Submittal / Substitution Request

SUBMITTED TO:

To: ______________________________

Firm: ______________________________

Project: ______________________________

Submitted Product: **SIMPSON STRONG-TIE® STRONG-BOLT™ 2** Wedge Anchor for Cracked and Uncracked Concrete

Specified Product: ______________________________

Section: ____________ Page: ____________ Detail/Sheet No.: ____________

Description of Application: ______________________________

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Attached information includes product description, installation instructions and pertinent technical data needed for evaluation of the submittal request.

SUBMITTED BY:

Name: ____________________ Signature: ____________________

Firm: ______________________________

Address: ______________________________

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Phone: ____________________ Fax: ____________________

E-Mail: ______________________________

Date of Submittal: ____________________

FOR ARCHITECT/ENGINEER USE:

Approved: ______ Approved As Noted: ______ Not Approved: ______

(Please briefly explain why not approved)

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By: ____________________ Date: ____________________

Remarks: ______________________________

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Strong-Bolt™ 2 *Wedge Anchor*

The Strong-Bolt™ 2 wedge anchor is the next-generation solution for cracked and uncracked concrete. Following rigorous testing according to ICC-ES acceptance criteria, the Strong-Bolt™ 2 anchor received classification as a Category 1 anchor, the highest attainable anchor category for performance in cracked concrete under static and seismic loading. Available in stainless steel, it is code-listed by ICC-ES under the 2009 IBC requirements for post-installed anchors in cracked and uncracked concrete.

FEATURES:

- **Category 1 anchor classification:** The Strong-Bolt™ 2 anchor received classification as a Category 1 anchor, which is established by performance in reliability tests in accordance with AC193 and ACI355.2 test criteria. Category 1 is the highest attainable anchor category for reliability.
- **Tri-segmented clip:** Each segment adjusts independently, increasing follow-up expansion should the hole increase in size as a result of a crack
- **Dual embossments on each clip segment:** Enables clip to undercut into the concrete thereby increasing follow-up expansion should a crack occur
- **The only ⅜" anchor solution approved for 3¼" concrete thickness:** The Strong-Bolt 2 anchor can be installed in cracked concrete with a minimum thickness of 3¼", including concrete-over-metal decking
- **High-strength alloy clip on carbon-steel anchors:** This special alloy clip offers improved performance
- **Standard (ANSI) fractional anchor:** Fits most fixtures and installs with common drill bit sizes and tools
- **Easy post-installation identification:** The head is stamped with Simpson Strong-Tie "≠" symbol and a letter for length identification
- **Type 316 stainless-steel clip on stainless steel anchors:** In addition to superior corrosion resistance, a stainless-steel clip offers "memory" that contributes to the anchor's performance if the hole increases in size because of a crack

MATERIAL: Carbon-steel stud with special alloy clip; stainless-steel stud with stainless-steel clip (⅜" diameter only)

FINISH: Zinc-plated (carbon steel)

CODES: ICC-ES ESR-3037 (carbon and stainless steel); City of Los Angeles – Pending; UL – Pending; FM – Pending; Florida – Pending

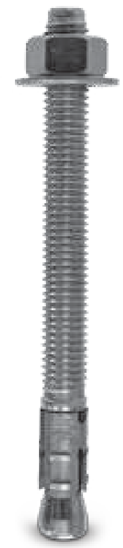
TEST CRITERIA:

The Strong-Bolt 2 wedge anchor has been tested in accordance with ICC-ES's Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC 193) and ACI 355.2 for the following:

- Static tension and shear loading in cracked and uncracked concrete
- Seismic and wind loading in cracked and uncracked concrete
- Performance in cracked concrete
- Performance in lightweight concrete over metal deck

NOTE PRODUCT AVAILABILITY AS FOLLOWS:

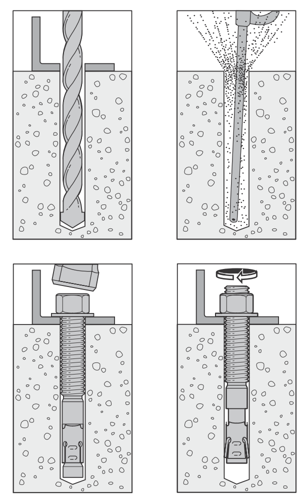
STB2 ⅜"- diameter in carbon steel, stainless steel: first quarter 2011
STB2 ½"- and ⅝"-diameter in carbon steel: second quarter 2011



Strong-Bolt™ 2 Wedge Anchor

Head Stamp
The head is stamped with the Simpson Strong-Tie "No-Equal" symbol and the length identification letter.

Installation Sequence



Length Identification Head Marks on Strong-Bolt™ 2 Wedge Anchors (corresponds to length of anchor – inches)

Mark	Units	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
From	in.	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11	12	13	14	15	16	17	18
Up To But Not Including	in.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11	12	13	14	15	16	17	18	19

Strong-Bolt™ 2 *Wedge Anchor Product Information*

Strong-Bolt™ 2 Anchor Product Data

Size (in.)	Carbon Steel Model No.	316 Stainless Steel Model No.	Drill Bit Dia. (in.)	Thread Length (in.)	Quantity	
					Box	Carton
⅜ x 2¾	STB2-37234	STB2-372346SS	⅜	1 5⁄16	50	250
⅜ x 3	STB2-37300	STB2-373006SS	⅜	1 9⁄16	50	250
⅜ x 3½	STB2-37312	STB2-373126SS	⅜	2 1⁄16	50	250
⅜ x 3¾	STB2-37334	STB2-373346SS	⅜	2 5⁄16	50	250
⅜ x 5	STB2-37500	STB2-375006SS	⅜	3 9⁄16	50	200
⅜ x 7	STB2-37700	STB2-377006SS	⅜	5 9⁄16	50	200
½ x 3¾	STB2-50334	•	½	2 1⁄16	25	125
½ x 4¼	STB2-50414	•	½	2 9⁄16	25	100
½ x 5½	STB2-50512	•	½	3 13⁄16	25	100
½ x 7	STB2-50700	•	½	5 5⁄16	25	100
½ x 8½	STB2-50812	•	½	6	25	50
½ x 10	STB2-50100	•	½	6	25	50
⅝ x 4½	STB2-62412	•	⅝	2 7⁄16	20	80
⅝ x 5	STB2-62500	•	⅝	2 15⁄16	20	80
⅝ x 6	STB2-62600	•	⅝	3 15⁄16	20	80
⅝ x 7	STB2-62700	•	⅝	4 15⁄16	20	80
⅝ x 8½	STB2-62812	•	⅝	6	20	40
⅝ x 10	STB2-62100	•	⅝	6	10	20

Material Specifications

Carbon Steel - Zinc Plated[1]			
Component Materials			
Anchor Body	Nut	Washer	Clip
Carbon Steel	Carbon Steel ASTM A 563, Grade A	Carbon Steel ASTM F844	Carbon Steel ASTM A 568

1. Zinc meets ASTM B 633, Class SC 1 (Fe / Zn 5), Type III.

Stainless Steel			
Component Materials			
Anchor Body	Nut	Washer	Clip
Type 316 Stainless Steel	Type 316 Stainless Steel	Type 316 Stainless Steel	Type 316 Stainless Steel

Strong-Bolt 2 Installation Information[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.)								
			Carbon Steel							Stainless Steel	
			⅜		½			⅝		⅜	
Installation Information											
Nominal Diameter	d_a[3]	in.	⅜		½			⅝		⅜	
Drill Bit Diameter	d	in.	⅜		½			⅝		⅜	
Baseplate Clearance Hole Diameter[2]	d_c	in. (mm)	7⁄16 (11.1)		9⁄16 (14.3)			11⁄16 (17.5)		7⁄16 (11.1)	
Installation Torque	T_{inst}	ft-lbf (N-m)	30 (40.7)		60 (81.3)			90 (122.0)		30 (40.7)	
Nominal Embedment Depth[5]	h_{nom}	in. (mm)	2 (51)	2⅞ (73)	2¾ (70)		3⅞ (98)	3⅜ (86)	5⅛ (130)	2 (51)	2⅞ (73)
Effective Embedment Depth	h_{ef}	in. (mm)	1⅝ (41)	2½ (64)	2¼ (57)		3⅜ (86)	2¾ (70)	4½ (114)	1⅝ (41)	2½ (64)
Minimum Overall Anchor Length	ℓ_{anch}	in. (mm)	2¾ (70)	3½ (89)	3¾ (95)		5½ (140)	4½ (114)	6 (152)	2¾ (70)	3½ (89)
Critical Edge Distance	c_{ac}	in. (mm)	6½ (165)	6 (152)	6½ (165)	6½ (165)	7½ (191)	7½ (191)	9 (229)	6½ (165)	8½ (216)
Minimum Edge Distance	c_{min}	in. (mm)	6 (152)		7 (178)	4 (102)	4 (102)	6½ (165)		6 (152)	
	for $s \geq$	in. (mm)	— —		— —	— —	— —	— —		10 (254)	
Minimum Spacing	s_{min}	in. (mm)	3 (76)		7 (178)	4 (102)	4 (102)	5 (127)		3 (76)	
	for $c \geq$	in. (mm)	— —		— —	— —	— —	— —		10 (254)	
Minimum Concrete Thickness	h_{min}	in. (mm)	3¼ (83)	4½ (114)	4½ (114)	5½ (140)	6 (152)	5½ (140)	7⅞ (200)	3¼ (83)	4½ (114)
Additional Data											
Yield Strength	f_{ya}	psi (MPa)	92,000 (634)		85,000 (586)					80,000 (552)	
Tensile Strength	f_{uta}[4]	psi (MPa)	115,000 (793)							100,000 (689)	
Minimum Tensile and Shear Stress Area	A_{se}	in² (mm²)	0.0514 (33)		0.105 (68)			0.166 (107)		0.0514 (33)	
Axial Stiffness in Service Load Range – Cracked and Uncracked Concrete	β	lb./in (N/mm)	34,820 (6,098)		63,570 (11,133)			91,370 (16,001)		29,150 (5,105)	

For **SI**: 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lbf/in = 0.175 N/mm.

1. The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.
2. The clearance must comply with applicable code requirements for the connected element.
3. For the 2006 IBC, d_0 replaces d_a.
4. For the 2003 IBC, f_{ut} replaces f_{uta}.
5. Drilled hole depth to be greater than or equal to nominal embedment depth.

