1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2013 Abu Dhabi International Building Code (ADIBC)†

†The ADIBC is based on the 2009 IBC. 2009 IBC code sections referenced in this report are the same sections in the ADIBC.

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS), see ESR-2776 LABC and LARC Supplement.

Property evaluated:
Structural

2.0 USES

Hilti’s X-HSN 24 and X-ENP-19 L15 powder-driven frame fasteners; Hilti’s S-SLC 01 M HWH and S-SLC 02 M HWH sidelan connectors; and Verco’s VSC2 sidelan connections are used for the connection of steel deck diaphragms. The powder-driven fasteners are used to attach the steel deck panels to supporting steel framing, and the sidelan connectors/connections are used to connect the steel deck panels together at the panel sidelanaps.

3.0 DESCRIPTION

3.1 Hilti Powder-Driven Frame Fasteners:

The Hilti powder-driven fasteners are manufactured from hardened carbon steel with an electroplated zinc coating complying with ASTM B633, SC 1, Type III. Table 1 and Figures 1 and 2 provide illustrations and additional information on the fasteners. Table 1 also provides depictions of the Hilti powder-driven fasteners and the corresponding steel support framing application ranges.

The X-HSN 24 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.

The X-ENP-19 L15 fasteners are 0.937 inch (23.8 mm) long with a 0.177-inch-diameter (4.5 mm) fully knurled tip and tapered shank fitted with two 0.590-inch-diameter (15 mm) steel cupped washers.

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 5 depicts the Hilti SDK2 sealing cap.

3.2 Sidelan Connectors / Connections:

3.2.1 Hilti Sidelan Connectors (SLC):

The Hilti S-SLC 01 M HWH sidelan connectors are proprietary No. 10, double-thread, self-piercing, carbon steel threaded fasteners with an electroplated zinc coating, Cr3+ passivation.

The Hilti S-SLC 02 M HWH sidelan connectors are proprietary No. 12, single thread, self-drilling, carbon steel threaded fasteners with an electroplated zinc coating complying with ASTM F1941. Table 2 provides illustrations and corresponding steel material application limits.

3.2.2 Verco Sidelan Connections (VSC2):

The VSC2 Connection is an interlocking connection between the male and female lips of the Verco PLB steel roof deck panels. A VSC2 Connection is made in either direction relative to the female lip. A VSC2 Connection is made when the sidelan material has been sheared and offset so the sheared surface of the steel deck panel male leg is visible. The punched portion measures a minimum 0.45-inch nominal width by 0.30-inch nominal height. The resulting VSC2 Connection is illustrated in Figure 4e.

3.3 Steel Deck Panels:

The steel deck panels must be Type B (nestable), Type BI (interlocking) or Verco PLB (interlocking) steel deck panels complying with Table 3.

Type B and Type BI panels must comply with ASTM A653 SS Grade 33 (minimum) with a minimum G60 galvanized coating designation, or be phosphatized steel
complying with ASTM A1008 SS Grade 33 (minimum). Steel deck panels may also be produced from ASTM A653 SS Grade 50 steel with a minimum G60 galvanized coating designation, except the minimum tensile strength must be 92 ksi (634 MPa).

Verco’s PLB panels must comply with ASTM A653 SS Grade 50 Classes 1, 3, or 4 (minimum) steel, with a minimum G30 galvanized coating designation, or be phosphatized/painted, painted/painted, or mill-finished steel complying with ASTM A1008 Grade SS Grade 50 (minimum).

3.4 Steel Support Framing:

Structural steel supports of the steel deck panels (such as bar joists and structural steel shapes) must be manufactured from a code-compliant steel having minimum strength requirements of ASTM A36 and minimum thicknesses as noted in the tables of this report. Table 10 provides pullout values for fasteners installed into framing manufactured from code-compliant steel having minimum strength requirements of ASTM A572 Grade 50 or ASTM A992, in addition to pullout values for fasteners installed into code-compliant steel having minimum strength requirements of ASTM A36.

4.0 DESIGN AND INSTALLATION

4.1 Design:

For symbols and definitions, see the American Iron and Steel Institute’s North American Standard for the Design of Profiled Steel Diaphragm Panels (AISI S31016).

4.1.1 Diaphragm Shear and Stiffness by Calculations:

The allowable (ASD) or factored (LRFD) diaphragm shear strength and stiffness must be determined in accordance with AISI S310-13 while using Tables 4, 5, 6, and 8. The diaphragm shear strength must also be multiplied by the correlation factors in Table 5. The allowable (ASD) or factored (LRFD) diaphragm shear strength must not be greater than the allowable (ASD) or factored (LRFD) diaphragm buckling strengths in Table 9.

Minimum sidelap spacing of fasteners noted in Table 7 must be considered.

An example calculation can be found at the end of this report.

4.1.2 Uplift/Tension: For designs considering uplift/tension forces, see Tables 10 and 11.

4.1.3

4.2 Installation:

The B and BI decks are fastened to the structural supports with the Hilti powder-driven frame fasteners X-HSN 24 or X-ENP-19 in accordance with Table 2. The Hilti frame fasteners, Hilti sidelpap connectors, Verco sidelpap connectors, and the Hilti SDK2 Sealing Caps must be installed in accordance with the manufacturer’s published installation instructions.

Steel deck panel ends must overlap a minimum of 2 inches (51 mm) as shown in Figure 6b. End lap and corner lap conditions of two- and four-deck layers must be snug and tight to one another and the supporting steel frame, prior to frame fastener attachment. Standing seam interlocking-type sidelpaps must be well engaged prior to sidelpap connector installation.

Powder-driven frame fasteners must be installed in the specified pattern, and sidelpap connectors must be installed at the specified spacing (see Figure 7a) or number of connectors per span (see Figure 6b). For conversion of specified fastener spacing to the number of sidelpap fasteners to be installed, see Table 12. The powder-driven frame fastener patterns are shown in Figure 3. Figure 4 shows typical frame and sidelpap connector connections. Figure 7 provides an overview of the steel deck fastening systems recognized in this report.

5.0 CONDITIONS OF USE

Steel deck diaphragms comprised of steel deck panels attached to steel supports with Hilti X-HSN 24, or X-ENP-19 L15 powder-driven fasteners, with Hilti S-81 SC 01 M HWH or Hilti S-81 SC 02 M HWH sidelpap connectors, or Verco’s VSC2 sidelpap connection, 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 Steel deck panels must comply with this report. When the steel deck panels are used as roof decks, the panel must be covered with an approved code-complying roof covering.

