

# ICC-ES Listing Report



**ELC-2502**

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**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 products, 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:** POWER-STUD®+ SD2 CARBON STEEL ANCHORS, POWER-STUD®+ SD4 STAINLESS STEEL ANCHORS AND POWER-STUD®+ SD6 STAINLESS STEEL ANCHORS IN CRACKED AND UNCRACKED CONCRETE

**Listee:** DEWALT

## 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:

Power-Stud+ SD2 carbon steel anchors and SD4 and SD6 stainless steel 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 anchors are torque-controlled, mechanical expansion anchors comprised of an anchor body, expansion wedge (clip), washer and hex nut. The anchor body is comprised of a high-strength carbon or stainless steel rod threaded at one end and having a tapered mandrel at the other end. The tapered mandrel is enclosed by a three-section expansion clip which freely moves around the mandrel. The expansion clip movement is restrained by the mandrel taper and by a collar.

For the Power-Stud+ SD2, the anchor body is manufactured from medium carbon steel and has minimum 0.0002-inch (5 µm) zinc plating in accordance with ASTM B633. The expansion clip is manufactured from AISI Type 316 stainless steel. The washer conforms to ASTM F844. The hex nuts conform to ASTM A563, Grade A. The Power-Stud+ SD2 anchor is illustrated in Figure 1.

The Power-Stud+ SD4 anchor body is manufactured from Type 304 stainless steel, and the Power-Stud+ SD6 is manufactured from Type 316 stainless steel. The expansion clips and hex nuts are manufactured from Type 316 stainless steel. Washers are manufactured from 300 series stainless steel for the Power-Stud+ SD4 and Type 316 stainless steel for the Power-Stud+ SD6. The Power-Stud+ SD4 and Power-Stud+ SD6 anchors are illustrated in Figure 1.

The anchors are installed in a predrilled hole with a hammer. When torque is applied to the nut of the installed anchor on the threaded end of the anchor body, the mandrel at the other end of the anchor is drawn into the expansion clip, forcing it outward into the sides of the predrilled hole in the base material.

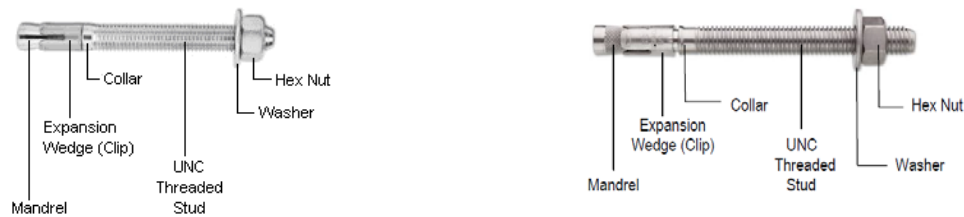


FIGURE 1—POWER-STUD+ SD2 (Left Picture), POWER-STUD+ SD4 AND POWER-STUD+ SD6 (Right Picture), ANCHOR ASSEMBLY


Identification:

1. The anchors are identified by dimensional characteristics and packaging. A length letter code head marking is stamped on each anchor on the exposed threaded stud end which is visible after installation. Table 2 shows the length code identification system. For the Power-Stud+ SD2 anchors, a plus sign “+” and the number “2” are also visible after installation. For the Power-Stud+ SD4 and Power-Stud+ SD6 anchors, a plus sign “+” is also marked with a number on all anchors with the exception of the 1/4-inch-diameter (6.4 mm) anchors. The number “4” designates the Power-Stud+ SD4 and the number “6” designates the Power-Stud+ SD6. Packages are identified with the anchor name, type and size, the company name, the listing report number (ELC-2502), and the ICC-ES listing mark.
2. The report holder’s contact information is the following:

DEWALT  
701 EAST JOPPA ROAD  
TOWSON, MARYLAND 21286  
(800) 524-3244  
[www.dewalt.com](http://www.dewalt.com)  
[anchors@dewalt.com](mailto:anchors@dewalt.com)

Installation:

The installation parameters are provided in Figure 2, Figure 3 and Table 1. Installation of the Power-Stud+ SD2 carbon steel anchors and Power-Stud+ SD4 and Power-Stud+ SD6 stainless steel anchors must be in accordance with the manufacturer’s published installation instructions (MPII) as provided in the packaging and described in Figure 3. Anchors must be installed in holes drilled into the concrete using carbide-tipped masonry drill bits complying with ANSI B212.15-1994. The nominal drill bit diameter must be equal to that of the anchor size. The predrilled hole must be cleaned free of dust and debris. The anchor must be hammered into the predrilled hole until the proper nominal embedment depth is achieved. The nut must be tightened against the washer until the installation torque values are achieved.

DeWALT Dust Removal Drilling Systems with HEPA Dust Extractor Options		
Tool	Accessories and Shrouds	HEPA Dust Extractor
SDS-Max Drills		
 Cordless	 SDS-Max Hollow Drill Bit	 Dust Extractor
 Corded	 SDS-Max With Shroud	
SDS-Plus Drills		
 Cordless	 SDS-Plus Bit	 Cordless Dust Extractor
	 SDS-Plus Hollow Drill Bit	 Dust Extractor
 Corded	 SDS-Plus With Telescope	
	 SDS-Plus With Shroud	

The DEWALT drilling systems shown collect and remove dust with a HEPA dust extractor during the hole drilling operation in dry base materials using hammer-drills (see manufacturer’s published installation instructions).

FIGURE 2—EXAMPLES OF DEWALT DUST REMOVAL DRILLING SYSTEMS WITH HEPA DUST EXTRACTORS FOR ILLUSTRATION

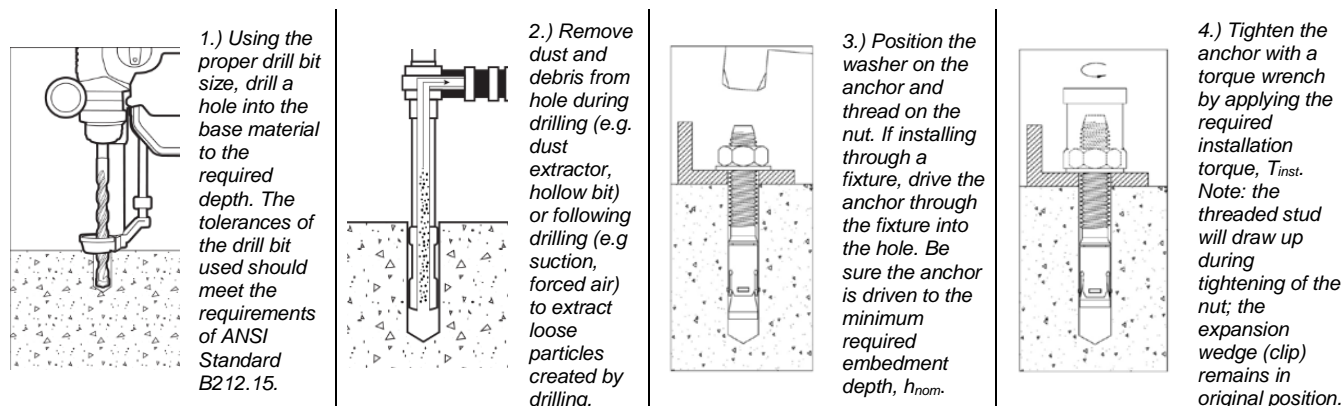


FIGURE 3— POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 INSTALLATION INSTRUCTIONS

