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UCAN

SZ HEAVY LOAD EXPANSION ANCHOR

REQUEST FOR APPROVAL

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☐ FASTENER SUBSTITUTION ☐ FASTENER RECOMMENDATION ☐ ALTERNATIVE FASTENER

Please review the attached technical data and approve the **SZ HEAVY LOAD EXPANSION ANCHOR** (Part No. TYPE HERE) for the following application(S) below:

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PROJECT:

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SPECIFIED FASTENER: TYPE HERE

FASTENING APPLICATION: TYPE HERE

LOCATION: TYPE HERE DWG NO.: TYPE HERE

SPECIFICATION REF: SECTION: TYPE HERE PAGE: TYPE # PARAGRAPH: TYPE HERE

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FOR USE BY THE ENGINEER OR/AND ARCHITECT

☐ APPROVED

☐ APPROVED AS NOTED

☐ ADDITIONAL INFORMATION REQUIRED

☐ REJECTED, REASON FOR REJECTION:

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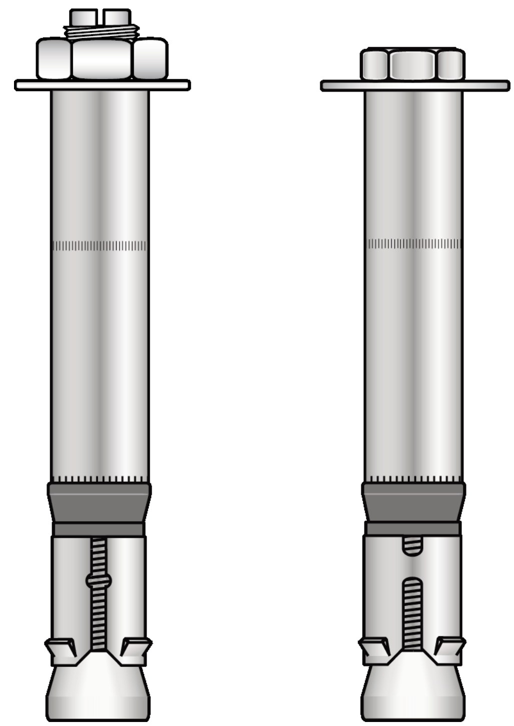
SZ HEAVY LOAD EXPANSION ANCHOR

DESCRIPTION

The UCAN SZ heavy load expansion anchor is a mechanical anchor with controlled expansion that displays exceptionally high tension and shear loads. Available in both zinc plated grade 8 carbon steel & type 316 stainless steel, heavy load anchors are ideal for applications requiring a high degree of security and reliability.



FEATURES

- ICC-ES® Listed ESR-3304
- ACI 318 category 1 anchor for cracked or uncracked concrete
- Superior fastening for dynamic and static loads
- Torque controlled expansion
- High shear load
- Four slot expansion sleeve ensures excellent load transfer
- Through fastening
- Collapsible collar provides reliable pull-down force

TYPICAL APPLICATIONS

- Road and bridge construction
- Seismic anchoring
- Heavy machinery and robotics installation
- Structural steel columns and frame
- Vibratory loading applications
- Parking structure rehabilitation

LIMITATIONS

Not recommended for uncured concrete (less than 7 days old), lightweight concrete, masonry block or brick.

MATERIAL SPECIFICATIONS

Anchor Component	Material Standard	Mechanical Properties Fu	Fy
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	≤5μm, 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		

