



EVALUATION SUBJECT: STEEL DECK PANELS

REPORT HOLDER NUCOR CORPORATION - VULCRAFT/VERCO GROUP

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CSI DIVISION: 05 00 00 – METALS
CSI SECTION: 05 31 00 – STEEL DECK
05 31 13 – STEEL FLOOR DECKING
05 31 23 – STEEL ROOF DECKING

1.0 SCOPE OF EVALUATION

1.1 Compliance to the following codes & regulations:

- 2015 International Building Code® (IBC)
- 2012 International Building Code® (IBC)
- 2009 International Building Code® (IBC)

1.2 Evaluated in accordance with:

- IAPMO EC 007-2015

1.3 Properties assessed:

- Structural

2.0 PRODUCT USE:

Steel deck panels are typically used as a component of horizontal or sloped floor and roof systems supporting vertical loads, in-plane diaphragm shears, and in-plane axial loads. The panels comply with requirements in IBC Sections 2210.1 and 2210.1.1.

3.0 PRODUCT DESCRIPTION

3.1 Product information

2.0D, 2.0DA, 3.5D and 3.5DA steel deck panels are cold-formed from steel conforming to ASTM A653 or A1063 SS Grade 40 minimum. The panels are made from No. 22, 20, 19, 18, 16, or 14 gage steel. 2.0D, 2.0DA, 3.5D and 3.5DA steel deck panel profiles are as indicated in Figure 1 of this report. Perforation patterns in the bottom flanges of 2.0DA and 3.5DA deck panels are as indicated in Figure 2. Panel descriptions are as follows:

1. 2.0D: 2-inch-deep (51 mm) non-acoustic deck panel.
2. 2.0DA: 2-inch-deep (51 mm) acoustic deck panel with perforations in the bottom flanges.
3. 3.5D: 3.5-inch-deep (89 mm) non-acoustic deck panel.
4. 3.5DA: 3.5-inch-deep (89 mm) acoustic deck panel with perforations in the bottom flanges.

The suffix FORMLOK is added to the 2.0D and 3.5D steel deck panels when used for composite steel deck slabs. 2.0D FORMLOK and 3.5D FORMLOK are identical to 2.0D and 3.5D, respectively.

3.2 Deck Panel Connections

3.2.1 Welds: Welds may be used to attach steel deck panels to supporting members and to attach the sidelaps of steel deck panels to each other in accordance with AISI S100 and AISI S310. The minimum tensile strength of the weld filler shall be designated as a minimum of 60 ksi (413.7 MPa) and comply with the appropriate AWS standard.

3.2.2 Power Actuated Fasteners (PAF's): Power actuated fasteners may be used to attach steel deck panels to supporting members in accordance with the Steel Deck Diaphragm Design Manual 3 (SDI DDM03). The fasteners shall be designed to attach steel deck panels to supporting members and shall be described in a current evaluation report issued by an approved and accredited evaluation service.

3.2.3 Self-Drilling Screws: Self-drilling screws may be used to attach steel deck panels to supporting members and to attach the sidelaps of steel deck panels to each other in accordance with AISI S100 and AISI S310. The screws shall be manufactured in accordance with SAE J78 and shall be compliant with ASTM C1513.

4.0 DESIGN, INSTALLATION AND INSPECTIONS

4.1 Design

4.1.1 Out-of-Plane Loads: Steel deck panels may be used to resist out-of-plane loads by either Allowable Strength Design (ASD) or Load and Resistance Factor Design (LRFD). Out-of-plane load capacity of deck panels shall be determined using engineering mechanics and deck panel section properties presented in the tables of this report. Deck panel section properties are determined in accordance with AISI S100 Chapter B and engineering mechanics. The imposed loads on the steel deck panels shall not exceed the ASD or LRFD strengths determined in accordance with this report.

The product described in this Uniform Evaluation Service (UES) Report has been evaluated as an alternative material, design or method of construction in order to satisfy and comply with the intent of the provision of the code, as noted in this report, and for at least equivalence to that prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety, as applicable, in accordance with IBC Section 104.11. This document shall only be reproduced in its entirety.





Deflections resulting from out-of-plane load shall comply with Section 1604.3 of the IBC.

4.1.2 Reactions: Reaction capacity of deck panels is governed by either web crippling capacity or web shear capacity presented in this report. Web crippling capacity is determined in accordance with AISI S100 Section C3.4. Deck panel shear strength of deck panel webs are determined in accordance with AISI S100 Section C3.2.

4.1.3 In-Plane (Diaphragm) Shear Strength and Stiffness: Steel deck panels may be used to resist ASD or LRFD in-plane shear loads and provide stiffness. The in-plane shear capacity of steel deck panels is influenced by panel geometry, support fastener shear strength and stiffness, and applicable out-of-plane loads, and shall be determined in accordance with AISI S310.

4.1.4 Axial Loads: Steel deck panels may be used to resist ASD or LRFD tensile and compressive axial loads in the longitudinal direction. The axial capacity of steel deck panels is influenced by panel geometry, support fastener shear strength, and applicable out-of-plane loads and shall be determined in accordance with AISI S100.

4.1.5 Openings, Holes or Penetrations through Steel Deck: The registered design professional may submit design calculations and opening details to the building official for approval based on the principles of engineering mechanics for openings, holes or penetrations.

4.1.6 Supporting Member Materials: Supporting members shall comply with the requirements of AISI S310.

4.1.7 Composite steel deck slabs: Composite steel deck-slabs may be used to resist out-of-plane loads by either Allowable Strength Design (ASD) or Load and Resistance Factor Design (LRFD). Out-of-plane load capacity of composite steel deck-slabs shall be determined in accordance with AISI/SDI C-2017 using the coefficients and factors listed in Table C of this report.

4.2 Installation: Steel deck panel erection sequence and installation method is the responsibility of the contractor(s) performing installation of the steel deck panels. Installation shall be in accordance with this report, ANSI/SDI-RD1.0 and ANSI/SDI-NC1.0, and all welds shall comply with AWS D1.3. Where conflicts occur, the more restrictive shall govern. Additional installation information is available in the Steel Deck Institute (SDI MOC) Manual of Construction with Steel Deck and manufacturer's recommendations. Mechanical fasteners shall be installed in accordance with the manufacturer's current evaluation report issued by an approved and accredited evaluation service.

4.3 Inspections: Special inspection is required in accordance with 2015 and 2012 IBC Section 1705.2.2 or 2009 IBC Section 1704.3.

4.3.1 Jobsite Welding: Periodic special inspection for welding shall be in accordance with 2015 IBC Section 1705.2.2, 2012 IBC Section 1705.2, or 2009 IBC Section 1704.3. Prior to proceeding, the welder shall demonstrate the ability to produce the prescribed weld to the special inspector's satisfaction. The inspector's duties include verification of materials, weld preparation, welding procedures, and welding processes.

4.3.2 Periodic Special Inspection: Periodic special inspections for screw and power-actuated fastener connections are required where the steel deck systems are used in a seismic-force-resisting system in structures assigned to Seismic Design Category C, D, E or F in accordance with 2015 IBC Section 1705.12, 2012 IBC Section 1705.11, or 2009 IBC Section 1707; or a wind-force resisting system in areas described in 2015 IBC Section 1705.11, 2012 IBC Section 1705.10, or 2009 IBC Section 1706.1.

5.0 CONDITIONS OF USE

The steel deck panels described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.1 of this report, subject to the following conditions:

5.1 The decks are manufactured, identified and installed in accordance with this report, the approved plans and Vulcraft's or Verco's published installation instructions. If there is a conflict between this report and the published installation instructions, the more restrictive governs.

5.2 Calculations and details demonstrating that the loads applied to the decks comply with this report shall be submitted to the code official for approval. Calculations and drawings must be prepared, signed, and sealed by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3 Special Inspections are required in accordance with Section 4.3 of this report.

