

ICC-ES Evaluation Report

ESR-4374

Reissued March 2024


This report also contains:

- LABC Supplement
- FBC Supplement

Subject to renewal March 2025

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<p>DIVISION: 05 00 00—METALS</p> <p>Section: 05 05 23—Metal Fastenings</p>	<p>REPORT HOLDER: DEWALT</p> <p>ADDITIONAL LISTEES: ELCO CONSTRUCTION PRODUCTS HILTI, INC</p>	<p>EVALUATION SUBJECT: BI-FLEX®, DRIL-FLEX® AND ALUMI-FLEX® SELF-DRILLING STRUCTURAL SCREWS USED WITH ALUMINUM (DEWALT)</p>	
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1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015 and 2012 [International Building Code® \(IBC\)](#)
- 2021, 2018, 2015 and 2012 [International Residential Code \(IRC\)](#)

For evaluation for compliance with codes adopted by [Los Angeles Department of Building and Safety \(LADBS\)](#), see [ESR-4374 LABC and LARC Supplement](#).

Property evaluated:

Structural

2.0 USES

The screws described in this report are used in engineered aluminum-to-aluminum and aluminum-to-steel connections, and to attach miscellaneous building materials to aluminum. The screws may be used in structures regulated under the IRC when an engineered design is submitted in accordance with IRC Section R301.1.3.

3.0 DESCRIPTION

3.1 General:

The evaluated screws are self-drilling, self-tapping screws with various head styles. See [Table 1](#) for detailed product descriptions including screw size, nominal diameter, head style, head diameter, point number, drilling capacities in aluminum and steel, as applicable, and minimum required protrusion length. See [Figure 1](#) for depictions of the screws. Product names for the report holder and the additional listees are presented in the following table:

Company Name	Product Name		
DEWALT	Dril-Flex®	Bi-Flex®	Alumi-Flex®
Elco Construction Products	Dril-Flex®	Bi-Flex®	Alumi-Flex®
Hilti	Kwik-Flex	Bi-Metal Kwik-Flex	—

3.1.1 Bi-Flex[®] Screws: The Bi-Flex[®] screws have a head and shank which are formed from 300 series stainless steel and a drill point and tapping threads which are formed from carbon steel which is hardened. The carbon steel and stainless steel parts are fused together, prior to being coated with a proprietary corrosion-resistant coating identified as Stalgard[®] GB, which is silver in color.

3.1.2 Dril-Flex[®] Screws: The Dril-Flex[®] screws are manufactured from alloy steel wire complying with the manufacturer's specifications. The drill point and lead threads of the screws are heat-treated to a relatively high hardness to facilitate drilling and thread forming. The balance of the screw is treated to a lower hardness complying with the hardness limits for SAE J429 Grade 5 screws and the hardness limits for ASTM A449 Type 1 screws. Hex washer head parts are coated with a corrosion-resistant coating identified as Stalgard[®] SUB, which is silver in color. All other head styles are coated with a corrosion-resistant coating identified as Stalgard[®], which is silver in color.

3.1.3 Alumi-Flex[®] Screws: The Alumi-Flex[®] screws are manufactured from 300 series stainless steel. The screws also have a corrosion resistant coating designated as Stalgard[®] GB.

3.2 Connected Materials:

3.2.1 Aluminum: The design values in this report apply to screw connections of flat pieces of 6063-T5, 6061-T6 or 6063-T6 aluminum. The minimum yield and tensile strengths of these materials are shown in the tables in this report and correspond to ASTM standards shown in Table A.4.3 of the Aluminum Design Manual (ADM). The aluminum thicknesses must be as indicated in the applicable tables.

3.2.2 Steel: The applicable minimum yield and tensile strengths of steel materials are shown in the tables in this report. The steel thickness must be as indicated in the applicable tables.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: The screws described in this report have been evaluated for use in engineered connections. Determination of the suitability of a particular screw described in this report for the specific application is the responsibility of the registered design professional and is outside the scope of this report. The registered design professional is also responsible for determining the applicable limit states for the connection that must be considered. Design provisions are based on the ADM and AISI S100, as applicable.

Screw length must equal or exceed the sum of the thickness of the fastened materials, including interstitial material, when applicable, and the minimum required protrusion length shown in [Table 1](#).

4.1.2 Available Strengths: Available strengths for the evaluated screws are tabulated as follows:

LIMIT STATE		TABLE	PAGE
Fastener Strength		2	4
Aluminum Pull-over Strength	ASD	3A	5
	LRFD	3B	
Aluminum Pull-out Strength	ASD	4A	6
	LRFD	4B	
Aluminum-to-Aluminum Shear Strength	ASD	5A	7
	LRFD	5B	
Steel Pull-out Strength	ASD	6A	8
	LRFD	6B	
Aluminum-to-Steel Shear Strength	ASD	7A	9
	LRFD	7B	

For aluminum-to-aluminum connections, shear (bearing) strengths are applicable to connections where the two connected pieces of aluminum are in direct contact with one another. For aluminum-to-steel connections, shear (bearing) strengths are applicable to connections where the spacing between the aluminum and steel pieces does not exceed the thickness of the spacer used in testing, which is addressed in [Tables 7A](#) and [7B](#).

Design provisions for self-drilling tapping screw connections subjected to combined shear and tension loading are outside the scope of the report.