*See page 5 for an explanation of the load table icons

Strong-Bolt™ 2 Wedge Anchor Tension Strength Design Data[1]

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.)							
			Carbon Steel						Stainless Steel	
			⅜		½		⅝		⅜	
Anchor Category	1,2 or 3	—	1						1	
Nominal Embedment Depth	h_{nom}	in. (mm)	2 (51)	2 ⅞ (73)	2 ¾ (70)	3 ⅞ (98)	3 ⅜ (86)	5 ⅛ (130)	2 (51)	2 ⅞ (73)
Steel Strength in Tension (ACI 318 Section D.5.1)										
Steel Strength in Tension	N_{sa}	lb (kN)	5,600 (24.9)		12,100 (53.8)		19,070 (84.8)		5,140 (22.9)	
Strength Reduction Factor – Steel Failure[2]	ϕ_{sa}	—	0.75						0.75	
Concrete Breakout Strength in Tension (ACI 318 Section D.5.2)										
Effective Embedment Depth	h_{ef}	in. (mm)	1⅝ (41)	2½ (64)	2¼ (57)	3⅜ (86)	2¾ (70)	4½ (114)	1⅝ (41)	2½ (64)
Critical Edge Distance	c_{ac}	in. (mm)	6½ (165)	6 (152)	6½ (165)	7½ (191)	7½ (191)	9 (229)	6½ (165)	8½ (216)
Effectiveness Factor – Uncracked Concrete	k_{uncr}	—	24		24		24		24	
Effectiveness Factor – Cracked Concrete	k_{cr}	—	17		17		17		17	
Modification Factor	$\psi_{c,N}$[8]	—	1.00		1.00		1.00		1.00	
Strength Reduction Factor – Concrete Breakout Failure[3]	ϕ_{cb}	—	0.65						0.65	
Pull-Out Strength in Tension (ACI 318 Section D.5.3)										
Pull-Out Strength Cracked Concrete (f'_c = 2500 psi)	$N_{p,cr}$	lb (kN)	1,300[5] (5.8)[5]	2,775[5] (12.3)[5]	N/A[4]	3,735[5] (16.6)[5]	N/A[4]	6,895[5] (30.7)[5]	1,720[6] (7.7)[6]	3,145[6] (14.0)[6]
Pull-Out Strength Uncracked Concrete (f'_c = 2500 psi)	$N_{p,uncr}$	lb (kN)	N/A[4]	3,340[5] (14.9)[5]	3,615[5] (16.1)[5]	5,255[5] (23.4)[5]	N/A[4]	9,025[5] (40.1)[5]	N/A[4]	4,770[6] (21.2)[6]
Strength Reduction Factor – Pullout Failure[7]	ϕ_p	—	0.65						0.65	
Tensile Strength for Seismic Applications (ACI Section D.3.3.3)										
Tension Strength of Single Anchor for Seismic Loads (f'_c = 2500 psi)	$N_{p,eq}$	lb (kN)	1,300[5] (5.8)[5]	2,775[5] (12.3)[5]	N/A[4]	3,735[5] (16.6)[5]	N/A[4]	6,895[5] (30.7)[5]	1,720[6] (7.7)[6]	2,830[6] (12.6)[6]
Strength Reduction Factor – Pullout Failure[7]	ϕ_{eq}	—	0.65						0.65	

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

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318 Appendix D, except as modified below.
2. The tabulated value of ϕ_{sa} applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{sa} must be determined in accordance with ACI 318 D.4.5. Strong-Bolt™ 2 anchors are ductile steel elements as defined in ACI 318 D.1.
3. The tabulated value of ϕ_{cb} applies when both the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 Section D.4.4(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided. For installations where complying supplementary reinforcement can be verified, the ϕ_{cb} factors described in ACI 318 D.4.4 for Condition A are allowed. If the load combinations of ACI 318 Section 9.2 are used and the requirements of ACI 318 Section D.4.4 for Condition A are met, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.4(c). If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.5(c).
4. N/A (Not Applicable) denotes that pullout resistance does not need to be considered.
5. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 2{,}500\ psi)^{0.5}$ or $(f'_c / 17.2\ MPa)^{0.5}$.
6. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 2{,}500\ psi)^{0.3}$ or $(f'_c / 17.2\ MPa)^{0.3}$.
7. The tabulated value of ϕ_p or ϕ_{eq} applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, appropriate value of ϕ must be determined in accordance with ACI 318 Section D.4.5(c).
8. For the 2003 IBC, Ψ_3 replaces $\Psi_{c,N}$.
9. When anchors are used in structural sand-lightweight concrete, the modification factor (λ) for concrete breakout strength may be taken as 0.6. In addition, the pullout strength $N_{p,uncr}$, $N_p cr$ and $N_{p,eq}$ shall be multiplied by 0.6 as applicable.

Strong-Bolt™ 2 Wedge Anchor Shear Strength Design Data [1]

*See page 5 for an explanation of the load table icons

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.)							
			Carbon Steel						Stainless Steel	
			⅜		½		⅝		⅜	
Anchor Category	1,2 or 3	—	1						1	
Nominal Embedment Depth	h_{nom}	in. (mm)	2 (51)	2⅞ (73)	2¾ (70)	3⅞ (98)	3⅜ (86)	5⅛ (130)	2 (51)	2⅞ (73)
Steel Strength in Shear (ACI 318 Section D.6.1)										
Steel Strength in Shear	V_{sa}	lb (kN)	1,800 (8.0)		7,235 (32.2)		11,035 (49.1)		3,085 (13.7)	
Strength Reduction Factor – Steel Failure[2]	$_{sa}$	—	0.65						0.65	
Concrete Breakout Strength in Shear (ACI 318 Section D.6.2)										
Outside Diameter	d_a[5]	in. (mm)	0.375 (9.5)		0.500 (12.7)		0.625 (15.9)		0.375 (9.5)	
Load Bearing Length of Anchor in Shear	ℓ_e	in. (mm)	1.625 (41)	2.500 (64)	2.250 (57)	3.375 (86)	2.750 (70)	4.500 (114)	1.625 (41)	2.500 (64)
Strength Reduction Factor – Concrete Breakout Failure[3]	$_{cb}$	—	0.70						0.70	
Concrete Pryout Strength in Shear (ACI 318 Section D.6.3)										
Coefficient for Pryout Strength	k_{cp}	—	1.0	2.0	1.0	2.0	2.0		1.0	2.0
Effective Embedment Depth	h_{ef}	in. (mm)	1⅝ (41)	2½ (64)	2¼ (57)	3⅜ (86)	2¾ (70)	4½ (114)	1⅝ (41)	2½ (64)
Strength Reduction Factor – Concrete Pryout Failure[4]	$_{cp}$	—	0.70						0.70	
Steel Strength in Shear for Seismic Applications (ACI 318 Section D.3.3.3)										
Shear Strength of Single Anchor for Seismic Loads (f'_c = 2500 psi)	V_{eq}	lb (kN)	1,800 (8.0)		6,510 (29.0)		9,930 (44.2)		3,085 (13.7)	
Strength Reduction Factor – Steel Failure[2]	$_{sa}$	—	0.65						0.65	

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

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318 Appendix D, except as modified below.
2. The tabulated value of $_{sa}$ applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of $_{sa}$ must be determined in accordance with ACI 318 D.4.5. Strong-Bolt™ 2 anchors are ductile steel elements as defined in ACI 318 D.1.
3. The tabulated value of $_{cb}$ applies when both the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 Section D.4.4(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided. For installations where complying supplementary reinforcement can be verified, the $_{cb}$ factors described in ACI 318 Section D.4.4 for Condition A are allowed. If the load combinations of ACI 318 Section 9.2 are used and the requirements of ACI 318 Section D.4.4 for Condition A are met, the appropriate value of $_{cb}$ must be determined in accordance with ACI 318 Section D.4.4(c). If the load combinations of ACI 318 Appendix C are used, the appropriate value of $_{cb}$ must be determined in accordance with ACI 318 Section D.4.5(c).
4. The tabulated value of $_{cp}$ applies when both the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of $_{cp}$ must be determined in accordance with ACI 318 D.4.5(c).
5. For the 2006 IBC, d_o replaces d_a.

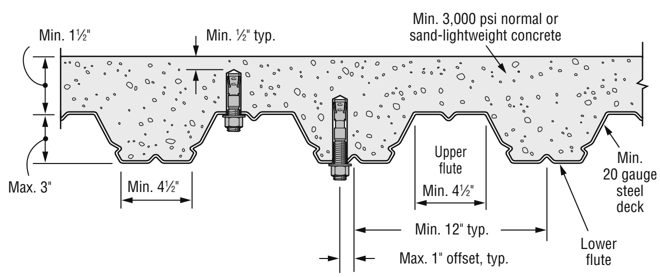
Strong-Bolt™ 2 Wedge Anchor Tension and Shear Strength Design Data for the Soffit of Concrete Over Profile Steel Deck, Floor and Roof Assemblies[1,2,6,9]

*See page 5 for an explanation of the load table icons

Characteristic	Symbol	Units	Nominal Anchor Diameter (in.)										
			Carbon Steel								Stainless Steel		
			Lower Flute						Upper Flute		Lower Flute		Upper Flute
			⅜		½		⅝		⅜	½	⅜		⅜
Nominal Embedment Depth	h_{nom}	in. (mm)	2 (51)	3⅜ (86)	2¾ (70)	4½ (114)	3⅜ (86)	5⅝ (143)	2 (51)	2¾ (70)	2 (51)	3⅜ (86)	2 (51)
Effective Embedment Depth	h_{ef}	in. (mm)	1⅝ (41)	3 (76)	2¼ (57)	4 (102)	2¾ (70)	5 (127)	1⅝ (41)	2¼ (57)	1⅝ (41)	3 (76)	1⅝ (41)
Installation Torque	T_{inst}	ft-lbf (N-m)	30 (40.7)		60 (81.3)		90 (122.0)		30 (40.7)	60 (81.3)	30 (40.7)		30 (40.7)
Pullout Strength, concrete on metal deck (cracked)[3,4]	$N_{p,deck,cr}$	lb (kN)	1,250[7] (5.6)[7]	2,230[7] (9.9)[7]	2,040[7] (9.1)[7]	2,730[7] (12.1)[7]	2,615[7] (11.6)[7]	4,990[7] (22.2)[7]	1,610[7] (7.2)[7]	3,785[7] (16.8)[7]	1,120[8] (5.0)[8]	2,795[8] (12.4)[8]	1,410[8] (6.3)[8]
Pullout Strength, concrete on metal deck (uncracked)[3,4]	$N_{p,deck,uncr}$	lb (kN)	1,765[7] (7.9)[7]	3,150[7] (14.0)[7]	2,580[7] (11.5)[7]	3,840[7] (17.1)[7]	3,685[7] (16.4)[7]	6,565[7] (29.2)[7]	2,275[7] (10.1)[7]	4,795[7] (21.3)[7]	1,580[8] (7.0)[8]	3,950[8] (17.6)[8]	1,990[8] (8.9)[8]
Steel Strength in Shear, concrete on metal deck[5]	$V_{st.deck}$	lb (kN)	1,595 (7.1)	3,490 (15.5)	2,135 (9.5)	4,580 (20.4)	2,640 (11.7)	7,000 (31.1)	4,060 (18.1)	5,920 (26.3)	2,285 (10.2)	3,785 (16.8)	3,830 (17.0)

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

1. The information presented in this table must be used in conjunction with the design criteria of ACI 318 Appendix D, except as modified below.
2. Profile steel deck must comply with the configuration in the figure below, and have a minimum base-steel thickness of 0.035 inch (0.889 mm) [20 gauge]. Steel must comply with ASTM A 653/A 653M SS Grade 33 with minimum yield strength of 38,000 psi (262 Mpa). Concrete compressive strength shall be 3,000 psi minimum.
3. For anchors installed in the soffit of sand-lightweight or normal-weight concrete over metal deck floor and roof assemblies, calculation of the concrete breakout strength may be omitted.
4. In accordance with ACI 318 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 metal deck floor and rood 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 $N_{p,uncr}$.
5. In accordance with ACI 318 Section D.6.1.2(c), the shear strength for anchors installed in the soffit of sand-lightweight or normal-weight concrete over metal deck floor and rood assemblies $V_{st,deck}$ shall be substituted for V_{sa}.
6. The minimum anchor spacing along the flute must be the greater of 3.0_{hef} 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 $(f'_c/3{,}000\ psi)^{0.5}$ or$(f'_c/20.7\ MPa)^{0.5}$.
8. The characteristic pull-out strength for greater concrete compressive strengths shall be increased by multiplying the tabular value by $(f'_c / 3{,}000\ psi)^{0.3}$ or $(f'_c / 20.7\ MPa)^{0.3}$.
9. Minimum distance to edge of panel is 2_{hef}.



