

ICC-ES Evaluation Report

ESR-2269

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
Section: 06 05 23—Wood, Plastic, and Composite Fastenings

REPORT HOLDER:

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EVALUATION SUBJECT:

HILTI LOW-VELOCITY X-U AND X-U 15 UNIVERSAL AND X-P CONCRETE POWDER DRIVEN FASTENERS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012 and 2009 *International Building Code*® (IBC)
- 2015, 2012 and 2009 *International Residential Code*® (IRC)

- * ■ ~~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.

Property evaluated:

Structural

2.0 USES

2.1 General:

The Hilti X-U and X-P fasteners are used to attach wood, light gage steel, and other building elements to base materials of normalweight concrete, sand-lightweight concrete, and steel deck panels with sand-lightweight concrete fill. The X-U fasteners are also used to attach building elements to concrete masonry and steel base

materials. The Hilti X-U 15 fasteners are used to attach light gage steel and other building elements to steel base material. The fasteners are alternatives to the cast-in-place anchors described in 2015 IBC Section 1901.3 (2012 IBC Section 1908; 2009 IBC Section 1911) for placement in concrete; the embedded anchors described in Section 8.1.3 of TMS 402-13, referenced in Section 2107 of the 2015 IBC (Section 2.1.4 of TMS 402-11 and -08 referenced in Section 2107 of the 2012 and 2009 IBC, respectively), for placement in masonry; and the welds and bolts used to attach materials to steel, described in IBC Sections 2204.1 and 2204.2, respectively. For structures regulated under the IRC, the fasteners may be used where an engineered design is submitted in accordance with IRC Section R301.1.3.

2.2 Horizontal Diaphragms:

The Hilti X-U fasteners may be used as alternates to 10d common nails for fastening wood structural panel horizontal diaphragms to structural steel members.

3.0 DESCRIPTION

3.1 Fasteners:

3.1.1 X-U: The X-U fasteners are powder-driven fasteners made from hardened steel complying with the manufacturer's quality documentation, austempered to a Rockwell C nominal hardness of 57.5 and zinc-plated in accordance with ASTM B633 SC 1, Type III. The fasteners have a shank diameter of 0.157 inch (4.0 mm), a head diameter of 0.32 inch (8.2 mm) and a knurled tip, and come in lengths ranging from 0.63 inch to 2.83 inches (16 to 72 mm). See Figure 1 for the fastener configuration.

3.1.2 X-U 15: The X-U 15 fasteners are powder-driven fasteners made from hardened steel complying with the manufacturer's quality documentation, austempered to a Rockwell C nominal hardness of 59 and zinc plated in accordance with ASTM B633 SC 1, Type III. The fasteners have a shank diameter of 0.145 inch (3.7 mm), a head diameter of 0.32 inch (8.2 mm) and a shank length of 0.63 inch (16 mm). See Figure 2 for the fastener configuration.

3.1.3 X-P: The X-P fasteners are powder-driven fasteners made from hardened steel complying with the manufacturer's quality documentation, austempered to a Rockwell C nominal hardness of 59 and zinc plated in accordance with ASTM B633 SC 1, Type III. The fasteners have a shank diameter of 0.157 inch (4.0 mm), a head diameter of 0.32 inch (8.2 mm) and come in lengths ranging from 0.87 inch to 1.57 inches (22 to 40 mm). See Figure 3 for the fastener configuration.

3.2 Substrate Materials:

3.2.1 Concrete: Normal-weight and sand-lightweight concrete must comply with IBC Chapter 19 or IRC Section R402.2, as applicable. The minimum concrete compressive strength at the time of fastener installation must be as noted in the applicable allowable load table. Hollow core precast concrete slabs must conform to the cross-sectional dimensions shown in Figure 7.

3.2.2 Concrete Masonry: Concrete masonry units (CMUs) must be minimum 8-inch-thick (203 mm), and must comply with ASTM C90. Mortar must comply with ASTM C270. Grout must be coarse grout complying with ASTM C476. Concrete masonry walls must have a minimum compressive strength, f'_m , of 1,500 psi (10.3 MPa). See Table 6 for applicable CMU density and mortar type.

3.2.3 Steel: Structural steel must comply with the minimum strength requirements of ASTM A36, ASTM A572 Grade 50 or ASTM A992, as applicable, and must have minimum yield and tensile strengths and thickness as noted in Table 2.

3.2.4 Steel Deck Panels: Steel deck panel properties and configurations must be as described in Table 5 and Figures 4 through 6, as applicable.

3.2.5 Cold-formed Steel Clips: Cold-formed steel clips must be the FCSC™ Fast Clip, FCEC™ Extended Fast Clip or UCEC™ Uni-Clip End Clip manufactured by Clark-Dietrich, as described in Table 7 and Figures 8 and 9 of this report and as described in [ESR-2570](#).

3.3 Wood Structural Panel Horizontal Diaphragms:

3.3.1 Wood Structural Panel: Wood structural panels must have a minimum thickness of $1\frac{5}{32}$ inch (11.9 mm) and must comply with the requirements of Section 4.2.6 of AWC SDPWS (which is referenced in IBC Section 2305).

3.3.2 Structural Steel Supports: Structural steel framing members supporting the wood structural panel diaphragm must comply with the minimum strength requirements of ASTM A36, ASTM A572 Grade 50 or ASTM A992, and have a thickness greater than or equal to $\frac{3}{16}$ inch (4.8 mm) as shown in Table 2.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Selection of fasteners must take into consideration the applicable base material and the length of the fastener. The minimum fastener length must be determined as follows:

- Unless otherwise noted, for installation into concrete, concrete-filled steel deck panels, concrete masonry and steel base materials, the minimum effective shank length shown in Table 1 must equal or exceed the sum of the thickness of the attached material and the minimum embedment depth (penetration) shown in the applicable tables in this report.
- For installation through steel base materials, the minimum effective shank length shown in Table 1 must equal or exceed the sum of the following: the thickness of the attached material, the thickness of the base material and the required point penetration shown in the applicable tables in this report.

4.1.2 Allowable Loads for Individual Fasteners: The applicable allowable shear and tension load tables for the Hilti X-U, X-U 15 and X-P fasteners driven into different base materials may be determined by referencing Table 1.

