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ROOF DECK DESIGN GUIDE

ASC STEEL DECK

Table of Contents

ASC Steel Deck is leading the way in innovation with ongoing testing of our profiles. As a result, the printed catalog may not contain/reflect the latest test results and values of our products. For the most current load tables, refer to the IAPMO ER-161 report online at **www.ascsd.com**.

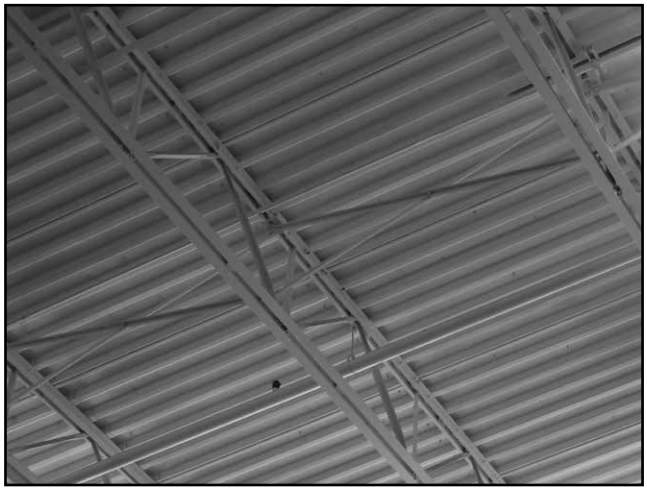
Your Feedback is Welcome

Leading the way in steel deck innovation is dependent upon your feedback. We invite architects, engineers, building owners, and all members of the building design and construction industry to reach out to ASC Steel Deck with any comments, suggestions, or needs for a profile we currently do not offer

Email us at **info@ascsd.com**

IAPMO ER-161 Report

1.1 **Introduction**



General Benefits of Steel

The many benefits of ASC Steel Deck profiles combine to make one of the most versatile and cost efficient building materials available today. The structural strength of steel deck, relative to its light weight and shear strength, make it the clear building material of choice when compared to wood frame construction. The versatility, recyclable content, structural performance, and ease of installation make steel deck the ideal building material for architects, building owners, and engineers.

Evolution of Company

ASC Steel Deck has provided structural steel roof and floor deck throughout the Western United States since the 1970s. Over this time, ASC Steel Deck has undergone a few ownership changes and operated under different business names (ASC Pacific, BHP Steel Building Products, and IMSA Building Products). Since 2002, however, we have operated under the name ASC Steel Deck, a division of ASC Profiles LLC. While the name of the company has changed over the years, our continuous dedication to product innovation, high quality steel deck products, and customer service has positioned ASC Steel Deck as a leader in the industry.

Offering a Full Line of Steel Deck Products

ASC Steel Deck is the only steel deck manufacturer on the West Coast which offers a full line of light-gage structural and deep deck products. From the typical 1½" to 3" roof and composite floor deck, to concrete form deck, to long spanning deep deck profiles, ASC Steel Deck's extensive product offer meets the needs of the most complex conditions and demands for structural performance and design. Most of our roof deck products are offered in a variety of acoustical and perforated options.

Aesthetic Value of Steel Deck

ASC Steel Deck products offer the beauty of exposed steel as an added benefit to the structural performance required of building designs. Our new Smooth Series™ cellular deck offers a blemish free beam-to-pan rivet attachment, providing a clean surface ideal for an exposed steel design. When noise reduction is a necessity, ASC Steel Deck's Acustadek® panels offer acoustical noise reduction capabilities with aesthetic features which complement its use on exposed applications. Acustadek® is generally preferred in high noise areas such as airports, schools, gymnasiums, and concert halls. Acustadek® can contribute to LEED v4 EQ Credit Acoustic Performance Option 2.

Industry Innovator

ASC Steel Deck strives to lead the way in providing innovative products that reduce installation costs while offering some of the highest diaphragm shear values in the market today. ASC Steel Deck was an early innovator of the mechanical side-seam attachment method with the introduction of the DeltaGrip® tool in 2003. First to market in 2009, our 36/7/4 attachment pattern provides the lowest installed value in the market using 1½" deep roof deck and has since replaced the previous industry standard 36/5 and 36/7 attachment patterns. Other innovations include N-32, a 32" wide 3" deep roof deck panel, and our new Smooth Series™ rivet attachment for our portfolio of cellular deck products. First to the West Coast market, our new Smooth Series rivet attachment offers a blemish free attachment solution, eliminating the need for field touch up. Each of these innovations and future product offerings are designed to offer the lowest installed cost at the highest level of performance for building owners.

1.2 **Panel Features and Benefits**

DGB-36/B-36

1½ ” depth, 36” coverage, 5’ to 12’ Optimal Span(s)

●●●●● Excellent Diaphragm Shear

Web and Total Perforated Acustadek® Options

- DeltaGrip produces the highest shear diaphragms in the industry for 1½” decks
- Highest shear lowest cost 36/7/4 attachment pattern in industry
- Published tables for welded, pinned, and screw attachments to supports

DGN-32/N-32®

3 ” depth, 32” coverage, 10’ to 16’ Optimal Span(s)

●●●●○ Good Diaphragm Shear

Web and Total Perforated Acustadek® Options

- DeltaGrip produces the highest shear diaphragms in the industry for 3 inch decks
- Wider 32” panel results in the most labor efficient 3” N Deck in the industry
- Lightest weight 3” N deck per square foot in the industry

BN-36 NESTABLE

1½ ” depth, 36” coverage, 5’ to 12’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

No Acustadek® Option

- Nestable configuration for screwed side lap attachment
- Meets Steel Deck Institute SDI wide rib requirements

NN-32™ NESTABLE

3” depth, 32” coverage, 10’ to 16’ Optimal Span(s)

●●○○○ Modest Diaphragm Shear

No Acustadek® Option

- Nestable configuration for screwed side lap attachment
- Replaces Steel Deck Institute SDI Deep Rib (DR) roof decks

DGBF-36/BF-36

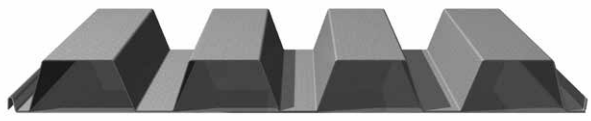
1½ ” depth, 36” coverage, 8’ to 14’ Optimal Span(s)

●●●●● Excellent Diaphragm Shear

Pan Perforated Acustadek® Option (Available with Smooth Series™ rivet attachments or welded)

- Aesthetic flat pan underside
- Longer Spanning than non-cellular profile
- DeltaGrip side-lap attachment provides the same benefits as non-cellular

DGNF-32/NF-32



3” depth, 32” coverage, 14’ to 20’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

Pan Perforated Acustadek® Option (Available with Smooth Series™ rivet attachments or welded)

- Aesthetic flat pan underside
- Longer Spanning than non-cellular profile
- DeltaGrip side-lap attachment provides the same benefits as non-cellular

DG2W-36/2W-36 (Roof Deck)

2” depth, 36” coverage, 8’ to 14’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

No Acustadek® Option

- DeltaGrip side-lap attachment for good shear performance
- Most economical panel per square foot for the span capacity
- Meets Steel Deck Institute SDI 2”x12” requirements

DG3Wx-36/3Wx-36 (Roof Deck)

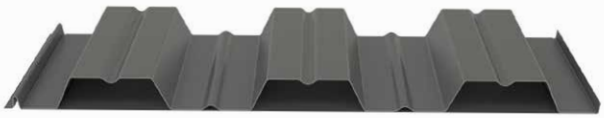
3” depth, 36” coverage, 11’ to 20’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

No Acustadek® Option

- DeltaGrip side-lap attachment for good shear performance
- Meets Steel Deck Institute SDI 3”x12” requirements

DG2WF-36/2WF-36 (Roof Deck)



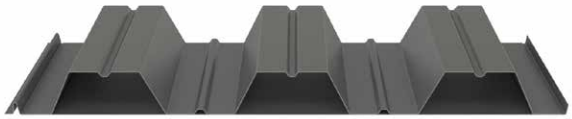
2” depth, 36” coverage, 10’ to 20’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

Pan perforated Acustadek® Option

- Aesthetic flat pan underside
- Longer Spanning than non-cellular profile
- Most economical panel per square foot
- Meets Steel Deck Institute SDI 2”x12” requirements

DG3WxF-36/3WxF-36 (Roof Deck)



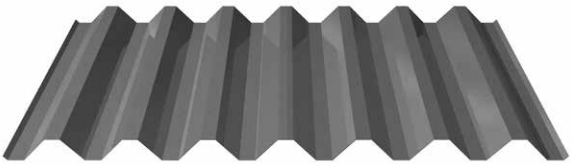
3” depth, 36” coverage, 14’ to 22’ Optimal Span(s)

●●●○○ Good Diaphragm Shear

Pan perforated Acustadek® Option

- Aesthetic flat pan underside
- Longer Spanning than non-cellular profile
- Meets Steel Deck Institute SDI 2”x12” requirements

CP-32



1⅜” depth, 32” coverage, 5’ to 10’ Optimal Span(s)

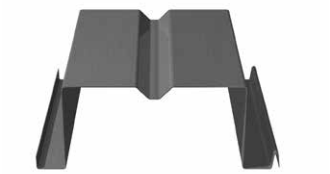
●●○○○ Modest Diaphragm Shear

No Acustadek® Options

- CP-32 is manufactured with a side lap rolled in vent for use with lightweight insulating concrete fill
- CF 1-3/8 is suitable for exposed roofing and siding conditions
- May be used in lieu of SDI C1.0

1.2 **Panel Features and Benefits**

4.5D-12 DEEP DECK



4½" depth, 12" coverage, 16' to 24' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Web Perforated Acustadek® option

- Single spans up to 32'
- Long span eliminates support framing

4.5DF-24 CELLULAR DEEP DECK

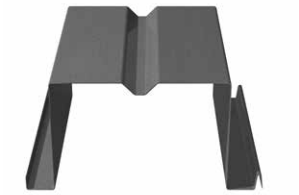
4½" depth, 24" coverage, 20 to 32' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Pan Perforated Acustadek® Option

- Aesthetic flat pan underside
- Higher out of plane capacity than non-cellular profile

6D-12 DEEP DECK



6" depth, 12" coverage, 20' to 32' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Web Perforated Acustadek® option

- Single spans up to 32'
- Long span eliminates support framing

6DF-24 CELLULAR DEEP DECK

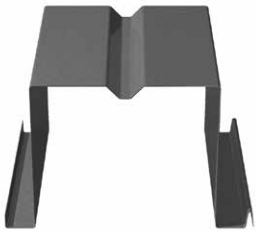
6" depth, 24" coverage, 24' to 32' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Pan Perforated Acustadek® Option

- Aesthetic flat pan underside
- Higher out of plane capacity than non-cellular profile

7.5D-12 DEEP DECK



7½" depth, 12" coverage, 22' to 32' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Web Perforated Acustadek® option

- Single spans up to 32'
- Long span eliminates support framing

7.5DF-24 CELLULAR DEEP DECK

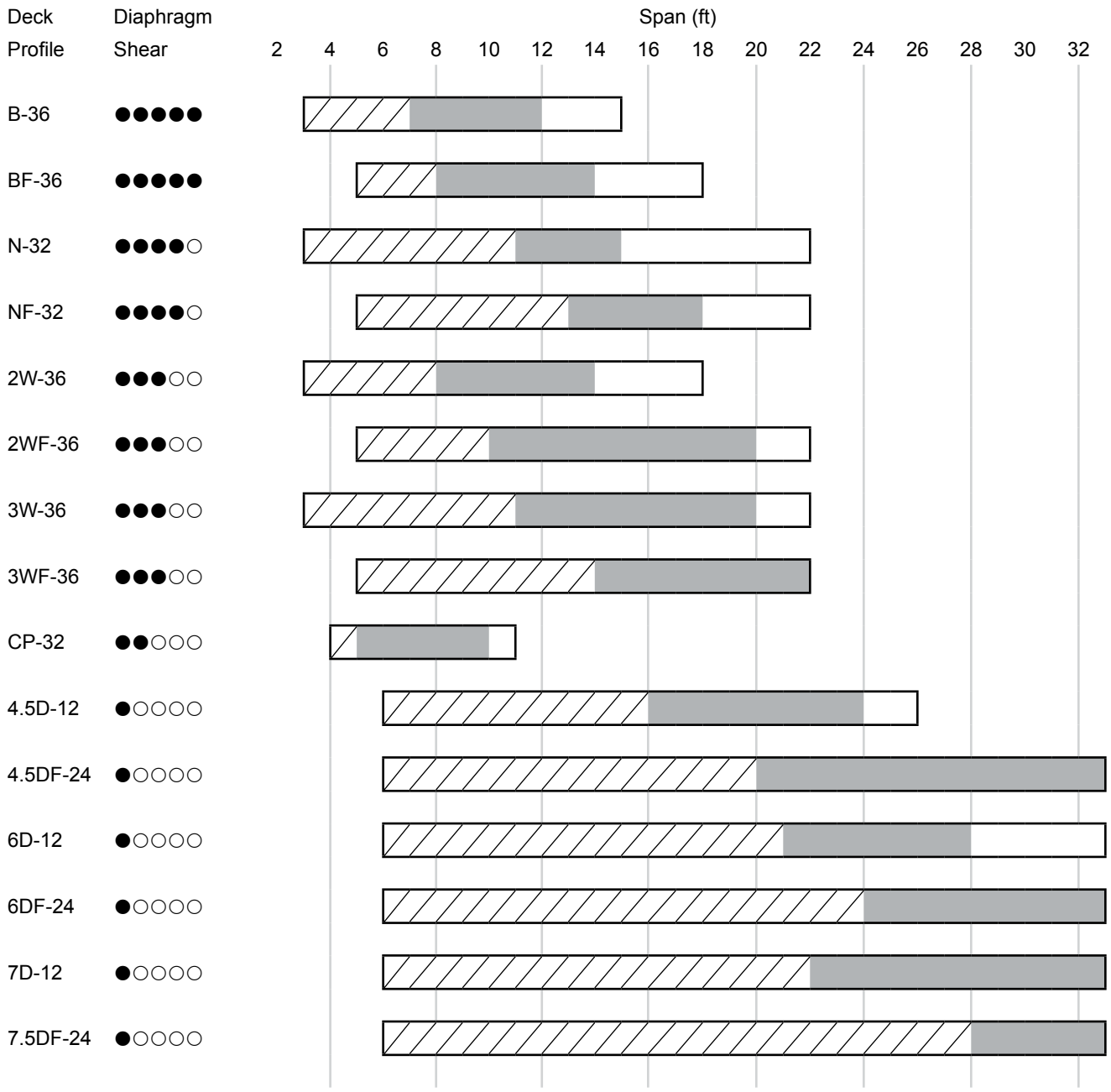
7½" depth, 24" coverage, 28' to 32' Optimal Span(s)

●○○○○ Modest Diaphragm Shear

Pan Perforated Acustadek® Option

- Aesthetic flat pan underside
- Higher out of plane capacity than non-cellular profile

PROFILE SELECTION GUIDE



Minimum span length on chart set to minimum panel manufactured length

Based on 25psf uniform vertical load and L/180 deflection limit

Based on 30 to 40psf uniform vertical load and L/240 deflection limit

Exceeds 40psf uniform vertical load and L/240 deflection limit

1.3 **Product Offer**

ASC Steel Deck offers a robust product offer. Our lightweight steel deck profiles have depths that range from 1⅜" to 7½". Panel lengths range from 5 feet to 45 feet. Steel deck panels are supplied with both galvanized and painted finishes to meet an array of project finish requirements.

Product Description

To assist designers with specifying the correct steel deck profile, see *Figure 1.3.3* which details how to specify the intended product. Following these guidelines will help to eliminate requests for information and change orders due to insufficient product descriptions in the plans and specifications. Designers can be assured that the product delivered is the product intended. Simply specify the gage, panel profile, panel coverage, metallic/paint coating, and any modifiers appropriate for the desired product.

Deck Panel Lengths

All ASC Steel Deck products are manufactured to the specified length for the project. The following table summarizes the minimum and maximum lengths that can be manufactured for each profile.

Figure 1.3.1: **MANUFACTURED PANEL LENGTHS**

Profile		Factory Cut Length	
		Minimum	Maximum
Non-cellular	B-36, N-32, 2W-36, 3W-36	3'-6"	45'-0"
	CP-32	4'-0"	45'-0"
	4.5D-12, 6D-12, 7.5D-12	6'-0"	32'-0"
Cellular	BF-36, NF-32, 2WF-36, 3WF-36	5'-0"	40'-0"
	4.5DF-24, 6DF-24, 7.5DF-24	6'-0"	32'-0"

Tolerances

ASC Steel Deck manufactures to industry standard tolerances. The tolerances are summarized as follows.

Figure 1.3.2: **PANEL TOLERANCES**

Length	±1/2"
Coverage Width	-3/8" +3/4"
Sweep	1/4" in 10' length
Square	1/8" per foot width

Finish Options

ASC Steel Deck offers several finish options that are appropriate for a variety of applications. Our standard G60 galvanized finish is suitable for most applications, offering excellent corrosion protection and compatibility with fire proofing when used in UL fire rated assemblies. We also offer PrimeShield®, an economical prime paint system over bare cold rolled steel. PrimeShield offers the steel limited interim protection from rusting during transport and erection before the weather-tight roof system is applied. PrimeShield should not be used in high humidity or corrosive environments. Prime paint over galvanized steel deck can also be specified to obtain the benefit of the corrosion protection of galvanized steel deck with a factory applied prime paint substrate.