SZ HEAVY LOAD EXPANSION ANCHOR

ANCHOR SELECTION - CARBON STEEL -

Part Number		Bolt/Stud	Drill Bit/ Anchor	Anchor Length		Maximum Thickness	Box Quantity
LHL	BHL	diameter	diameter	LHL	BHL		
		mm	mm	mm	mm	mm	
LHL600	BHL600	6	10	65	67	0	100
LHL610	BHL610			75	77	10	50
*LHL630	BHL630			95	97	30	50
*LHL650	BHL650			115	117	50	25
-	BHL6100			-	167	100	25
LHL800	BHL800	8	12	77	80	0	50
LHL810	BHL810			87	90	10	50
*LHL830	*BHL830			107	110	30	50
*LHL850	BHL850			127	130	50	25
-	BHL8100			-	180	110	25
LHL1000	BHL1000	10	15	93	96	0	25
LHL1015	BHL1015			108	116	15	25
*LHL1025	*BHL1025			118	121	25	25
*LHL1045	*BHL1045			138	141	45	25
LHL1095	BHL1095			188	191	95	25
LHL1200	BHL1200	12	18	107	112	0	20
LHL1210	BHL1210			117	122	10	20
*LHL1220	*BHL1220			127	132	20	20
*LHL1240	*BHL1240			147	152	40	20
LHL1270	BHL1270			177	182	70	20
-	BHL12100			-	212	100	10
LHL1600	BHL1600	16	24	132	137	0	10
*LHL1620	*BHL1620			152	157	20	10
*LHL1650	*BHL1650			182	187	50	10
-	BHL16100			-	237	100	5
LHL2000	BHL2000	20	28	152	161	0	10
*LHL2030	*BHL2030			192	201	30	10
*LHL2060	*BHL2060			222	231	60	5
LHL20100	BHL20100			262	271	100	5

***= Stock Items**

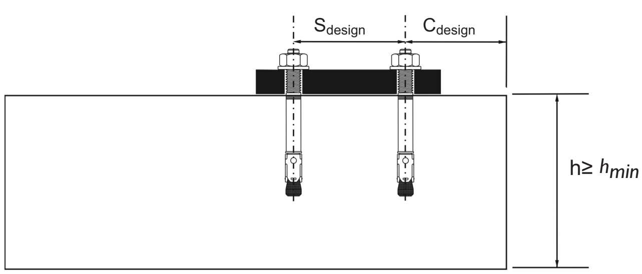
SZ HEAVY LOAD EXPANSION ANCHOR

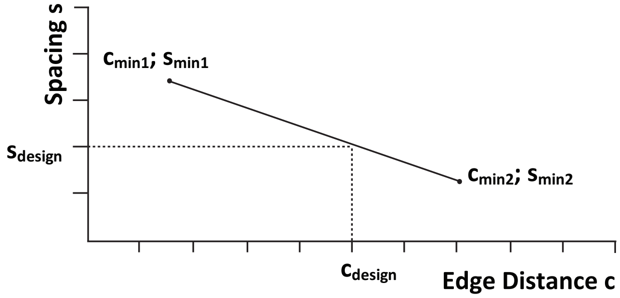
TECHNICAL DATA (LIMIT STATE DESIGN / STRENGTH DESIGN) IN CRACKED AND UNCRACKED CONCRETE - CARBON STEEL ANCHORS

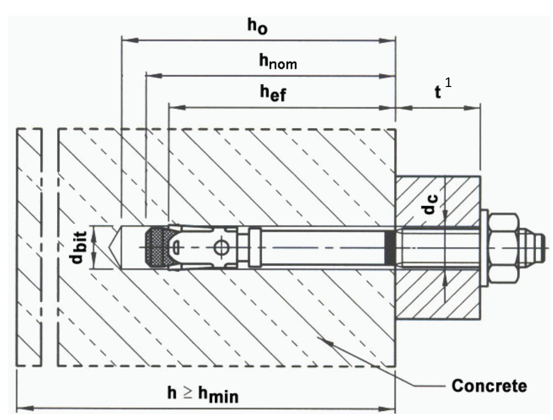
ANCHOR INSTALLATION

SETTING INFORMATION	SYMBOL	UNITS	NOMINAL ANCHOR DIAMETER	
			M16	M20
Anchor Outside diameter	d_a	in. (mm)	0.93 (23,5)	1.08 (27,5)
Drill Bit Diameter	d_{bit}	in. (mm)	0.95 (24)	1.10 (28)
Minimum Hole Depth	h_0	in. (mm)	5.12 (130)	6.3 (160)
Minimum Base Plate Clearance Hole Diameter[2]	d_c	in. (mm)	1.02 (26)	1.22 (31)
Installation torque (Carbon Steel)	T_{inst}	ft-lbf (N-m)	118 (160)	207 (280)
Embedment Depth	h_{nom}	in. (mm)	4.68 (118)	5.83 (148)
Effective Embedment depth	h_{ef}	in. (mm)	3.94 (100)	4.92 (125)
Minimum Edge Distance	C_{min1}	in. (mm)	4.7 (120)	7.1 (180)
Minimum Spacing[3]	S_{min1}	in. (mm)	12.6 (mm)	21.3 (540)
Minimum Edge Distance	C_{min2}	in. (mm)	7.1 (180)	11.8 (300)
Minimum Spacing[4]	S_{min2}	in. (mm)	3.9 (100)	4.9 (125)
Minimum Concrete Thickness	h_{min}	in. (mm)	7.9 (200)	9.8 (250)

