

Steel Roof Decks and Flute-Span Capability

By Brian A. Davis, AIA, LEED AP, GRP,
and James R. Kirby, AIA

The primary concern during the design and installation of a roof system is keeping water out of the building. Other common concerns (in no order of importance) include the fire resistance, wind resistance, impact resistance, and *R*-value of the installed system. The use of specific materials and system components raises additional concerns. For example, when installing a roof system over a steel roof deck, flute-span capability is added to the list of concerns.

As the term implies, flute-span capability is a physical characteristic of insulation and rigid boards that are placed directly on top of a steel roof deck. The selection of an appropriate material to be installed over the gaps in steel roof decks (the flutes) is important during both construction and the life of the roof. During construction, the first layer of material installed directly to the steel roof deck must support worker and equipment loads without being damaged. After installation, the entire roof assembly provides support for loads (including dead, live, snow, and traffic loads) that are imposed on a rooftop over the life of the roof.

STEEL ROOF DECK PROFILE AND GEOMETRY

The profile of a steel roof deck includes top flanges (the part of the steel deck upon which roofing materials are placed) and ribs that vary

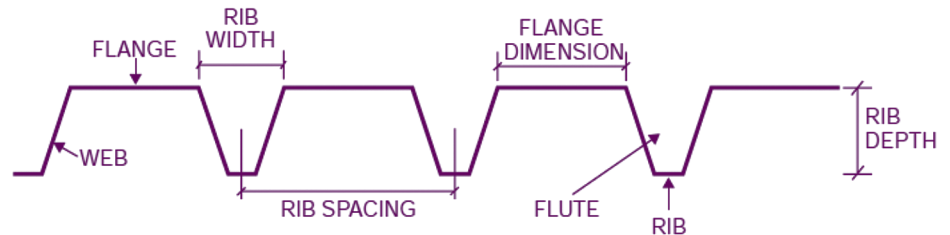


Figure 1. Nomenclature used to describe steel roof decks from the National Roofing Contractors Association (NRCA). Figure: NRCA. 2019. The NRCA Roofing Manual: Membrane Roof Systems. Rosemont, IL: NRCA.

in dimension. The ribs of steel roof decks are wider at the top than at the bottom of the rib. The web connects the top flange to the rib, and the ribs vary in width and depth (Fig. 1).

The geometry of a steel roof deck provides much of its structural capacity and is one of the primary reasons that a steel roof deck can span between structural supports that are spaced 5 or 6 ft (1.5 or 1.8 m) apart. Although the strength and thickness of the steel are important factors, the geometry of the steel roof deck is

critical. Consider how flexible a flat piece of steel of the same strength and thickness as the steel in a roof deck would be, and how much deflection would occur when that flat piece spanned 5 to 6 ft (Fig. 2).

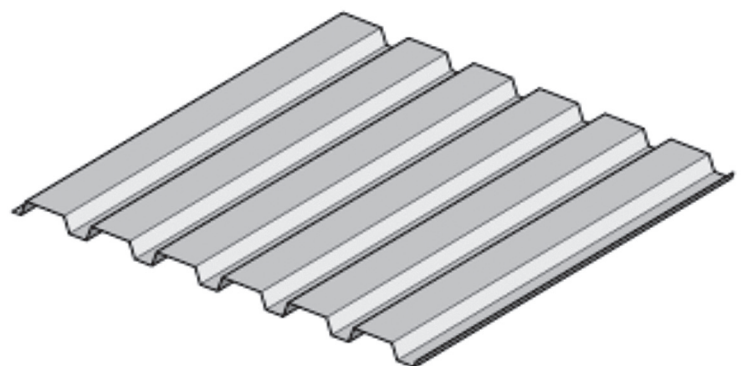


Figure 2. Isometric view of a common steel roof deck.