5.3 No adjustment for duration of load is permitted.

5.4 Steel deck diaphragms may be zoned by varying steel deck panel gage and/or connections across a diaphragm to meet varying shear and flexibility demands.

5.5 For intermediate steel deck panel thicknesses or panel steel strengths, diaphragm strength and stiffness values shall be based on straight-line interpolation between values determined in accordance with Section 4.1, as described in the note at the end of the diaphragm design example shown in Figure 8.

5.6 The design of the steel deck panels for vertical loads is outside the scope of this report.

5.7 Calculations demonstrating compliance with 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.

5.8 Hilti fasteners may be used for attachment of steel deck roof systems temporarily exposed to the exterior during construction prior to application of built-up roof covering systems. 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 Hilti X-ENP-19 L15 fasteners, these fasteners may be used in conjunction with the SDK2 Stainless Steel Sealing Caps, described in Section 3.1 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, for recognition under the 2018 and
2015 IBC.

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),
for recognition under the 2012 and 2009 IBC.

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

7.0 IDENTIFICATION

7.1 All Hilti powder-driven fasteners and sidelap
connectors described in this report are identified by
an “H” stamped on the fastener head. All fasteners
are packaged in containers noting the product
designation, the company name of Hilti, Inc. and the
evaluation report number (ESR-2776).

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
TABLE 1—HILTI POWDER-DRIVEN FRAME FASTENER SELECTOR GUIDE

<table>
<thead>
<tr>
<th>Steel Support Framing</th>
<th>Fastener Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Joist or Structural Steel Shape with $\frac{1}{8}$ in. ≤ $t_f$ ≤ $\frac{3}{8}$ in.</td>
<td>X-HSN 24</td>
</tr>
<tr>
<td>Structural Steel, Hardened Structural Steel or Heavy Bar Joist with $t_f \geq \frac{1}{4}$ in.</td>
<td>X-ENP-19 L15</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 ksi = 6.89 Mpa.

1Figure 7 illustrates an overview of the steel deck fastening systems recognized in this report and a visual representation of location for intended use on the steel deck diaphragm.

2The tensile strength ($F_u$) of the steel of the support framing must be less than 91 ksi for all fasteners and support framing steel thickness combinations, except for the X-HSN 24 fasteners with steel thicknesses greater than $\frac{3}{16}$-inch. In this case, the tensile strength of the steel of the support framing must be less than 75 ksi for the X-HSN 24. For minimum strength requirements of the steel support framing, see Section 3.4 of this report.

3Reference Figure 5 for information regarding the use of the SDK2 sealing cap.

TABLE 2—SIDELAP CONNECTOR SELECTOR GUIDE

<table>
<thead>
<tr>
<th>Steel Deck Panel Thicknesses</th>
<th>Fastener Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nos. 22, 20, 18 gage B and BI decks</td>
<td>Hilti S-SLC 01 M HWH</td>
</tr>
<tr>
<td>Nos. 22, 20, 18, 16 gage B and BI decks</td>
<td>Hilti S-SLC 02 M HWH</td>
</tr>
<tr>
<td>Nos. 22, 20, 18, 16 gage Verco PLB Deck</td>
<td>Verco’s VSC 2 Connection, See Figure 4e.</td>
</tr>
</tbody>
</table>

1Figure 7 illustrates an overview of the steel deck fastening systems recognized in this report and a visual representation of location for intended use on the steel deck diaphragm.
TABLE 3—STEEL DECK PANEL SELECTOR GUIDE 1, 2, 3

<table>
<thead>
<tr>
<th>Deck Type</th>
<th>Nominal Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-Deck</td>
<td>![B-Deck Diagram]</td>
</tr>
<tr>
<td>Bi-Deck and Verco PLB Deck</td>
<td>![Bi-Deck and Verco PLB Deck Diagram]</td>
</tr>
</tbody>
</table>

1. B-Deck (nestable) and Bi-Deck (interlocking) deck panel thicknesses must be 16, 18, 20 or 22 gage steel [(54, 43, 33 or 27 mil designations) (0.0598, 0.0474, 0.0358 or 0.0295 inch) (1.51, 1.21, 0.91 or 0.76 mm)], respectively. Intermediate steel deck panel thicknesses may be used (Reference Section 5.6 of this report).

2. PLB (interlocking) deck panel thicknesses must be 16, 18, 20 or 22 gage steel [(54, 43, 33 or 27 mil designations) (0.0598, 0.0478, 0.0359 or 0.0299 inch) (1.51, 1.21, 0.91 or 0.76 mm)], respectively. Intermediate steel deck panel thicknesses may be used (Reference Section 5.6 of this report).

3. Bi-Deck (interlocking) deck panels must have screwable sidelap edges for use with Hilti SLC fasteners.

TABLE 4—DIAPHRAGM STRENGTH (S) AND STIFFNESS FACTOR (G') EQUATION VARIABLE VALUES (to be used with equations in Sections 4.1.2 and 4.1.3)

<table>
<thead>
<tr>
<th>Deck Type \ Frame Fastener Pattern</th>
<th>(\alpha_1) or (\alpha_3) – end distribution factor</th>
<th>(\alpha_2) or (\alpha_4) – purlin distribution factor</th>
<th>(\Sigma x_{e1}^2) or (\Sigma x_{p1}^2), in.²</th>
<th>(\Sigma x_{e2}^2) or (\Sigma x_{p2}^2), in.²</th>
<th>(s/d)</th>
<th>A</th>
<th>N (\frac{\text{ft}^{-1}}{})</th>
<th>D – Warping Constant, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B- or Bi- Deck</td>
<td>36/11</td>
<td>3.667</td>
<td>3.667</td>
<td>1.944</td>
<td>1.944</td>
<td>1.365</td>
<td>2</td>
<td>3.000</td>
</tr>
<tr>
<td></td>
<td>36/9</td>
<td>3.000</td>
<td>3.000</td>
<td>1.656</td>
<td>1.656</td>
<td>1.365</td>
<td>2</td>
<td>2.333</td>
</tr>
<tr>
<td></td>
<td>36/7</td>
<td>2.000</td>
<td>2.000</td>
<td>1.008</td>
<td>1.008</td>
<td>1.365</td>
<td>1</td>
<td>2.000</td>
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<td>936</td>
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<td>1.333</td>
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<td>36/4</td>
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<td>1.333</td>
<td>720</td>
<td>720</td>
<td>1.365</td>
<td>1</td>
<td>1.000</td>
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<td></td>
<td>36/3</td>
<td>1.000</td>
<td>1.000</td>
<td>648</td>
<td>648</td>
<td>1.365</td>
<td>1</td>
<td>0.667</td>
</tr>
<tr>
<td>Verco PLB Deck</td>
<td>36/11</td>
<td>3.667</td>
<td>3.667</td>
<td>1.944</td>
<td>1.944</td>
<td>1.365</td>
<td>2</td>
<td>3.667</td>
</tr>
<tr>
<td></td>
<td>36/9</td>
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<td>3.000</td>
<td>1.656</td>
<td>1.656</td>
<td>1.365</td>
<td>2</td>
<td>3.000</td>
</tr>
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<td></td>
<td>36/8</td>
<td>2.333</td>
<td>2.333</td>
<td>1.152</td>
<td>1.152</td>
<td>1.365</td>
<td>2</td>
<td>2.667</td>
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<tr>
<td></td>
<td>36/7</td>
<td>2.000</td>
<td>2.000</td>
<td>1.008</td>
<td>1.008</td>
<td>1.365</td>
<td>1</td>
<td>2.333</td>
</tr>
<tr>
<td></td>
<td>36/6</td>
<td>1.500</td>
<td>1.500</td>
<td>684</td>
<td>684</td>
<td>1.365</td>
<td>1</td>
<td>2.000</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 in.² = 645 mm², 1 ft¹ = 3.28 m¹.

