Strong-Bolt® 2 Design Information — Concrete

Stainless-Steel Strong-Bolt 2 Installation Information and Additional Data[1]

IBC *

Characteristic	Symbol	Units	Nominal Anchor Diameter, d_a (in.)											
			¼[4]	⅜[5]		½[5]			⅝[5]			¾[5]		
Installation Information														
Nominal Diameter	d_a	in.	¼	⅜		½			⅝			¾		
Drill Bit Diameter	d	in.	¼	⅜		½			⅝			¾		
Baseplate Clearance Hole Diameter[2]	d_c	in.	5⁄16	7⁄16		9⁄16			11⁄16			⅞		
Installation Torque	T_{inst}	ft-lbf	4	30		65			80			150		
Nominal Embedment Depth	h_{nom}	in.	1¾	1⅞	2⅞	2¼[6]	2¾	3⅞	2¾[6]	3⅜	5⅛	3⅜[6]	4⅛	5¾
Effective Embedment Depth	h_{ef}	in.	1½	1½	2½	1¾	2¼	3⅜	2⅛	2¾	4½	2⅝	3⅜	5
Minimum Hole Depth	h_{hole}	in.	1⅞	2	3	2½	3	4⅛	3	3⅝	5⅜	3⅝	4⅜	6
Minimum Overall Anchor Length	ℓ_{anch}	in.	2¼	2¾	3½	2¾	3¾	5½	3½	4½	6	4¾	5½	7
Critical Edge Distance	c_{ac}	in.	2½	6½	8½	4½	4½	7	7½	7½	9	8	8	8
Minimum Edge Distance	c_{min}	in.	1¾	6		6½	6½	5 / 4	4	4		6	6	
	for $s \geq$	in.	—	10		—	—	— / 8	8	8		—	—	
Minimum Spacing	s_{min}	in.	2¼	3		8	8	5½ / 4	6¼	6¼		6½	6½	
	for $c \geq$	in.	—	10		—	—	— / 8	5½	5½		—	—	
Minimum Concrete Thickness	h_{min}	in.	3¼	3¼	4½	4½	4½	6	5½	5½	7⅞	6¾	6¾	8¾
Additional Data														
Yield Strength	f_{ya}	psi	96,000	80,000		92,000			82,000			68,000		
Tensile Strength	f_{uta}	psi	120,000	100,000		115,000			108,000			95,000		
Minimum Tensile and Shear Stress Area	A_{se}	in.²	0.0255	0.0514		0.105			0.166			0.270		
Axial Stiffness in Service Load Range — Cracked and Uncracked Concrete	β	lb./in.	54,430[3]	29,150		54,900[3]	54,900		61,270[3]	61,270		154,290[3]	154,290	

1. The information presented in this table is to be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D.
2. The clearance must comply with applicable code requirements for the connected element.
3. The tabulated value of β is for installtions in uncracked concrete only.
4. The ¼"-diameter (6.4 mm) anchor may be installed in top of uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in this table.
5. The ⅜"- through ¾"-diameter (9.5 mm through 19.1 mm) anchors may be installed in top of cracked and uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in this table and in the table on p. 116 for the ⅜"- and ½"-diameter anchors.
6. Tabulated values for this embedment depth are based on internal testing and they are not listed in ICC-ES ESR-3037.

*See p. 14 for an explanation of the load table icons.