Example: Strong-Bolt™ 2 Wedge Anchor Allowable Stress Design Tension Values for Illustrative Purposes[1,2,3,4,5,6,7,8,9]

*See page 5 for an explanation of the load table icons

Nominal Anchor Diameter (in.)	Nominal Embedment Depth, h_{nom} (in.)	Effective Embedment Depth, h_{ef} (in.)	Allowable Tension Load, fN_n/a (lbs.)
Carbon Steel			
⅜	2	1⅝	1,090
	2⅞	2½	1,465
½	2¾	2¼	1,585
	3⅞	3⅜	2,305*
⅝	3⅜	2¾	2,400
	5⅛	4½	3,965
Stainless Steel			
⅜	2	1⅝	1,090
	2⅞	2½	2,080

Design Assumptions:
1. Single anchor.
2. Tension load only.
3. Concrete assumed to remain uncracked for the life of the anchorage.
4. Load combinations taken from ACI 318 Section 9.2 (no seismic loading).
5. 30% Dead Load (D) and 70% Live Load (L); Controlling load combination is 1.2D + 1.6L. Calculation of a based on weighted average: $\alpha = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48$.
6. Normal weight concrete with $f'_c = 2{,}500$ psi.
7. $c_{a1} = c_{a2} \geq c_{ac}$
8. Concrete thickness, $h \geq h_{min}$
9. Values are for Condition B (supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided.)

*Illustrative Procedure (reference Strong-Bolt™ 2 Tension Strength Design Data Table): Strong-Bolt™ 2, ½"-diameter with an effective embedment depth, h_{ef} = 3 ⅜".

Step 1: Calculate steel strength in tension in accordance with ACI 318 D.5.1; $_{sa}N_{sa} = 0.75 \times 12{,}100 = 9{,}075$ lbs.

Step 2: Calculate concrete breakout strength in tension in accordance with ACI 318 D.5.2; $_{cb}N_{cb} = 0.65 \times 7{,}440 = 4{,}836$ lbs.

Step 3: Calculate pullout strength in tension in accordance with ACI 318 D.5.3; $_{p}N_{p,\,uncr} = 0.65 \times 5{,}255 = 3{,}416$ lbs.

Step 4: The controlling value from Steps 1, 2, and 3 above in accordance with ACI 318 D.4.1.2; $N_n = 3{,}416$ lbs.

Step 5: Divide the controlling value by the conversion factor a as determined in footnote 5; $T_{allowable,ASD} = N_n/\alpha = 3{,}416 / 1.48 = 2{,}305$ lbs.

The edge distance, spacing and member thickness requirements in the Strong-Bolt™ 2 Installation Information Table apply to a single anchor and anchor groups.

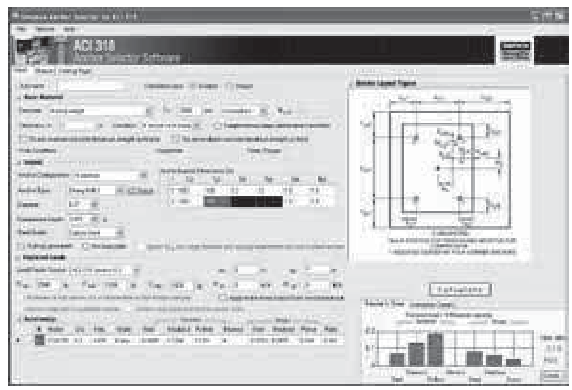
Anchor Selector™ Software ACI 318

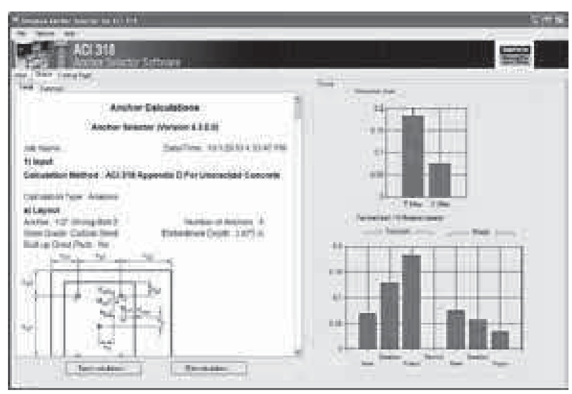
Anchor Selector™ Software for ACI 318
Anchor Selector Software for ACI 318 analyzes and offers anchor solutions using the ACI 318, Appendix D strength design methodology (or CAN/CSA A23.3 Annex D limit states design methodology). It provides cracked- and uncracked-concrete anchor solutions for many Simpson Strong-Tie Anchor Systems® mechanical and adhesive anchors.

With its easy-to-use graphical interface, Anchor Selector Software for ACI 318 eliminates the need for tedious calculations by hand that would otherwise be necessary to determine cracked concrete anchor solutions.

Features/Benefits

- Free download
- Quick and accurate analysis or design of anchor solutions results in increased productivity by eliminating the need to conduct time consuming calculations
- Graphical User Interface is intuitive and easy to use
- Includes prequalified post-installed mechanical and adhesive anchor solutions for cracked and/or uncracked concrete
- Includes a variety of concrete base material configurations
- Concrete Types
  – Normal weight concrete
  – Lightweight concrete
  – Normal weight concrete over metal deck
  – Sand-lightweight concrete over metal deck
- Includes cast-in-place anchor solutions
- Single and multiple anchor layouts provide solutions for multiple design applications
- Determines proper anchor solutions in situations where tension and shear forces will be acting simultaneously
- Capability to save input and results allows the designer to save data for later use. Additionally, input files can be easily modified to create new analysis/ design cases.
- Ability to save and print detailed calculations allows for verification of results
- Capability to resolve bi-axial bending moments imposed from attached member into anchor forces
- Auto update feature allows notification and download of the latest version of the software as updates become available





To download this free software, go to **www.simpsonanchors.com/software/as-aci318**.

ICC-ES Evaluation Report

ESR-3037

Issued November 1, 2010

This report is subject to re-examination August 1, 2011.

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

REPORT HOLDER:

SIMPSON STRONG-TIE COMPANY, INC.
5956 WEST LAS POSITAS BOULEVARD
PLEASANTON, CALIFORNIA 94588
(925) 560-9000
www.strongtie.com

EVALUATION SUBJECT:

STRONG-BOLT™ 2 WEDGE ANCHOR FOR CRACKED AND UNCRACKED CONCRETE

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009 *International Building Code®* (2009 IBC)
- 2009 *International Residential Code®* (2009 IRC)
- 2006 *International Building Code®* (2006 IBC)
- 2006 *International Residential Code®* (2006 IRC)
- 2003 *International Building Code®* (2003 IBC)
- 2003 *International Residential Code®* (2003 IRC)

Property evaluated:

Structural

2.0 USES

The Simpson Strong-Tie Strong-Bolt™ 2 Wedge Anchor is used to resist static, wind and seismic tension and shear loads in cracked and uncracked normal-weight concrete and structural sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and cracked and uncracked structural sand-lightweight or normal-weight concrete over steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

The Strong-Bolt™ 2 complies with Section 1912 of the 2009 and 2006 IBC, and Section 1913 of the 2003 IBC. The anchors are alternatives to cast-in-place anchors described in Section 1911 of the 2009 and 2006 IBC, and Section 1912 of the 2003 IBC. The anchors may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION

3.1 Strong-Bolt™ 2:

3.1.1 General: Strong-Bolt™ 2 anchors are torque-controlled, mechanical expansion anchors consisting of an anchor body, expansion clip, nut, and washer. A typical anchor (carbon steel version) is shown in Figure 1 of this report. The anchor body has a tapered mandrel formed on the installed end of the anchor and a threaded section at the opposite end. The taper of the mandrel increases in diameter toward the installed end of the anchor. The three-segment expansion clip wraps around the tapered mandrel. Before installation, this expansion clip is free to rotate about the mandrel. The anchor is installed in a predrilled hole. When the anchor is set by applying torque to the hex nut, the mandrel is drawn into the expansion clip, which engages the drilled hole and transfers the load to the base material. Pertinent dimensions are as set forth in Table 1 of this report.

3.1.2 Strong-Bolt™ 2, Carbon Steel: The anchor bodies are manufactured from carbon steel material with zinc plating conforming to ASTM B 633, SC1, Type III. The expansion clip for the carbon steel Strong-Bolt™ 2 anchor is fabricated from carbon steel and conforms to ASTM A 568. The hex nut for the carbon steel Strong-Bolt™ 2 anchor conforms to ASTM A 563, Grade A. The washer for the carbon steel Strong-Bolt™ 2 anchor conforms to ASTM F 844. The available anchor diameters under this report are $^3/_8$ inch, $^1/_2$ inch and $^5/_8$ inch (9.5 mm, 12.7 mm and 15.9 mm).

3.1.3 Strong-Bolt™ 2, Stainless Steel: The anchor bodies are manufactured from AISI Type 316 stainless steel. The expansion clip, hex nut and washer for the stainless steel Strong-Bolt™ 2 anchor conform to AISI Type 316 stainless steel. The available anchor diameter under this report is $^3/_8$ inch (9.5 mm).

3.2 Concrete:

Normal-weight and structural sand-lightweight concrete must conform to Sections 1903 and 1905 of the IBC.

3.3 Profile Steel Deck:

The profile steel deck must comply with the configuration in Figure 4 and have a minimum base-steel thickness of 0.035 inch (0.889 mm) [20 gauge]. Steel must comply with ASTM A 653/A 653M SS Grade 33 with minimum yield strength of 38,000 psi (262 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Strength Design:

Design strength of anchors complying with the 2009 and 2003 IBC, as well as Section 301.1.3 of the 2009 and 2003 IRC, must be determined in accordance with ACI 318-08 Appendix D and this report.

Design strength of anchors complying with the 2006 IBC and 2006 IRC must be in accordance with ACI 318-05 Appendix D and this report.

Design parameters are based on the 2009 IBC (ACI 318-08) unless noted otherwise in Sections 4.1.1 through 4.1.11 of this report. The strength design of anchors must comply with ACI 318 D.4.1, except as required in ACI 318 D.3.3.

Strength reduction factors, ϕ, as given in ACI 318 D.4.4 must be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC and Section 9.2 of ACI 318. Strength reduction factors, ϕ, as given in ACI 318 D.4.5 must be used for load combinations calculated in accordance with ACI 318 Appendix C.

The value of f'_c used in the calculations must be limited to 8,000 psi (55.2 MPa), maximum, in accordance with ACI 318 D.3.5. Strength reduction factors, ϕ, corresponding to ductile steel elements may be used for this anchor. A design example according to the 2009 IBC is given in Figure 6 of this report.

4.1.1 Requirements for Static Steel Strength in Tension: The nominal steel strength of a single anchor in tension, N_{sa}, in accordance with ACI 318 D.5.1.2, is given in Table 2 of this report. The strength reduction factor, ϕ, corresponding to a ductile steel element must be used as described in Table 2 of this report.

4.1.2 Requirements for Static Concrete Breakout Strength in Tension: The nominal concrete breakout strength of a single anchor or group of anchors in tension, N_{cb} and N_{cbg}, must be calculated in accordance with ACI 318 D.5.2, with modifications as described in this section. The basic concrete breakout strength in tension, N_b, must be calculated in accordance with ACI 318 D.5.2.2 using the values of h_{ef} and k_{cr} as described in Table 2 of this report. The nominal concrete breakout strength in tension, N_{cb} or N_{cbg}, in regions of a concrete member where analysis indicates no cracking at service loads in accordance with ACI 318 D.5.2.6, must be calculated with the value of k_{uncr} as given in Table 2 of this report and with $\Psi_{c,N}$ = 1.0, as described in Table 2.