1See Table 3 for applicable steel deck panels.

2See Figure 3a and 3b for frame fastener patterns.
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Steel Deck Panel Gage Thickness</th>
<th>No. 22</th>
<th>No. 20</th>
<th>No. 18</th>
<th>No. 16</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck Type</td>
<td>Minimum Deck Tensile, F&lt;sub&gt;u&lt;/sub&gt;, (Yield, F&lt;sub&gt;y&lt;/sub&gt;) Strengths, ksi</td>
<td>Frame Fastener/Steel Support Framing Thickness, in.</td>
<td>Sidelap Connector&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>P&lt;sub&gt;nf&lt;/sub&gt;, (lb)</td>
<td>P&lt;sub&gt;ns&lt;/sub&gt;, (lb)</td>
<td>P&lt;sub&gt;nf&lt;/sub&gt;, (lb)</td>
<td>P&lt;sub&gt;ns&lt;/sub&gt;, (lb)</td>
<td>P&lt;sub&gt;nf&lt;/sub&gt;, (lb)</td>
<td>P&lt;sub&gt;ns&lt;/sub&gt;, (lb)</td>
</tr>
<tr>
<td>45 (33)</td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 1/8 ≤ t&lt;sub&gt;f&lt;/sub&gt; &lt; 3/16</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,357 844 1,282 1,260 1,865 1,701 - -</td>
<td>1.155 1.172 1.203 - -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 3/16 ≤ t&lt;sub&gt;f&lt;/sub&gt; ≤ 3/8</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,590 844 2,107 1,260 2,663 1,701 3,035 2,024</td>
<td>1.121 1.102 1.066 1.028</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>X-ENP-19 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 t&lt;sub&gt;f&lt;/sub&gt; ≥ 1/4</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,597 844 2,112 1,260 2,764 1,701 3,079 2,024</td>
<td>1.257 1.205 1.106 1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>92 (80)</td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 1/8 ≤ t&lt;sub&gt;f&lt;/sub&gt; &lt; 3/16</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,357 844 1,824 1,260 1,865 1,701 - -</td>
<td>1.155 1.172 1.203 - -</td>
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</tr>
<tr>
<td></td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 3/16 ≤ t&lt;sub&gt;f&lt;/sub&gt; ≤ 3/8</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,941 954 2,208 1,341 2,698 1,859 3,095 2,343</td>
<td>1.052 1.054 1.058 1.062</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>X-ENP-19 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 t&lt;sub&gt;f&lt;/sub&gt; ≥ 1/4</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,964 954 2,165 1,341 3,022 1,859 3,577 2,343</td>
<td>1.197 1.166 1.108 1.046</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>45 (33)</td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 1/8 ≤ t&lt;sub&gt;f&lt;/sub&gt; &lt; 3/16</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,357 844 1,712 1,111 1,865 1,591 - -</td>
<td>1.155 1.172 1.203 - -</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>X-HSN 24 36/3, 36/4, 36/5, 36/7, 36/9, 36/11 3/16 ≤ t&lt;sub&gt;f&lt;/sub&gt; ≤ 3/8</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>1,516 882 1,712 1,111 2,450 1,591 2,553 2,051</td>
<td>1.284 1.233 1.140 1.040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
|               | (continued)
### TABLE 5—DIAPHRAGM STRENGTH EQUATION VARIABLE VALUES (Continued)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Steel Deck Panel Gage Thickness</th>
<th>Sidelap Connector</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
<th>Correlation Factor, c</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deck Type</strong></td>
<td><strong>Minimum Deck Tensile, ( F_u )</strong> (Yield, ( F_y ) ) Strengths, ksi</td>
<td><strong>Frame Fastener/Steel Support Framing Thickness, in.</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
</tr>
<tr>
<td>Verco PLB 65 (50)</td>
<td>X-HSN 24 36/7, 36/9, 36/11 ( \frac{1}{16} \leq t &lt; \frac{3}{16} )</td>
<td>Verco VSC2</td>
<td>1.357 2.067 1.712 2.823 1.865 4.323 1.865 4.323</td>
<td>1.000 1.000 1.000 1.000</td>
<td>1.000 1.000 1.000 1.000</td>
<td>1.000 1.000 1.000 1.000</td>
</tr>
<tr>
<td>Verco PLB 65 (50)</td>
<td>X-HSN 24 36/7, 36/9, 36/11 ( \frac{3}{16} \leq t \leq \frac{3}{8} )</td>
<td>Verco VSC2</td>
<td>1.489 2.067 1.795 2.823 2.348 4.323 2.924 5.835</td>
<td>1.000 1.000 1.000 1.000</td>
<td>1.000 1.000 1.000 1.000</td>
<td>1.000 1.000 1.000 1.000</td>
</tr>
<tr>
<td>Verco PLB 65 (50)</td>
<td>X-ENP-19 36/6 ( t \geq \frac{1}{4} )</td>
<td>Verco VSC2</td>
<td>1.624 2.067 1.938 2.823 2.549 4.323 3.149 5.835</td>
<td>1.056 1.095 1.173 1.251</td>
<td>1.056 1.095 1.173 1.251</td>
<td>1.056 1.095 1.173 1.251</td>
</tr>
<tr>
<td>Verco PLB 65 (50)</td>
<td>X-ENP-19 36/8 ( t \geq \frac{1}{4} )</td>
<td>Verco VSC2</td>
<td>1.624 2.067 1.938 2.823 2.549 4.323 3.149 5.835</td>
<td>1.014 1.004 0.985 0.965</td>
<td>1.014 1.004 0.985 0.965</td>
<td>1.014 1.004 0.985 0.965</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.
1Sidelap connector spacing must comply with requirements in Table 7.
2For steel deck panel thicknesses applicable to the specific panel sidelpap connector, see Table 2.
3See Table 3 for steel deck panel thicknesses in inches [(mils), (mm)].