5.4 Diaphragm Design: When steel deck panels are used as the stressed skin shear carrying element of a horizontal or sloped diaphragm as defined in Sections 202 and 1602 of the IBC, the diaphragm length and width shall be limited by one of the following: engineering mechanics; applied loads; shear capacity of the diaphragm; diaphragm shear deflection limited by the requirements of ASCE 7 in Sections 12.8.6 entitled, "Story Drift Determination"; or Section 12.12 entitled, "Drift and Deformation".

Shear deflection shall be based on the shear stiffness for the steel deck diaphragm and equations of mechanics. Common shear web deflection equations shown in Figure 5 may be used.

The use of steel deck diaphragms for vertical diaphragms (shear walls) is beyond the scope of this report.



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5.5 Fatigue Loads: Steel deck shall not be used in conditions subject to loads that are predominately cyclic in nature unless a licensed design professional submits substantiating calculations to the Building Official in accordance with AISI S100 Chapter G.

5.6 Fire-Resistance Ratings: Use within fire-resistive assemblies is beyond the scope of this report.

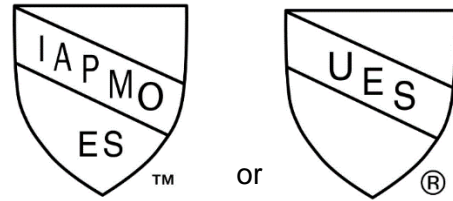
5.7 Sound Transmission Performance: Acoustic performance is beyond the scope of this report.

6.0 EVIDENCE SUBMITTED

Data in accordance with the IAPMO Uniform Evaluation Service Evaluation Criteria EC007-2015, Evaluation Criteria for Steel Composite, Non-composite, and Roof Deck Construction.

7.0 IDENTIFICATION

Each bundle of deck panels are identified with a visible label. The label includes the manufacturer’s name (Vulcraft or Verco Decking, Inc.), production location (Alabama) and address, evaluation report number, deck type, steel specification, base metal thickness and gage, one of the IAPMO ES Marks of Conformity noted below, and evaluation report number (ER-0423).



IAPMO ER #0423

8.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research carried out by IAPMO Uniform Evaluation Service on Vulcraft/Verco Group Steel Floor Decking and Steel Roof Decking.

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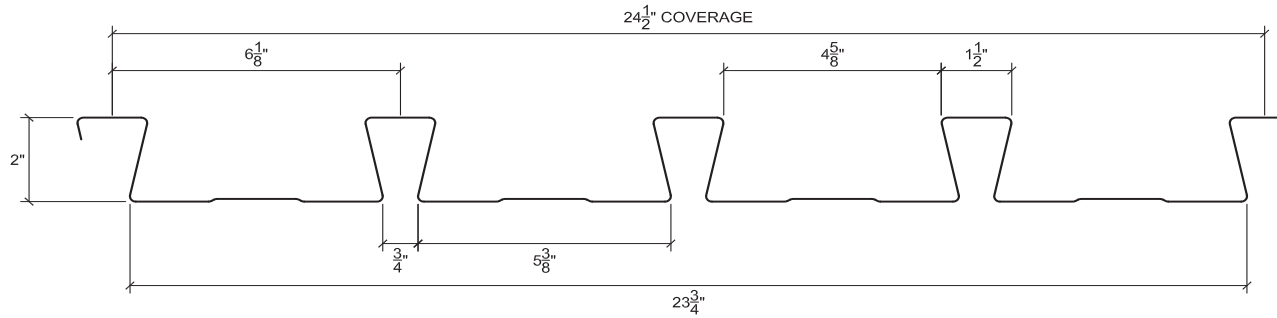


DEFINITION OF SYMBOLS

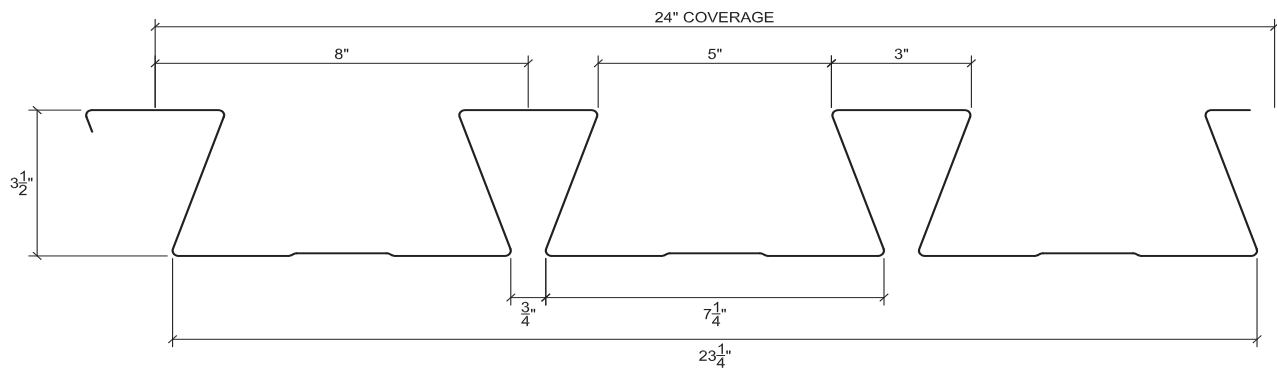
Variable	Description	Units
A_g	Gross area of section	in ² /ft
D	Warping Factor (Constant)	in.
E	Modulus of Elasticity of Steel, 29,500 ksi	ksi
F_u	Tensile strength of steel, 55 ksi	ksi
F_n	Nominal buckling stress	ksi
F_y	Yield stress of steel, 40 ksi	ksi
F_{xx}	Tensile strength of electrode classification, 60 ksi	ksi
h_w	Flat width of web	in.
I_x	Moment of inertia of full unreduced section	in ⁴ /ft
I_{e+}	Positive effective moment of inertia	in ⁴ /ft
I_{e-}	Negative effective moment of inertia	in ⁴ /ft
I_{d+}	Positive effective moment of inertia for deflection due to uniform loads, $I_{d+} = (2I_{e+} + I_x) / 3$	in ⁴ /ft
I_{d-}	Negative effective moment of inertia for deflection due to uniform loads, $I_{d-} = (2I_{e-} + I_x) / 3$	in ⁴ /ft
K	Composite deck coefficient	
M_{n+}	Positive nominal flexural strength of section	kip-ft/ft
M_{n-}	Negative nominal flexural strength of section	kip-ft/ft
P_n	Nominal axial strength of panel	kip/ft
P_{no}	Nominal axial strength of panel with $F_n = F_y$	kip/ft
P_{nf}	Nominal shear strength of a support connection	kip
P_{ns}	Nominal shear strength of a sidelap connection	kip
P_{nt}	Nominal tension strength of a support connection	kip
P_{nov}	Nominal tensile strength of support connection controlled by pull-over	kip
r	Radius of gyration of full unreduced section	in.
r_w	Bend radius of web/flange transition, 1/8 in.	in.
R/Ω	ASD available reaction capacity at support based on web crippling	lb/ft
ϕR	LRFD available reaction capacity at support based on web crippling	lb/ft
S_{e+}	Positive elastic section modulus of effective section	in ³ /ft
S_{e-}	Negative elastic section modulus of effective section	in ³ /ft
S_f	Structural support connection flexibility	in./kip
S_s	Sidelap fastener stiffness	in./kip
t	Base steel thickness of panel	in.
T_n	Nominal tensile axial strength of panel	kip/ft
V/Ω	ASD available reaction capacity at support based on web shear	lb/ft
ϕV	LRFD available reaction capacity at support based on web shear	lb/ft
w_{dd}	Weight of steel panel	psf
y_b	Distance from extreme bottom fiber to neutral axis of gross section	in.
y_t	Distance from extreme top fiber to neutral axis of gross section	in.
θ	Web angle relative to the deck support	degrees
Ω	Safety Factor	
ϕ	Resistance Factor	