4.1.3 Rupture: Connected members must be checked for rupture in accordance with Section J6 of AISI S100 (Section E6 of AISI S100 for the 2015 IBC, Section E5 of AISI S100 for the 2012 IBC) and/or Section J.7.3 of the ADM, as applicable.

4.1.4 Geometric Parameters: The minimum edge and end distances for the screws must be 1.5 times the nominal diameter of the screw, in accordance with Section J.5.3 of the ADM and Section J4.2 of AISI S100

(Section E4.2 for the 2015 and 2012 IBC). For screws installed into aluminum, screw spacing must be a minimum of 2.5 times the nominal diameter of the screw, in accordance with Section J.5.2 of the ADM. For screws installed into steel, the minimum spacing must be 3 times the nominal diameter of the screw. The maximum spacing of screws in aluminum must comply with Section J.1.3 of the ADM. See [Table 8](#) for required spacing, edge and distance dimensions based on these requirements.

4.1.5 Corrosion Resistance: Screws formed partially or entirely from carbon steel have been tested for corrosion resistance in accordance with ASTM B117, and exhibit no white corrosion after three hours and no red rust after twelve hours. Resistance to corrosion due to environmental conditions and/or galvanic action between aluminum and steel base material and/or fastener material is outside the scope of this evaluation. The registered design professional is responsible for determining the required corrosion resistance.

4.2 Installation:

Installation of screws must be in accordance with the published installation instructions from the report holder or applicable listee and this report. The published installation instructions must be available at the jobsite at all times during installation.

The screws must be installed perpendicular to the work surface using a screw gun incorporating a depth-sensitive or torque-limiting nose piece with a maximum speed of 1800 rpm for all 1/4-inch screws and for #12 screws with a #4 or #5 point type; and a maximum speed of 2500 rpm for all other screws.

5.0 CONDITIONS OF USE:

The screws 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 screws must be installed in accordance with this report and the applicable published installation instructions. In the case of a conflict between the published installation instructions and this report, the more restrictive requirements govern.
- 5.2 Design loads for the screws must not exceed the available strengths described in Section 4.1.
- 5.3 Construction documents and calculations demonstrating that the design loads do not exceed the available strengths must be submitted to the code official. The calculations must be prepared by a registered design professional when required by statutes of the jurisdiction in which the project is to be constructed.
- 5.4 The screws are manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the [ICC-ES Acceptance Criteria for Self-drilling Tapping Screws Used with Aluminum \(AC491\)](#) dated June 2017 (editorially revised February 2021).

7.0 IDENTIFICATION

- 7.1 The screw heads are marked as shown in [Figure 1](#). Packages of the screws are labeled with one of the applicable company names (DEWALT, Elco, or Hilti), the product name, the fastener size, length, point number and coating and the evaluation report number (ESR-4374).

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

DEWALT
701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286
(800) 524-3244
www.DEWALT.com
anchors@DEWALT.com

- 7.3 The Additional Listees' contact information is the following:

ELCO CONSTRUCTION PRODUCTS
701 EAST JOPPA ROAD
TOWSON, MARYLAND 21286
(800) 524-3244
www.elcoconstruction.com

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

TABLE 1—SCREW DESCRIPTIONS¹

SCREW TYPE	DESCRIPTION (nominal size and tpi)	NOMINAL DIAMETER (inch)	HEAD STYLE ²	DRIVE SIZE (inch) / PHILLIPS SIZE (No.)	NOMINAL HEAD DIAMETER (inch)	POINT TYPE	MAXIMUM DRILLING CAPACITY (inch)		MINIMUM REQUIRED PROTRUSION LENGTH (inch)
							In Aluminum	In Steel	
Bi-Flex® Screws									
1	#8-18	0.164	HWH	1/4	0.335	#2	0.125	0.110	0.594
2	#8-18	0.164	PPH	2	0.315	#2	0.125	0.110	0.594
3	#10-16	0.190	HWH	5/16	0.400	#2	0.125	0.110	0.500
4	#10-16	0.190	Pancake	2	0.435	#2	0.125	0.110	0.500
5	#10-16	0.190	PPH	2	0.365	#2	0.125	0.110	0.500
6	#12-14	0.216	HWH	5/16	0.415	#2	0.125	0.110	0.594
7	#12-14	0.216	PUFH	3	0.415	#2	0.125	0.110	0.594
8	#12-14	0.216	HWH	5/16	0.415	#3	0.250	0.230	0.594
9	#12-14	0.216	Pancake	2	0.435	#3	0.250	0.230	0.594
10	#12-24	0.216	HWH	5/16	0.415	#5	0.500	0.500	1.000
11	1/4-14	0.250	HWH	3/8	0.500	#2	0.125	0.110	0.594
12 ⁽³⁾	1/4-20	0.250	PUFH	3	0.480	#3	0.250	0.230	0.594
13	1/4-20	0.250	HWH	3/8	0.500	#3	0.250	0.230	0.594
14 ⁽³⁾	1/4-20	0.250	HWH	3/8	0.500	#3	0.250	0.230	0.594
15	1/4-20	0.250	HWH	3/8	0.500	#5	0.500	0.500	1.000
16 ⁽³⁾	1/4-20	0.250	HWH	3/8	0.500	#5	0.500	0.500	1.000
Dril-Flex® Screws									
17	#10-16	0.190	PPH	2	0.365	#2	0.125	0.110	0.406
18A	#10-16	0.190	HWH	5/16	0.400	#3	0.175	0.150	0.500
18B	#10-16	0.190	HWH	5/16	0.415	#3	0.175	0.150	0.500
19	#10-24	0.190	PWH	2	0.470	#3	0.175	0.150	0.468
20	#12-14	0.216	HWH	5/16	0.500	#2	0.125	0.110	0.625
21	#12-14	0.216	HWH	5/16	0.415	#3	0.210	0.188	0.500
22	#12-14	0.216	PUFH	3	0.415	#3	0.210	0.188	0.500
23	#12-24	0.216	HWH	5/16	0.415	#5	0.500	0.500	1.000
24	1/4-14	0.250	HWH	3/8	0.500	#3	0.210	0.210	0.563
25	1/4-20	0.250	HWH	3/8	0.500	#4	0.313	0.313	0.813
26 ⁽³⁾	1/4-20	0.250	HWH	3/8	0.500	#4	0.313	0.313	0.813
27 ⁽³⁾	1/4-20	0.250	PUFH	3	0.460	#4	0.313	0.313	0.813
28	1/4-20	0.250	HWH	3/8	0.500	#5	0.500	0.500	1.000
Alumi-Flex® Screws									
29	#10-16	0.190	HWH	5/16	0.400	#3	0.175	–	0.438
30	#10-16	0.190	PUFH	2	0.350	#3	0.175	–	0.438
31	#12-14	0.216	HWH	5/16	0.415	#3	0.210	–	0.500
32	1/4-14	0.250	HWH	3/8	0.500	#3	0.250	–	0.563
33	1/4-14	0.250	PUFH	3	0.480	#3	0.250	–	0.563
34	1/4-20	0.250	HWH	5/16	0.500	#4	0.313	–	0.625