### TABLE 6—DIAPHRAGM STIFFNESS (\( G' \)) EQUATION VARIABLE VALUES

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Steel Deck Panel Gage Thickness</th>
<th>Sidelap Connector</th>
<th>( S_r ), in./kip</th>
<th>( S_r ), in./kip</th>
<th>( S_r ), in./kip</th>
<th>( S_r ), in./kip</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deck Type</strong></td>
<td><strong>Minimum Deck Tensile, ( F_u )</strong> (Yield, ( F_y ) ) Strengths, ksi</td>
<td><strong>Frame Fastener</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
<td><strong>Correlation Factor, c</strong></td>
</tr>
<tr>
<td>B or BI 45 to 92 (33 to 80)</td>
<td>X-HSN 24</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>0.0073 0.0066 0.0057 0.0051</td>
<td>0.0175 0.0159 0.0138 0.0123</td>
<td>0.0044 0.0040 0.0034 0.0031</td>
<td>0.0175 0.0159 0.0138 0.0123</td>
</tr>
<tr>
<td>Verco PLB 65 (50)</td>
<td>X-ENP-19</td>
<td>S-SLC 01 M HWH S-SLC 02 M HWH</td>
<td>0.0073 0.0066 0.0057 0.0051</td>
<td>0.0360 0.0253 0.0115 0.0074</td>
<td>0.0044 0.0040 0.0034 0.0031</td>
<td>0.0360 0.0253 0.0115 0.0074</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 in/kip = 5.7 mm/kN, 1 ksi = 6.89 MPa.
1For steel deck panel thicknesses applicable to the specific panel sidelpap connector, see Table 2.
2See Table 3 for steel deck panel thicknesses in inches [(mils), (mm)].
<table>
<thead>
<tr>
<th>Frame Fastener/Steel Support Framing Thickness, in.</th>
<th>Deck Gage No.</th>
<th>36/3</th>
<th>36/4</th>
<th>36/5</th>
<th>36/6</th>
<th>36/7</th>
<th>36/8</th>
<th>36/9&lt;sup&gt;4&lt;/sup&gt;</th>
<th>36/11&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-HSN 24</td>
<td>22</td>
<td>_</td>
<td>12</td>
<td>12</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>1/8 ≤ t&lt;sub&gt;f&lt;/sub&gt; &lt; 3/16</td>
<td>20</td>
<td>_</td>
<td>6</td>
<td>6</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>18</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>16</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>X-HSN 24</td>
<td>22</td>
<td>12</td>
<td>_</td>
<td>6</td>
<td>6</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>1/16 ≤ t&lt;sub&gt;f&lt;/sub&gt; ≤ 1/8</td>
<td>20</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>18</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>16</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>X-ENP-19</td>
<td>22</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>t ≥ 1/4</td>
<td>20</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>18</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>16</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 ksi = 6.89 MPa.

<sup>1</sup>When the specified sidelap connector spacing is less than those tabulated, the tabulated spacing shall be used in the calculation of diaphragm strength and stiffness when using the values for P<sub>nlf</sub>, P<sub>nfs</sub> and c from Table 5. As an alternate, when the specified sidelap connector spacing is less than those tabulated, but not less than 3 inches, the following values for P<sub>nlf</sub>, P<sub>nfs</sub> and c may replace the values from Table 5:

- X-HSN 24 – All deck types, strengths, and steel support framing thicknesses listed in Table 5
  - No. 22 Gage (0.0295 in.) – P<sub>nlf</sub> = 1,489 lb, P<sub>nfs</sub> = 716 lb, c = 1.000
  - No. 20 Gage (0.0358 in.) – P<sub>nlf</sub> = 1,795 lb, P<sub>nfs</sub> = 869 lb, c = 1.000
  - No. 18 Gage (0.0474 in.) – P<sub>nlf</sub> = 2,348 lb, P<sub>nfs</sub> = 1,151 lb, c = 1.000

- X-ENP-19 L15 – All deck types, strengths and steel support framing thicknesses listed in Table 5
  - No. 22 Gage (0.0295 in.) – P<sub>nlf</sub> = 1,603 lb, P<sub>nfs</sub> = 716 lb, c = 1.000
  - No. 20 Gage (0.0358 in.) – P<sub>nlf</sub> = 1,933 lb, P<sub>nfs</sub> = 869 lb, c = 1.000
  - No. 18 Gage (0.0474 in.) – P<sub>nlf</sub> = 2,529 lb, P<sub>nfs</sub> = 1,151 lb, c = 1.000

<sup>2</sup>Noted minimum recommended sidelap connection spacings given for Hilti S-SLC 01 M HWH and S-SLC 02 M HWH sidelap connectors. For Verco VSC2 Connections, the minimum recommended sidelap connection spacing for these configurations is 4 inches.

<sup>3</sup>Frame fastener patterns recognized for specific deck type, frame fastener, sidelap combinations are shown in Table 5.

<sup>4</sup>For 36/9 and 36/11 patterns, when allowable seismic (or wind) diaphragm shear capacities exceed the values as shown below, the fastening pattern must be increased at the building perimeter, chords, collectors or other shear transfer elements to two fasteners per rib (i.e. 36/14 pattern). The allowable seismic (or wind) diaphragm shear capacity must not be greater than that determined from the 36/9 and 36/11 patterns, as applicable.