Galvanized

ASC Steel Deck offers steel deck products that are galvanized in accordance with ASTM A 653. The standard galvanized coating is G60 (0.6 ounce per square foot). G-90 (0.9 ounce per square foot) is recommended for high humidity and corrosive conditions. G-40 (0.4 ounce per square foot) may be specified for greater economy. Heavier galvanized finishes than G-90 can be specified for more severe environmental conditions and exposures. Inquire for product availability and minimum order sizes for G-40 or galvanizing heavier than G-90.

All ASC Steel Deck galvanized decks are manufactured from chemically treated steel coil in accordance with ASTM A 653. Chemical treatment is often referred to as passivation. The chemical treatment protects the galvanized steel from developing white rust during storage and transport of both coil and finished product. Some field-applied paint systems may not be compatible with the chemical treatment. The paint manufacture should be consulted to determine how the deck should be prepared prior to painting. ASC Steel Deck is not responsible for the adhesion of field applied primers and paints.

Galvanized with Prime Paint

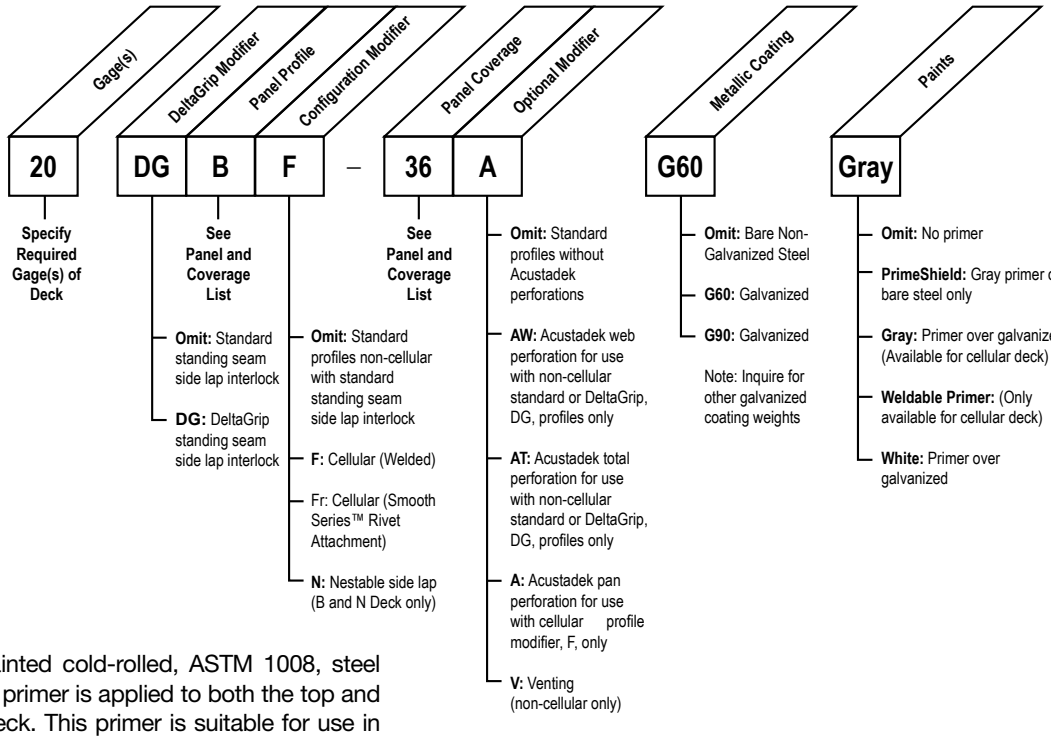
ASC Steel Deck offers all of its standard galvanized options with factory applied prime paint on the underside of the deck. The prime paint is available in standard gray. White primer is also available. The standard 0.3mil water-based gray acrylic primer has been specially developed to provide superior adhesion to the galvanized steel deck and is suitable for use in many UL fire rated assemblies. Factory applied primer is an impermanent interim coating that is intended to have finish paint applied after the deck is installed. The galvanized with prime paint option may eliminate the need for any special surface preparation for field applied paint applications which is often a requirement for chemically treated bare galvanized steel deck panels. ASC Steel Deck is not responsible for the adhesion of paint systems applied in the field.

Cellular deck is offered with a galvanized steel pan or a prime paint over galvanized steel pan. This 0.3mil gray primer is applied to the underside of the pan prior to resistance welding or riveting the cellular deck beam to the pan. Our new Smooth Series™ rivet attachment is flush with the exposed bottom surface, omitting visible "bumps" and burn marks, eliminating the cost of touch-ups associated with resistance welded deck products. Resistance welded deck, the current industry standard, leaves burn marks on the pan which generally require cleaning and touch-up prior to the application of a finish paint system being applied. Touching up the burn marks is generally much more cost effective than preparing an unpainted, chemically treated surface for the application of a field primer. The prime painted galvanized pan provides a good substrate for the application of most field-applied paint systems. ASC Steel Deck is not responsible for the adhesion of paint systems applied in the field.

DECK PROFILE & COVERAGE LIST

Panel	Coverage
B	36 inches
N	32 inches
2W	36 inches
3W	36 inches
CP	32 inches
4.5D	12 inches
4.5DF	24 inches
6D	12 inches
6DF	24 inches
7.5D	12 inches
7.5DF	24 inches

Figure 1.3.3: **PRODUCT OFFER DESCRIPTION**



Prime Shield®

PrimeShield is prime painted cold-rolled, ASTM 1008, steel deck. The standard gray primer is applied to both the top and underside of the steel deck. This primer is suitable for use in many UL fire rated assemblies. The prime paint is intended to be an impermanent interim coating to protect the bare cold-rolled steel, for a short period, from ordinary atmospheric conditions prior to weathertighting the building. PrimeShield should receive a finish paint system if left exposed in the interior of a building. This 0.3mil water-based acrylic primer provides a good base for most field-applied paint systems. ASC Steel Deck is not responsible for the adhesion of paint systems applied in the field.

Cellular Deck

Cellular deck is a good choice when a flat appearance on the underside of steel deck is desired. Cellular deck is manufactured from a top fluted section of steel deck referred to as the beam and a flat bottom section referred to as the pan. The male and female side seam interlock is formed on the edges of the pan.

The welded method offers resistance welds in accordance with UL 209. There is one row of resistance welds in each low flute of the beam.

The new Smooth Series™ rivet attachment is flush with the exposed bottom surface, eliminating "bumps" and burn marks and the need for touch-ups in the field. Smooth Series rivets are available in galvanized and white finish, complementing our factory applied Prime Shield® primer gray and white finish cellular deck. The high quality rivet attachments are uniformly repeated along the deck profile.

All attachments to the underside of riveted cellular deck and Acustadek for the support of suspended items shall be made at low flute location only. The design professional is responsible for checking if the connection to the low flute material has sufficient capacity to resist the suspended load.

This product should not be used in floor assemblies where spray on fire proofing is to be applied to the bottom surface of the deck.

Cellular deck beam and pan may be manufactured out of the same gage or out of different gages. The following shows how to correctly specify the desired beam and pan gage combination.

Specify Cellular Deck Gage "xx/yy"

- The first (xx) is the gage of the beam (top fluted section)
- The second number (yy) is the gage of the pan (the bottom flat section with the side seam)

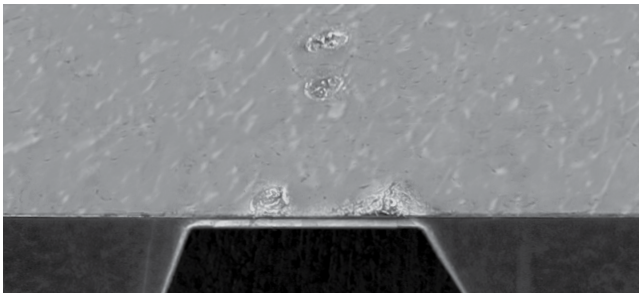


Figure 1.2.4: WELDED ATTACHMENT
(Pictured from topside)

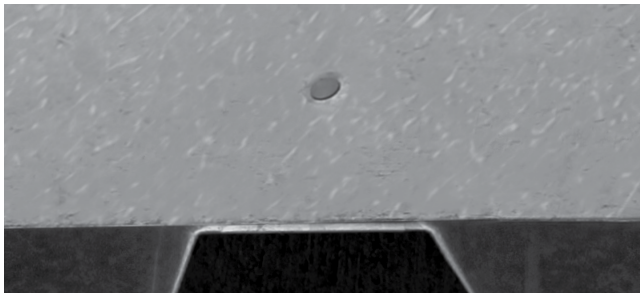


Figure 1.2.5: SMOOTH SERIES™ RIVET ATTACHMENT
(Pictured from topside)

1.3 **Product Offer**

Venting

Some materials in the roof assembly may require venting of the steel roof deck, such as roof systems with light weight insulating concrete. Venting does not impact the structural performance of the steel deck. Deck should not be specified as vented when it is not required. The drawback of venting deck is when concrete is poured, the slurry drips through the vent tabs creating debris on the surface below. Cleaning up the slurry or protecting the surfaces underneath with plastic sheets adds cost to the project without providing any added value to the owner when venting is not required. The requirement for venting the deck should be clearly indicated in the specifications and be clearly stated in the deck schedule on the structural drawings.

For B, N, 2W, and 3W deck, upward protruding vent tabs are factory punched in the low flutes of the steel deck when venting is specified. For CP-32 venting is achieved by adding embossments to the side lap holding the lap open. (*Figures 1.3.4 and 1.3.5*)

Figure 1.3.4: **B-36 WITH VENTING**
(Pictured from underside)

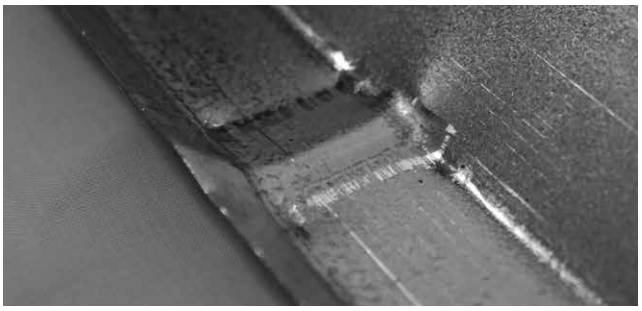


Figure 1.3.5: **CP32 WITH VENTING**
(Pictured from topside)

Die Set Ends (Swage)

Die set ends allow for the roof deck to be easily end lapped to increase the diaphragm stiffness. The die set swages the top flange and webs of the steel deck which allows the top sheet of end lapped deck to nest tightly over the bottom sheet. When deck is not die set, the installer may have to hammer the deck to get the ends to nest together tightly to ensure good quality connections. The die set ends are standard for B-36 and N-32 profiles. B-36 is optionally available without die set ends. 2W, 3W, and Deep Deck are not end lapped and do not have die set ends. *Figure 1.3.6* shows a die-set end on N-32 deck.

Die set ends affect detailing and layout of the steel deck. Deck is spread in the direction of the male leg of the side seam. This allows the next sheet's female side seam to drop over the male side seam. The die set is on the left side relative to the direction of spreading deck. The next adjacent run of deck will be on the left side of the deck relative to the spreading direction to nest over the dies set ends. (*Figure 1.3.7*)

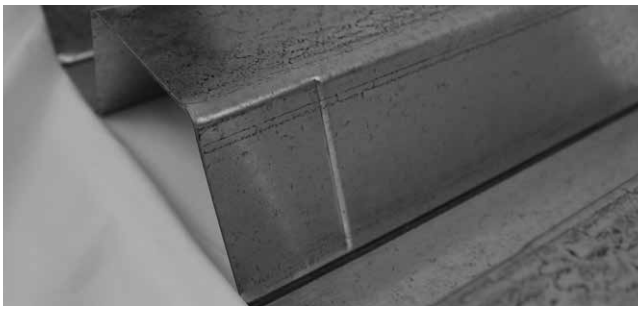


Figure 1.3.6: **N-32 WITH DIE-SET (Swage)**

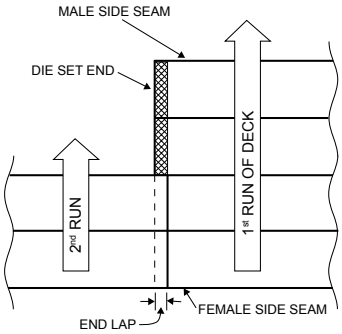


Figure 1.3.7: **DECK LAYOUT**

Exposed Deck

ASC Steel Deck roof and floor deck products are designed to be structural components for steel framed structures. As part of the normal manufacturing, handling, and transport procedures, it is common for the panel bundles to exhibit some degree of incidental scratching and denting. The surface defects are typically superficial and do not impact the structural capacity of the deck. On projects where the deck will be exposed to view after installation, it may be desirable to minimize the occurrence of these marks. In these cases, it is important for the designer specifying and the customer or contractor ordering the deck to request that the product be manufactured, handled, and transported for "EXPOSED" installation. This will result in modified handling and loading procedures designed to minimize (not eliminate) typical scratching and denting. *Figure 1.2.10 and 1.2.11* shows typical handling marks from forklifts or dunnage.

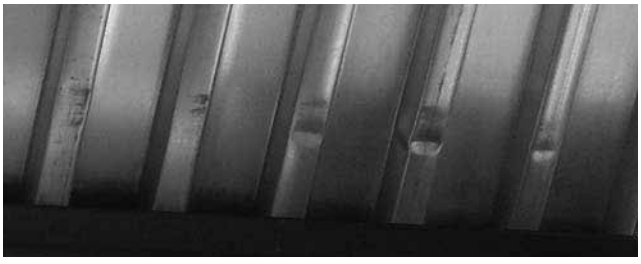


Figure 1.3.7: **UNDERSIDE HANDLING MARKS**

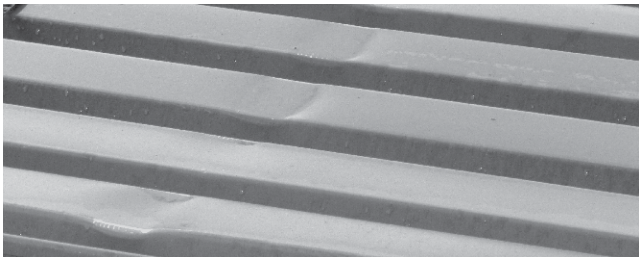


Figure 1.3.8: **TOPSIDE HANDLING MARKS**

ASC Steel Deck conducts extensive test programs with independent testing labs to ensure that our products comply with the stringent criteria of today's building codes. The structural performance of our steel deck products have been verified and approved by reputable evaluation agencies, International Association of Plumbing and Mechanics Officials Evaluation Services (IAPMO-ES), Los Angeles City Research Reports (LARR), Factory Mutual (FM), and Underwriters Laboratory (UL).

IAPMO-ES

ASC Steel Deck panels are independently evaluated for conformance with the IBC by IAPMO-ES. Both evaluation services are accredited by the American Standards Institute (ANSI) per ISO/IEC Guide 65 General Requirements for Bodies Operating Product Certification Systems. LA City Research Reports (LARR), are derived from the IAPMO-ES reports. The technical evaluation for conformance with the IBC are made available to code officials, contractors, specifies, architects, engineers, and others. IAMPO-ER reports provide evidence that ASC Steel Deck products meet the most rigorous standards and are compliant under current code requirements.

Factory Mutual Approvals

ASC Steel Deck B and N deck profiles have been evaluated and approved by Factory Mutual (FM). The steel decks meet the strict FM requirements for fire, foot traffic and wind uplift loads up to class 1-90. Both standard and DeltaGrip versions of the deck profiles are approved with a wide array of fasteners to supports. **Complete FM approval reports for ASC Steel Deck products can be found at www.ascsteedldeck.com.** These steel decks may be used as a component in an FM approved roof assembly. Deck selection, as a part of an FM assembly, should be made using the FM RoofNav selection tool at **roofnav.fmglobal.com.**

Deck	Gage	Maximum Span
DGB-36 DGB-36AW Acustadek B-36 B-36AW Acustadek	22	6'-1"
	20	6'-7"
	18	7'-7"
	16	8'-5"
DGBF-36 DGBF-36A Acustadek BF-36 BF-36A Acustadek	20/20	9'-4"
	20/18	9'-8"
	20/16	10'-1"
	18/20	10'-4"
	18/18	10'-9"
	18/16	11'-2"
	16/16	12'-2"
DGN-32 DGN-32AW Acustadek N-32 N-32AW Acustadek	22	11'-7"
	20	12'-10"
	18	15'-2"
	16	17'-2"
DGNF-32 DGNF-32A Acustadek NF-32 NF-32A Acustadek	20/20	12'-10"
	20/18	
	20/16	
	18/20	15'-2"
	18/18	
	18/16	
	16/20	17'-2"
	16/18	
	16/16	

Figure 1.4.1: **FM MAXIMUM DECK SPANS**

Underwriters Laboratories UL-Fire Ratings

ASC Steel Deck products that bare the UL approved mark have been investigated for fire resistance. Underwriters Laboratories is an independent, product safety testing and certification organization. ASC Steel Deck has been evaluated for fire resistance per *UL 263 Fire Tests of Building Construction and Materials. See UL directory for fire rated assemblies.*

The **Fire Ratings** table (*Figure 1.5.1*) offers a quick reference summary of design numbers, fire ratings, deck type, SFRM Spray Applied Fire Resistive material listings and more. The details of the each design assembly are listed on UL Online Certification Directory **www.ul.com**.