For anchors installed in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 4, determination of the concrete breakout strength in accordance with ACI 318 D.5.2 is not required.

4.1.3 Requirements for Static Pullout Strength in Tension: The nominal pullout strength of a single anchor in tension in accordance with ACI 318 D.5.3 in cracked and uncracked concrete, $N_{p,cr}$ and $N_{p,uncr}$, is given in Table 2 of this report. Where analysis indicates no cracking at service load levels in accordance with ACI 318 D.5.3.6, the nominal pullout strength in uncracked concrete, $N_{p,uncr}$, applies. Where values for $N_{p,cr}$ or $N_{p,uncr}$ are not provided in Table 2, the pullout strength does not need to be considered. In lieu of ACI 318 D.5.3.6, $\Psi_{c,p}$ = 1.0 for all design cases. The nominal pullout strengths must be adjusted for concrete strengths according to Eq-1:

$$N_{p,f'c} = N_{p,cr/uncr}\left(\frac{f'_c}{2{,}500}\right)^n \quad \text{(lb, psi)} \qquad \text{(Eq-1)}$$

$$N_{p,f'c} = N_{p,cr/uncr}\left(\frac{f'_c}{17.2}\right)^n \quad \text{(N, MPa)}$$

where f'_c is the specified compressive strength and n is the factor defining the influence of concrete strength on the pullout strength. For the stainless steel $^3/_8$-inch-diameter anchor, n is 0.3. For all other cases, n is 0.5.

The pullout strength in cracked and uncracked concrete for anchors installed in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 4, is given in Table 4. The nominal pullout strength in cracked concrete must be adjusted for concrete strength according to Eq-1, using the value of $N_{p,deck,cr}$ in lieu of $N_{p,cr}$, and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. Where analysis indicates no cracking at service load levels in accordance with ACI 318 D.5.3.6, the nominal pullout strength in uncracked concrete must be adjusted for concrete strength according to Eq-1, using the value of $N_{p,deck,uncr}$ in lieu of $N_{p,uncr}$, and the value of 3,000 psi (20.7 MPa) must be substituted for the value of 2,500 psi (17.2 MPa) in the denominator. The value of $\Psi_{c,p}$ = 1.0 for all cases.

4.1.4 Requirements for Static Steel Strength in Shear: The nominal steel strength in shear, V_{sa}, of a single anchor in accordance with ACI 318 D.6.1.2, is given in Table 3 of this report and must be used in lieu of values derived by calculation from ACI 318, Eq. D-20. The strength reduction factor, ϕ, corresponding to a ductile steel element must be used for all anchors as described in Table 3 of this report.

The shear strength, $V_{st,deck}$, of anchors installed in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 4, is given in Table 4 of this report.

4.1.5 Requirements for Static Concrete Breakout Strength in Shear: The nominal concrete breakout strength of a single anchor or group of anchors in shear, V_{cb} or V_{cbg}, must be calculated in accordance with ACI 318 D.6.2, with modifications as described in this section. The basic concrete breakout strength in shear, V_b, must be calculated in accordance with ACI 318 D.6.2.2 using the values of ℓ_e and d_a provided in Table 3 of this report.

For anchors installed in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 4, calculation of the concrete breakout strength in accordance with ACI 318 D.6.2 is not required.

4.1.6 Requirements for Static Concrete Pryout Strength in Shear: The nominal concrete pryout strength of a single anchor or group of anchors in shear, V_{cp} or V_{cpg}, must be calculated in accordance with ACI 318 D.6.3, modified by using the value of k_{cp} described in Table 3 of this report and the value of N_{cb} or N_{cbg} as calculated in accordance with Section 4.1.2 of this report.

For anchors installed in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, as shown in Figure 4, calculation of the concrete pryout strength in accordance with ACI 318 D.6.3 is not required.

4.1.7 Requirements for Seismic Design:

4.1.7.1 General: For load combinations including seismic, the design must be performed in accordance with ACI 318 D.3.3, as modified by Section 1908.1.9 of the 2009 IBC, or Section 1908.1.16 of the 2006 IBC, or the following:

CODE	ACI 318 SECTION D.3.3 SEISMIC REGION	CODE EQUIVALENT DESIGNATION
2003 IBC and 2003 IRC	Moderate or high seismic risk	Seismic Design Categories C, D, E, and F

Except for anchors used under Seismic Design Categories A and B (IBC), design strengths must be determined presuming cracked concrete unless it can be demonstrated that it remains uncracked. The anchors comply with ACI 318 D.1 as ductile steel elements and must be designed in accordance with ACI 318-08 Section D.3.3.4, D.3.3.5 or D.3.3.6, or ACI 318-05 Section D.3.3.4 or D.3.3.5, as applicable.

4.1.7.2 Seismic Tension: The nominal steel strength and concrete breakout strength in tension must be calculated in accordance with ACI 318 D.5.1 and D.5.2, as described in Sections 4.1.1 and 4.1.2 of this report.

In accordance with ACI 318 D.5.3.2, the appropriate value for nominal pullout strength in tension for seismic loads, $N_{p,eq}$ or $N_{p,deck,cr}$, provided in Tables 2 and 4 of this report, must be used in lieu of N_p. If no values for $N_{p,eq}$ or $N_{p,deck,cr}$ are given in Table 2 or 4, the pullout strength for seismic loads need not be evaluated. The values of $N_{p,eq}$ or $N_{p,deck,cr}$ can be adjusted for concrete strength according to Section 4.1.3 Eq-1.

4.1.7.3 Seismic Shear: The nominal concrete breakout and concrete pryout strength for anchors in shear must be calculated in accordance with ACI 318 D.6.2 and D.6.3, as described in Sections 4.1.5 and 4.1.6 of this report. In accordance with ACI 318 D.6.1.2, the appropriate value for nominal steel strength in shear for seismic loads, $V_{sa,eq}$ or $V_{st,deck}$, provided in Tables 3 and 4 of this report, must be used in lieu of V_{sa}.

4.1.8 Requirements for Interaction of Tensile and Shear Forces: For loadings that include combined tension and shear, the design must be performed in accordance with ACI 318 D.7.

4.1.9 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 strength in tension for uncracked concrete, calculated according to ACI 318 D.5.2, must be further multiplied by the factor $\Psi_{cp,N}$ given by Eq-2:

$$\Psi_{cp,N} = \frac{c}{c_{ac}} \qquad \text{(Eq-2)}$$

where the factor $\Psi_{cp,N}$ need not be taken as less than $\frac{1.5h_{ef}}{c_{ac}}$. For all other cases, $\Psi_{cp,N} = 1.0$. In lieu of ACI 318 D.8.6, values of c_{ac} provided in Table 1 of this report must be used.

4.1.10 Requirements for Minimum Member Thickness, Minimum Anchor Spacing and Minimum Edge Distance: In lieu of ACI 318 D.8.3, values of c_{min} and s_{min} provided in Table 1 of this report must be used. In lieu of ACI 318 D.8.5, minimum member thickness, h_{min}, must be in accordance with Table 1 of this report.

For $^3/_8$-inch-diameter stainless steel Strong-Bolt™ 2 anchors, additional combinations for minimum edge distance c_{min} and minimum spacing s_{min} may be derived by linear interpolation between the boundary given in Table 1 and as shown in Figure 5 of this report.

For anchors installed in the soffit of steel deck assemblies, the anchors must be installed in accordance with Figure 4 and must have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

4.1.11 Structural Sand-lightweight Concrete: For ACI 318-08, when anchors are used in structural sand-lightweight concrete, the modification factor λ for concrete breakout must be taken as 0.6 in lieu of ACI 318 D.3.4. In addition, the pullout strength $N_{p,cr}$, $N_{p,uncr}$ and $N_{p,eq}$ must be multiplied by 0.60, as applicable.

For ACI 318-05, when anchors are used in structural sand-lightweight concrete, N_b, $N_{p,cr}$, $N_{p,uncr}$, N_{eq} and V_b determined in accordance with this report must be multiplied by 0.60, in lieu of ACI 318 D.3.4.

For anchors installed in the lower or upper flute of the soffit of structural sand-lightweight concrete filled profile steel deck floor and roof assemblies, this reduction is not required.

4.2 Allowable Stress Design (ASD):

4.2.1 General: Design values for use with allowable stress design load combinations calculated in accordance with Section 1605.3 of the IBC, must be established using the following equations:

$$T_{allowable,ASD} = \frac{\phi N_n}{\alpha}$$

and

$$V_{allowable,ASD} = \frac{\phi V_n}{\alpha}$$

where:

$T_{allowable,ASD}$ = Allowable tension load (lbf or N)

$V_{allowable,ASD}$ = Allowable shear load (lbf or N)

ϕN_n = The lowest design strength of an anchor or anchor group in tension as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

ϕV_n = The lowest design strength of an anchor or anchor group in shear as determined in accordance with ACI 318 Appendix D, Section 4.1 of this report, and 2009 IBC Section 1908.1.9 or 2006 IBC Section 1908.1.16, as applicable (lbf or N).

α = Conversion factor calculated as a weighted average of the load factors for the controlling load combination. In addition, α must include all applicable factors to account for nonductile failure modes and required over-strength.

The requirements for member thickness, edge distance and spacing, as described in this report, must apply. An example calculation for the derivation of allowable stress design tension values is presented in Table 5.

4.2.2 Interaction of Tensile and Shear Forces: The interaction of tension and shear loads must be consistent with ACI 318 D.7 as follows:

If $T_{applied} \leq 0.2T_{allowable,ASD}$, then the full allowable strength in shear, $V_{allowable,ASD}$, must be permitted.

If $V_{applied} \leq 0.2V_{allowable,ASD}$, then the full allowable strength in tension, $T_{allowable,ASD}$, must be permitted.

For all other cases: $\frac{T_{applied}}{T_{allowable,ASD}} + \frac{V_{applied}}{V_{allowable,ASD}} \leq 1.2$

4.3 Installation:

Installation parameters are provided in Table 1 and in Figures 2, 3 and 4. Anchor locations must comply with this report and the plans and specifications approved by the code official. The Strong-Bolt™ 2 must be installed in accordance with the manufacturer's published instructions and this report. Anchors must be installed in holes drilled into the concrete using carbide-tipped drill bits conforming to ANSI B212.15-1994. The nominal drill bit diameter must be equal to the nominal diameter of the anchor. The minimum drilled hole depth, h_o, is given in Table 1. The drilled hole must be cleaned, with all dust and debris removed using compressed air. The anchor, nut, and washer must be assembled so that the top of the nut is flush with the top of the anchor. The anchor must be driven into the hole using a hammer until the proper embedment depth is achieved. The nut and washer must be tightened against the base material or material to be fastened until the appropriate installation torque value specified in Table 1 is achieved.

For installation in the soffit of normal-weight or structural sand-lightweight concrete over profile steel deck floor and roof assemblies, the hole diameter in the steel deck must not exceed the diameter of the hole in the concrete by more than $^1/_8$ inch (3.2 mm). For edge distance and member thickness requirements for installations into the soffit of concrete over steel deck assemblies, see Figure 4. For installation in the soffit of structural sand-lightweight or normal-weight concrete over profile steel deck floor and roof assemblies, torque must be applied until the appropriate installation torque value specified in Table 4 is achieved.