- X-HSN 24 – with steel support framing thicknesses < 3/16-inch
  - No. 22 Gage (0.0295 in.) – 1,200 plf (1275 plf)
  - No. 20 Gage (0.0358 in.) – 1,500 plf (1,600 plf)
  - No. 18 Gage (0.0474 in.) – 1,700 plf (1,825 plf)

- X-HSN 24 – with steel support framing thicknesses ≥ 3/16-inch
  - No. 22 Gage (0.0295 in.) – 1,300 plf (1,400 plf)
  - No. 20 Gage (0.0358 in.) – 1,600 plf (1,700 plf)
  - No. 18 Gage (0.0474 in.) – 2,100 plf (2,250 plf)
  - No. 16 Gage (0.0598 in.) – 2,600 plf (2,775 plf)
### TABLE 8—SAFETY FACTORS FOR ALLOWABLE STRENGTH DESIGN (ASD) AND RESISTANCE FACTORS FOR LOAD AND RESISTANCE FACTOR DESIGN (LRFD) IN ACCORDANCE WITH AISI S310

<table>
<thead>
<tr>
<th>LOAD TYPE OR COMBINATIONS INCLUDING</th>
<th>CONNECTION TYPE</th>
<th>CONNECTION RELATED LIMIT STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>X-HSN 24, or X-ENP-19 L15</td>
<td>Ω&lt;sub&gt;df&lt;/sub&gt; (ASD) 2.00, Φ&lt;sub&gt;df&lt;/sub&gt; (LRFD) 0.800</td>
</tr>
<tr>
<td>Earthquake and all others</td>
<td>S-SLC 01 M HWH or S-SLC 02 M HWH</td>
<td>Ω&lt;sub&gt;df&lt;/sub&gt; (ASD) 2.34, Φ&lt;sub&gt;df&lt;/sub&gt; (LRFD) 0.683</td>
</tr>
<tr>
<td>Wind</td>
<td>Verco Decking VSC2</td>
<td>Ω&lt;sub&gt;df&lt;/sub&gt; (ASD) 2.35, Φ&lt;sub&gt;df&lt;/sub&gt; (LRFD) 0.700</td>
</tr>
<tr>
<td>Earthquake and all others</td>
<td></td>
<td>Ω&lt;sub&gt;df&lt;/sub&gt; (ASD) 2.50, Φ&lt;sub&gt;df&lt;/sub&gt; (LRFD) 0.650</td>
</tr>
</tbody>
</table>

1The available shear strength or factored shear resistance must be the lesser of the values determined using Table 8 and the tabulated values in Table 9.

### TABLE 9—DIAPHRAGM SHEAR STRENGTHS (plf) FOR BUCKLING

<table>
<thead>
<tr>
<th>Deck Type</th>
<th>Deck Gauge No.</th>
<th>Minimum Moment of Inertia&lt;sub&gt;I&lt;/sub&gt;xg (in&lt;sup&gt;4&lt;/sup&gt;/ft)</th>
<th>Span, l (ft-in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B, BI, and Verco PLB</td>
<td>22</td>
<td>0.173</td>
<td>7,750</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.210</td>
<td>10,363</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>0.279</td>
<td>15,829</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.353</td>
<td>22,479</td>
</tr>
<tr>
<td>ASTM A36 (F&lt;sub&gt;y&lt;/sub&gt;= 36 ksi, F&lt;sub&gt;u&lt;/sub&gt;= 58 ksi)</td>
<td>22</td>
<td>0.173</td>
<td>12,401</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.210</td>
<td>16,581</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>0.279</td>
<td>25,327</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.353</td>
<td>35,966</td>
</tr>
<tr>
<td>B, BI, and Verco PLB</td>
<td>22</td>
<td>0.173</td>
<td>12,401</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.210</td>
<td>16,581</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>0.279</td>
<td>25,327</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>0.353</td>
<td>35,966</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 ksi = 6.89 MPa, 1 plf = 14.6 N/m, 1 in<sup>4</sup>/ft = 1368 mm<sup>4</sup>/mm.

1.Tabulated values are based on AISI S310 Eq. D-1 and Eq. D2.1-1.
2. The available shear strength or factored shear resistance must be the lesser of the values determined using Table 8 and the tabulated values in Table 9.
3. I<sub>xg</sub> is the moment of inertia of the fully effective panel.

### TABLE 10—ALLOWABLE (ASD) TENSION PULLOUT LOADS TO RESIST TENSION (UPLIFT) LOADS FOR STEEL ROOF DECK PANELS ATTACHED WITH X-HSN 24 OR X-ENP-19 L15 FASTENERS (pounds)

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Steel Support Framing Thickness, in.</th>
<th>1/8</th>
<th>3/16</th>
<th>1/4</th>
<th>3/8</th>
<th>1/2</th>
<th>3/4</th>
<th>5/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A36 (F&lt;sub&gt;y&lt;/sub&gt;= 36 ksi, F&lt;sub&gt;u&lt;/sub&gt;= 58 ksi)</td>
<td>X-HSN 24</td>
<td>435</td>
<td>635</td>
<td>750</td>
<td>750</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-ENP-19 L15</td>
<td>-</td>
<td>-</td>
<td>905</td>
<td>1,010</td>
<td>1,125</td>
<td>1,010</td>
<td>965</td>
</tr>
<tr>
<td>ASTM A572 Grade 50 or A992 (F&lt;sub&gt;y&lt;/sub&gt;= 50 ksi, F&lt;sub&gt;u&lt;/sub&gt;= 65 ksi)</td>
<td>X-HSN 24</td>
<td>445</td>
<td>635</td>
<td>750</td>
<td>750</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-ENP-19 L15</td>
<td>-</td>
<td>-</td>
<td>975</td>
<td>1,090</td>
<td>1,205</td>
<td>1,090</td>
<td>1,040</td>
</tr>
</tbody>
</table>

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 Ω safety factor of 5.0. To obtain LRFD pullout capacities, the tabulated values must be multiplied by 1.6.
2.Unless otherwise noted, the tabulated pullout load values are based on minimum penetration of the fasteners of 9/16-inch for the X-ENP-19 fasteners. X-HSN 24 tabulated values are based upon fastener stand-off dimensions meeting those shown in Figure 2.
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 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 11—ALLOWABLE (ASD) TENSION PULLOVER LOADS TO RESIST TENSION (UPLIFT) LOADS FOR STEEL ROOF DECK PANELS ATTACHED WITH X-HSN 24 OR X-ENP-19 L15 FASTENERS (pounds)\(^1, 2\)

<table>
<thead>
<tr>
<th>Fastener</th>
<th>Deck Gage [base-metal thickness, (t) (inches)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. 22 (0.0295)</td>
</tr>
<tr>
<td>X-HSN 24</td>
<td>500</td>
</tr>
<tr>
<td>X-ENP-19 L15</td>
<td>660</td>
</tr>
</tbody>
</table>

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

\(^1\)Tabulated allowable (ASD) values are based upon a \(\Omega\) safety factor of 3.0. To obtain LRFD pullover 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 3.3 of this report.