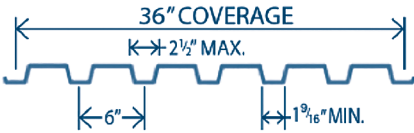
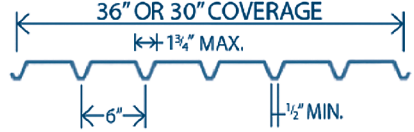


Roof Deck Profiles	Name	Nominal Thickness Range	Weight Range	Comments
	1 1/2" X 6" Wide Rib (WR)	.03" to .06"	2 psf to 4 psf	May be referred to as "B" deck. Sidelaps may be flat adjustable or button punchable. Acoustical deck will have perforated webs.
	1 1/2" X 6" Intermediate Rib (IR)	.03" to .06"	2 psf to 4 psf	May be referred to as "F" deck.
	1 1/2" X 6" Narrow Rib (NR)	.03" to .06"	2 psf to 4 psf	May be referred to as "A" deck.
	3" X 8" Deep Rib (DR)	.03" to .06"	2 psf to 4 psf	May be referred to as "N" deck. Sidelaps may be flat adjustable or button punchable. Acoustical deck will have perforated webs.

Figure 3. Steel roof deck profiles from the Steel Deck Institute (SDI). Figure: Reprinted with permission from SDI. 2016. Manual of Construction with Steel Deck. 3rd ed. Glenshaw, PA: SDI. Note: 1" = 1 in. = 25.4 mm; 1 psf = 1 lb/ft² = 0.0479 kPa.

STEEL ROOF DECK TYPES

Commercial steel roof decks come in various sizes, profiles, material gauges, finishes, and loading capabilities. Figures 3 and 4 present examples from the Steel Deck Institute (SDI)¹ and the National Roofing Contractors Association (NRCA),² respectively, of four of the most common types of steel roof deck profiles. Using NRCA nomenclature (which is slightly different from the names used by SDI), they are as follows.

- Wide-rib steel deck (Type B)
- Intermediate-rib steel deck (Type F)
- Narrow-rib steel deck (Type A)
- Deep-rib steel deck (Type 3DR)

It is worth noting that narrow-rib (NR) steel decks (also known as Type A) are infrequently used today. NR decks were more prevalent when thin layers of insulation (for example, 1/2 to 1 in. [13 to 25 mm]) were hot-mopped

directly to steel decks. Most of the steel roof decks used for North American commercial buildings are Type B decks, which are 1 1/2 in. (38 mm) deep with 6 in. (150 mm) rib spacing. The top flange of a Type B deck is 3/2 in. (89 mm) wide, which leaves 2 1/2 in. (64 mm) that needs to be spanned by the material installed directly on the steel roof deck.