For SI: 1 inch = 25.4 mm.

¹Screws are fully threaded unless noted otherwise.

²Head style abbreviations denote the following: HWH = Hex Washer Head, PPH = Phillips Pan Head, PUFH = Phillips Undercut Flat Head, PWH = Phillips Wafer Head and Pancake = Phillips Pancake Head.

³This screw is partially threaded.

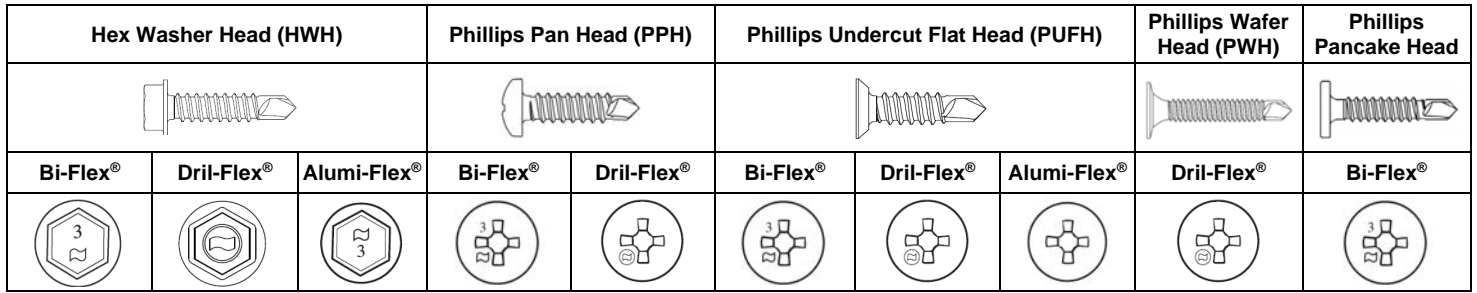


FIGURE 1—SCREW SHAPES AND HEAD MARKINGS

TABLE 2—FASTENER SHEAR AND TENSION STRENGTHS^{1,2,3}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (inch)	HEAD STYLE ⁴	NOMINAL STRENGTH (lbf)		ALLOWABLE STRENGTH (ASD) Ω=3 (lbf)		DESIGN STRENGTH (LRFD) Φ=0.5 (lbf)	
				Shear, P _{ss}	Tension, P _{ts}	Shear, P _{ss} /Ω	Tension, P _{ts} /Ω	Shear, ΦP _{ss}	Tension, ΦP _{ts}
Bi-Flex® Screws									
1	#8-18	0.164	HWH	1,195	1,508	398	503	598	754
2	#8-18	0.164	PPH	1,066	1,437	355	479	533	719
3	#10-16	0.190	HWH	1,506	2,038	502	679	753	1,019
4	#10-16	0.190	Pancake	1,251	1,713	417	571	626	857
5	#10-16	0.190	PPH	1,274	1,758	425	586	637	879
6	#12-14	0.216	HWH	2,084	2,850	695	950	1,042	1,425
7	#12-14	0.216	PUFH	1,616	2,409	539	803	808	1,205
8	#12-14	0.216	HWH	2,148	2,788	716	929	1,074	1,394
9	#12-14	0.216	Pancake	1,668	2,331	556	777	834	1,166
10	#12-24	0.216	HWH	2,147	2,939	716	980	1,074	1,470
11	1/4-14	0.250	HWH	2,601	3,582	867	1,194	1,301	1,791
12	1/4-20	0.250	PUFH	2,356	3,042	785	1,014	1,178	1,521
13, 14	1/4-20	0.250	HWH	3,043	4,006	1,014	1,335	1,522	2,003
15 16	1/4-20	0.250	HWH	3,289	3,834	1,096	1,278	1,645	1,917
Dril-Flex® Screws									
17,	#10-16	0.190	PPH	1,526	2,273	509	758	763	1,136
18A, 18B	#10-16	0.190	HWH	1,463	2,276	488	759	732	1,138
19	#10-24	0.190	PWH	1,080	2,613	360	871	540	1,307
20, 21	#12-14	0.216	HWH	1,992	3,216	664	1,072	996	1,608
22	#12-14	0.216	PUFH	1,980	2,149	660	716	990	1,075
23	#12-24	0.216	HWH	1,933	3,254	644	1,085	967	1,627
24	1/4-14	0.250	HWH	2,692	4,363	897	1,454	1,346	2,182
25, 28	1/4-20	0.250	HWH	2,617	4,359	872	1,453	1,308	2,179
26	1/4-20	0.250	HWH	2,659	4,729	886	1,576	1,330	2,364
27	1/4-20	0.250	PUFH	2,865	4,592	955	1,531	1,433	2,296
Alumi-Flex® Screws									
29	#10-16	0.190	HWH	1,169	1,525	390	508	585	762
30	#10-16	0.190	PUFH	1,140	1,728	380	576	570	864
31	#12-14	0.216	HWH	1,544	2,110	515	703	772	1,055
32	1/4-14	0.250	HWH	2,054	2,966	685	989	1,027	1,483
33	1/4-14	0.250	PUFH	2,062	3,202	687	1,067	1,031	1,601
34	1/4-20	0.250	HWH	2,177	3,404	726	1,135	1,089	1,702