For SI: 1 inch = 25.4 mm, 1ft-lbf = 1.356 N-m.
[1]The information presented in this table must be used in conjunction with the design requirements of ACI 318 Appendix D
[2]The clearance must comply with applicable code requirements for the connected element.
[3]S_{min1} applies when C_{min1} is provided.
[4]S_{min2} applies when C_{min2} is provided.







[1] Thickness of base plate

SZ HEAVY LOAD EXPANSION ANCHOR

STRENGTH DESIGN INFORMATION (TENSION) - CARBON STEEL ANCHORS

Characteristic	Symbol	Units	Nominal anchor diameter	
			M16	M20
Anchor Category	1,2 or 3	-	1	1
Embedment Depth	h_{nom}	in. (mm)	4.65 (118)	5.83 (148)
Steel Strength in Tension (ACI 318 D.5.1)				
Specified Yield Strength	f_{ya}	psi (N/mm²)	92,888 (640)	92,888 (640)
Specified Tensile Strength	f_{uta}	psi (N/mm²)	116,110 (800)	116,110 (800)
Effective Tensile Stress Area	A_{se}	in² (mm²)	0.2429 (156.7)	0.3794 (244.8)
Tension Resistance of Steel	N_{sa}	lbf (kN)	28,171 (125.4)	44,009 (195.8)
Strength Reduction Factor-Steel Failure[2]	$\varnothing_{sa}$	-	0.65	0.65
Concrete Breakout Strength in Tension (ACI 318 D.5.2)				
Effective Embedment Depth	h_{ef}	in. (mm)	3.94 (100)	4.92 (125)
Critical Edge Distance	C_{ac}	in. (mm)	9.1 (230)	11.3 (288)
Effectiveness Factor-Uncracked Concrete	k_{uncr}	-	27 (11.3)	27 (11.3)
Effectiveness Factor-Cracked Concrete	k_{cr}	-	21 (8.8)	21 (8.8)
Racio of k_{uncr}/k_{cr}	$\Psi_{c,N}$[6]	-	1.0	1.0
Strength Reduction Factor-Concrete Breakout Failure[3]	$\varnothing_{cb}$	-	0.65	0.65
Pull-Out Strength in Tension (ACI 318 D.5.3				
Pull-Out Resistance Cracked Concrete (f'_c=2,500 psi)[5]	$N_{pn,cr}$	lbf (kN)	N/A[4]	N/A[4]
Pull-Out Resistance Uncracked Concrete (f'_c=2,500 psi)[5]	$N_{pn,uncr}$	lbf (kN)	N/A[4]	N/A[4]
Strength Reduction Factor-Pullout Failure[6]	Φ_p	-	0.65	0.65
Tension Strength for Seismic Applications (ACI 318 D.3.3.3)				
Tension Resistance of Single Anchor for Seismic Loads (f'_c=2,500 psi)[5]	$N_{np,eq}$	lbf (kN)	N/A[4]	N/A[4]
Strength Reduction Factor-Pullout Failure[6]	Φ_{eq}	-	0.65	0.65
Axial Stiffness in Service Load Range, Cracked Concrete	β_{min}	lb/in. (kN/mm)	57,102 (10)	142,754 (25)
	β_m	lb/in. (kN/mm)	171,305 (30)	256,957 (45)
	β_{max}	lb/in. (kN/mm)	285,508 (50)	371,161 (65)
Axial Stiffness in Service Load Range, Uncracked Concrete	β_{min}	lb/in. (kN/mm)	114,203 (20)	485,364 (85)
	β_m	lb/in. (kN/mm)	456,813 (80)	827,974 (145)
	β_{max}	lb/in. (kN/mm)	799,423 (140)	1,170,583 (205)

For **SI:** 1inch = 25.4mm, 1lbf = 4.45N, 1 lb/in = 0.175 N/mm, 1 psi = 6.89 Pa, 1 in² = 645 mm², 1 lb/in = 0.175 N/mm.