The most critical applied loads, excluding seismic load effects, resulting from the load combinations in IBC Section 1605.3.1 or 1605.3.2 must not exceed the allowable loads. For fasteners which are subjected to seismic loads, see Section 4.1.7 for additional information. The stress increases and load reductions described in IBC Section 1605.3 are not allowed.

Allowable shear and tension loads in this report apply to the connection of the fastener to the base material only. Other limit states applicable to the design of a connection, such as fastener pull-through (pull-over) and lateral bearing on the attached material, which are governed by the properties of attached materials, are outside the scope of this report. Design of the connection to the attached material must comply with the applicable requirements of the IBC. When designing the connection of wood members to the base material, the bending yield strength of the PAFs can be assumed to be the same as that of a nail with the same shank diameter.

4.1.3 Combined Loading: For fasteners subjected to both shear and tension loads, compliance with the following interaction equation must be verified:

$$(p/P_a) + (v/V_a) \leq 1$$

where:

- p = Actual applied tension load on fastener, lbf (N).
- P_a = Allowable tension load for the fastener, lbf (N).
- v = Actual applied shear load on fastener, lbf (N).
- V_a = Allowable shear load for the fastener, lbf (N).

4.1.4 Allowable Loads for Connections of Cold-formed Steel Clips to Steel Base Material: Allowable loads for the connections of the steel clip angles described in Section 3.2.5 to steel base material are given in Table 7. The most critical applied loads, excluding seismic load effects, resulting from the load combinations in IBC Section 1605.3.1 or 1605.3.2 must not exceed these allowable loads. The tension, shear and 45-degree loads are assumed to act independently. The stress increases and load reductions described in IBC Section 1605.3 are not allowed. Allowable loads recognized in this report apply to the connection of the clip to the base material only. Design of the clip and the connection between the clip and the supported cold-formed steel member must comply with the applicable requirements of the IBC. Allowable loads for the FCSC and FCEC clips and for the connections of the clips to the supported cold-formed steel members are addressed in [ESR-2570](#).

4.1.5 Wood Structural Panel Horizontal Diaphragms: When the X-U fastener is used to fasten wood structural panels to steel members, the fastener is recognized as equivalent to a 10d common nail. Diaphragm design, including fastener spacing, diaphragm capacity and diaphragm deflection, must comply with Section 4.2 of AWC SDPWS, which is referenced in IBC Sections 2305.1 and IBC Section 2306.2.

4.1.6 Steel-to-steel Connections: When the Hilti fasteners listed in Table 2 are used in connections of two steel elements in accordance with Section E5 of AISI S100-12, connection capacity must be determined in accordance with Sections 4.1.6.1 and 4.1.6.2, as applicable.

4.1.6.1 Connection Strength - Tension: To determine tensile connection strength in accordance with Section E5.2 of AISI S100-12, the fastener tension strength, pull-out strength and pull-over strength must be known. These characteristics must be determined as follows:

- **Pull-out Strength:** See Table 2 for available pull-out strength.
- **Pull-over Strength:** The available pull-over strengths must be calculated in accordance with Section E5.2.3 of AISI S100-12.
- **PAF Tensile Strength:** The allowable fastener tension strengths, determined in accordance with Section E5.2.1 of AISI S100-12, exceed the corresponding allowable pull-out strengths in Table 2.

4.1.6.2 Connection Strength - Shear: To determine shear connection strength in accordance with Section E5.3 of AISI S100-12, the fastener shear strength, bearing and tilting strength, pull-out strength in shear, net section rupture strength and shear strength limited by edge distance must be known. These characteristics must be determined as follows:

- **Bearing and Tilting Strength:** The available bearing and tilting strengths must be calculated in accordance with Section E5.3.2 of AISI S100-12.
- **Pull-out Strength in Shear:** The available pull-out strength in shear must be the applicable allowable shear strength from Table 2, or must be calculated in accordance with Section E5.3.3 of AISI S100-12.
- **Net Section Rupture Strength and Shear Strength Limited by Edge Distance:** The net section rupture strength must be determined in accordance with Section E5.3.4 of AISI S100-12 and the shear strength limited by edge distance must be determined in accordance with Section E5.3.5 of AISI S100-12.
- **PAF Shear Strength:** The allowable fastener shear strengths, determined in accordance with Section E5.3.1 of AISI S100-12, exceed the corresponding allowable pull-out in shear strengths in Table 2.

4.1.7 Seismic Considerations: The Hilti fasteners are recognized for use when subjected to seismic loads as follows:

1. The Hilti fasteners may be used for attachment of nonstructural components listed in Section 13.1.4 of ASCE 7, which are exempt from the requirements of ASCE 7.
2. The Hilti fasteners installed in concrete may be used to support acoustical tile or lay-in panel suspended ceiling systems, distributed systems and distribution systems where the service load on any individual fastener does not exceed 90 lbf (400 N).
3. For interior, nonstructural walls that are not subject to sustained tension loads and are not a bracing application, the power-driven fasteners may be used to attach steel track to concrete or steel in all Seismic Design Categories. In Seismic Design Categories D, E, and F, the allowable shear load due to transverse pressure shall be no more than 90 pounds (400 N) when attaching to concrete; and no more than the applicable allowable load shown for the Hilti X-U and X-U 15 fasteners in Table 2 when attaching to steel. Substantiating calculations shall be submitted to the code official addressing the fastener-to-base-material connection capacity and the fastener-to-attached-material connection capacity. Interior nonstructural walls are limited to locations where bearing walls, shear walls or braced walls are not required by the approved plans. The design load on the fastener must not exceed the allowable load established in this report for the concrete or steel base material, as applicable.

4. The Hilti X-U and X-U 15 fasteners may be used in conjunction with wood structural panel diaphragms in accordance with Sections 3.3, 4.1.5 and 4.2.9.
5. For Hilti X-U and X-U 15 fasteners installed in steel base materials, the most critical load applied to each individual fastener must be determined from the applicable equations in IBC Section 1605.3.1 or Section 1605.3.2 which include seismic load effects, and must not exceed the allowable load shown in Table 2. Except as noted in Item 4, above, recognition of the Hilti fasteners installed in steel base material for use in the design of lateral force resisting systems, such as shear walls and diaphragms, is outside the scope of this report.