Strong-Bolt® 2 Design Information — Concrete

Stainless-Steel Strong-Bolt 2 Tension Strength Design Data[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter, d_a (in.)											
			¼[9]	⅜[10]		½[10]			⅝[10]			¾[10]		
Anchor Category	1, 2 or 3	—	1											
Nominal Embedment Depth	h_{nom}	in.	1¾	1⅞	2⅞	2¼[11]	2¾	3⅞	2¾[11]	3⅜	5⅛	3⅜[11]	4⅛	5¾
Steel Strength in Tension (ACI 318-19 17.6.1, ACI 318-14 17.4.1 or ACI 318-11 Section D5.1)														
Steel Strength in Tension	N_{sa}	lb.	3,060	5,140		12,075			17,930			25,650		
Strength Reduction Factor — Steel Failure[2,3]	ϕ_{sa}	—	0.75											
Concrete Breakout Strength in Tension (ACI 318-19 17.6.2, ACI 318-14 17.4.2 or ACI 318-11 Section D5.2)														
Effective Embedment Depth	h_{ef}	in.	1½	1½	2½	1¾	2¼	3⅜	2⅛	2¾	4½	2⅝	3⅜	5
Critical Edge Distance	c_{ac}	in.	2½	6½	8½	4½	4½	7	7½	7½	9	8	8	8
Effectiveness Factor — Uncracked Concrete	k_{uncr}	—	24											
Effectiveness Factor — Cracked Concrete	k_{cr}	—	—[8]	17		—[12]	17		—[12]	17		—[12]	17	
Modification Factor	$\psi_{c,N}$	—	—[8]	1.00		—[12]	1.00		—[12]	1.00		—[12]	1.00	
Strength Reduction Factor — Concrete Breakout Failure[3]	ϕ_{cb}	—	0.65											
Pullout Strength in Tension (ACI 318-19 17.6.3, ACI 318-14 17.4.3 or ACI 318-11 Section D5.3)														
Pullout Strength, Cracked Concrete (f'_c = 2,500 psi)	$N_{p,cr}$	lb.	—[8]	1,720[6]	3,145[6]	—[12]	2,560[5]	4,305[5]	—[12]	N/A[4]	6,545[7]	—[12]	N/A[4]	8,230[5]
Pullout Strength, Uncracked Concrete (f'_c = 2,500 psi)	$N_{p,uncr}$	lb.	1,925[7]	N/A[4]	4,770[6]	2,180[5]	3,230[5]	4,495[5]	2,380[5]	N/A[4]	7,615[5]	6,770[13]	7,725[7]	9,625[7]
Strength Reduction Factor — Pullout Failure[3]	ϕ_p	—	0.65											
Tensile Strength for Seismic Applications (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 Section D.3.3.3)														
Nominal Pullout Strength for Seismic Loads (f'_c = 2,500 psi)	$N_{p,eq}$	lb.	—[8]	1,720[6]	2,830[6]	—[12]	2,560[5]	4,305[5]	—[12]	N/A[4]	6,545[7]	—[12]	N/A[4]	8,230[5]
Strength Reduction Factor — Pullout Failure[3]	ϕ_{eq}	—	0.65											

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, as applicable, except as modified below.
2. The stainless-steel Strong-Bolt 2 anchors are ductile steel elements as defined in ACI 318-19 2.3, ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.
3. The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.
4. N/A (not applicable) denotes that pullout resistance does not need to be considered.
5. The characteristic pullout strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c/2{,}500\ psi)^{0.5}$.
6. The characteristic pullout strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c/2{,}500\ psi)^{0.3}$.
7. The characteristic pullout strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c/2{,}500\ psi)^{0.4}$.
8. The ¼"-diameter stainless-steel Strong-Bolt 2 anchor installation in cracked concrete is beyond the scope of this table.
9. The ¼"-diameter (6.4 mm) anchor may be installed in top of uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in the table on p. 113.
10. The ⅜"- through ¾"-diameter (9.5 mm through 19.1 mm) anchors may be installed in top of cracked and uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in the table on p. 113 and in the table on p. 116 for the ⅜"- and ½"-diameter anchors.
11. Tabulated values for this embedment depth are based on internal testing and they are not listed in ICC-ES ESR-3037.
12. Anchor installation in cracked concrete is beyond the scope of this table for this embedment depth.
13. The characteristic pullout strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c/2{,}500\ psi)^{0.15}$.

*See p. 14 for an explanation of the load table icons.