FIGURE 1: DECK PROFILES

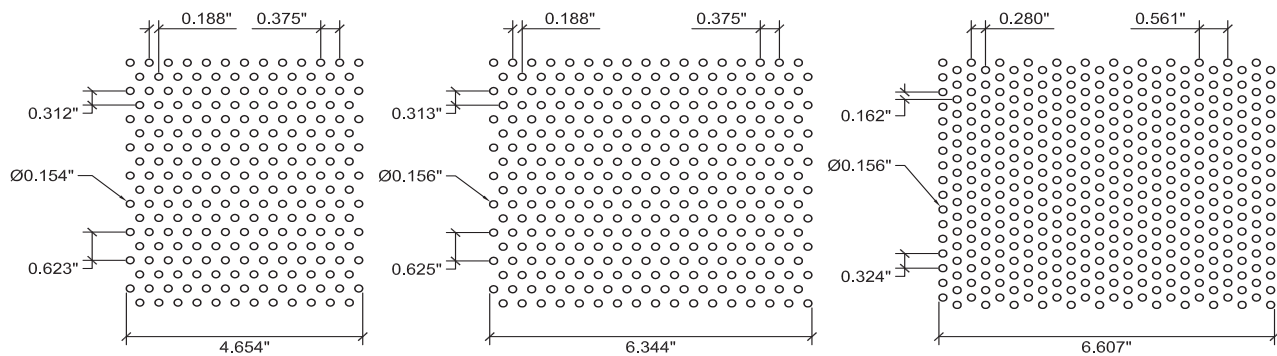


2.0D and 2.0DA



3.5D and 3.5DA

FIGURE 2: ACOUSTIC DECK PERFORATION PATTERNS



Applicable Profiles

- 2.0DA22
- 2.0DA20
- 2.0DA19
- 2.0DA18
- 2.0DA16

Applicable Profiles

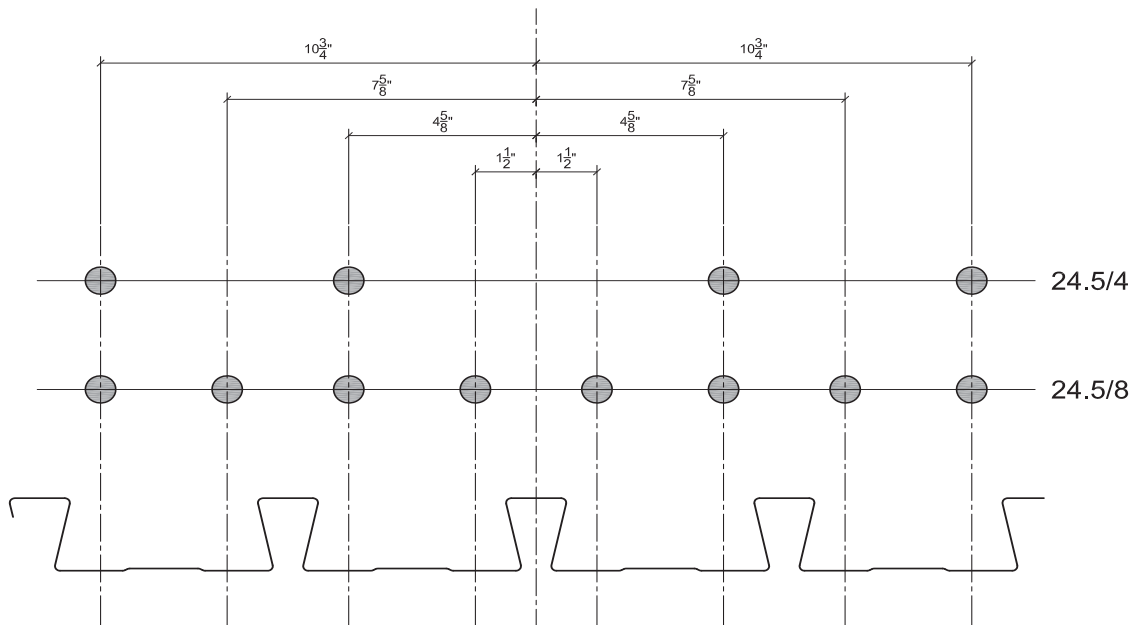
- 3.5DA20
- 3.5DA19
- 3.5DA18
- 3.5DA16

Applicable Profile

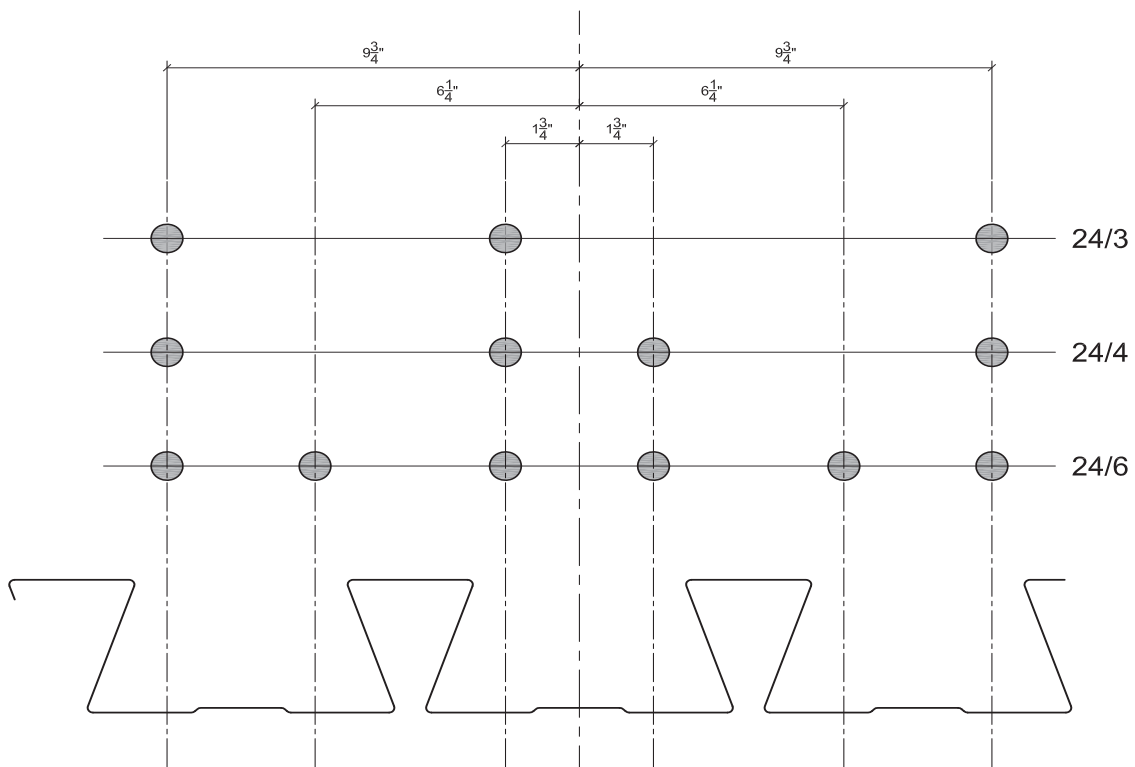
- 3.5DA14



FIGURE 3: ATTACHMENT PATTERNS @ SUPPORTS AND APPROXIMATE FASTENER LOCATIONS



2.0D and 2.0DA



3.5D and 3.5DA



TABLE A: ASD SAFETY FACTORS AND LRFD RESISTANCE FACTORS ^a FOR GRAVITY AND UPLIFT						
Factor	Web Crippling				Web Shear	Bending Strength
	One Flange Loading		Two Flange Loading			
	End	Int.	End	Int.		
ASD, Ω	1.70	1.75	1.80	1.75	1.60	1.67
LRFD, ϕ	0.90	0.85	0.85	0.85	0.95	0.90

a. Values taken from AISI S100-2012

TABLE B: ASD SAFETY FACTORS AND LRFD RESISTANCE FACTORS ^d FOR DIAPHRAGM CAPACITY					
Load Type or Combinations Including	Connection Type	Limit State			
		Connection Related		Panel Buckling ^a	
		ASD, Ω	LRFD, ϕ	ASD, Ω	LRFD, ϕ
Earthquake	Welds	3.00	0.55	2.00	0.80
	Screws ^{b,c}	2.50	0.65		
Wind	Welds	2.35	0.70		
	Screws ^{b,c}				
Others	Welds	2.65	0.60		
	Screws ^{b,c}	2.50	0.65		

a. Panel buckling is considered out-of-plane buckling and not local buckling at fasteners.