4.4 Special Inspection:

Special inspection is required in accordance with Section 1704.15 of the 2009 IBC, or Section 1704.13 of the 2006 or 2003 IBC. The special inspector must make periodic inspections during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, drill-bit type, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, concrete member thickness, anchor embedment, tightening torque and adherence to the manufacturer's published installation instructions. The special inspector must be present as often as required by the "statement of special inspection." Under the IBC, additional requirements as set forth in Sections 1705, 1706 and 1707 must be observed, where applicable.

5.0 CONDITIONS OF USE

The Simpson Strong-Tie Strong Bolt™ 2 Wedge Anchor described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The anchors must be installed in accordance with the manufacturer's published installation instructions and this report. In case of a conflict, this report governs.

5.2 Anchor sizes, dimensions and minimum embedment depths are as set forth in this report.

5.3 The anchor must be installed in cracked and uncracked normal-weight and structural sand-lightweight concrete having a specified compressive strength, f'_c, of 2,500 psi to 8,500 psi (17.2 MPa to 58.6 MPa); and in cracked and uncracked structural sand-lightweight or normal-weight concrete over profile steel deck having a minimum specified compressive strength, f'_c, of 3,000 psi (20.7 MPa).

5.4 The value of f'_c used for calculation purposes must not exceed 8,000 psi (55.2 MPa).

5.5 Strength design values must be established in accordance with Section 4.1 of this report.

5.6 Allowable stress design values are established in accordance with Section 4.2 of this report.

5.7 Anchor spacing and edge distance, as well as minimum member thickness, must comply with Tables 1 and 4, and Figures 4 and 5, of this report.

5.8 Prior to anchor 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 statutes of the jurisdiction in which the project is to be constructed.

5.9 Since an ICC-ES acceptance criteria for evaluating data to determine the performance of expansion anchors subjected to fatigue or shock loading is unavailable at this time, the use of these anchors under such conditions is beyond the scope of this report.

5.10 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.

5.11 Anchors may be used to resist short-term loading due to wind or seismic forces, subject to the conditions of this report.

5.12 Where not otherwise prohibited in the code, Strong-Bolt™ 2 anchors are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchors are used to resist wind or seismic forces only.
- 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.
- Anchors are used to support nonstructural elements.

5.13 Use of zinc-plated carbon steel anchors is limited to dry, interior locations.

5.14 Special inspection must be provided in accordance with Section 4.4 of this report.

5.15 The anchors are manufactured by Simpson Strong-Tie Company, Inc., under an approved quality control program with inspections by CEL Consulting (AA-639).

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193), dated February 2010, including optional suitability tests for seismic tension and shear; and profile steel deck soffit tests.

6.2 Quality Control Documentation.

7.0 IDENTIFICATION

The Strong-Bolt™ 2 anchors are identified in the field by dimensional characteristics, head stamp, and packaging. The Strong-Bolt™ 2 anchor has the Simpson Strong-Tie Company, Inc., No Equal logo ≠ stamped on the expansion clip, and a length identification code embossed on the exposed threaded end. Table 6 shows the length identification codes. The packaging label bears the manufacturer's name and contact information, anchor name, anchor size and length, quantity, the evaluation report number (ICC-ES ESR-3037), and the name of the inspection agency (CEL Consulting).

TABLE 1—STRONG-BOLT™2 INSTALLATION INFORMATION[1]

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR SIZE								
			Carbon Steel							Stainless Steel	
			3/8 inch		1/2 inch			5/8 inch		3/8 inch	
Installation Information											
Nominal Diameter	d_a[3]	in.	3/8		1/2			5/8		3/8	
Drill Bit Diameter	d	in.	3/8		1/2			5/8		3/8	
Baseplate Clearance Hole Diameter[2]	d_c	in. (mm)	7/16 (11.1)		9/16 (14.3)			11/16 (17.5)		7/16 (11.1)	
Installation Torque	T_{inst}	ft-lbf (N-m)	30 (40.7)		60 (81.3)			90 (122.0)		30 (40.7)	
Nominal Embedment Depth	h_{nom}	in. (mm)	2 (51)	2 7/8 (73)	2 3/4 (70)		3 7/8 (98)	3 3/8 (86)	5 1/8 (130)	2 (51)	2 7/8 (73)
Effective Embedment Depth	h_{ef}	in. (mm)	1 5/8 (41)	2 1/2 (64)	2 1/4 (57)		3 3/8 (86)	2 3/4 (70)	4 1/2 (114)	1 5/8 (41)	2 1/2 (64)
Minimum Hole Depth	h_o	in. (mm)	2 1/4 (57)	3 1/8 (79)	3 (76)		4 1/8 (105)	3 5/8 (92)	5 3/8 (137)	2 1/4 (57)	3 1/8 (79)
Minimum Overall Anchor Length	ℓ_{anch}	in. (mm)	2 3/4 (70)	3 1/2 (89)	3 3/4 (95)		5 1/2 (140)	4 1/2 (114)	6 (152)	2 3/4 (70)	3 1/2 (89)
Critical Edge Distance	c_{ac}	in. (mm)	6 1/2 (165)	6 (152)	6 1/2 (165)	6 1/2 (165)	7 1/2 (191)	7 1/2 (191)	9 (229)	6 1/2 (165)	8 1/2 (216)
Minimum Edge Distance	c_{min}	in. (mm)	6 (152)		7 (178)	4 (102)	4 (102)	6 1/2 (165)		6 (152)	
	for s ≥	in. (mm)	- -		- -	- -	- -	- -		10 (254)	
Minimum Spacing	s_{min}	in. (mm)	3 (76)		7 (178)	4 (102)	4 (102)	5 (127)		3 (76)	
	for c ≥	in. (mm)	- -		- -	- -	- -	- -		10 (254)	
Minimum Concrete Thickness	h_{min}	in. (mm)	3 1/4 (83)	4 1/2 (114)	4 1/2 (114)	5 1/2 (140)	6 (152)	5 1/2 (140)	7 7/8 (200)	3 1/4 (83)	4 1/2 (114)
Additional Data											
Yield Strength	f_{ya}	psi (MPa)	92,000 (634)		85,000 (586)					80,000 (552)	
Tensile Strength	f_{uta}[4]	psi (MPa)	115,000 (793)							100,000 (689)	
Minimum Tensile and Shear Stress Area	A_{se}	in^2 (mm^2)	0.0514 (33)		0.105 (68)			0.166 (107)		0.0514 (33)	
Axial Stiffness in Service Load Range - Cracked and Uncracked Concrete	β	lb./in (N/mm)	34,820 (6,098)		63,570 (11,133)			91,370 (16,001)		29,150 (5,105)	

For **SI:** 1 inch = 25.4 mm, 1 ft-lbf = 1.356 N-m, 1 psi = 6.89 Pa, 1 in^2 = 645 mm2, 1 lbf/in = 0.175 N/mm.

[1]The information presented in this table is to be used in conjunction with the design criteria of ACI 318 Appendix D.

[2]The clearance must comply with applicable code requirements for the connected element.

[3]For the 2006 IBC d_o replaces d_a.

[4]For the 2003 IBC f_{ut} replaces f_{uta}.

TABLE 2—STRONG-BOLT™2 TENSION STRENGTH DESIGN DATA[1]

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER							
			Carbon Steel						Stainless Steel	
			$^3/_8$ inch		$^1/_2$ inch		$^5/_8$ inch		$^3/_8$ inch	
Anchor Category	1,2 or 3	-	1						1	
Nominal Embedment Depth	h_{nom}	in.	2	$2^7/_8$	$2^3/_4$	$3^7/_8$	$3^3/_8$	$5^1/_8$	2	$2^7/_8$
		(mm)	(51)	(73)	(70)	(98)	(86)	(130)	(51)	(73)
Steel Strength in Tension (ACI 318 Section D.5.1)										
Steel Strength in Tension	N_{sa}	lb	5,600		12,100		19,070		5,140	
		(kN)	(24.9)		(53.8)		(84.8)		(22.9)	
Strength Reduction Factor - Steel Failure[2]	ϕ_{sa}	-	0.75						0.75	
Concrete Breakout Strength in Tension (ACI 318 Section D.5.2)										
Effective Embedment Depth	h_{ef}	in.	$1^5/_8$	$2^1/_2$	$2^1/_4$	$3^3/_8$	$2^3/_4$	$4^1/_2$	$1^5/_8$	$2^1/_2$
		(mm)	(41)	(64)	(57)	(86)	(70)	(114)	(41)	(64)
Critical Edge Distance	c_{ac}	in.	$6^1/_2$	6	$6^1/_2$	$7^1/_2$	$7^1/_2$	9	$6^1/_2$	$8^1/_2$
		(mm)	(165)	(152)	(165)	(191)	(191)	(229)	(165)	(216)
Effectiveness Factor - Uncracked Concrete	k_{uncr}	-	24		24		24		24	
Effectiveness Factor - Cracked Concrete	k_{cr}	-	17		17		17		17	
Modification Factor	$\psi_{c,N}$[8]	-	1.00		1.00		1.00		1.00	
Strength Reduction Factor - Concrete Breakout Failure[3]	ϕ_{cb}	-	0.65						0.65	
Pull-Out Strength in Tension (ACI 318 Section D.5.3)										
Pull-Out Strength Cracked Concrete (f'_c = 2500 psi)	$N_{p,cr}$	lb	1,300[5]	2,775[5]	N/A[4]	3,735[5]	N/A[4]	6,895[5]	1,720[6]	3,145[6]
		(kN)	(5.8)[5]	(12.3)[5]	-	(16.6)[5]	-	(30.7)[5]	(7.7)[6]	(14.0)[6]
Pull-Out Strength Uncracked Concrete (f'_c = 2500 psi)	$N_{p,uncr}$	lb	N/A[4]	3,340[5]	3,615[5]	5,255[5]	N/A[4]	9,025[5]	N/A[4]	4,770[6]
		(kN)	-	(14.9)[5]	(16.1)[5]	(23.4)[5]	-	(40.1)[5]	-	(21.2)[6]
Strength Reduction Factor - Pullout Failure[7]	ϕ_p	-	0.65						0.65	
Tensile Strength for Seismic Applications (ACI Section D.3.3.3)										
Tension Resistance of Single Anchor for Seismic Loads (f'_c = 2500 psi)	$N_{p,eq}$	lb	1,300[5]	2,775[5]	N/A[4]	3,735[5]	N/A[4]	6,895[5]	1,720[6]	2,830[6]
		(kN)	(5.8)[5]	(12.3)[5]	-	(16.6)[5]	-	(30.7)[5]	(7.7)[6]	(12.6)[6]
Strength Reduction Factor - Pullout Failure[7]	ϕ_{eq}	-	0.65						0.65	

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

[1]The information presented in this table must be used in conjunction with the design criteria of ACI 318 Appendix D.

[2]The tabulated value of ϕ_{sa} applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{sa} must be determined in accordance with ACI 318 D.4.5. Strong-Bolt™ 2 anchors are ductile steel elements as defined in ACI 318 D.1.

[3]The tabulated value of ϕ_{cb} applies when both the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided. For installations where complying supplementary reinforcement can be verified, the ϕ_{cb} factors described in ACI 318 D.4.4 for Condition A are allowed. If the load combinations of ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4 for Condition A are met, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.4(c). If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.5(c).

[4]As described in Section 4.1.3 of this report, N/A (Not Applicable) denotes that pullout resistance does not need to be considered.

[5]The characteristic pull-out strength for greater concrete compressive strengths must be increased by multiplying the tabular value by $(f'_c / 2{,}500\text{psi})^{0.5}$ or $(f'_c / 17.2\text{MPa})^{0.5}$.

