ICC-ES Listing Report

ELC-4386

Reissued December 2024

This listing is subject to renewal December 2025.

CSI: DIVISION: 03 00 00—CONCRETE
Section: 03 16 00—Concrete Anchors

DIVISION: 05 00 00—METALS
Section: 05 05 19—Post-Installed Concrete Anchors

Product Certification System:

The ICC-ES product-certification system includes evaluating reports of tests of standard manufactured product, prepared by accredited testing laboratories and provided by the listee, to verify compliance with applicable codes and standards. The system also involves factory inspections, and assessment and surveillance of the listee's quality system.

Product: Hilti HSL4 Carbon Steel Heavy Duty Expansion Anchors for Cracked and Uncracked Concrete

Listee: HILTI, INC.

Compliance with the following standards:

- Annex D, Anchorage of CSA A23.3 (-14, -04), Design of Concrete Structures, CSA Group.

Compliance with the following codes:

Hilti HSL4 Carbon Steel Heavy Duty Expansion Anchors for Cracked and Uncracked Concrete, as described in this listing report, are in conformance with CSA A23.3 (-14, -04), Annex D, as referenced in the applicable section of the following code editions:

- *National Building Code of Canada*® 2015 and 2010

  Applicable Section: Division B, Part 4, Section 4.3.3.

Description of anchors:

The Hilti HSL4 Carbon Steel Heavy Duty Expansion Concrete Anchor, designated as the HSL4, is a torque-set, sleeve-type mechanical expansion anchor. The HSL4 is comprised of seven components which vary slightly according to anchor diameter, as shown in Figure 1 of this report. It is available in four head configurations, illustrated in Figure 2 of this report.

All carbon steel parts receive a minimum 5 µm (0.0002 inch) thick galvanized zinc plating.

Dimensions and installation criteria are set forth in Tables 1 and 2 of this report. Application of torque at the head of the anchor causes the cone to be drawn into the expansion sleeve. This in turn causes the sleeve to expand against the wall of the drilled hole. The ribs on the collapsible element prevent rotation of the sleeve and cone during application of torque. Application of the specified installation torque induces a tension force in the bolt that is equilibrated by a precompression force in the concrete acting through the component being fastened. Telescopic deformation of the collapsible element prevents buildup of precompression in the anchor sleeve in cases where the shear sleeve is in contact with the washer, and permits the closure of gaps between the work surface and the component being fastened. Application of tension loads that exceed the precompression force in the bolt will cause the cone to displace further into the expansion sleeve (follow-up expansion), generating additional expansion force.

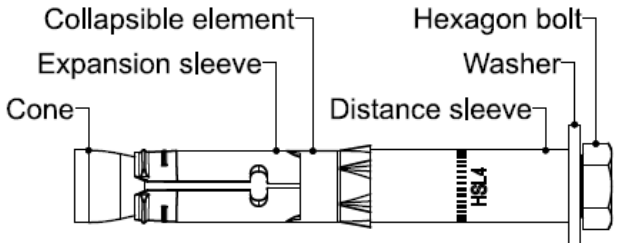


FIGURE 1—COMPONENTS OF THE HSL4 (BOLT VERSION SHOWN)

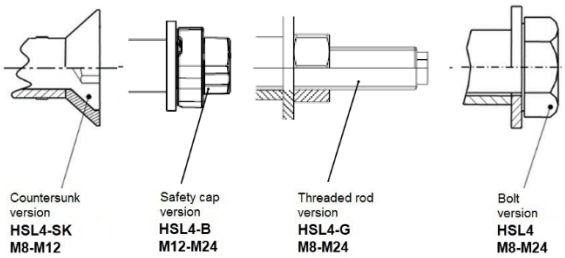


FIGURE 2—HEAD STYLES OF THE HSL4

Identification:

1. The anchors are identified by packaging labeled with the evaluation report holder's name (Hilti, Inc.) and address, anchor name, anchor size, evaluation report number (ELC-4386). The anchors have the letters HSL4 and the anchor size embossed on the sleeve.

2. The report holder's contact information is the following:

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

Installation: Installation parameters are provided in Table 1 and in Figure 3 of this report. Anchors must be installed per the manufacturer's printed installation instructions, as depicted in Figure 4, and this report. Anchor locations must comply with this report and the plans and specifications approved by the code official. Anchors must be installed in holes drilled into concrete using carbide-tipped drill bits complying with ANSI B212.15-1994 or using the Hilti SafeSet System™ with Hilti TE-YD or TE-CD Hollow Drill Bits complying with ANSI B212.15-1994 with a Hilti vacuum with a minimum value for the maximum volumetric flow rate of 129 CFM (61 l/s).