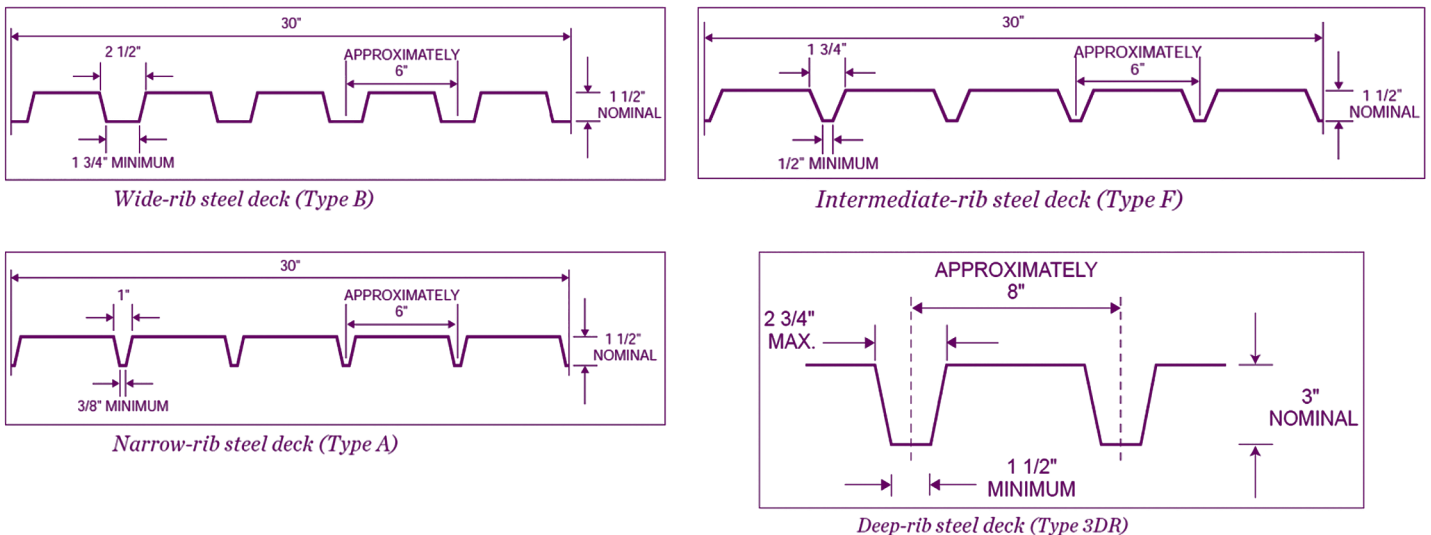


Figure 4. Examples of steel roof deck panels from the National Roofing Contractors Association (NRCA). Figure: Adapted from NRCA. 2019. The NRCA Roofing Manual: Membrane Roof Systems. Rosemont, IL: NRCA. Note: 1" = 1 in. = 25.4 mm.

Gypsum-based rigid roof board	
Minimum product thickness, in.	Flute-span capability, in.
¼	≤2⅝
½	≤5
¾	≤8

Note: 1 in. = 25.4 mm.

Table 1. Flute-span capability of gypsum-based rigid roof board for use over metal decks.

Perlite roof insulation	
Minimum product thickness, in.	Flute-span capability, in.
¾	≤1
1	≤1¼
1½	≤2½

Note: 1 in. = 25.4 mm.

Table 2. Flute-span capability of perlite roof insulation for use over metal decks

Gypsum-fiber roof board	
Minimum product thickness, in.	Flute-span capability, in.
¼	≤2⅝
⅜	≤5
½	≤8
¾	≤10

Note: 1 in. = 25.4 mm.

Table 3. Flute-span capability of gypsum-fiber roof board for use over metal decks.

Polyisocyanurate roof insulation (20 and 25 psi)	
Minimum product thickness, in.	Flute-span capability, in.
1–1.3	≤2⅝
1.4–4.6	≤4⅝

Note: 1 in. = 25.4 mm; 1 psi = 6.895 kPa.

Table 4. Flute-span capability of polyisocyanurate roof insulation (20 and 25 psi) for use over metal decks.

High-density polyisocyanurate roof insulation (80 and 110 psi)	
Minimum product thickness, in.	Flute-span capability, in.
½	≤3¼

Note: 1 in. = 25.4 mm; 1 psi = 6.895 kPa.

Table 5. Flute-span capability of high-density polyisocyanurate roof insulation (80 and 110 psi) for use over metal decks.

High-density fiberboard roof insulation	
Minimum product thickness, in.	Flute-span capability, in.
½	≤1⅝

Note: 1 in. = 25.4 mm.

Table 6. Flute-span capability of high-density fiberboard roof insulation for use over metal decks.

USING PRODUCTS DIRECTLY OVER STEEL DECKS

Multiple products can be used directly over steel decks. The flute-span capability of products is specific to manufacturer, product type, surfacing, and thickness. Therefore, it is difficult to provide a comprehensive list of materials. However, **Tables 1** through **6** provide specific information based on material type and product thickness. The tables were derived from product manufacturers' publicly available information, but they are not exhaustive lists. Additionally, the information may vary based on manufacturer. Flute-span capability should be verified by the manufacturer of the specific product.

Consideration of Flute-Span Capability During Construction

When working with Type B decks, roofing contractors concern themselves with joist spacing for performance under load—for example, wind performance—and typically place polyisocyanurate (polyiso) insulation or a rigid board directly over a steel roof deck for use as a fire barrier. This roofing system configuration is very common, and the potential for a misstep is low because both polyiso insulation and rigid boards can generally span standard steel roof deck configurations such as Type B decks.