b. For mechanical fasteners other than screws, Ω shall not be less than the values for screws.

c. For mechanical fasteners other than screws, ϕ shall not be greater than the values for screws.

d. Reference AISI S310-2013

TABLE C: COMPOSITE DECK COEFFICIENT, K, ASD SAFETY FACTOR AND LRFD RESISTANCE FACTOR FOR COMPOSITE STEEL DECK-SLABS ^{a,b}			
Deck Type	K	ASD, Ω	LRFD, ϕ
2.0D FORMLOK	0.76	1.75	0.85
3.5D FORMLOK	1.12		

a. $f'_c = 3000$ psi (Minimum)

b. Reference ANSI/SDI C-2017

FIGURE 5: DIAPHRAGM SHEAR WEB DEFLECTION EQUATIONS

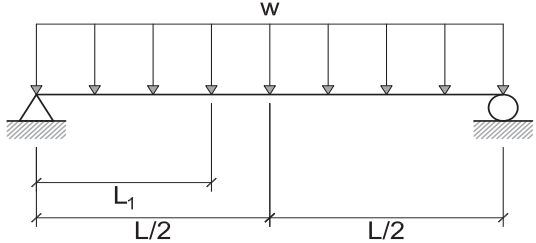
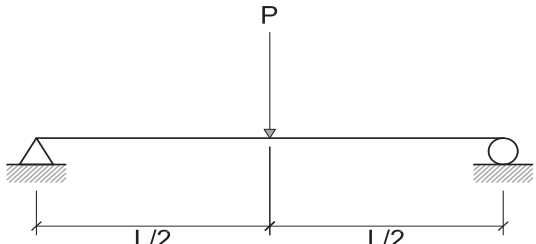
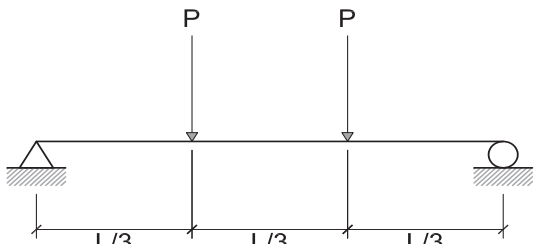
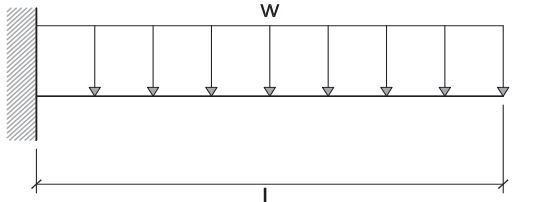
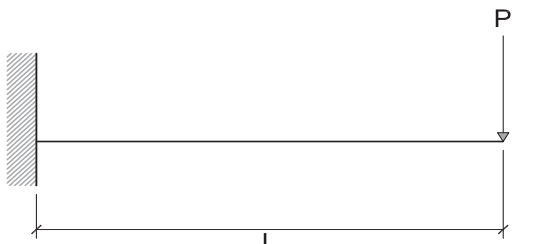
Type of Load	Loading Condition	Shear Deflection	
Simple Beam at Center	Uniform Load, w	$\Delta_w = \frac{w \cdot L^2}{8 \cdot b \cdot G'}$	
Simple Beam at L ₁	Uniform Load, w	$\Delta_w = \frac{q_{ave} \cdot L_1}{G'}$	
Simple Beam at Center	Point Load, P	$\Delta_w = \frac{P \cdot L}{4 \cdot b \cdot G'}$	
Simple Beam at 1/3 Points	Point Load, P	$\Delta_w = \frac{w \cdot L^2}{8 \cdot b \cdot G'}$	
Cantilever Beam at End	Uniform Load, w	$\Delta_w = \frac{w \cdot L^2}{2 \cdot b \cdot G'}$	
Cantilever Beam at End	Point Load, P	$\Delta_w = \frac{P \cdot L}{b \cdot G'}$	
Relationship Between Flexibility Factor and Stiffness Factor		$f = \frac{1000}{G'}$	
Where:			
b = Depth of Diaphragm (ft)			
f = Flexibility Factor (micro-in/lb)			
G' = Stiffness Factor (kips/in)			
L = Diaphragm Length (ft)			
L ₁ = Distance to Point where Deflection is Calculated (ft)			
P = Concentrated Load (kips)			
q _{ave} = Average Shear in Diaphragm (kips/ft over Length, L ₁)			
w = Uniform Load (kips/ft)			
Δ _w = Web Deflection (in.)			



TABLE 1: DECK SECTION PROPERTIES¹

Deck Type	Basic Properties		Gross Section Properties					Geometry for Web Crippling		Effective Section Properties @ $F_y = 40$ ksi		Effective Moment of Inertia for Deflection @ Service Load			
	t in.	w_{dd} psf	A_g in ² /ft	I_x in ⁴ /ft	y_b in.	y_t in.	r in.	h_w in.	θ deg.	S_{e+} in ³ /ft	S_{e-} in ³ /ft	I_{e+} in ⁴ /ft	I_{e-} in ⁴ /ft	Uniform Load Only	
														I_{d+} in ⁴ /ft	I_{d-} in ⁴ /ft
2.0D22	0.0295	2.13	0.626	0.388	0.693	1.337	0.787	1.698	100.4	0.272	0.272	0.386	0.345	0.387	0.359
2.0D20	0.0358	2.59	0.761	0.472	0.697	1.339	0.788	1.691	100.6	0.343	0.334	0.472	0.435	0.472	0.447
2.0D19	0.0418	3.03	0.889	0.551	0.700	1.342	0.787	1.683	100.8	0.406	0.394	0.551	0.523	0.551	0.532
2.0D18	0.0474	3.43	1.009	0.626	0.704	1.343	0.788	1.677	101.1	0.463	0.450	0.626	0.605	0.626	0.612
2.0D16	0.0598	4.34	1.276	0.792	0.711	1.349	0.788	1.662	101.6	0.587	0.576	0.792	0.791	0.792	0.791
2.0DA22	0.0295	1.98	0.583	0.341	0.808	1.222	0.765	1.698	100.4	0.261	0.258	0.339	0.294	0.340	0.310
2.0DA20	0.0358	2.41	0.708	0.415	0.811	1.225	0.766	1.691	100.6	0.330	0.317	0.415	0.370	0.415	0.385
2.0DA19	0.0418	2.82	0.828	0.485	0.815	1.227	0.765	1.683	100.8	0.391	0.374	0.485	0.445	0.485	0.458
2.0DA18	0.0474	3.20	0.940	0.551	0.818	1.229	0.766	1.677	101.1	0.445	0.427	0.551	0.516	0.551	0.528
2.0DA16	0.0598	4.04	1.188	0.697	0.825	1.235	0.766	1.662	101.6	0.564	0.546	0.697	0.677	0.697	0.684
3.5D20	0.0358	3.25	0.955	1.891	1.389	2.147	1.407	3.293	108.4	0.676	0.781	1.697	1.524	1.762	1.646
3.5D19	0.0418	3.80	1.116	2.210	1.392	2.150	1.407	3.286	108.6	0.837	0.934	2.039	1.845	2.096	1.967
3.5D18	0.0474	4.31	1.266	2.508	1.395	2.152	1.407	3.280	108.7	0.980	1.070	2.368	2.154	2.415	2.272
3.5D16	0.0598	5.44	1.600	3.170	1.402	2.158	1.408	3.267	109.0	1.317	1.377	3.115	2.867	3.133	2.968
3.5D14	0.0747	6.81	2.002	3.968	1.411	2.164	1.408	3.251	109.3	1.742	1.751	3.948	3.763	3.955	3.831
3.5DA20	0.0358	3.06	0.899	1.639	1.584	1.952	1.350	3.293	108.4	0.655	0.657	1.477	1.325	1.531	1.430
3.5DA19	0.0418	3.57	1.050	1.915	1.588	1.954	1.350	3.286	108.6	0.797	0.794	1.775	1.587	1.822	1.696
3.5DA18	0.0474	4.06	1.192	2.174	1.591	1.956	1.350	3.280	108.7	0.934	0.928	2.060	1.838	2.098	1.950
3.5DA16	0.0598	5.13	1.506	2.748	1.598	1.962	1.351	3.267	109.0	1.255	1.241	2.704	2.425	2.719	2.533
3.5DA14	0.0747	6.27	1.843	3.236	1.681	1.894	1.325	3.251	109.3	1.624	1.500	3.223	2.956	3.227	3.049