4.2 Installation:

4.2.1 General: The Hilti X-U, X-U 15 and X-P fasteners must be installed in accordance with this report and the Hilti, Inc. published installation instructions. A copy of these instructions must be available on the jobsite at all times during installation. Installation must be limited to dry, interior locations.

Fastener installation requires the use of a low-velocity powder-actuated tool in accordance with Hilti, Inc. recommendations. Installers must be certified by Hilti and have a current, Hilti-issued, operator's license.

4.2.2 Fastening to Steel: When installing the Hilti X-U or X-U 15 fastener in steel, the minimum spacing between fasteners must be 1 inch (25.4 mm) and the minimum edge distance must be $\frac{1}{2}$ inch (12.7 mm).

4.2.3 Fastening to Concrete: Hilti X-U and X-P fasteners must be driven into the concrete after the concrete attains the compressive strength specified in the applicable tables of this report. Minimum spacing between fasteners must be 4 inches (102 mm) and minimum edge distance must be 3 inches (76 mm). Unless noted otherwise in this report, concrete thickness must be a minimum of three times the penetration depth of the fastener.

4.2.4 Fastening to Hollow Core Precast Concrete Slabs: Hilti X-U fasteners must be installed into the top or bottom of the hollow core precast concrete slab at the center of a core as shown in Figure 7, and must not make contact with the prestressing steel. The concrete thickness at these locations must be a minimum of $1\frac{3}{8}$ inches thick. Spacing along the length of the slab must be a minimum of 4 inches (102 mm).

4.2.5 DX-KWIK System: Installation of the Hilti X-U fastener into normal-weight concrete, using the Hilti DX-KWIK system as an alternate procedure, requires the drilling of a pilot hole using a Special DX-KWIK drill bit (TX-C) supplied by Hilti, Inc., prior to the installation of the fastener with the powder-actuated tool.

4.2.6 Fastening to Sand-lightweight Concrete-filled Steel Deck Panels: Installation of Hilti X-U or X-P fasteners in sand-lightweight concrete-filled steel deck panels must comply with Figures 4 through 6. Minimum distances from fastener centerline to rolled deck panel flute edges must be as depicted in Figures 4 through 6.

4.2.7 Fastening to Masonry: Hilti X-U fasteners must be driven into the masonry after the mortar and grout materials have attained the specified strength. Fasteners must be located in accordance with Table 6.

4.2.8 Fastening Cold-formed Steel Clips to Steel: The Hilti X-U fasteners must be driven through the cold-formed steel clips in the locations shown in the figures in Table 7. The edge distance in the base steel must be a minimum of $\frac{1}{2}$ inch (12.7 mm).

4.2.9 Wood Structural Panel Diaphragms: The wood structural panels must be fastened with Hilti X-U fasteners to the steel members at the spacing specified in the approved plans. When used, the optional steel strap is placed on top of the panels and the fasteners are driven through the strap and panel into the supporting steel member. The minimum distance from the centerline of the fasteners to the edge of the panel is $\frac{3}{8}$ inch (9.5 mm). Fastener penetration and distance to the edge of the supporting steel member must be as described in Section 4.2.2. See Figure 10 for a typical installation detail showing one row of fasteners. Multiple rows of fasteners may be installed if required by the approved plans. The remainder of the diaphragm must be constructed in accordance with the code and the approved plans.

4.2.10 Use with Treated Lumber: The Hilti carbon steel fasteners described in Table 1 may be used in contact with fire-retardant-treated wood in dry, interior locations only, in accordance with 2015 IBC Section 2304.10.5.4 (2012 and 2009 IBC Section 2304.9.5.4) and Hilti's recommendations. Use of fasteners in contact with preservative-treated wood or fire-retardant-treated wood in exterior applications is outside the scope of this report

5.0 CONDITIONS OF USE

The Hilti X-U, X-U 15 and X-P fasteners 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 and identified in accordance with this report.
- 5.2 Fastener installation complies with this report and the Hilti, Inc., instructions. In the event of conflict between this report and the Hilti, Inc., published instructions, the more restrictive requirements govern.
- 5.3 Calculations demonstrating that the actual loads are less than the allowable loads described 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.
- 5.4 For steel-to-steel connections that meet the applicability requirements of Section E5 of AISI S100-12, calculations demonstrating that the

available connection strength has been determined in accordance with Section E5 of AISI S100-12 and Section 4.1.6 of this report, and equals to or exceeds the applied load, must be submitted to the code official. 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.

- 5.5 Refer to Section 4.1.7 for seismic considerations.
- 5.6 The use of fasteners is limited to installation in uncracked concrete or masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations.
- 5.7 Use of fasteners is limited to dry, interior locations, which include exterior walls which are protected by an exterior wall envelope.
- 5.8 Installation must comply with Section 4.2.10 regarding fasteners in contact with preservative-treated and fire-retardant-treated wood.
- 5.9 Installers must be certified by Hilti, Inc., and have a current, Hilti-issued, operator's license.
- 5.10 The Hilti products addressed in this report are manufactured under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

- 6.1 Data in accordance with the ICC-ES Acceptance Criteria for Fasteners Power-actuated Fasteners Driven into Concrete, Steel and Masonry Elements (AC70), dated February 2016, including seismic load test data in accordance with Annex A of AC70.
- 6.2 Test reports and engineering analysis regarding capacity of X-U fastener groups used to connect cold-formed steel clips to steel base material.

7.0 IDENTIFICATION

- 7.1 Each package of fasteners is labeled with the fastener type and size, the manufacturer's name (Hilti) and the evaluation report number (ESR-2269). An "H", for Hilti, is imprinted on the head of the fastener as shown in Figures 1, 2 and 3.
- 7.2 The cold-formed steel clip angles must be identified as described in ESR-2570.