Alternatively, HSL4 carbon steel anchors (all variants) may be installed in holes drilled using SPX-T core bits (with the DD-30 or DD-EC-1 coring tools) or SPX-H, SPX-L or SPX-L Handheld core bits (with the DD-110 to DD-250 coring tools). Prior to anchor installation, the hole must be cleaned in accordance with the manufacturer's published installation instructions. The nut must be tightened against the washer until the torque values, T_{inst}, specified in Table 1 are achieved. HSL4 and HSL4-G anchors with diameters of M8 through M16 may be tightened using the Hilti AT Tool in accordance with Figure 4.

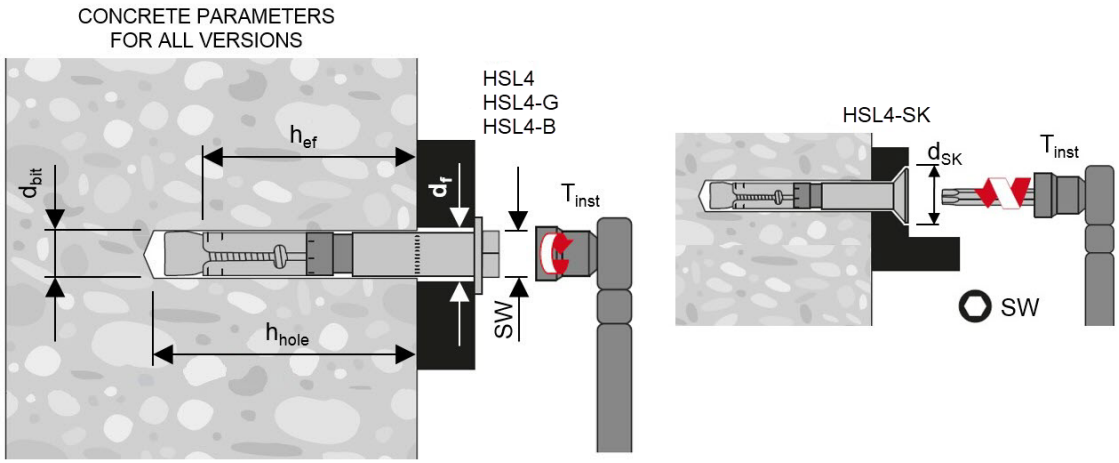
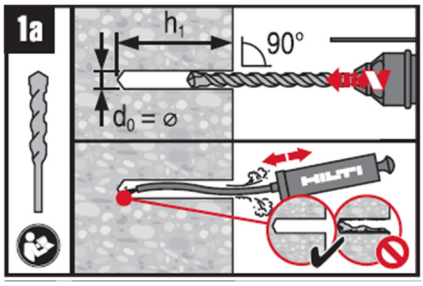
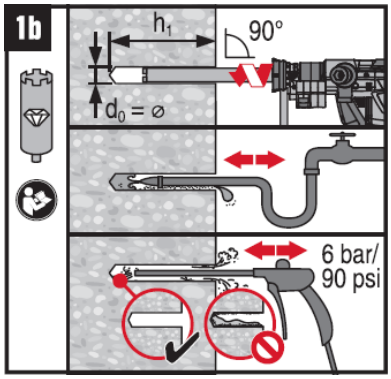


FIGURE 3—HSL4 IN THE INSTALLED CONDITION

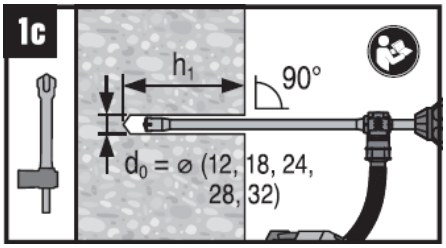
HSL4 carbon steel anchors with standard carbide drill bit



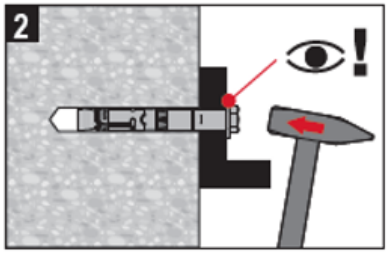
HSL4 carbon steel anchors with anchors with hollow diamond core drilling

