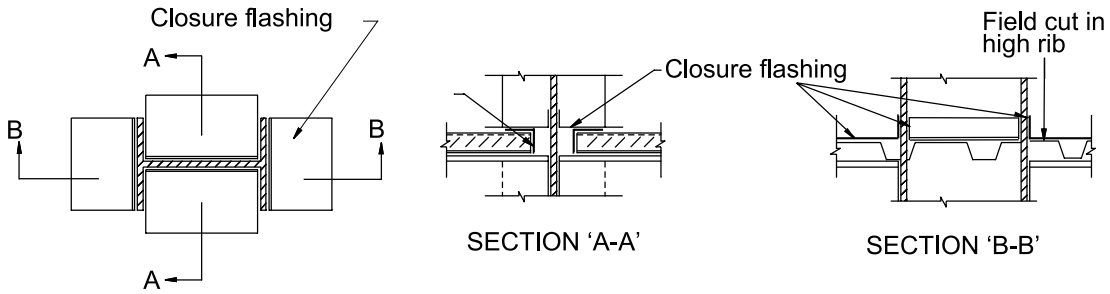
Detail 4: Standard Side Conditions



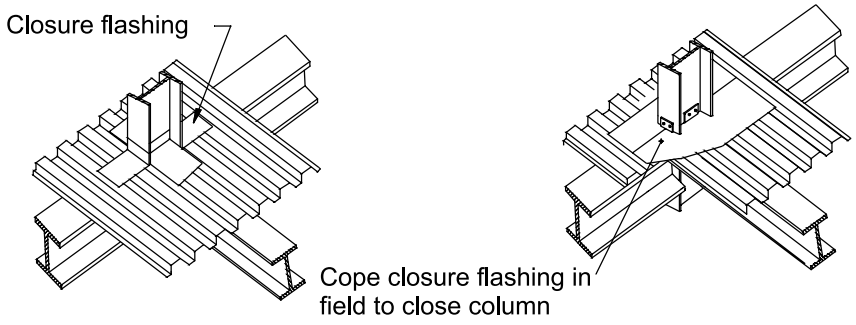
Detail 5: Retaining Angles at Perpendicular and Parallel Conditions



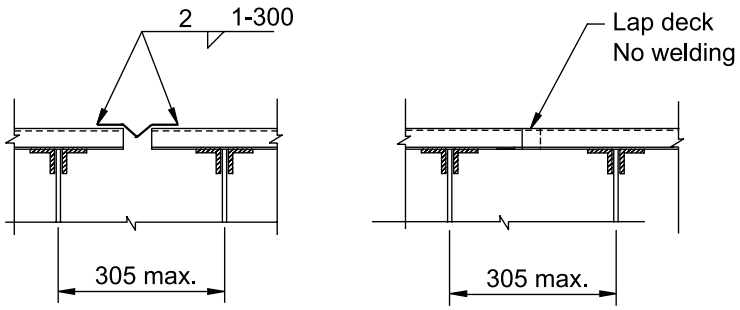
Detail 6: Framing Around Interior Columns



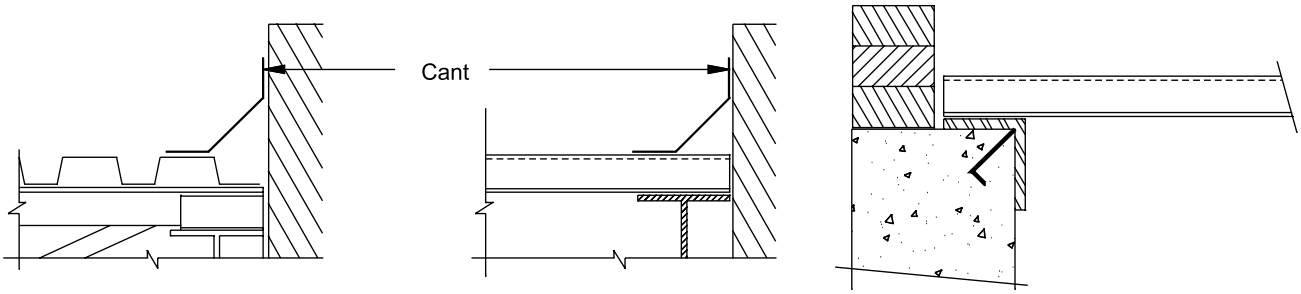
ISOMETRIC VIEW OF DECK AT COLUMNS



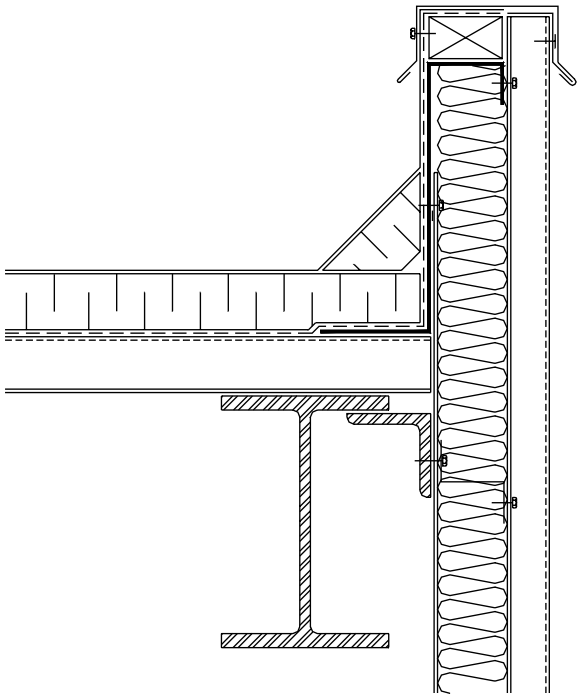
Detail 7: Expansion Joints



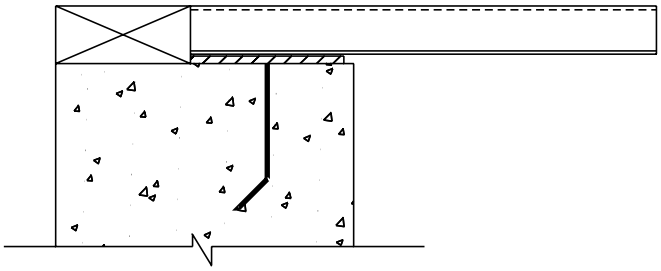
Detail 8: Roof Deck Meeting Masonry Wall



Detail 9: Roof Deck at Insulated Sheet Steel Wall



Detail 10: Roof Deck at Eave



Detail 11: Composite Beam Connections