TABLE 12—POST CALCULATION CONVERSION TABLE TO CONVERT SPECIFIED SIDELAP CONNECTOR SPACING (SS) TO NUMBER OF SIDELAP CONNECTORS TO BE INSTALLED PER PANEL SPAN (SPS)\(^1, 2\)

<table>
<thead>
<tr>
<th>SIDELAP CONNECTOR SPACING (SS) (inches)</th>
<th>PANEL SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3'-0&quot;</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>36</td>
<td>1</td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

\(^1\)This post calculation conversion table provides the quantity of sidelap connectors per panel span, where the sidelap connectors are specified by spacing. The numbers of sidelap connectors from this table are not for use in the diaphragm design equations.

\(^2\)Conversion of sidelap spacing (SS) to quantity of fasteners at panel sidelaps per span (SPS) is completed using the following formula:

\[
SPS = \frac{(\text{span in feet} \times 12)}{(\text{SS in inches})}
\]

For SI: \(SPS = \frac{(\text{span in meters} \times 1000)}{(\text{SS in millimeters})}\). This value is conservatively rounded up to the next whole sidelap connector. A similar approach may be used for intermediate sidelap spacings or joist/beam spans.
FOOTNOTES TO TABLES 4 THROUGH 12

1. Hilti X-HSN 24 or X-ENP-19 L15 frame fasteners must be used at all panel ends, interior supports and panel edges parallel to the panel corrugations. The sides of adjacent panels parallel to the corrugations must be lapped by nesting or interlocking and then fastened with Hilti S-SLC 01 M HWH, Hilti S-SLC 02 M HWH sidelap connectors, or Verco VSC2 sidelap connections along the panel-to-panel side seam overlap.

2. The following apply to diaphragms designed in accordance with this report:
   a. The deck sheet length is equal to the span times the number of spans.
   b. For steel deck diaphragms, the number of diaphragm edge fasteners at walls or transfer zones parallel to the deck corrugations must be greater than or equal to the number of stitch sidelap connectors at nearest interior sidelaps.

3. All equations and tables apply to wide rib 1 1/2-inch-deep (38 mm) steel deck panels complying with Section 3.3 of this report.

4. The embedment of Hilti fasteners into the structural support member must be such that the standoff dimension, h_{NVS} in Figures 1 and 2 is obtained.

5. Hilti powder-driven frame fasteners must be centered not less than 1 inch (25 mm) from the panel ends for single fastener in flute and not less than 1/2-inch (12.7 mm) for two fasteners in flute and not less than 5/16-inch (7.9 mm) from the panel edges parallel to corrugations at the sidelaps.

6. Diaphragm deflections must be considered in the design. Table 13 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:
   \[ \frac{d^2y}{dx^2} = \frac{M}{EI} + \frac{q}{B G'} \]
   For a uniformly loaded rectangular diaphragm on a simple span, the maximum deflection at the centerline of the diaphragm is:
   \[ \Delta = \frac{5(1728)qL^4}{384EI} + \frac{qLF}{10^6} \]
   For SI:
   \[ \Delta = \frac{5(1000)qL^4}{384EI} + \frac{qLF}{10^6} \]
   \[ \Delta \] 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 or flange material.
   \[ I \] Moment of inertia, inches^4 (mm^4).

7. All end perimeter and interior members and their attachments must be designed to resist all applied loads.
### TABLE 13—DIAPHRAGM FLEXIBILITY LIMITATION\textsuperscript{1,2,3,4,5}

(Only applicable to the 2015 IBC and earlier codes)

<table>
<thead>
<tr>
<th>$F$</th>
<th>MAXIMUM SPAN IN FEET FOR MASONRY OR CONCRETE WALLS</th>
<th>SPAN-DEPTH LIMITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rotation Not Considered in Diaphragm</td>
<td>Rotation Considered in Diaphragm</td>
</tr>
<tr>
<td></td>
<td>Masonry or Concrete Walls</td>
<td>Flexible Walls</td>
</tr>
<tr>
<td>More than 150</td>
<td>Not used</td>
<td>Not used</td>
</tr>
<tr>
<td>70 – 150</td>
<td>200</td>
<td>2:1 as required for deflection</td>
</tr>
<tr>
<td>10 – 70</td>
<td>400</td>
<td>2$^{1/2}$:1 or as required for deflection</td>
</tr>
<tr>
<td>1 – 10</td>
<td>No limitation</td>
<td>3:1 as required for deflection</td>
</tr>
<tr>
<td>Less than 1</td>
<td>No limitation</td>
<td>As required for deflection</td>
</tr>
</tbody>
</table>

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

\textsuperscript{1}Diaphragms are to be investigated regarding their flexibility and recommended span-depth limitations.

\textsuperscript{2}Diaphragms supporting masonry or concrete walls are to have their deflections limited to the following amount:

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

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, $f_c = F_b = 0.33 f'_m$.

\textsuperscript{3}The total deflection $\Delta$ of the diaphragm may be computed from the equation: $\Delta = \Delta_f + \Delta_w$.

where:

- $\Delta_f$ = Flexural deflection of the diaphragm determined in the same manner as the deflection of beams.
- $\Delta_w$ = The web deflection may be determined by the equation:

\[
\Delta_w = \frac{q_{\text{ave}} L F}{10^6} \quad \text{For SI: } \Delta_w = \frac{q_{\text{ave}} L F}{175}
\]

where:

- $L$ = Distance in feet between vertical resisting element (such as shear wall) and the point to which the deflection is to be determined.
- $q_{\text{ave}}$ = 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).

\textsuperscript{4}When applying these limitations to cantilevered diaphragms, the allowable span-depth ratio will be half that shown.

\textsuperscript{5}Diaphragm classification (flexible or rigid) and deflection limits shall comply with Section 4.1.
**FIGURE 3a—COMMON FRAME FASTENER PATTERNS**

Notes:
1. B-Deck shown for illustration purposes only. See Table 3 for applicable decks.
2. Bar joist shown. Connection to structural steel members is also allowed by this report as set forth in Table 1 and Figure 7.
3. For B-Decks, the side frame fasteners are installed through both connecting steel decks and into the supporting framing.
4. For BI-Decks and Verco PLB Decks, the same number of side frame fasteners, are installed on each side of the sidelap and into supporting framing.

