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ICC-ES Evaluation Report

ESR-2197

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This report is subject to renewal December 2023.

DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings
Section: 05 31 00—Steel Decking

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

BARE STEEL DECK AND CONCRETE-FILLED STEEL DECK DIAPHRAGMS ATTACHED WITH HILTI X-HSN 24 OR X-ENP-19 L15 POWDER-DRIVEN FRAME FASTENERS

1.0 EVALUATION SCOPE

Compliance with the following codes:

2018, 2015 and 2012 *International Building Code*® (IBC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see ESR-2197 LABC Supplement.

Property evaluated:

Structural

2.0 USES

Hilti X-HSN 24 and X-ENP-19 L15 powder-driven frame fasteners are used for the attachment of bare steel deck and concrete-filled steel deck diaphragms to structural steel members.

3.0 DESCRIPTION

3.1 Power-driven Fasteners:

The Hilti fasteners are manufactured from hardened carbon steel with an electroplated zinc coating conforming to ASTM B633-07, SC 1, Type III.

The X-HSN 24 fasteners are manufactured from hardened carbon steel with an electroplated zinc coating complying with ASTM B633, SC 1, Type III. The fasteners are 0.960 inch (24.4 mm) long, with a 0.157-inch-diameter (4.0 mm), fully knurled tip and tapered shank. The X-HSN 24 fasteners have a dome-style head and a premounted 0.472-inch-diameter (12 mm) steel top hat washer with red plastic collation strip. See Table 1 for fastener drawings.

The X-ENP-19 L15 fasteners are 0.937 inch (23.8 mm) long with a 0.177-inch-diameter (4.5 mm) knurled, tapered shank fitted with two 0.590-inch-diameter (15.0 mm) steel cupped washers. The X-ENP-19 L15 fasteners have a flattened head design to accept a sealing cap. See Table 1 for fastener drawings.

3.2 Steel Deck Panels:

Bare steel and concrete-filled decks must have nominally $1^1/_2$-, 2- or 3-inch-deep flutes and must have nestable-type or interlocking-type (standing seam) sidelaps. The decks must conform to the requirements of ASTM A653 SS, Grade 33 (minimum), with minimum G60 galvanized coating. Bare steel decks may also be painted or phosphatized steel complying with ASTM A1008 SS, Grade 33 (minimum). Concrete-filled steel decks must have deck embossments or indentations for positive interlock with concrete fill.

The $1^1/_2$-inch-deep (38 mm) steel deck panels must have minimum base-steel thicknesses of 0.0598, 0.0474, 0.0358 or 0.0295 inch (1.52, 1.19, 0.91 or 0.76 mm) [59, 47, 35 or 29 mils (No. 16, 18, 20 or 22 gage)]. The steel deck panels must have a width of 36 inches (914 mm) with flutes spaced 6 inches (152 mm) on center.

The 2-inch-deep (51 mm) steel deck panels must have minimum base-steel thicknesses of 0.0598, 0.0474, 0.0418 or 0.0358 inch (1.52, 1.19, 1.06 or 0.91 mm) [59, 47, 41 or 35 mils (No. 16, 18, 19 or 20 gage)]. The steel deck panels must have a width of 36 inches (914 mm) with flutes spaced 12 inches (305 mm) on center.

The 3-inch-deep (76 mm) steel deck panels must have minimum base-steel thicknesses of 0.0478, 0.0418, 0.0359 or 0.0299 inch (1.21, 1.06, 0.91 or 0.76 mm) [47, 41, 35 or 29 mils (No. 18, 19, 20 or 22 gage)]. The steel deck panels must have widths of 24 or 36 inches (610 and 914 mm), with flutes spaced 8 or 12 inches (203 and 305 mm) on center, respectively.

3.3 Concrete Fill:

Concrete fill must be either normal weight [145 lb/ft^3 (2323 kg/m^3)] or lightweight [110 lb/ft^3 (1782 kg/m^3)] with aggregate conforming to ASTM C33 or ASTM C330, and have a minimum 28-day compressive strength, f'_c, of 3,000 psi (20.7 MPa). Concrete fill must be specified in accordance with the applicable code.

3.4 Reinforcement (Temperature and Shrinkage):

For the 2018 and 2015 IBC, welded plain wire reinforcement must comply with ASTM A1064-13 (see ACI 318-14).

For the 2012 IBC, welded plain wire reinforcement must comply with ASTM A1064-10 (see ACI 318-11).

For the 2009, welded plain wire reinforcement must consist of plain wires conforming to ASTM A82-07 fabricated into sheets in accordance with ASTM A185-07 (see ACI 318-08).

Wire must be embedded 1 inch (25.4 mm) from the top surface of the concrete slab. Table 14 provides the minimum welded wire reinforcement for allowable concrete-filled diaphragm shears.

3.5 Welded Steel Headed Stud Anchors:

The steel headed stud anchors must have diameters of at least $^{3}/_{4}$ inch (19.1 mm) and lengths complying with Table 15. Shear studs must conform to the requirements of the American Welding Society (AWS) Structural Welding Code—Steel, AWS D1.1-2010, and have a minimum tensile strength of 65 ksi (450 MPa). Studs at shear transfer points within the diaphragm or at perimeters must be spaced as required in Table 13. Stud shear connectors may be substituted for Hilti fasteners where their locations coincide.

3.6 Sealing Cap:

The Hilti SDK2 sealing cap is made from SAE 316 stainless steel with a neoprene washer, and is intended to be installed over the flattened head of the X-ENP-19 L15 fastener. Figure 6 depicts the Hilti SDK2 sealing cap.

3.7 Sidelap Screws:

The screws for steel deck panel sidelap connections must be minimum No. 10 by $^{3}/_{4}$-inch-long (19.1 mm), HWH or HHWH, self-drilling steel screws conforming to ASTM C1513 requirements and manufactured by Hilti, Inc. These fasteners are recognized in ICC-ES evaluation report ESR-2196.

3.8 Supports:

Structural steel supports must comply with the minimum strength requirements of ASTM A36, ASTM A572 Grade 50, or ASTM A992. See Table 1 for applicable thicknesses of structural steel supports used with Hilti powder-driven frame fasteners.

4.0 DESIGN AND INSTALLATION

4.1 Design:

Design information for steel deck panels attached to structural steel supports with Hilti X-HSN 24 and X-ENP-19 L15 fasteners is found in the tables of this report.

Table 1 provides guidance for determining the proper fastener.

The required number and placement of fasteners for various spans with allowable diaphragm shears, *q*, and flexibility factors, *F*, are shown in Tables 3 through 6 for bare-steel deck diaphragms, and in Tables 8 through 11 for concrete-filled steel deck diaphragms.

Nominal shear and flexibility factors for the fasteners are provided in Table 16.

Allowable uplift loads for fasteners must be the lower of the allowable pullout or pullover strength provided in Tables 17 and 18.

The notes after Table 18 describe additional design requirements and limitations.

Allowable diaphragm shear values in Tables 3 through 6 are for diaphragms described in this report subjected to earthquake loads or subjected to load combinations which include earthquake loads.

Allowable diaphragm shear values found in Tables 3 through 6 must also be limited to the respective ASD and LRFD buckling diaphragm capacities found in Table 7.

The diaphragm shear values in Tables 3 through 6 may be increased for other applications as follows:

DESIGN METHOD	FOR	MULTIPLY DIAPHRAGM SHEARS IN TABLE BY
ASD	Bare deck diaphragms subjected to wind loads or load combinations which include wind loads, Ω_{df} = 2.00	1.15
ASD	Bare deck diaphragms subject to earthquake and all other load combinations, Ω_{df} =2.30	1.00
LRFD	Bare deck diaphragms subjected to earthquake loads and all other load combinations, ϕ_{df} = 0.70	1.61
LRFD	Bare deck diaphragms subjected to wind loads or load combinations which include wind loads, ϕ_{df} = 0.80	1.84
ASD	Concrete-filled diaphragms subjected to wind, earthquake or other load combinations, Ω_{df} = 3.25	1.00
LRFD	Concrete-filled diaphragms subjected to wind, earthquake or other load combinations, ϕ_{df} = 0.50	1.63

Allowable strength design (ASD) diaphragm capacities in Tables 8 through 11 are for concrete-filled steel deck diaphragms subjected to earthquake loads or subjected to load combinations which include earthquake loads. For LRFD diaphragm capacities, the tabulated "*q*" value must be multiplied by 1.63.

4.2 Installation:

Frame fastener selection must be in accordance with Table 1. Figures and tables are summarized in the table of contents that appears following the text of this report. Standing seam interlocking-type sidelaps must be well engaged, and the button-punching sharp and deep. The coating of the outer protruding nose of the punched lap should be "starred," indicating a near-penetration of the button punching tool.

5.0 CONDITIONS OF USE

The bare steel deck and concrete-filled steel deck diaphragms attached with Hilti X-HSN 24 or X-ENP-19 L15 powder driven fasteners, as described in this report, comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The fasteners are manufactured, identified and installed in accordance with this report, the manufacturer's instructions and the approved plans. If there is a conflict, this report governs.

5.2 The base metal thickness for deck panels delivered to the jobsite must be a least 95% of the design base metal thickness.

5.3 Special inspections must comply with IBC Chapter 17.

5.4 Steel deck and concrete-filled steel deck diaphragm construction must comply with this report.

5.5 Calculations demonstrating that the applied loads do not exceed the capacities in this report must be submitted to the code official for approval. The calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.6 The Diaphragm Flexibility Limitations in Table 19 must be considered, as applicable.