1.5 **Fire Ratings**

Figure 1.5.1: **ASC STEEL DECK- (UL) UNDERWRITERS LABORATORIES FIRE RESISTANCE**

UL Design Number	ANSI/UL 263 Fire Resistance Ratings Restrained and Unrestrained Assemblies (hrs)	Support Type Beam / Joist
P225	Restrained Assembly Ratings — 1 and 1½ Hr. Unrestrained Assembly Ratings — 1 and 1½ Hr	Beam-W6x12min, Joist- 20min depth
P230	Restrained Assembly Rating — 1 and 1½ Hr. Unrestrained Assembly Rating — 1 and 1½ Hr	Beam-W6x12min, Joist- 20min depth
P518	Restrained Assembly Rating — 1 Hr. Unrestrained Assembly Rating — 1 Hr	Joist - Cee-shaped sections, min 8 in. deep with 1-9/16 in. flanges and 9/16 in. lips, made from No. 18 gage or heavier, Steel truss - chords shall be min of 18 ga. and web sections a min of 20 ga. min depth of 8 in.
P701	Restrained Assembly Rating — ¾, 1, 1½ or 2 Hr. Unrestrained Assembly Rating — ¾, 1, 1½ or 2 Hr	Beam-W16x16min, Joist-20in joist girders
P711	Restrained Assembly Ratings — 1, 1½ or 2 Hr. Unrestrained Assembly Ratings — 1, 1½ or 2 Hr	Beam - W6x16 min size. , Joist girders -20 in. min depth, Joists Types 10J4, 10H4, 12J4, 14J7 or 14K4 min size.
P717	Restrained Assembly Rating — 1, 1½ or 2 H Unrestrained Assembly Rating — 1, 1½ or 2 H	Beam - W6x16 min size, Joist - 10H4, 14J7, 12K3 or 16K3 min sizes.
P719	Restrained Assembly Rating — 1, 1½, 2 or 3 Hr. Unrestrained Assembly Rating — 1, 1½ or 2 Hr	Beams-W6x16 min , Joist-10 K1 min, Joist girders -20 in. min depth and 13 lb/lin ft min weight.
P723	Restrained Assembly Ratings — 1, 1½, 2 and 3 Hr Unrestrained Assembly Ratings — 1, 1½, 2 and 3 Hr	Beam- W6x16 , Joist -min 10K1 or 12K5
P726	Restrained Assembly Rating — ¾, 1, 1½ or 2 Hr Unrestrained Assembly Rating — ¾, 1, 1½, or 2 Hr	Beam-W6X16 min, Joist -10K1 min , Joist girders - 20 in. min depth
P732	Restrained Assembly Ratings — 1, 1½, 2 or 3 Hr Unrestrained Assembly Ratings — ¾, 1, 1½, 2 or 3 Hr	Beam - Min W6x16 or W8x28 , Joist - 10K1 or 16K2 min, or 12K3 or 12K5 min size
P734	Restrained Assembly Ratings — ¾, 1, 1½ or 2 Hr Unrestrained Assembly Ratings — ¾, 1, 1½ or 2 Hr	Beam - W6x16min, Joist - 12J4, 14J7 or 14K4 min, Joist girders-20 in. min, any LH-Series joist may be used.
P739	Restrained Assembly Ratings — 1, 1½ and 2 Hr Unrestrained Assembly Ratings — 1, 1½ and 2 Hr	Beam- W6x16 min , Joist - 10H4, 14J7, 10K1 or 12K3 min.
P740	Restrained Assembly Ratings — 1, 1½ & 2 Hr Unrestrained Assembly Ratings — ¾, 1, 1½ & 2 Hr	Beam -W6x16 min , Joist 10K1 or 16K2 min or 12K3 min
P741	Restrained Assembly Ratings — 1, 1½ or 2 Hr Unrestrained Assembly Ratings — 0, 1, 1½ or 2 Hr	Beam - Min W6x16, Joist - Min 10K1

Table Notes:

1. P2XX have suspended acoustical ceilings with an exposed grid system.
2. P3XX have mineral or fiber board applied to the underside of the deck.
3. P4XX have suspended gypsum board.
4. P7XX have (SFRM) Spray Applied Fire Resistive Material applied to the deck.
5. P9XX have not SFRM on the deck but it is required on the beams and joists.
6. P9XX includes lightweight insulating concrete.
7. The designer shall refer to the UL Fire Resistance directory for a detailed list of components in the fire rated assembly listing.

Figure 1.5.1: **ASC STEEL DECK- (UL) UNDERWRITERS LABORATORIES FIRE RESISTANCE**

UL Design Number	Panel Type (gages)					Coatings		Side-Lap Fastening				Support Fastening			Fire Protection	Lightweight Insulating Concrete
	DGB-36, B-36	DGN-32, N-32	DG2W-36, 2W-36	DG3W-36, 3W-36	CP-1 3/8, CP-32	Galvanized	Prime Shield	Screws	Button Punch	DeltaGrip	Welds	Screws	PAF (Pins/Nails)	Welds	(SRFM) Spray Applied Fire Resistive Material (Fiber or Cementitious)	
P225	✓	✓				✓	✓			✓	✓			✓	✓	
P230	✓					✓	✓			✓	✓			✓	✓	
P518	✓				✓	✓	✓	✓		✓		✓			✓	
P701	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P711	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P717	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
P719	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	
P723	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	
P726	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P732	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
P734	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P739	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
P740	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P741	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	

8. ASC Steel Deck does not assume responsibility for adhesion of any spray-applied fireproofing material, surface preparation, cleaning, or other treatments of the deck surface.
9. "Gray" prime painted deck is supplied for application of spray-applied fireproofing.
10. Please contact ASC Steel Deck for galvanizing options.

1.5 **Fire Ratings**

Figure 1.5.1: **ASC STEEL DECK- (UL) UNDERWRITERS LABORATORY FIRE RESISTANCE**

UL Design Number	ANSI/UL 263 Fire Resistance Ratings Restrained and Unrestrained Assemblies (hrs)	Support Type Beam / Joist
P742	Restrained Assembly Ratings - 1, 1½ or 2 Hr. Unrestrained Assembly Ratings - 1, 1½ or 2 Hr	Beam-W6x16, Joist - 12J4 or 14J7 min, Joist girders-20 in. min depth and 13 lb/lin ft min weight, any LH-Series joist may be used.
P743	Restrained Assembly Ratings — 1, 1½ and 2 Hr Unrestrained Assembly Ratings — 1, 1½ and 2 Hr	Beam - W6x16 min size, Joist -10H4, 14J7, 10K1 or 12K3 min
P815	Restrained Assembly Rating- 1, 1½ , 2 Hrs Unrestrained Assembly Rating- 1, 1½, 2 Hr	Beam W6x16 min size, Joist-10K1 or 12K3 min size.
P819	Restrained Assembly Rating — 1, 1½ or 2 Hr. Unrestrained Assembly Rating — 1, 1½ or 2 Hr	Beam - W6x16 min size, Joist 10K1 or 12K3
P908	Restrained Assembly Ratings — 1, 1½ or 2 Hr. Unrestrained Assembly Rating — 0, 1½, or 2 Hr	Beam- W6x16, W8x10, W8x18 or W8x28 min, Joists - 10K1, 12J4, 14K4 or 16K3 min, Joist girders-20 in. min depth and 13 lb/lin ft min weight
P920	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam - W8x10, W8x17, W6x16 or W8x28 min, Joists- 10K1, 12J4, 12K5 or 14K3 min
P921	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr Unrestrained Beam Rating — 1, 1½ or 2 Hr	Beam - W6X16 or W8X10 beam, Joist girders - 20 in. min depth and 13 lb/lin ft min weight.12K5 or heavier steel joist may be used as secondary support
P922	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam - W6x16, or W8x28 min, Joists- 10K1 min with steel bridging angles required per SJI specifications.
P925	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam- W6X16 or W8X10, Joists -12K5 min, Joists or Joist girders 10K1- 20 in. min depth and 13 lb/lin ft min weight
P927	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam-W6x16, W8x10 or W8x1, Joists-12J4, 14K4 or 16K3 min, Joist girders-20 in. min depth and 13 lb/lin ft min weight
P928	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam - W6X16 or W8X10, Joist girders-20 in. min depth and 13 lb/lin ft min weight
P930	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam - W8x28 min size steel beam; or steel joists welded or bolted to end supports.
P936	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr Restricted Load Condition	Beam - W6x16 or W8x28 min size, Joists 10K1 or 16K2 min size with a max tensile stress of 30,000 psi or 12K3 or 12K5 min size with a max tensile stress of 24,000 psi.
P937	Restrained Assembly Rating — 1, 1½ or 2 Hr Unrestrained Assembly Rating — 0 Hr	Beam-W8x28 min, Joists-10K1 min

Table Notes:

1. P2XX have suspended acoustical ceilings with an exposed grid system.
2. P3XX have mineral or fiber board applied to the underside of the deck.
3. P4XX have suspended gypsum board.
4. P7XX have (SFRM) Spray Applied Fire Resistive Material applied to the deck.
5. P9XX have not SFRM on the deck but it is required on the beams and joists.
6. P9XX includes lightweight insulating concrete.
7. The designer shall refer to the UL Fire Resistance directory for a detailed list of components in the fire rated assembly listing.

Figure 1.5.1: **ASC STEEL DECK- (UL) UNDERWRITERS LABORATORY FIRE RESISTANCE**

UL Design Number	Panel Type (gages)					Coatings		Side-Lap Fastening				Support Fastening			Fire Protection	Lightweight Insulating Concrete
	DGB-36, B-36	DGN-32, N-32	DG2W-36, 2W-36	DG3W-36, 3W-36	CP-1 3/8, CP-32	Galvanized	Prime Shield	Screws	Button Punch	DeltaGrip	Welds	Screws	PAF (Pins/Nails)	Welds	(SRFM) Spray Applied Fire Resistive Material (Fiber or Cementitious)	
P742	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
P743	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P815	✓	✓				✓	✓		✓	✓	✓			✓	✓	
P819	✓	✓				✓	✓	✓	✓	✓	✓			✓	✓	
P908	✓	✓				✓	✓			✓	✓			✓		✓
P920	✓	✓	✓			✓	✓			✓	✓			✓		✓
P921	✓	✓	✓		✓	✓	✓			✓	✓			✓		✓
P922	✓	✓				✓	✓		✓	✓	✓			✓		✓
P925	✓		✓		✓	✓			✓	✓	✓			✓		✓
P927	✓	✓	✓		✓					✓	✓			✓		✓
P928	✓	✓	✓		✓					✓	✓			✓		✓
P930		✓			✓					✓	✓			✓		✓
P936	✓	✓	✓		✓					✓	✓			✓		✓
P937	✓	✓	✓		✓					✓	✓			✓		✓

8. ASC Steel Deck does not assume responsibility for adhesion of any spray-applied fireproofing material, surface preparation, cleaning, or other treatments of the deck surface.
9. "Gray" prime painted deck is supplied for application of spray-applied fireproofing.
10. Please contact ASC Steel Deck for galvanizing options.

1.6 **Section Properties**

ASC STEEL DECK

Section Properties

All of ASC Steel Deck's section properties are calculated in accordance with the American Iron and Steel Institute Specification for the Design of Cold-Formed Steel Structural Members, AISI S100-2007, Section B. Section properties can be used to develop the bending capacity of the steel deck for out-of-plane loads, which are typically defined by gravity or wind uplift. The section properties can also be used to determine the combined axial and bending capacity of the steel deck for bracing walls or other vertical elements of a building.

The section properties for steel roof deck, like other cold-formed steel members such as Cee, Zee, hat-shaped purlins, studs, and track are based on post-buckling strength. Post-buckling strength is based on the concept that compression flanges and portions of webs will exhibit some local buckling prior to the load capacity of the member being reached. To account for this, the widths of the flat compression elements of the steel deck are reduced for the purpose of determining the section properties, excluding the portion that can no longer effectively carry compression loads. This reduction of the gross section properties results in the effective section properties.

Steel Thickness

The thickness of steel roof deck is typically specified by a gage designation. The design of steel deck is dependent on the specified design base steel thickness in accordance with AISI S100-2007. The base steel thickness should not be confused with the total coated thickness, which is the combined thickness of the base steel, the optional galvanizing thickness, and any factory-applied paint system thickness.

The minimum acceptable base steel thickness to be supplied shall not be less than 95% of the design base steel thickness. This is specified in Section A2.4 Delivered Minimum Thickness of AISI S100-2007.

Some standards reference non-mandatory tables that list the thickness of sheet steel by gage designation. These include the AISC Manual of Steel Construction in the Miscellaneous Information section of the appendix and AWS D1.3 in the Annex. Both references indicate that the values are non-mandatory and are for reference only. The nominal total coated thicknesses listed for each gage in these sources should not be used to determine if the cold-formed steel structural member,
including steel deck, meets the minimum thickness requirement for the specified gage.

Effective Section Properties

Effective section properties for a steel deck panel are used to check for the maximum bending and axial load capacities.

The effective properties are determined at the full yield stress of the steel. As the grade of steel increases, the effective section properties decrease. The effective width of the compression elements decreases as the localized plate-like buckling increases. The moment capacity of the deck increases with the increased grade because the increasing yield strength of the steel outpaces the loss of effective compression width of the combined elements. Steel decks cannot be compared based strictly on effective section properties without considering the grade of the steel. The following demonstrates this for B-36 steel deck.

20 Gage B-36 Steel Deck Panel

Yield ksi	I_e^+ (in^4)	I_e^- (in^4)	S_g^+ (in^3)	S_e^- (in^3)	M_n^+ (k-in)
33	0.193	0.237	0.235	0.251	13.95
37	0.187	0.233	0.233	0.247	15.52
38	0.187	0.233	0.233	0.246	15.91
40	0.187	0.233	0.232	0.244	16.69
55	0.177	0.227	0.223	0.233	22.02
80	0.173	0.223	0.218	0.233	23.51

Figure 1.6.1: **EFFECTIVE SECTION PROPERTIES**

Many steel deck panels are not symmetric. In most cases, the top and bottom flange widths are not equivalent. The bending stress and location of the neutral axis is therefore different for positive and negative bending, resulting in different positive and negative section properties.

Gross Section Properties

The gross section properties of the steel deck are based on the entire cross section of the panel. Determination of gross section properties assumes that there are no compression buckling compression flanges or web elements of the steel deck and that there are no ineffective elements. The gross section properties are used in combination with effective section properties to determine the deflection of the steel deck under uniform out-of-plane loads, and for checking axial compression and bending.

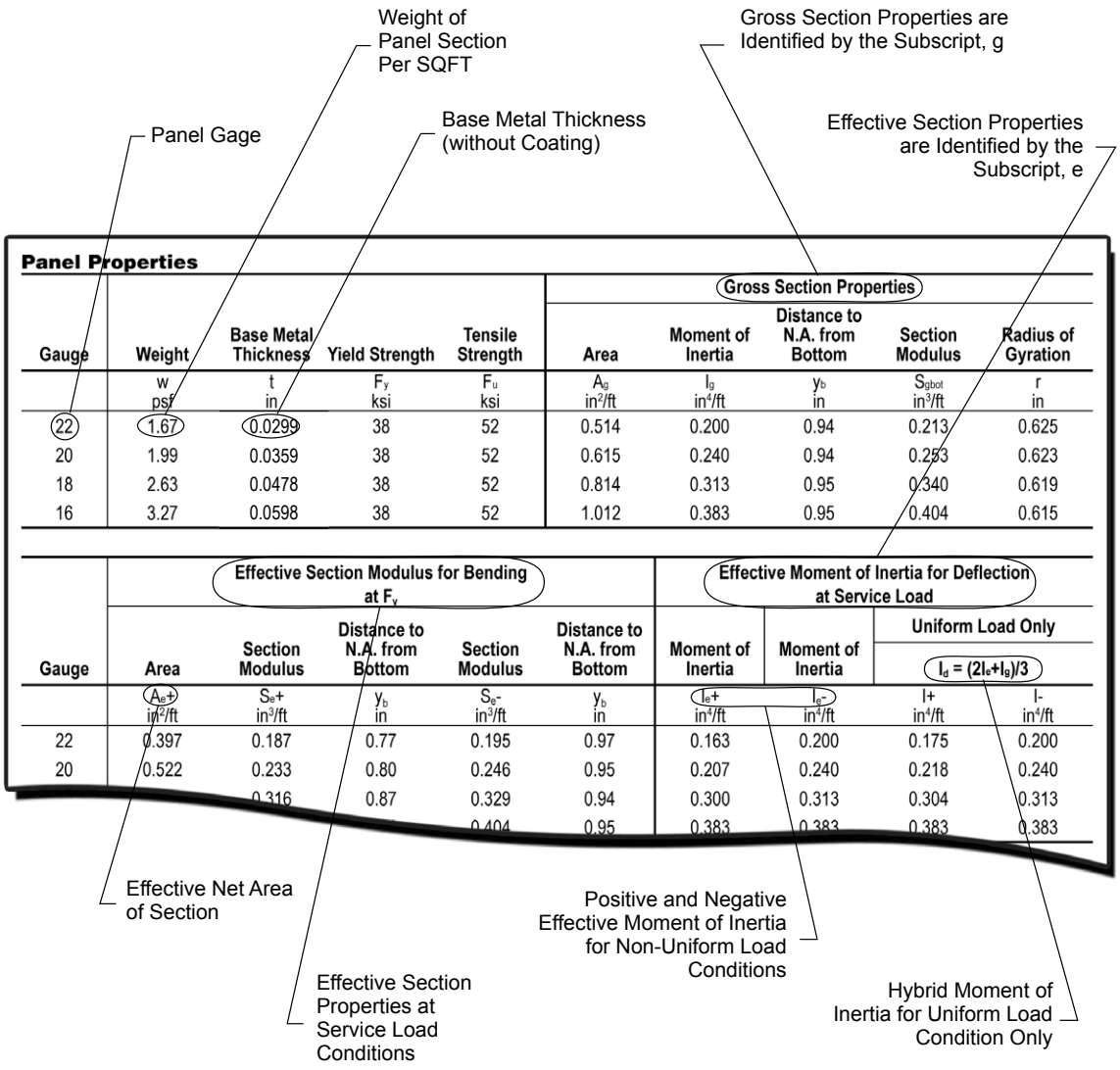
Service Load Section Properties

The service load moment of inertia is used to determine the deflection of the steel deck for out-of-plane loads. The calculated moments of inertia are determined at a working stress level of 0.6Fy. Following accepted practice, the hybrid moment of inertia is based on the sum of two times the effective moment of inertia and the gross moment of inertia divided by three, as follows.

$$I_d = \frac{2I_e + I_g}{3}$$

This deflection equation for uniformly distributed loads takes into account that, throughout the length of the span, portions of the steel deck will have low bending stress below the onset of localized compression buckling in which the gross section properties would be valid and the other portions of the span will have bending stresses high enough to push beyond the onset of localized compression buckling in which effective section properties would be appropriate.