[6]The characteristic pull-out strength for greater concrete compressive strengths must be increased by multiplying the tabular value by $(f'_c / 2{,}500\text{psi})^{0.3}$ or $(f'_c / 17.2\text{MPa})^{0.3}$.

[7]The tabulated value of ϕ_p or ϕ_{eq} applies when the load combinations of IBC Section 1605.2.1 or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5(c).

[8]For the 2003 IBC Ψ_3 replaces $\Psi_{c,N}$.

TABLE 3—STRONG-BOLT™2 SHEAR STRENGTH DESIGN DATA[1]

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER							
			Carbon Steel						Stainless Steel	
			$^{3}/_{8}$ inch		$^{1}/_{2}$ inch		$^{5}/_{8}$ inch		$^{3}/_{8}$ inch	
Anchor Category	1,2 or 3	-	1						1	
Nominal Embedment Depth	h_{nom}	in. (mm)	2 (51)	$2^{7}/_{8}$ (73)	$2^{3}/_{4}$ (70)	$3^{7}/_{8}$ (98)	$3^{3}/_{8}$ (86)	$5^{1}/_{8}$ (130)	2 (51)	$2\ ^{7}/_{8}$ (73)
Steel Strength in Shear (ACI 318 Section D.6.1)										
Shear Resistance of Steel	V_{sa}	lb (kN)	1,800 (8.0)		7,235 (32.2)		11,035 (49.1)		3,085 (13.7)	
Strength Reduction Factor - Steel Failure[2]	ϕ_{sa}	-	0.65						0.65	
Concrete Breakout Strength in Shear (ACI 318 Section D.6.2)										
Outside Diameter	d_a[5]	in. (mm)	0.375 (9.5)		0.500 (12.7)		0.625 (15.9)		0.375 (9.5)	
Load Bearing Length of Anchor in Shear	ℓ_e	in. (mm)	1.625 (41)	2.500 (64)	2.250 (57)	3.375 (86)	2.750 (70)	4.500 (114)	1.625 (41)	2.500 (64)
Strength Reduction Factor - Concrete Breakout Failure[3]	ϕ_{cb}	-	0.70						0.70	
Concrete Pryout Strength in Shear (ACI 318 Section D.6.3)										
Coefficient for Pryout Strength	k_{cp}	-	1.0	2.0	1.0	2.0	2.0		1.0	2.0
Effective Embedment Depth	h_{ef}	in. (mm)	$1^{5}/_{8}$ (41)	$2^{1}/_{2}$ (64)	$2^{1}/_{4}$ (57)	$3^{3}/_{8}$ (86)	$2^{3}/_{4}$ (70)	$4^{1}/_{2}$ (114)	$1^{5}/_{8}$ (41)	$2^{1}/_{2}$ (64)
Strength Reduction Factor - Concrete Pryout Failure[4]	ϕ_{cp}	-	0.70						0.70	
Steel Strength in Shear for Seismic Applications (ACI 318 Section D.3.3.3)										
Shear Strength of Single Anchor for Seismic Loads (f'_c = 2500 psi)	V_{eq}	lb (kN)	1,800 (8.0)		6,510 (29.0)		9,930 (44.2)		3,085 (13.7)	
Strength Reduction Factor - Steel Failure[2]	ϕ_{sa}	-	0.65						0.65	

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

[1]The information presented in this table must be used in conjunction with the design criteria of ACI 318 Appendix D.

[2]The tabulated value of ϕ_{sa} applies when the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of or ACI 318 Appendix C are used, the appropriate value of ϕ_{sa} must be determined in accordance with ACI 318 D.4.5. Strong-Bolt™ 2 anchors are ductile steel elements as defined in ACI 318 D.1.

[3]The tabulated value of ϕ_{cb} applies when both the load combinations of Section 1605.2.1 of the IBC, or ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. Condition B applies where supplementary reinforcement is not provided. For installations where complying supplementary reinforcement can be verified, the ϕ_{cb} factors described in ACI 318 D.4.4 for Condition A are allowed. If the load combinations of ACI 318 Section 9.2 are used and the requirements of ACI 318 D.4.4 for Condition A are met, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.4(c). If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{cb} must be determined in accordance with ACI 318 D.4.5(c).

[4]The tabulated value of ϕ_{cp} applies when the load combinations of IBC Section 1605.2.1 or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are met. If the load combinations of ACI 318 Appendix C are used, the appropriate value of ϕ_{cp} must be determined in accordance with ACI 318 D.4.5(c).

[5]For the 2006 IBC d_o replaces d_a.

TABLE 4—STRONG-BOLT™2 TENSION AND SHEAR STRENGTH DESIGN DATA FOR THE SOFFIT OF CONRETE OVER PROFILE STEEL DECK, FLOOR AND ROOF ASSEMBLIES[1,2,6]

CHARACTERISTIC	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER										
			Carbon Steel								Stainless Steel		
			Lower Flute						Upper Flute		Lower Flute		Upper Flute
			3/8 inch		1/2 inch		5/8 inch		3/8 inch	1/2 inch	3/8 inch		3/8 inch
Embedment Depth	h_{nom}	in.	2	3 3/8	2 3/4	4 1/2	3 3/8	5 5/8	2	2 3/4	2	3 3/8	2
		(mm)	(51)	(86)	(70)	(114)	(86)	(143)	(51)	(70)	(51)	(86)	(51)
Effective Embedment Depth	h_{ef}	in.	1 5/8	3	2 1/4	4	2 3/4	5	1 5/8	2 1/4	1 5/8	3	1 5/8
		(mm)	(41)	(76)	(57)	(102)	(70)	(127)	(41)	(57)	(41)	(76)	(41)
Installation Torque	T_{inst}	ft-lbf	30		60		90		30	60	30		30
		(N-m)	(40.7)		(81.3)		(122.0)		(40.7)	(81.3)	(40.7)		(40.7)
Pullout Strength, concrete on metal deck (cracked)[3]	$N_{p,deck,cr}$	lb	1,250[7]	2,230[7]	2,040[7]	2,730[7]	2,615[7]	4,990[7]	1,610[7]	3,785[7]	1,120[8]	2,795[8]	1,410[8]
		(kN)	(5.6)[7]	(9.9)[7]	(9.1)[7]	(12.1)[7]	(11.6)[7]	(22.2)[7]	(7.2)[7]	(16.8)[7]	(5.0)[8]	(12.4)[8]	(6.3)[8]
Pullout Strength, concrete on metal deck (uncracked)[4]	$N_{p,deck,uncr}$	lb	1,765[7]	3,150[7]	2,580[7]	3,840[7]	3,685[7]	6,565[7]	2,275[7]	4,795[7]	1,580[8]	3,950[8]	1,990[8]
		(kN)	(7.9)[7]	(14.0)[7]	(11.5)[7]	(17.1)[7]	(16.4)[7]	(29.2)[7]	(10.1)[7]	(21.3)[7]	(7.0)[8]	(17.6)[8]	(8.9)[8]
Steel Strength in Shear, concrete on metal deck[5]	$V_{st.deck}$	lb	1,595	3,490	2,135	4,580	2,640	7,000	4,060	5,920	2,285	3,785	3,830
		(kN)	(7.1)	(15.5)	(9.5)	(20.4)	(11.7)	(31.1)	(18.1)	(26.3)	(10.2)	(16.8)	(17.0)

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

[1]Installation must comply with Section 4.3 and Figure 4.

[2]Profile steel deck must comply with Figure 4 and Section 3.3 of this report.

[3]The values must be used in accordance with Section 4.1.3 and 4.1.7.2 of this report.

[4]The values must be used in accordance with Section 4.1.3 of this report.

[5]The values must be used in accordance with Section 4.1.4 and 4.1.7.3 of this report.

[6]The minimum anchor spacing along the flute must be the greater of $3h_{ef}$ or 1.5 times the flute width.

[7]The characteristic pull-out strength for greater concrete compressive strengths must be increased by multiplying the tabular value by $(f'_c / 3{,}000psi)^{0.5}$ or $(f'_c / 20.7MPa)^{0.5}$.

[8]The characteristic pull-out strength for greater concrete compressive strengths must be increased by multiplying the tabular value by $(f'_c / 3{,}000psi)^{0.3}$ or $(f'_c / 20.7MPa)^{0.3}$.

TABLE 5—EXAMPLE STRONG-BOLT™2 ALLOWABLE STRESS DESIGN TENSION VALUES FOR ILLUSTRATIVE PURPOSES[1,2,3,4,5,6,7,8,9]

Nominal Anchor Diameter (in.)	Embedment Depth (in.)	Effective Embedment Depth, h_{ef} (in.)	Allowable Tension Load, $T_{allowable}$ (lbs.)
Carbon Steel			
3/8	2	1 5/8	1,090
	2 7/8	2 1/2	1,465
1/2	2 3/4	2 1/4	1,585
	3 7/8	3 3/8	2,305*
5/8	3 3/8	2 3/4	2,400
	5 1/8	4 1/2	3,965
Stainless Steel			
3/8	2	1 5/8	1,090
	2 7/8	2 1/2	2,080

Design Assumptions:
1. Single Anchor.
2. Tension load only.
3. Concrete determined to remain uncracked for the life of the anchorage.
4. Load combinations taken from ACI 318 Section 9.2 (no seismic loading).
5. 30 percent Dead Load (D) and 70 percent Live Load (L); Controlling load combination is 1.2D + 1.6L. Calculation of a based on weighted average: α = 1.2D + 1.6L = 1.2(0.3) + 1.6(0.7) = 1.48.
6. Normal weight concrete with f'_c = 2,500 psi.
7. $c_{a1} = c_{a2} \geq c_{ac}$
8. Concrete thickness, $h \geq h_{min}$
9. Values are for Condition B (supplementary reinforcement in accordance with ACI 318 D.4.4 is not provided.)

*Illustrative Procedure (reference Table 2 of this report for design data):
Strong-Bolt™ 2: 1/2-inch diameter with an effective embedment depth, h_{ef} = 3 3/8".
Step 1: Calculate steel strength in tension in accordance with ACI 318 D.5.1;
$\phi_{sa}N_{sa}$ = 0.75 x 12,100 = 9,075 lbs.
Step 2: Calculate concrete breakout strength in tension in accordance with ACI 318 D.5.2;
$\phi_{cb}N_{cb}$ = 0.65 x 7,440 = 4,836 lbs.
Step 3: Calculate pullout strength in tension in accordance with ACI 318 D.5.3;
$\phi_p N_{p,uncr}$ = 0.65 x 5,255 = 3,416 lbs.
Step 4: The controlling value from Steps 1, 2, and 3 above in accordance with ACI 318 D.4.1.2;
ϕN_n = 3,416 lbs.
Step 5: Divide the controlling value by the conversion factor α as determined in footnote 5 and in accordance with Section 4.2.1 of this report;
$T_{allowable,ASD} = \phi N_n/\alpha$ = 3,416 / 1.48 = 2,305 lbs.

For single anchor and anchor groups, the edge distance, spacing and member thickness requirements in Table 1 of this report apply.