5.7 Concrete-filled steel decks panels must not be used to support loads that are predominantly vibratory, such as those for operation of heavy machinery, reciprocating motors and moving loads.

5.8 Fasteners are manufactured by Hilti, Inc. in Schaan, Liechtenstein, under a quality control program with annual inspections by ICC-ES.

5.9 When the steel deck panels are used as roof decks, the panels must be covered with an approved code-complying roof covering.

5.10 Hilti fasteners may be used for attachment of steel deck roof and floor systems temporarily exposed to the exterior during construction prior to application of a built-up roof covering system or concrete fill. The fasteners on permanently exposed steel deck roof coverings must be covered with a corrosion-resistant paint or sealant. As an alternate to applying a corrosion-resistant paint or sealant to the X-ENP-19 L15 fasteners, these fasteners may be used in conjunction with the SDK2 Stainless Steel Sealing Caps, described in Section 3.6 of this report, on permanently exposed steel deck roof coverings. For permanently exposed steel deck roof covering installations, the roof covering system's compliance with Chapter 15 of the code must be justified to the satisfaction of the code official.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43), dated October 2018.

6.2 Data in accordance with the ICC-ES Acceptance Criteria for Steel Deck Roof and Floor Systems (AC43), dated October 2010 (editorially revised September 2013).

6.3 Data in accordance with the ICC-ES Acceptance Criteria for Power-actuated Fasteners Driven into Concrete, Steel and Masonry Elements (AC70), dated February 2016 (editorially revised November 2017).

7.0 IDENTIFICATION

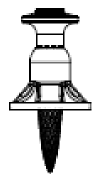
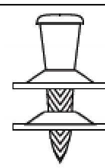
7.1 The Hilti X-HSN 24 and X-ENP-19 L15 fasteners are identified by an "H" stamped on the fastener head. Fasteners are packaged in containers noting the fastener type, the Hilti, Inc., name and address, and the evaluation report number (ESR-2197).

7.2 The report holder's contact information is the following:

HILTI, INC.
7250 DALLAS PARKWAY, SUITE 1000
PLANO, TEXAS 75024
(800) 879-8000
www.us.hilti.com/decking
deck@hilti.com

FIGURE

TABLE 1—FRAME FASTENER SELECTOR GUIDE

Base Material[1,2]	Fastener Type	Reference Tables	
		Bare Steel Deck Diaphragm	**Concrete Filled Diaphragm**
Bar Joist or Structural Steel Shape with $^1/_8$ in. ≤ t_f ≤ $^3/_8$ in.	 X-HSN 24	Tables 3, 4, 7	Tables 8-11, 13
Structural Steel, Hardened Structural Steel or Heavy Bar Joist with $t_f \geq {}^1/_4$ in.	 X-ENP-19 L15[2]	Tables 5, 6,7	Tables 8-11, 13

For **SI:** 1 inch = 25.4 mm.

[1]t_f = Structural framing minimum uncoated base metal thickness. Steel base material tensile strength (F_u) must range from 58 to 91 ksi for all fasteners and base steel thickness combinations, except for the X-HSN 24 fastener with steel thicknesses greater than $^5/_{16}$ inch. In this case, the tensile strength for the X-HSN 24 fastener must range from 58 to 75 ksi. Base metal must comply with minimum strength requirements of ASTM A36.
[2]Reference Figure 6 for information regarding the use of the SDK2 sealing cap.

TABLE 2—SAFETY FACTORS FOR AVAILABLE SHEAR STRENGTH (ASD) AND RESISTANCE FACTORS FOR FACTORED RESISTANCE (LRFD)[1,2]

LOAD TYPE OR COMBINATIONS INCLUDING	CONNECTION TYPE		Ω_{df} (ASD)	ϕ_{df} (LRFD)
	FRAME	SIDELAP		
Wind	X-HSN 24, or X-ENP-19 L15	Minimum No.10 Screws or Button Punch	2.00	0.800
Earthquake and all others			2.30	0.700
Wind		Decking with Concrete Fill	3.25	0.500
Earthquake and all others			3.25	0.500

[1]For bare decks, Tables 3 - 6 include the available diaphragm shear strength for earthquake and all other load combinations (i.e. Ω_{df} = 2.30). The available diaphragm shear strength or factored diaphragm shear resistance must be the lesser of:

- Tables 3 - 6 values applying the appropriate multiplier per Section 4.1 and
- Table 7 values for buckling.

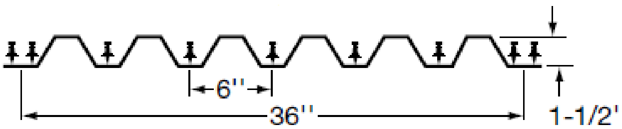
[2]For concrete filled decks, Tables 8-11 include available shear strength for wind, earthquake, and all other load combinations (i.e. Ω_{df} = 2.35).The factored shear resistance is determined by applying the multiplier in Section 4.1.

TABLE 3—ALLOWABLE DIAPHRAGM SHEARS, S_{nf}/Ω_{nf} (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2]

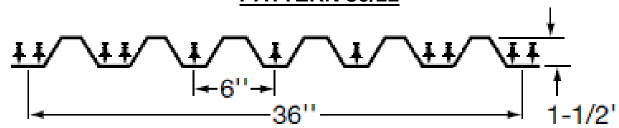
(F = 1000/G') where the diaphragm stiffness (G') is in kips/in

DECK: $1^1/_2$ -INCH DEEP, 6-INCH ON CENTER FLUTES (see figures below)
FRAME FASTENERS: HILTI X-HSN 24 (see applicable patterns below)
SIDELAP CONNECTIONS: MINIMUM No. 10 SELF-DRILLING SCREW (see Section 3.7)

PATTERN 36/9



PATTERN 36/11



GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT–IN.)													
			4′-0″		5′-0″		6′-0″		7′-0″		8′-0″		9′-0″		10′-0″	
			FASTENERS PER SHEET TO SUPPORT													
			9	11	9	11	9	11	9	11	9	11	9	11	9	11
22	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	659	762	576	658	516	582	465	520	426	474	398	440	376	415
		F	15.6	15.3	14.1	13.9	13.2	12.9	12.6	12.3	12.2	11.9	11.8	11.5	11.6	11.3
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	723	831	645	732	589	662	547	610	515	565	489	531	467	505
		F	15.1	14.9	13.6	13.4	12.5	12.3	11.8	11.6	11.3	11.1	10.9	10.7	10.6	10.4
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	782	896	710	802	658	735	619	686	588	647	564	617	544	592
		F	14.8	14.6	13.1	13.0	12.1	11.9	11.3	11.2	10.8	10.6	10.3	10.2	10.0	9.9
20	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	812	937	713	813	642	725	588	654	541	598	504	555	477	524
		F	11.2	11.0	10.4	10.2	9.9	9.7	9.6	9.4	9.4	9.1	9.2	9.0	9.1	8.9
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	896	1028	804	910	738	827	689	765	650	718	620	676	595	645
		F	10.8	10.6	9.9	9.7	9.3	9.1	8.9	8.7	8.6	8.5	8.4	8.2	8.2	8.1
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	972	1113	888	1003	827	924	781	865	746	820	718	784	694	755
		F	10.5	10.4	9.5	9.4	8.9	8.8	8.5	8.3	8.1	8.0	7.9	7.8	7.7	7.6
18	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	1099	1266	973	1106	882	993	814	910	762	841	717	784	678	739
		F	7.3	7.1	7.0	6.8	6.9	6.7	6.8	6.6	6.8	6.5	6.7	6.5	6.7	6.5
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	1222	1401	1107	1251	1024	1145	962	1067	914	1006	875	958	844	918
		F	6.9	6.8	6.6	6.4	6.3	6.2	6.2	6.0	6.1	5.9	6.0	5.9	5.9	5.8
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	1333	1526	1229	1387	1154	1288	1097	1214	1053	1157	1018	1112	989	1075
		F	6.7	6.6	6.3	6.2	6.0	5.9	5.8	5.7	5.7	5.6	5.6	5.5	5.5	5.4

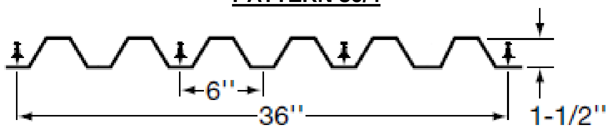
For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Refer to footnotes following Table 18 for additional installation and design requirements.
[2]Allowable stress design diaphragm capacities are presented for diaphragms mechanically connected to the structure subjected to earthquake loads or load combinations which include earthquake loads. Diaphragm shears may be increased for other applications as prescribed in Section 4.1 of this report.