TABLE 1—FASTENER DESCRIPTION AND APPLICATIONS

FASTENER ¹	FASTENER DESCRIPTION	SHANK TYPE	SHANK DIAMETER [inch (mm)]	HEAD DIAMETER [inch (mm)]	MAXIMUM POINT LENGTH [inch (mm)]	MINIMUM EFFECTIVE SHANK LENGTH ² [inch (mm)]	FASTENER COATING	APPLICABLE BASE MATERIAL	APPLICABLE LOAD TABLES
X-U ##	Universal Powder Actuated Fastener	Knurled, straight	0.157 (4.0)	0.323 (8.2)	0.433 (11.0)	See Footnote 2	ASTM B633, SC1, Type III	Steel	2, 7
								Concrete	3, 4
								Conc.-filled deck	5
								CMU	6
X-U 15	Powder Actuated Fastener	Knurled, stepped	0.145 (3.7)	0.323 (8.2)	0.413 (10.5)	0.61 (15.5)	ASTM B633, SC1, Type III	Steel	2
X-P ##	Powder Actuated Fastener	Smooth straight	0.157 (4.0)	0.323 (8.2)	0.524 (13.3)	See Footnote 3	ASTM B633, SC1, Type III	Concrete	3
								Conc.-filled deck	5

For SI: 1 inch = 25.4 mm.

¹## denotes numbers used in fastener designation to represent nominal fastener length in mm, e.g. X-U 27 has a nominal shank length of 27 mm.

²For fastener lengths of 16 mm, the minimum effective shank length is 14.8 mm (0.58 inch). For longer fasteners, the minimum effective shank length can be calculated in terms of the designated length as (##-0.5) in mm and (##-0.5)/25.4 in inches.

³The minimum effective shank length can be calculated in terms of the designated length as (##-1) in mm and (##-1)/25.4 in inches.

TABLE 2—ALLOWABLE LOADS FOR FASTENERS DRIVEN INTO STEEL^{1,2,6}

FASTENER DESCRIPTION	FASTENER	SHANK DIAMETER (inch)	ALLOWABLE LOADS (lbf)									
Steel Thickness (inch):			³ / ₁₆		¹ / ₄		³ / ₈		¹ / ₂		≥ ³ / ₄	
Load Direction:			Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear
Universal Knurled Shank	X-U	0.157	500 ⁷	720	775 ⁷	720	935	720	900	720	350 ⁴	375 ⁴
											275 ³	350 ³
Universal Knurled Shank	X-U 15	0.145	155	400	230	395	420	450	365 ⁵	500 ⁵	365 ⁵	400 ⁵

For SI: 1 inch = 25.4 mm, 1 lbf = 4.4 N; 1 ksi = 6.9 MPa.

¹Allowable load capacities are based on base steel with a minimum yield strength (F_y) of 36 ksi and a minimum tensile strength (F_u) of 58 ksi.

²The fasteners must be driven to where the point of the fastener penetrates through the steel base material, unless otherwise noted.

³Based upon a minimum point penetration of ³/₈ inch.

⁴Based upon a minimum point penetration of ¹/₂ inch.

⁵Based upon a minimum point penetration of ¹⁵/₃₂ inch.

⁶Allowable loads are applicable to static and seismic loads in accordance with Section 4.1.

⁷For steel-to-steel connections designed in accordance with Section 4.1.6 for static loads only, the tabulated allowable load may be increased by a factor of 1.25, and the design strength may be taken as the tabulated allowable load multiplied by a factor of 2.0.

TABLE 3—ALLOWABLE LOADS FOR FASTENERS DRIVEN INTO NORMAL-WEIGHT CONCRETE^{1,2,4}

FASTENER DESCRIPTION	FASTENER	SHANK DIAMETER (inch)	MINIMUM EMBEDMENT DEPTH (inches)	ALLOWABLE LOADS (lbf)							
Concrete Compressive Strength:				2000 psi		4000 psi		6000 psi		8000 psi	
Load Direction:				Tension	Shear	Tension	Shear	Tension	Shear	Tension	Shear
Universal Knurled Shank	X-U	0.157	³ / ₄	100	125	100	125	105	205	—	—
			1	165	190	170	225	110 ³	280 ³	—	—
			¹ / ₄	240	310	280	310	180	425	—	—
			¹ / ₂	275	420	325	420	—	—	—	—
Smooth Shank	X-P	0.157	³ / ₄ ⁵	100	155	100	175	105	205	135	205
			1 ⁵	165	220	180	225	150	300	150	215
			¹ / ₄ ⁵	240	310	280	310	180	425	—	—
			¹ / ₂ ⁵	310	420	—	—	—	—	—	—

For SI: 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 psi = 6895 Pa.

¹Unless otherwise noted, values apply to normal weight cast-in-place concrete. Fasteners must not be driven until the concrete has reached the designated minimum compressive strength.

²Unless otherwise noted, concrete thickness must be a minimum of 3 times the embedment depth of the fastener.

³This allowable load value for the X-U fastener also applies to normal weight hollow core concrete slabs with f'_c of 6600 psi and minimum dimensions shown in Figure 7, when installed in accordance with Section 4.2.4.

⁴The fasteners listed in the table above may be used for static load conditions and for the seismic load conditions described in Section 4.1.7, as applicable. The tabulated allowable loads apply to static load conditions. For seismic load conditions, the allowable loads must be limited in accordance with Section 4.1.7, Items 2 and 3, as applicable.

⁵Applies to fastening of cold-formed steel up to 54 mil thick using the X-P 22, X-P 27, X-P 34 and X-P 40 fasteners, respectively, for the ³/₄, 1, ¹/₄ and ¹/₂ inch embedment depths.

TABLE 4—ALLOWABLE LOADS FOR FASTENERS DRIVEN INTO NORMAL-WEIGHT CONCRETE USING DX-KWIK^{1,2,3,4}

FASTENER DESCRIPTION	FASTENER	SHANK DIAMETER (inch)	MINIMUM EMBEDMENT (inches)	ALLOWABLE LOADS (lbf)			
Concrete Compressive Strength:				4,000 psi		6,000 psi	
Load Direction:				Tension	Shear	Tension	Shear
Universal Knurled Shank	X-U 47 P8 w/ DX-KWIK	0.157	¹ / ₂	395	405	360	570

For SI: 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 psi = 6895 Pa.

¹X-U Fastener is installed using the DX-KWIK drilled pilot hole installation procedure described in Section 4.2.5.

²Pilot holes must not be drilled until the concrete has reached the designated minimum compressive strength.

³Concrete thickness must be a minimum of 3 times the embedment depth of the fastener.

⁴The fasteners listed in the table above may be used for static load conditions and for the seismic load conditions described in Section 4.1.7, as applicable. The tabulated allowable loads apply to static load conditions. For seismic load conditions, the allowable loads must be limited in accordance with Section 4.1.7, Items 2 and 3, as applicable.