[1] The information presented in this table must be used in conjunction with the design requirements 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, Section 1612.2.1 of the UBC, or ACI 18 9.2 are used. If the load combinations of Section 1909.2 of the UBC or ACI 318 Appendix C are used, the appropriate value of Φ_{sa} must be determined in accordance with ACI 318 D.4.5. The M16 and M20 diameter anchors are brittle 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, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are satisfied. 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 Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4 for Condition A are satisfied, 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 or Section 1902. 2 of the UBC are used, the appropriate value of Φ_{cb} must be determined in accordance with ACI 318 D.4.5.
[4] As described in Section 4.1.3 of this report, N/A (Not Applicable) denotes that pullout resistance is not critical and does not need to be considered.
[5] Minimum axial stiffness value, maximum values may be larger (e.g., due to high-strength concrete).
[6] 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.
[7] The notation in parentheses is for the 2006 IBC.

STRENGTH DESIGN INFORMATION (SHEAR) - CARBON STEEL ANCHORS

Characteristic	Symbol	Units	Nominal anchor diameter			
			M16		M20	
Anchor type			B	S	B	S
Anchor Category	1,2 or 3	-	1		1	
Embedment Depth	h_{nom}	in. (mm)	4.65 (118)		5.83 (148)	
Steel Strength in Shear (ACI 318 D.6.1)						
Shear Resistance of Steel	V_{sa}	lb (kN)	19,100 (85,0)	21,600 (96)	22,400 (100)	27,600 (123)
Strength Reduction Factor-Steel Failure[2]	Φ_{sa}	-	0.60		0.60	
Concrete Breakout Strength is Shear (ACI 318 D.6.2)						
Anchor Outside Diameter	d_a	in. (mm)	0.93 (23,5)		1.08 (27,5)	
Load Bearing Length of Anchor in Shear	l_e	in. (mm)	1.85 (47)		2.17 (55)	
Strength Reduction Factor-Concrete Breakout Failure[3]	Φ_{cb}	-	0.7		0.7	
Concrete Pryout Strength in Shear (ACI 318 D.6.3)						
Coefficient for Pryout Strength	k_{cp}	-	2		2	
Strength Reduction Factor-Concrete Pryout Failure[4]	Φ_{cp}	-	0.7		0.7	
Shear Strength for Seismic Applications (ACI 318 D.3.3.3)						
Shear Resistance of Single Anchor for Seism. loads(f'_c=2,500 psi)	$V_{sa,eq}$	lb (kN)	13,488 (60)		22,480 (100)	
Strength Reduction Factor-Steel Failure	Φ_{cq}	-	0.60		0.60	

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

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

[2] The tabulated value of Φ_{sa} applies when both the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are satisfied. If the load combinations of Section 1909.2 of the UBC or ACI 318 Appendix C are used, the appropriate value of Φ_{sa} must be determined in accordance with ACI 318 D.4.5. The M16 and M20 diameter anchors are brittle 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, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4(c) for Condition B are satisfied. Condition B applies where supplementary reinforcement is not provided or where strength governs. For installations where complying supplementary reinforcement can be verified, the Φ factors described in ACI 318 D.4.4 for Condition A are allowed. If the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 D.4.4 for Condition A are satisfied, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.4(c). If the load combinations of ACI 318 Appendix C or Section 1902. 2 of the UBC are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

[4] The tabulated value of Φ_{cb} applies when both the load combinations of Section 1605.2.1 of the IBC, Section 1612.2.1 of the UBC, or ACI 318 9.2 are used and the requirements of ACI 318 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 Φ factors described in ACI 318 D.4.4 for Condition A are allowed. If the load combinations of ACI 318 Appendix C or Section 1902. 2 of the UBC are used, the appropriate value of Φ must be determined in accordance with ACI 318 D.4.5.