**FIGURE 3b—HILTI X-ENP-19 FRAME FASTENER PATTERNS WITH VERCO PLB DECK**
4a. Powder-Driven Fastener
Attachment of Steel Deck to Frame

4c. Sidelap Connector with B-Deck

4d. Sidelap Connector with BI-Deck

4b. Steel Deck Endlap Condition

4a. Powder-Driven Fastener Attachment of Steel Deck to Frame

FIGURE 4—TYPICAL FRAME, ENDLAP AND SIDE LAP CONNECTIONS

Note: Some fastener patterns may require two fasteners. Fasteners may be installed on either side of the structural steel beam or bar joist.

Note: To be used with X-ENP-19 L15 fasteners. X-ENP-19 Nailhead standoff (hNVS) must be as shown in Figure 1

FIGURE 5—SDK2 SEALING CAP
Example: A 4'-0" span with a 12 in. sidelap connector spacing will typically start 6 in. from the first joist / beam line at the diaphragm zone perimeter, and then have equal spacings of 12 in. across the entire diaphragm length or width, off-set at the interior joist / beam locations. The interior joist / beam fastening locations are frame fasteners and not sidelap connectors. This convention of specifying sidelap connectors by spacing does not consider each deck span independently as a discrete element, but rather as a larger steel deck diaphragm system consisting of 3 or more spans.

Note: If the sidelap connector spacing does not divide evenly into the span length, some spans may have more sidelap connectors than adjacent spans. For this reason, \( n_a \) and \( n_b \) may not be whole numbers.

6a: SPECIFIED BY SIDELAP CONNECTOR SPACING (SS)

Example: A 4'-0" span specified with 3 sidelap connectors per span will have 3 sidelap connectors evenly spaced 12 in. from each joist/beam line and each other making 4 equal 12 in. spaces per span. This convention of specifying sidelap connectors by the number of sidelap connectors per span considers each deck span independently as a discrete element.

6b: SPECIFIED BY NUMBER OF SIDELAP CONNECTORS PER SPAN (SPS)

FIGURE 6—EXAMPLE ILLUSTRATION OF SIDELAP CONNECTOR SPECIFICATION CONVENTIONS - SPACING OR NUMBER PER SPAN
(REF. TABLE 12 FOR CONVERSION OF SIDELAP CONNECTOR SPACINGS FOR JOIST / BEAM SPAN COMBINATIONS)
FIGURE 7—HILTI DECK FASTENER INSTALLATION OVERVIEW
Given:
Load Type: Seismic Design
Support Span, Lv: 6'-0"
No. of Spans: 3
Total Length, L: 18'-0"
Deck: No. 20 gage (0.0358 inch) 1½" deep B-Deck (Fy = 33 ksi)
Support Framing: Steel Bar Joist with ⅜" Thick Top Chord
Frame Fastener: X-HSN 24
Frame Fastener Pattern: 36/7
Sidelap Fastener: S-SLC 02 M HWH
Sidelap Fastener Spacing (SS): 12" o.c.

Problem:
Determine Allowable (ASD) Diaphragm Shear Strength \( \frac{S}{n} \), \( \Psi \) and Stiffness \( G' \) for the given steel deck diaphragm.

Step 1: Calculate Nominal Diaphragm Shear Strength Limited by Interior Panel Fasteners:

\[
S_{ni} = \left[ 2A(\lambda - 1) + \beta \right] \times \frac{P_{nf}}{L} = \left[ 2 \times 1 \times (0.802 - 1) + 16.99 \right] \times \frac{2,107}{18} = 1,942 \text{ plf}
\]

where:
\( A = 1 \)
\( \lambda = 1 - \frac{D_{pL}v}{240 \sqrt{t}} = 1 - \frac{1.5 \times 6}{240 \sqrt{0.0358}} = 0.802 \geq 0.7 \)
\( \beta = n_s \alpha_s + 2n_p \alpha_p^2 + 4 \alpha_e^2 \)
\( \alpha_p^2 = \left( \frac{1}{w^2} \right) \sum x_p^2 \)
\( \alpha_e^2 = \left( \frac{1}{w^2} \right) \sum x_e^2 \)
\( n_p = 2 \)
\( \beta = n_s \alpha_s + 2n_p \alpha_p^2 + 4 \alpha_e^2 = \frac{1}{w^2} \times \left[ 2 \times 2.0 \times \sum (x_p^2) + 4 \sum (x_e^2) \right] = 18 \times 0.598 + \frac{2 \times 2 \times 1,008 + 4 \times 1,008}{36} = 16.99 \)

\( \sum(x_p^2) = \sum(x_e^2) = 1,008 \)

\( \alpha_s = \frac{P_{ns}}{P_{nf}} = \frac{1.260}{2,107} = 0.598 \)  

Step 2: Calculate Nominal Diaphragm Shear Strength Limited by Corner Fasteners:

\[
S_{nc} = P_{nf} \times \sqrt{\frac{N^2 \beta^2}{L^2 \times N^2 + \beta^2}} = 2,107 \times \sqrt{\frac{2.00^2 \times 16.99^2}{18^2 \times 2.00^2 + 16.99^2}} = 1,798 \text{ plf}
\]

where:
\( N = 2.00 \)

\( \beta = \text{same as in Step 1} \)

FIGURE 8—DIAPHRAGM DESIGN EXAMPLE
Step 3: Calculate Nominal Diaphragm Shear Strength Limited by Edge Fasteners:

\[
S_{ne} = \frac{\left(2 \alpha_1 + n_p \alpha_2\right) P_{nf} + n_p P_{ofs}}{L} = \frac{\left(2 \times 2 + 2 \times 2\right) \times 2.107 + 18 \times 2.107}{18} = 3.043 \text{ plf}
\]

where:
\[
\alpha_1 = \alpha_2 = 2
\]
\[
P_{nf} = P_{ofs}
\]
\[
n_p = \frac{L \times 12}{SS} = \frac{18 \times 12}{12} = 18
\]

Step 4: Calculate Nominal Diaphragm Shear Strength Controlled By Connections and Adjusted by the Correlation Factor

\[
S_{nf} = \text{min} \left( S_{nf}, S_{nc}, S_{ne} \right) c = 1,798 \times 1.102 = 1,981 \text{ plf}
\]

where:
\[
c = 1.102
\]

Step 5: Calculate Allowable Diaphragm Shear Strength

\[
\frac{S_{nf}}{B_{nf}} = \frac{1.981}{2.34} = 847 \text{ plf}
\]

where:
\[
B_{nf} = 2.36
\]

Step 6: Select Allowable Diaphragm Buckling Strength

\[
S_{ab} = 2,591 \text{ plf}
\]

Step 7: Determine Controlling Allowable Diaphragm Shear Strength

\[
\frac{S_n}{\Pi} = \frac{S_{nf} - S_{ab}}{B_{nf} - B_{ab}} = 847 \text{ plf}
\]