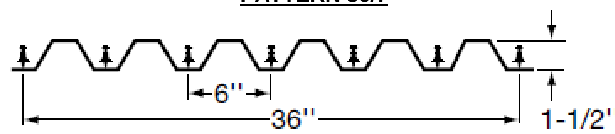
TABLE 4—ALLOWABLE DIAPHRAGM SHEARS, S_{nf}/Ω_{nf} (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2]

DECK: $1^1/_2$ -INCH DEEP, 6-INCH ON CENTER FLUTES (see figure below)
FRAME FASTENERS: HILTI X-HSN 24 (see applicable pattern below)
SIDELAP CONNECTIONS: MINIMUM No. 10 SELF-DRILLING SCREW (see Section 3.7)

PATTERN 36/4



PATTERN 36/7



GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)													
			4′-0″		5′-0″		6′-0″		7′-0″		8′-0″		9′-0″		10′-0″	
			FASTENERS PER SHEET TO SUPPORT													
			4	7	4	7	4	7	4	7	4	7	4	7	4	7
22	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	353	480	323	425	302	387	286	358	273	334	263	316	255	303
		F	82.0	16.2	67.6	14.7	57.8	13.8	50.8	13.1	45.7	12.7	41.7	12.3	38.5	12.0
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	402	550	377	499	359	463	346	437	335	417	327	401	320	388
		F	81.3	15.5	66.2	13.9	56.5	12.9	49.8	12.1	44.4	11.6	40.3	11.2	37.2	10.8
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	441	615	421	568	407	534	396	510	387	491	380	476	374	464
		F	80.6	15.0	65.8	13.4	55.9	12.3	49.0	11.5	43.7	10.9	39.7	10.5	36.4	10.1
20	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	439	598	405	532	380	487	361	453	347	428	335	405	326	389
		F	52.4	11.8	43.7	11.0	37.7	10.4	33.4	10.1	30.4	9.9	27.9	9.7	26.0	9.6
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	501	690	473	629	453	587	438	556	426	532	416	514	409	498
		F	51.5	11.1	42.6	10.2	36.6	9.6	32.4	9.2	29.2	8.9	26.7	8.6	24.7	8.5
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	550	773	528	718	512	680	500	651	490	629	482	612	476	598
		F	51.0	10.7	42.0	9.7	36.1	9.1	31.7	8.6	28.5	8.3	26.0	8.0	24.0	7.8
18	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	603	823	561	739	531	681	508	638	490	606	476	580	464	559
		F	28.2	7.8	23.9	7.5	21.0	7.3	19.0	7.2	17.5	7.2	16.3	7.1	15.4	7.1
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	689	957	656	882	633	829	615	790	601	760	590	737	581	717
		F	27.4	7.2	23.0	6.8	20.1	6.6	18.0	6.4	16.4	6.3	15.2	6.2	14.3	6.1
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	754	1078	729	1010	711	963	698	928	687	901	678	879	671	862
		F	27.0	6.9	22.5	6.4	19.6	6.2	17.5	6.0	15.9	5.8	14.6	5.7	13.7	5.6

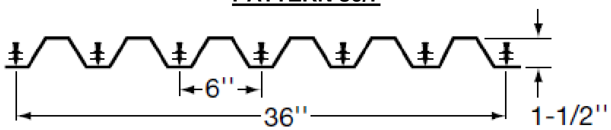
For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Refer to footnotes following Table 18 for additional installation and design requirements.
[2]Allowable stress design diaphragm capacities are presented for diaphragms mechanically connected to the structure subjected to earthquake loads or load combinations which include earthquake loads. Diaphragm shears may be increased for other applications as prescribed in Section 4.1 of this report.

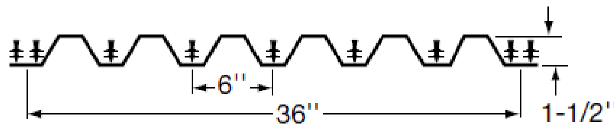
TABLE 5—ALLOWABLE DIAPHRAGM SHEARS, S_{nf}/Ω_{nf} (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2]

DECK: $1^1/_2$ -INCH DEEP, 6-INCH ON CENTER FLUTES (see figures below)
FRAME FASTENERS: HILTI X-ENP-19 L15 (see applicable patterns below)
SIDELAP CONNECTIONS: MINIMUM No. 10 SELF-DRILLING SCREW (see Section 3.7)

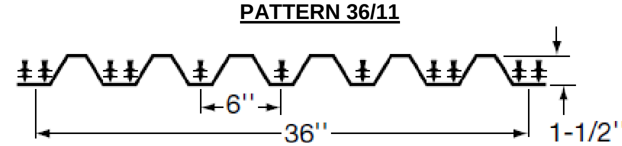
PATTERN 36/7



PATTERN 36/9



PATTERN 36/11



GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)																				
			4′-0″			5′-0″			6′-0″			7′-0″			8′-0″			9′-0″			10′-0″		
			FASTENERS PER SHEET TO SUPPORT																				
			7	9	11	7	9	11	7	9	11	7	9	11	7	9	11	7	9	11	7	9	11
22	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	506	700	810	446	609	697	404	543	612	371	487	546	345	445	496	327	414	460	312	391	432
		F	15.5	14.9	14.6	14.0	13.4	13.2	13.1	12.5	12.2	12.5	11.9	11.6	12.0	11.4	11.1	11.7	11.1	10.8	11.4	10.9	10.6
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	577	764	879	521	679	771	482	618	695	453	572	637	431	535	587	413	505	551	399	482	523
		F	15.0	14.6	14.4	13.4	13.1	12.9	12.4	12.0	11.9	11.7	11.4	11.2	11.2	10.8	10.7	10.8	10.5	10.3	10.5	10.2	10.0
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	643	825	945	591	745	842	554	688	770	527	645	715	507	611	674	490	585	640	477	563	614
		F	14.7	14.4	14.3	13.1	12.8	12.7	12.0	11.7	11.6	11.3	11.0	10.9	10.7	10.5	10.3	10.3	10.0	9.9	9.9	9.7	9.6
20	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	629	861	995	558	753	860	508	676	765	472	615	686	442	564	626	418	524	579	400	495	545
		F	11.1	10.6	10.4	10.3	9.8	9.5	9.8	9.3	9.0	9.5	9.0	8.7	9.3	8.7	8.5	9.1	8.6	8.3	9.0	8.5	8.2
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	722	946	1087	656	845	958	610	773	868	576	719	801	550	677	747	529	644	700	513	617	666
		F	10.7	10.3	10.2	9.8	9.5	9.3	9.2	8.9	8.7	8.8	8.5	8.3	8.5	8.2	8.0	8.3	8.0	7.8	8.1	7.9	7.7
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	808	1024	1173	747	931	1052	704	864	966	673	814	902	649	775	852	630	743	813	614	718	781
		F	10.4	10.2	10.0	9.5	9.2	9.1	8.8	8.6	8.5	8.4	8.2	8.0	8.1	7.9	7.7	7.8	7.6	7.5	7.6	7.4	7.3
18	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	864	1164	1342	773	1026	1168	710	927	1046	663	853	955	627	796	877	599	744	816	577	702	767
		F	7.2	6.8	6.6	6.9	6.5	6.2	6.8	6.3	6.1	6.7	6.2	6.0	6.6	6.2	5.9	6.6	6.2	5.9	6.6	6.2	5.9
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	1001	1289	1479	918	1162	1315	860	1071	1199	817	1003	1113	784	950	1047	758	908	995	737	874	952
		F	6.9	6.5	6.4	6.5	6.2	6.0	6.3	6.0	5.8	6.1	5.8	5.7	6.0	5.7	5.6	5.9	5.7	5.5	5.9	5.6	5.5
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	1125	1403	1606	1050	1288	1453	998	1204	1344	959	1141	1263	929	1093	1201	905	1054	1151	885	1022	1110
		F	6.6	6.4	6.3	6.2	6.0	5.9	5.9	5.7	5.6	5.7	5.5	5.4	5.6	5.4	5.3	5.5	5.3	5.2	5.4	5.3	5.2

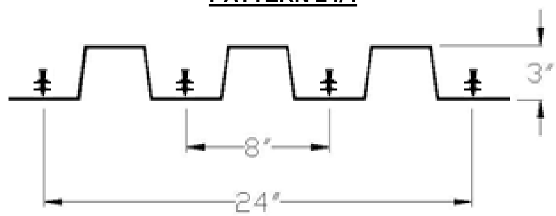
For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Refer to footnotes following Table 18 for additional installation and design requirements.
[2]Allowable stress design diaphragm capacities are presented for diaphragms mechanically connected to the structure subjected to earthquake loads or load combinations which include earthquake loads. Diaphragm shears may be increased for other applications as prescribed in Section 4.1 of this report.