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

¹Strengths are based on laboratory tests.

²For tension connections, the lowest of the available pull-out, pull-over, and screw tension strength must be used for design.

³For shear connections, the lower of the available screw shear strength and the available shear (bearing) must be used for design.

⁴Head style abbreviations denote the following: HWH = Hex Washer Head, PPH = Phillips Pan Head, PUFH = Phillips Undercut Flat Head, PWH = Phillips Wafer Head, and Pancake = Phillips Pancake Head.

TABLE 3A—ALLOWABLE (ASD) PULL-OVER STRENGTH OF ALUMINUM IN SCREW CONNECTIONS (lbf)^{1,2,3,4}

Table with columns: SCREW TYPE, SCREW SIZE, NOMINAL DIAMETER (in.), HEAD STYLE, and THICKNESS OF ALUMINUM MEMBER IN CONTACT WITH SCREW HEAD (inch). Rows include Bi-Flex® Screws, Dril-Flex® Screws, and Alumi-Flex® Screws.

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N. See notes below Table 3B.

TABLE 3B—DESIGN (LRFD) PULL-OVER STRENGTH OF ALUMINUM IN SCREW CONNECTIONS (lbf)^{1,2,3,4}

Table with columns: SCREW TYPE, SCREW SIZE, NOMINAL DIAMETER (in.), HEAD STYLE, and THICKNESS OF ALUMINUM MEMBER IN CONTACT WITH SCREW HEAD (inch). Rows include Bi-Flex® Screws, Dril-Flex® Screws, and Alumi-Flex® Screws.

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

1 Available strengths in shaded cells are based on laboratory tests, which exceed available strengths calculated in accordance with the ADM. Safety factors and resistance factors have been determined in accordance with the ADM. These values only apply to screws which are self-drilled.

2 Available strengths in unshaded cells are based on calculations in accordance with the ADM. These values are applicable to screws which are self-drilled and to screws which are installed in existing holes in the aluminum which have the following dimensions: 0.177 inch for #8 screws; 0.201 inch for #10 screws; 0.228 inch for #12 screws; 0.266 inch for 1/4-inch screws.

3 Available strengths for member thicknesses which are not addressed in the table may be determined by calculation in accordance with the ADM.

4 For tension connections, the lowest of the available pull-out, pull-over, and screw tension strength must be used for design.

5 Head style abbreviations denote the following: HWH = Hex Washer Head, PPH = Phillips Pan Head, PUFH = Phillips Undercut Flat Head, PWH = Phillips Wafer Head, and Pancake = Phillips Pancake Head.