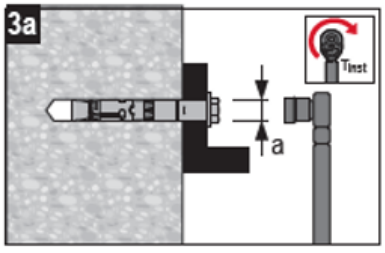


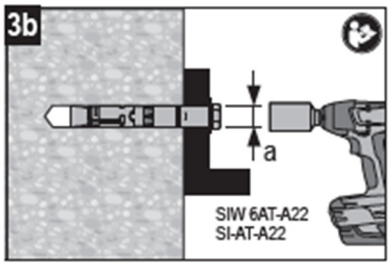
HSL4 carbon steel drill bit

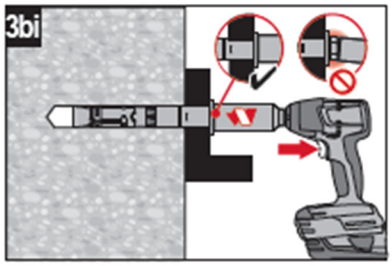


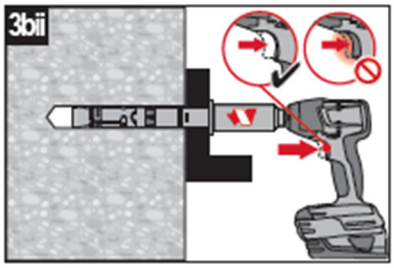
HSL4

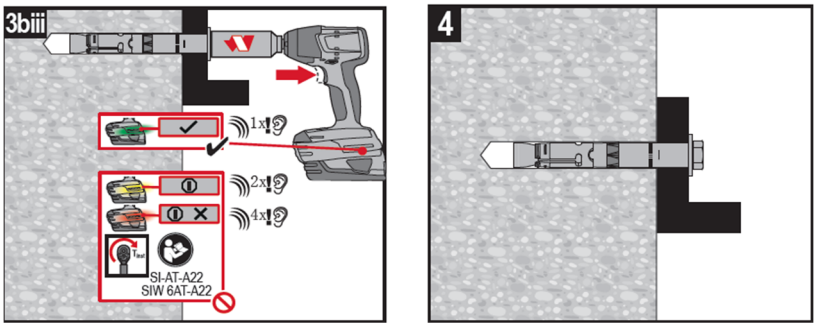




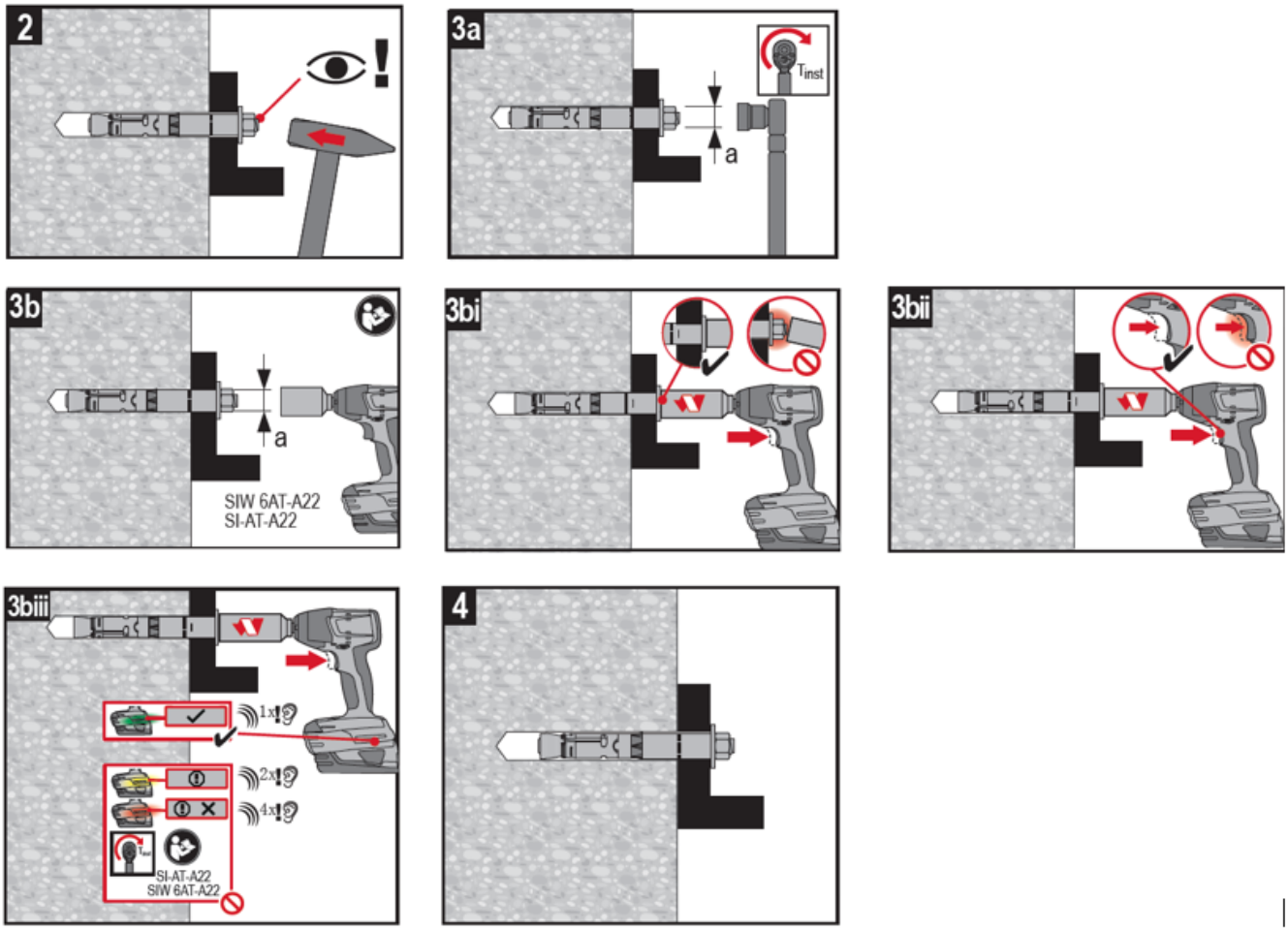




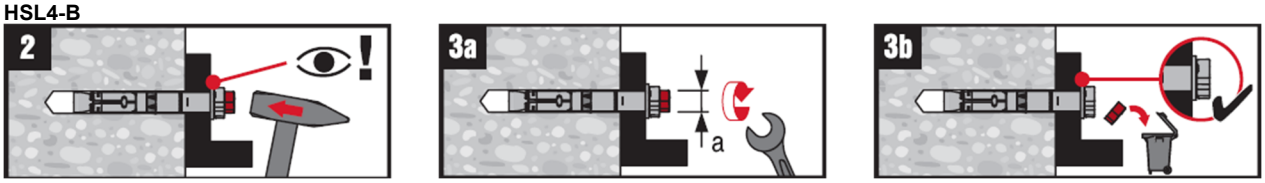




HSL4-G



HSL4-B



HSL4-SK

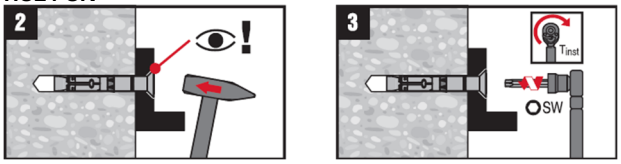


FIGURE 4—MANUFACTURER'S PRINTED INSTALLATION INSTRUCTIONS

Anchor setting information:

TABLE 1—SETTING INFORMATION[2]

Setting Information		Symbol	Units	Nominal anchor diameter					
				M8	M10	M12	M16	M20	M24
Nominal drill bit or core bit diameter[1]		d_{bit}	mm	12	15	18	24	28	32
Minimum hole depth	HSL4, HSL4-G, HSL4-B, HSL4-SK	h_{hole}	mm (in.)	80 (3.15)	90 (3.54)	105 (4.13)	125 (4.92)	155 (6.10)	180 (7.09)