1. Decks made from ASTM A653 or A1063 SS GR40 (min.) steel with minimum $F_y = 40$ ksi and $F_u = 55$ ksi.



TABLE 2: DECK STRENGTH¹ AND STIFFNESS

Deck Type	M _{n+} k-ft/ft	M _{n-} k-ft/ft	T _n kip/ft	P _{no} kip/ft	P _n [For laterally unbraced (span) Length in Feet], kip/ft													D in.
					4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'	16'	
2.0D22	0.907	0.907	25.04	16.75	14.46	13.29	11.93	10.49	9.03	7.55	6.30	5.35	4.61	4.01	3.52	3.06	2.69	1343
2.0D20	1.143	1.113	30.44	22.40	19.12	17.49	15.66	13.67	11.52	9.49	7.92	6.72	5.77	4.96	4.28	3.73	3.28	1005
2.0D19	1.353	1.313	35.56	27.88	23.74	21.58	19.03	16.40	13.81	11.37	9.48	8.03	6.80	5.79	5.00	4.35	3.82	796
2.0D18	1.543	1.500	40.36	33.24	27.76	25.05	22.09	19.04	16.04	13.20	10.99	9.19	7.72	6.58	5.68	4.94	4.35	660
2.0D16	1.957	1.920	51.04	44.01	36.66	33.07	29.16	25.12	21.13	17.34	14.07	11.63	9.77	8.33	7.18	6.26	5.50	465
2.0DA22	0.870	0.860	23.32	12.63	10.89	9.97	8.91	7.80	6.67	5.52	4.61	3.91	3.38	2.95	2.60	2.31	2.08	1639
2.0DA20	1.100	1.057	28.32	17.45	14.81	13.50	12.04	10.40	8.67	7.10	5.94	5.05	4.36	3.81	3.36	2.96	2.60	1226
2.0DA19	1.303	1.247	33.12	22.26	18.84	17.01	14.87	12.70	10.60	8.70	7.28	6.20	5.35	4.61	3.97	3.46	3.04	972
2.0DA18	1.483	1.423	37.60	27.03	22.32	20.01	17.51	14.98	12.51	10.27	8.60	7.32	6.15	5.24	4.52	3.93	3.46	805
2.0DA16	1.880	1.820	47.52	36.59	30.18	27.09	23.75	20.34	17.01	13.83	11.20	9.26	7.78	6.63	5.71	4.98	4.37	568
Deck Type	M _{n+} k-ft/ft	M _{n-} k-ft/ft	T _n kip/ft	P _{no} kip/ft	P _n [For laterally unbraced (span) Length in Feet], kip/ft													D in.
					10'	11'	12'	13'	14'	15'	16'	17'	18'	19'	20'	21'	22'	
3.5D20	2.253	2.603	38.20	20.16	15.37	14.52	13.63	12.72	11.81	10.89	9.98	9.19	8.49	7.88	7.33	6.81	6.34	6189
3.5D19	2.790	3.113	44.64	25.90	19.70	18.58	17.43	16.25	15.05	13.86	12.67	11.63	10.69	9.84	9.09	8.43	7.77	4905
3.5D18	3.267	3.567	50.64	31.71	24.03	22.65	21.22	19.76	18.27	16.78	15.24	13.89	12.72	11.65	10.64	9.75	8.98	4062
3.5D16	4.390	4.590	64.00	45.99	34.51	32.44	30.17	27.86	25.54	23.16	20.66	18.56	16.77	15.23	13.90	12.73	11.63	2867
3.5D14	5.807	5.837	80.08	65.20	47.53	44.10	40.52	36.95	33.45	30.04	26.78	24.04	21.70	19.52	17.62	15.98	14.56	2041
3.5DA20	2.183	2.190	35.96	15.39	11.68	11.02	10.33	9.62	8.91	8.18	7.53	6.95	6.45	6.00	5.57	5.18	4.84	7559
3.5DA19	2.657	2.647	42.00	20.35	15.37	14.48	13.55	12.60	11.64	10.66	9.78	8.98	8.25	7.61	7.05	6.49	5.98	5992
3.5DA18	3.113	3.093	47.68	25.51	19.17	18.02	16.84	15.63	14.40	13.11	11.92	10.88	9.97	9.06	8.28	7.60	7.01	4962
3.5DA16	4.183	4.137	60.24	38.39	28.45	26.61	24.62	22.62	20.62	18.37	16.40	14.74	13.34	12.14	11.10	10.18	9.27	3502
3.5DA14	5.413	5.000	73.72	54.43	38.37	35.18	31.99	28.86	25.83	22.70	19.95	17.67	15.76	14.15	12.77	11.58	10.55	2791

1. Safety and resistance factors are given by Tables A or B as applicable. The available strength is computed by dividing the nominal value by Ω or multiplying the nominal value by ϕ as applicable.



TABLE 3: REACTION CAPACITIES BASED ON WEB CRIPPLING AND WEB SHEAR STRENGTH^{2,3,4}

Deck Type	Bearing Length in.	ASD ¹					LRFD ¹				
		Web Crippling, R/Ω (lb/ft)				Web Shear Strength V/Ω (lb/ft)	Web Crippling, φR (lb/ft)				Web Shear Strength φV (lb/ft)
		One Flange Loading		Two Flange Loading			One Flange Loading		Two Flange Loading		
		End	Int.	End	Int.		End	Int.	End	Int.	
2.0D22 & 2.0DA22	1.00	576	940	639	1118	2896	882	1398	977	1663	4401
	2.00	718	1133	757	1373		1098	1686	1159	2042	
	3.00	827	1282	849	1568		1265	1907	1298	2333	
	4.00	918	1407	925	1733		1405	2093	1416	2578	
	5.00	999	1517	993	1878		1528	2257	1519	2794	
	6.00	1006	1527	999	1891		1539	2272	1529	2813	
2.0D20 & 2.0DA20	1.00	826	1355	966	1631	3496	1264	2016	1478	2427	5314
	2.00	1021	1621	1136	1987		1563	2411	1739	2955	
	3.00	1171	1825	1267	2260		1791	2714	1939	3361	
	4.00	1297	1996	1377	2489		1984	2970	2107	3703	
	5.00	1408	2148	1474	2692		2154	3195	2256	4004	
	6.00	1415	2158	1481	2706		2165	3210	2266	4025	
2.0D19 & 2.0DA19	1.00	1102	1815	1340	2203	4062	1686	2701	2050	3277	6175
	2.00	1353	2157	1566	2665		2070	3208	2395	3965	
	3.00	1546	2419	1739	3020		2365	3598	2660	4493	
	4.00	1708	2640	1885	3319		2613	3927	2883	4937	
	5.00	1851	2834	2013	3583		2832	4216	3080	5329	
	6.00	1858	2843	2019	3595		2842	4230	3089	5348	
2.0D18 & 2.0DA18	1.00	1390	2300	1742	2807	4584	2127	3422	2665	4176	6967
	2.00	1698	2718	2024	3378		2598	4043	3097	5025	
	3.00	1934	3039	2241	3816		2960	4520	3429	5677	
	4.00	2134	3309	2424	4186		3264	4922	3708	6226	
	5.00	2309	3547	2585	4511		3533	5276	3954	6710	
	6.00	2314	3554	2589	4520		3540	5286	3961	6724	
2.0D16 & 2.0DA16	1.00	2137	3563	2816	4387	5722	3270	5300	4308	6526	8697
	2.00	2585	4168	3240	5227		3954	6200	4957	7775	
	3.00	2928	4632	3566	5871		4480	6891	5456	8733	
	4.00	3217	5024	3841	6414		4923	7473	5876	9541	
	5.00	3469	5364	4079	6886		5307	7979	6241	10243	
	6.00	3469	5364	4079	6886		5307	7979	6241	10243	

See Page 13 for footnotes.