TABLE 4A—ALLOWABLE (ASD) PULL-OUT STRENGTH OF SCREWS INSTALLED IN ALUMINUM (lbf)^{1,2}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	THICKNESS OF ALUMINUM MEMBER NOT IN CONTACT WITH SCREW HEAD (inch)														
				6063-T5 (F _y = 16 ksi, F _u = 22 ksi)					6063-T6 (F _y = 25 ksi, F _u = 30 ksi)					6061-T6 (F _y = 35 ksi, F _u = 38 ksi)				
				1/16	1/8	3/16	1/4	5/16	1/16	1/8	3/16	1/4	5/16	1/16	1/8	3/16	1/4	5/16
Bi-Flex® Screws																		
1, 2	#8-18	0.164	#2	69	175	—	—	—	101	252	—	—	—	123	320	—	—	—
3, 4, 5	#10-16	0.190	#2	72	190	—	—	—	100	280	—	—	—	128	360	—	—	—
6, 7	#12-14	0.216	#2	70	206	—	—	—	106	308	—	—	—	134	406	—	—	—
8, 9	#12-14	0.216	#3	55	164	353	504	—	85	270	496	646	—	110	348	590	696	—
10	#12-24	0.216	#5	—	145	309	387	436	—	214	421	518	606	—	275	467	595	704
11	1/4-14	0.250	#2	84	237	—	—	—	133	357	—	—	—	180	473	—	—	—
12, 13, 14	1/4-20	0.250	#3	60	171	330	488	—	95	257	477	656	—	122	342	594	758	—
15, 16	1/4-20	0.250	#5	—	120	259	355	395	—	190	340	508	565	—	273	357	660	706
Dril-Flex® Screws																		
17	#10-16	0.190	#2	78	200	—	—	—	119	298	—	—	—	153	391	—	—	—
18A, 18B	#10-16	0.190	#3	76	180	—	—	—	100	277	—	—	—	132	381	—	—	—
19	#10-24	0.190	#3	82	193	—	—	—	100	283	—	—	—	109	361	—	—	—
20	#12-14	0.216	#2	103	226	—	—	—	114	329	—	—	—	146	415	—	—	—
21, 22	#12-14	0.216	#3	103	216	420	—	—	114	317	592	—	—	145	403	704	—	—
23	#12-24	0.216	#5	—	183	358	410	449	—	262	487	664	664	—	322	542	812	812
24	1/4-14	0.250	#3	85	241	437	—	—	123	346	644	—	—	144	428	832	—	—
25, 26, 27	1/4-20	0.250	#4	—	233	447	589	641	—	336	617	847	977	—	416	708	1,113	1,195
28	1/4-20	0.250	#5	—	224	437	596	600	—	333	621	842	882	—	434	752	1,075	1,134
Alumi-Flex® Screws																		
29, 30	#10-16	0.190	#3	71	190	—	—	—	109	286	—	—	—	143	379	—	—	—
31	#12-14	0.216	#3	66	189	391	—	—	114	286	556	—	—	132	382	556	—	—
32, 33	1/4-14	0.250	#3	72	199	422	826	—	107	313	589	826	—	130	401	688	826	—
34	1/4-20	0.250	#4	—	195	376	580	580	—	291	547	782	782	—	382	719	880	880

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

¹Allowable strengths are based on laboratory tests. Safety factors have been determined in accordance with the ADM. These values only apply to screws which are self-drilled.

²For tension connections, the lowest of the allowable pull-out, pull-over, and screw tension strength must be used for design.

TABLE 4B—DESIGN (LRFD) PULL-OUT STRENGTH OF SCREWS INSTALLED IN ALUMINUM (lbf)^{1,2}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	THICKNESS OF ALUMINUM MEMBER NOT IN CONTACT WITH SCREW HEAD (inch)														
				6063-T5 (F _y = 16 ksi, F _u = 22 ksi)					6063-T6 (F _y = 25 ksi, F _u = 30 ksi)					6061-T6 (F _y = 35 ksi, F _u = 38 ksi)				
				1/16	1/8	3/16	1/4	5/16	1/16	1/8	3/16	1/4	5/16	1/16	1/8	3/16	1/4	5/16
Bi-Flex® Screws																		
1, 2	#8-18	0.164	#2	103	262	—	—	—	152	377	—	—	—	185	480	—	—	—
3, 4, 5	#10-16	0.190	#2	109	285	—	—	—	150	420	—	—	—	193	541	—	—	—
6, 7	#12-14	0.216	#2	105	309	—	—	—	159	462	—	—	—	201	610	—	—	—
8, 9	#12-14	0.216	#3	82	246	529	756	—	127	405	744	968	—	166	523	885	1,044	—
10	#12-24	0.216	#5	—	218	464	581	655	—	321	631	778	909	—	413	701	892	1,056
11	1/4-14	0.250	#2	127	356	—	—	—	200	535	—	—	—	270	710	—	—	—
12, 13, 14	1/4-20	0.250	#3	91	257	496	733	—	143	386	715	984	—	184	513	892	1,137	—
15, 16	1/4-20	0.250	#5	—	180	389	532	592	—	286	510	762	848	—	410	536	990	1,059
Dril-Flex® Screws																		
17	#10-16	0.190	#2	118	300	—	—	—	179	447	—	—	—	230	586	—	—	—
18A, 18B	#10-16	0.190	#3	114	270	—	—	—	150	416	—	—	—	198	572	—	—	—
19	#10-24	0.190	#3	124	290	—	—	—	150	425	—	—	—	164	542	—	—	—
20	#12-14	0.216	#2	154	339	—	—	—	170	493	—	—	—	219	622	—	—	—
21, 22	#12-14	0.216	#3	155	325	630	—	—	170	475	887	—	—	218	605	1,057	—	—
23	#12-24	0.216	#5	—	275	537	615	674	—	393	730	996	996	—	483	813	1,219	1,219
24	1/4-14	0.250	#3	128	361	655	—	—	185	519	966	—	—	216	642	1,249	—	—
25, 26, 27	1/4-20	0.250	#4	—	350	671	884	962	—	503	926	1,271	1,465	—	625	1,063	1,670	1,793
28	1/4-20	0.250	#5	—	336	656	894	900	—	499	931	1,262	1,323	—	651	1,128	1,613	1,701
Alumi-Flex® Screws																		
29, 30	#10-16	0.190	#3	107	285	—	—	—	164	428	—	—	—	215	569	—	—	—
31	#12-14	0.216	#3	100	284	586	—	—	170	429	834	—	—	198	574	834	—	—
32, 33	1/4-14	0.250	#3	109	299	633	1,239	—	160	469	883	1,239	—	195	602	1,032	1,239	—
34	1/4-20	0.250	#4	—	293	565	870	870	—	437	821	1,172	1,172	—	574	1,078	1,321	1,321

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

¹Design strengths are based on laboratory tests. Resistance factors have been determined in accordance with the ADM. These values only apply to screws which are self-drilled.