Clearance hole diameter in part being fastened		d_f	mm (in.)	14 (0.55)	17 (0.67)	20 (0.79)	26 (1.02)	31 (1.22)	35 (1.38)
Max. cumulative gap between part(s) being fastened and concrete surface		-	mm (in.)	4 (0.16)	5 (0.20)	8 (0.31)	9 (0.35)	12 (0.47)	16 (0.63)
Washer diameter HSL4, HSL4-G, HSL4-B		d_w	mm (in.)	20 (0.79)	25 (0.98)	30 (1.18)	40 (1.57)	45 (1.77)	50 (1.97)
Installation torque	HSL4	T_{inst}	Nm (ft-lb)	15 (11)	25 (18)	60 (44)	75 (55)	145 (107)	210 (155)
	HSL4-G		Nm (ft-lb)	20 (15)	27 (20)	60 (44)	70 (52)	105 (77)	180 (132)
	HSL4-SK		Nm (ft-lb)	25 (18)	32 (24)	65 (48)	N/A	N/A	N/A
Wrench size	HSL4, HSL4-G	*SW*	mm	13	17	19	24	30	36
	HSL4-B	*SW*	mm	N/A	N/A	24	30	36	41
Allen wrench size	HSL4-SK	*SW*	mm	5	6	8	N/A	N/A	N/A
Diameter of countersunk hole HSL4-SK		d_{sk}	mm (in.)	22.5 (0.89)	25.5 (1.00)	32.9 (1.29)	N/A	N/A	N/A