How to Read Section Properties Table



Panel Properties

Gauge	Weight	Base Metal Thickness	Yield Strength	Tensile Strength	Gross Section Properties: Area	Moment of Inertia	Distance to N.A. from Bottom	Section Modulus	Radius of Gyration
	w psf	t in	F_y ksi	F_u ksi	A_g in²/ft	I_g in⁴/ft	y_b in	S_{gbot} in³/ft	r in
22	1.67	0.0299	38	52	0.514	0.200	0.94	0.213	0.625
20	1.99	0.0359	38	52	0.615	0.240	0.94	0.253	0.623
18	2.63	0.0478	38	52	0.814	0.313	0.95	0.340	0.619
16	3.27	0.0598	38	52	1.012	0.383	0.95	0.404	0.615

Gauge	Effective Section Modulus for Bending at F_y: Area	Section Modulus	Distance to N.A. from Bottom	Section Modulus	Distance to N.A. from Bottom	Effective Moment of Inertia for Deflection at Service Load: Moment of Inertia	Moment of Inertia	Uniform Load Only: $I_d = (2I_e+I_g)/3$	
	A_{e+} in²/ft	S_{e+} in³/ft	y_b in	S_{e-} in³/ft	y_b in	I_{e+} in⁴/ft	I_{e-} in⁴/ft	I+ in⁴/ft	I- in⁴/ft
22	0.397	0.187	0.77	0.195	0.97	0.163	0.200	0.175	0.200
20	0.522	0.233	0.80	0.246	0.95	0.207	0.240	0.218	0.240
	0.316		0.87	0.329	0.94	0.300	0.313	0.304	0.313
				0.404	0.95	0.383	0.383	0.383	0.383

Figure 1.6.2: **SAMPLE OF B-36 PANEL PROPERTIES TABLE**

1.7 **Out of Plane Vertical Loads**

Out-of-Plane Loads
Out-of-plane loads are loads applied to the panel that are perpendicular to the panel surface. These loads, uniform and non-uniform, are a combination of the applied forces due to wind, roofing materials, equipment, machinery, live loads, and other factors. The allowable and factored load tables provide the panel capacity, the deck profile, gage (base metal thickness), span length, and the number of spans created by the support spacing.

Uniformly Distributed Loads
Inward out-of-plane uniform loads are typically a combination of gravity (dead, live, and snow) and inward wind loading conditions.

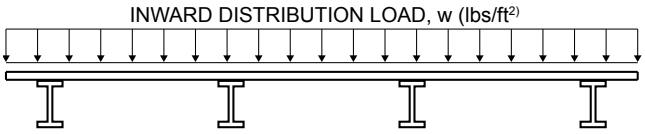


Figure 1.7.1: **INWARD DISTRIBUTED LOAD**

Outward out-of-plane uniform loads are typically wind uplift loads.

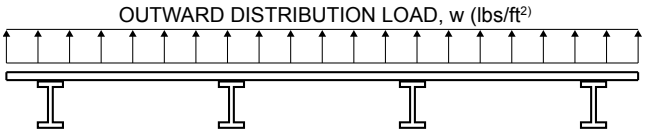


Figure 1.7.2: **OUTWARD DISTRIBUTED LOAD**

The allowable load capacities for each panel type, subject to uniform inward and/or outward load conditions, are determined by equations of mechanics and the published section properties. The panel capacities for outward uniform load conditions (wind uplift) shall be determined by the designer. ASC Steel Deck publishes inward allowable,(f_b/Ω), and factored, (ϕf_b), uniform distributed load tables that are based upon the bending capacity of the steel deck panels. In addition, service level distributed loads subject to varied deflection limits are presented in the tables. Where no deflection limit is listed, the panel bending capacity governs for the span and deflection limit combination.

Openings, Holes or Penetrations
The reinforcement of openings, holes, or penetrations in the diaphragm shall be in accordance with the Steel Deck Institute (SDI) *Manual of Construction with Steel Deck*. Alternatively, for openings that exceed the scope of the SDI Manual of Construction with Steel Deck, the designer should provide framing to transfer vertical and lateral loads around the opening in the steel deck.

Point Loads
Out of plane point loads do not have a uniform load distribution over the entire deck panel. Deck panels subject to point loads or concentrated out of plane loads such as hanging loads from suspended ceilings, mechanical and electrical equipment, plumbing or other utilities should be evaluated by the design professional based on bending capacity and web crippling where applicable. Load distribution devices should be specified where need to distribute the point or concentrated loads.

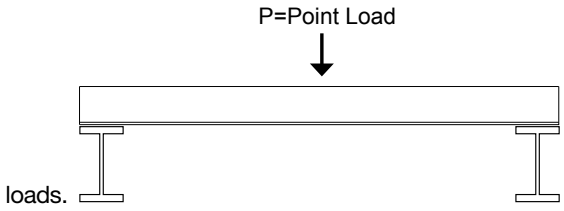


Figure 1.7.3: **POINT LOAD**

Most point loads will require some type of distribution device to spread the shear load to the webs of the steel deck. This can be accomplished with plates, angle, channels or other common structural shapes on top or below the steel deck. These devices may be secured using welds or bolts. There are no general maximum or minimum hanging load limits for steel deck.

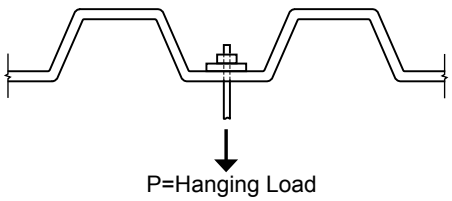


Figure 1.7.4: **HANGING LOAD**

Cantilever End Conditions
For cantilever end conditions, where the end of the deck panel is unsupported, the allowable length of the cantilever shall be determined by the designer using the published section properties, deflection limits, and material strength of the specified panel.

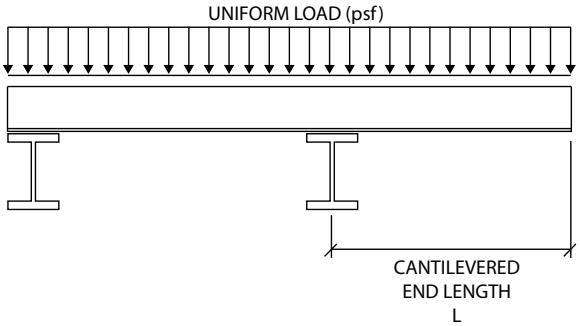


Figure 1.7.5: **CANTILEVER END CONDITIONS**

Deflection Limits

Steel deck panels deflect under out of plane loads. The deflections should be restricted to the recommended limits of the building code. The building code prescribes different defection limits to address material stiffness compatibility, and to limit the possibility of perceivable vibrations. The common deflection limits as present in the IBC are listed in the table below. Steel deck panels will deflect under out of plane loading conditions such as live (temporary) and dead (permanent) loads.

Figure 1.7.6: **DEFLECTION LIMITS FROM IBC TABLE 1604.3**

Contruction	Load Combinations		
	Live	Dead + Live	Wind or Snow 4.5
Roof: Plaster ceiling	L/360	L/240	L/360
Roof: Non-plaster ceiling	L/240	L/180	L/240
Roof: No ceiling	L/180	L/120	L/180
Structural roofing and siding metal panels	. . .	L/60	. . .
Secondary roof members supporting metal roofing panels	L/150	. . .	. . .
Secondary roof support members supporting metal roof panels with no roof covering	. . .	. . .	L/90
Floor	L/360	L/240	. . .

Notes:

1. Where an ellipsis (. . .) appears in this table, there is no requirement.
2. Reference the current IBC, Table 1603.4 and the supporting notes for additional information.
3. Reference the current IBC, Section 1611 for rain and ponding and Section 1503.4 for roof drainage requirements.
4. Wind load is permitted to be taken as 0.7 times the “component and cladding loads” for the purpose of determining deflection limits.
5. For steel structural members, the dead load shall be taken as zero.For cantilever members, L shall be taken as twice the length of the cantilever.

1.8 **Web Crippling**

Steel Deck Reactions at Supports

Steel deck reactions at supports are governed by the web crippling capacity of the steel deck webs on the supporting member. This is calculated in accordance with Section C3.4 of AISI S100-2007 for multi-web steel decks.

Reactions Due to Uniform Loads

The end and interior reactions listed in the tables in the IAPMO ER-161 report are for a uniformly distributed out-of-plane load applied to the deck (see *Figure 1.8.1).*

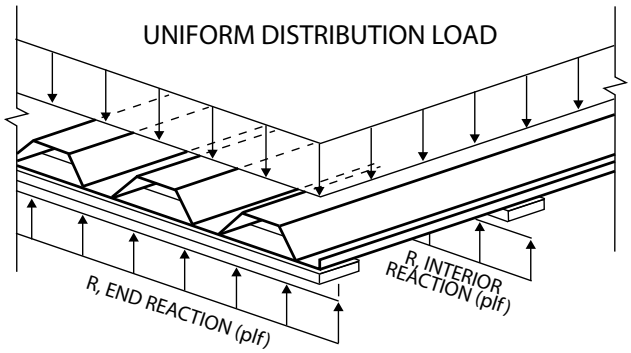


Figure 1.8.1: **UNIFORM DISTRIBUTED OUT-OF-PLANE LOAD**

The allowable R_n/Ω and factored ϕR_n reactions presented in the tables are in pounds per linear foot running axially along the support for a given deck-bearing length (the support member width) on the support. This is based on the web crippling capacity multiplied by the number of webs per foot. *Figure 1.8.3* shows how to read the reaction tables in the IAPMO ER-161 report.

Panels must be attached to supports with fastener patterns not less than the minimum attachment patterns shown for the deck panel.

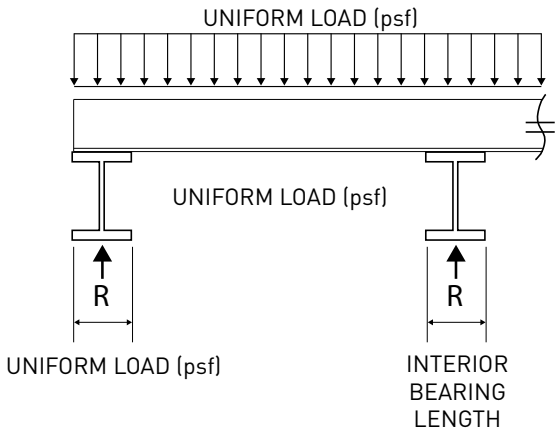
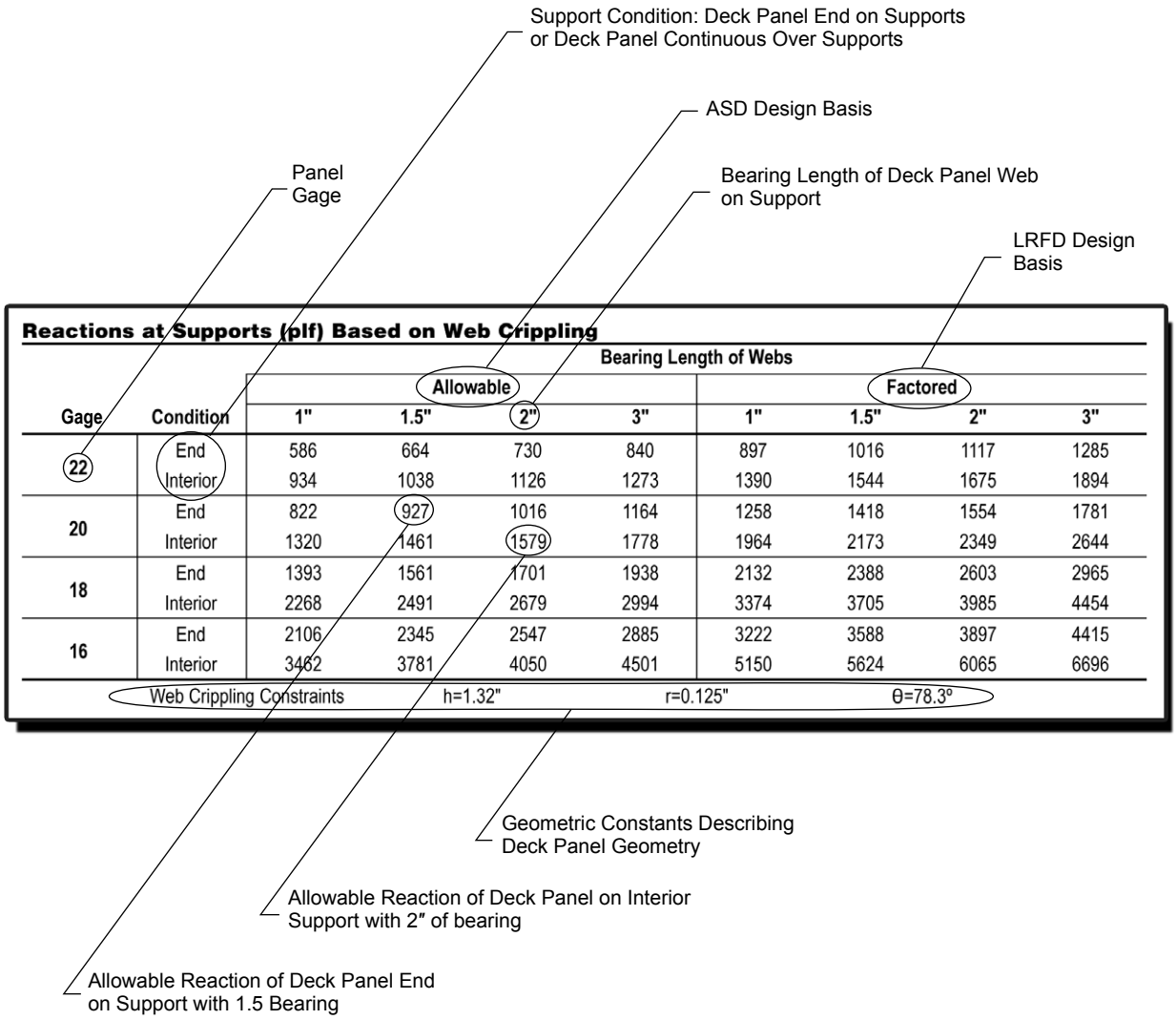


Figure 1.8.2: **SUPPORT REACTIONS**

Point or Line Load Reactions

For load conditions that exceed the uniform reaction tables, including point load and line loads on the steel deck panel, the maximum reactions should be based on the web crippling capacity for the steel deck. Reactions exceeding the published values, or for conditions other than a uniformly distributed loads, shall be determined by the designer in accordance with section C3.4 of the North American Specifications for the Design of Cold-Formed Steel Structural Members for multi-web steel panels and the geometric constants presented in the web crippling tables for the deck panel.

How to Read Web Crippling Table



Reactions at Supports (plf) Based on Web Crippling

		Bearing Length of Webs							
		Allowable				Factored			
Gage	Condition	1"	1.5"	2"	3"	1"	1.5"	2"	3"
22	End	586	664	730	840	897	1016	1117	1285
	Interior	934	1038	1126	1273	1390	1544	1675	1894
20	End	822	927	1016	1164	1258	1418	1554	1781
	Interior	1320	1461	1579	1778	1964	2173	2349	2644
18	End	1393	1561	1701	1938	2132	2388	2603	2965
	Interior	2268	2491	2679	2994	3374	3705	3985	4454
16	End	2106	2345	2547	2885	3222	3588	3897	4415
	Interior	3462	3781	4050	4501	5150	5624	6065	6696
Web Crippling Constraints		h=1.32"		r=0.125"		θ=78.3º			

Figure 1.8.3: **SAMPLE OF WEB CRIPPLING TABLE**

1.9 **In Plane Diaphragm Shear**

ASC STEEL DECK

Diaphragm Shear and Flexibility

Diaphragm shear and flexibility for steel deck diaphragms have been developed through a combination of fastener strength testing, full-scale diaphragm shear testing, and analytic equations. The steel deck panels produced by ASC Steel Deck can be used in assemblies not covered in this design guide using the design methods in the *Steel Deck Institute, Diaphragm Design Manua*l, 3rd Edition.

Allowable and Factored Diaphragm Shear Tables

The allowable and factored diaphragm shears presented in the tables are based on load combinations, including earthquake (seismic) loading in accordance with Section D5 of the North American Specification for the Design of Cold-Formed Steel Structural Members. The values above and to the right in the shaded areas, as indicated on the partial table (*see Figure 1.9.3)*, indicate that plate-like buckling governs for the span condition listed. For wind load combinations, the nominal diaphragm shear may be backed out of the allowable or factored shear, the appropriate factor from Table D5 for wind loading can be applied.