TABLE 3 CONTINUED: REACTION CAPACITIES BASED ON WEB CRIPPLING AND WEB SHEAR STRENGTH^{2,3,4}

Deck Type	Bearing Length in.	ASD ¹					LRFD ¹				
		Web Crippling, R/Ω (lb/ft)				Web Shear Strength V/Ω (lb/ft)	Web Crippling, φR (lb/ft)				Web Shear Strength φV (lb/ft)
		One Flange Loading		Two Flange Loading			One Flange Loading		Two Flange Loading		
		End	Int.	End	Int.		End	Int.	End	Int.	
3.5D20 & 3.5DA20	2.00	693	1185	714	1376	3434	1060	1762	1092	2047	5220
	3.00	794	1333	796	1565		1215	1984	1218	2328	
	4.00	880	1459	865	1724		1346	2170	1324	2564	
	5.00	955	1570	926	1864		1461	2335	1417	2773	
	6.00	1023	1670	981	1991		1566	2484	1501	2962	
	8.00	1117	1807	1057	2165		1708	2688	1617	3220	
3.5D19 & 3.5DA19	2.00	925	1577	1000	1855	4676	1415	2346	1530	2760	7108
	3.00	1056	1768	1111	2102		1616	2630	1699	3127	
	4.00	1167	1930	1204	2310		1786	2871	1842	3437	
	5.00	1265	2072	1286	2494		1935	3082	1968	3710	
	6.00	1353	2201	1360	2660		2071	3273	2081	3956	
	8.00	1510	2429	1492	2954		2311	3613	2283	4394	
3.5D18 & 3.5DA18	2.00	1168	1989	1310	2362	6010	1787	2959	2004	3514	9135
	3.00	1330	2224	1450	2669		2035	3308	2218	3969	
	4.00	1467	2422	1568	2927		2244	3602	2399	4354	
	5.00	1588	2596	1672	3154		2429	3861	2559	4692	
	6.00	1697	2753	1766	3360		2596	4096	2703	4998	
	8.00	1890	3033	1934	3725		2892	4512	2958	5541	
3.5D16 & 3.5DA16	2.00	1793	3054	2137	3679	8313	2744	4542	3270	5473	12636
	3.00	2032	3394	2352	4133		3108	5048	3599	6148	
	4.00	2233	3681	2533	4515		3416	5475	3876	6717	
	5.00	2410	3933	2693	4852		3687	5851	4120	7218	
	6.00	2569	4162	2837	5157		3931	6191	4341	7671	
	8.00	2854	4567	3093	5697		4366	6794	4733	8475	
3.5D14 & 3.5DA14	2.00	2721	4637	3417	5653	10353	4163	6898	5228	8409	15737
	3.00	3065	5125	3739	6314		4690	7623	5720	9393	
	4.00	3356	5535	4011	6872		5135	8234	6136	10222	
	5.00	3612	5897	4250	7363		5526	8772	6502	10952	
	6.00	3843	6225	4466	7806		5880	9259	6833	11612	
	8.00	4254	6805	4850	8595		6509	10123	7421	12784	

1. Reaction capacity is minimum of web crippling and web shear strength values in table.
2. The reaction capacities are reactions (or concentrated loads) applied to bare deck.
3. Conditions outside the scope of this table may be evaluated in accordance with AISI S100 Sections C3.2.1 and C3.4.1.
4. The bend radius of web/flange transition, $r_w = 1/8$ in.



TABLE 4: ARC SPOT WELD SHEAR STRENGTH, TENSION STRENGTH AND FLEXIBILITY FOR DECK SUPPORT CONNECTION

Deck Type	3/4" Visible Diameter Arc Spot Weld			Deck Type	7/8" Visible Diameter Arc Spot Weld		
	P _{nf} kips	S _f in/kip	P _{nt} kips		P _{nf} kips	S _f in/kip	P _{nt} kips
2.0D22	2.062	0.0067	1.768	2.0DA22	1.201	0.0338	0.364
2.0D20	2.949	0.0061	2.127	2.0DA20	1.872	0.0349	0.667
2.0D19	3.582	0.0056	2.463	2.0DA19	2.511	0.0334	0.956
2.0D18	4.030	0.0053	2.770	2.0DA18	3.108	0.0310	1.225
2.0D16	4.994	0.0047	3.433	2.0DA16	4.429	0.0261	1.822
3.5D20	2.949	0.0061	2.127	3.5DA20	1.872	0.0349	0.667
3.5D19	3.582	0.0056	2.463	3.5DA19	2.511	0.0334	0.956
3.5D18	4.030	0.0053	2.770	3.5DA18	3.108	0.0310	1.225
3.5D16	4.994	0.0047	3.433	3.5DA16	4.429	0.0261	1.822
3.5D14	6.014	0.0042	4.196	3.5DA14	6.016	0.0326	2.539



TABLE 5: HILTI PAF, PNEUTEK PAF AND #12 SCREW FASTENER PROPERTIES

Specified Properties	Hilti		Pneutek				#12 Screws ⁵
	X-HSN 24	X-ENP-19	SDK61	SDK63	K64	K66	
Minimum Substrate Thickness (in)	0.125	0.250	0.113	0.155	0.187	0.281	0.0385
Maximum Substrate Thickness (in)	0.375	∞	0.155	0.250	0.312	∞	0.500
Minimum Spacing (in) ¹	1.000	1.000	1.000	1.000	1.000	1.000	0.650
Minimum Edge Distance (in) ¹	0.500	0.500	0.500	0.500	0.500	0.500	0.325
Shank Diameter (in)	0.157	0.177	0.144	0.173	0.181	0.199	0.216 ⁶
Head or Washer Diameter (in)	0.474	0.591	0.500	0.500	0.500	0.500	0.415 ⁷
Tensile Strength of Material (ksi)	260	260	240	240	240	240	Varies ⁴
Tensile Strength based on Material strength (kip) ²	5.033	6.397	3.909	5.641	6.175	7.465	Varies ⁴
Shear Strength based on Material strength (kip) ³	3.020	3.838	2.345	3.385	3.705	4.479	Varies ⁴

Table 5 Notes:

- Minimum spacing and edge distance for Screws and Power Actuated Fasteners is determined in accordance with AISI S100 Section E4 and E5.1 respectively.
- Tension strength of fastener based on material strength is calculated in accordance with AISI S100 Section E5.2.1.
- Shear strength of fastener based on material strength is calculated in accordance with AISI S100 Section E5.3.1.
- Strength of screws shall be provided by manufacturer.
- Select appropriate screw based on actual substrate thickness. The following table is provided as a guide, proper selection should be verified based on the specific fasteners used.

Support Thickness	Fastener Designation
0.0346" to 3/16"	#3 Drill Point
1/8" to 1/4"	#4 Drill Point
1/8" to 1/2"	#5 Drill Point

- Tabulated values are based on this #12 Screw shank diameter.
- Tabulated values are based on this #12 Screw head or washer diameter.