For pound-inch units: 1 mm = 0.03937 inches, 1 Nm = 0.7376 ft-lbf.

[1]Use metric bits only.
[2] The information presented in this table is to be used in conjunction with the design criteria of CSA A23.3 (-14, -04), Annex D, as applicable.
N/A = Not Available

Ultimate Limit States Design:

Design resistance of anchors for compliance with the 2015 NBCC must be determined in accordance with CSA A23.3-14 Annex D, and this listing report.

Design resistance of anchors for compliance with the 2010 NBCC must be determined in accordance with CSA A23.3-04 Annex D and this listing report.

Design parameters are provided in Tables 2 and 3 of this listing report are based on the 2015 NBCC 2010 NBCC (CSA A23.3-14 and CSA A23.3-04). The limit states design of anchors must comply with CSA A23.3-14 D.5.1 or CSA A23.3-04 D.5.1, as applicable, except as required in CSA A23.3-14 D.4.3.1 or CSA A23.3-04 D.4.3.1, as applicable.

Material resistance factors must be $\phi_c = 0.65$ *and* $\phi_s = 0.85$ in accordance with CSA A23.3 (-14 and -04) Sections 8.4.2 and 8.4.3*,* and resistance modification factor, *R,* as given in CSA A23.3-14 Section D.5.3, or CSA A23.3-04 Section D.5.4, as applicable, and noted in Table 3 of this listing report, must be used for load combinations calculated in accordance with Division B, Part 4, Section 4.1.3 of the 2015 NBCC, or Division B, Part 4, Section 4.1.3 of the 2010 NBCC or Annex C of CSA A23.3-14, or Annex C of CSA A23.3-04, as applicable. The factored steel strength, N_{sar}, V_{sar} or $V_{sar\ eq}$, in Table 3 of this listing report must be multiplied ϕ_s, and *R* to determine the factored resistance. The factored pullout strengths $N_{cpr,\ uncr}$, $N_{cpr,\ cr}$, or $N_{cpr,\ eq}$ in Table 3 of this listing report must be multiplied ϕ_s, and *R* to determine the factored resistance.

Requirements for Factored Pullout Resistance in Tension: The factored pullout resistance of a single anchor in accordance with CSA A23.3-14 D.6.3.1 and D.6.3.2, or CSA A23.3-04 D.6.3.1 and D.6.3.2, as applicable, in cracked and uncracked concrete, $N_{cpr,\ cr}$ and $N_{cpr,\ uncr}$, respectively, is given in Table 3. For all design cases, $\Psi_{c,\ P} = 1.0$. In accordance with CSA A23.3-14 D.6.3, or CSA A23.3-04 D.6.3, as applicable, the factored pullout resistance in cracked concrete may be calculated in accordance with the following equation:

$$N_{cpr,cr,f_c'} = N_{cpr,cr}\sqrt{\frac{f_c'}{17.2}}\ \text{(N, MPa) (Eq-1)}$$

In regions where analysis indicates no cracking in accordance with CSA A23.3-14 D.6.3.6, or CSA A23.3-04 D.6.3.6, as applicable, the factored pullout resistance in tension may be calculated in accordance with the following equation:

$$N_{cpr,uncr,f_c'} = N_{cpr,uncr}\sqrt{\frac{f_c'}{17.2}}\ \text{(N,MPa) (Eq-2)}$$

Where values for $N_{cpr,\ cr}$ or $N_{cpr,\ uncr}$ are not provided in Table 3, the pullout resistance in tension need not be evaluated.

Requirements for Critical Edge Distance: In applications where $c < c_{ac}$ and supplemental reinforcement to control splitting of the concrete is not present, the concrete breakout resistance in tension for uncracked concrete must be calculated in accordance with CSA A23.3-14 D.6.2 or CSA A23.3-04 D.6.2, as applicable.