TABLE 6—ALLOWABLE DIAPHRAGM SHEARS, S_{nf}/Ω_{nf} (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2]

DECK: 3-INCH DEEP, 8-INCH ON CENTER FLUTES (see figure below)
FRAME FASTENERS: HILTI X-ENP-19 L15 (see applicable pattern below)
SIDELAP CONNECTIONS: MINIMUM No. 10 SELF-DRILLING SCREW (see Section 3.7)

PATTERN 24/4



GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)								
			7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13′-0″	14′-0″	15′-0″
			FASTENERS PER SHEET TO SUPPORT								
			4	4	4	4	4	4	4	4	4
22	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	309	293	281	271	263	256	250	245	241
		F	40.3	36.8	34.1	32.1	30.3	28.8	27.6	26.6	25.7
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	390	375	363	353	346	339	333	328	324
		F	38.8	35.2	32.5	30.3	28.5	27.0	25.7	24.6	23.7
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	459	445	434	426	419	413	407	403	399
		F	37.9	34.4	31.5	29.2	27.4	25.9	24.6	23.5	22.5
20	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	396	377	362	350	341	332	325	320	314
		F	27.5	25.4	23.9	22.6	21.6	20.7	20.0	19.4	18.9
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	498	480	467	455	446	438	432	426	421
		F	26.2	24.0	22.4	21.1	20.0	19.0	18.3	17.6	17.1
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	587	571	559	549	541	534	528	523	518
		F	25.4	23.2	21.5	20.1	19.0	18.1	17.3	16.6	16.0
18	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	566	541	522	507	494	483	474	466	459
		F	16.6	15.7	14.9	14.4	13.9	13.6	13.3	13.0	12.8
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	710	689	672	658	646	637	628	621	615
		F	15.5	14.5	13.7	13.0	12.5	12.1	11.8	11.4	11.2
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	837	819	804	792	781	773	766	760	754
		F	14.8	13.7	12.9	12.3	11.7	11.3	10.9	10.6	10.3
16	Screws @ 12″ o.c.	S_{nf}/Ω_{nf}	756	727	704	685	670	656	645	636	628
		F	11.5	11.1	10.7	10.5	10.2	10.1	9.9	9.8	9.7
	Screws @ 8″ o.c.	S_{nf}/Ω_{nf}	953	927	907	891	877	866	856	848	840
		F	10.5	10.0	9.6	9.2	9.0	8.7	8.6	8.4	8.3
	Screws @ 6″ o.c.	S_{nf}/Ω_{nf}	1121	1099	1082	1068	1056	1047	1038	1031	1025
		F	9.9	9.3	8.9	8.5	8.2	8.0	7.8	7.6	7.5

For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Refer to footnotes following Table 18 for additional installation and design requirements.
[2]Allowable stress design diaphragm capacities are presented for diaphragms mechanically connected to the structure subjected to earthquake loads or load combinations which include earthquake loads. Diaphragm shears may be increased for other applications as prescribed in Section 4.1 of this report.

TABLE 7—ALLOWABLE DIAPHRAGM SHEARS (ASD), S_{nb}/Ω_{nb} (POUNDS PER LINEAL FOOT) FOR BUCKLING AND LRFD DIAPHRAGM SHEARS, $\phi_{nb}S_{nb}$ (POUNDS PER LINEAL FOOT), BASED ON BUCKLING OF STANDARD $1^1/_2$ –INCH-DEEP FLUTES, 6-INCHES CENTER-TO-CENTER STEEL DECK AND STANDARD 3–INCH-DEEP FLUTES, 8 INCHES CENTER-TO-CENTER STEEL DECK [1,2,3]

STEEL DECK TYPE	DECK GAGE	Minimum Moment of Inertia[4], I in^4/ft	SPAN (FT - IN.)											
			4′-0″	5′-0″	6′-0″	7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13’-0”	14’-0”	15’-0”
ASD – S_{nb}/Ω_{nb} where Ω_{nb} = 2.00														
Standard $1^1/_2$-inch Deep Flutes, 6 Inches Center-to-Center	22	0.173	4,360	2,790	1,938	1,424	1090	861	698	576	484	413	356	310
	20	0.210	5,829	3,731	2,591	1,903	1,457	1,151	933	771	648	552	476	415
	18	0.279	8,904	5,698	3,957	2,907	2,226	1,759	1,425	1,177	989	843	727	633
	16	0.353	12,644	8,092	5,620	4,129	3,161	2,498	2,023	1,672	1,405	1,197	1,032	899
Standard 3-Inch Deep Flutes, 8 Inches Center-to-Center	22	0.808	13,281	8,500	5,903	4,337	3,320	2,623	2,125	1,756	1,476	1,257	1,084	944
	20	0.989	17,870	11,437	7,942	5,835	4,467	3,530	2,859	2,363	1,986	1,692	1,459	1,271
	18	1.323	27,435	17,559	12,193	8,958	6,859	5,419	4,390	3,628	3,048	2,597	2,240	1,951
	16	1.672	38,928	24,914	17,301	12,711	9,732	7,689	6,228	5,147	4,325	3,685	3,178	2,768
LRFD - $\phi_{nb}S_{nb}$ where ϕ_{nb} = 0.80														
Standard $1^1/_2$-inch Deep Flutes, 6 Inches Center-to-Center	22	0.173	6,975	4,464	3,100	2,278	1,744	1,378	1,116	922	775	843	7,27	633
	20	0.210	9,327	5,969	4,145	3,046	2,332	1,842	1,492	1,233	1,036	1,197	1,032	899
	18	0.279	14,246	9,118	6,332	4,652	3,562	2,814	2,279	1,884	1,583	1,257	1,084	944
	16	0.353	20,231	12,948	8,992	6,606	5,058	3,996	3,237	2,675	2,248	1,692	1,459	1,271
Standard 3-inch Deep Flutes, 8 Inches Center-to-Center	22	0.808	21,250	13,600	9,444	6,939	5,312	4,197	3,400	2,810	2,361	2,597	2,240	1,951
	20	0.989	28,591	18,298	12,707	9,336	7,148	5,648	4,575	3,781	3,177	3,685	3,178	2,768
	18	1.323	43,896	28,094	19,509	14,334	10,974	8,671	7,023	5,804	4,877	843	727	633
	16	1.672	62,284	39,862	27,682	20,338	15,571	12,303	9,965	8,236	6,920	1,197	1,032	899

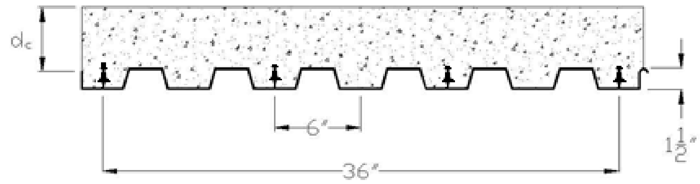
For **SI:** 1 inch = 25.4 mm, 1 ksi = 6.89 MPa, 1 plf = 0.0146 N/mm, 1 in^4/ft = 1,368 mm^4/mm.

[1]Tabulated values are based on AISI S310 Eq. D-1 and Eq. D2.1-1.
[2]Diaphragm shears in this table are for steel deck buckling failure mode only and are to be used as prescribed in Section 4.1 of this report.
[3]Diaphragm resistance must be limited to lesser of values in this table and the corresponding respective ASD and LRFD shear capacities shown in Tables 3 through 6 or calculated per Section 4.1 of this report.
[4]The tabulated moment of inertia, I, is the moment of inertia of the fully effective panel**.**

TABLE 8—ALLOWABLE DIAPHRAGM SHEARS, q (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2,3,4,5,6]

DECK: $1^1/_2$-INCH DEEP, 6-INCH ON CENTER FLUTES (see figure below)
FRAME FASTENERS: HILTI X-HSN 24 or X-ENP-19 L15 (see applicable pattern below)
SIDELAP CONNECTIONS: BUTTON PUNCH (see Section 4.2)
CONCRETE FILL: LIGHTWEIGHT (see Section 3.3)

PATTERN 36/4



d_c f'_c FILL TYPE	GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)								
				6′-0″	7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13′-0″	14′-0″
				FASTENERS PER SHEET TO SUPPORT								
				4	4	4	4	4	4	4	4	4
$2^1/_2$″ 3,000 psi Lightweight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1120	1104	1092	1083	1075	1069	1064	1060	1056
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1144	1124	1110	1098	1089	1082	1076	1070	1066
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.42
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1186	1160	1141	1126	1114	1105	1097	1090	1084
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1229	1198	1174	1155	1141	1129	1118	1110	1103
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
$3^1/_4$″ 3,000 psi Lightweight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1420	1403	1391	1382	1374	1368	1363	1359	1355
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1443	1423	1409	1397	1388	1381	1375	1369	1365
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1485	1459	1440	1425	1413	1404	1396	1389	1383
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1529	1497	1473	1455	1440	1428	1418	1409	1402
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
$4^1/_2$″ 3,000 psi Lightweight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1918	1902	1890	1880	1873	1867	1862	1857	1853
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1941	1922	1907	1896	1887	1879	1873	1868	1863
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1983	1958	1939	1924	1912	1902	1894	1887	1881
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2027	1995	1972	1953	1938	1926	1916	1908	1900
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23

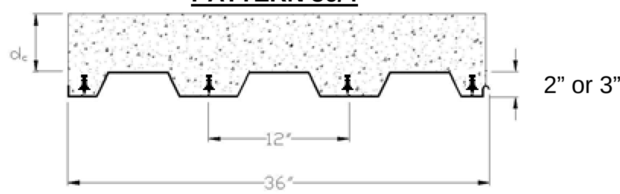
For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Concrete cover depth as indicated in table above.
[2]Refer to footnotes following Table 18 for additional installation and design requirements.
[3]See Table 1 for required base steel thickness ranges for each fastener.
[4]Steel deck and reinforcement must comply with Section 3.2 and 3.4, respectively.
[5] For LRFD, multiply the tabulated "q" value by 1.63.
[6]Lightweight concrete may be any lightweight concrete complying with ACI 318.