ASD $\qquad$ LRFD

$$S_a = \frac{S_n}{\Omega} \qquad S_f = \phi S_n$$

S_a Allowable diaphragm shear, plf
S_f Factored diaphragm strength, plf
S_n Nominal diaphragm strength, plf
Φ Resistance factor for LRFD, per Section D5 of the North American Specification for the Design of Cold-Formed Steel Structural Members
Ω Safety Factor for ASD, per Section D5 of the North American Specification for the Design of Cold-Formed Steel Structural Members

Using Diaphragm Shear and Flexibility Tables

The allowable or factored diaphragm shear (pounds per lineal foot) and flexibility factor (micro inches per pound) are presented in the tables. The shear and flexibility calculations are based on the following variables:

1. Deck panel
2. Deck gage
3. Deck vertical load span (support spacing)
4. Connection type to supports
5. Connection to support pattern
6. Side lap connection type
7. Side lap connection spacing

In addition to the above conditions, the flexibility is also affected by the following:

8. End lap condition, end lapped or butted
9. Ratio of span to sheet length

Deck panels and gage are generally selected using the vertical load requirements for a given span. The connection type to supports is based on the supporting member thickness. The attachment pattern, the side lap connection type and spacing are generally selected to meet the diaphragm shear demand on the diaphragm. The deck panel gage may need to be increased to meet high diaphragm shear demands. It is generally more cost effective to exhaust deck attachment options to achieve a required diaphragm shear capacity before increasing the gage of the deck *(see Figure 1.9.3)*

TABLE D5
Factors of Safety and Resistance Factors for Diaphragms

Load Type or Combinations I Including	Connection Type[1]	Limit State					
		Connection Related			Panel Buckling[2]		
		USA and Mexico		Canada	USA and Mexico		Canada
		Ω_d (ASD)	Φ_d (LRFD)	Φ_d (LSD)	Ω_d (ASD)	Φ_d (LRFD)	Φ_d (LSD)
Earthquake	Welds	3.00	0.55	0.55	2.00	0.80	0.75
	Screws	2.50	0.65	0.65			
Wind	Welds	2.35	0.70	0.70			
	Screws						
All Others	Welds	2.65	0.60	0.60			
	Screws	2.50	0.65	0.65			

Note: Panel buckling is out-of-plane and not local buckling at fasteners

Figure 1.9.1: **TABLE D5 FROM THE 2004 SUPPLEMENT & 2007 NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS**

Diaphragm Shear and Flexibility of Cellular Panels

Specific diaphragm shear and flexibility tables are available for some of our cellular deck panels. For those cellular products that do not have specific tables, refer to the diaphragm shear and flexibility of the non-cellular version of the profile, using the gage of the flat bottom section of the cellular product. When designing based on the non cellular version of the panel, the actual shear of the cellular panel is higher and the flexibility is lower. The shear is higher because the connection to supports includes both the bottom flat sheet and the top profile sheet, which increases the strength of the connection. The cellular deck is stiffer than the non-cellular version of the profile because the flat bottom panel is much stiffer than the profile section alone.

End Lap or Butted Deck

The end lapping of deck panels verses butted deck panels does not affect diaphragm shear strength. The end lap does affect the diaphragm shear stiffness by eliminating most of the end warping for the deck flutes due to diaphragm shear. End lapping stiffens the diaphragm, reducing the in-plane deflection of the roof structure. End lapping also reduces the number of connections to supports at the sheet ends, leading to reduced erection costs. Butted deck panels ends are necessary in certain conditions, such as at valleys or ridges on steep slope roofs.

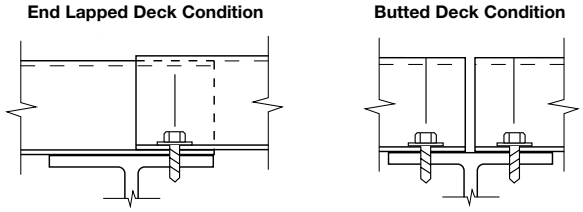


Figure 1.9.2: **END LAP AND BUTTED DECK**

Fastener Selection to Supporting Members

The fastening of deck to the supporting members has an impact of the diaphragm shear. The higher shear of the fastener, the higher the shear for a given sheet of deck. Welds produce high shears. Power actuated fasteners (nails/pins) can produce a wide range of shears depending on the sup-

How to Read Diaphragm Shear Table

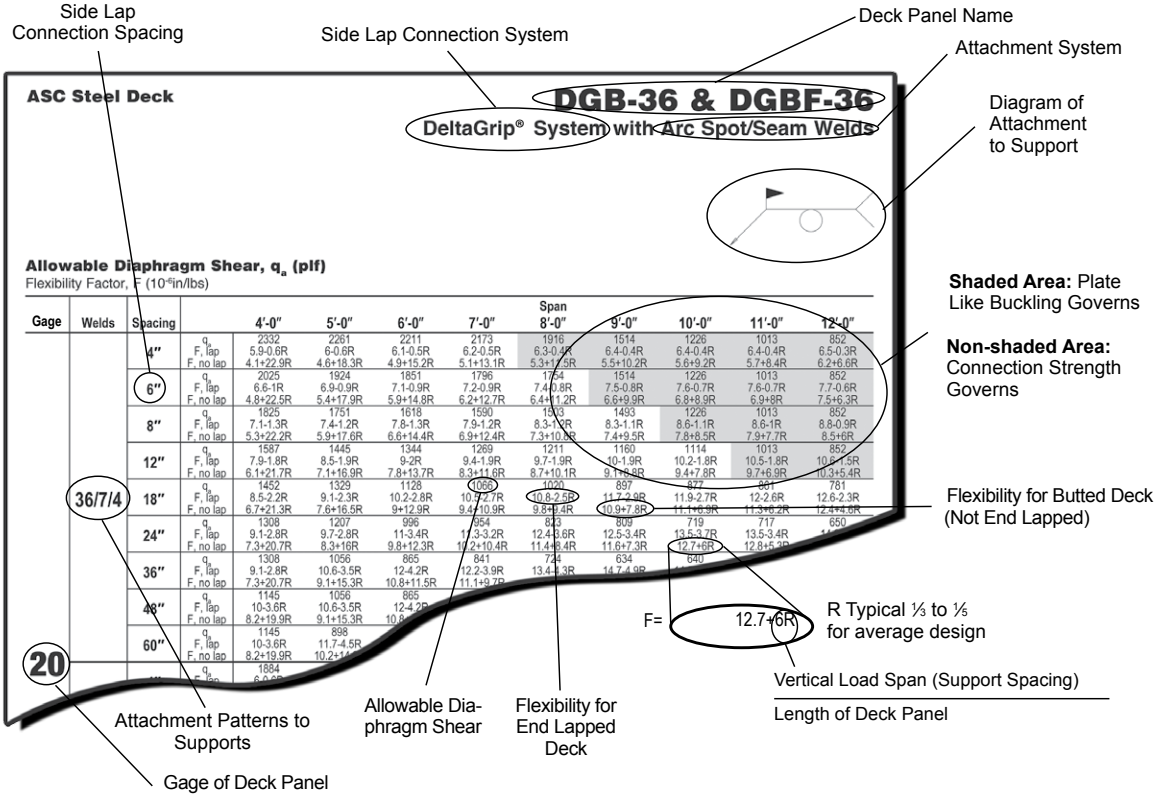


Figure 1.9.3: **SAMPLE OF DIAGRAM SHEAR AND FLEXIBILITY TABLE**

port member thickness and the selected fastener. Self drilling screws produce shears on the lower end of the mechanical fastener range. The fastening system must be compatible with the support member thickness and deliver the required performance for the diaphragm. Refer to the fastener section of the design guide for more information.

Side Seam/Side Lap Fasteners

All standard steel deck panels have a standing seam interlock which is suitable for button punch, top seam welds, and our revolutionary DeltaGrip® side lap fastening system (for panels designated DG). The button punch side lap fastener is the most cost effective, yet provides the lowest diaphragm shear capacity. Welded top seam fastening is the least cost effective but offers significantly higher diaphragm shear capacities than button punching. The most efficient and cost effective side lap fastener type is the DeltaGrip system. This system provides high diaphragm shear capacities similar to the top seam weld with installation costs equivalent to button punching.

Another side lap fastening option is the use of screws, with nestable side lap steel deck panels. Side lap screws provide moderate diaphragm shear capacities compared to low shear button punchs and the high shear DeltaGrip systems. The installation cost of screws is greater than button punching and much less expensive than top seam welding.

Side Seam/Side Lap Fastener Spacing

The first side lap connection from the supporting member shall not be more than one-half the specified spacing of the side lap connections, (*see Figure 1.9.4*). No side lap connection should be installed directly over the center line of the support member.

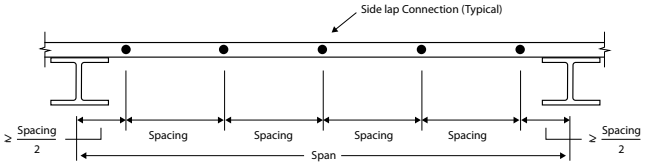


Figure 1.9.4: **SIDE LAP FASTENER SPACING**

Diaphragm Boundary Fasteners to Supports

Diaphragm boundary connection to supports, perpendicular to the deck, should be the specified attachment pattern for the steel deck panels.

Diaphragm boundary fastener spacing, parallel with panel ribs, shall not exceed the spacing, which is determined by dividing the required diaphragm shear demand by the fastener shear strength. Connector shear strengths are presented in Figures 1.11.10 and 1.11.11.

$$Spacing(in) = \frac{Q_{fa}}{s_a}\left(\frac{12in}{ft}\right) \qquad Spacing(in) = \frac{Q_{ff}}{s_f}\left(\frac{12in}{ft}\right)$$

Q_{fa} Allowable fastener strength using safety factor from AISI S100-2007 Table D5
Q_{ff} Factored fastener strength using resistance factor from AISI S100-2007 Table D5
S_a Allowable shear diaphragm demand
S_f Factored shear diaphragm demand

1.10 **In Plane Diaphragm Flexibility**

Skew Cut Diaphragm Boundary

At skew cut conditions, the minimum number of fasteners is determined based on the location of the fasteners in the ribs per the perpendicular attachment schedule. The average spacing of the fastener per sheet shall not be greater than the spacing of the parallel boundary fasteners. Fasteners may need to be doubled up in some flutes to achieve this. (*See figure 1.10.1)*

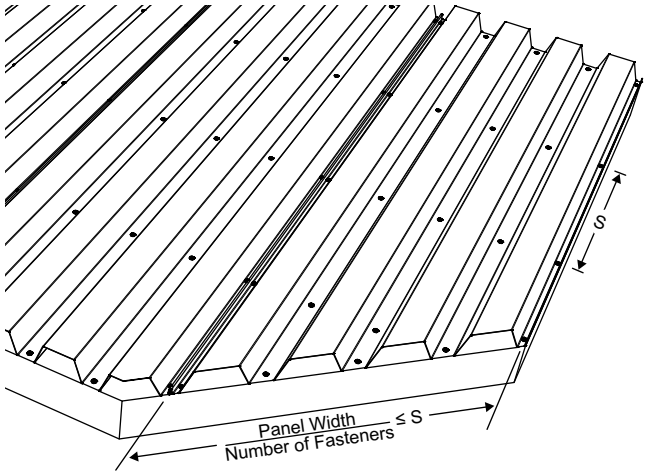


Figure 1.10.1: **SKEW DIAPHRAGM**

Diaphragm Shear Zoning

Steel deck diaphragms may be zoned based on shear demand on the diaphragm to create the most economical roof structure. This may not be practical for every building, but many rectangular large roof structures lend themselves to zoning. The deck panel along the collectors will have the highest shear demand dropping off toward the middle of the diaphragm. The deck gage and attachment pattern can be reduced as the shear demand in the diaphragm diminishes (*see Figure 1.10.2*).

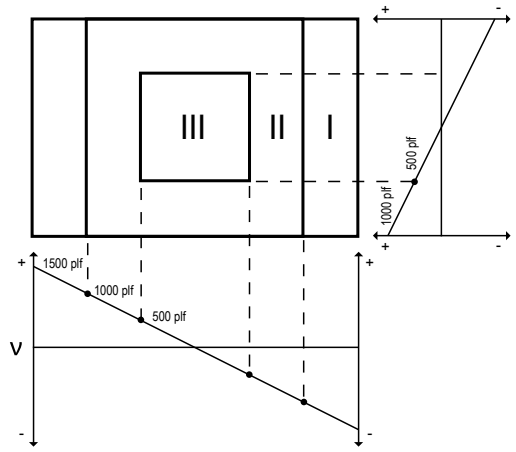


Figure 1.10.2: **DIAPHRAGM SHEAR ZONING**

Diaphragm Deflection

Diaphragms in plane deflections should be based on the shear deflection of the diaphragm. For diaphragms that do not have a large aspect ratio of length to depth, flexural deflection should not be considered. Flexural deflection equations based on slender beams do not apply to deflection of deep beams, which are generally considered beams with a length to depth ratio of 5:1 or less. Diaphragms with length to depth ratios greater than 5:1 probably do not meet the requirements for flexural deflections because the diaphragm, acting as the web of the beam, is orders of magnitude more flexible than the diaphragm cords, acting as the flanges of the beam.

Typical lengths of steel deck panels that are safe and efficient for erection are in the 20 to 35 foot range. For erection safety, 3 span sheets are the desirable minimum sheet length. A minimum 3 span condition should not be specified because single and double spans are required for layout in most buildings. For design purposes a ratio of span to length, R, from ⅓ to ⅕ is appropriate for general design.

$$F = \#.\#+\#.\#R \qquad R = \frac{L_v}{L}$$

F = Diaphragm stiffness in micro inches per lbs
L_v = Vertical load span, which is the support spacing
L = Deck panel length, which is a multiple of the vertical load span

Example:
DGB-36, 20 gage, 36/7/4 attachment pattern, DeltaGrip® spacing of 12 inches, Vertical load span of 5 feet F=7.1+19.6R
Assume R = 1/5, a 25 foot long panel with 5 foot vertical load span

$$F = 7.1+19.6R = 7.1+19.6(1/5) = 11$$

Figure 1.10.3: **DIAPHRAGM STIFFNESS FACTOR**

Diaphragm Deflection Concept

The deflection of a diaphragm that is zoned for shear can be approximated by summing the deflection of each deck zone, based on the diaphragm stiffness of each zone (*see Figure 1.10.4).* For zone 3 in the figure, the diaphragm stiffness of the least stiff zone is applied to the entire building depth.

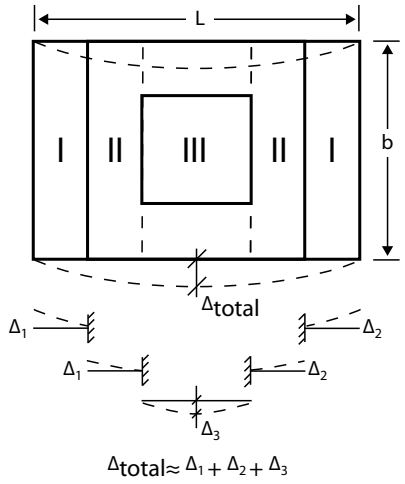


Figure 1.10.4: **DIAPHRAGM DEFLECTION CONCEPT**

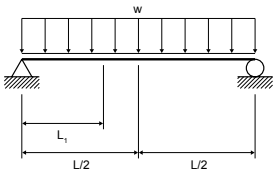
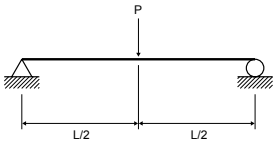
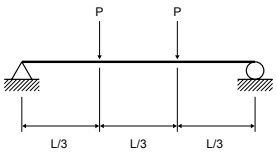
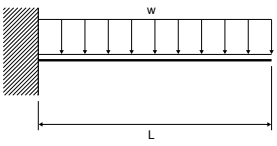
Diaphragm Deflecton Equations

Determination of diaphragm shear (web) deflections shall be based on the shear Stiffness, G' and equations of engineering mechanics. The diaphragm deflection is determined by one of the following equations.

Relationship between Flexibility Factor and Stiffness Factor When F is in micro-inches per pound and G' is in kips per inch

$$F = \frac{1000}{G'}$$

Figure 1.10.5: **DIAPHRAGM SHEAR DEFLECTION EQUATIONS**

Type of Loading	Loading Condition	Shear Deflection	Load Diaphragm
Simple Beam at Center	Uniform Load, w	$\Delta_w = \frac{wL^2}{8bG'}$	
Simple Beam at L_1	Uniform Load, w	$\Delta_w = \frac{q_{ave}L_1}{G'}$	
Simple Beam at Center	Point Load, P	$\Delta_w = \frac{PL}{4bG'}$	
Simple Beam at ⅓ Points	Point Load, P	$\Delta_w = \frac{PL}{3bG'}$	
Cantilever Beam at End	Uniform Load, P	$\Delta_w = \frac{PL}{bG'}$	
Cantilever Beam at End	Uniform Load, W	$\Delta_w = \frac{WL^2}{2bG'}$	

b = Depth of diaphragm

F = Flexibility factor (typically micro in/lbs)

G' = Stiffness factor (typically kips/in)

L = Diaphragm length

L_1 = Distance to point where deflection is calculated

P = Concentrated load

q_{ave} = Average diaphragm shear (typically lbs/ft)

w = Uniform load

Δw = Web deflection

1.11 **Support Fastening**

Support Fastening

A variety of fastening systems may be used to connect steel deck to the supporting steel members. The type of fastening system used depends on the required diaphragm shear capacity, uplift capacity, and the thickness of the supporting steel members. These fastening systems include arc spot welds, arc seam welds, self-drilling screws, and power-actuated fasteners (PAF).

The strength of each fastener type is mathematically derived from specified standards and testing. The shear strength for arc spot and arc seam welds is derived from the equations in Section E2.6 of AISI S100-2007. The strength for self-drilling screws and PAF is determined in accordance with the *Steel Deck Institute Diaphragm Design Manual DDM-03*. The strengths for these fasteners are listed in the Weld and Shear capacities (*see Figure 1.11.10 and Figure 1.11.11*). The pull-out and pull-over capacity for fasteners are in accordance with Sections E4.4.1 and E4.4.2 of AISI S100-2007. The pull-out for PAF's should be obtained from the manufacturer's data for the selected fastener.