In lieu of using CSA A23.3-14 D.9.7, or CSA A23.3-04 D.9.7, as applicable, values of c_{ac} must comply with Table 2.

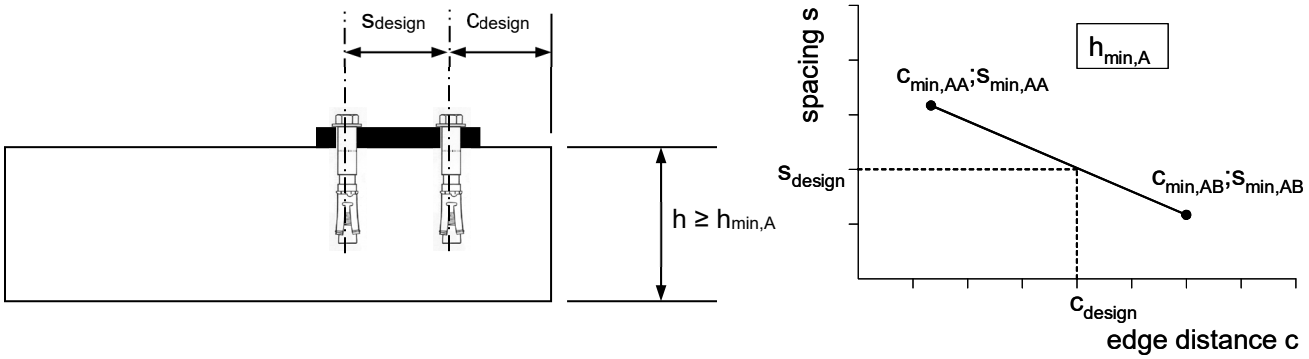


FIGURE 5—EXAMPLE OF ALLOWABLE INTERPOLATION OF MINIMUM EDGE DISTANCE AND MINIMUM SPACING

TABLE 2—HSL4 EDGE DISTANCE, SPACING AND MEMBER THICKNESS REQUIREMENTS[1,2,4]

Case	Dimensional parameter	Symbol	Units	Nominal anchor diameter					
				M8	M10	M12	M16	M20	M24
A	Minimum concrete thickness	$h_{min,A}$	(in.)	(4 3/4)	(5 1/2)	(6 1/4)	(7 7/8)	(9 7/8)	(11 7/8)
			mm	120	140	160	200	250	300
A	Critical edge distance[2]	$c_{ac,A}$	(in.)	(4 3/8)	(4 3/8)	(4 3/4)	(5 7/8)	(8 7/8)	(8 7/8)
			mm	110	110	120	150	225	225
A	Minimum edge distance[3]	$c_{min,AA}$	(in.)	(2 3/8)	(2 3/4)	(3 1/2)	(4 3/4)	(5)	(5 7/8)
			mm	60	70	90	120	125	150
A	Minimum anchor spacing[3]	$s_{min,AA}$	(in.)	(5 1/2)	(9 1/2)	(11)	(12 5/8)	(13 3/4)	(11 7/8)
			mm	140	240	280	320	350	300
A	Minimum edge distance[3]	$c_{min,AB}$	(in.)	(3 3/8)	(5)	(6 1/8)	(7 7/8)	(8 1/4)	(8 1/4)
			mm	85	125	155	200	210	210
A	Minimum anchor spacing[3]	$s_{min,AB}$	(in.)	(2 3/8)	(2 3/4)	(3 1/8)	(4)	(5)	(5 7/8)
			mm	60	70	80	100	125	150
B	Minimum concrete thickness	$h_{min,B}$	(in.)	(4 3/8)	(4 3/4)	(5 3/8)	(6 1/4)	(7 1/2)	(8 7/8)
			mm	110	120	135	160	190	225
B	Critical edge distance[2]	$c_{ac,B}$	(in.)	(5 7/8)	(6 7/8)	(7 7/8)	(9 7/8)	(12 3/8)	(14 3/4)
			mm	150	175	200	250	312.5	375
B	Minimum edge distance[3]	$c_{min,BA}$	(in.)	(2 3/8)	(3 1/2)	(4 3/8)	(6 1/4)	(7 7/8)	(8 7/8)
			mm	60	90	110	160	200	225
B	Minimum anchor spacing[3]	$s_{min,BA}$	(in.)	(7)	(10 1/4)	(12 5/8)	(15)	(15 3/4)	(15)
			mm	180	260	320	380	400	380
B	Minimum edge distance[3]	$c_{min,BB}$	(in.)	(4)	(6 1/4)	(7 7/8)	(10 5/8)	(11 7/8)	(12 5/8)
			mm	100	160	200	270	300	320
B	Minimum anchor spacing[3]	$s_{min,BB}$	(in.)	(2 3/8)	(2 3/4)	(3 1/8)	(4)	(5)	(5 7/8)
			mm	60	70	80	100	125	150

For SI: 1 inch = 25.4 mm.