TABLE 9—ALLOWABLE DIAPHRAGM SHEARS, q (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2,3,4,5,6]

DECK: 2 OR 3-INCH-DEEP, 12-INCH ON CENTER FLUTES (see figure below)
FRAME FASTENERS: HILTI X-HSN 24 or X-ENP-19 L15
(see applicable pattern below)
SIDELAP CONNECTIONS: BUTTON PUNCH (see Section 4.2)
CONCRETE FILL: LIGHTWEIGHT (see Section 3.3)

PATTERN 36/4



d_c f'_c FILL TYPE	GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)								
				6′-0″	7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13′-0″	14′-0″
				FASTENERS PER SHEET TO SUPPORT								
				4	4	4	4	4	4	4	4	4
2″ 3,000 psi Lightweight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	944	925	910	899	890	882	876	871	866
			F	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	986	961	942	927	915	905	897	890	884
			F	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	0.52
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1030	998	975	956	941	929	919	910	903
			F	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
3¼″ 3,000 psi Lightweight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1443	1423	1409	1397	1388	1381	1375	1369	1365
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1485	1459	1440	1425	1413	1404	1396	1389	1383
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1529	1497	1473	1455	1440	1428	1418	1409	1402
			F	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
4″ 3,000 psi Lightweight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1742	1722	1708	1697	1687	1680	1674	1669	1664
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1784	1758	1739	1725	1713	1703	1695	1688	1682
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1828	1796	1772	1754	1739	1727	1717	1708	1701
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
5″ 3,000 psi Lightweight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2141	2121	2107	2095	2086	2079	2073	2067	2063
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2183	2157	2138	2123	2111	2102	2094	2087	2081
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2227	2195	2171	2153	2138	2126	2115	2107	2100
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

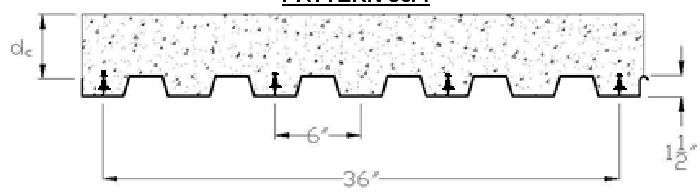
For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Concrete cover depth as indicated in table above.
[2]Refer to footnotes following Table 18 for additional installation and design requirements.
[3]See Table 1 for required base steel thickness ranges for each fastener.
[4]Steel deck and reinforcement must comply with Section 3.2 and 3.4, respectively.
[5]For LRFD, multiply the tabulated “q” value by 1.63.
[6]Lightweight concrete may be any lightweight concrete complying with ACI 318

TABLE 10—ALLOWABLE DIAPHRAGM SHEARS, q (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2,3,4,5]

DECK: $1^1/_2$-INCH-DEEP, 6-INCH ON CENTER FLUTES (see figure below)
FRAME FASTENERS: HILTI X-HSN 24 X-ENP-19 L15 (see applicable pattern below)
SIDELAP CONNECTIONS: BUTTON PUNCH (see Section 4.2)
CONCRETE FILL: NORMAL WEIGHT (see Section 3.3)

PATTERN 36/4



d_c f′c FILL TYPE	GAUGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.) 6′-0″	7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13′-0″	14′-0″
				FASTENERS PER SHEET TO SUPPORT								
				4	4	4	4	4	4	4	4	4
$2^1/_2$″ 3,000 psi Normal Weight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1632	1616	1604	1595	1587	1581	1576	1571	1568
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1656	1636	1622	1610	1601	1594	1587	1582	1578
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.42
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1698	1672	1653	1638	1626	1617	1608	1602	1596
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1741	1710	1686	1667	1653	1640	1630	1622	1614
			F	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
$3^1/_2$″ 3,000 psi Normal Weight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2236	2220	2208	2198	2191	2185	2179	2175	2171
			F	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2259	2240	2225	2214	2205	2197	2191	2186	2181
			F	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2301	2276	2257	2242	2230	2220	2212	2205	2199
			F	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2345	2313	2289	2271	2256	2244	2234	2225	2218
			F	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30
$4^1/_2$″ 3,000 psi Normal Weight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2840	2823	2811	2802	2794	2788	2783	2779	2775
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2863	2843	2829	2817	2808	2801	2795	2789	2785
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2905	2879	2860	2845	2834	2824	2816	2809	2803
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2949	2917	2893	2875	2860	2848	2838	2829	2822
			F	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
$5^1/_2$″ 3,000 psi Normal Weight Concrete	22	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3443	3427	3415	3406	3398	3392	3387	3382	3379
			F	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3466	3447	3432	3421	3412	3404	3398	3393	3389
			F	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3508	3483	3464	3449	3437	3427	3419	3412	3407
			F	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3552	3521	3497	3478	3463	3451	3441	3433	3425
			F	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Concrete cover depth as indicated in table above.
[2]Refer to footnotes following Table 18 for additional installation and design requirements.
[3]See Table 1 for required base steel thickness ranges for each fastener.
[4]Steel deck and reinforcement must comply with Section 3.2 and 3.4, respectively.
[5]For LRFD, multiply the tabulated "q" value by 1.63.

TABLE 11—ALLOWABLE DIAPHRAGM SHEARS, q (plf) AND FLEXIBILITY FACTORS, F (micro-inches/lb)[1,2,3,4,5]

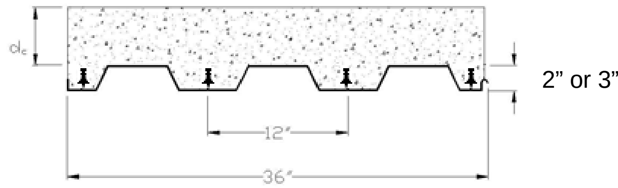
DECK: 2- OR 3-INCH-DEEP, 12-INCH ON CENTER FLUTES (see figure below)

FRAME FASTENERS: HILTI X-HSN 24 or X-ENP-19 L15
(see applicable pattern below)

SIDELAP CONNECTIONS: BUTTON PUNCH (see Section 4.2)

CONCRETE FILL: NORMAL WEIGHT (see Section 3.3)

PATTERN 36/4



d_c f'_c FILL TYPE	GAGE	SIDELAP CONNECTION	FACTOR	SPAN (FT – IN.)								
				6′-0″	7′-0″	8′-0″	9′-0″	10′-0″	11′-0″	12′-0″	13′-0″	14′-0″
				FASTENERS PER SHEET TO SUPPORT								
				4	4	4	4	4	4	4	4	4
2″ 3,000 psi Normal Weight Concrete[6]	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1422	1381	1354	1334	1320	1308	1299	1292	1286
			F	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52
	19	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1454	1406	1375	1352	1336	1322	1312	1303	1296
			F	0.51	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1485	1432	1396	1370	1351	1336	1325	1315	1307
			F	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.52	0.52
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	1551	1484	1440	1408	1384	1366	1351	1339	1329
			F	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
3″ 3,000 psi Normal Weight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2026	1985	1957	1938	1923	1912	1903	1895	1889
			F	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35	0.35
	19	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2057	2010	1979	1956	1939	1926	1916	1907	1900
			F	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.35
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2089	2035	1999	1974	1955	1940	1928	1918	1910
			F	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2154	2088	2043	2011	1988	1969	1954	1942	1932
			F	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.35	0.35
4″ 3,000 psi Normal Weight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2629	2588	2561	2542	2527	2516	2507	2499	2493
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	19	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2661	2614	2582	2560	2543	2530	2519	2511	2503
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2692	2639	2603	2578	2558	2544	2532	2522	2514
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	2758	2691	2647	2615	2591	2573	2558	2546	2536
			F	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
5″ 3,000 psi Normal Weight Concrete	20	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3233	3192	3165	3145	3131	3119	3110	3103	3096
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	19	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3265	3217	3186	3163	3146	3133	3123	3114	3107
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	18	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3296	3242	3207	3181	3162	3147	3135	3126	3117
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
	16	Button Punch @ 36″ o.c.	S_{nf}/Ω_{nf}	3362	3295	3250	3219	3195	3176	3162	3149	3139
			F	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

For **SI:** 1 inch = 25.4 mm, 1 foot = 305 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1inch/lb = 5.7 mm/N.

[1]Concrete cover depth as indicated in table above.
[2]Refer to footnotes following Table 18 for additional installation and design requirements.
[3]See Table 1 for required base steel thickness ranges for each fastener.
[4]Steel deck and reinforcement must comply with Section 3.2 and 3.4, respectively.
[5]For LRFD, multiply the tabulated "q" value by 1.63.

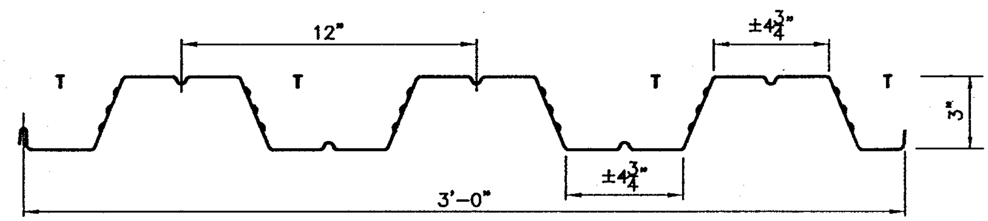
TABLE 12—DECK TYPES FOR CONCRETE FILLED DIAPHRAGMS WITH WELDED STEEL HEADED STUD ANCHORS

DECK	DECK TYPES	GAGE	FIGURE
$1^1/_2$″ deep B deck – 36″ wide	Type A	Minimum 22	Figure 1
2″ deep – 36″ wide	Type B	Minimum 22	Figure 2
3″ deep – 36″ wide	Type C	Minimum 22	Figure 3

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.89 kPa.

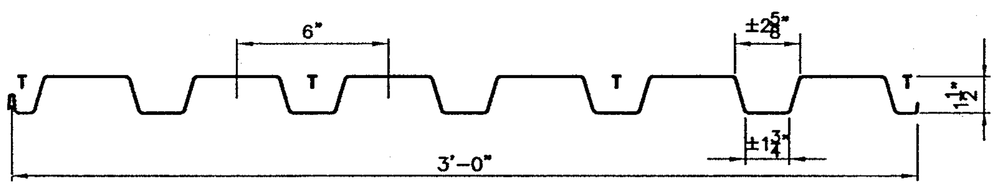
Notes:

1.) Steel deck panels must comply with Section 3.2.
2.) Refer to notes following Tables 13.