Step 8: Determine Diaphragm Stiffness:

\[
G' = \left( \frac{Et}{2(1+\nu)B^2} \right) K, \text{ kips/in.}
\]

\[
G' = \left( \frac{Et}{2(1+\nu)B^2} \right) K = \frac{Et}{2(1+\nu)B^2} \frac{29.500 \times 0.0558}{1.5549 + 0.0358} = 95.6 \text{ kips/in.}
\]

\[
F = \frac{1000}{gr} = \frac{1000}{90.6} = 10.46 \text{ micro-inches/lb}
\]

where:
\[
D_n = \frac{D}{L} = \frac{924}{18 \times 12} = 4.28
\]

(Step 8 continued)
\[ C = \left( \frac{Es}{W} \right) \left( \frac{2L}{2\alpha_3 + n_p \alpha_4 + 2n_L S_{\theta}/S_f} \right) S_f = \left( \frac{29,500 \times 0.0358}{36} \right) \left( \frac{2 \times 18 \times 12}{2 \times 2 + 2 \times 2 + 2 \times 18} \right) \frac{0.0066}{0.0159} = 3.65 \]  

where:

\( n_0 = 18 \), same as Step 3
\( n_p = 2 \)
\( \alpha_3 = \alpha_4 = 2 \)
\( S_f = 0.0066 \)
\( S_\Delta = 0.0159 \)

NOTE: Straight-line interpolation between different steel deck thicknesses and steel deck strengths for the calculation of diaphragm shear strength values is permitted. For example, to calculate the allowable diaphragm shear strength, \( \frac{S_\Delta}{\Omega} \), for 65 ksi steel deck, the following formula would be used.

\[ \frac{S_\Delta}{\Omega} (65 \text{ ksi}) = \frac{S_\Delta}{\Omega} (45 \text{ ksi}) + (65 \text{ ksi} - 45 \text{ ksi}) \times \frac{\frac{S_\Delta}{\Omega} (92 \text{ ksi}) - \frac{S_\Delta}{\Omega} (45 \text{ ksi})}{92 - 45} \]

where:

\( \frac{S_\Delta}{\Omega} (45 \text{ ksi}) = \) Allowable diaphragm shear for 45 ksi steel deck as calculated per Section 4.1.2 of this report.
\( \frac{S_\Delta}{\Omega} (92 \text{ ksi}) = \) Allowable diaphragm shear for 92 ksi steel deck as calculated per Section 4.1.2 of this report.
\( \frac{S_\Delta}{\Omega} (65 \text{ ksi}) = \) Allowable diaphragm shear for 65 ksi steel deck.

Similarly, to calculate the allowable diaphragm shear, \( S_{A,60} \), for 19 gauge (0.0418 in.) steel deck, the following formula would be used.

\[ \frac{S_\Delta}{\Omega} (19 \text{ Ga.}) = \frac{S_\Delta}{\Omega} (20 \text{ Ga.}) + (0.0418 \text{ in.} - 0.0358 \text{ in.}) \times \frac{\frac{S_\Delta}{\Omega} (18 \text{ Ga.}) - \frac{S_\Delta}{\Omega} (20 \text{ Ga.})}{0.0474 \text{ in.} - 0.0358 \text{ in.}} \]

where:

\( \frac{S_\Delta}{\Omega} (20 \text{ Ga.}) = \) Allowable diaphragm shear for 20 gauge (0.0358 in.) steel deck as calculated per Section 4.1.2 of this report.
\( \frac{S_\Delta}{\Omega} (18 \text{ Ga.}) = \) Allowable diaphragm shear for 18 gauge (0.0474 in.) steel deck as calculated per Section 4.1.2 of this report.
\( \frac{S_\Delta}{\Omega} (19 \text{ Ga.}) = \) Allowable diaphragm shear for 19 gauge (0.0418 in.) steel deck.

**FIGURE 8—DIAPHRAGM DESIGN EXAMPLE (Continued)**
1.0 REPORT PURPOSE AND SCOPE

Purpose:
The purpose of this evaluation report supplement is to indicate that Steel Deck Diaphragms attached with Hilti X-HSN 24 or X-ENP-19 L15 Powder-Driven Frame Fasteners and Hilti S-SLC 01 M HWH or S-SLC 02 M HWH Sidelap Connectors, or Verco Decking VSC2 Sidelap Connection, described in ICC-ES evaluation report ESR-2776, have also been evaluated for compliance with the code noted below as adopted by the Los Angeles Department of Building and Safety (LABS).

Applicable code editions:
- 2020 City of Los Angeles Building Code (LABC)

2.0 CONCLUSIONS

The Steel Deck Diaphragms attached with Hilti X-HSN 24 or X-ENP-19 L15 Powder-Driven Frame Fasteners and Hilti S-SLC 01 M HWH or S-SLC 02 M HWH Sidelap Connectors, or Verco Decking VSC2 Sidelap Connection, described in Sections 2.0 through 7.0 of the evaluation report ESR-2776, comply with LABC Chapter 22, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Steel Deck Diaphragms attached with Hilti X-HSN 24 or X-ENP-19 L15 Powder-Driven Frame Fasteners and Hilti S-SLC 01 M HWH or S-SLC 02 M HWH Sidelap Connectors, or Verco Decking VSC2 Sidelap Connection, described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-2776.
- 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-2776.
- 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 design professional to the satisfaction of the code official.

This supplement expires concurrently with the evaluation report, reissued April 2019 and revised January 2020.
1.0 REPORT PURPOSE AND SCOPE

Purpose:
The purpose of this evaluation report supplement is to indicate that Hilti’s X-HSN 24 and X-ENP-19 L15 powder-driven frame fasteners and Hilti’s S-SLC 01 M HWH and S-SLC 02 M HWH sidelap connectors, recognized in ICC-ES master evaluation report ESR-2776, have also been evaluated for compliance with the codes noted below.

Applicable code edition:
2017 Florida Building Code—Building

2.0 CONCLUSIONS

The powder-driven fasteners and sidelap connectors described above, which are also described in Sections 2.0 through 7.0 of the master evaluation report, ESR-2776, comply with the Florida Building Code—Building, provided the design and installation are in accordance with the 2015 International Building Code® (IBC) provisions noted in the master report.

Use of the powder-driven fasteners and sidelap connectors 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 Condition of Use:

When the powder-driven fasteners and sidelap connectors 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 9N-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 April 2019 and revised January 2020.