²For tension connections, the lowest of the design pull-out, pull-over, and screw tension strength must be used for design.

TABLE 5A—ALLOWABLE (ASD) SHEAR (BEARING) CAPACITY OF ALUMINUM-TO-ALUMINUM SCREW CONNECTIONS (lbf)^{1,2,3,4}

Table with columns: SCREW TYPE, SCREW SIZE, NOMINAL DIAMETER (in.), POINT TYPE, HEAD STYLE, THICKNESS OF ALUMINUM (IN CONTACT - NOT IN CONTACT) WITH SCREW HEAD (inch). Rows include Bi-Flex, Dril-Flex, and Alumi-Flex screws.

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N. Notes for Tables 5A and 5B are on page 8.

TABLE 5B—DESIGN (LRFD) SHEAR (BEARING) CAPACITY OF ALUMINUM-TO-ALUMINUM SCREW CONNECTIONS (lbf)^{1,2,3,4}

Table with columns: SCREW TYPE, SCREW SIZE, NOMINAL DIAMETER (in.), POINT TYPE, HEAD STYLE, THICKNESS OF ALUMINUM (IN CONTACT - NOT IN CONTACT) WITH SCREW HEAD (inch). Rows include Bi-Flex, Dril-Flex, and Alumi-Flex screws.

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N. Notes for Tables 5A and 5B are on page 8.

Notes for Tables 5A and 5B:

¹Available strengths in shaded cells are based on laboratory tests, and exceed available strengths calculated in accordance with the ADM. Safety factors and resistance factors have been determined in accordance with the ADM. These values only apply to screws which are self-drilled.

²Available strengths in unshaded cells are based on calculations in accordance with the ADM. These values are applicable to screws which are self-drilled and to screws which are installed in existing holes in the aluminum which have the following dimensions: 0.177 inch for #8 screws; 0.201 inch for #10 screws; 0.228 inch for #12 screws; 0.266 inch for 1/4-inch screws.

³Available strengths for member thicknesses which are not addressed in the tables may be determined by calculation in accordance with the ADM.

⁴For lateral connections, the lower of the available shear (bearing) strength and screw shear strength must be used for design.

⁵Head style abbreviations denote the following: HWH = Hex Washer Head, PPH = Phillips Pan Head, PUFH = Phillips Undercut Flat Head, PWH = Phillips Wafer Head, and Pancake = Phillips Pancake Head.

TABLE 6A—ALLOWABLE (ASD) PULL-OUT STRENGTH OF SCREWS INSTALLED IN STEEL (lbf)^{1,2}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	DESIGN THICKNESS OF STEEL MEMBER NOT IN CONTACT WITH SCREW HEAD (INCH):											
				$(F_y = 33 \text{ ksi}, F_u = 45 \text{ ksi})$				$(F_y = 36 \text{ ksi}, F_u = 58 \text{ ksi})$				$(F_y = 50 \text{ ksi}, F_u = 65 \text{ ksi})$			
				1/8	3/16	1/4	5/16	1/8	3/16	1/4	5/16	1/8	3/16	1/4	5/16
Bi-Flex® Screws															
8, 9	#12-14	0.216	#3	387	523	–	–	447	674	–	–	447	755	–	–
10	#12-24	0.216	#5	390	429	601	652	451	553	774	841	451	620	867	943
12, 13, 14	1/4-20	0.250	#3	533	620	–	–	616	799	–	–	616	895	–	–
15, 16	1/4-20	0.250	#5	453	582	666	912	524	750	859	1,176	524	841	963	1,318
Dril-Flex® Screws³															
17	#10-16	0.190	#2	297	–	–	–	383	–	–	–	428	–	–	–
18A, 18B	#10-16	0.190	#3	297	–	–	–	383	–	–	–	428	–	–	–
19	#10-24	0.216	#3	546	–	–	–	704	–	–	–	704	–	–	–
21, 22	#12-14	0.216	#3	510	665	–	–	658	858	–	–	734	958	–	–
23	#12-24	0.216	#5	507	891	1,020	1,020	654	1,149	1,316	1,316	654	1,149	1,469	1,469
24	1/4-14	0.250	#3	561	899	–	–	724	1,160	–	–	808	1,295	–	–
25, 26, 27	1/4-20	0.250	#4	524	914	1,044	1,206	677	1,179	1,347	1,556	677	1,179	1,503	1,736
28	1/4-20	0.250	#5	524	914	1,044	1,206	677	1,179	1,347	1,556	677	1,179	1,503	1,736

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

¹Allowable strengths are based on laboratory tests. The safety factors have been determined in accordance with AISI S100. These values only apply to screws which are self-drilled.

²For tension connections, the lowest of the allowable pull-out, pull-over, and fastener tension strength must be used for design.

³Dril-Flex® fasteners have also been evaluated for use in steel-to-steel connections, as addressed in [ESR-3332](#), which includes pull-out values for thinner steel members.