## Anchor setting information:

TABLE 1—POWER-STUD+ SD2 ANCHOR INSTALLATION SPECIFICATIONS

ANCHOR PROPERTY AND SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE <sup>4</sup> (inch)							
			<sup>3</sup> / <sub>8</sub> inch	<sup>1</sup> / <sub>2</sub> inch		<sup>5</sup> / <sub>8</sub> inch		<sup>3</sup> / <sub>4</sub> inch		
Outside diameter of anchor	$d_a$	mm (in.)	9.5 (0.375)	12.7 (0.500)		15.9 (0.625)		19.1 (0.750)		
Minimum diameter of hole clearance in fixture	$d_h$	mm (in.)	<sup>7</sup> / <sub>16</sub> (11.1)	<sup>9</sup> / <sub>16</sub> (14.3)		<sup>11</sup> / <sub>16</sub> (17.5)		<sup>13</sup> / <sub>16</sub> (20.6)		
Nominal drill bit diameter	$d_{bit}$	in.	<sup>3</sup> / <sub>8</sub> ANSI	<sup>1</sup> / <sub>2</sub> ANSI		<sup>5</sup> / <sub>8</sub> ANSI		<sup>3</sup> / <sub>4</sub> ANSI		
Minimum nominal embedment depth <sup>2</sup>	$h_{nom}$	mm	60	64	83	98	124	114	146	
Effective embedment	$h_{ef}$	mm	51	51	83	83	108	95	127	
Minimum concrete member thickness	$h_{min}$	mm	102	114	152	146	146	146	165	203
Critical edge distance	$c_{ac}$	mm	165	203	254	203	400	254	305	305
Minimum edge distance	$c_{min}$	mm	64	102	70	102	70	108	108	127
Minimum spacing distance	$s_{min}$	mm	89	152	152	102	152	108	108	152
Minimum hole depth	$h_o$	mm	67	70	102	108	133	127	159	
Minimum overall anchor length <sup>3</sup>	$\ell_{anch}$	mm	76	95	114	121	152	159	178	
Installation torque	$T_{inst}$	N-m	27	54		81		149		
Torque wrench / socket size	-	in.	<sup>9</sup> / <sub>16</sub>	<sup>3</sup> / <sub>4</sub>		<sup>15</sup> / <sub>16</sub>		<sup>1</sup> / <sub>8</sub>		
Nut height	-	in.	<sup>21</sup> / <sub>64</sub>	<sup>7</sup> / <sub>16</sub>		<sup>35</sup> / <sub>64</sub>		<sup>41</sup> / <sub>64</sub>		

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

<sup>1</sup>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.<sup>2</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.<sup>3</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment.

TABLE 2—POWER-STUD+ SD4 AND POWER-STUD+ SD6 STAINLESS STEEL ANCHOR INSTALLATION SPECIFICATIONS<sup>1</sup>

ANCHOR PROPERTY AND SETTING INFORMATION	NOTATION	UNITS	NOMINAL ANCHOR SIZE <sup>3</sup> (inch)								
			1/4	3/8	1/2	5/8		3/4			
Outside diameter of anchor	$d_a$	mm (in.)	6.4 (0.250)	9.5 (0.375)	12.7 (0.500)	15.9 (0.625)		19.1 (0.750)			
Minimum diameter of hole clearance in fixture	$d_h$	mm (in.)	7.9 (5/16)	11.1 (7/16)	14.3 (9/16)	17.5 (11/16)		20.6 (13/16)			
Nominal drill bit diameter	$d_{bit}$	in.	1/4 ANSI	3/8 ANSI	1/2 ANSI	5/8 ANSI		3/4 ANSI			
Minimum nominal embedment depth <sup>2</sup>	$h_{nom}$	mm	44	48	64	83		114			
Effective embedment	$h_{ef}$	mm	38	38	51	70		95			
Minimum concrete member thickness	$h_{min}$	mm	83	83	102	102	127		152		
Critical edge distance	$c_{ac}$	mm	127	127		191		241		229	
Minimum edge distance	$c_{min}$	mm	45	76	89	8	76	114	216	127	229
Minimum spacing distance	$s_{min}$	mm	51	140	76	76	8	216	127	229	127
Minimum hole depth	$h_o$	mm	48	51		67		89		121	
Minimum overall anchor length <sup>2</sup>	$\ell_{anch}$	mm	57	70		95		114		140	
Installation torque	$T_{inst}$	N-m	8	34		54		81		149	
Torque wrench / socket size	-	in.	7/16	9/16		3/4		15/16		1 1/8	
Nut height	-	In.	7/32	21/64		7/16		35/64		41/64	

For SI: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m.