The concept of flute-span capability is directly associated with the strength of the material being installed and its ability to handle the anticipated loads where the material is not supported by the top flange of the roof deck (that is, over the flute). This capability is often needed during construction but not necessary for the completed roofing system; therefore, flute-span capability may be a larger concern during construction than it is once the roof system is completed. For example, let us suppose that 1 in. (25 mm) of perlite insulation is installed on a Type B deck and then covered with 3 in. (75 mm) of polyiso insulation. Because 1 in. perlite insulation is rather sturdy, many would not see the risk associated with this type of installation. However, the maximum flute span for 1 in. perlite insulation is 1¼ in. (44 mm), which is ¾ in. (19 mm) less than the rib opening of a Type B roof deck. It could be presumed that when covering the perlite insulation with the polyiso insulation (which is more rigid and has higher flute-span capability), the combined total insulation will be fine. However, this logic is based on the false premise that there is no traffic on the perlite insulation while the polyiso insulation is being installed (**Fig. 5**).

Figure 5. Installation of a gypsum-based board over a metal deck. The ability for workers to walk on this surface without doing harm to the rigid board is critical to the long-term success of the roof system.



Acoustical Decks

When a designer moves from common types of steel roof decks to other styles to meet a design or building need, that design choice can cause challenges for the roofing professional with regard to flute-span capability. For example, a less-common steel roof deck is a dovetail acoustical roof deck, which has a very narrow top flange and a very wide rib opening (Fig. 6). This type of deck can be an appealing option for some designs because it has a smooth linear plank look on its underside and because it can—with flute fill—provide acoustical benefits.

When an acoustical roof deck is used as a substrate for roof systems, it is important to recognize that its profile is quite different from common steel roof decks. The flutes of an acoustical roof deck are quite wide (relative to the four most common steel roof deck types) and the top flange is quite small. This profile accommodates the use of acoustic (sound-deadening) insulation within the flutes (Fig. 6).

While the acoustic benefit is important for certain buildings, the choice of material that is installed directly on this type of deck should be carefully specified to ensure the long-term performance and constructability of the roof system. There are very few materials that can span the 4 $\frac{1}{2}$ in. (117 mm) rib opening.

Another consideration is how the first layer of material will be attached given the small top

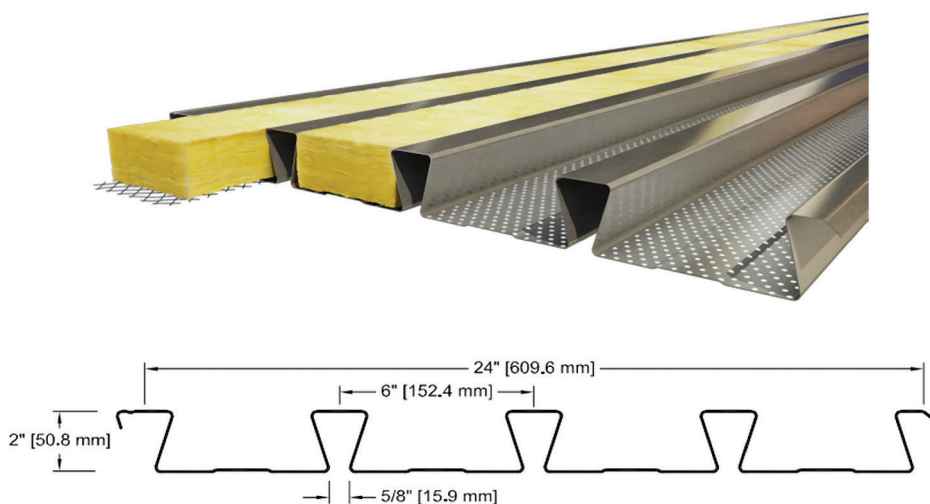


Figure 6. The dimensions of an acoustical dovetail roof deck (bottom); use of sound-deadening insulation in the flutes (top).