TABLE 6B—DESIGN (LRFD) PULL-OUT STRENGTH OF SCREWS INSTALLED IN STEEL (lbf)^{1,2}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	DESIGN THICKNESS OF STEEL MEMBER NOT IN CONTACT WITH SCREW HEAD (INCH):											
				$(F_y = 33 \text{ ksi}, F_u = 45 \text{ ksi})$				$(F_y = 36 \text{ ksi}, F_u = 58 \text{ ksi})$				$(F_y = 50 \text{ ksi}, F_u = 65 \text{ ksi})$			
				1/8	3/16	1/4	5/16	1/8	3/16	1/4	5/16	1/8	3/16	1/4	5/16
Bi-Flex® Screws															
8, 9	#12-14	0.216	#3	619	837	–	–	715	1,079	–	–	715	1,209	–	–
10	#12-24	0.216	#5	624	643	961	1,044	721	829	1,238	1,345	721	929	1,387	1,507
12, 13, 14	1/4-20	0.250	#3	852	930	–	–	985	1,199	–	–	985	1,344	–	–
15, 16	1/4-20	0.250	#5	726	931	1,066	1,460	839	1,200	1,374	1,882	839	1,345	1,540	2,109
Dril-Flex® Screws³															
17	#10-16	0.190	#2	476	–	–	–	614	–	–	–	685	–	–	–
18A, 18B	#10-16	0.190	#3	476	–	–	–	614	–	–	–	685	–	–	–
19	#10-24	0.216	#3	874	–	–	–	1,127	–	–	–	1,127	–	–	–
21, 22	#12-14	0.216	#3	816	1,064	–	–	1,053	1,373	–	–	1,175	1,532	–	–
23	#12-24	0.216	#5	811	1,426	1,632	1,632	1,046	1,840	2,105	2,105	1,046	1,840	2,350	2,350
24	1/4-14	0.250	#3	897	1,439	–	–	1,157	1,493	–	–	1,292	2,072	–	–
25, 26, 27	1/4-20	0.250	#4	838	1,462	1,670	1,930	1,081	1,886	2,154	2,490	1,081	1,886	2,405	2,779
28	1/4-20	0.250	#5	838	1,462	1,670	1,930	1,081	1,886	2,154	2,490	1,081	1,886	2,405	2,779

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

¹Design strengths are based on laboratory tests. The resistance factors have been determined in accordance with AISI S100. These values only apply to screws which are self-drilled.

²For tension connections, the lowest of the design pull-out, pull-over, and fastener tension strength must be used for design.

³Dril-Flex® fasteners have also been evaluated for use in steel-to-steel connections, as addressed in [ESR-3332](#), which includes pull-out values for thinner steel members.

TABLE 7A—ALLOWABLE (ASD) SHEAR (BEARING) CAPACITY OF ALUMINUM-TO-STEEL SCREW CONNECTIONS (lbf)^{1,2,3,4,5}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	HEAD STYLE	6063-T5 ($F_y = 16$ ksi, $F_u = 22$ ksi)			6063-T6 ($F_y = 25$ ksi, $F_u = 30$ ksi)			6061-T6 ($F_y = 35$ ksi, $F_u = 38$ ksi)		
					Thickness of Aluminum – Thickness of Steel (inch)								
					0.0625	0.125	0.125	0.0625	0.125	0.125	0.0625	0.125	0.125
Bi-Flex® Screws													
8	#12-14	0.216	#3	HWH	301 ⁽⁶⁾	–	–	470 ⁽⁶⁾	–	–	499 ⁽⁶⁾	–	–
9	#12-14	0.216	#3	Pancake	303 ⁽⁶⁾	–	–	473 ⁽⁶⁾	–	–	501 ⁽⁶⁾	–	–
10	#12-24	0.216	#5	HWH	293	708	619	458	841	735	486	841	735
13	1/4-20	0.250	#3	HWH	305 ⁽⁶⁾	–	–	477 ⁽⁶⁾	–	–	506 ⁽⁶⁾	–	–
15	1/4-20	0.250	#5	HWH	291	453	785	455	538	932	482	765	932
Dril-Flex® Screws⁸													
21	#12-14	0.216	#3	HWH	300 ⁽⁷⁾	–	–	468 ⁽⁷⁾	–	–	496 ⁽⁷⁾	–	–
22	#12-14	0.216	#3	PUFH	323 ⁽⁷⁾	–	–	505 ⁽⁷⁾	–	–	535 ⁽⁷⁾	–	–
23	#12-24	0.216	#5	HWH	301	706	591	470	839	702	498	839	702
24	1/4-14	0.250	#3	HWH	301 ⁽⁶⁾	–	–	471 ⁽⁶⁾	–	–	499 ⁽⁶⁾	–	–
25	1/4-20	0.250	#4	HWH	292	766	–	457	910	–	484	910	–
28	1/4-20	0.250	#5	HWH	301	755	611	471	896	726	499	896	726

For SI: 1 inch = 25.4 mm, 1 lbf = 4.45 N. See notes below Table 7B.