TABLE 6: NOMINAL SHEAR STRENGTH OF HILTI PAF, PNEUTEK PAF AND #12 SCREW SUPPORT CONNECTION, P_{nf} (kip)

Deck Type	Hilti		Pneutek				#12 Screws ¹
	X-HSN 24	X-ENP-19	SDK61	SDK63	K64	K66	
2.0D22	1.489	1.603	1.527	1.711	1.699	1.814	0.946
2.0D20	1.795	1.933	1.828	1.973	2.209	2.251	1.148
2.0D19	2.083	2.243	2.107	2.203	2.629	2.683	1.341
2.0D18	2.348	2.529	2.345	2.403	2.985	3.101	1.520
2.0D16	2.924	3.149	2.345	2.812	3.686	4.076	1.918
2.0DA22	0.964	0.905	0.797	0.975	0.894	1.109	0.721
2.0DA20	1.186	1.099	1.023	1.211	1.151	1.330	0.966
2.0DA19	1.398	1.284	1.237	1.436	1.395	1.540	1.199
2.0DA18	1.595	1.457	1.438	1.646	1.624	1.736	1.416
2.0DA16	2.033	1.839	1.881	2.111	2.130	2.171	1.897
3.5D20	1.795	1.933	1.828	1.973	2.209	2.251	1.148
3.5D19	2.083	2.243	2.107	2.203	2.629	2.683	1.341
3.5D18	2.348	2.529	2.345	2.403	2.985	3.101	1.520
3.5D16	2.924	3.149	2.345	2.812	3.686	4.076	1.918
3.5D14	-	-	-	-	-	-	2.396
3.5DA20	1.186	1.099	1.023	1.211	1.151	1.330	0.966
3.5DA19	1.398	1.284	1.237	1.436	1.395	1.540	1.199
3.5DA18	1.595	1.457	1.438	1.646	1.624	1.736	1.416
3.5DA16	2.033	1.839	1.881	2.111	2.130	2.171	1.897
3.5DA14	-	-	-	-	-	-	2.396

1. The following minimum substrate thickness and tensile strength of steel, F_u are required to attain the tabulated strengths for a #12 Screw:

Gage	Minimum Substrate Thickness (in.)	
	$F_u = 45$ ksi	$F_u = 65$ ksi
22	0.0361	0.0250
20	0.0438	0.0303
19	0.0511	0.0354
18	0.0579	0.0401
16	0.0731	0.0506
14	0.0893	0.0635



TABLE 7: HILTI PAF, PNEUTEK PAF AND #12 SCREW SUPPORT CONNECTION FLEXIBILITY, S_f (in/kip)

Deck Type	Hilti		Pneutek				#12 Screws
	X-HSN 24	X-ENP-19	SDK61	SDK63	K64	K66	
2.0D22	0.0073	0.0044	0.0175	0.0175	0.0175	0.0175	0.0076
2.0D20	0.0066	0.0040	0.0159	0.0159	0.0159	0.0159	0.0069
2.0D19	0.0061	0.0037	0.0147	0.0147	0.0147	0.0147	0.0064
2.0D18	0.0057	0.0034	0.0138	0.0138	0.0138	0.0138	0.0060
2.0D16	0.0051	0.0031	0.0123	0.0123	0.0123	0.0123	0.0053
2.0DA22	0.0325	0.0418	0.0506	0.0308	0.0368	0.0399	0.1009
2.0DA20	0.0308	0.0368	0.0498	0.0302	0.0366	0.0380	0.0471
2.0DA19	0.0301	0.0333	0.0490	0.0298	0.0364	0.0362	0.0438
2.0DA18	0.0302	0.0313	0.0482	0.0293	0.0362	0.0345	0.0529
2.0DA16	0.0332	0.0307	0.0465	0.0283	0.0358	0.0307	0.0511
3.5D20	0.0066	0.0040	0.0159	0.0159	0.0159	0.0159	0.0069
3.5D19	0.0061	0.0037	0.0147	0.0147	0.0147	0.0147	0.0064
3.5D18	0.0057	0.0034	0.0138	0.0138	0.0138	0.0138	0.0060
3.5D16	0.0051	0.0031	0.0123	0.0123	0.0123	0.0123	0.0053
3.5D14	-	-	-	-	-	-	0.0048
3.5DA20	0.0308	0.0368	0.0498	0.0302	0.0366	0.0380	0.0471
3.5DA19	0.0301	0.0333	0.0490	0.0298	0.0364	0.0362	0.0438
3.5DA18	0.0302	0.0313	0.0482	0.0293	0.0362	0.0345	0.0529
3.5DA16	0.0332	0.0307	0.0465	0.0283	0.0358	0.0307	0.0511
3.5DA14	-	-	-	-	-	-	0.0925

- The following minimum substrate thickness and tensile strength of steel, F_u are required to attain the tabulated flexibility for a #12 Screw:

Gage	Minimum Substrate Thickness (in.)	
	$F_u = 45$ ksi	$F_u = 65$ ksi
22	0.0361	0.0250
20	0.0438	0.0303
19	0.0511	0.0354
18	0.0579	0.0401
16	0.0731	0.0506
14	0.0893	0.0635



TABLE 8: NOMINAL TENSILE STRENGTH OF HILTI PAF, PNEUTEK PAF AND #12 SCREW SUPPORT CONNECTION CONTROLLED BY PULL-OVER, P_{nov} (kip)

Deck Type	Hilti		Pneutek				#12 Screws
	X-HSN 24	X-ENP-19	SDK61	SDK63	K64	K66	
2.0D22	1.307	1.379	0.771	0.771	0.771	0.771	1.010
2.0D20	1.587	1.674	1.135	1.135	1.135	1.135	1.226
2.0D19	1.853	1.954	1.547	1.547	1.547	1.547	1.431
2.0D18	2.101	2.216	1.990	1.990	1.990	1.990	1.623
2.0D16	2.650	2.796	3.167	3.167	3.167	3.167	2.047
2.0DA22	1.307	0.814	0.771	0.771	0.771	0.771	1.010
2.0DA20	1.477	1.132	1.135	1.135	1.135	1.135	1.226
2.0DA19	1.606	1.436	1.547	1.547	1.547	1.547	1.431
2.0DA18	1.727	1.719	1.893	1.893	1.893	1.893	1.623
2.0DA16	1.995	2.346	2.393	2.393	2.393	2.393	2.047
3.5D20	1.587	1.674	1.135	1.135	1.135	1.135	1.226
3.5D19	1.853	1.954	1.547	1.547	1.547	1.547	1.431
3.5D18	2.101	2.216	1.990	1.990	1.990	1.990	1.623
3.5D16	2.650	2.796	3.167	3.167	3.167	3.167	2.047
3.5D14	-	-	-	-	-	-	2.558
3.5DA20	1.477	1.132	1.135	1.135	1.135	1.135	1.226
3.5DA19	1.606	1.436	1.547	1.547	1.547	1.547	1.431
3.5DA18	1.727	1.719	1.893	1.893	1.893	1.893	1.623
3.5DA16	1.995	2.346	2.393	2.393	2.393	2.393	2.047
3.5DA14	-	-	-	-	-	-	2.558



TABLE 9: NOMINAL SHEAR STRENGTH, P_{ns} (kips) AND FLEXIBILITY, S_s (in./kip) OF #8, #10, #12 AND #14 SCREW SIDELAP CONNECTION

Deck Type	Screw Size and Minimum Shank Diameter							
	#8 (0.164")		#10 (0.190")		#12 (0.216")		#14 (0.250")	
	P_{ns}	S_s	P_{ns}	S_s	P_{ns}	S_s	P_{ns}	S_s
2.0D22 & 2.0DA22	0.474	0.0175	0.510	0.0175	0.544	0.0175	0.585	0.0175
2.0D20 & 2.0DA20	0.634	0.0159	0.682	0.0159	0.727	0.0159	0.782	0.0159
2.0D19 & 2.0DA19	0.799	0.0147	0.861	0.0147	0.917	0.0147	0.987	0.0147
2.0D18 & 2.0DA18	0.965	0.0138	1.039	0.0138	1.108	0.0138	1.192	0.0138
2.0D16 & 2.0DA16	1.368	0.0123	1.472	0.0123	1.570	0.0123	1.689	0.0123
3.5D20 & 3.5DA20	0.634	0.0159	0.682	0.0159	0.727	0.0159	0.782	0.0159
3.5D19 & 3.5DA19	0.799	0.0147	0.861	0.0147	0.917	0.0147	0.987	0.0147
3.5D18 & 3.5DA18	0.965	0.0138	1.039	0.0138	1.108	0.0138	1.192	0.0138
3.5D16 & 3.5DA16	1.368	0.0123	1.472	0.0123	1.570	0.0123	1.689	0.0123
3.5D14 & 3.5DA14	1.819	0.0110	2.056	0.0110	2.192	0.0110	2.358	0.0110