Fastener Selection

To ensure quality fastening to supports, the fastener, weld, screw, or PAF must be compatible with the thickness of the steel support member. Arc spot and arc seam welds do not have a mandatory minimum support member thickness. Experience has shown that a support thickness as thin as 10 gage is reasonable. Welders with light gage welding experience can weld steel deck to thinner gage supports. Self-drilling screws are suitable for use with supporting members from 0.0385 inches gage to ½", depending on thread pitch and drill point configuration. The fastener manufacturer should be consulted to determine which screw is appropriate. PAFs are selected based on a range of support thickness for a given fastener. Follow the PAF manufacturer's support thickness recommendations. The fastener selection chart *(see Figure 1.11.1*) provides a quick and easy guide to help select the appropriate fastening system for the support member thickness.

Minimum Fastener Edge Distance

The minimum edge distance for fasteners used with ASC Steel Deck profiles has been verified through full-scale diaphragm shear testing. The minimum edged distance for self-drilling screws and PAFs is ½". The minimum edge distance for arc spot and arc seam welds is ¾". Edge distance is measured from the center of the fastener or the center of the radius of an arc spot or seam weld.

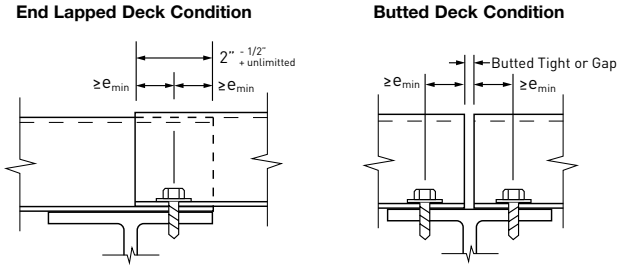
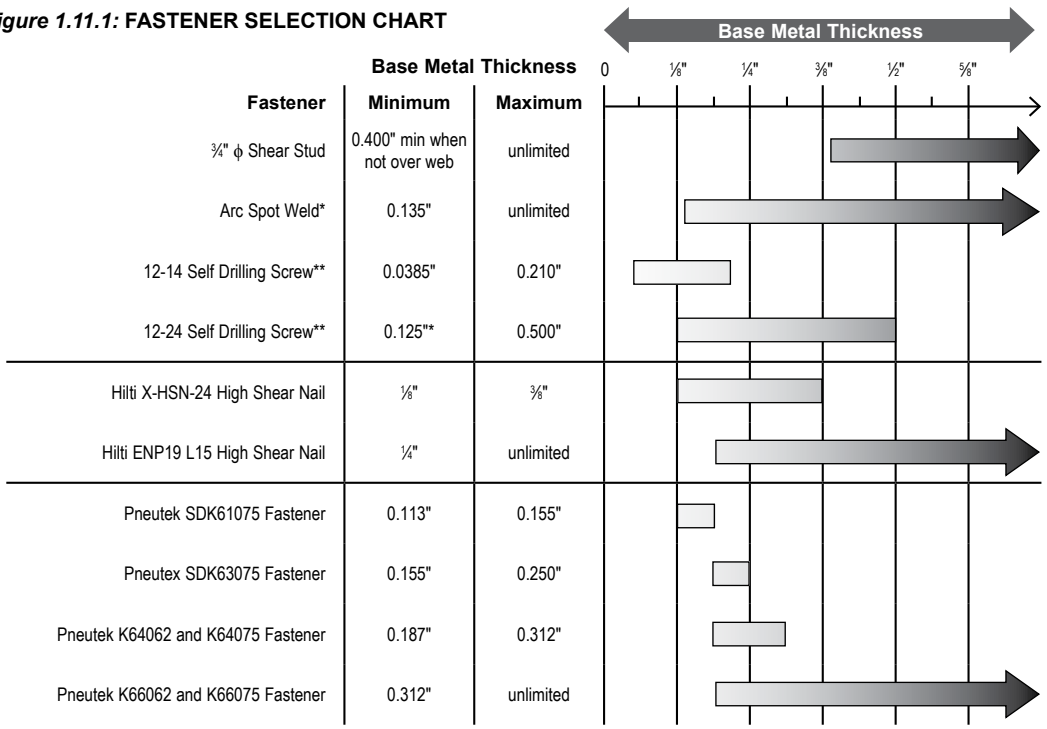


Figure 1.11.2: **END LAP AND BUTTED DECK**

Figure 1.11.1: **FASTENER SELECTION CHART**



Fastener	Minimum	Maximum
¾" ϕ Shear Stud	0.400" min when not over web	unlimited
Arc Spot Weld*	0.135"	unlimited
12-14 Self Drilling Screw**	0.0385"	0.210"
12-24 Self Drilling Screw**	0.125"*	0.500"
Hilti X-HSN-24 High Shear Nail	⅛"	⅜"
Hilti ENP19 L15 High Shear Nail	¼"	unlimited
Pneutek SDK61075 Fastener	0.113"	0.155"
Pneutex SDK63075 Fastener	0.155"	0.250"
Pneutek K64062 and K64075 Fastener	0.187"	0.312"
Pneutek K66062 and K66075 Fastener	0.312"	unlimited

*Below 10 gage is not recommended due to the difficulty of producing a good quality weld. **Correct drill point must be selected for the base material thickness.

Power-Actuated Fasteners, PAF

Power-actuated fasteners, PAFs, are an excellent fastening system. Commonly referred to as high shear nails or pins, they can be used to achieve mid to high range diaphragm shear capacities depending on the fastener selected and the support thickness. The benefits of using PAFs is that they can be installed without skilled qualified welders, are efficient to install, do not pose a jobsite fire risk, and do not leave any burn marks associated with welding. This makes PAFs an attractive option for architecturally exposed steel deck.

A drawback of PAF systems is that it may be difficult for the design engineer to select the fastener size when designing with open-web steel joists because the thickness of the top chord maybe unknown. Good practice would be to design the diaphragm with the minimum expected substrate steel thickness and indicate a range of acceptable fasteners based on the thickness of the supporting steel member. The inspection process on the jobsite should be tasked with ensuring that the correct fastener is used based on the substrate thickness.

Pneutek

Pneutek's PAF system uses a pneumatic actuated tool. This system does not use a powder charge to drive the fastener. Contact Pneutek for fastener installation instructions and for additional technical support relating to their fastening systems.
www.pneutek.com 800-431-8665

Pneutek Fasteners
SDK61075, SDK63075, K64062, K66075, K66056, K66062, K66075

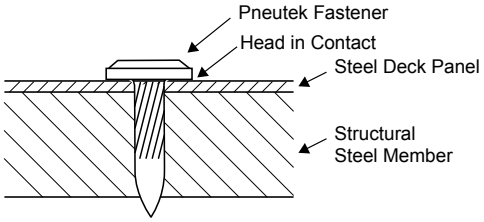


Figure 1.11.3: **PNEUTEK K64062**

Hilti, Inc.

Hilti, Inc.'s PAF system includes powder fired tools to install their high shear nails (HSN) and ENP fasteners. The operator of the powder-fired tools must have OSHA compliant safety training. Contact Hilti, Inc. for fastener installation instructions and for additional technical support relating to their fastening systems.
www.us.hilti.com 800-879-8000

Hilti Inc. Fasteners
X-ENP-19 L15, X-EDN-19 THQ12, X-EDNK-22 THQ12

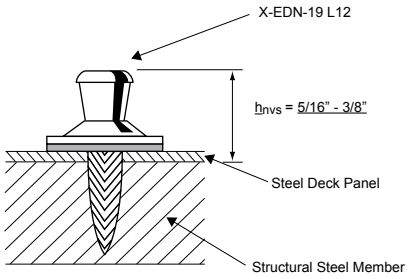


Figure 1.11.4: **HILTI X-ENP-19**

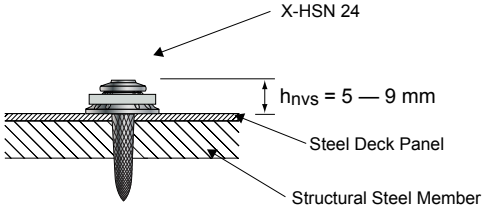


Figure 1.11.5: **HILTI X-HSN 24**

1.11 **Support Fastening**

Arc Spot and Arc Seam Welds

Traditionally, arc spot welds and arc seam welds are used to attach the steel deck to supports. The arc welds have high shear capacity leading to diaphragms with high shear capacities and low diaphragm flexibilities. Significant drawbacks of welded connections include cost of the required skilled labor and lengthy time to install. Additionally, welding cannot be performed in the rain or if standing water is present on the deck. Welding often results in burn marks visible from the underside of the deck and supporting members. Jobsite safety is of great concern as welding also creates a fire risk. Many specifications require the weld to receive touch-up paint after slagging the welds.

Arc spot and seam welds for ASC Steel Decks are specified based on the effective diameter or length and width. This is approximately the diameter or width and length of a weld at the interface between the deck and supporting member. The effective weld size is less than the visible weld size and is verified through the development of weld qualifications and procedures. See AISI S100-2007 Section E2 for more information regarding weld design. Weld inspection, procedures, and qualifications should be in accordance with AWS D1.3

Arc spot welds in deck less than 0.028 inches thick require weld washers in accordance with AWS D1.3. Weld washers are not recommended for thicker decks.

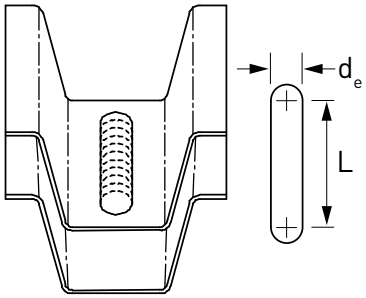


Figure 1.11.7: **ARC SEAM WELD**
(weld to support)

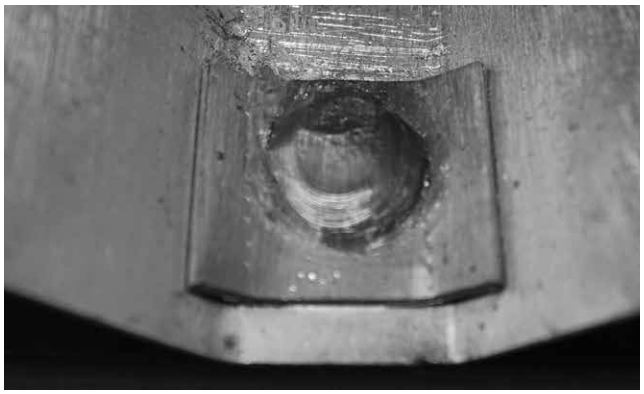
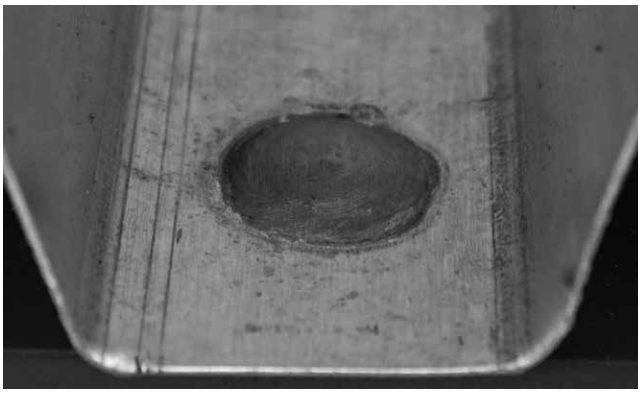


Figure 1.11.6: **WELD WASHER**



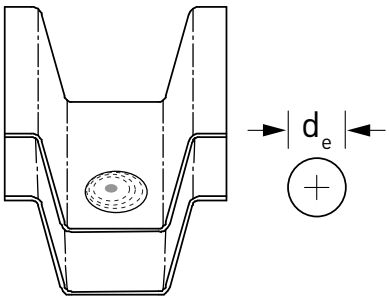


Figure 1.11.8: **ARC SPOT WELD**
(weld to support)

Self-Drilling Screws

Self-drilling screws are an excellent option for attaching deck to thin-gage metal supporting members. Although diaphragms that are attached with screws tend to have a lower shear capacity than other support fastening systems, screws install quickly with lower skilled labor and do not leave any burn marks on the deck or supporting members. This makes them an attractive option for architecturally exposed steel deck. Self drilling screws may not be practical on heavier structural steel support members because it can be time consuming to drill through the steel deck panel into the supporting member. When installed, the driven screw penetrates both the steel deck panel and the supporting member; as a result, the screw points are visible from the underside of the roof structure.

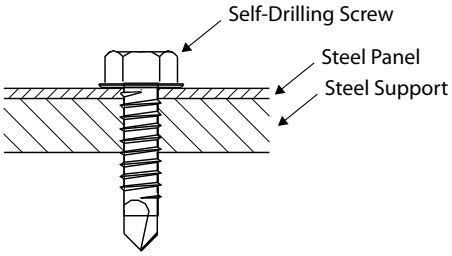


Figure 1.11.9: **#12-24R1-1/4 SCREW**

1.11 **Support Fastening**

Figure 1.11.10

Nominal Strength **WELDING CAPACITIES**

Deck Panel	Gage	Arc Spot (puddle) Weld (1/2 in effective diameter)		Arc Seam Weld (3/8 in x 1 in effective width & length)
		Shear (lbs)	Tensile (lbs) IBC	Shear (lbs)
B, DGB	22	2116	2048	3098
	20	2955	2442	3751
	18	4710	3207	5075
	16	5810	3956	6452
N, DGN	22	2416	2310	3873
	20	3364	2755	4688
	18	5701	3618	6344
	16	7263	4463	8065
2W, DG2W, 3W, DG3W	22	2002	1988	3001
	21	2532	2252	3434
	20	2820	2383	3652
	19	3950	2837	4425
	18	4635	3156	4985
	16	5738	3907	6359
Deep Deck	20	2595	2048	3161
	18	4011	2717	4314
	16	4965	338/	5503
	14	6193	4188	7143
BF, DGBF	20/20	6886	4689	7881
	20/18	7835	5335	9217
	20/16	8836	6082	10714
	18/20	7912	5387	9328
	18/18	8836	6075	10701
	18/16	8836	6958	12238
	16/20	8836	6148	10827
	16/18	8836	6958	12238
	16/16	8836	7867	13817
NF, DGNF	20/20	8608	5290	9851
	20/18	8836	6019	11521
	20/16	8836	6862	13392
	18/20	8836	6078	11660
	18/18	8836	6853	13376
	18/16	8836	7850	15298
	16/20	8836	6935	13534
	16/18	8836	7850	15298
	16/16	8836	8875	17271
2WF, DG2WF, 3WF, DG3WF	20/20	6807	4635	7773
	20/18	7759	5283	9106
	20/16	8836	6017	10600
	18/20	7844	5341	9229
	18/18	8836	6017	10600
	18/16	8836	6898	12134
	16/20	8836	6089	10600
	16/18	8836	6898	10600
	16/16	8836	7805	13710
Cellular Deep Deck	20/20	5815	3932	6624
	20/18	6714	4540	7780
	20/16	7647	5171	9173
	18/20	6714	4540	7780
	18/18	7647	5171	9173
	18/16	8767	5928	10501
	16/20	7647	5171	9173
	16/18	8767	5928	10501
	16/16	8836	6708	11865

Calculated in accordance with section E of the *AISI Cold Formed Steel Design Manual 2004 supplement to the 2001 & 2007 NASPEC, AISI S100-2012*

Figure 1.11.11

Nominal Strength **MECHANICAL FASTENER CAPACITIES**

Deck Panel	Gage	Nominal Shear Strength (lbs)							
		Screws	Hilti			Pneutek			
		#12 Self Drill	X-ENP-19 L15	X-EDN 19 THQ 12	X-EDNK22 THQ12 X-HSN-24	K64062 K64075	K63062 K63075	SDK63075	SDK61075
B, DGB, N, DGN	22	1150	1624	1604	1508	1841	1735	1728	1546
	20	1381	1938	1914	1800	2258	2216	1977	1833
	18	1839	2549	2517	2367	3132	3009	2417	2378
	16	2301	3149	3109	2924	4076	3686	2812	2896
2W, DG2W, 3W, DG3W	22	1116	1577	1557	1464	1780	1655	1689	1502
	21	1270	1787	1765	1659	2055	1993	1860	1695
	20	1347	1891	1868	1756	2195	2149	1941	1790
	19	1616	2253	2225	2092	2698	2642	2210	2116
	18	1808	2508	2477	2329	3071	2960	2389	2342
	16	2270	3109	3070	2887	4011	3644	2787	2862
Deep Deck	20	1206	1891	1868	1756	2195	2149	1941	1790
	18	1619	2508	2477	2329	3071	2960	2389	2342
	16	2032	3109	3070	2887	4011	3644	2787	2862
	14	2583	3885	3836	3608	5363	4440	3265	3506
BF, DGBF, NF, DGNF	20/20	2766	3737	3690	3470	5092	4294	3176	3386
	20/18	3190	4258	4204	3953	6071	4800	3485	3804
	20/16	3651	4810	4750	4466	7201	5314	3801	4229
	18/20	3224	4300	4246	3992	6154	4840	3509	3837
	18/18	3647	4806	4745	4462	7191	5310	3799	4225
	18/16	4109	5342	5275	4960	8383	5793	4099	4619
	16/20	3686	4851	4790	4504	7288	5351	3824	4259
	16/18	4109	5342	5275	4960	8383	5793	4099	4619
	16/16	4571	5862	5789	5444	9639	6251	4385	4982
2WF, DG2WF, 3WF, DG3WF	20/20	2732	3694	3648	3430	5014	4250	3150	3350
	20/18	3155	4215	4163	3914	5989	4760	3460	3770
	20/16	3617	4769	4710	4429	7114	5277	3778	4198
	18/20	3193	4262	4209	3958	6081	4804	3487	3807
	18/18	3617	4769	4710	4429	7114	5277	3778	4198
	18/16	4078	5307	5240	4928	8302	5762	4079	4594
	16/20	3655	4815	4754	4471	7211	5318	3804	4232
	16/18	4078	5307	5240	4928	8302	5762	4079	4594
	16/16	4540	5828	5755	5412	9553	6221	4367	4958
Cellular Deep Deck	20/20	2411	3646	3600	3385	4928	4202	3121	3311
	20/18	2824	4215	4163	3914	5989	4760	3460	3770
	20/16	3238	4769	4710	4429	7114	5277	3778	4198
	18/20	2824	4215	4163	3914	5989	4760	3460	3770
	18/18	3238	4769	4710	4429	7114	5277	3778	4198
	18/16	3651	5307	5240	4928	8302	5762	4079	4594
	16/20	3238	4769	4710	4429	7114	5277	3778	4198
	16/18	3651	5307	5240	4928	8302	5762	4079	4594
	16/16	4064	5828	5755	5412	9553	6221	4367	4958

Calculated in accordance with the *Steel Deck Institute Diaphragm Design Manual*

1.12 **Side Seam Fastening**

Side Seam Attachment

Side seam attachment is an integral part of developing the shear resistance and flexibility of a diaphragm system. The side seam attachment also creates a positive connection, limiting differential movement between the sheets of deck under out-of-plane loads. Limiting differential movement between the sheets helps to prevent damage to the roof system installed on the top side of the steel deck. The common side seam attachment systems are the button punch, top seam weld, and DeltaGrip® system for standing seam interlock side seams. Self-drilling screws are used for nestable side seams. The two common types of side seams are the standing seam interlock and the nestable side seam (*see Figure 1.12.1)*.