TABLE 6—LENGTH IDENTIFICATION HEAD MARKS ON STRONG-BOLT™2 ANCHORS (CORRESPONDS TO LENGTH OF ANCHOR – INCHES)

Mark	Units	A	B	C	D	E	F	G	H	I	J	K	L	M
From	in	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2
Up To But Not Including	in	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 /2	7	7 1/2	8

Mark	Units	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
From	in	8	8 /2	9	9 1/2	10	11	12	13	14	15	16	17	18
Up To But Not Including	in	8 1/2	9	9 1/2	10	11	12	13	14	15	16	17	18	19

FIGURE 1—STRONG-BOLT™ 2 WEDGE ANCHOR (CARBON STEEL VERSION)

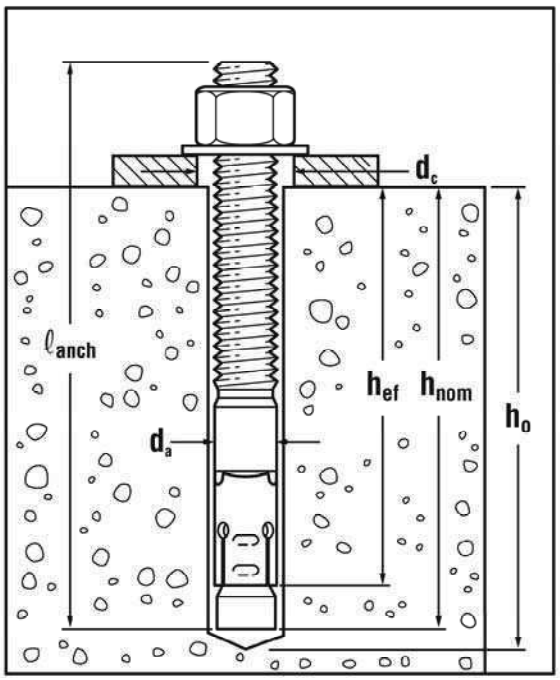


FIGURE 2—STRONG-BOLT™ 2 WEDGE ANCHOR INSTALLATION

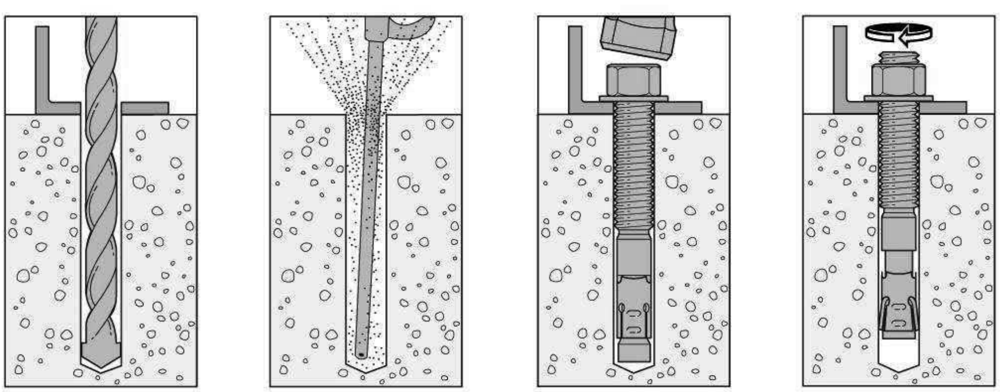


FIGURE 3—STRONG-BOLT™ 2 WEDGE ANCHOR INSTALLATION SEQUENCE

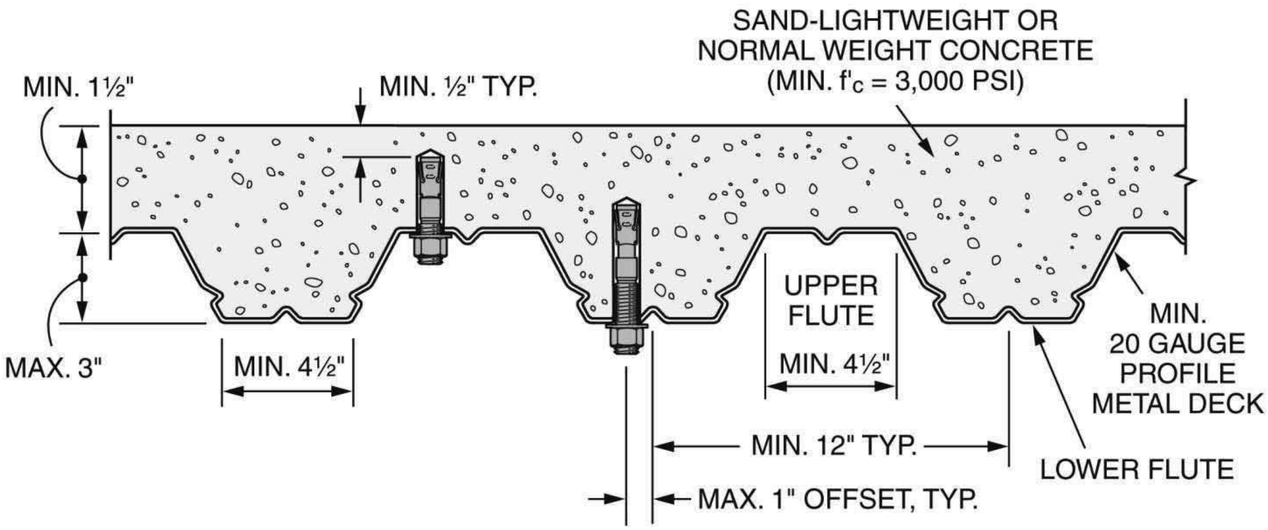


FIGURE 4—INSTALLATION IN THE SOFFIT OF CONCRETE OVER PROFILE STEEL DECK FLOOR AND ROOF ASSEMBLIES[1]

[1]Anchors may be placed in the upper flute or lower flute of the steel deck assembly provided a minimum $^1/_2$-inch concrete cover beyond the end of the anchor is provided. Anchors in the lower flute of Figure 4 may be installed with a maximum1-inch offset in either direction from the centerline of the flute.

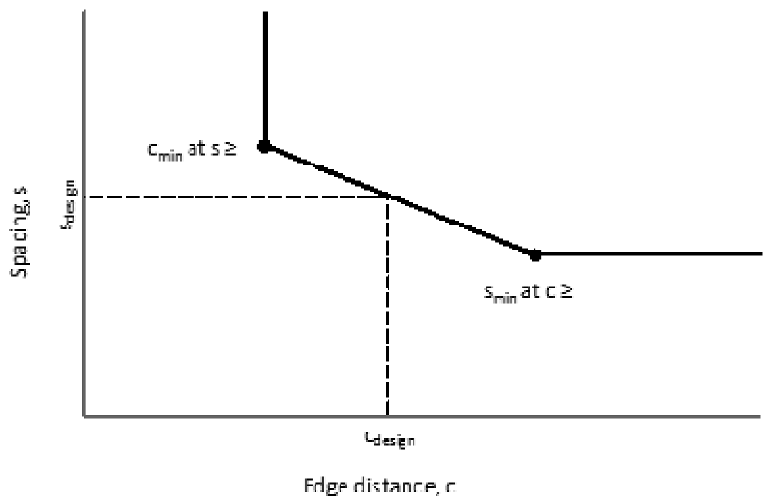
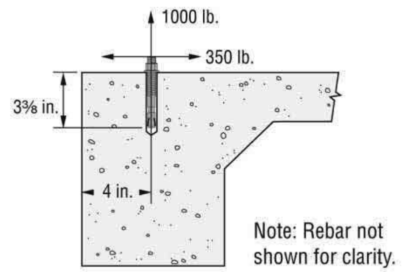


FIGURE 5—INTERPOLATION OF MINIMUM EDGE DISTANCE AND ANCHOR SPACING[1]

[1]Interpolation only valid for $^3/_8$-inch diameter stainless steel anchor. Spacing and edge distance combinations must fall on or above and to the right of the diagonal line.

Determine if a single ½ inch diameter Strong-Bolt™ 2 torque-controlled expansion anchor with a minimum 3⅞ inch embedment (h_{ef} = 3⅜ inches) installed 4 inches from the edge of a 12 inch deep spandrel beam is adequate for a service tension load of 1,000 lb. for wind and a reversible service shear load of 350 lb. for wind. The anchor will be in the tension zone, away from other anchors in f'_c = 3,000 psi normal-weight concrete.



	ACI 318-08 Code Ref.	Report Ref.
1. Determine the Factored Tension and Shear Design Loads:	*9.2.1*	
$N_{ua} = 1.6W = 1.6 \times 1{,}000 = 1{,}600$ lb.		
$V_{ua} = 1.6W = 1.6 \times 350 = 560$ lb.		
2. Steel Capacity under Tension Loading:	*D.5.1*	
$N_{sa} = 12{,}100$		*Table 2*
$\phi = 0.75$		*Table 2*
$n = 1$ (single anchor)		
Calculating for ϕN_{sa}:		
$\phi N_{sa} = 0.75 \times 1 \times 12{,}100 = 9{,}075$ lb.		
3. Concrete Breakout Capacity under Tension Loading:	*D.5.2*	
$N_{cb} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N} N_b$	*Eq. (D-4);*	
where:		
$N_b = k_c \lambda \sqrt{f'_c}\, h_{ef}^{1.5}$	*Eq. (D-7)*	
substituting:		
$\phi N_{cb} = \phi \frac{A_{Nc}}{A_{Nco}} \Psi_{ed,N}\Psi_{c,N}\Psi_{cp,N} k_c \lambda \sqrt{f'_c}\, h_{ef}^{1.5}$		
where:		
$k_c = k_{cr} = 17$		*Table 2*
$\lambda = 1.0$ for normal-weight concrete	8.6.1	
$\Psi_{cp,N} = 1.0$	*D.5.2.7*	
$\Psi_{ed,N} = 0.7 + 0.3 \frac{c_{a,min}}{1.5h_{ef}}$ when $c_{a,min} < 1.5\, h_{ef}$	*Eq. (D-11)*	
by observation, $c_{a,min} = 4 < 1.5h_{ef}$		
$\Psi_{ed,N} = 0.7 + 0.3 \frac{(4)}{1.5(3.375)} = 0.94$		
$\Psi_{c,N} = 1.0$ assuming cracking at service loads ($f_t > f_r$)	*D.5.2.6*	
$\phi = 0.65$ for Condition B (no supplementary reinforcement provided)		*Table 2*
$A_{Nco} = 9h_{ef}^2 = 9(3.375)^2 = 102.52$ in.^{2}	*Eq. (D-6)*	
$A_{Nc} = (c_{a1} + 1.5h_{ef})(2 \times 1.5h_{ef})$ $= (4 + 1.5(3.375))(2 \times 1.5(3.375)) = 91.76$ in.^{2}	*Fig. RD.5.2.1(a)*	
$\frac{A_{Nc}}{A_{Nco}} = \frac{91.76}{102.52} = 0.90$		
Calculating for ϕN_{cb}:		
$\phi N_{cb} = 0.65 \times 0.90 \times 0.94 \times 1.0 \times 1.0 \times 17 \times 1.0 \times \sqrt{3{,}000} \times (3.375)^{1.5} = 3{,}175$ lb.		