[1]See Requirements for Critical Edge Distance Section of this report.
[2]See Figure 5 of this report.
[3]Denotes admissible combinations of h_{min}, c_{ac}, c_{min} and s_{min}. For example, $h_{min,A} + c_{ac,A} + c_{min,AA} + s_{min,AA}$ or $h_{min,A} + c_{ac,A} + c_{min,AB} + s_{min,AB}$ are admissible, but $h_{min,A} + c_{ac,B} + c_{min,AB} + s_{min,BB}$ is not. However, other admissible combinations for minimum edge distance c_{min} and spacing s_{min} for $h_{min,A}$ or $h_{min,B}$ may be derived by linear interpolation between boundary values (see example for $h_{min,A}$ below).
[4]The information presented in this table is to be used in conjunction with the design criteria of CSA A23.3 (-14, -04), Annex D, as applicable.

TABLE 3 —DESIGN INFORMATION FOR CARBON STEEL HSL4 (ALL VERSIONS)

Design parameter		Symbol	Units	Nominal anchor diameter					
				M8	M10	M12	M16	M20	M24
Anchor O.D.		d_a	mm (in.)	12 (0.47)	15 (0.59)	18 (0.71)	24 (0.94)	28 (1.10)	32 (1.26)
Effective min. embedment depth[1]		$h_{ef,min}$	mm (in.)	60 (2.36)	70 (2.76)	80 (3.15)	100 (3.94)	125 (4.92)	150 (5.91)
Anchor category[3]		*1,2 or 3*	-	1	1	1	1	1	1
Steel embed, material resistance factor for reinforcement		ϕ_s		0.85					
Resistance modification factor for tension, steel failure modes[2]		R	-	0.80					
Resistance modification factor for shear, steel failure modes[2]		R	-	0.75					
Resistance modification factor for tension, concrete failure modes[6]		R	Cond.A	1.15					
			Cond.B	1.00					
Resistance modification factor for shear, concrete failure modes[6]		R	Cond.A	1.15					
			Cond.B	1.00					
Yield strength of anchor steel		f_{ya}	(lb/in^2) N/mm^2	(92,800) 640.0					
Ultimate strength of anchor steel		f_{uta}	(lb/in^2) N/mm^2	(116,000) 800.0					
Tensile stress area		$A_{se,N}$	(in^2) mm^2	(0.057) 36.6	(0.090) 58.0	(0.131) 84.3	(0.243) 157.0	(0.380) 245.0	(0.547) 353.0
Steel strength in tension		N_{sar} (N_{sr})[9]	(lb) kN	(6,612) 29.4	(10,440) 46.4	(15,196) 67.6	(28,188) 125.4	(44,080) 196.1	(63,452) 282.2
Concrete material resistance factor		ϕ_c	-	0.65					
Effectiveness factor uncracked concrete		k_{uncr}	- (SI)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)
Effectiveness factor cracked concrete[4]		k_{cr}	- (SI)	17 (7.1)	24 (10)	24 (10)	24 (10)	24 (10)	24 (10)
Modification factor for anchor resistance for cracked and uncracked concrete[5]		$\psi_{C,N}$	-	1.00	1.00	1.00	1.00	1.00	1.00
Pullout resistance uncracked concrete[7]		$N_{cpr,uncr}$	(lb) kN	(4,204) 18.7	N/A	N/A	N/A	N/A	N/A
Pullout resistance cracked concrete[7]		$N_{cpr,cr}$	(lb) kN	(2,810) 12.5	(4,496) 20.0	N/A	N/A	N/A	N/A
Steel strength in shear HSL4,-B,-SK		V_{sar} (V_{sr})[9]	(lb) kN	(7,239) 32.2	(10,229) 45.5	(14,725) 65.5	(26,707) 118.8	(39,521) 175.8	(45,951) 204.4
Steel strength in shear HSL4-G			(lb) kN	(6,070) 27.0	(8,385) 37.3	(12,162) 54.1	(22,683) 100.9	(33,159) 147.5	(43,169) 192.0
Coefficient for pryout strength		k_{cp}	-	1.0	2.0				
Load bearing length of anchor in shear		ℓ_e	mm (in.)	(24) 0.94	(30) 1.18	(36) 1.42	(48) 1.89	(56) 2.20	(64) 2.52
Pullout resistance in tension seismic HSL4,-B,-SK		$N_{cpr,eq}$	(lb) kN	(2,810) 12.5	(4,496) 20.0	N/A	N/A	N/A	(14,320) 63.7
Pullout resistance in tension seismic HSL4-G			(lb) kN	(2,810) 12.5	(4,496) 20.0	N/A	N/A	N/A	N/A
Steel strength in shear, seismic HSL4,-B,-SK		$V_{sar,eq}$	(lb) kN	(4,609) 20.5	(8,453) 37.6	(11,892) 52.9	(24,796) 110.3	(29,135) 129.6	(38,173) 169.8
Steel strength in shear, seismic HSL4-G			(lb) kN	(3,777) 16.8	(6,924) 30.8	(9,824) 43.7	(21,065) 93.7	(24,459) 108.8	N/A
Axial stiffness in service load range[8]	uncracked concrete	β_{uncr}	kN/mm (10^3 lb/in.)	52.5 (300)					
	cracked concrete	β_{cr}		5.25 (30)	12.25 (70)	22.76 (130)	22.76 (130)	22.76 (130)	22.76 (130)