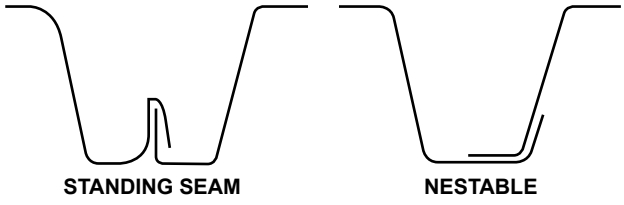


Figure 1.12.1: **STANDING SEAM AND NESTABLE DIAGRAM**

Button Punch

The button punch attachment is used to connect standing seam side seams. This low cost attachment uses a pneumatic or hand-operated button punch tool that clinches the seam together. The button punch option is used for low shear diaphragms that generally have high flexibilities. For architecturally exposed deck, the button punch system is a good option because no unsightly burn marks occur, which are typically associated with welded connections. Although skilled labor is not required, the quality of the button punch that has been installed with a hand-operated tool is dependent on the operator. A "good" button punch should not become disengaged when a person jumps on the adjacent sheet of deck.

Figure 1.12.2: **BUTTON PUNCH SIDE LAPS**

Self-Drilling Screws

Self-drilling screws are used to attach nestable side lap steel decks. The screws have a mid range shear strength compared to button punches and top seam welds making them suitable for mid range diaphragm shears. The screws can be easily installed with low-skill labor using screw guns that are readily available. The screws do not leave burn marks associated with welding, but the screw points do protrude through the underside of the steel deck. As a result, screws may not be acceptable for some architecturally exposed steel decks.

Figure 1.12.3: **SIDE SEAM SELF-DRILLING SCREW**

Top Seam Weld

The top seam weld connects the standing seam deck side seams by welding the three layers of steel deck together. This is done after the hem is crimped using a hand or pneumatically operated crimping tool. Top seam welds can be used to produce high diaphragm shears and low flexibilities. Top seam welding is a slow process requiring skilled welders, leading to increased installation costs. The welding creates burn marks on the underside of the deck and occasional burn-through holes. Top seam welds are not recommended for architecturally exposed steel deck. Weld inspection, procedures, and qualifications should be in accordance with AWS D1.3. Due to the high cost associated with installation and inspection, top seam weld connections have been largely replaced by the DeltaGrip side lap connection.

Figure 1.12.4: **TOP SEAM WELD**

DeltaGrip®

The DeltaGrip system was developed in 2003 to reduce the installed costs of high shear diaphragms by eliminating the costly top seam weld. This revolutionary clinching system punches three triangular tabs though the standing seam interlock side seam. This interlock creates the equivalent strength of a time consuming top seam weld with the rapid action of a pneumatically powered DeltaGrip tool. High-quality DeltaGrip connections can be installed with low-skill labor compared to the skilled welders required to make top seam welds.

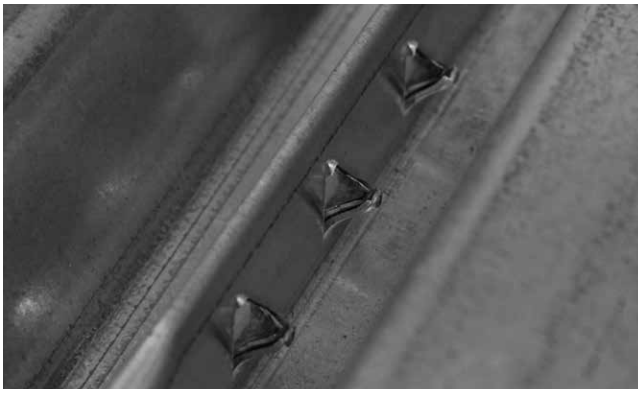


Figure 1.12.5: **DELTAGRIP PUNCH**

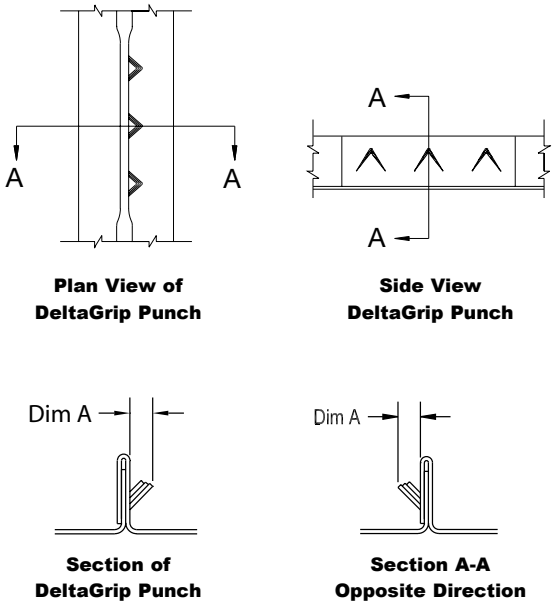


Figure 1.12.7: **DELTAGRIP PUNCH VIEWS**

DeltaGrip Inspection

The DeltaGrip system can be visually inspected from the top side of the steel deck by observing that all three layers of the side lap are engaged and that the punch-out distance meets the minimum offset required *(Figure 1.12.6 and 1.12.7)*. To assist with this task, ASC Steel Deck has developed a Go/No-Go gage to provide a rapid jobsite check of the punch-out distances *(Figure 1.12.8).*

Schedule Minimum Offset	
Gage	Dim A (in)
22	0.19
21	0.19
20	0.19
19	0.16
18	0.16
16	0.16
For SI 1 inch = 25.4mm	

Figure 1.12.6: **DELTAGRIP PUNCH OUT DISTANCES**

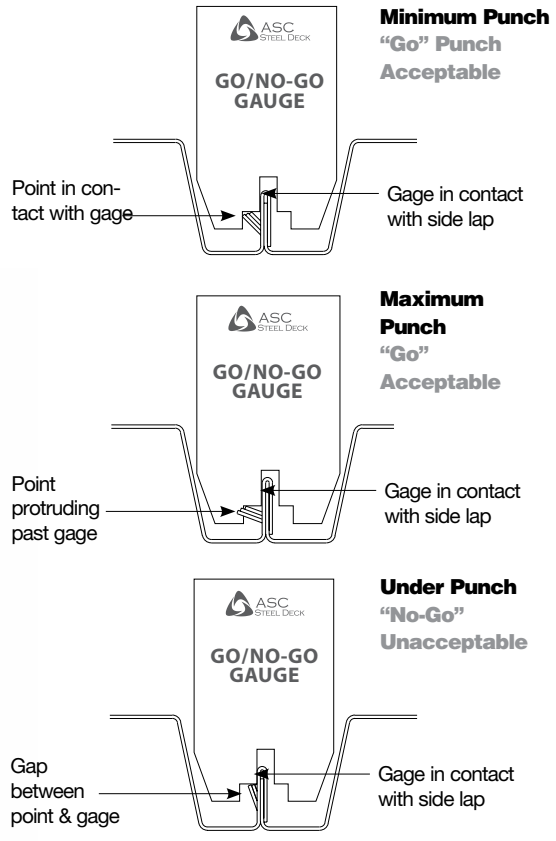


Figure 1.12.8: **DELTAGRIP GO/NO-GO GUAGE**

1.13 **Accessories**

ASC Steel Deck offers a variety of accessories to complement our steel deck offer. These include flashings, sump pans, weld washers, and profile cut top (small void) and bottom (large void) neoprene foam and galvanized steel closures.

When accessories are called for in the specifications, the location must be clearly shown on the structural and architectural drawings. Specifications that call for the use of profile cut closures where walls meet the metal deck may lead to unnecessary construction costs if they are only needed at exterior walls or specific interior locations.

Profile Cut Neoprene Closures.
Neoprene closures may be used on the top and bottom of the steel deck to reduce vapor, moisture, and air from infiltrating into the building or roof assembly. These are die-cut from black closed cell neoprene foam. The foam is manufactured in accordance with ASTM D-1056 and passes the FM VSS No. 302, UL 94HBF, and UL 94 HF1 flammability tests.

Profile Cut Metal Closures.
Metal closures may be used to control animal nesting within the building structure. Metal closures may be used in combination with neoprene closures. Metal closures with calking can also be used to reduce noise infiltration as part of an acoustically engineered system. The metal closures are stamped out of 22 gage galvanized sheet steel.

B36 DECK NEOPRENE AND METAL CLOSURES

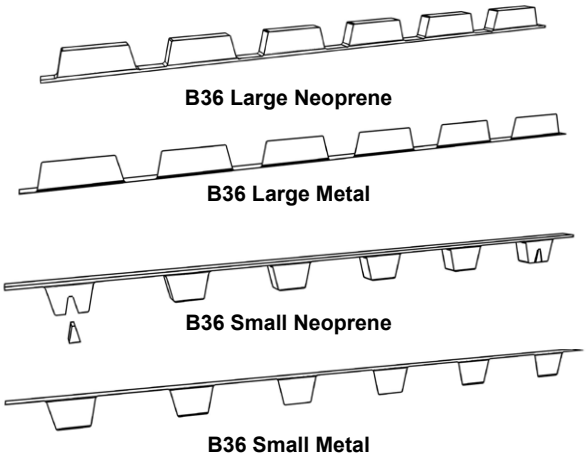


Figure 1.13.1

N32 DECK NEOPRENE AND METAL CLOSURES

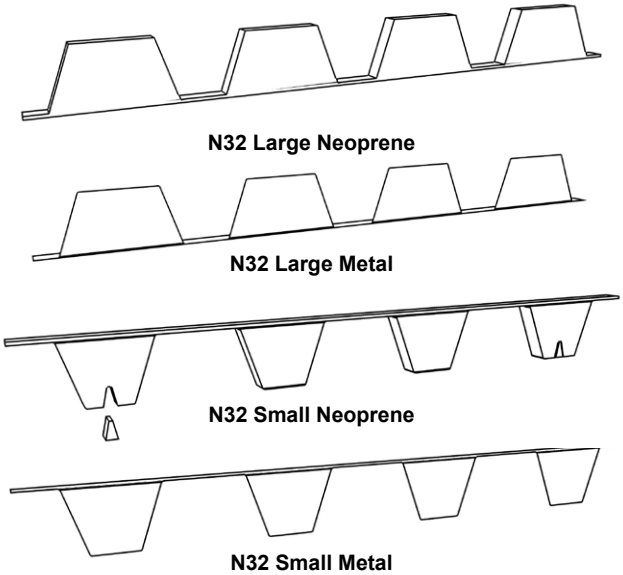


Figure 1.13.2

2W NEOPRENE AND METAL CLOSURES

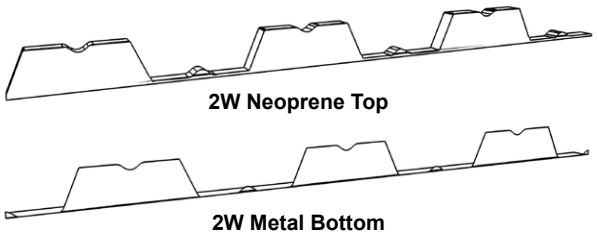


Figure 1.13.3

3W NEOPRENE AND METAL CLOSURES

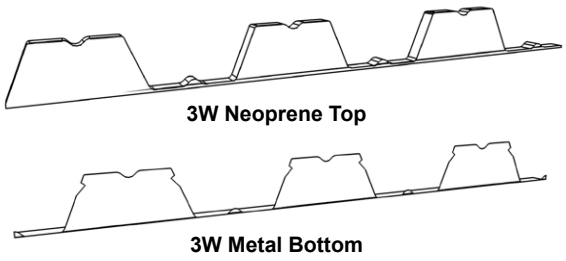


Figure 1.13.4

DEEP DECK NEOPRENE CLOSURES

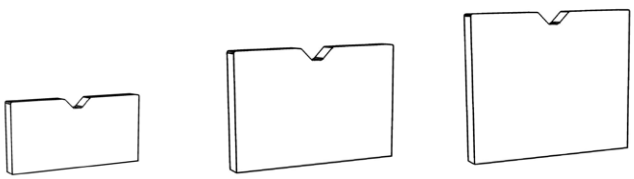


Figure 1.13.5

Weld Washers.
14 gauge x 3/8" dia. hole for welded attachment of CP-32. For use with 26 and 24 gage CP32 only.

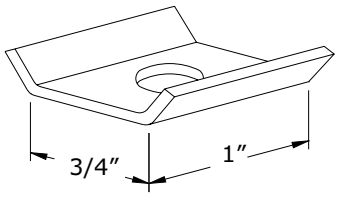


Figure 1.13.6

Anchor Washers
16 gauge x 7/16" dia. hole for welded attachment of CP-32 where higher diaphragm shear values must be achieved.

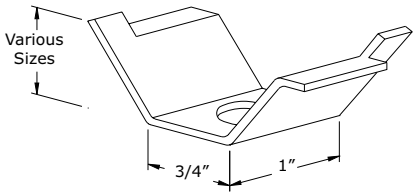


Figure 1.13.7

Sump Pans.
Sump pans are a common part of many low slope roof systems. These may be provided as part of the metal deck scope of work or may be provided by the roof or mechanical trade(s) installing the drainage system.

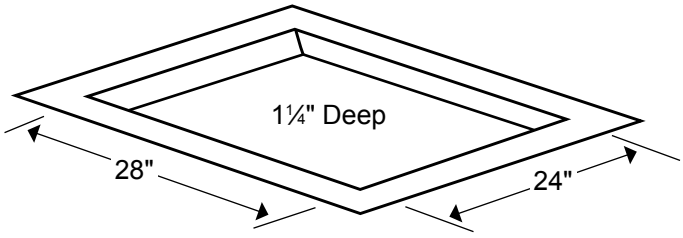


Figure 1.13.8

FLASHING THICKNESS BY GAGE	
Gage	Base Steel Thickness
22	0.0290
20	0.0350
18	0.0470
16	0.0590
14	0.0700
12	0.1050
10	0.1350

Figure 1.13.9

Flashings.
Galvanized steel flashings are custom manufactured by ASC Steel Deck to meet the project requirements. The flashings are formed from ASTM A653 SS Grade 33 galvanized steel sheets. Flashings are available in most common structural shapes in 7 gages. *(Figure 1.13.9 and 1.13.10)*. The standard length is 10 feet, shorter lengths available upon request. The minimum width of any stiffener or flat cross section width is ¾". Channels, Hats, and Cee's web must be ¾" wider than the flange width, see figures below.