Strong-Bolt® 2 Design Information — Concrete

Stainless-Steel Strong-Bolt 2 Shear Strength Design Data[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter, d_a (in.)											
			¼[5]	⅜[6]		½[6]			⅝[6]			¾[6]		
Anchor Category	1, 2 or 3	—	1											
Nominal Embedment Depth	h_{nom}	in.	1¾	1⅞	2⅞	2¼[7]	2¾	3⅞	2¾[7]	3⅜	5⅛	3⅜[7]	4⅛	5¾
Steel Strength in Shear (ACI 318-19 17.7.1, ACI 318-14 17.5.1 or ACI 318-11 Section D.6.1)														
Steel Strength in Shear	V_{sa}	lb.	1,605	3,085		3,665	7,245		6,745		10,760	12,765	15,045	
Strength Reduction Factor — Steel Failure[2,3]	ϕ_{sa}	—	0.65											
Concrete Breakout Strength in Shear (ACI 318-19 17.7.2, ACI 318-14 17.5.2 or ACI 318-11 Section D.6.2)														
Outside Diameter	d_a	in.	0.250	0.375		0.500			0.625			0.750		
Load Bearing Length of Anchor in Shear	ℓ_e	in.	1.500	1.500	2.500	1.75	2.250	3.375	2.125	2.750	4.500	2.625	3.375	5.000
Strength Reduction Factor — Concrete Breakout Failure[3]	ϕ_{cb}	—	0.70											
Concrete Pryout Strength in Shear (ACI 318-19 17.7.3, ACI 318-14 17.5.3 or ACI 318-11 Section D.6.3)														
Coefficient for Pryout Strength	k_{cp}	—	1.0		2.0	1.0		2.0	1.0	2.0				
Effective Embedment Depth	h_{ef}	in.	1½	1½	2½	1¾	2¼	3⅜	2⅛	2¾	4½	2⅝	3⅜	5
Strength Reduction Factor — Concrete Pryout Failure[3]	ϕ_{cp}	—	0.70											
Steel Strength in Shear for Seismic Applications (ACI 318-19 17.10.3, ACI 318-14 17.2.3.3 or ACI 318-11 Section D.3.3.3)														
Shear Strength of Single Anchor for Seismic Loads (f'_c = 2,500 psi)	$V_{sa,eq}$	lb.	—[4]	3,085		—[8]	6,100		—[8]	6,745	10,760	—[8]	13,620	
Strength Reduction Factor — Steel Failure[2,3]	ϕ_{sa}	—	0.65											

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, except as modified below.
2. The stainless steel Strong-Bolt 2 anchors are ductile steel elements as defined in ACI 318-19 2.3, ACI 318-14 2.3 or ACI 318-11 D.1, as applicable.
3. The strength reduction factor applies when the load combinations from the IBC or ACI 318 are used and the requirements of ACI 318-19 17.5.3, ACI 318-14 17.3.3 or ACI 318-11 D.4.3, as applicable, are met. If the load combinations of ACI 318-11 Appendix C are used, the appropriate strength reduction factor must be determined in accordance with ACI 318-11 D.4.4.
4. The ¼"-diameter stainless-steel Strong-Bolt 2 anchor installation in cracked concrete is beyond the scope of this table.
5. The ¼"-diameter (6.4 mm) anchor may be installed in top of uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in the table on p. 113.
6. The ⅜"- through ¾"-diameter (9.5 mm through 19.1 mm) anchors may be installed in top of cracked and uncracked normal-weight and sand-lightweight concrete over profile steel deck, where concrete thickness above upper flute meets the minimum thickness specified in the table on p. 116.
7. Tabulated values for this embedment depth are based on internal testing and they are not listed in ICC-ES ESR-3037.
8. Anchor installation in cracked concrete is beyond the scope of this table for this embedment depth.

*See p. 14 for an explanation of the load table icons.