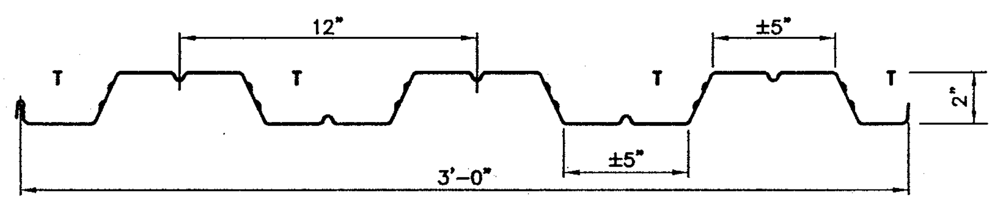
For SI: 1 inch = 25.4 mm.

FIGURE 1—$1^1/_2$″ B DECK – 36″ WIDE (TYPE A)



For SI: 1 inch- 25.4 mm.

FIGURE 2—2″ DECK – 36″ WIDE (TYPE B)



For SI: 1 inch = 25.4 mm.

FIGURE 3—3″ DECK – 36″ WIDE (TYPE C)

TABLE 13—ALLOWABLE DIAPHRAGM SHEARS (plf) AND FLEXIBILITY FACTORS (micro-inches/lb) FOR CONCRETE-FILLED STEEL DECK DIAPHRAGMS ATTACHED WITH HILTI FASTENERS AND 3/4″ DIAMETER STEEL HEADED STUD ANCHORS [1-12]

CONCRETE TYPES	CONCRETE THICKNESS, d_c[13]	Spacing of Steel Headed Stud Anchors (inch)[14, 15]							F
		12″	16″	18″	24″	30″	32″	36″	
Normal Weight (145 pcf)	2″	3110 (1320)	3110 (1320)	3110 (1320)	3110 (1320)	3110 (1320)	3110 (1320)	2870 (1320)	0.40
	2 1/2″	3890 (1640)	3890 (1640)	3890 (1640)	3890 (1640)	3450 (1640)	3230 (1640)	2870 (1640)	0.32
	3″	4670 (1970)	4670 (1970)	4670 (1970)	4310 (1970)	3450 (1970)	3230 (1970)	2870 (1970)	0.26
	3 1/2″	5450 (2300)	5450 (2300)	5450 (2300)	4310 (2300)	3450 (2300)	3230 (2300)	2870 (2300)	0.23
	4″	6230 (2630)	6230 (2630)	5740 (2630)	4310 (2630)	3450 (2630)	3230 (2630)	2870 (2630)	0.20
	4 1/2″	7010 (2960)	6460 (2960)	5740 (2960)	4310 (2960)	3450 (2960)	3230 (2960)	2870 (2870)	0.18
	6″	8610 (3940)	6460 (3940)	5740 (3940)	4310 (3940)	3450 (3450)	3230 (3230)	2870 (2870)	0.13
Sand-Lightweight (110 pcf)	2″	2920 (1120)	2920 (1120)	2920 (1120)	2920 (1120)	2920 (1120)	2920 (1120)	2870 (1120)	0.56
	2 1/2″	3650 (1400)	3650 (1400)	3650 (1400)	3650 (1400)	3650 (1400)	3230 (1400)	2870 (1400)	0.45
	3″	4380 (1680)	4380 (1680)	4380 (1680)	4310 (1680)	3450 (1680)	3230 (1680)	2870 (1680)	0.37
	3 1/4″	4740 (1820)	4740 (1820)	4740 (1820)	4310 (1820)	3450 (1820)	3230 (1820)	2870 (1820)	0.35
	3 1/2″	5110 (1960)	5110 (1960)	5110 (1960)	4310 (1960)	3450 (1960)	3230 (1960)	2870 (1960)	0.32
	4 1/4″	6200 (2370)	6200 (2370)	5740 (2370)	4310 (2370)	3450 (2370)	3230 (2370)	2870 (2370)	0.26
	6″	8610 (3350)	6460 (3350)	5740 (3350)	4310 (3350)	3450 (3350)	3230 (3350)	2870 (2870)	0.19

For **SI:** 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 psi = 6.89 kPa, 1 psf = 16 kg/m^3, 1 in^2/foot = 2,117 mm^2/m, 1 pcf = 16.018 kg/m^3.

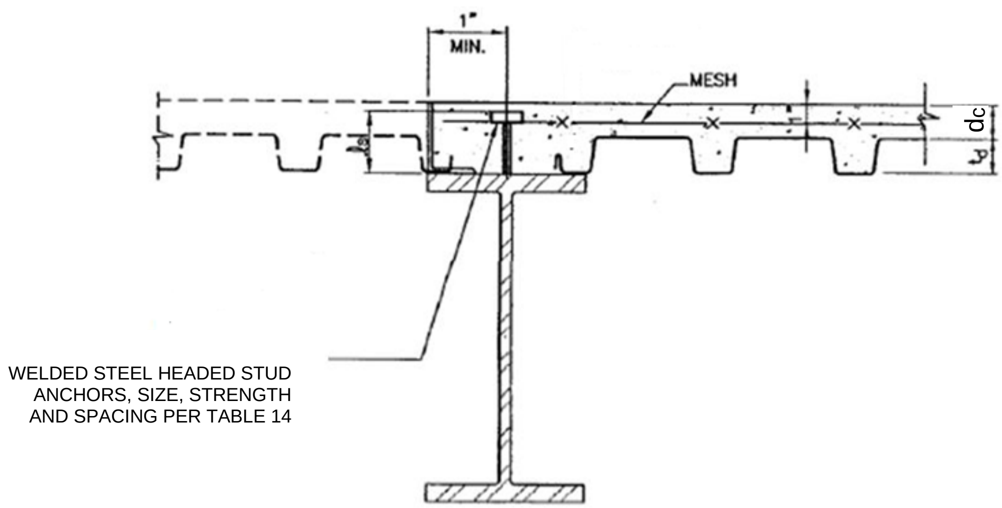
[1]Reinforcement in each direction must have an area of 0.0025 times the area of fill above top of steel deck to use the tabulated values. Reinforcement in each direction must have an area of 0.00075 times the area of fill above top of steel deck to use the tabulated values in parentheses. The common welded wire fabric of the size listed in Table 14 meets this requirement.
[2]Concrete fill must have a f'_c = 3,000 psi minimum.
[3]See details in Figures 1, 2, and 3 for qualified deck types with location of minimum number of Hilti fasteners to supports perpendicular to flutes.
[4]Place reinforcement 1 inch below the top surface of the concrete. Welded wire reinforcement must have $F_y \geq 65$ ksi.
[5]Minimum lap of welded wire reinforcement must be 12 inches.
[6]Sidelap connections must be a maximum of 36 inches on center. Sidelaps must be fastened using button punches or minimum No. 10 x 3/4-inch-long self-drilling steel screws.
[7] The thickness of the base metal to which the steel headed stud anchors are welded must not be less than 0.300 inch, unless it is welded to a flange directly over a web. Reference AISC 360-10 Section I8.1
[8]Tabulated values must be multiplied by $\Phi/0.75$ per Section 12.5.3.2 of ACI 318-14, where $\Phi < 0.75$.
[9]For LRFD diaphragm shear strength, multiply tabulated values by 1.50.
[10]F = Flexibility factor (Deflection in micro-inches of 1-foot element under shear of 1 pound per foot.)
[11]Linear interpolation between steel headed stud anchor spacing for a given concrete fill thickness is acceptable for determination of intermediate diaphragm shears and flexibility factors.
[12]Decks need not be embossed for composite slab shear transfer.
[13]Concrete fill thickness, d_C (see Figures 4 and 5) is measured from the top of steel deck to the top of concrete.
[14]Steel headed stud anchors must have an installed length complying with Table 15. The maximum stud spacing noted in the table is for studs at the diaphragm perimeter.
[15]The maximum center-to-center spacing of steel headed stud anchors must not exceed eight times the total slab thickness ($t_d + d_c$, see Figures 4 and 5), nor 36 inches. Reference AISC 360-10 Section I8.2d

TABLE 14—MINIMUM WELDED WIRE REINFORCEMENT FOR TABULATED SHEAR VALUES

TABLE 13	CONCRETE THICKNESS, d_c (inch)[1]	MINIMUM WELDED WIRE REINFORCEMENT FOR TABULATED SHEAR VALUES
0.00075 times area of fill above top of steel deck	2″ to 3″	6 x 6 – W1.4 x W1.4
	$3^{1}/_{4}$″ to $4^{1}/_{4}$″	6 x 6 – W2.0 x W2.0
	$4^{1}/_{2}$″ to 6″	6 x 6 – W2.9 x W2.9
0.0025 times area of fill above top of steel deck	2″ to $2^{1}/_{2}$″	6 x 6 – W4.0 x W4.0
	3″ to 4″	4 x 4 – W4.0 x W4.0
	$4^{1}/_{4}$″ to $4^{1}/_{2}$″	6 x 6 – W7.5 x W7.5
	$4^{3}/_{4}$″ to 6″	4 x 4 – W6.0 x W6.0