<sup>1</sup>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.

<sup>2</sup>The embedment depth,  $h_{nom}$ , is measured from the outside surface of the concrete member to the embedded end of the anchor prior to tightening.

<sup>3</sup>The listed minimum overall anchor length is based on anchor sizes commercially available at the time of publication compared with the requirements to achieve the minimum nominal embedment depth and possible fixture attachment.

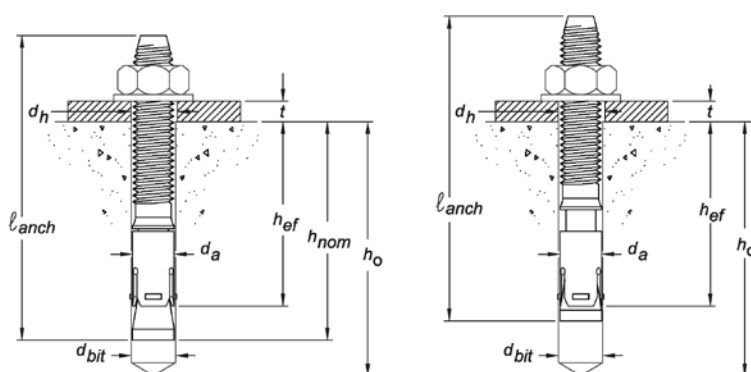


FIGURE 4—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR DETAIL Before (Left Picture) and After (Right Picture) Application of Installation Torque

TABLE 3—POWER-STUD+ SD2, POWER-STUD+ SD4 AND POWER-STUD+ SD6 ANCHOR LENGTH CODE IDENTIFICATION SYSTEM

Length ID marking on threaded stud head		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Overall anchor length, $\ell_{anch}$ , (mm)	From	38	51	64	76	89	102	114	127	140	152	165	178	191	203	216	229	241	254	279	305
	Up to but not including	51	64	76	89	102	114	127	140	152	165	178	191	203	216	229	241	254	279	305	330

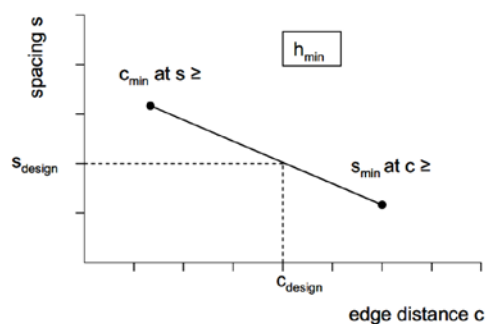
**Ultimate Limit States Design:**

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 provided in Tables 1, 2, 4, 5, 6, and 7 of this listing report are based on the 2015 NBCC and 2010 NBCC (CSA A23.3-14 and CSA A23.3-04). The limit states design of anchors must comply with CSA A23.3 (-14, -04) D.5.1, except as required in CSA A23.3 (-14, -04) D.4.3.1.

Material resistance factors must be  $\phi_c = 0.65$  and  $\phi_s = 0.85$  in accordance with CSA A23.3 (-14, 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, and noted in Tables 4, 5, 6 and 7 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 and 2010 NBCC, or Annex C of CSA A23.3 (-14, -04). The nominal steel strength  $N_{sa}$  or  $V_{sa}$ , in Tables 4, 5, 6 and 7 of this listing report must be multiplied by  $\phi_s$  and  $R$  to determine the factored resistance  $N_{sar}$  or  $V_{sar}$ . The nominal pullout strengths  $N_{p,uncr}$ ,  $N_{p,cr}$  or  $N_{p,eq}$  in Tables 4, and 6 of this listing report must be multiplied by  $\phi_c$  and  $R$  to determine the factored resistance  $N_{cpr,uncr}$ ,  $N_{cpr,cr}$ , or  $N_{cpr,eq}$ , respectively..