Stainless-Steel Strong-Bolt 2 Information for Installation in the Topside of Concrete-Filled Profile Steel Deck Floor and Roof Assemblies[1,2,3,4]

IBC *

Design Information	Symbol	Units	Nominal Anchor Diameter (in.)		
			⅜		½
Nominal Embedment Depth	h_{nom}	in.	1⅞		2¾
Effective Embedment Depth	h_{ef}	in.	1½		2¼
Minimum Concrete Thickness[5]	$h_{min,deck}$	in.	2½	3¼	3¼
Critical Edge Distance	$c_{ac,deck,top}$	in.	4¾	4	4
Minimum Edge Distance	$c_{min,deck,top}$	in.	4¾		6
Minimum Spacing	$s_{min,deck,top}$	in.	6½		8

For **SI**: 1 inch = 25.4 mm; 1 lbf = 4.45N

1. Installation must comply with the table on p. 113 and Figure 1 below.
2. Design capacity shall be based on calculations according to values in the tables on pp. 114 and 115.
3. Minimum flute depth (distance from top of flute to bottom of flute) is 1½".
4. Steel deck thickness shall be a minimum 20 gauge.
5. Minimum concrete thickness ($h_{min,deck}$) refers to concrete thickness above upper flute.

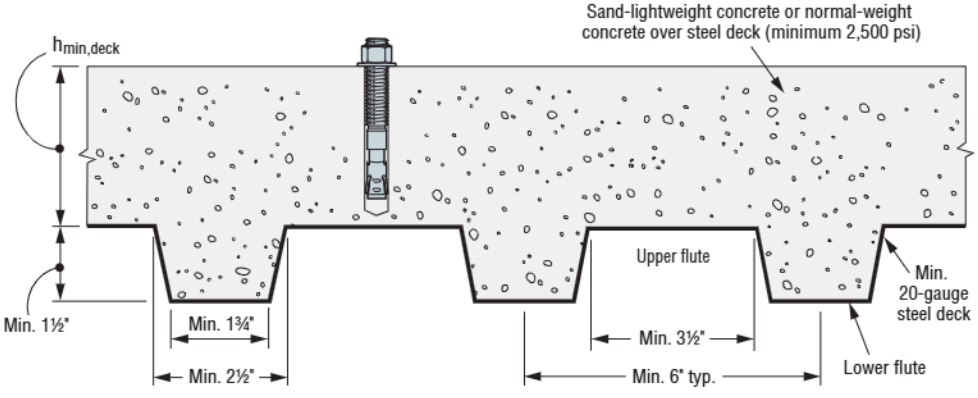

Figure 1

*See p. 14 for an explanation of the load table icons.

Strong-Bolt® 2 Design Information — Concrete

Stainless-Steel Strong-Bolt 2 Tension and Shear Strength Design Data for the Soffit of Concrete over Steel Deck Floor and Roof Assemblies[1,2,6,10,11]

IBC *

Characteristic	Symbol	Units	Stainless Steel								
			Lower Flute							Upper Flute	
			⅜		½		⅝		¾	⅜	½
Nominal Embedment Depth	h_{nom}	in.	2	3⅜	2¾	4½	3⅜	5⅛	4⅛	2	2¾
Effective Embedment Depth	h_{ef}	in.	1⅝	3	2¼	4	2¾	5	3⅜	1⅝	2¼
Installation Torque	T_{inst}	ft.-lbf	30		65		80		150	30	65
Pullout Strength, concrete on steel deck (cracked)[3]	$N_{p,deck,cr}$	lb.	1,230[8]	2,605[8]	1,990[7]	2,550[7]	1,750[9]	4,020[9]	3,030[7]	1,550[8]	2,055[7]
Pullout Strength, concrete on steel deck (uncracked)[3]	$N_{p,deck,uncr}$	lb.	1,580[8]	3,950[8]	2,475[7]	2,660[7]	2,470[7]	5,000[7]	4,275[9]	1,990[8]	2,560[7]
Pullout Strength, concrete on steel deck (seismic)[5]	$N_{p,deck,eq}$	lb.	1,230[8]	2,345[8]	1,990[7]	2,550[7]	1,750[9]	4,020[9]	3,030[7]	1,550[8]	2,055[7]
Steel Strength in Shear, concrete on steel deck[4]	$V_{sa,deck}$	lb.	2,285	3,085	3,430	4,680	3,235	5,430	6,135	3,085	5,955
Steel Strength in Shear, concrete on steel deck (seismic)[5]	$V_{sa,deck,eq}$	lb.	2,285	3,085	2,400	3,275	3,235	5,430	5,520	3,085	4,170

