MECHANICAL ANCHORS

Power-Stud+™ SD2 *Wedge Expansion Anchor*

PRODUCT DESCRIPTION

The Power-Stud+ SD2 anchor is a fully threaded, torque-controlled, wedge expansion anchor which is designed for consistent performance in cracked and uncracked concrete. Suitable base materials include normal-weight concrete, structural sand-lightweight concrete and concrete over steel deck. The anchor is manufactured with a zinc plated carbon steel body and stainless steel expansion clip for premium performance.

GENERAL APPLICATIONS AND USES

- Structural connections, i.e., beam and column anchorage
- Utility and safety-related attachments
- Interior applications / low level corrosion environment
- Tension zone applications, i.e., cable trays and strut, pipe supports, fire sprinklers
- Seismic and wind loading
- Medium to heavy duty purposes

FEATURES AND BENEFITS

+ Consistent performance in high and low strength concrete
+ Nominal drill bit size is the same as the anchor diameter
+ Anchor can be installed through standard fixture holes
+ Length ID code and identifying marking stamped on head of each anchor
+ Anchor design allows for follow-up expansion after setting under tensile loading

APPROVALS AND LISTINGS

International Code Council, Evaluation Service (ICC-ES), ESR-2502 for concrete
Code compliant with the 2009 IBC, 2009 IRC, 2006 IBC, 2006 IRC, 2003 IBC, 2003 IRC and 1997 UBC
Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI 318 (Strength Design method using Appendix D)
Evaluated and qualified by an accredited independent testing laboratory for recognition in cracked and uncracked concrete including seismic and wind loading (Category 1 anchors)
FM Global (Factory Mutual) - File No. 3033795, 3/8" and 1/2" diameters
Pipe hanger components for automatic sprinkler systems
Underwriters Laboratories (UL Listed) - File No. EX1289 - See listing.

GUIDE SPECIFICATIONS

CSI Divisions: *03151-Concrete Anchoring, Masonry Anchorage and 05090-Metal Fastenings.*
Expansion anchors shall be Power-Stud+ SD2 as supplied by Powers Fasteners, Inc., Brewster, NY. Anchors shall be installed in accordance with published instructions and the Authority Having Jurisdiction.

MATERIAL SPECIFICATIONS

Anchor component	Specification
Anchor body	Medium carbon steel
Hex nut	Carbon steel, ASTM A 563, Grade A
Washer	Carbon steel, ASTM F 844; meets dimensional requirements of ANSI B18.22.2, Type A Plain
Expansion wedge (clip)	Type 316 stainless steel
Plating (anchor body, nut and washer)	Zinc plating according to ASTM B 633, SC1, Type III (Fe/Zn 5) Minimum plating requirment for Mild Service Condition

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Power-Stud+ SD2 Assembly

THREAD VERSION

UNC threaded stud

ANCHOR MATERIALS

Zinc plated carbon steel body with stainless steel expansion clip, zinc plated carbon steel nut and washer

ANCHOR SIZE RANGE (TYP.)

3/8" diameter through 3/4" diameter

SUITABLE BASE MATERIALS

Normal-weight concrete
Structural sand-lightweight concrete
Concrete over steel deck
Grout-filled concrete masonry (CMU)

This Product Available In

PDA®

Powers Design Assist
Real Time Anchor Design Software
www.powersdesignassist.com

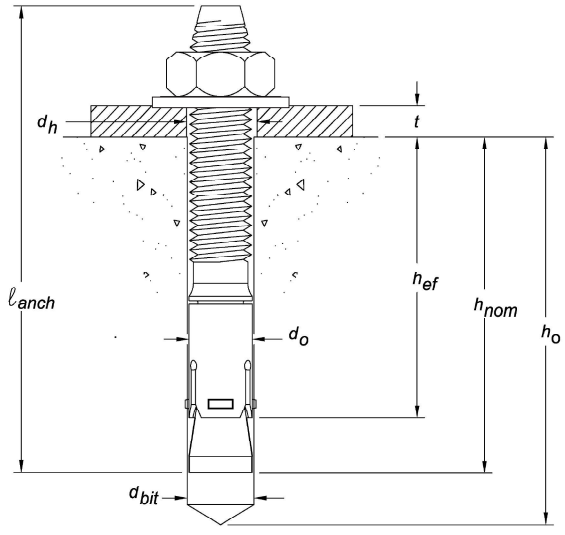
INSTALLATION SPECIFICATIONS

Installation Table for Power-Stud+ SD2[1]

Anchor Property/Setting Information	Notation	Units	Nominal Anchor Size									
			3/8"	1/2"			5/8"			3/4"		
Anchor diameter	d_o	in. (mm)	0.375 (9.5)	0.500 (12.7)			0.625 (15.9)			0.750 (19.1)		
Minimum diameter of hole clearance in fixture	d_h	in. (mm)	7/16 (11.1)	9/16 (14.3)			11/16 (17.5)			13/16 (20.6)		
Nominal drill bit diameter	d_{bit}	in.	3/8 ANSI	1/2 ANSI			5/8 ANSI			3/4 ANSI		
Minimum nominal embedment depth	h_{nom}	in. (mm)	2 3/8 (60)	2 1/2 (64)		3 3/4 (95)	3 7/8 (98)		4 7/8 (124)	4 1/2 (114)		5 3/4 (146)
Effective embedment	h_{ef}	in. (mm)	2 (51)	2 (51)		3 1/4 (83)	3 1/4 (83)		4 1/4 (108)	3 3/4 (95)		5 (127)
Minimum hole depth[1]	h_o	in. (mm)	2 5/8 (67)	2 3/4 (70)		4 (102)	4 1/4 (108)		5 1/4 (133)	4 3/4 (121)		6 (152)
Minimum concrete member thickness[1]	h_{min}	in. (mm)	4 (102)	4 1/2 (114)	6 (152)	5 3/4 (146)	5 3/4 (146)		6 1/2 (165)	8 (203)	7 (178)	10 (254)
Minimum overall anchor length	ℓ_{anch}	in. (mm)	3 (76.2)	3 3/4 (95)		4 1/2 (114)	4 3/4 (121)		6 (152)		6 1/4 (159)	7 (178)
Minimum edge distance[1]	c_{min}	in. (mm)	2 1/2 (63.5)	4 (102)	2 3/4 (70)	4 (102)	2 3/4 (70)	4 1/4 (108)		4 1/4 (108)	5 (127)	4 1/2 (114)
Minimum spacing distance[1]	s_{min}	in. (mm)	3 1/2 (88.9)	6 (152)	6 (152)	4 (102)	6 (152)	4 1/4 (108)		4 1/4 (108)	6 (152)	6 (152)
Critical edge distance[1]	c_{ac}	in. (mm)	6 1/2 (165.1)	8 (203)		10 (254)	8 (203)		15 3/4 (400)	10 (254)	12 (305)	12 (305)
Installation torque	T_{inst}	ft.-lb. (N-m)	20 (27)	40 (54)			60 (81)			110 (149)		
Torque wrench socket size	-	in.	9/16	3/4			15/16			1 1/8		
Nut height	-	in.	21/64	7/16			35/64			41/64		

1. For installations through the soffit of steel deck into concrete, see the installation detail. Anchors in the lower flute may be installed with a maximum 1-inch offset in either direction from center of the flute. In addition, anchors shall have an axial spacing along the flute equal to the greater of $3h_{ef}$ or 1.5 times the flute width.

Power-Stud+ SD2 Anchor Detail



Head Marking

Legend

Letter Code = Length Identification Mark

'+' Symbol = Strength Design Compliant Anchor

Number Code = Carbon Steel Body and Stainless Steel Expansion Clip

Length Identification

Mark	A	B	C	D	E	F	G	H	I	J
From	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"
Up to but not including	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"	6-1/2"

Mark	K	L	M	N	O
From	6-1/2"	7"	7-1/2"	8"	8-1/2"
Up to but not including	7"	7-1/2"	8"	8-1/2"	9"

Length identification mark indicates overall length of anchor.

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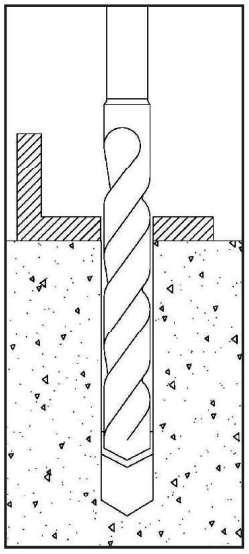
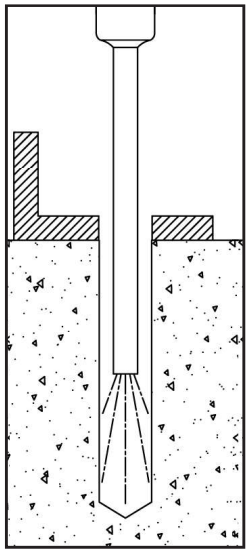
INSTALLATION INSTRUCTIONS

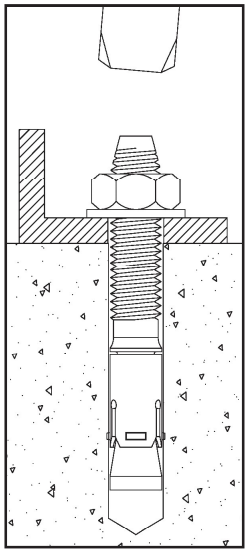
Installation Instructions for Power-Stud+ SD2



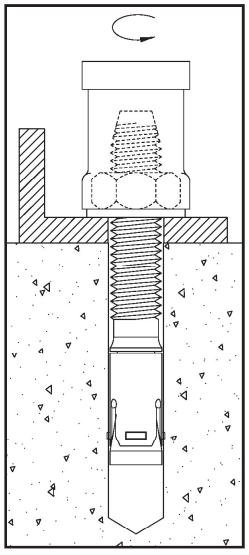
1.) *Using the proper drill bit size, drill a hole into the base material to the required depth. The tolerances of the drill bit used should meet the requirements of ANSI Standard B212.15.*



2.) *Remove dust and debris from the hole.*

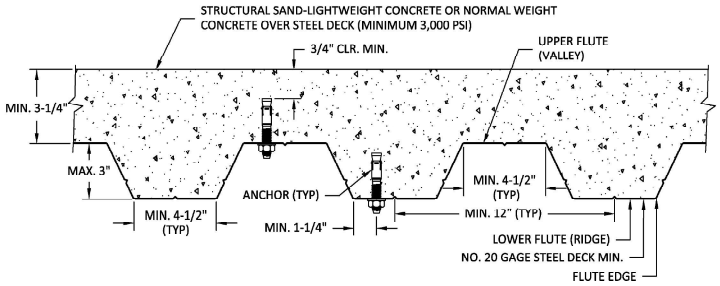


3.) *Position the washer on the anchor and thread on the nut. If installing through a fixture, drive the anchor through the fixture into the hole. Be sure the anchor is driven to the minimum required nominal embedment depth, h_{nom}*

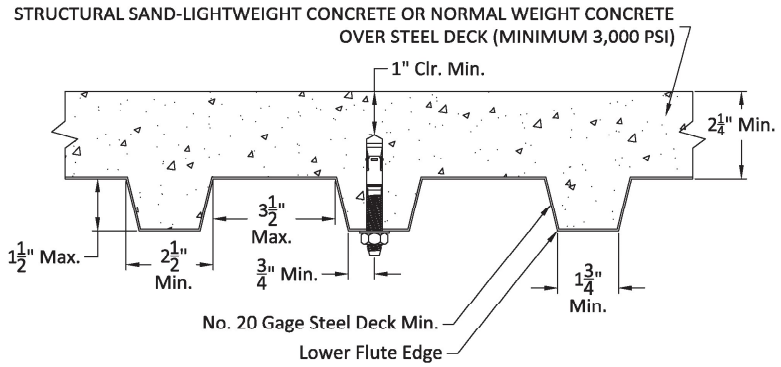


4.) *Tighten the anchor with a torque wrench by applying the required installation torque, T_{inst} .*

Installation Detail A: for Power-Stud+ SD2 Installed Through Soffit of Steel Deck into Concrete[1]



Installation Detail B: for Power-Stud+ SD2 Installed Through Soffit of Steel Deck into Concrete[2,3]



1. Anchors may be placed in the upper flute or lower flute of the steel deck profiles in accordance with installation Detail A provided the minimum hole clearance is satisfied. Anchors in the lower flute of installation Detail A profiles may be installed with a maximum 1-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

2. Anchors may be placed in the lower flute of the steel deck profiles in accordance with installation Detail B provided the minimum hole clearance is satisfied. Anchors in the lower flute of installation Detail B profiles may be installed with a maximum 1/8-inch offset in either direction from the center of the flute. The offset distance may be increased proportionally for profiles with lower flute widths greater than those shown provided the minimum lower flute edge distance is also satisfied.

3. Anchors may be placed in the upper flute of the steel deck profiles in accordance with installation Detail B provided the concrete thickness above the upper flute is minimum 3-1/4-inch a minimum hole clearance 3/4-inch is satisfied.

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PERFORMANCE DATA

Tension Design Information (For use with load combinations taken from ACI 318 Section 9.2)[1,2]

Design Characteristic	Notation	Units	Nominal Anchor Size							
			3/8"	1/2"		5/8"		3/4"		
Anchor category	1, 2 or 3	-	1	1		1		1		
STEEL STRENGTH IN TENSION[4]										
Minimum specified yield strength (neck)	f_y	ksi (N/mm²)	96.0 (662)	85.0 (586)		85.0 (586)		70.0 (483)		
Minimum specified ultimate strength (neck)	f_{uta}	ksi (N/mm²)	120.0 (827)	106.0 (731)		106.0 (731)		90.0 (620)		
Effective tensile stress area (neck)	A_{se}	in² (mm²)	0.0552 (35.6)	0.1007 (65.0)		0.1619 (104.5)		0.2359 (153.2)		
Steel strength in tension	N_{sa}	lb (kN)	6,625 (29.4)	10,445 (48.0)		13,080 (58.2)		21,230 (94.4)		
Reduction factor for steel strength[3]	ϕ	-	0.75							
CONCRETE BREAKOUT STRENGTH IN TENSION[8]										
Effective embedment	h_{ef}	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)	
Effectiveness factor for uncracked concrete	k_{uncr}	-	24	24		24		24		
Effectiveness factor for cracked concrete	k_{cr}	-	17	17		17		17		
Modification factor for cracked and uncracked concrete[5]	$\psi_{c,N}$	-	1.0 See note 5	1.0 See note 5		1.0 See note 5		1.0 See note 5		
Critical edge distance	c_{ac}	in. (mm)	8 (203)	8 (203)	10 (254)	8 (203)	15-3/4 (400)	12 (305)	12 (305)	
Reduction factor for concrete breakout strength[3]	ϕ	-	0.65 (Condition B)							
PULLOUT STRENGTH IN TENSION (NON-SEISMIC APPLICATIONS)[8]										
Characteristic pullout strength, uncracked concrete (2,500 psi)[6]	$N_{p,uncr}$	lb (kN)	2,775 (12.3)	See note 7	6,615 (29.4)	See note 7	See note 7	See note 7	See note 7	
Characteristic pullout strength, cracked concrete (2,500 psi)[6]	$N_{p,cr}$	lb (kN)	2,165 (9.6)	See note 7	4,375 (19.5)	See note 7	4,980 (22.4)	See note 7	7,795 (35.1)	
Reduction factor for pullout strength[3]	ϕ	-	0.65 (Condition B)							
PULLOUT STRENGTH IN TENSION FOR SEISMIC APPLICATIONS[8]										
Characteristic pullout strength, seismic[6,9]	N_{eq} ($N_{p,seis}$)	lb (kN)	2,165 (9.6)	See note 7	4,375 (19.5)	See note 7	4,980 (22.4)	See note 7	7,795 (35.1)	
Reduction factor for pullout strength[3]	ϕ	-	0.65 (Condition B)							
PULLOUT STRENGTH IN TENSION FOR STRUCTUAL SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK										
Characteristic pullout strength, cracked concrete over steel deck, according to Installation Detail A[10]	$N_{p,deck,uncr}$	lb (kN)	1,855 (8.3)	2,065 (9.2)	3,930 (17.5)	4,665 (20.8)	7,365 (32.8)	4,900 (21.8)		
Characteristic pullout strength, uncracked concrete over steel deck, according to Installation Detail A[10]	$N_{p,deck,cr}$	lb (kN)	1,445 (6.4)	1,465 (6.5)	2,600 (11.6)	3,305 (14.7)	3,490 (15.5)	3,470 (15.4)		
Characteristic pullout strength, uncracked concrete over steel deck, according to Installation Detail B[10]	$N_{p,deck,cr}$	lb (kN)	1,600 (5.6)	2,025 (6.4)	Not Applicable	Not Applicable	Not Applicable	Not Applicable		
Characteristic pullout strength, cracked concrete over steel deck, according to Installation Detail B[10]	$N_{p,deck,uncr}$	lb (kN)	1,250 (5.6)	1,435 (6.4)	Not Applicable	Not Applicable	Not Applicable	Not Applicable		
Reduction factor for pullout strength[3]	ϕ	-	0.65 (Condition B)							

1. The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of ACI 318 D.3.3 shall apply.
2. Installation must comply with published instructions and details.
3. All values of ϕ were determined from the load combinations of ACI 318 Section 9.2. If the load combinations of Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 D.4.5. For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318 D.4.4 for the appropriate ϕ factor.
4. The Power-Stud+ SD2 is considered a ductile steel element in tension as defined by ACI 318 D.1. Reported values for steel strength in tension are based on test results per ACI 355.2 and shall be used for design.
5. For all design cases use $\Psi_{c,N} = 1.0$. Select appropriate effectiveness factor for cracked concrete (k_{cr}) or uncracked concrete (k_{uncr}).
6. For all design cases use $\Psi_{c,P} = 1.0$. For concrete compressive strength greater than 2,500 psi, N_{pn} = (pullout strength value from table)*(specified concrete compressive strength/2500)^n. For concrete over steel deck the value of 2500 must be replaced with the value of 3000. For all anchors $n = 1/2$ with the *exception* of the 3/8" anchor size for cracked concrete where $n = 1/3$.
7. Pullout strength does not control design of indicated anchors. Do not calculate pullout strength for indicated anchor size and embedment.
8. Anchors are permitted to be used in structural sand-lightweight concrete provided that N_b, N_{eq} and N_{pn} are multiplied by a factor of 0.60 (not required for steel deck).
9. Reported values for characteristic pullout strength in tension for seismic applications are based on test results per ACI 355.2, Section 9.5.
10. Values for $N_{p,deck}$ are for structural sand-lightweight concrete ($f'_{c,min} = 3{,}000$ psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.5.2 is not required for anchors installed in the flute (soffit).

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PERFORMANCE DATA

Shear Design Information (For use with load combinations taken from ACI 318 Section 9.2)[1-2]

Design Characteristic	Notation	Units	Nominal Anchor Size						
			3/8"	1/2"	5/8"	3/4"			
Anchor category	1, 2 or 3	-	1	1	1	1			
STEEL STRENGTH IN SHEAR[4]									
Minimum specified yield strength (threads)	f_y	ksi (N/mm²)	76.8 (530)	68.0 (469)	68.0 (469)	56.0 (386)			
Minimum specified ultimate strength (threads)	f_{uta}	ksi (N/mm²)	96.0 (662)	84.8 (585)	84.8 (585)	72.0 (496)			
Effective tensile stress area (threads)	A_{se}	in² (mm²)	0.0775 (50.0)	0.1419 (65.7)	0.2260 (104.9)	0.3345 (215.8)			
Steel strength in shear[5]	V_{sa}	lb (kN)	2,190 (9.7)	4,640 (20.6)	9,800 (44.1)	10,175 (45.3)			
Reduction factor for steel strength[3]	ϕ	-	0.60	0.65					
CONCRETE BREAKOUT STRENGTH IN SHEAR[6]									
Load bearing length of anchor (h_{ef} or $8d_o$, whichever is less)	ℓ_e	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Reduction factor for concrete breakout strength[3]	ϕ	-	0.70 (Condition B)						
PRYOUT STRENGTH IN SHEAR[6]									
Coefficient for pryout strength (1.0 for $h_{ef} < 2.5$ in., 2.0 for $h_{ef} \geq 2.5$ in.)	k_{cp}	-	1.0	1.0	2.0	2.0	2.0	2.0	2.0
Effective embedment	h_{ef}	in. (mm)	2.00 (51)	2.00 (51)	3.25 (83)	3.25 (83)	4.25 (108)	3.75 (95)	5.00 (127)
Reduction factor for pryout strength[3]	ϕ	-	0.70 (Condition B)						
STEEL STRENGTH IN SHEAR FOR SEISMIC APPLICATIONS[6]									
Steel strength in shear, seismic[7]	V_{eq} ($V_{sa,seis}$)	lb (kN)	1,955 (8.7)	4,640 (20.6)	6,530 (29.0)	6,635 (29.5)			
Reduction factor for steel strength in shear, seismic[3]	ϕ	-	0.60	0.65					
STEEL STRENGTH IN SHEAR FOR STRUCTUAL SAND-LIGHTWEIGHT AND NORMAL-WEIGHT CONCRETE OVER STEEL DECK[9]									
Steel strength in shear, concrete over steel deck according to installation Detail A[8]	$V_{sa,deck}$	lb (kN)	2,170 (9.7)	3,815 (17.0)	5,040 (22.4)	4,015 (17.9)	6,670 (29.7)	4,325 (19.2)	
Steel strength in shear, concrete over steel deck, according to Installation Detail B[3]	$V_{sa,deck}$	lb (kN)	2,170 (9.7)	2,880 (12.8)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
Reduction factor for steel strength in shear for concrete over steel deck[3]	ϕ	-	0.60	0.65					

1. The data in this table is intended to be used with the design provisions of ACI 318 Appendix D; for anchors resisting seismic load combinations the additional requirements of AC 318 D.3.3 shall apply.
2. Installation must comply with published instructions and details.
3. All values of ϕ were determined from the load combinations of ACI 318 Section 9.2. If the load combinations of Appendix C are used, the appropriate value of ϕ must be determined in accordance with ACI 318 Section D.4.5. For reinforcement that meets ACI 318 Appendix D requirements for Condition A, see ACI 318 D.4.4 for the appropriate ϕ factor.
4. The Power-Stud+ SD2 is considered a ductile steel element as defined by ACI 318 D.1 with the exception of the 3/8" anchor size in shear.
5. Reported values for steel strength in shear are based on test results per ACI 355.2, Section 9.4 and shall be used for design. These reported values may be lower than calculated results using equation D-20 in ACI 318-05 D.6.1.2 and D-18 in ACI 318-02, D.6.1.2.
6. Anchors are permitted to used in structural sand-lightweight concrete provided that V_b and V_{cp} are multiplied by a factor of 0.60 (not required for steel deck).
7. Reported values for steel strength in shear for seismic applications are based on test results per ACI 355.2, Section 9.6.
8. Values for $V_{sa,\ deck}$ are for structual sand-lightweight concrete ($f'_{c,\ min}$ = 3,000 psi) and additional lightweight concrete reduction factors need not be applied. In addition, evaluation for the concrete breakout capacity in accordance with ACI 318 D.6.2 and the pryout capacity in accordance with ACI 318 D.6.3 are not required for anchors installed in the flute (soffit).
9. Shear loads for anchors installed through steel deck into concrete may be applied in any direction.

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