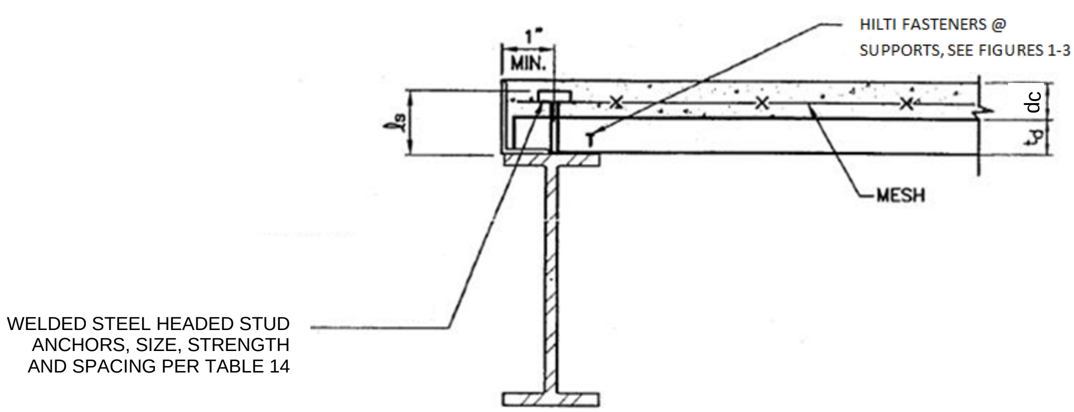
For **SI:** 1 inch = 25.4 mm.

[1]The concrete thickness is measured from the top of steel deck.



For **SI:** 1 inch = 25.4 mm.

FIGURE 4—STEEL HEADED STUD ANCHORS AT SUPPORTS PARALLEL TO FLUTES



For **SI:** 1 inch = 25.4 mm.

FIGURE 5—STEEL HEADED STUD ANCHORS AT SUPPORTS PERPENDICULAR TO FLUTES

TABLE 15—TYPICAL LENGTH OF EXTERIOR OR INTERIOR WELDED STEEL HEADED STUD ANCHORS

t_d	MINIMUM STUD LENGTH (ℓ_s) = t_d+1$^1/_2$"
1$^1/_2$″	3″
2″	3$^1/_2$″
3″	4$^1/_2$″

For **SI:** 1 inch = 25.4 mm.

Refer to footnotes following Table 18.

TABLE 16—NOMINAL SHEAR, P_{nf} (LBS), AND FLEXIBILITY FACTORS, S_f (IN./KIP), FOR X-HSN 24 OR X-ENP-19 L15 FASTENERS ATTACHING STEEL DECK TO STEEL SUPPORTS[1]

FASTENER	FACTOR	PANEL THICKNESS (IN.)			
		0.0598 (16 GAGE)	0.0474 (18 GAGE)	0.0358 (20 GAGE)	0.0295 (22 GAGE)
X-HSN 24	P_{nf}	2924	2348	1795	1489
	S_f	0.0051	0.0057	0.0066	0.0073
X-ENP-19 L15	P_{nf}	3149	2529	1933	1603
	S_f	0.0031	0.0034	0.0040	0.0044

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 inch/kip = 5.7 mm/kN.

[1]Refer to footnotes following Table 18 for additional installation and design requirements.

TABLE 17—ALLOWABLE (ASD) TENSION PULLOUT LOADS TO RESIST TENSION (UPLIFT) LOADS FOR STEEL DECK PANELS ATTACHED WITH X-HSN 24 OR X-ENP-19 L15 FASTENERS (LBS) [1, 2]

FASTENER	BASE MATERIAL THICKNESS, in.						
	$^1/_8$	$^3/_{16}$	$^1/_4$	$^5/_{16}$	$^3/_8$	$^1/_2$ [3]	≥ $^5/_8$ [4]
ASTM A36 (F_y = 36 ksi, F_u = 58 ksi)							
X-HSN 24	435	635	750	750	750	-	-
X-ENP-19 L15	-	-	905	1,010	1,125	1,010	965
ASTM A572 or A992 Grade 50 (F_y = 50 ksi, F_u = 65 ksi)							
X-HSN 24	445	635	750	750	750	-	-
X-ENP-19 L15	-	-	975	1,090	1,205	1,090	1,040

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.

[1]Tabulated allowable (ASD) values based upon a safety factor (Ω) of 5.0. To obtain LRFD pullout capacities, the tabulated values must be multiplied by 1.6.

[2]Unless otherwise noted, the tabulated pullout values are based on minimum penetration of fasteners of $^9/_{16}$-inch for the X-ENP-19 fasteners. The X-HSN 24 fastener tabulated values are based upon fastener stand-off dimensions shown in Figure 8.

[3]Tabulated pullout capacities in $^1/_2$-inch steel based upon a minimum point penetration of $^1/_2$-inch. If $^1/_2$-inch point penetration is not achieved, but a point penetration of at least $^3/_8$-inch is obtained, the tabulated value must be multiplied by a factor of 0.63.

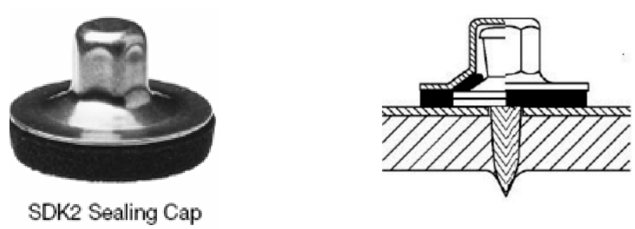
[4]Tabulated pullout capacities in greater than or equal to $^5/_8$-inch steel based upon a minimum point penetration of $^1/_2$-inch. If $^1/_2$-inch point penetration is not achieved, but a point penetration of at least $^3/_8$-inch is obtained, the tabulated value must be multiplied by a factor of 0.82.

TABLE 18—ALLOWABLE TENSION PULLOVER LOADS TO RESIST TENSION (UPLIFT) LOADS FOR STEEL DECK PANELS ATTACHED WITH X-HSN 24 OR X-ENP-19 L15 FASTENERS (LBS) [1, 2]

FASTENER	BASE STEEL THICKNESS, in.	DECK GAGE (in.)			
		No. 22 (0.0295)	No. 20 (0.0358)	No. 18 (0.0474)	No. 16 (0.0598)
X-HSN 24	$^{1}/_{8} \le t_f \le ^{3}/_{8}$	500	560	725	865
X-ENP-19 L15	$\ge ^{1}/_{4}$	660	705	805	880

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]Tabulated allowable (ASD) values are based upon a safety factor (Ω) of 3.0. To obtain LRFD pullout capacities, the tabulated values must be multiplied by 1.6.
[2]Based upon minimum ASTM A653 SS Grade 33 (F_y = 33 ksi, F_u = 45 ksi) steel deck as described in Section 3.2 of this report.



Note: To be used with X-ENP-19 L15 fasteners. X-ENP-19 Nailhead standoff (h_{NVS}) must be as shown in Figure 7

FIGURE 6—SDK2 SEALING CAP

FOOTNOTES TO TABLES 3 THROUGH 18

1. Hilti, X-HSN 24 or X-ENP-19 L15 fasteners are used at all panel ends, interior supports and deck edges parallel to the deck corrugations. The sides of adjacent panels parallel to the corrugations are lapped by nesting or interlocking and then fastened with a minimum No. 10 self-drilling steel screws as described in Section 3.7 or button punched.
2. Evenly spaced seam connectors per span length excluding those at supports.
3. The following assumptions apply to the attached tables:
    a. The deck sheet length is assumed to equal the span times the number of spans.
    b. All tables are based on a three span condition.
    c. For steel deck diaphragms in Tables 3 – 6, the number of diaphragm edge fasteners at walls or transfer zones parallel to the deck corrugations is assumed to equal the same number of stitch or sidelap connectors at interior sidelaps.
    d. For concrete filled diaphragms in Tables 8 – 11, the number of edge fasteners at walls or transfer zones parallel to the deck corrugations shall not exceed 30 inches (762 mm) on center.
4. Tables 3 – 5, 8, and 10 apply to intermediate and wide rib $1^1/_2$-inch (38 mm) deep steel deck with a flute pitch of 6 inches provided adequate space is available for fastener placement.
5. Tables 6 apply to 3-inch deep steel deck with flute pitch of 8 inches and Tables 12 - 14 apply to 2-inch and 3-inch deep steel decking with flute pitch of 12 inches, provided adequate space is available for fastener placement.
6. For Tables 8 – 11, No.10 screws or larger may be substituted for the specified button punches.
7. For Tables 8-11, the number of perimeter edge and perimeter end support fasteners for concrete-filled diaphragms must be determined in accordance with AISI S310-16 or AISI S310-13 Section D4.4. However, the number of perimeter edge and perimeter end support fasteners must be at least equivalent to the number of side-lap connections per span.
8. The embedment of Hilti fasteners into the structural support member is such that the standoff dimension, h_{NVS} in Figures 7 – 8 is obtained.
9. Hilti fasteners shall be centered not less than 1 inch (25 mm) from the panel ends and not less than 5/16 inch (7.9 mm) from the panel edges parallel to corrugations at the sidelaps.
10. Diaphragm deflections must be considered in the design. Table 19 describes diaphragm limitations.
    a. Flexibility Factor F is defined as the average micro-inches a diaphragm web will deflect in a span of one foot under a shear load of one pound per foot.