The concept of flute-span capability is directly associated with the strength of the material being installed and its ability to handle the anticipated loads where the material is not supported by the top flange of the roof deck (that is, over the flute).

Roof	
Roof System	Modified Bitumen
Roof Application	New Roof Re-Roof Recover

Deck	
Deck Type	Steel
Deck Attributes	Grade: 33 Min. Gauge: 22 Type: B
Other Details	Not specified

Performance	
Tested Wind Uplift Load Capacity	90 psf
Wind Uplift Standard	FM 4474 (2010/2011)

Layer Summary	
Layer 4	Hot Asphalt SBS Cap Sheet (Optional) Hot Asphalt Ply Sheet Hot Asphalt Base Sheet
Layer 3	Hot Asphalt Wood Fiber Coverboard or Gypsum Fiber Coverboard or Glass Mat Gypsum Coverboard
Layer 2	(Optional) Hot Asphalt Polyisocyanurate Insulation
Layer 1	Fastened Polyisocyanurate Insulation
Deck	Steel

Figure 7. An example of an approval listing in the Directory of Roofing Assemblies (dora-directory.com).

flange on an acoustical deck. Ensuring that fasteners are properly engaged into the top flute of an acoustical deck that has a top flute width of 1½ in. (38 mm) can be challenging. Chalk lines could be used to help ensure fasteners are located correctly. This process is effective for the first layer of rigid board, but once the deck is fully covered with a layer of insulation or rigid

board, it becomes more difficult to ensure that the fasteners hit the top flange. Careful alignment of upper fasteners with the previous layer's fasteners may allow proper fastener installation; however, the use of a low-rise foam adhesive to adhere additional layers of insulation or rigid board can provide a more confident solution for this concern. (Please note: Ensuring fasteners

engage with the top flange is important for all types of steel roof decks, not just acoustical decks.)

Roof System Approval Listings

Approval listings promulgated by roofing manufacturers provide a wealth of information. One provider of approval listings is the Directory of Roofing Assemblies (DORA: dora-directory.com). Figure 7 is an example from an approval listing in DORA that provides information about the roof deck, including the deck type and deck attributes. Notice that one of the attributes is that the roof deck is Type B. Although not shown in Fig. 7, the listing also identifies the minimum thickness of the layer of material that is installed directly to the roof deck: minimum 2-in.-thick (50-mm-thick) polyiso. From the information in Table 4, we can determine that this polyiso thickness exceeds the minimum thickness required to span a 2½-in.-wide (64-mm-wide) flute.

Another approval listing tool is RoofNav (roofnav.com). It can be used to find valuable information about the required steel roof deck for a specific listing. Figures 8 and 9 provide an

The screenshot shows the RoofNav website interface. At the top, there is a navigation bar with 'Help', 'Support', and 'Training'. Below that is a main menu with 'MY PROJECTS', 'PRODUCT SEARCH', 'SYSTEM SEARCH', 'ASSEMBLY SEARCH', and 'RATINGS CALCULATOR'. The main content area is titled 'Assembly Properties' and contains the following information:

Assembly #: 295300-0-0	Slope: 0.2500
Roof System: Single-Ply System	Wind Uplift*: 165
Application: New Roof	Internal Fire: 1
Cover Securement: Adhered	Exterior Fire: A
Deck Type: Steel	Hail: SH
Assembly limited to use with noncombustible walls only: No	

Figure 8. Summary of an approval listing in RoofNav (roofnav.com).

6. (Deck) Steel	
See Separate Steel Deck Manufacturer Listing	steel deck, 22 to 18 ga., wide rib (>90 psf) View
Securement (Deck Lap)	
ITW Commercial Construction North American	#10 HWH Tek's 1 View
7. Securement (Deck) from 6. (Deck) Steel to 8. Structure	
SSSP15442 View	
Generic	3/4 in. washer
ITW Commercial Construction North American	#12 HWH Tek's 5


Figure 9. Detailed information about the roof deck from the RoofNav approval listing shown in Fig. 8.

example of such a listing. In this example, the steel deck must be 22 to 18 gauge and is listed as wide rib, which is Type B. The securement of the side lap between two steel roof deck panels is also provided, as is the method of attachment of the steel roof deck to the structure it is installed over.

Clicking “View” for the steel deck (Fig. 9) reveals additional information (Fig. 10). The steel deck for this example is required to be a minimum 33 ksi (230 MPa) steel with a maximum span of 6 ft (1.8 m), minimum depth of 1.5 in. (38 mm), and width within the range of 24 to 36 in. (0.6 to 0.9 m). However, not all listings provide the specific rib type as is shown in the example listing. In those cases, the RoofNav user must investigate further to determine which steel roof deck profile is appropriate for use. It’s worth noting that new steel roof decks are now minimum 40 ksi (280 MPa) steel; this approval remains relevant because the required grade is listed as “minimum.” Additionally, there are many existing steel roof decks that were designated to be grade 33 ksi steel.

CONCLUSION

Roofing professionals should take care to always understand and familiarize themselves with the specifics of the steel roof deck that is being specified and actually installed. Just because plans and specs may call out “steel deck” does not mean the widest rib opening (flute dimension) that may be encountered is 2½ in. (64 mm). The information in Table 7 can help roofing professionals avoid problems with a material’s flute-span capability.

Roofing professionals are well advised to pay attention to the details of construction specification documents, and to investigate the specifics of what is being called out as “steel deck,” which may be drawn as a straight line or non-specific graphic form. Without this attention to detail, material selection could be incorrect for the specific type of steel roof deck installed as the substrate for the roofing system. 

REFERENCES

1. National Roofing Contractors Association (NRCA). 2019. *The NRCA Roofing Manual: Membrane Roof Systems*. Rosemont, IL: NRCA.
2. Steel Deck Institute (SDI). 2016. *Manual of Construction with Steel Deck*. 3rd ed. Glenshaw, PA: SDI.

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Figure 10. Additional information provided from the “View” link for the RoofNav steel roof deck listing in Fig. 9.

Usage Details	
Deck (Steel)	
Company:	See Separate Steel Deck Manufacturer Listing
Trade Name:	steel deck, 22 to 18 ga., wide rib (>90 psf)
Acoustical:	No
Design Thickness:	0.0295 in
Rib Type:	Type WR
Max Span:	72.0000 in
Min Depth:	1.5000 in
Min Grade:	33.0000 ksi
Max Depth:	1.5000 in
Min Thickness:	0.0000 in
Min Width:	24.0000 in
Max Width:	36.0000 in
Comments:	none

Material	Steel deck type			
	A	B	F	3DR
Gypsum-based rigid roof board		¼ in.		½ in.
Polyisocyanurate roof insulation		½ in.		1.4 in.
High-density polyisocyanurate roof insulation		½ in.		
Perlite roof insulation	¾ in.	1½ in.	1 in.	1½ in.
Gypsum fiber roof board		¼ in.		¾ in.
High-density fiberboard roof insulation	½ in.	n/a	½ in.	n/a

Note: n/a = not applicable. 1 in. = 25.4 mm.

Table 7. Minimum thickness of materials based on steel roof deck type.



Brian A. Davis, AIA, LEED AP, GRP is an associate American Institute of Architects (AIA) member, LEED AP, and a Green Roof Professional. He is an active member of AIA, the Asphalt Roofing Manufacturers Association, IIBEC, National Roofing Contractors Association (NRCA), and the Roofing Industry Committee on Weather Issues, and currently sits on the board of directors for the Single Ply Roofing Industry. Davis holds a bachelor’s degree in architectural engineering from Alfred State University.



James R. Kirby, AIA is an architect in GAF’s Building Enclosure Research + Innovation group. Kirby has a master of architecture—structures option and is a licensed architect. His 30-plus years in the roofing industry covered low-slope, steep-slope, metal, SPF, green, and solar. He presents and writes about building and roofing science to all segments of the roofing industry. Kirby is a member of AIA, ASTM International, International Code Council, IIBEC, NRCA, and the Western States Roofing Contractors Association.