TABLE 10: NOMINAL SHEAR STRENGTH, P_{ns} (kips) AND FLEXIBILITY, S_s (in./kip) OF 3/8" x 1" LONG ARC SEAM WELD SIDELAP CONNECTION

Deck Type	P_{ns}	S_s
2.0D22 & 2.0DA22	0.925	0.0073
2.0D20 & 2.0DA20	1.102	0.0066
2.0D19 & 2.0DA19	1.264	0.0061
2.0D18 & 2.0DA18	1.409	0.0057
2.0D16 & 2.0DA16	1.711	0.0051
3.5D20 & 3.5DA20	1.102	0.0066
3.5D19 & 3.5DA19	1.264	0.0061
3.5D18 & 3.5DA18	1.409	0.0057
3.5D16 & 3.5DA16	1.711	0.0051
3.5D14 & 3.5DA14	-	-

TABLE 11: ITW BUILDEX SAMMY X-PRESS SWIVEL HEAD [®] CONNECTION STRENGTH ¹⁻⁶			
Gage	Part Number & Model	Connection Strength (lbs)	
		ASD P_n / Ω	LRFD ϕP_n
22	8294922-SXP 20 8272957-SXP 2.0	200	320
20		240	390
19		280	460
18		320	520
16	8295922-SXP 35	400	660
14	8271957-SXP 3.5	500	820

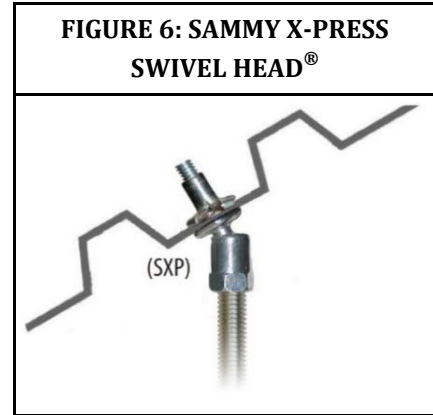


Table 11 Notes:

- Sammy X-press Swivel Head fasteners may be installed in any flat portion of the bottom flange for the following bare steel decks listed in this report; 2.0D, 2.0DA, 3.5D, and 3.5DA.
- The load may be applied at any angle, θ , from 0 to 90 degrees, $0 \leq \theta \leq 90$, relative to the axis of the base of the Sammy X-press as shown in Figure 7.
- The load may be applied at any angle, α , from 0 to 360 degrees, $0 \leq \alpha \leq 360$, relative to the ribs of the steel deck as shown in Figure 7.
- The allowable strength, P_n / Ω , shall be equal to or greater than the governing load combination for Allowable Stress Design (ASD) as stipulated in the IBC or ASCE/SEI 7.
- The factored strength, ϕP_n , shall be equal to or greater than the governing load combination for Load and Resistance Factor Design (LRFD) as stipulated in the IBC or ASCE/SEI 7.
- Safety and resistance factors included in the table are $\Omega = 2.50$ (ASD) and $\phi = 0.65$ (LRFD) respectively.

FIGURE 7: SAMMY X-PRESS SWIVEL HEAD[®] INSTALLATION

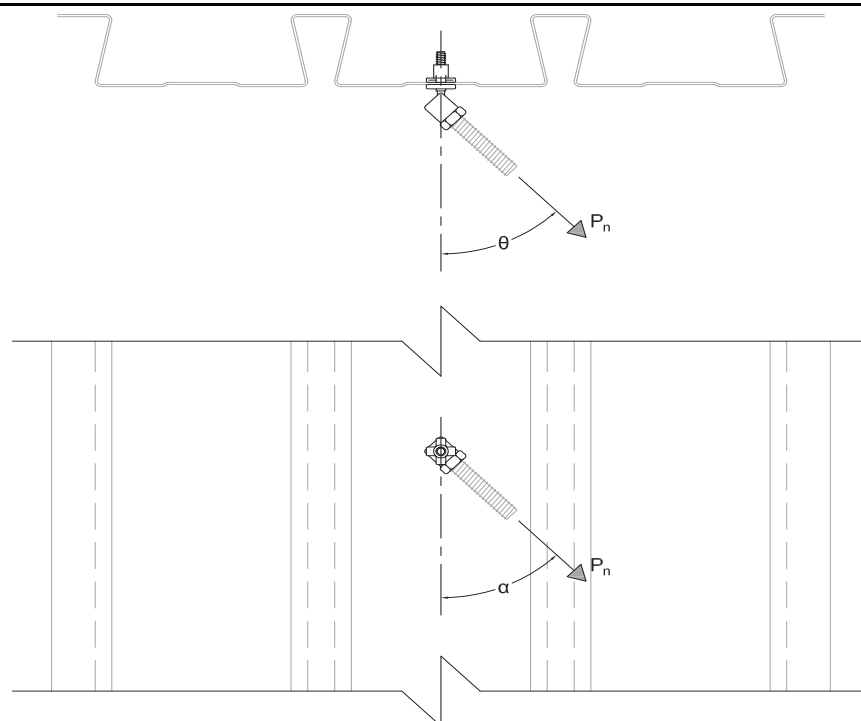




TABLE 12: NOMINAL STRENGTH OF #12 SCREW IN PERFORATED MATERIAL (lbs) ¹⁻³		
Deck Type	Shear Strength, P _{ns}	Pull-out Strength, P _{not}
2.0DA22	594	247
2.0DA20	715	322
2.0DA19	829	392
2.0DA18	934	458
2.0DA16	1170	604
3.5DA20	715	322
3.5DA19	829	392
3.5DA18	934	458
3.5DA16	1170	604
3.5DA14	1458	780

Table 12 Notes:

- Screw must be installed directly into perforation hole.
- Tabulated values are based on perforated material not in contact with the head of the screw. The connecting material in contact with the head of the screw must have a minimum thickness of 16 gage (0.0598") and maximum hole size measuring 1/4" x 5/8".
- Safety and resistance factors are $\Omega = 2.50$ (ASD) and $\phi = 0.65$ (LRFD) respectively.

TABLE 13: NOMINAL PULL-OVER STRENGTH OF #12 SCREW IN SOLID MATERIAL WITH SLOTTED HOLE ¹		
Gage	t in.	P _{nov} ²⁻⁵ lbs
16	0.0598	971

Table 13 Notes:

- Maximum slotted hole size = 1/4" x 5/8"
- Tabulated values are based on a minimum effective pull-over resistance diameter, d'_w of 0.423".
- Tabulated values are based on a minimum tensile strength of steel, F_u of 65 ksi.
- For eccentrically loaded connections that produce a non-uniform pull-over force on the screw, the nominal pull-over strength shall be taken as 50 percent of P_{nov}
- Safety and resistance factors are $\Omega = 2.50$ (ASD) and $\phi = 0.65$ (LRFD) respectively.

FIGURE 8: COMBINED SHEAR AND TENSION EQUATIONS

The following design equations can be used to check shear and tension interaction for assemblies meeting the requirements of Tables 12 and 13:

$$\text{ASD: } \frac{Q}{P_{ns}} + \frac{T}{\min(P_{not}, P_{nov})} \leq \frac{1.0}{\Omega} \quad \Omega = 2.50$$

$$\text{LRFD: } \frac{\bar{Q}}{P_{ns}} + \frac{\bar{T}}{\min(P_{not}, P_{nov})} \leq 1.0\phi \quad \phi = 0.65$$

Where:

Q = Required allowable shear strength per connection screw

T = Required allowable tension strength per connection screw

\bar{Q} = Required shear strength per connection screw

\bar{T} = Required tension strength per connection screw