This interpolation applies to the cases when two sets of minimum edge distances,  $c_{min}$ , and minimum spacing distances,  $s_{min}$ , are given in Tables 1, and 2 for a given anchor diameter under the same effective embedment depth,  $h_{ef}$ , and corresponding minimum member thickness,  $h_{min}$ .

**FIGURE 5—INTERPOLATION OF MINIMUM EDGE DISTANCE AND MINIMUM ANCHOR SPACING**

TABLE 4—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHORS IN CONCRETE<sup>1,2</sup>

Design Characteristic	Notation	Units	Nominal Anchor Size (inch)						
			<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub>			
Anchor category	1, 2 or 3	-	1	1	1	1			
STEEL STRENGTH IN TENSION <sup>4</sup>									
Minimum specified yield strength (neck)	$f_{ya}$	N/mm <sup>2</sup>	662	586	586	483			
Minimum specified ultimate strength (neck)	$f_{uta}$	N/mm <sup>2</sup>	827	731	731	620			
Effective tensile stress area (neck)	$A_{se,N}$	mm <sup>2</sup>	35.6	65.0	104.5	153.2			
Steel strength in tension <sup>5</sup>	$N_{sa}$	kN	29.5	46.5	58.2	94.4			
Resistance modification factor for steel strength, tension <sup>3,4</sup>	$R$	-	0.80						
CONCRETE BREAKOUT STRENGTH IN TENSION <sup>9</sup>									
Effective embedment	$h_{ef}$	mm	51	51	83	83	108	95	127
Effectiveness factor for uncracked concrete	$k_{uncr}$	-	10	10	10	10	10	10	10
Effectiveness factor for cracked concrete	$k_{cr}$	-	7	7	7	7	7	7	7
Modification factor for cracked and uncracked concrete <sup>6</sup>	$\psi_{c,N}$	-	1.0 See note 6	1.0 See note 6	1.0 See note 6	1.0 See note 6	1.0 See note 6	1.0 See note 6	1.0 See note 6
Critical edge distance	$c_{ac}$	mm	See Table 1						
Resistance modification factor for tension, concrete failure modes, Condition B <sup>3</sup>	$R$	-	1.0						
PULLOUT STRENGTH IN TENSION <sup>9</sup>									
Characteristic pullout strength, uncracked concrete (217.2 MPa) <sup>7</sup>	$N_{p,uncr}$	kN	12.3	See note 8	29.4	See note 8	See note 8	See note 8	See note 8
Characteristic pullout strength, cracked concrete (17.2 MPa) <sup>7</sup>	$N_{p,cr}$	kN	9.6	See note 8	19.5	See note 8	See note 8	See note 8	35.1
Resistance modification factor for tension, pullout strength, Condition B <sup>3</sup>	$R$	-	1.0						
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS <sup>9</sup>									
Characteristic pullout strength, seismic (17.2 MPa) <sup>7,10</sup>	$N_{p,eq}$	kN	9.6	See note 8	19.5	See note 8	See Note 8	See note 8	35.1
Resistance modification factor for pullout strength, seismic, Condition B <sup>3</sup>	$R$	-	1.0						
Mean axial stiffness values service load range <sup>11</sup>	Uncracked concrete	$\beta$	kN/mm	1517	1258	998	747		
	Cracked concrete	$\beta$	kN/mm	87	100	113	126		

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of CSA A23.3 (-14, -04) Annex D, as applicable; for anchors resisting seismic load combinations the additional requirements CSA A23.3 (-14, -04) D.4.3, as applicable, must apply

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of  $R$  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

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element in tension as defined by CSA A23.3-14 D.2 or CSA A23.3-04 D.2, as applicable.

<sup>5</sup>Tabulated values for steel strength in tension are based on test results per ACI 355.2 and must be used for design in lieu of calculation.

<sup>6</sup>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.

<sup>7</sup>For all design cases  $\psi_{c,P}=1.0$ . For the calculation of  $N_{p,cr}$ , see CSA A23.3 (-14, -04) D.6.3.

<sup>8</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>9</sup>Anchors are permitted to be used in lightweight concrete in accordance with CSA A23.3 (-14, -04) D.4.

<sup>10</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2 (Section 9.5), as referenced in CSA A23.3-14 Annex D, Section D.4.3.4.

<sup>11</sup>Actual stiffness of the mean value varies considerably depending on concrete strength, loading and geometry of application.

TABLE 5—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD2 ANCHORS IN CONCRETE<sup>1,2</sup>

Design Characteristic	Notation	Units	Nominal Anchor Diameter (inch)						
			$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$			
Anchor category	1, 2 or 3	-	1	1	1	1			
STEEL STRENGTH IN SHEAR <sup>4</sup>									
Minimum specified yield strength (threads)	$f_{ya}$	N/mm <sup>2</sup>	530	469	469	386			
Minimum specified ultimate strength (threads)	$f_{uta}$	N/mm <sup>2</sup>	690	607	607	551			
Effective tensile stress area (threads)	$A_{se,V}$	mm <sup>2</sup>	50.0	65.7	104.9	215.8			
Steel strength in shear <sup>5</sup>	$V_{sa}$	kN	13.9	21.4	45.2	56.1			
Resistance modification factor for steel strength, shear <sup>3,4</sup>	$R$	-	0.75						
CONCRETE BREAKOUT STRENGTH IN SHEAR <sup>6</sup>									
Load-bearing length of anchor ( $h_{ef}$ or $8d_o$ , whichever is less)	$\ell_e$	mm	51	51	83	83	108	95	127
Nominal anchor diameter	$d_a$	mm	9.5	12.7	15.9	19.1			
Resistance modification factor for shear, concrete failure modes, Condition B <sup>3</sup>	$R$	-	1.0						
PRYOUT STRENGTH IN SHEAR <sup>6</sup>									
Coefficient for prout strength (1.0 for $h_{ef} < 2.5$ in., 2.0 for $h_{ef} \geq 2.5$ in.)	$k_{cp}$	-	1.0	1.0	2.0	2.0	2.0	2.0	2.0
Effective embedment	$h_{ef}$	mm	51	51	83	83	108	95	127
Resistance modification factor for prout strength <sup>3</sup>	$R$	-	1.0						
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS									
Steel strength in shear, seismic <sup>7</sup>	$V_{sa,eq}$	kN	11.0	21.4	30.1	35.9			
Resistance modification factor for steel strength, shear, seismic <sup>3</sup>	$R$	-	0.75						

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of CSA A23.3 (-14, -04) Annex D, as applicable; for anchors resisting seismic load combinations the additional requirements CSA A23.3 (-14, -04) D.4.3, as applicable, must apply..

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of R 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 prout strength governs. For cases where the presence of supplementary reinforcement can be verified, the strength reduction factors associated with Condition A may be used.

<sup>4</sup>The Power-Stud+ SD2 is considered a ductile steel element as defined by CSA A23.3-14 D.2 or CSA A23.3-04 D.2, as applicable.

<sup>5</sup>Tabulated values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and must be used for design. These tabulated values are lower than calculated results using equation D.31 in CSA A23.3-14.

<sup>6</sup>Anchors are permitted to be used in lightweight concrete in accordance with CSA A23.3 (-14, -04) D.4.6.

<sup>7</sup>Tabulated values for steel strength in shear are for seismic applications and based on test results in accordance with ACI 355.2 (Section 9.6), as referenced in CSA A23.3-14 Annex D, Section D.4.3.4.



**TABLE 6—TENSION DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6  
STAINLESS STEEL ANCHORS IN CONCRETE<sup>1,2,8</sup>**

Design Characteristic		Notation	Units	Nominal Anchor Size (inch)				
				1/4	3/8	1/2	5/8	3/4
Anchor category		1, 2 or 3	-	1	1	1	1	1
STEEL STRENGTH IN TENSION								
Minimum specified yield strength (neck)		$f_{ya}$	N/mm <sup>2</sup>	414	414	414	414	414
Minimum specified ultimate strength (neck)		$f_{uta}$	N/mm <sup>2</sup>	621	621	621	621	621
Effective tensile stress area (neck)		$A_{se,N}$	mm <sup>2</sup>	16.1	34.2	65.8	105.2	151
Steel strength in tension		$N_{sa}$	kN	10.0	21.3	40.8	65.1	95.1
Resistance modification factor for steel strength, tension <sup>3,4</sup>		$R$	-	0.80				
CONCRETE BREAKOUT STRENGTH IN TENSION <sup>7</sup>								
Effective embedment		$h_{ef}$	mm	38	38	51	70	95
Effectiveness factor for uncracked concrete		$k_{uncr}$	-	10	10	10	10	10
Effectiveness factor for cracked concrete		$k_{cr}$	-	Not applicable	7	9	9	9
Modification factor for cracked and uncracked concrete		$\psi_{c,N}$	-	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5	1.0 See note 5
Critical edge distance		$c_{ac}$	mm	See Table 2				
Resistance modification factor for tension, concrete failure modes, Condition B <sup>3</sup>		$R$	-	1.0				
PULLOUT STRENGTH IN TENSION <sup>8</sup>								
Characteristic pullout strength, uncracked concrete (17.2 MPa) <sup>6</sup>		$N_{p,uncr}$	kN	6.7	See note 7	See note 7	See note 7	37.8
Characteristic pullout strength, cracked concrete (17.2 MPa) <sup>6</sup>		$N_{p,cr}$	kN	Not applicable	7.3	See note 7	See note 7	See note 7
Resistance modification factor for tension, pullout strength, Condition B <sup>3</sup>		$R$	-	1.0				
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS <sup>8</sup>								
Characteristic pullout strength, seismic (17.2 MPa) <sup>6,9</sup>		$N_{p,eq}$	kN	Not applicable	7.3	See note 7	See note 7	See note 7
Resistance modification factor for pullout strength, seismic, Condition B <sup>3</sup>		$R$	-	1.0				
Mean axial stiffness values for service load range <sup>10</sup>	Uncracked concrete	$\beta$	kN/mm	30,060	86,000	80,500	41,000	69,300
	Cracked concrete	$\beta$	kN/mm	Not applicable	40,000	68,800	33,800	13,400

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of CSA A23.3 (-14, -04) Annex D, as applicable; for anchors resisting seismic load combinations the additional requirements CSA A23.3 (-14, -04) D.4.3, as applicable, must apply.

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of  $R$  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.

<sup>4</sup>The anchors are ductile steel elements as defined in CSA A23.3-14 D.2 or CSA A23.3-04 D.2, as applicable. Tabulated values for steel strength in tension are based on test results per ACI 355.2 and must be used for design.

<sup>5</sup>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.

<sup>6</sup>For all design cases  $\psi_{c,P}=1.0$ . For the calculation of  $N_{opr}$ , see CSA A23.3 (-14, -04) D.6.3.

<sup>7</sup>Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.

<sup>8</sup>Anchors are permitted to be used in lightweight concrete in accordance with CSA A23.3 (-14, -04) D.4.6.

<sup>9</sup>Tabulated values for characteristic pullout strength in tension are for seismic applications are based on test results per ACI 355.2 (Section 9.5), as referenced in CSA A23.3-14 Annex D, Section D.4.3.4.

<sup>10</sup>Actual stiffness of the mean value varies depending on concrete strength, loading and geometry of application.



**TABLE 7—SHEAR DESIGN INFORMATION FOR POWER-STUD+ SD4 AND POWER-STUD+ SD6  
STAINLESS STEEL ANCHORS IN CONCRETE<sup>1,2</sup>**

Design Characteristic	Notation	Units	Nominal Anchor Diameter				
			<sup>1</sup> / <sub>4</sub>	<sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>8</sub>	<sup>3</sup> / <sub>4</sub>
Anchor category	1, 2 or 3	-	1	1	1	1	1
STEEL STRENGTH IN SHEAR <sup>4</sup>							
Minimum specified yield strength (threads)	$f_{ya}$	N/mm <sup>2</sup>	414	414	414	414	414
Minimum specified ultimate strength (threads)	$f_{uta}$	N/mm <sup>2</sup>	621	621	621	621	621
Effective shear stress area (threads)	$A_{se,V}$	mm <sup>2</sup>	20.5	50.3	91.6	145.8	212
Steel strength in shear <sup>5</sup>	$V_{sa}$	kN	5.0	6.6	14.1	33.2	53,2
Resistance modification factor for steel strength, shear <sup>3,4</sup>	$R$	-	0.75				
CONCRETE BREAKOUT STRENGTH IN SHEAR <sup>6</sup>							
Load-bearing length of anchor ( $h_{ef}$ or $8d_o$ , whichever is less)	$\ell_e$	mm	38	38	51	70	95
Nominal anchor diameter	$d_a$	mm	6.4	9.5	12.7	15.9	19.1
Resistance modification factor for shear, concrete failure modes, Condition B <sup>3</sup>	$R$	-	1.0				
PRYOUT STRENGTH IN SHEAR <sup>6</sup>							
Coefficient for pryout strength	$k_{cp}$	-	1.0	1.0	1.0	2.0	2.0
Effective embedment	$h_{ef}$	mm	38	38	51	70	95
Resistance modification factor for pryout strength <sup>3</sup>	$R$	-	1.0				
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS							
Steel strength in shear, seismic <sup>7</sup>	$V_{sa,eq}$	kN	Not applicable	5.8	12.3	23.3	34.45
Resistance modification factor for steel strength, shear, seismic <sup>3</sup>	$R$	-	0.75				

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 ksi = 6.895 N/mm<sup>2</sup>, 1 lbf = 0.0044 kN.

<sup>1</sup>The data in this table is intended to be used with the design provisions of CSA A23.3 (-14, -04) Annex D, as applicable; for anchors resisting seismic load combinations the additional requirements CSA A23.3 (-14, -04) D.4.3, as applicable, must apply.

<sup>2</sup>Installation must comply with published instructions and details.

<sup>3</sup>All values of R 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.

<sup>4</sup>The anchors are ductile steel elements as defined by CSA A23.3-14 D.2 or CSA A23.3-04 D.2, as applicable.

<sup>5</sup>Tabulated values for steel strength in shear must be used for design. These tabulated values are lower than calculated results using equation D.31 in CSA A23.3-14.

<sup>6</sup>Anchors are permitted to be used in lightweight concrete in accordance with CSA A23.3 (-14, -04) D.4.6.

<sup>7</sup>Tabulated values for steel strength in shear are for seismic applications are based on test results per ACI 355.2 (Section 9.6), as referenced in CSA A23.3-14 Annex D, Section D.4.3.4.

**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, minimum embedment depths and other installation parameters are as set forth in this listing report.
5. The 6.4 mm ( $1/4$ -inch) anchors must be installed in uncracked normal-weight or lightweight concrete; 9.5 mm to 31.8 mm ( $3/8$ -inch to  $1 1/4$ -inch) anchors must be installed in cracked or uncracked normal-weight or lightweight concrete having a specified compressive strength,  $f'_c$ , of 17.2 MPa to 58.6 MPa.
6. The values of  $f'_c$ , used for calculation purposes must not exceed 55 MPa.
7. Limit states design values must be established in accordance with this listing report.
8. The use of fatigue or shock loading for these anchors under such conditions is beyond the scope of this listing report.
9. Anchors [except the 6.4 mm ( $1/4$ -inch)] may be used to resist short-term loading due to wind or seismic forces in locations designed according to NBCC 2015 and NBCC 2010.
10. Where not otherwise prohibited in the code as referenced in CSA A23.3 (-14, -04), Power-Stud+ SD2, SD4, and SD6 expansion 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.
11. Use of zinc-coated carbon steel anchors is limited to dry, interior locations.
12. Use of anchors made of stainless steel as specified in this report are permitted for exterior exposure and damp environments.
13. Steel anchoring materials in contact with preservative-treated wood and fire-retardant-treated wood must be of zinc-coated carbon steel or stainless steel. The minimum coating weights for zinc-coated steel must comply with ASTM A153.