**TABLE 5—ALLOWABLE LOADS FOR FASTENERS DRIVEN INTO
MINIMUM $f'_c = 3000$ psi STRUCTURAL SAND-LIGHTWEIGHT CONCRETE WITH OR WITHOUT METAL DECK^{1,6}**

FASTENER DESCRIPTION	FASTENER	SHANK DIAMETER (inch)	MINIMUM EMBEDMENT (inch)	ALLOWABLE LOADS (lbf)							
Fastener Location:				Installed into Concrete ⁴		Installed Through Metal Deck Panel into Concrete ⁵					
						3-inch deep composite floor deck panel ²			1½-inch deep composite floor deck panel ³		
Load Direction:				Tension	Shear	Tension		Shear	Tension		Shear
						Upper Flute	Lower Flute	Lower Flute	Upper Flute	Lower Flute	Lower Flute
Universal Knurled Shank	X-U	0.157	³ / ₄	125	115	130	95	245	95	95	370
			1	205	260	215	155	330	125	125	415
			1¼	315	435	295	200	375	—	—	—
			1½	425	475	400	260	430	—	—	—
Smooth Shank	X-P	0.157	³ / ₄ ⁷	155	165	130	105	285	140	130	335
			1 ⁷	225	300	215	165	340	215	215	385
			1¼ ⁷	325	445	295	230	375	—	270	465
			1½ ⁷	425	480	400	330	365	—	—	—

For SI: 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 psi = 6895 Pa.

¹Fasteners must not be driven until the concrete has reached the designated minimum compressive strength.

²The steel deck profile for the 3-inch deep composite floor deck panel has a minimum thickness of 0.0359 inch (0.91 mm) and a minimum F_y of 50 ksi and a minimum tensile strength of 65 ksi. Lower and upper flute width must be a minimum of 3⅞ inches. Figure 4 shows the nominal flute dimensions, fastener locations, and load orientations for the deck panel profile. Sand-lightweight concrete fill above top of steel deck panel must be minimum 3¼ inches thick.

³The steel deck profile for the 1½-inch deep composite floor deck panel has a minimum thickness of 0.0359 inch (0.91 mm) and a minimum F_y of 33 ksi and a minimum tensile strength of 45 ksi. Lower flute and upper flute widths must be a minimum of 1¾ inch and 3½ inch, respectively. This deck panel may also be inverted as shown in Figure 6. Figures 5 and 6 show the nominal flute dimensions, fastener locations, and load orientations for the deck panel profile. Sand-lightweight concrete fill above top of steel deck panel must be minimum 2½ inches thick.

⁴Concrete thickness must be a minimum of 3 times the embedment depth of the fastener.

⁵Minimum allowable spacing parallel to the deck flutes is 5.1 inches.

⁶The fasteners listed in the table above may be used for static load conditions and for the seismic load conditions described in Section 4.1.7, as applicable. The tabulated allowable loads apply to static load conditions. For seismic load conditions, the allowable loads must be limited in accordance with Section 4.1.7, Items 2 and 3, as applicable.

⁷Applies to fastening of cold-formed steel up to 54 mil thick using the X-P 22, X-P 27, X-P 34 and X-P 40 fasteners, respectively, for the ¾, 1, 1¼ and 1½ inch embedment depths.

TABLE 6—ALLOWABLE LOADS FOR FASTENERS DRIVEN INTO CONCRETE MASONRY UNITS^{1,2,8}

FASTENER DESCRIPTION	FASTENER	SHANK DIAMETER (inch)	MINIMUM EMBEDMENT DEPTH (inch)	ALLOWABLE LOADS (lbf)									
Masonry Type:				Hollow CMU				Grouted CMU					
Fastener Location:				Face Shell ³		Mortar Joint ⁴		Face Shell ³		Mortar Joint ⁴		Top of Grouted Cell ⁶	
Load Direction:				Tension	Shear ⁷	Tension	Shear ⁵	Tension	Shear ⁷	Tension	Shear ⁵	Tension	Shear ⁷
Universal Knurled Shank	X-U	0.157	1	70	85	25	70	215	210	150	190	165	240

¹The tabulated allowable load values are for fasteners installed in masonry conforming to the requirements of Section 3.2.2 of this report.

CMUs must be normal weight. Mortar must be Type S.

²No more than one low-velocity fastener may be installed in an individual concrete masonry unit cell. The fastener must be installed a minimum of 4 inches from the top, bottom and edges of the wall.

³Fastener must be located a minimum of 1 inch from the mortar joints.






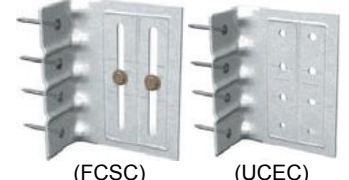
⁴Fasteners must not be installed in the head joints. Fasteners installed in the bed joints must be installed a minimum of 8 inches from the end of the wall. Multiple fasteners in a bed joint must be spaced a minimum of 8 inches. ⁵Shear load direction can be horizontal or vertical along the CMU wall plane.

⁶Fastener located in center of grouted cell installed vertically.

⁷Shear load can be in any direction.

⁸The fasteners listed in the table above may be used for static load conditions and for the seismic load condition described in Item 1 of Section 4.1.7.

**TABLE 7—ALLOWABLE LOADS FOR FASTENERS DRIVEN THROUGH
THE SHORT LEG OF COLD-FORMED STEEL CLIPS INTO MINIMUM $\frac{3}{16}$ " BASE STEEL** ^{1,2,3,4,5,6}

COLD-FORMED STEEL CLIP TYPE	HILTI FASTENER	LOAD DIRECTION ⁵	ALLOWABLE LOAD FOR FASTENER GROUP (lbf)	NUMBER OF FASTENERS USED TO ATTACH CLIP TO SUPPORT AND LOCATIONS OF FASTENERS INSTALLED THROUGH THE SHORT LEG OF THE CLIP ⁴
Clark Dietrich FCEC™	X-U	Tension	765	2 Fasteners 
		Tension	1120	3 Fasteners 
		Tension	1595	4 Fasteners 
Clark Dietrich FCSC™ and UCEC™	X-U	Tension	745	2 Fasteners  (FCSC) (UCEC)
Clark Dietrich UCEC™		Shear	1215	
		45-degree	980	
Clark Dietrich FCSC™ and UCEC™		Tension	910	3 Fasteners  (FCSC) (UCEC)
Clark Dietrich UCEC™		Shear	1300	
		45-degree	1185	
Clark Dietrich FCSC™ and UCEC™		Tension	1225	4 Fasteners  (FCSC) (UCEC)
Clark Dietrich UCEC™		Shear	1715	
	45-degree	1185		

For **SI**: 1 inch = 25.4 mm; 1 lbf = 4.4 N; 1 ksi = 6.9 MPa.