       F = 1000/G′, micro-inches/pound (μm/N)

    b. The general deflection equation is:

       $$\frac{d^2y}{dx^2} = M / EI + q / B G'$$

       For a uniformly loaded rectangular diaphragm on a simple span, the maximum deflection at the centerline of the diaphragm is:

       $\Delta = 5(1728)qL^4 / 384\ EI + qLF/ 10^6$

       (For **SI:** $5(1000)^4\ qL^4 / 384\ EI + qLF/10^6$)

       Δ = Diaphragm deflection, inches (mm).

       q = Wind or seismic load, kips per lineal foot (N/m)

       q_{ave} = Average shear in diaphragm in pounds per foot (N/m) over length L.

       L = Length of diaphragm normal to load, feet (m).

       B = Width of diaphragm parallel to load, feet (m).

       E = Modulus of elasticity of supporting steel chord material, pounds per square inch (kPa).

       I = Moment of inertia, $inches^4$ (mm^4).

       Diaphragm deflection equations provided apply to rectangular symmetrical diaphragms only. Nonrectangular diaphragms, nonsymmetrical diaphragms with re-entrant corners or diaphragms subjected to torsional loadings require special design considerations.

    c. Roof diaphragms supporting masonry or concrete walls shall have their deflections limited to the following:

       $\Delta = H^2\ f_c / 0.01E\ t$

       (For **SI:** $694{,}000\ H^2 f'_c / EI$)

       Δ = Deflection of top of wall, inches (mm).

       H = Wall height, feet (mm).

       T = Thickness of the wall, inches (mm).

       E = Modulus of elasticity of the wall material, pounds per square inch (kPa).

       f_c = Allowable flexural compressive strength of the wall material, pounds per square inch (kg/m^3). For masonry $f_c = 0.33f'_m$; for concrete $f_c = 0.45f'_c$.

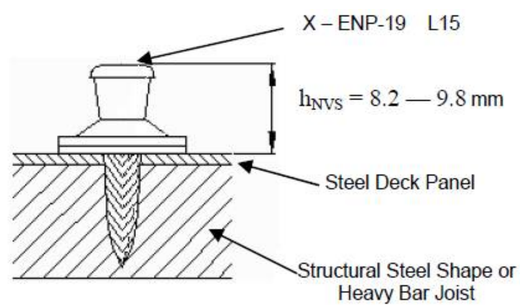


FIGURE 7—NAIL HEAD STANDOFF (h_{NVS}) FOR X-ENP-19 L15 FASTENERS

FIGURE 8—NAIL HEAD STANDOFF (h_{NVS}) FOR X-HSN 24 FASTENERS

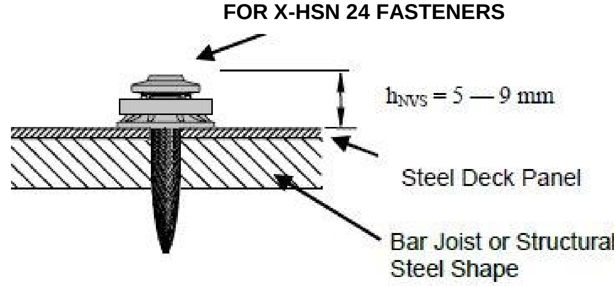


TABLE 19—DIAPHRAGM FLEXIBILITY LIMITATION[1,2,3,4,5]

(Only applicable to 2015 IBC and earlier editions)

F	MAXIMUM SPAN IN FEET FOR MASONRY OR CONCRETE WALLS	SPAN-DEPTH LIMITATION			
		Rotation Not Considered in Diaphragm		Rotation Considered in Diaphragm	
		Masonry or Concrete Walls	Flexible Walls	Masonry or Concrete Walls	Flexible Walls
More than 150	Not used	Not used	2:1	Not used	$1^1/_2$:1
70 – 150	200	2:1 or as required for deflection	3:1	Not used	2:1
10 – 70	400	$2^1/_2$:1 or as required for deflection	4:1	As required for deflection	$2^1/_2$:1
1 – 10	No limitation	3:1 or as required for deflection	5:1	As required for deflection	3:1
Less than 1	No limitation	As required for deflection	No limitation	As required for deflection	$3^1/_2$:1

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 plf = 14.594 N/m, 1 psi = 6894 Pa.

[1]Diaphragms are to be investigated regarding their flexibility and recommended span-depth limitations.
[2]Diaphragms supporting masonry or concrete walls are to have their deflections limited to the following amount:

$$\Delta_{wall} = \frac{H^2 f_c}{0.01\,Et} \quad \text{For } \mathbf{SI}\text{: } \Delta_{wall} = \frac{694{,}000\,H^2 f_c}{Et}$$

where:

H = Unsupported height of wall in feet or millimeters.
t = Thickness of wall in inches or millimeters.
E = Modulus of elasticity of wall material for deflection determination in pounds per square inch or kilopascals.
f_c = Allowable compression strength of wall material in flexure in pounds per square inch or kilopascals. For concrete, $f_c = 0.45\,f'_c$. For masonry, $f_c = F_b = 0.33\,f'_m$.

[3]The total deflection Δ of the diaphragm may be computed from the equation: $\Delta = \Delta_f + \Delta_w$.

where:

Δ_f = Flexural deflection of the diaphragm determined in the same manner as the deflection of beams.
Δ_w = The web deflection may be determined by the equation:

$$\Delta_w = \frac{q_{ave}\,L\,F}{10^6} \quad \text{For } \mathbf{SI}\text{: } \Delta_w = \frac{q_{ave}\,L\,F}{175}$$

where:

L = Distance in feet between vertical resisting element (such as shear wall) and the point to which the deflection is to be determined.
q_{ave} = Average shear in diaphragm in pounds per foot or newtons per meter over length L.
F = Flexibility factor: The average microinches or micrometers (μm) a diaphragm web will deflect in a span of 1 foot (m) under a shear of 1 pound per foot (N/m).

[4]When applying these limitations to cantilevered diaphragms, the allowable span-depth ratio will be half that shown.

ICC-ES Evaluation Report

ESR-2197 LABC Supplement

Reissued December 2021

This report is subject to renewal December 2023.

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DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings
Section: 05 31 00—Steel Decking

REPORT HOLDER:

HILTI, INC.

EVALUATION SUBJECT:

BARE STEEL DECK AND CONCRETE-FILLED STEEL DECK DIAPHRAGMS ATTACHED WITH HILTI X-HSN 24 OR X-ENP-19 L15 POWDER-DRIVEN FRAME FASTENERS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the bare steel deck and concrete-filled steel deck diaphragms attached with Hilti X-HSN 24 or X- ENP-19 L 15 powder-driven frame fasteners, described in ICC-ES evaluation report ESR-2197, have also been evaluated for compliance with the code noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code edition:

- 2020 *City of Los Angeles Building Code* (LABC)

2.0 CONCLUSIONS

The bare steel deck and concrete-filled steel deck diaphragms attached with Hilti X-HSN 24 or X- ENP-19 L 15 powder-driven frame fasteners, described in Sections 2.0 through 7.0 of the evaluation report ESR-2197, comply with the LABC Chapter 22*,* and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The bare steel deck and concrete-filled steel deck diaphragms attached with Hilti X-HSN 24 or X- ENP-19 L 15 powder-driven frame fasteners described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-2197.
- The design, installation, conditions of use and identification are in accordance with the 2018 *International Building Code*® (2018 IBC) provisions noted in the evaluation report ESR-2197.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Diaphragm shear strength values in the evaluation report must not be increased for load combinations that include wind or seismic loads.
- For diaphragms that are used to provide wall anchorage, the adequacy of the steel deck panel end and side seam connections must be verified by a registered design professional to the satisfaction of the code official.

This supplement expires concurrently with the evaluation report, reissued December 2021.

ICC-ES Evaluation Report

ESR-2197 FBC Supplement

Reissued December 2021

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HILTI, INC.

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BARE STEEL DECK AND CONCRETE-FILLED STEEL DECK DIAPHRAGMS ATTACHED WITH HILTI X-HSN 24 OR X-ENP-19 L15 POWDER-DRIVEN FRAME FASTENERS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that Bare Steel Deck and Concrete-Filled Steel Deck Diaphragms Attached with HILTI X-HSN 24 or X-ENP-19 L15 Power-Driven Frame Fasteners, described in ICC-ES evaluation report ESR-2197, has also been evaluated for compliance with the code noted below.

Applicable code edition:

- 2020 *Florida Building Code—Building*

2.0 CONCLUSIONS

The Bare Steel Deck and Concrete-Filled Steel Deck Diaphragms Attached with HILTI X-HSN 24 or X-ENP-19 L15 Power-Driven Frame Fasteners , described in Sections 2.0 through 7.0 of ICC-ES evaluation report ESR-2197, comply with the *Florida Building Code—Building*. The design requirements shall be determined in accordance with the *Florida Building Code—Building*. The installation requirements noted in ICC-ES evaluation report ESR-2197 for the 2018 *International Building Code®* meet the requirements of the *Florida Building Code—Building*, with the following conditions:

Use of the Bare Steel Deck and Concrete-Filled Steel Deck Diaphragms Attached with HILTI X-HSN 24 or X-ENP-19 L15 Power-Driven Frame Fasteners has also been found to be in compliance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and must comply with the following conditions of use:

When the power-driven frame fasteners are used with 22 gage or less (thinner) steel decking, the steel decking must have minimum G90 galvanizing in accordance with Section 2222.6.1 of the FBC.

For products falling under Florida Rule 61G20-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued December 2021.