	ACI 318-08 Code Ref.	Report Ref.
4. Pullout Capacity:	*D.5.3*	
$N_{pn,cr} = 3{,}735 \times \left(\frac{3{,}000}{2{,}500}\right)^{0.5} = 4{,}091$ lb.		*Table 2*
$\phi = 0.65$		*Table 2*
$\phi N_{pn} = 0.65 \times 4{,}091 = 2{,}659$		
5. Check All Failure Modes under Tension Loading:	*D.4.1.2*	
Summary:		
Steel Capacity = 9,075 lb.		
Concrete Breakout Capacity = 3,175 lb.		
Pullout Capacity = 2,659 lb. ← **Controls**		
∴ ϕN_n = 2,659 lb. as Pullout Capacity controls > N_{ua} = 1,600 lb. – OK		
6. Steel Capacity under Shear Loading:	*D.6.1*	
$V_{sa} = 7{,}235$ lb.		*Table 3*
$\phi = 0.65$		*Table 3*
Calculating for ϕV_{sa}:		
$\phi V_{sa} = 0.65 \times 7{,}235 = 4{,}703$ lb.		
7. Concrete breakout Capacity under Shear Loading:	*D.6.2*	
$V_{cb} = \frac{A_{Vc}}{A_{Vco}} \Psi_{ed,V}\Psi_{c,V}\Psi_{h,V} V_b$	*Eq. (D-21)*	
where:		
$V_b = 7\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\, \lambda \sqrt{f'_c}\, c_{a1}^{1.5}$	*Eq. (D-24)*	
substituting:		
$\phi V_{cb} = \phi \frac{A_{Vc}}{A_{Vco}} \Psi_{ed,V}\Psi_{c,V}\Psi_{h,V} 7\left(\frac{\ell_e}{d_a}\right)^{0.2}\sqrt{d_a}\, \lambda \sqrt{f'_c}\, c_{a1}^{1.5}$		
where:		
$\phi = 0.70$ for Condition B (no supplementary reinforcement provided)		*Table 3*
$A_{Vco} = 4.5c_{a1}^2 = 4.5(4)^2 = 72$ in.^{2}	*Eq. (D-23)*	
$A_{Vc} = 2(1.5c_{a1})(1.5c_{a1}) = 2(1.5(4))(1.5(4)) = 72$ in.^{2}	*Fig. RD.6.2.1(a)*	
$\frac{A_{Vc}}{A_{Vco}} = \frac{72}{72} = 1$	*D.6.2.1*	
$\Psi_{ed,V} = 1.0$ since $c_{a2} > 1.5c_{a1}$	*Eq. (D-27)*	
$\Psi_{c,V} = 1.0$ assuming cracking at service loads ($f_t > f_r$)	*D.6.2.7*	
$h_a = 12$ in.		
$\Psi_{h,V} = 1.0$ since $h_a > 1.5c_{a1}$	*D.6.2.8*	
$d_a = 0.5$ in.		
$\ell_e = 3.375$ in.	*D.6.2.2*	
$\lambda = 1.0$ for normal-weight concrete	8.6.1	
$c_{a1} = 4$ in.		
$\phi V_{cb} = 0.70 \times 1 \times 1.0 \times 1.0 \times 1.0 \times 7 \times \left(\frac{3.375}{0.5}\right)^{0.2} \times \sqrt{0.5} \times 1.0 \times \sqrt{3{,}000} \times (4)^{1.5} = 2{,}224$ lb.		

FIGURE 6—STRONG-BOLT™ 2 EXAMPLE CALCULATION

	ACI 318-08 Code Ref.	Report Ref.
8. Concrete Pryout Strength:	*D.6.3*	
$V_{cp} = k_{cp} N_{cb}$	*Eq. (D-30)*	
where:		
$n = 1$		
$\phi = 0.70$		*Table 3*
$k_{cp} = 2.0$	*D.6.3.1*	
$k_{cp} N_{cb} = 2.0 \times \frac{3{,}175}{0.65} = 9{,}769$ lb.	*D.6.3.1*	
$\phi n V_{cp} = 0.70 \times 1 \times 9{,}769 = 6{,}838$ lb.		
9. Check All Failure Modes under Shear Loading:	*D.4.1.2*	
Summary:		
Steel Capacity = 4,703 lb.		
Concrete Breakout Capacity = 2,224 lb. ← **Controls**		
Pryout Capacity = 6,838 lb.		
∴ **ϕV_n = 2,224 lb. as Concrete Breakout Capacity controls > V_{ua} = 560 lb. – OK**		

	ACI 318-08 Code Ref.	Report Ref.
10. Check Interaction of Tension and Shear Forces:	*D.7*	
If $0.2\,\phi V_n \geq V_{ua}$, then the full tension design strength is permitted.	*D.7.1*	
By observation, this is not the case.		
If $0.2\,\phi N_n \geq N_{ua}$, then the full shear design strength is permitted	*D.7.2*	
By observation, this is not the case.		
Therefore:		
$\frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n} \leq 1.2$	*Eq. (D-32)*	
$\frac{1{,}600}{2{,}659} + \frac{560}{2{,}224} = 0.60 + 0.25 = 0.85 < 1.2$ – OK		

11. Summary

A single ½ in. diameter Strong-Bolt™ 2 anchor at a 3⅞ in. embedment depth is adequate to resist the applied service tension and shear loads of 1,000 lb. and 350 lb., respectively.

FIGURE 6—STRONG-BOLT™ 2 EXAMPLE CALCULATION (Continued)

SIMPSON Strong-Tie ANCHOR SYSTEMS

MECHANICAL ANCHORS - MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Retrofit Bolt, Blue Banger Hanger®, Crimp Anchor, Drop-In Anchor, Easy-Set Expansion Anchor, Heli-Tie® Helical Wall Tie, Hollow Wall Anchor, IXP™ Anchor, Lag Screw Expansion Shield, Machine Screw Anchor, Nailon Pin Drive Anchor, Plastic Screw Anchor, Sleeve-All® Anchor, Split Drive Anchor, Spring Wing Toggle Bolt, Strong-Bolt™ Wedge Anchor, Strong-Bolt™2 Wedge Anchor, Sure Wall Drywall Anchor/Toggle, Titen® Screw, Titen HD® Anchor, Torq-Cut™ Anchor, Wedge-All® Anchor

Company: Simpson Strong-Tie Company Inc.
Address: 5956 W. Las Positas Blvd.
Pleasanton, CA 94588 USA

Emergency Telephone Number: (24h) 1-800-535-5035 **USA/CANADA**
1-352-323-3500 **International**

Date Prepared or Revised: January 2011
For most current MSDS, please visit our web site at www.simpsonanchors.com

2. COMPOSITION / INFORMATION ON INGREDIENTS

Various Metals, Ferrous and Non-Ferrous Platings

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
None known.

POTENTIAL HEALTH EFFECTS

Eye Contact: Beware of airborne particles during installation.
Skin Contact: Sharp edges of anchors may cause abrasions or even cuts if not handled carefully.
Inhalation: Not considered an inhalation hazard.
Ingestion: Not considered to pose an ingestion hazard.
Systemic Effects: None known.

4. FIRST AID MEASURES

Inhalation: For over-exposure to airborne fumes and particulate, remove exposed person to fresh air. If breathing is difficult or has stopped, administer artificial respiration or oxygen as indicated. Seek medical attention promptly.
Eye Contact: Flush with large amounts of clean water to remove particles. Seek medical attention if irritation persists.
Skin Contact: Remove contaminated clothing. Wash affected areas with soap or mild detergent and water. If thermal burn has occurred, flush area with cold water and seek medical attention. If a persistent rash or irritation occurs, seek medical attention.
Ingestion: Not a probable route of industrial exposure. However, if ingested, seek medical attention immediately.

5. FIRE FIGHTING MEASURES

Not applicable.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Not Applicable.
Environmental Precautions: Not Applicable.
Clean-up Methods: Not Applicable.

7. HANDLING AND STORAGE

Handling Precautions: Operations with the potential for generating high concentrations of airborne particulates should be evaluated and controlled as necessary. Practice good housekeeping. Avoid breathing metal fumes and/or dust.

Storage Requirements: Store away from acids and incompatible materials.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Use controls as appropriate to minimize exposure to metal fumes and dusts during handling operations.

Protective Measure: Protective coatings are used on most metal fasteners. Typically this will be commercial zinc, zinc plating with chromate conversion coating, hot dipped galvanizing, ceramic plating, or mechanically galvanized plating. This information should be considered when evaluating employee personal protective equipment and health risks during normal use.

Eye Protection: Avoid contact with eyes. Safety glasses required.

Skin and Hand Protection: Gloves recommended.

Ingestion: Do not ingest or place any metal fasteners in mouth.

Respirator Protection: Not required in well ventilated areas.

9. PHYSICAL AND CHEMICAL PROPERTIES

Form: Solid

Appearance: Various diameters and lengths

Odor: None

Boiling Point: Not applicable

Melting Point: 2600-2700 ˚F

Vapor Pressure: Not applicable

Vapor Density: Not applicable

Solubility In Water: Insoluble

10. STABILITY AND REACTIVITY

Stability: Stable

Incompatibility: Acid

Hazardous Decomposition Products: Thermal oxidative decomposition of galvanized steel products can produce fumes containing oxides of zinc, iron and manganese as well as other elements.

Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity:

Oral (LD_{50}, Rat): Not established.

Dermal (LD_{50}, Rabbit): Not established.

Inhalation (LC_{50}, Rat): Not established.

12. ECOLOGICAL INFORMATION

Ecotoxicity: This product has not been evaluated.

Chemical Fate Information: No data available.

13. DISPOSAL CONSIDERATIONS

Disposal: This material is not a hazardous waste by RCRA criteria (40 CFR 261). Steel scrap should be recycled whenever possible.

Container Cleaning and Disposal: Follow applicable Federal, state and local regulations. Observe safe handling precautions.

14. TRANSPORTATION INFORMATION

DOT/TDG: Not Regulated For Transport.
IATA: Not Regulated For Transport.
IMO: Not Regulated For Transport.

15. REGULATORY INFORMATION

US FEDERAL REGULATIONS:

EPA Reportable Quantities:

Clean Water Act (40CFR Section 112): None required.
CERCLA Hazardous Substance (40CFR Part 302, Table 302.4): None required.
EPCRA Extreme Hazardous Substance (40CFR Section 302 Part 355): None required.

Toxic Chemical Release Inventory (TRI) Reporting - (SARA Title III Section 313 (40 CFR 372) Component(s) above 'de minimus' level): Manganese and Zinc are subject to SARA 313 reporting requirements.

SARA Title III Hazard Classes (40CFR 370 Sections 311 and 312):

Fire Hazard: No
Reactive Hazard: No
Release of Pressure: No
Acute Health Hazard: Yes
Chronic Health Hazard: Yes

US STATE REGULATIONS:

California - **"Safe Drinking Water and Toxic Enforcement Act" (Proposition 65):**
This product may contain chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

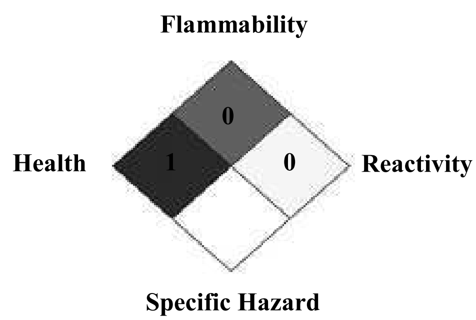
16. OTHER INFORMATION

HAZARD RATINGS:

Hazardous Material Information System (HMIS)

Health	1*
Flammability	0
Physical Hazard	0
Personal Protection	B

National Fire Protection Association (NFPA)



HMIS/NFPA Definitions: 0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme
Protective Equipment: (B) - Safety glasses, gloves

* Denotes possible chronic hazard if airborne dusts or fumes are generated.

This Material Safety Data Sheet (MSDS) is prepared by Simpson Strong-Tie Co. in compliance with the requirements of OSHA 29 CFR Part 1910.1200. The information it contains is offered in good faith as accurate as of the date of this MSDS. This MSDS is provided solely for the purpose of conveying health, safety, and environmental information. No warranty, expressed or implied, is given. Health and Safety precautions may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations.