



FASTENING PRODUCTS

REQUEST FOR APPROVAL

**TO:**

NAME: \_\_\_\_\_ TITLE: \_\_\_\_\_

COMPANY: \_\_\_\_\_ PHONE: \_\_\_\_\_

FAX: \_\_\_\_\_ E-MAIL: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

FASTENER SUBSTITUTION	FASTENER RECOMMENDATION	ALTERNATIVE FASTENER
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Please review the attached technical data and approve the ( Part No. \_\_\_\_\_ ) for the following application(S) below:

**PROJECT:**

NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

SPECIFIED FASTENER: \_\_\_\_\_

FASTENING APPLICATION: \_\_\_\_\_

LOCATION: \_\_\_\_\_ DWG NO.: \_\_\_\_\_

SPECIFICATION REF: \_\_\_\_\_ DWG NO: \_\_\_\_\_ PAGE: \_\_\_\_\_ PARAGRAPH: \_\_\_\_\_

**SUBMITTED BY:**

NAME: \_\_\_\_\_

COMPANY: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

PHONE: \_\_\_\_\_

FAX: \_\_\_\_\_

E-MAIL: \_\_\_\_\_

DATE: \_\_\_\_\_

**FOR USE BY THE ENGINEER OR/AND ARCHITECT**

APPROVED

APPROVED AS NOTED

ADDITIONAL  
INFORMATION REQUIRED

REJECTED,  
REASON FOR REJECTION:

BY: \_\_\_\_\_

DATE: \_\_\_\_\_

**DESCRIPTION**

UCAN SZ Heavy Load Anchors are mechanical anchors with controlled expansion that deliver exceptionally high tension and shear loads. Available in both zinc plated Grade 8.8 carbon steel & Grade 316 stainless steel, heavy load anchors are ideal for applications requiring a high degree of security and reliability. UCAN SZ heavy load anchors are offered in a choice of 3 head styles, finished hex bolt, hex nut and countersunk. The size range is now expanded to include M24.

**FEATURES**

- ICC-ES® Listed ESR-3304
- ACI 318 category I anchor for cracked or uncracked concrete
- Superior fastening for dynamic and static loads
- Torque controlled expansion, High shear load, Through fastening
- Collapsible collar provides reliable pull-down force
- Expanded size range – now includes M24
- Available in Stainless Steel & Galvanized finish to order
- Offered in three different head styles - hex bolt, stud + hex nut & countersunk

**TYPICAL APPLICATIONS**

High load capacity, safety-relevant or dynamic applications including

- Road and bridge construction
- Medical equipment installation
- Heavy machinery and robotics installation
- Structural steel columns and frame
- Dynamic and seismic loading applications
- Parking structure rehabilitation
- Cantilevers, cranes, car hoists
- Heavy pipe supports, pumps

**LIMITATIONS**

- Not recommended for uncured concrete (less than 7 days old), lightweight concrete, masonry block or brick.
- Concrete compressive strength range:  
2,500 Psi (17.2 MPa) 8,500 Psi (58.6 MPa)

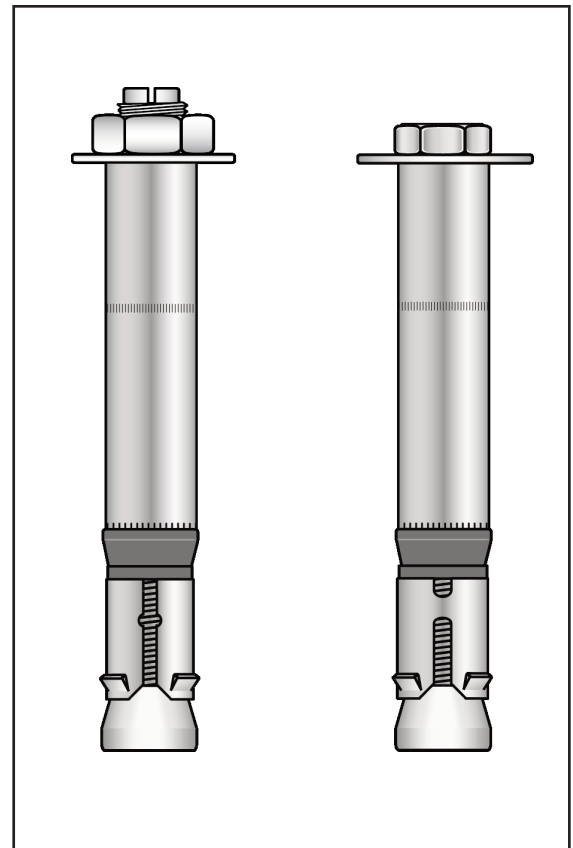
**LISTING AND APPROVALS**



- ACI 318 category I anchor for cracked or uncracked concrete

**COMPLIANCE WITH THE FOLLOWING CODES**

- 2012, 2009, 2006 International Building Code® (IBC)
- 2012, 2009, 2006 International Residential Code® (IRC)



**LEED® COMPLIANCE**



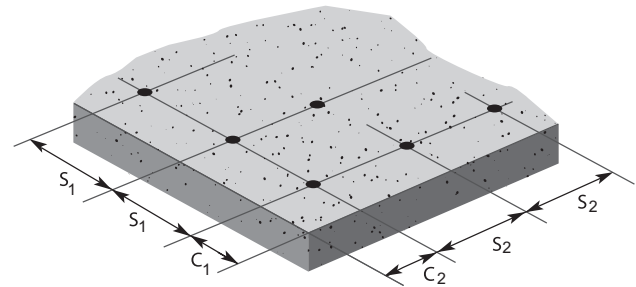
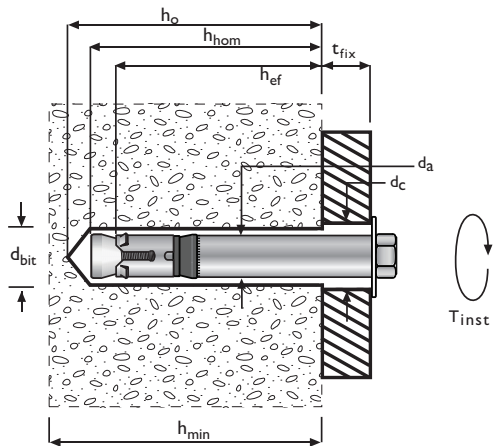
MRc4 - 25% Recycled Materials

**MATERIAL SPECIFICATIONS**

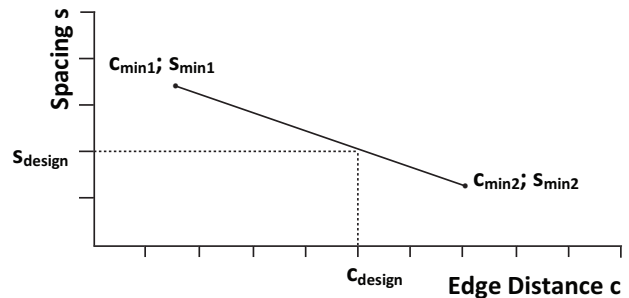
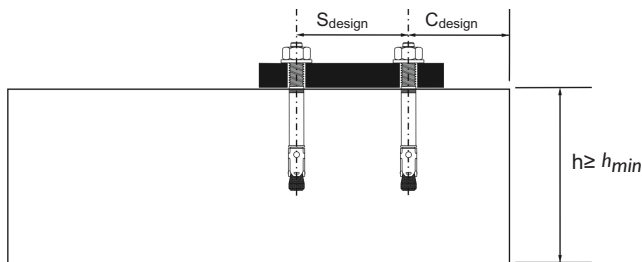
Anchor Component	Material Standard	Mechanical Properties	
		$F_u$	$F_y$
Carbon steel hex-head bolt	Class 8.8; EN ISO 891-1	800 MPa (116 ksi)	640 MPa (93 ksi)
Carbon steel threaded stud	Class 8.8; EN ISO 891-1	800 MPa (116 ksi)	640 MPa (93 ksi)
Collapsible collar	-	Polyethylene	
Corrosion protection	DIN ISO 4042	$\leq 5\mu\text{m}$ , zinc plated	
Stainless steel (A4) hex bolt, distance and expansion sleeve cone, washer (EN 10088)	Class 70; EN10088 1.4401/ 1.4404 / 1.4571	700 MPa (101.5 ksi)	450 MPa (65.3 ksi)
Stainless steel hex nut (A4)	Class 70; ISO 3506		

**ANCHOR INSTALATION**

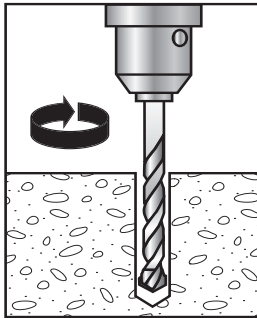
**INSTALLATION DETAILS**



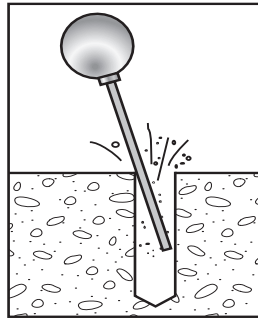
**EXAMPLE OF ALLOWABLE INTERPOLATION OF MINIMUM EDGE DISTANCE AND MINIMUM SPACING**



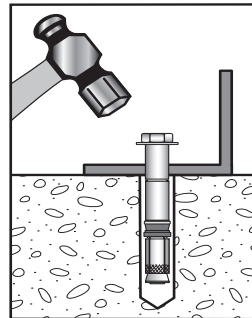
• **INSTALLATION INSTRUCTION**



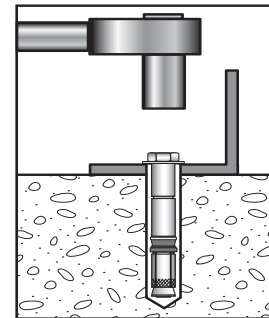
1) Select the correct diameter metric drill bit, drill hole to minimum required hole depth or deeper.



2) Remove drilling debris with a blowout bulb, compressed air or vacuum



3) Using a hammer, tap the anchor through the part being fastened into the drilled hole until the washer is in contact with the fastened part. Do not expand anchor by hand prior to installation.



4) Using a torque wrench, apply the specified installation to the anchor.

**TABLE 1A - SZ CARBON STEEL INSTALLATION INFORMATION<sup>1</sup>**

Setting Information	Symbol	Units	Nominal Anchor Diameter					
			M8	M10	M12	M16	M20	M24
Anchor Outside diameter	$d_a (d_o)^5$	in. (mm)	0.45 (11.5)	0.57 (14.5)	0.69 (17.5)	0.93 (23.5)	1.08 (27.5)	1.26 (32)
Drill Bit Diameter	$d_{bit}$	mm	12	15	18	24	28	32
Minimum Hole Depth	$h_0$	in. (mm)	3.15 (80)	3.74 (95)	4.13 (105)	5.12 (130)	6.3 (160)	7.08 (180)
Minimum Base Plate Clearance Hole Dia. <sup>2</sup>	$d_c$	in. (mm)	0.55 (14)	0.67 (17)	0.79 (20)	1.20 (26)	1.22 (31)	1.38 (35)
Installation torque (Carbon Steel)	$T_{inst}$	ft-lbf (N-m)	22.1 (30)	36.8 (50)	59 (80)	118 (160)	207 (280)	207 (280)
Embedment Depth	$h_{nom}$	in. (mm)	2.72 (69)	3.25 (82.5)	3.72 (94.5)	4.65 (118)	5.83 (148)	6.65 (169)
Effective Embedment depth	$h_{ef}$	in. (mm)	2.4 (60)	2.8 (70)	3.1 (80)	3.94 (100)	4.92 (125)	5.92 (150)
Minimum Edge Distance	$C_{min1}$	in. (mm)	2.4 (60)	2.8 (70)	3.5 (90)	4.7 (120)	7.1 (180)	5.9 (150)
Minimum Spacing <sup>3</sup>	$S_{min1}$	in. (mm)	4.9 (125)	6.9 (175)	7.9 (200)	12.6 (320)	21.3 (540)	11.8 (300)
Minimum Edge Distance	$C_{min2}$	in. (mm)	3.9 (100)	5.1 (130)	6.3 (160)	7.1 (180)	11.8 (300)	11.8 (300)
Minimum Spacing <sup>4</sup>	$S_{min2}$	in. (mm)	2.4 (60)	2.8 (70)	3.1 (80)	3.9 (100)	4.9 (125)	5.9 (150)
Minimum Concrete Thickness	$h_{min}$	in. (mm)	4.7 (120)	5.5 (140)	6.3 (160)	7.9 (200)	9.8 (250)	11.8 (300)

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

<sup>1</sup>The information presented in this table must be used in conjunction with the design requirements of ACI 318 Appendix D, or CSA A23.3-19 Annex D

<sup>2</sup>The clearance must comply with applicable code requirements for the connected element.

<sup>3</sup> $S_{min1}$  applies when  $C_{min1}$  is provided.

<sup>4</sup> $S_{min2}$  applies when  $C_{min2}$  is provided.

<sup>5</sup>The notation in parenthesis is for 2006 IBC

# SZ HEAVY LOAD EXPANSION ANCHOR

## CARBON STEEL SELECTION

Part Number		Bolt/Stud	Drill Bit/ Anchor	Anchor Length		Maximum Fixture Thickness	Box Quantity
SHL	BHL	diameter	diameter	SHL/SHS	BHL/BHS		
		mm	mm	mm	mm	mm	
SHL600	BHL600	6	10	65	67	0	100
SHL610	BHL610			75	77	10	50
SHL630	BHL630			95	97	30	50
SHL650	BHL650			115	117	50	25
–	BHL6100			–	167	100	25
SHL800	BHL800	8	12	77	80	0	50
SHL810	BHL810			87	90	10	50
SHL830	BHL830			107	110	30	50
SHL850	BHL850			127	130	50	25
–	BHL8100			–	180	100	25
SHL1000	BHL1000	10	15	93	96	0	25
SHL1015	BHL1015			108	111	15	25
SHL1025	BHL1025			118	121	25	25
SHL1045	BHL1045			138	141	45	25
SHL1095	BHL1095			188	191	95	25
SHL1200	BHL1200	12	18	107	112	0	20
SHL1210	BHL1210			117	122	10	20
SHL1220	BHL1220			127	132	20	20
SHL1240	BHL1240			147	152	40	20
SHL1270	BHL1270			177	182	70	20
–	BHL12100	–	212	100	10		
SHL1600	BHL1600	16	24	132	137	0	10
SHL1620	BHL1620			152	157	20	10
SHL1650	BHL1650			182	187	50	10
–	BHL16100			–	237	100	5
SHL2010	BHL2010	20	28	152	161	0	10
SHL2030	BHL2030			192	201	30	10
SHL2060	BHL2060			222	231	60	5
SHL20100	BHL20100			262	271	100	5
SHL2410	BHL2410	24	32	212	217	10	5
SHL2430	BHL2430			232	237	10	5
SHL2460	BHL2460			262	267	10	5

**TABLE 1B - SZ STAINLESS STEEL INSTALLATION INFORMATION<sup>1</sup>**

Setting Information	Symbol	Units	Nominal Anchor Diameter			
			M8	M10	M12	M16
Anchor Outside diameter	$d_a$ ( $d_o$ )	in. (mm)	0.45 (11.5)	0.57 (14.5)	0.69 (17.5)	0.93 (23.5)
Drill Bit Diameter	$d_{bit}$	(mm)	12	15	18	24
Minimum Hole Depth	$h_o$	in. (mm)	3.15 (80)	3.74 (95)	4.13 (105)	5.12 (130)
Minimum Base Plate Clearance Hole Diameter <sup>2</sup>	$d_c$	in. (mm)	0.55 (14)	0.67 (17)	0.79 (20)	1.20 (26)
Installation torque (Stainless Steel)	$T_{inst}$	SHS BHS ft-lbf (N-m)	22.1 (30)	36.8 (50)	59 (80)	125 (170)
			25.8 (35)	40.5 (55)	66.3 (90)	125 (170)
Embedment Depth	$h_{nom}$	in. (mm)	2.72 (69)	3.25 (82.5)	3.72 (94.5)	4.67 (118.5)
Effective Embedment depth	$h_{ef}$	in. (mm)	2.4 (60)	2.8 (70)	3.1 (80)	3.9 (100)
Minimum Edge Distance	$C_{min1}$	in. (mm)	2.9 (75)	3.3 (85)	3.9 (100)	7.1 (180)
Minimum Spacing <sup>3</sup>	$S_{min1}$	in. (mm)	5.3 (135)	7.2 (185)	8.3 (210)	7.1 (180)
Minimum Edge Distance	$C_{min2}$	in. (mm)	3.9 (100)	5.5 (140)	6.7 (170)	7.1 (180)
Minimum Spacing <sup>4</sup>	$S_{min2}$	in. (mm)	2.8 (70)	3.3 (85)	3.9 (100)	7.1 (180)
Minimum Concrete Thickness	$h_{min}$	in. (mm)	4.7 (120)	5.5 (140)	6.3 (160)	7.8 (200)

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

<sup>1</sup>The information presented in this table must be used in conjunction with the design requirements of ACI 318 Appendix D, or CSA A23.3-19 Annex D

<sup>2</sup>The clearance must comply with applicable code requirements for the connected element.

<sup>3</sup> $S_{min1}$  applies when  $C_{min1}$  is provided.

<sup>4</sup> $S_{min2}$  applies when  $C_{min2}$  is provided.

**STAINLESS STEEL SELECTION**

Part Number		Bolt/Stud	Drill Bit/ Anchor	Anchor Length		Maximum Fixture Thickness	Box Quantity
SHS	BHS	diameter	diameter	SHL/SHS	BHL/BHS		
		mm	mm	mm	mm	mm	
SHS830	BHS830	8	10	105	109	30	50
SHS850	BHS850			125	129	50	25
SHSI025	BHSI025	10	15	116	120	25	25
SHSI045	BHSI045			136	140	45	25
SHSI220	BHSI220	12	18	128	131	20	20
SHSI240	BHSI240			148	151	40	25
SHSI620	BHSI620	16	24	150	157	20	10
SHSI650	BHSI650			180	187	50	10

<sup>1</sup>Stainless steel sizes are in limited stock or special order

<sup>2</sup>Other lengths, sizes countersunk type anchors and custom assemblies are special order items.

**TECHNICAL DATA (LIMIT STATE DESIGN / STRENGTH DESIGN) IN CRACKED AND UNCRACKED CONCRETE**

**TABLE 2A - SZ CARBON STEEL CHARACTERISTIC TENSION STRENGTH DESIGN DATA<sup>1</sup>**

Characteristic	Symbol	Units	Nominal anchor diameter					
			M8	M10	M12	M16	M20	M24
Anchor Category	1,2 or 3	-	3	1	1	1	1	1
Embedment Depth	$h_{nom}$	in. (mm)	2.76 (70)	3.31 (84)	3.74 (95)	4.65 (118)	5.83 (148)	6.65 (169)
<b>Steel Strength in Tension</b>								
Specified Yield Strength	$f_{ya}$	psi (N/mm <sup>2</sup> )	92,888 640	92,888 640	92,888 640	92,888 640	92,888 640	92,888 640
Specified Tensile Strength	$f_{uta}$	psi (N/mm <sup>2</sup> )	116,110 800	116,110 800	116,110 800	116,110 800	116,110 800	116,110 800
Effective Tensile Stress Area	$A_{se}$	in <sup>2</sup> (mm <sup>2</sup> )	0.06 (36.6)	0.09 (58)	0.13 (84.3)	0.24 (156.7)	0.38 (244.8)	0.55 (352.8)
Tension Resistance of Steel	$N_{sa}$	lbf (kN)	6,580 29.3	10,427 46.4	15,155 67.4	28,171 125.4	44,009 195.8	63,486 282.4
Strength Reduction Factor-Steel Failure <sup>2,9</sup>	$\Phi_{sa}$	-	0.65	0.65	0.65	0.65	0.65	0.65
<b>Concrete Breakout Strength in Tension</b>								
Effective Embedment Depth	$h_{ef}$	in. (mm)	2.4 (60)	2.8 (71)	3.1 (80)	3.94 (100)	4.92 (125)	5.92 (150)
Critical Edge Distance	$C_{ac}$	in. (mm)	5.2 (132)	7.0 (178)	6.3 (160)	9.1 (230)	11.3 (288)	12.2 (310)
Effectiveness Factor-Uncracked Concrete	$k_{unscr}$	-	24 (10)	24 (10)	24 (10)	27 (11.3)	27 (11.3)	27 (11.3)
Effectiveness Factor-Cracked Concrete	$k_{cr}$	-	17 (7.1)	17 (7.1)	21 (8.8)	21 (8.8)	21 (8.8)	24 (10)
Modification Factor <sup>8,9</sup>	$\Psi_{c,N}$	-	1.0	1.0	1.0	1.0	1.0	1.0
Strength Reduction Factor-Concrete Breakout Failure <sup>3,9</sup>	$\Phi_{cb}$	-	0.65	0.65	0.65	0.65	0.65	0.65
<b>Pull-Out Strength in Tension</b>								
Pull-Out Resistance Cracked Concrete ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{pn,cr}$	lbf (kN)	2,911 (12.9)	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>
Pull-Out Resistance Uncracked Concrete ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{pn,unscr}$	lbf (kN)	3,887 (17.3)	4,734 (21.1)	6,149 (27.4)	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>
Strength Reduction Factor-Pullout Failure <sup>6,9</sup>	$\Phi_p$	-	0.65	0.65	0.65	0.65	0.65	0.65
<b>Tension Strength for Seismic Applications</b>								
Tension Resistance of Single Anchor for Seismic Loads ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{np,eq}$	lbf (kN)	2,911 (12.9)	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	N/A <sup>4</sup>	16,748 (74.5)
Strength Reduction Factor-Pullout Failure <sup>6,8</sup>	$\Phi_{eq}$	-	0.65	0.65	0.65	0.65	0.65	0.65
Axial Stiffness in Service Load Range, Cracked Concrete <sup>7</sup>	$\beta_{cr}$	lb/in. (kN/mm)	145,923 25.6	229,946 40.3	143,155 25.1	57,102 10	142,754 25	217,714 (38.1)
Axial Stiffness in Service Load Range, Uncracked Concrete <sup>7</sup>	$\beta_{unscr}$	lb/in. (kN/mm)	386,670 67.7	455,987 80.0	483,412 84.7	114,203 20	485,364 85	1,056,000 184.8

For **S1**: 1 inch = 25.4mm, 1 lbf = 0.00445kN, 1 lb/in = 0.175 N/mm, 1 psi = 0.00689 N/mm<sup>2</sup>, 1 in<sup>2</sup> = 645 mm<sup>2</sup>

<sup>1</sup>The information presented in this table must be used in conjunction with the design requirements of ACI 318 Appendix D, or CSA A23.3 - 19 Annex D.

<sup>2</sup>The tabulated value of  $\Phi_{sa}$  applies when the load combinations of Section 1605.2 of the IBC or ACI 318 9.2 are used. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{sa}$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05 D.4.5). The M16 and M20 diameter anchors are brittle steel elements as defined in ACI 318 D.1.

<sup>3</sup>The tabulated value of  $\Phi_{cb}$  applies when both the load combinations of Section 1605.2 of the IBC, or ACI 318 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. For installations where complying supplementary reinforcement can be verified, the  $\Phi_{cb}$  factors described in ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{cb}$  must be determined in accordance with ACI 318 D.4.4. (ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5

<sup>4</sup>As described in Section 4.1.3 of ESR-3304, N/A (Not Applicable) denotes that pullout resistance is not critical and does not need to be considered.

<sup>5</sup>For all design cases  $\Psi_{c,N} = 1.0$ . The appropriate effectiveness factor for cracked concrete ( $K_{cr}$ ) or uncracked concrete ( $K_{unscr}$ ) must be used.

<sup>6</sup>The tabulated value of  $\Phi_p$  or  $\Phi_{eq}$  applies when both the load combinations of Section 1605.2 of the IBC, or ACI 318 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where pullout strength governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318-11 D.4.3

(ACI 318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 D.4.4 and -05 D.4.5).

<sup>7</sup>Minimum axial stiffness value. Actual stiffness may vary depending on the concrete strength, loading and geometry of the application.

<sup>8</sup>For all design cases  $\Psi_{c,N} = 1.0$ . The appropriate effectiveness factor for cracked concrete ( $K_{cr}$ ) or uncracked concrete ( $K_{unscr}$ ) must be used.

<sup>9</sup>For limit State Design as per CSA A23.3-19 Annex D, material resistance factors ( $\Phi$ ) and resistance modification factor (R) listed in Table 4 shall be used.

**TABLE 2B - SZ STAINLESS STEEL CHARACTERISTIC TENSION STRENGTH DESIGN DATA<sup>1</sup>**

Characteristic	Symbol	Units	Nominal anchor diameter				
			M8	M10	M12	M16	
Anchor Category	1,2 or 3	-	1	1	1	1	
Embedment Depth	$h_{nom}$	in. (mm)	2.72 (69)	3.25 (82.5)	3.72 (94.5)	4.67 (118.5)	
<b>Steel Strength in Tension</b>							
Specified Yield Strength	$f_{ya}$	SHS	psi (N/mm <sup>2</sup> )	65,312 (450)	65,312 (450)	65,312 (450)	65,312 (450)
		BHS		81,277 (560)	81,277 (560)	81,277 (560)	81,277 (560)
Specified Tensile Strength	$f_{uta}$	psi (N/mm <sup>2</sup> )	101,600 (700)	101,600 (700)	101,600 (700)	101,600 (700)	
Effective Tensile Stress Area	$A_{se}$	in <sup>2</sup> (mm <sup>2</sup> )	0.06 (36.6)	0.09 (58)	0.13 (84.3)	0.24 (157)	
Tension Resistance of Steel	$N_{sa}$	lbf (kN)	5,845 (26)	9,217 (41)	13,263 (59)	24,429 (110)	
Strength Reduction Factor-Steel Failure <sup>2,9</sup>	$\Phi_{sa}$	-	0.65	0.65	0.65	0.65	
<b>Concrete Breakout Strength in Tension</b>							
Effective Embedment Depth	$h_{ef}$	in. (mm)	2.4 (60)	2.8 (71)	3.1 (80)	3.94 (100)	
Critical Edge Distance	$C_{ac}$	in. (mm)	7.1 (180)	9.3 (235)	10.4 (265)	13.0 (330)	
Effectiveness Factor-Uncracked Concrete	$k_{uncr}$	-	24 (10)	24 (10)	24 (10)	27 (11.3)	
Effectiveness Factor-Cracked Concrete	$k_{cr}$	-	17 (7.1)	17 (7.1)	17 (7.1)	24 (10)	
Modification Factor for uncracked Concrete <sup>8,9</sup>	$\psi_{c,N}$	-	1.0	1.0	1.0	1.0	
Strength Reduction Factor-Concrete Breakout Failure <sup>3,9</sup>	$\Phi_{cb}$	-	0.65	0.65	0.65	0.65	
<b>Pull-Out Strength in Tension</b>							
Pull-Out Resistance Cracked Concrete ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{pn,cr}$	lbf (kN)	2,700 (12)	3,600 (16)	N/A <sup>4</sup>	N/A <sup>4</sup>	
Pull-Out Resistance Uncracked Concrete ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{pn,uncr}$	lbf (kN)	3,600 (16)	5,600 (25)	N/A <sup>4</sup>	N/A <sup>4</sup>	
Strength Reduction Factor-Pullout Failure <sup>6,9</sup>	$\Phi_p$	-	0.65	0.65	0.65	0.65	
<b>Tension Strength for Seismic Applications</b>							
Tension Resistance of Single Anchor for Seismic Loads ( $f'_c=2,500$ psi) <sup>5</sup>	$N_{np,eq}$	lbf (kN)	2,700 (12)	3,600 (16)	5,685 (25.3)	N/A <sup>4</sup>	
Strength Reduction Factor-Pullout Failure <sup>6,9</sup>	$\Phi_{eq}$	-	0.65	0.65	0.65	0.65	
Axial Stiffness in Service Load Range, Cracked Concrete <sup>7</sup>	$\beta_{cr}$	lb/in. (kN/mm)	74,200 (13)	62,800 (11)	85,600 (15)	103,000 (18)	
Axial Stiffness in Service Load Range, Uncracked Concrete <sup>7</sup>	$\beta_{uncr}$	lb/in. (kN/mm)	285,000 (50)	211,000 (37)	114,000 (20)	365,000 (64)	

For **S1**: 1 inch = 25.4mm, 1 lbf = 4.45N, 1 lb/in = 0.175 N/mm, 1 psi = 6.89 Pa, 1 in<sup>2</sup> = 645 mm<sup>2</sup>, 1 lb/in = 0.175 Nmm

<sup>1</sup> The information presented in this table must be used in conjunction with the design requirements of ACI 318 Appendix D, or CSA A23.3 -19 Annex D.

<sup>2</sup> The tabulated value of  $\Phi_{sa}$  applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used. If the load combination of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{sa}$  must be determined in accordance with ACI 318-11 D.4.3. (ACI 318-08 and -05 D.4.4). The M16 and M20 diameter anchors are brittle steel elements as defined in ACI 318 D.1.

<sup>3</sup> The tabulated value of  $\Phi_{cb}$  applies when both the load combinations of Section 1605.2 of the IBC, or ACI 318 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. For installations where complying supplementary reinforcement can be verified, the  $\Phi_{cb}$  factors described in ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{cb}$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05 D.4.5).

<sup>4</sup> As described in Section 4.1.3 of ESR-3304, N/A (Not Applicable) denotes that pullout resistance is not critical and does not need to be considered.

<sup>5</sup> The characteristic pull-out resistance for greater concrete compressive strengths may be increased by multiplying the tabular value by ( $f'_c/2,500$ )<sup>0.5</sup> in accordance with Section 4.1.3 of this report.

<sup>6</sup> The tabulated value of  $\Phi_p$  or  $\Phi_{eq}$  applies when both the load combinations of Section 1605.2 of the IBC, or ACI 318 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where pullout strength governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318-11 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 D.4.4 and -05 D.4.5).

<sup>7</sup> Minimum axial stiffness value. Actual stiffness may vary depending on the concrete strength, loading and geometry of the application.

<sup>8</sup> For all design cases  $\psi_{c,N} = 1.0$ . The appropriate effectiveness factor for cracked concrete ( $K_{cr}$ ) or uncracked concrete ( $K_{uncr}$ ) must be used.

<sup>9</sup> For limit State Design as per CSA A23.3-19 Annex D, material resistance factors ( $\Phi$ ) and resistance modification factor (R) listed in Table 4 shall be used.



TABLE 3A - SZ CARBON STEEL CHARACTERISTIC SHEAR DESIGN DATA

Characteristic	Symbol	Units	Nominal anchor diameter											
			M8		M10		M12		M16		M20		M24	
Anchor type			BHL	SHL	BHL	SHL	BHL	SHL	BHL	SHL	BHL	SHL	BHL	SHL
Anchor Category	1,2 or 3	-	3		1		1		1		1		1	
Embedment Depth	$h_{nom}$	in. (mm)	2.76 (70)		3.31 (84)		3.74 (95)		4.65 (118)		5.83 (148)		6.65 (169)	
<b>Steel Strength in Shear</b>														
Shear Resistance of Steel	$V_{sa}$	lb (kN)	5,475 (24.3)		8,793 (39.1)		13,037 (58.0)		19,100 (85)	21,600 (96)	22,400 (100)	27,600 (123)	44,984(200.1)	
Strength Reduction Factor-Steel Failure <sup>2,5</sup>	$\Phi_{sa}$	-	0.6		0.6		0.6		0.6		0.6		0.6	
<b>Concrete Breakout Strength in Shear</b>														
Anchor Outside Diameter	$d_a$ ( $d_{nom}$ )	in. (mm)	0.45 (11.5)		0.57 (14.5)		0.69 (17.5)		0.93 (23.5)		1.08 (27.5)		1.26 (32)	
Load Bearing Length of Anchor in Shear	$l_e$	in. (mm)	0.91 (23)		1.14 (29)		1.38 (35)		1.85 (47)		2.17 (55)		2.52 (64)	
Strength Reduction Factor-Concrete Breakout Failure <sup>3,5</sup>	$\Phi_{cb}$	-	0.7		0.7		0.7		0.7		0.7		0.7	
<b>Concrete Pryout Strength in Shear</b>														
Coefficient for Pryout Strength	$k_{cp}$	-	1		2		2		2		2		2	
Strength Reduction Factor-Concrete Pryout Failure <sup>4,5</sup>	$\Phi_{cp}$	-	0.7		0.7		0.7		0.7		0.7		0.7	
<b>Shear Strength for Seismic Applications</b>														
Shear Resistance of Single Anchor for Seismic loads ( $f'_c=2,500$ psi)	$V_{sa,eq}$	lb (kN)	3,934 (17.5)		6,627 (29.5)		8,977 (39.9)		9,217 (41)		22,256 (99)		35,992 (160.1)	
Strength Reduction Factor-Steel Failure <sup>5</sup>	$\Phi_{cq}$	-	0.6		0.6		0.6		0.6		0.6		0.6	

For **SI**: 1 inch = 25.4mm, 1 lbf = 4.45N, 1 psi = 6.89 Pa, 1 in<sup>2</sup> = 645 mm<sup>2</sup>.

<sup>1</sup>The information presented in Table 3A must be used in conjunction with the design criteria of ACI 318 Appendix D.

<sup>2</sup>The tabulated value of  $\Phi_{sa}$  applies when the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{sa}$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05D.4.5(c)) The M16 and M20 diameter anchors are brittle steel elements as defined in ACI 318 D.1.1

<sup>3</sup>The tabulated value of  $\Phi_{cb}$  applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where pryout strength governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318-11 D.4.3 (ACI318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05 D.4.5).

<sup>4</sup>The tabulated value of  $\Phi_{cp}$  applies when both the load combinations of Section 1605.2.1 of the IBC or ACI 318 9.2 are used and the requirements of ACI 318 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where Pryout governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318 D.4.3 (ACI 318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318 D.4.4 (ACI 318-08 and -05 D.4.5).

<sup>5</sup>For limit State Design as per CSA A23.3-19 Annex D, material resistance factors ( $\Phi$ ) and resistance modification factor (R) listed in Table 4 shall be used.

**TABLE 3B - SZ STAINLESS STEEL CHARACTERISTIC SHEAR DESIGN DATA**

Characteristic	Symbol	Units	Nominal anchor diameter			
			M8	M10	M12	M16
Anchor Category	1,2 or 3	-	1	1	1	1
Embedment Depth	$h_{nom}$	in. (mm)	2.72 (69)	3.25 (82.5)	3.72 (94.5)	4.67 (118.5)
<b>Steel Strength in Shear</b>						
Shear Resistance of Steel	$V_{sa}$	lb (kN)	5,463 (24.3)	8,273 (36.8)	13,668 (60.8)	19,963 (88.8)
Strength Reduction Factor-Steel Failure <sup>2,5</sup>	$\Phi_{sa}$	-	0.60	0.60	0.60	0.60
<b>Concrete Breakout Strength in Shear</b>						
Anchor Outside Diameter	$d_a (d_{nom})$	in. (mm)	0.45 (11.5)	0.57 (14.5)	0.69 (17.5)	0.93 (23.5)
Load Bearing Length of Anchor in Shear	$l_e$	in. (mm)	0.91 (23)	1.14 (29)	1.38 (35)	1.85 (47)
Strength Reduction Factor-Concrete Breakout Failure <sup>3,5</sup>	$\Phi_{cb}$	-	0.7	0.7	0.7	0.7
<b>Concrete Pryout Strength in Shear</b>						
Coefficient for Pryout Strength	$k_{cp}$	-	2	2	2	2
Strength Reduction Factor-Concrete Pryout Failure <sup>4,5</sup>	$\Phi_{cp}$	-	0.7	0.7	0.7	0.7
<b>Shear Strength for Seismic Applications</b>						
Shear Resistance of Single Anchor for Seismic loads( $f_c=2,500$ psi)	$V_{sa,eq}$	lb (kN)	2,158 (9.6)	3,012 (13.4)	5,485 (24.4)	15,983 (71.1)
Strength Reduction Factor-Steel Failure <sup>5</sup>	$\Phi_{cq}$	-	0.60	0.60	0.60	0.60

For **SI**: 1inch = 25.4mm, 1lbf = 4.45N, 1 psi = 6.89 Pa, 1 in<sup>2</sup> = 645 mm<sup>2</sup>.

<sup>1</sup>The information presented in Table 3A and 3B must be used in conjunction with the design criteria of ACI 318 Appendix D.

<sup>2</sup>The tabulated value of  $\Phi_{sa}$  applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi_{sa}$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05 D.4.5) The M16 and M20 diameter anchors are brittle steel elements as defined in ACI 318 D.1.1

<sup>3</sup>The tabulated value of  $\Phi_{cb}$  applies when both the load combinations of Section 1605.2 of the IBC or ACI 318 Section 9.2 are used and the requirements of ACI 318-11 D.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where pryout strength governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318-11 D.4.3 (ACI318-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318-11 D.4.4. (ACI 318-08 and -05 D.4.5).

<sup>4</sup>The tabulated value of  $\Phi_{cp}$  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.4.3(c) (ACI 318-08 and -05 D.4.4(c)) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where Pryout governs. For installations where complying supplementary reinforcement can be verified, the  $\Phi$  factors described in ACI 318-11 D.4.3 (ACI18-08 and -05 D.4.4) for Condition A are allowed. If the load combinations of ACI 318 Appendix C are used, the appropriate value of  $\Phi$  must be determined in accordance with ACI 318-11 D.4.4 (ACI 318-08 and -05 D.4.5).

<sup>5</sup>For limit State Design as per CSA A23.3-19Annex D, material resistance factors ( $\Phi$ ) and resistance modification factor (R) listed in Table 4 shall be used.

**TABLE 4 - RESISTANCE FACTORS FOR LIMIT STATE DESIGN IN ACCORDANCE  
WITH CSA A23.3-14, ANNEX D<sup>1</sup>**

Setting Information	Symbol	Units	Nominal Anchor Diameter				
			M8	M10	M12	M16	M20
Concrete material resistance factor	$\Phi_c$	-	0.65				
Steel material resistance factor	$\Phi_s$	-	0.85				
Strength reduction factor for tension, steel failure modes	R		0.80			0.70	
Strength reduction factor for shear, steel failure modes	R		0.75			0.65	
Strength reduction factor for tension, concrete failure modes	R	Cond. A	1.15				
		Cond. B	1.00				
Strength reduction factor for Shear, concrete failure modes	R	Cond. A	1.15				
		Cond. B	1.00				
Coefficient for factored concrete breakout in tension, cracked concrete	$k$	-	7				
Modification factor concrete resistance to account uncracked concrete	$\psi_{c,N}$	-	1.4				

<sup>1</sup>The M16 and M20 diameter anchors are brittle steel elements as defined in ACI 318 D.1.1

## ALLOWABLE STRESS DESIGN

**TABLE 5A - SZ CARBON STEEL SAMPLE ALLOWABLE DESIGN VALUES FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7</sup>**

Nominal Anchor Diameter	Embedment Depth, $h_{nom}$ (in.)	Effective Embedment Depth, $h_{ef}$ (in.)	Allowable Tension Load, $\Phi N_n / a$ (lbf)
M8	2.76	2.4	1,707
M10	3.31	2.8	2,079
M12	3.74	3.1	2,802
M16	4.65	3.94	4,117
M20	5.83	4.94	4,634
M24	6.65	5.92	8,540

For **SI**: 1 inch = 25.4 mm, 1ft-lbf = 1.356 N-m, 1 lbf = 4.45 N.

**TABLE 5B - SZ STAINLESS STEEL SAMPLE ALLOWABLE DESIGN VALUES FOR ILLUSTRATIVE PURPOSES<sup>1,2,3,4,5,6,7</sup>**

Nominal Anchor Diameter	Embedment Depth, $h_{nom}$ (in.)	Effective Embedment Depth, $h_{ef}$ (in.)	Allowable Tension Load, $\Phi N_n / a$ (lbf)
M8	2.72	2.4	1,581
M10	3.25	2.8	2,459
M12	3.72	3.1	2,877
M16	4.67	3.94	4,637

For **SI**: 1 inch = 25.4 mm, 1ft-lbf = 1.356 N-m, 1 lbf = 4.45 N.

<sup>1</sup>Single anchor with static tension load only

<sup>2</sup>Concrete determined to remain uncracked for the life of the anchorage.

<sup>3</sup>load combination from ACI 318 Section 9.2 (no seismic loading) with  $\Phi_{sa} = 0.65$ ,  $\Phi_{cb} = 0.65$ , and  $\Phi_p = 0.65$

<sup>4</sup>30%dead load and 70% live load. Controlling load combination is 1.2D + 1.6L. calculation of  $a = 0.3*1.2 + 0.7*1.6 = 1.48$

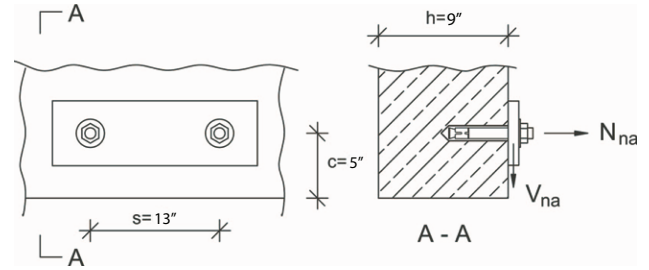
<sup>5</sup> $f'_c = 2,500$  psi (normal weight concrete)

<sup>6</sup> $C_{a1} = C_{a2} \geq C_{ac}$

<sup>7</sup> $h \geq h_{min}$

**EXAMPLE CALCULATION - STRENGTH DESIGN**

Determine if two M16 diameter SZ-B (Stud) carbon steel High Load anchors with an effective embedment depth  $h_{ef} = 3.94$  inches installed 13 inches from center to center and 5 inches from the edge of a 9 inch deep slab is adequate for a service tension load of 4,000 lb. (live load) and a reversible service shear load of 2,000 lb. (live load) The anchor group will be in the tension zone, away from other anchors in  $f'_c = 3,000$  psi normal – weight concrete.



ACI318-08 Report  
(ACI 318-19)  
Code Ref. Ref.

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(ACI 318-19)  
Code Ref. Ref.

1. Verify minimum Member Thickness, Spacing and Edge Distance:

$h = 9 \text{ in.} \geq h_{min} = 7.9 \text{ in.}$  o.k. Table 1A  
 $s = 13 \text{ in.} \geq S_{min} = 12.6 \text{ in.}$  o.k. Table 1A  
 $c_{a, min} = 5 \text{ in.} \geq c_{min} = 4.7 \text{ in.}$  o.k. Table 1A

calculation for  $\frac{A_{Nc}}{A_{Nco}}$

$$A_{Nco} = 9h_{ef}^2 = 9(3.94)^2 = 139.71 \text{ in}^2 \quad \text{Eq. (D-5)}$$

$$A_{Nc} = (c_{a1} + 1.5h_{ef})(2 \times 1.5h_{ef} + s_1) \\ = (5 + 1.5 \times 3.94)(2 \times 1.5 \times 3.94 + 13) \quad \text{Fig. RD.5.2.1 b} \\ = 270.8 \text{ in.}^2$$

2. Determine the Factored Tension and Shear Design Loads:

9.2.1

$$N_{ua} = 1.6 L = 1.6 \times 4,000 = 6,400 \text{ lb.}$$

$$V_{ua} = 1.6 L = 1.6 \times 2,000 = 3,200 \text{ lb.}$$

$$\frac{A_{Nc}}{A_{Nco}} = \frac{270.8}{139.71} = 1.94$$

3. Steel Capacity under Tension Loading:

D.5.1

$N_{sa} = 28,171$  Table 2A  
 $\Phi = 0.65$  Table 2A  
 $n = 2$  (double anchor group)  
Calculating for  $\Phi N_{sa}$ :  
 $\Phi N_{sa} = 0.65 \times 2 \times 28,171 = 36,622 \text{ lb.}$

Calculation for  $N_b$  and  $N_{cbg}$ :

$$N_b = 21 \times 1.0 \times \sqrt{3,000} \times (3.94)^{1.5} = 8,995 \text{ lb.}$$

$$N_{cbg} = 1.94 \times 1.0 \times 0.95 \times 1.0 \times 1.0 \times 8,995 = 16,576 \text{ lb.}$$

$\Phi = 0.65$  for Condition B  
(no supplementary reinforcement provided) Table 2A

$$\Phi N_{cb} = 0.65 \times 16,576 = 10,776 \text{ lb.}$$

4. Concrete Breakout Capacity under Tension Loading

D.5.2

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b \quad \text{Eq.(D-6)}$$

where:

$$N_b = K_c \lambda \sqrt{f'_c} h_{ef}^{1.5} \quad \text{Table 2A}$$

$$\text{with } K_c = K_{cr} = 21$$

$$\lambda = 1.0 \text{ for normal-weight concrete}$$

$$\Psi_{ec,N} = 1.0 \text{ since eccentricity } e_N = 0 \quad \text{Eq.(D-8)}$$

$$\Psi_{ed,N} = 0.7 + 0.3 \frac{C_{a,min}}{1.5h_{ef}} \text{ when } C_{a,min} \leq 1.5h_{ef} \quad \text{Eq.(D-10)}$$

$$\text{by observation } C_{a,min} = 3 < 1.5h_{ef} = 5.91 \text{ in.}$$

$$\Psi_{ed,N} = 0.7 + 0.3 \frac{(5)}{1.5(3.94)} = 0.95$$

$$\Psi_{c,N} = 1.0 \text{ assuming cracking at service loads } (f_t > f_r) \quad \text{D.5.2.6}$$

$$\Psi_{cp,N} = 1.0 \text{ designed for cracked concrete} \quad \text{D.5.2.7}$$

5. Pullout Capacity

D.5.3

not decisive Table 2A

6. Check all Failure Modes under Tension Loading:

D.4.1.2

Summary:

Steel Capacity = 36,622 lb.  
Concrete Breakout Capacity = 10,776 lb. ← **Controls**  
Pullout Capacity = not decisive

$$\Phi N_n = 10,776 \text{ lb. as Concrete Breakout Capacity Controls} \\ > N_{ua} = 6,400 \text{ lb. - OK}$$

7. Steel Capacity under Shear Loading:

D.6.1

Calculating for  $\Phi V_{sa}$ :

$$V_{sa} = 2 \times 19,100 = 38,200 \text{ lb.} \quad \text{Table 3A}$$

$$\Phi = 0.65 \quad \text{Table 3A}$$

$$\Phi V_{sa} = 0.65 \times 38,200 = 24,830 \text{ lb.}$$

8. Concrete Breakout Capacity under Shear Loading: ACI318-08 Report  
(ACI318-19)  
Code Ref. Ref.

D.6.2

$$V_{cbg} = \frac{A_{vc}}{A_{vco}} \Psi_{ec,v} \Psi_{ed,v} \Psi_{c,v} V_b \quad \text{Eq.(D-31)}$$

where:

$$V_b = 7 \left( \frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \lambda_a \sqrt{f'_c} c_{a1}^{1.5} \quad \text{Eq. (D-33)}$$

$\Psi_{ec,v} = 1.0$  since eccentricity  $e'_v = 0$  Eq.(D-36)

$\Psi_{ed,v} = 1.0$  since  $c_{a2} > 1.5c_{a1}$  Eq.(D-37)

$\Psi_{c,v} = 1.0$  assuming cracking at service loads ( $f_t > f_r$ ) D.6.2.7

calculating for  $\frac{A_{vc}}{A_{vco}}$

$h = 9 > 1.5 c_{a1} = 1.5 \times 5 = 7.5$  in.

$$A_{vc} = (2(1.5c_{a1}) + s_1) 1.5c_{a1} \quad \text{Fig. RD.6.2.1b}$$

$$= (2 \times 1.5 \times 5 + 13) \times 1.5 \times 5$$

$$= 210 \text{ in.}^2$$

$$A_{vco} = 4.5 (c_{a1})^2 = 4.5 \times 5^2 = 112.5 \text{ in.}^2 \quad \text{Eq.(D-32)}$$

$$\frac{A_{vc}}{A_{vco}} = \frac{210}{112.5} = 1.87 \quad \text{D.6.2.1}$$

calculating for  $V_b$  and  $\Phi V_{cbg}$

$d_a = 0.93$  in. Table 3A

$l_e = 2d_a = 1.86$  in. D.6.2.2

$c_{a1} = 5$  in.

$\Phi = 0.70$  for Condition B Table 3A  
(no supplementary reinforcement provided)

$$V_b = 7 \times \left( \frac{1.86}{0.93} \right)^{0.2} \times \sqrt{0.93} \times 1.0 \times \sqrt{3,000} \times (5)^{1.5} = 4,749 \text{ lb.}$$

$$\Phi V_{cbg} = 0.70 \times 1.87 \times 1.0 \times 1.0 \times 1.0 \times 4,749 = 6,216 \text{ lb.}$$

9. Concrete Pryout Strength: D.6.3

$$V_{cpg} = K_{cp} N_{cbg} \quad \text{Eq. (D-40)}$$

Where:

$K_{cp} = 2.0$  for  $h_{ef} \geq 2.5$

$$V_{cpg} = 2.0 \times 16,579 = 33,158 \text{ lb. } \Phi V_{cbg} = 0.70$$

ACI318-08 Report  
(ACI318-19)  
Code Ref. Ref.

10. Check all Failure Modes under Shear Loading: ACI318-08 Report  
D.4.1.2

Summary:

Steel Capacity = 24,870 lb.  
Concrete Breakout Capacity = 6,216 lb. ← **Controls**  
Pryout Capacity = 23,211 lb

**$\Phi V_n = 6,216$  lb. as Concrete Breakout Capacity controls  $> V_{ua} = 3,000$  lb. - OK**

11. 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:

$$\frac{N_{ua}}{\Phi N_n} + \frac{V_{ua}}{\Phi V_n} \leq 1.2$$

$$\frac{6,400}{10,776} + \frac{3,200}{6,216} = 0.59 + 0.51 = 1.10 \leq 1.2 - \text{OK}$$

12. Summary

**Two M16 diameter SZ High Load anchor at 3.94 in. effective embedment depth are adequate to resist the applied service tension and shear loads of 4,000 lb. and 2,000 lb., respectively.**