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318-19 Chapter 17, ACI 318-14 Chapter 17 or ACI 318-11 Appendix D, except as modified below.
2. The steel deck profile must comply with the configuration in Figure 2 below, and have a minimum base-steel thickness of 0.035 inch (20 gauge). Steel must comply with ASTM A 653/A 653M SS Grade 33 with minimum yield strength of 33,000 psi. Concrete compressive strength shall be 3,000 psi minimum.
3. For anchors installed in the soffit of sand-lightweight or normal-weight concrete over steel deck floor and roof assemblies, calculation of the concrete breakout strength may be omitted.
4. In accordance with ACI 318-19 Section 17.6.3.2.1, ACI 318-14 Section 17.4.3.2 or ACI 318-11 Section D.5.3.2, the nominal pullout strength in cracked concrete for anchors installed in the soffit of sand-lightweight or normal-weight concrete over steel deck floor and roof assemblies $N_{p,deck,cr}$ shall be substituted for $N_{p,cr}$. Where analysis indicates no cracking at service loads, the normal pullout strength in uncracked concrete $N_{p,deck,uncr}$ shall be substituted for $N_{p,uncr}$. For seismic loads, $N_{p,deck,eq}$ shall be substituted for N_p.
5. In accordance with ACI 318-19 Section 17.7.1.2(c), ACI 318-14 Section 17.5.1.2(c) or ACI 318-11 Section D.6.1.2(c), the shear strength for anchors installed in the soffit of sand-lightweight or normal-weight concrete over steel deck floor and roof assemblies V_{sa},deck shall be substituted for V_{sa}. For seismic loads, $V_{sa,\ deck,eq}$ shall be substituted for V_{sa}.
6. The minimum anchor spacing along the flute must be the greater of $3.0h_{ef}$ or 1.5 times the flute width.
7. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 3{,}000\ psi)^{0.5}$.
8. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 3{,}000\ psi)^{0.3}$.
9. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 3{,}000\ psi)^{0.4}$.
10. Concrete shall be normal-weight or structural sand-lightweight concrete having a minimum specified compressive strength, f'_c, of 3,000 psi.
11. Minimum distance to edge of panel is $2h_{ef}$.

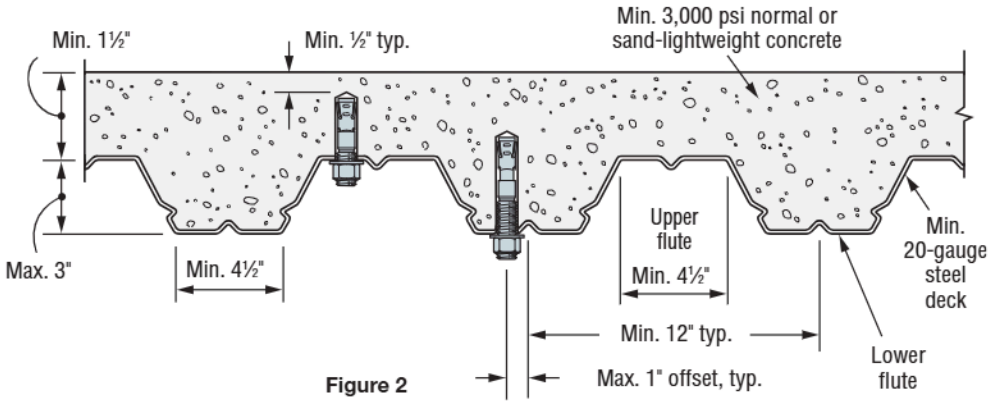

Figure 2

*See p. 14 for an explanation of the load table icons.