TABLE 7B—DESIGN (LRFD) SHEAR (BEARING) CAPACITY OF ALUMINUM-TO-STEEL SCREW CONNECTIONS (lbf)^{1,2,3,4,5}

SCREW TYPE	SCREW SIZE	NOMINAL DIAMETER (in.)	POINT TYPE	HEAD STYLE	6063-T5 ($F_y = 16$ ksi, $F_u = 22$ ksi)			6063-T6 ($F_y = 25$ ksi, $F_u = 30$ ksi)			6061-T6 ($F_y = 35$ ksi, $F_u = 38$ ksi)		
					Thickness of Aluminum – Thickness of Steel (inch)								
					0.0625	0.125	0.125	0.0625	0.125	0.125	0.0625	0.125	0.125
Bi-Flex® Screws													
8	#12-14	0.216	#3	HWH	452 ⁽⁶⁾	–	–	706 ⁽⁶⁾	–	–	748 ⁽⁶⁾	–	–
9	#12-14	0.216	#3	Pancake	454 ⁽⁶⁾	–	–	709 ⁽⁶⁾	–	–	752 ⁽⁶⁾	–	–
10	#12-24	0.216	#5	HWH	440	1,062	929	687	1,261	1,103	728	1,261	1,103
13	1/4-20	0.250	#3	HWH	458 ⁽⁶⁾	–	–	716 ⁽⁶⁾	–	–	759 ⁽⁶⁾	–	–
15	1/4-20	0.250	#5	HWH	437	680	1,178	682	808	1,398	723	1,148	1,398
Dril-Flex® Screws⁸													
21	#12-14	0.216	#3	HWH	450 ⁽⁷⁾	–	–	702 ⁽⁷⁾	–	–	744 ⁽⁷⁾	–	–
22	#12-14	0.216	#3	PUFH	485 ⁽⁷⁾	–	–	757 ⁽⁷⁾	–	–	803 ⁽⁷⁾	–	–
23	#12-24	0.216	#5	HWH	452	1,059	887	705	1,258	1,054	748	1,258	1,054
24	1/4-14	0.250	#3	HWH	452 ⁽⁶⁾	–	–	707 ⁽⁶⁾	–	–	749 ⁽⁶⁾	–	–
25	1/4-20	0.250	#4	HWH	439	1,149	–	685	1,365	–	685	1,365	–
28	1/4-20	0.250	#5	HWH	452	1,132	917	706	1,344	1,089	706	1,344	1,089

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

¹Available strengths are based on laboratory test with safety factors and resistance factors determined in accordance with the ADM and AISI S100.

²For shear connections, the lower of the available shear (bearing) strength and screw shear strength must be used for design.

³Head style abbreviations denote the following: HWH = Hex Washer Head, PUFH = Phillips Undercut Flat Head and Pancake = Phillips Pancake Head.

⁴Minimum steel strengths: $F_u = 58$ ksi, $F_y = 36$ ksi

⁵Testing included use of a flexible spacer material between the aluminum and the steel to simulate the use of interstitial materials intended to prevent galvanic corrosion of the steel. Unless otherwise noted, the spacer thickness used in testing was 0.063 inch.

⁶Spacer thickness used in testing was 0.05 inch.

⁷Spacer thickness used in testing was 0.008 inch.

⁸Dril-Flex® fasteners have also been evaluated for steel-to-steel connections, which are addressed in ICC-ES ESR-3332.

TABLE 8—SCREW SPACING, EDGE AND END DISTANCE REQUIREMENTS (inch)¹

BASIC SCREW DIAMETER (inch)	ALUMINUM		STEEL	
	MINIMUM SPACING (2.5d)	MINIMUM EDGE AND END DISTANCE (1.5d)	MINIMUM SPACING (3d)	MINIMUM EDGE AND END DISTANCE (1.5d)
0.164 (#8)	7/16	1/4	1/2	1/4
0.190 (#10)	1/2	5/16	9/16	5/16
0.216 (#12)	9/16	3/8	1 1/16	3/8
0.250 (1/4)	5/8	3/8	3/4	3/8

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

¹Maximum screw spacing in aluminum must comply with Section J.1.3 of the ADM.

DIVISION: 05 00 00—METALS

Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

DEWALT

EVALUATION SUBJECT:

BI-FLEX®, DRIL-FLEX® AND ALUMI-FLEX® SELF-DRILLING STRUCTURAL SCREWS USED WITH ALUMINUM (DEWALT)

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the screws described in ICC-ES evaluation report [ESR-4374](#) have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

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

2.0 CONCLUSIONS

The screws described in Sections 2.0 through 7.0 of the evaluation report [ESR-4374](#), comply with the LABC Chapter 20, and the LARC, and are subjected to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The screws described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report [ESR-4374](#).
- The design, installation, conditions of use and identification of the screws are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report [ESR-4374](#).
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.

This supplement expires concurrently with the evaluation report, reissued March 2024.

DIVISION: 05 00 00—METALS

Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

DEWALT

EVALUATION SUBJECT:

BI-FLEX®, DRIL-FLEX® AND ALUMI-FLEX® SELF-DRILLING STRUCTURAL SCREWS USED WITH ALUMINUM (DEWALT)

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the screws used with aluminum, described in evaluation report ESR-4374, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2020 *Florida Building Code—Building*
- 2020 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The screws described in Sections 2.0 through 7.0 of the evaluation report, ESR-4374, comply with the *Florida Building Code—Building* and the *Florida Building Code—Residential*. The design requirements must be determined in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable. The installation requirements noted in ICC-ES evaluation report ESR-4374 for the 2018 *International Building Code*® meet the requirements of the *Florida Building Code—Building* or the *Florida Building Code—Residential*, as applicable.

Use of the screws has also been found to be in compliance with the High-velocity Hurricane Zone provisions on the *Florida Building Code—Building* and the *Florida Building Code—Residential*.

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 March 2024.