¹Allowable load capacities are based on base steel with minimum yield strength (F_y) of 36 ksi and minimum tensile strength (F_u) of 58 ksi.

²The fasteners must be driven to where the point of the fastener penetrates through the steel base material.

³Allowable load values are for the connection of the cold-formed steel clip to base steel. Evaluation of the cold-formed steel clip itself and the connection of the cold-formed steel clip to the supported cold-formed steel members must be in accordance with [ESR-2570](#).

⁴See Figure 8 for steel clip dimensions.

⁵See Figure 9 for a depiction of the load orientations.

⁶The fastener groupings listed in the table above may be used for static load conditions and for the seismic load condition described in Item 1 of Section 4.1.7. The tabulated allowable loads apply to static load conditions.



FIGURE 1—HILTI X-U FASTENER



FIGURE 2—X-U 15 FASTENER



FIGURE 3—X-P FASTENER

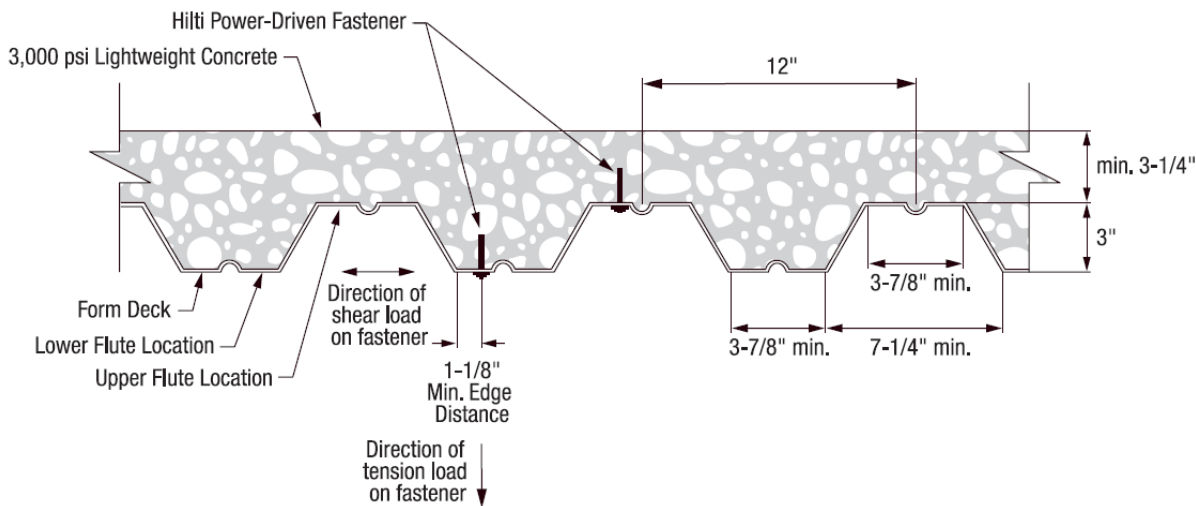


FIGURE 4—HILTI FASTENER LOCATION IN 3-INCH-DEEP COMPOSITE FLOOR DECK PANEL, NORMAL DECK PANEL PROFILE ORIENTATION

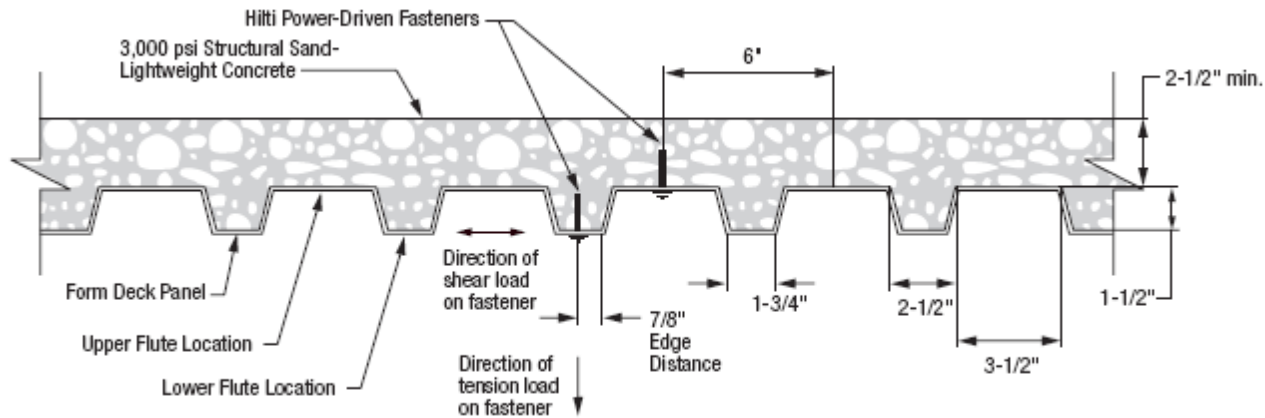


FIGURE 5—HILTI FASTENER LOCATION IN 1 1/2-INCH-DEEP COMPOSITE FLOOR DECK PANEL, NORMAL DECK PANEL PROFILE ORIENTATION

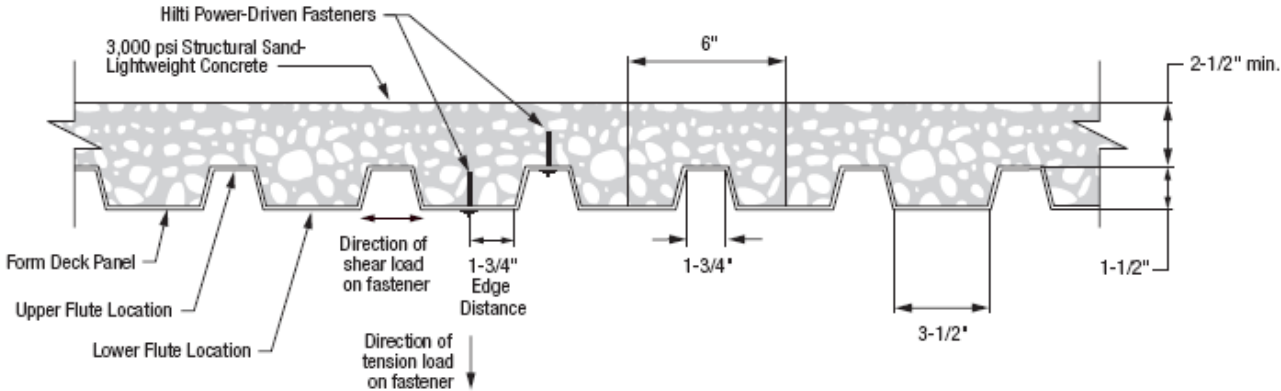


FIGURE 6—HILTI FASTENER LOCATION IN 1 1/2-INCH-DEEP COMPOSITE FLOOR DECK PANEL, INVERTED DECK PANEL PROFILE ORIENTATION

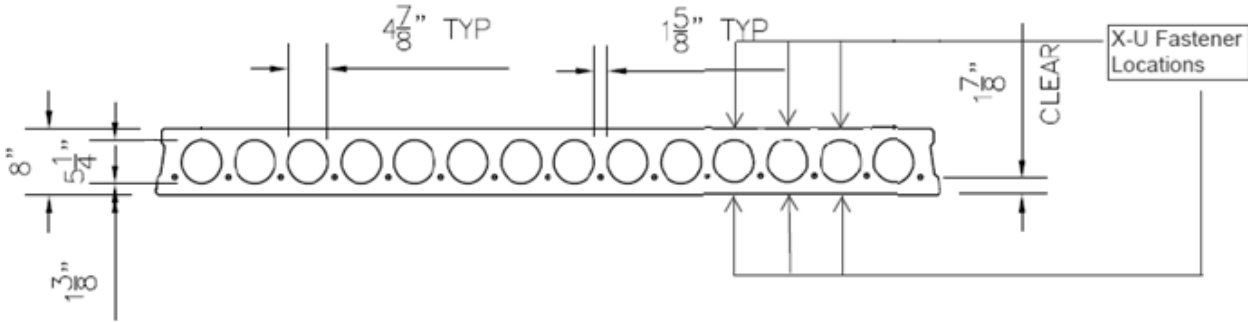


FIGURE 7—HILTI X-U FASTENER LOCATION IN HOLLOW-CORE CONCRETE SLABS

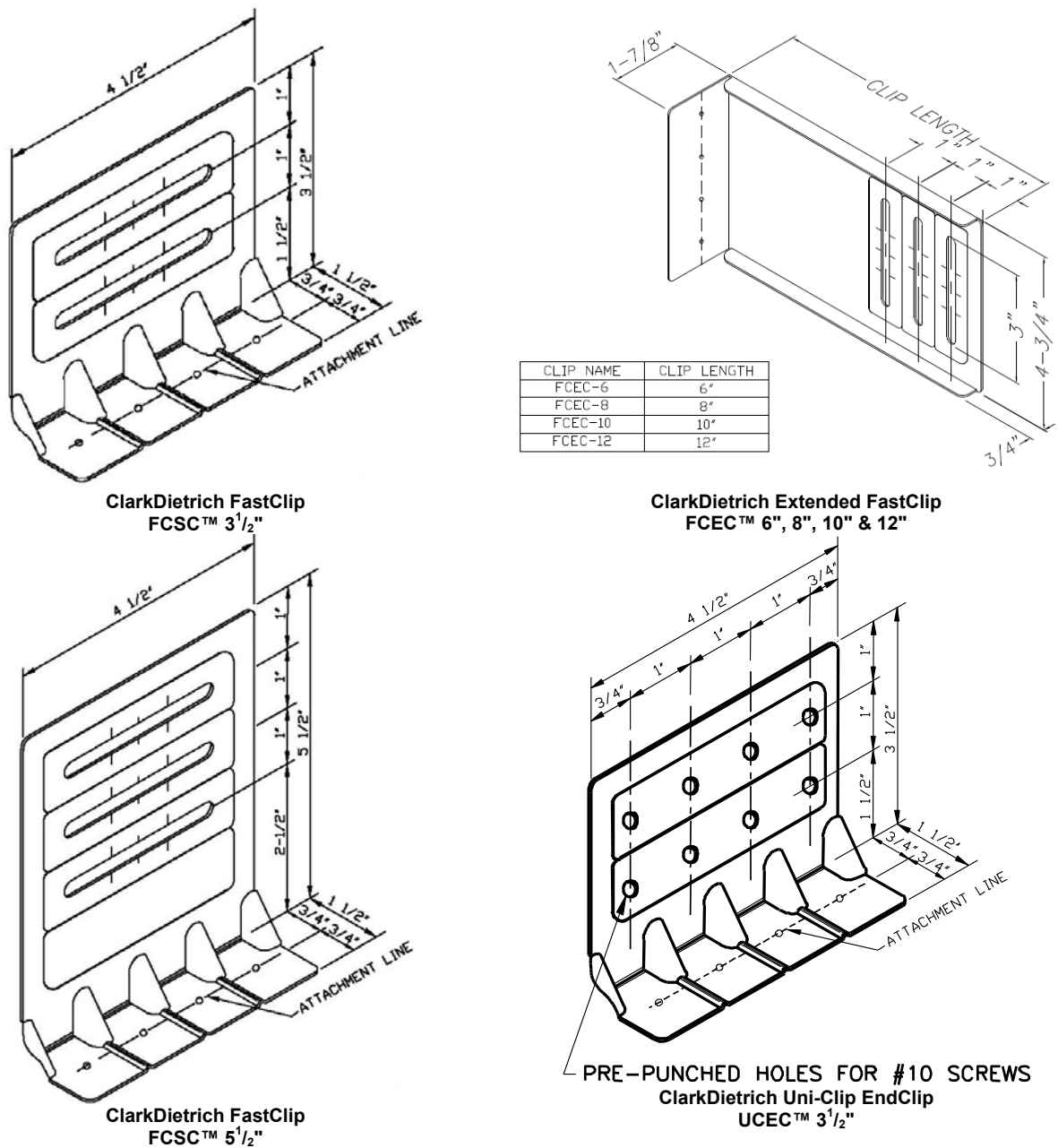
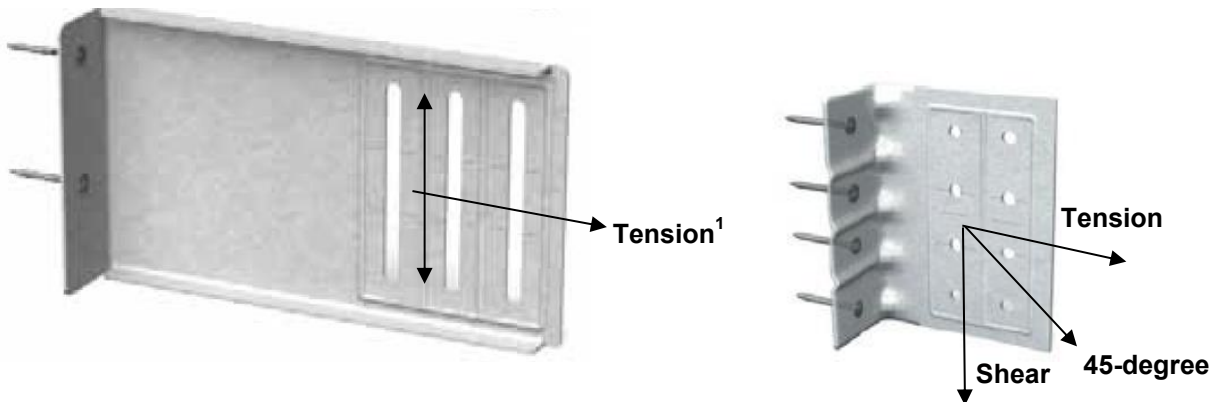


FIGURE 8—CLARK-DIETRICH COLD-FORMED STEEL CLIP DIMENSIONS (Reference [ESR-2570](#))



¹For FCEC and FCSC clips, tension loads applied perpendicular to the clips at any position along the slot.

FIGURE 9—COLD-FORMED STEEL CLIP LOAD ORIENTATIONS

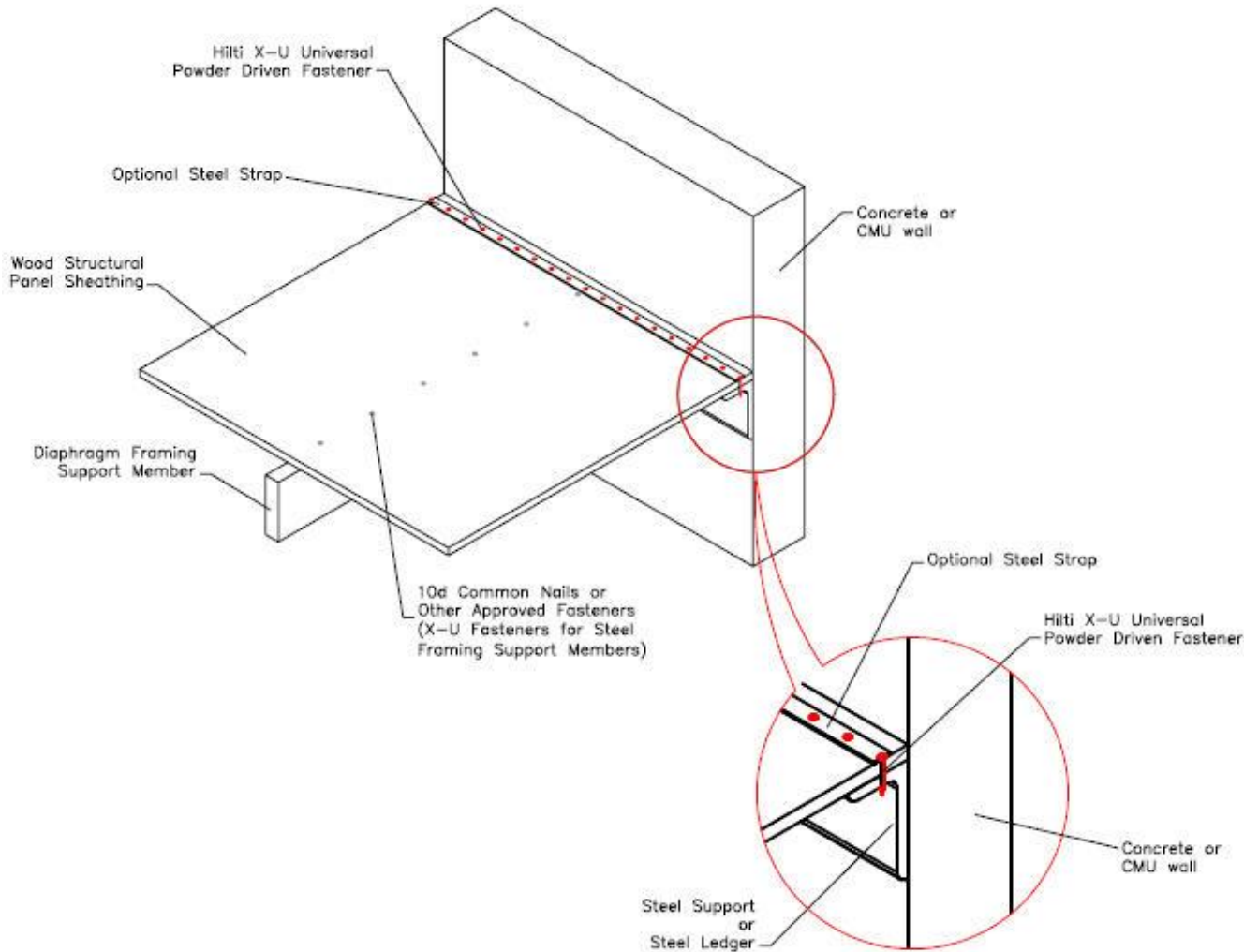


FIGURE 10—WOOD STRUCTURAL PANEL DECK ATTACHMENT TO STEEL LEDGER WITH HILTI X-U UNIVERSAL POWDER DRIVEN FASTENER