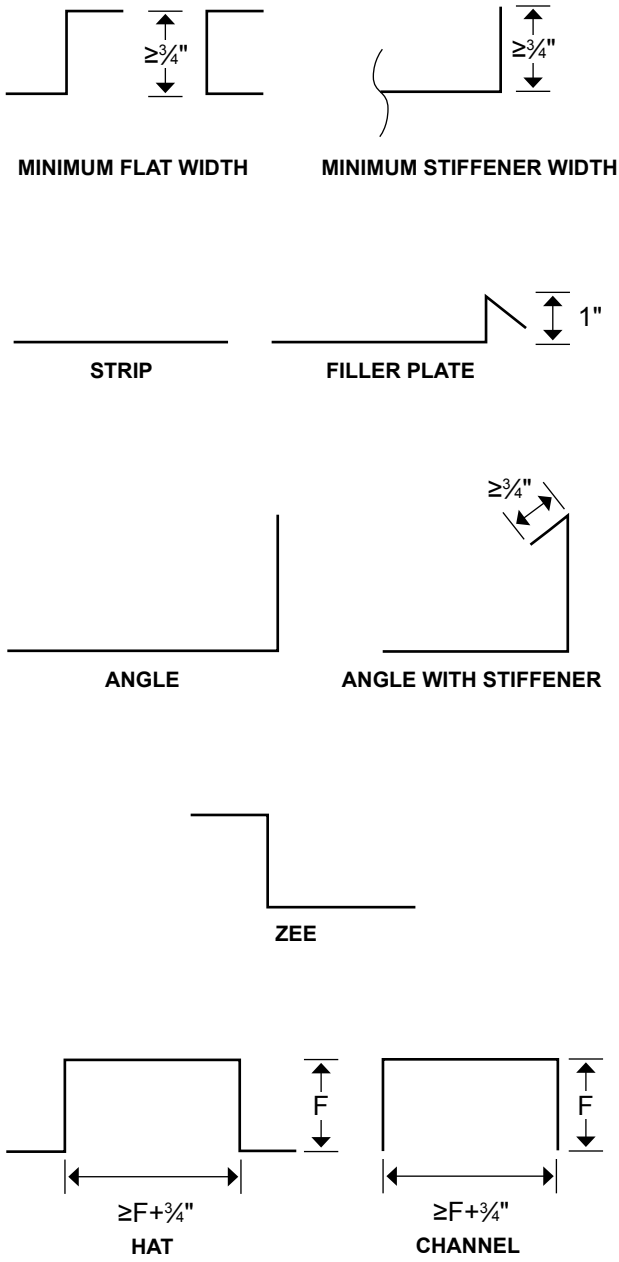


Figure 1.13.10

2.1 **Acustadek®**

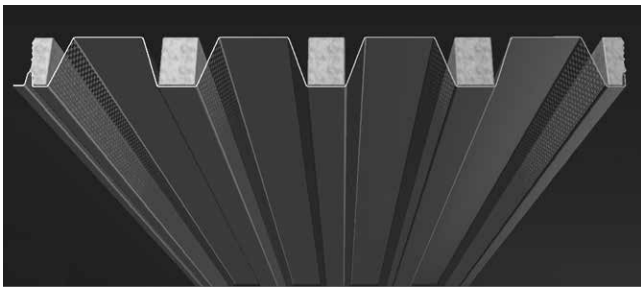
ASC Steel Deck

Acustadek®

Acustadek provides the extraordinary beauty of exposed steel, while providing the same noise reduction performance of common Mineral Fiber, Fiberglass, and Bio Acoustic ceiling tile systems. It is an excellent option for reducing noise inside buildings, increasing the comfort for the occupants. Acustadek is a dual-purpose panel which helps lower costs by providing an interior finish while contributing to the structural performance of the building. This is accomplished by perforating the structural steel deck and adding fiberglass batt acoustic media in the webs or in the cells of cellular deck, turning the profile into Acustadek. Our new Smooth Series™ rivets offer a clean attachment solution for the Acustadek cellular deck system.

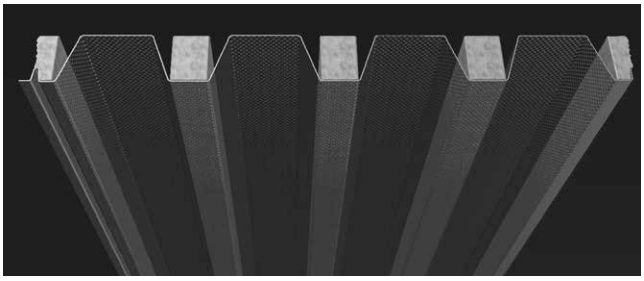
Web-Perforated Acustadek

Web-perforated Acustadek has 0.127" diameter holes spaced 0.375" on center in the webs of the flutes of the deck. Fiberglass batts supplied by ASC Steel Deck are field installed typically by the roofing contractor in the low flutes of the deck before the roof system is applied. Web-perforated roof decks are a component of many common roof systems. Ridged insulation boards, engineered wood panels (Plywood and OSB), fiber reinforced gypsum board, and glass matt covered gypsum board are all suitable cover boards for web-perforated steel decks.



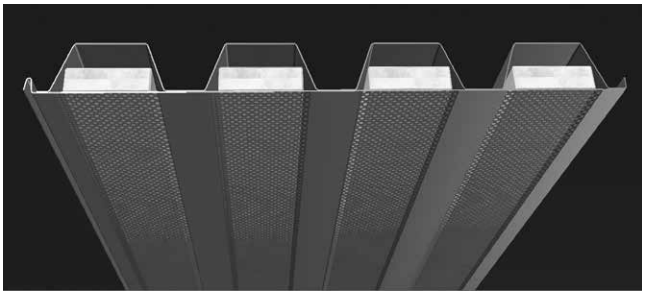
Total Perforation Acustadek

Total perforation Acustadeck has 0.127" diameter holes spaced 0.375" on center over the entire width of the profile, except the lower interlock flutes. Fiberglass batts supplied by ASC Steel Deck are field installed by the roofing contractor in the low flutes of the deck before the roof system is applied. Total-perforated roof decks are a component of many common roof systems. Ridged insulation boards, engineered wood panels (Plywood and OSB), fiber reinforced gypsum board and glass matt covered gypsum board are all suitable cover boards for total-perforated steel decks.



Cellular Acustadek

Cellular Acustadek has 0.157" diameter holes spaced 0.433" inches on center in the sections of the pan below the top flutes of the steel deck. Fiberglass batts are factory inserted in the cells of the deck before shipping to the project locations. Any roof system utilizing structural or insulating concrete fill, rigid insulation board, or other roof substrate material suitable for installation on a steel roof deck may be applied to the cellular Acustadek.



Fiberglass Batts

Fiberglass batts are used to absorb sound in the Acustadek assemblies. ASC Steel deck supplies the fiberglass batts that a cut to size for the specified profile. The standard batts are unfaced. Optional batts encapsulated with 0.75 mil clear pvc plastic can be specified.

Acoustical Performance

All Acustadeks have been tested for the sound absorption characteristics of the assemblies. This is commonly presented as a Noise Reduction Coefficient (NRC). The NRC is the average of the 250, 500, 1000, and 2000 hertz sound absorption coefficients. Acustadeks have between a 0.6 and 1.0 NRC, which can meet LEED v4 EQ Credit Acoustic Performance Option 2.

Acustadek should be a portion of a holistic approach to reducing the noise level in a building. Simply specifying an NRC rating for a single material may not get the level of sound control you require. In general, steel decks tend to have better sound absorption coefficients in the higher audible range. Other materials such as fabric wall treatments and carpet tend to have better sound absorption coefficients in the lower audible frequency ranges. The use of Acustadek in combination with other materials may create the best overall quiet environment. An experienced acoustic designer is key to developing the best overall performance using ASC Steel Deck Acustadek products.

The sound absorption coefficient varies across the spectrum of audible sound. In buildings with equipment that creates a specific frequency, the sound absorption coefficient for that frequency range should determine the type of deck rather than the overall NRC rating. For example, if a machine emits a sound in the 2000 Hz range, a total perforation deck such as DGB-36AT with an absorption coefficient of 0.95 would be a better choice than a web-perforated Acustadek such

as DGB-36AW, which only has a 0.53 coefficient for the 2000 Hz range. Some sound absorption coefficients may be greater than 1.0 because of the measurement methods. When designing for a specific frequency, use 1.0 for any absorption coefficients greater than 1.0.

The type of cover board on non-cellular Acustadek has an impact on the sound absorption coefficients and NRC rating of the assembly. The acoustical testing is based on an assembly comprising the Acustadek profile, the fiberglass batts, and the cover board on top of the steel deck that supports the roof system. Historically, fiberglass board was used as the cover board on top of the steel deck. These assemblies have higher acoustical performance than modern assemblies using poly-iso insulation board on top of the deck. The Acustadek tables in this section provide information for both fiberglass and poly-iso deck cover board assemblies.

The NRC should not be confused with the Sound Transmission Coefficient (STC). STCs measure the blocking of sound through an assembly as it relates to the decibel drop in the intensity of the sound. Acustadek may not be a good choice if a high STC is required. As an example, consider a room with noisy equipment. The Acustadek may be a good solution to reduce the noise level in the room for the occupants, but may not be a good material to block the noise from escaping the room. The holes in the perforated Acustadek may in fact let more sound escape the room than a conventional deck.

Detailing and Installation of Acustadek

Acustadek provides an exposed finish in the building. Steel deck is a structural element in the building and is subject to incidental dents in the handling and steel erection process. To minimize the potential damage, use 20 gage or heavier. 22 gage may be an economical option when minor dents can be tolerated; dark paint finishes or high roof structures can mask these types of minor blemishes.

Acustadek can be specified with a galvanized finish or factory prime painted over galvanized steel. Most Acustadeks will receive finish paint to meet the aesthetic requirements of the building. The galvanized steel can be field painted following the paint manufacturer's preparation and application recommendations. As an option, factory-applied primer can be specified, which may reduce the surface preparation of the deck.

Attaching the Acustadek to the structure and connection of the side laps of the deck can impact the appearance of the installed product. Side lap top seam welds will leave burn marks in the galvanized finish and an occasional burn through should be expected. This may be unsightly if the galvanized finish is intended to be left exposed. The burns can be easily cleaned up prior to prime painting the deck after installation. A better solution is to use the DeltaGrip® side lap connection. This mechanical interlock connection provides high strength similar to a weld without any thermal damage to the deck or galvanized coating and is not visible from the underside of the deck. Arc spot and arc seam welds may also leave visible burn marks on the deck near the support or on the underside of the supporting steel. A good alternative to welding the deck to supports is to attach the deck with self-drilling screws or power-actuated fasteners (PAF), such as the high shear nails manufactured by Hilti, Inc. or fasteners manufactured by Pneutek Inc. that are intended for decking applications.

Structural Performance of Acustadek

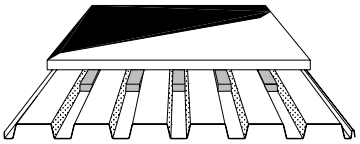
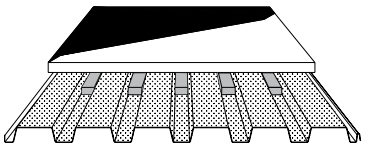
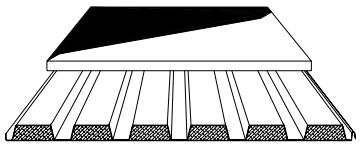
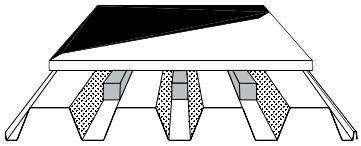
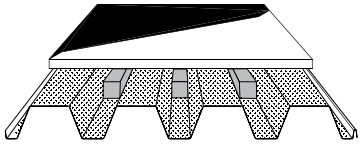
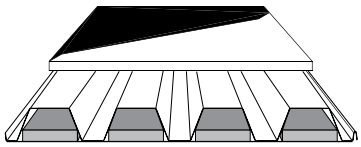
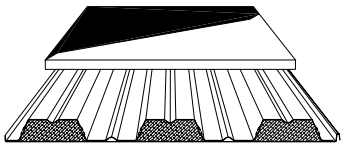
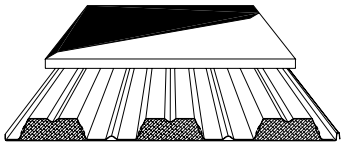
The perforation of the webs, top and bottom flutes and pans of the Acustadeks has a small impact on the structural performance of the deck profiles. Section properties are reduced from the non-Acustadek version of the profiles leading to reduced vertical load capacity. The reactions at supports are unaffected by the perforation in the Acustadek. The diaphragm shear and flexibility of cellular and web-perforated Acustadek is the same as the non-Acustadek version of the profile. Total perforation Acustadek flexibility is the same as the nonacoustical version of the profile, but the diaphragm shear capacity is 85% of the non-Acustadek profile. *(See Figure 7.1.1)*

Figure 7.1.1: **ACUSTADEK STRUCTURAL PROPERTIES SUMMARY**

Section Properties	Use Acustadek section properties
Reactions at Supports (based on Web Crippling)	Use non Acustadek reactions for the profile
Diaphragm Shear	Web perforated and cellular pan perforated use shear for non-Acustadek profile Total perforated Acustadek use 85% of the diaphragm shear for the profile
Diaphragm Flexibility	Use diaphragm flexibility of the non-perforated profile

2.2 **Acustadek®**

ASC Steel Deck

Acustadek® Profile (Perforation Type)	Cover Board[2,3,4]	Batt[5]	Absorption Coefficient[1] 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Noise Reduction Coefficient[1]
 **DGB-36AW & B-36AW**	Poly-Iso	Unfaced	0.08	0.18	0.61	1.05	0.53	0.30	0.60
	Fiberglass	Unfaced	0.23	0.67	1.21	0.82	0.46	0.24	0.80
 **DGB-36AT & B-36AT**	Poly-Iso	Unfaced	0.08	0.21	0.51	0.83	0.82	0.70	0.60
	Fiberglass	Unfaced	0.23	0.48	0.92	0.97	0.95	0.76	0.85
 **DGBF-36A & BF-36A**	Poly-Iso	Unfaced	0.20	0.45	0.77	1.09	0.84	0.56	0.80
	Poly-Iso	Encapsu-lated	0.16	0.37	0.70	1.01	0.64	0.49	0.70
 **DGN-32AW & N-32AW**	Poly-Iso	Unfaced	0.26	0.42	0.83	0.94	0.54	0.44	0.70
	Fiberglass	Unfaced	0.67	1.11	1.15	1.00	0.49	0.38	0.95
 **DGN-32AT & N-32AT**	Poly-Iso	Unfaced	0.21	0.33	0.71	0.89	0.78	0.74	0.70
	Fiberglass	Unfaced	0.59	0.96	1.04	1.02	1.00	0.87	1.00
 **DGNF-32A & NF-32A**	Poly-Iso	Unfaced	0.44	0.57	1.08	1.00	0.82	0.63	0.85
	Poly-Iso	Encapsu-lated	0.49	0.63	1.17	0.93	0.72	0.48	0.85
 **DG2WF-36A & 2WF-36A**	Poly-Iso	Unfaced	0.43	0.49	0.80	0.86	0.67	0.56	0.70
	Poly-Iso	Encapsu-lated	0.38	0.42	0.79	0.79	0.48	0.41	0.60
 **DG3WF-36A & 3WF-36A**	Poly-Iso	Unfaced	0.49	0.56	1.06	0.90	0.69	0.54	0.80
	Poly-Iso	Encapsu-lated	0.60	0.79	0.66	0.50	0.46	0.46	0.60

Sound Absorption Data

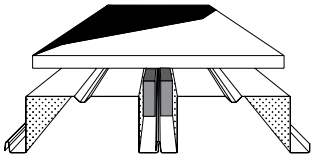
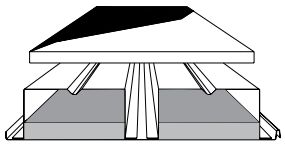
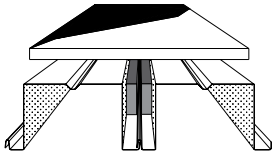
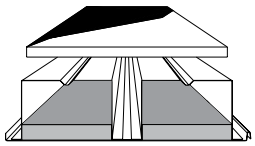
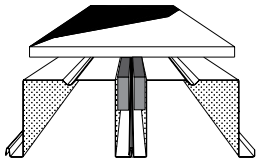
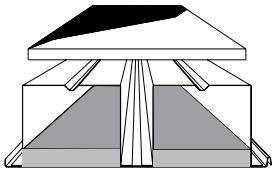
Acustadek® Profile (Perforation Type)	Cover Board[2,3,4]	Batt[5]	Absorption Coefficient[1] 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Noise Reduction Coefficient[1]
 4.5D-12AW	Foil Faced Poly-Iso	Unfaced	0.22	0.49	0.96	0.78	0.53	0.45	0.70
	Poly-Iso	Encapsu-lated	0.18	0.38	0.83	0.62	0.45	0.29	0.55
 4.5DF-24A	Poly-Iso	Unfaced	0.40	0.75	0.83	0.68	0.70	0.54	0.75
	Poly-Iso	Encapsu-lated	0.58	0.91	0.93	0.68	0.59	0.46	0.80
 6D-12AW	Foil Faced Poly-Iso	Unfaced	0.27	0.59	0.79	0.69	0.61	0.55	0.65
	Poly-Iso	Encapsu-lated	INQUIRE						
 6DF-24A	Poly-Iso	Unfaced	0.40	0.89	0.85	0.72	0.70	0.53	0.80
	Poly-Iso	Encapsu-lated	0.53	0.88	0.82	0.70	0.63	0.52	0.75
 7.5D-12AW	Poly-Iso	Unfaced	0.35	0.68	0.72	0.81	0.68	0.58	0.70
	Poly-Iso	Encapsu-lated	INQUIRE						
 7.5DF-24A	Poly-Iso	Unfaced	0.78	0.99	0.86	0.79	0.72	0.52	0.85
	Poly-Iso	Encapsu-lated	0.84	0.93	0.79	0.75	0.65	0.93	0.80

Table Notes:

1. Noise reduction coefficient testing was conducted in accordance with ASTM C423 and ASTM E795.
2. Test conducted with 2" thick 3 pcf fiberglass cover board.
3. Test conducted with 2" thick felt faced Poly-Iso (polyisocyanurate) cover board.
4. Test conducted with 2" thick foil faced Poly-Iso (polyisocyanurate) cover board.
5. Unfaced or encapsulated fiberglass batts wrapped with clear plastic film.

Metric Conversion Chart

Metric Conversions

	Multiply	By	To Obtain
Spans, length & thickness	Inches	25.4	Millimeters
	Feet	304.8	Millimeters
	Inches	0.0254	Metres
	Feet	0.3048	Metres
Vertical Load & Superimposed Load	psf	0.0479	kPa
	psi	6.8948	kPa
Area	Square feet	0.0929	Square Metre
	Square	9.2903	Square Metre
Diaphragm Shear	plf	0.0146	KN/m
Section Properties	in^3/ft	53,763	mm^3/m
	in^4/ft	1,365,588	mm^4/m
	in^3/ft	53.763	cm^3/m
	in^4/ft	136.559	cm^4/m
Weight	Pounds	0.00445	kN
	psf	4.8824	kg/m^2
Volume	pcf	16.018	kg/m^3

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