[1]See Fig. 3.
[2]The HSL4 is a ductile steel element as defined by CSA A23.3-14 D.2 or CSA A23.3-04 D.2, as applicable.
[3]See CSA A23.3-14 D.5.3 or CSA A23.3-04 D.5.4, as applicable.
[4]See CSA A23.3-14 D.6.2.2 or CSA A23.3-04 D.6.2.2, as applicable.
[5]For all design cases $\Psi_{c,N}$ =1.0. The appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}) must be used.
[6]For use with the load combinations of Division B, Part 4, Section 4.1.3 of the 2015 NBCC or 2010 NBCC, CSA A23.3-14 Annex C or CSA A23.3-04 Annex C, as applicable. Condition B applies where supplementary reinforcement in conformance with CSA A23.3-14 D.5.3(c) or CSA A23.3-04 D.5.4(c), as applicable, is not provided, or where pullout or pryout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.
[7]For all design cases $\Psi_{c,P}$=1.0. N/A (not applicable) denotes that this value does not control for design.
[8]Mean values shown, actual stiffness may vary considerably depending on concrete strength, loading and geometry of application. 1 lb/in = 0.175 KN/m.
[9]The notation in parenthesis is for the CSA A23.3-04.

Conditions of listing:

1. The listing report addresses only conformance with the standards and code sections noted above.
2. Approval of the product's use is the sole responsibility of the local code official.
3. The listing report applies only to the materials tested and as submitted for review by ICC-ES.
4. Anchor sizes, dimensions and minimum embedment depths are as set forth in the tables of this report.
5. The anchors must be installed in accordance with the manufacturer's published installation instructions and this report, in cracked and uncracked normal-weight and lightweight concrete having a specified compressive strength of f'_c = 17.2 MPa to 58.6 MPa. In case of conflict between this report and the manufacturer's instructions, this report governs.
6. The values of f'_c used for calculation purposes must not exceed 55.1 MPa.
7. The concrete shall have attained its minimum design strength prior to installation of the anchors.
8. Limit states design values must be established in accordance with this listing report.
9. Anchor spacing and edge distance as well as minimum member thickness must comply with Table 2 and Figure 5 of this report.
10. Prior to installation, calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statues of the jurisdiction in which the project is to be constructed.
11. The use of fatigue or shock loading for these anchors under such conditions is beyond the scope of this listing report.
12. Anchors may be installed in regions of concrete where cracking has occurred or where analysis indicates cracking may occur ($f_t > f_r$), subject to the conditions of this report.
13. Anchors may be used to resist short-term loading due to wind or seismic forces in locations designed according to NBCC 2010 and NBCC 2015.
14. Where not otherwise prohibited in the code as referenced in CSA A23.3 (-14 or -04), anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:
    a. Anchors are used to resist wind or seismic forces only.
    b. Anchors that support a fire-resistance-rated envelope or a fire-resistance-rated membrane, are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
    c. Anchors are used to support nonstructural elements.
15. Use of zinc-coated carbon steel anchors is limited to dry, interior locations.
16. Use of anchors in contact with preservative-treated and fire-retardant-treated wood must be zinc-coated carbon steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.