SZ HEAVY LOAD EXPANSION ANCHOR

TECHNICAL DATA (ALLOWABLE STRESS DESIGN) IN CRACKED AND UNCRACKED CONCRETE

- CARBON STEEL ANCHOR -

Load & Performance Data	Conc.(psi)	Symbol	Units	M6	M8	M10	M12
Cracked Concrete							
Aveg. ultimate load, tension	4,000	N_{pn}	lbs	3,765	5,780	7,717	9,988
Aveg. ultimate load shear BHL	4,000	V_n	lbs	5,620	8,497	12,510	18,849
Aveg. ultimate load shear LHL	4,000	V_n	lbs	5,125	7,171	10,363	19,041
Allowable Tension Loads[1]	2,500	N_{allow}	lbs	484	1,162	1,549	2,206
	4,000	N_{allow}	lbs	612	1,469	1,959	2,790
	6,000	N_{allow}	lbs	750	1,799	2,399	3,417
	8,500	N_{allow}	lbs	892	2,142	2,856	4,068
Uncracked Concrete							
Allowable Tension Loads[1]	2,500	N_{allow}	lbs	1,537	1,936	2,604	3,114
	4,000	N_{allow}	lbs	1,927	2,449	3,294	3,939
	6,000	N_{allow}	lbs	1,927	2,999	4,034	4,825
	8,500	N_{allow}	lbs	1,927	3,493	4,801	5,742
Cracked and Uncracked Concrete							
Allowable Shear Loads[1]	2,500	V_{allow}	lbs	1,670	2,557	3,778	4,751
	4,000	V_{allow}	lbs	1,670	2,557	3,778	6,010
	6,000	V_{allow}	lbs	1,670	2,557	3,778	6,597
Spacing & Edge Distance							
Effective Anchorage Depth		h_{ef}	in. (mm)	1.97 (50)	2.36 (60)	2.80 (71)	3.15 (80)
Critical Edge Distance		C_{ac}	in. (mm)	2.95 (75)	3.54 (90)	4.89 (107)	4.72 (102)
Critical Anchor Spacing		S_{ac}	in. (mm)	5.90 (150)	7.09 (180)	(213)	8.34 (240)
Minimum Spacing for Edge Distance C		S_{min}/C	in. (mm)	1.97/3.15 (50/80)	2.36/3.94 (60/100)	2.76/4.72 (70/120)	3.15/6.30 (80/160)
Minimum Edge Distance for Spacing S		C_{min}/S	in. (mm)	1.57/3.94 (50/100)	2.56/4.72 (60/120)	2.76/6.89 (70/175)	3.15/7.87 (80/200)
Minimum Thickness of Concrete slab		h_m	in. (mm)	3.94 (100)	4.72 (120)	5.51 (140)	6.30(160)
Installation Parameters							
Drilled Hole Diameter		d_o	in. (mm)	.39 (10)	.47 (12)	.59 (15)	.71 (18)
Diameter of Clearance Hole		d_c	in.(mm)	.47 (12)	.55 (14)	.67 (17)	.79 (20)
Depth of Drilled Hole		h_o	in. (mm)	2.25 (65)	3.15 (80)	3.74 (95)	4.13 (105)
Installation Torque		T_{inst}	ft-lbs	11	22	37	59
Wrench Size		WS	(mm)	(10)	(13)	(17)	(19)

NOTES:

1) Design strengths for use with allowable stress design (ASD) are calculated in accordance with ACI 318, Appendix D

SZ HEAVY LOAD EXPANSION ANCHOR

ANCHOR SELECTION - STAINLESS STEEL (GRADE A4-70)

Part Number		Bolt/Stud	Drill Bit/ Anchor	Anchor Length		Maximum Thickness	Box Quantity
LHS	BHS	diameter	diameter	LHS	BHS		
		mm	mm	mm	mm	mm	
LHS800	BHS800	8	12	75	79	0	50
LHS810	BHS810			85	89	10	50
*LHS830	*BHS830			105	109	30	50
LHS850	BHS850			125	129	50	25
-	BHS8100			-	179	110	25
LHS1000	BHS1000	10	15	91	95	0	25
LHS1015	BHS1015			106	110	15	25
*LHS1025	BHS1025			116	120	25	25
*LHS1045	*BHS1045			136	140	45	25
LHS1095	BHS1095			186	190	95	25
LHS1200	BHS1200	12	18	108	110	0	20
LHS1210	BHS1210			118	122	10	20
*LHS1220	*BHS1220			128	131	20	20
*LHS1240	*BHS1240			148	151	40	20
LHS1270	BHS1270			178	182	70	20
-	BHS12100			-	212	100	10
LHS1600	BHS1600	16	24	130	137	0	10
*LHS1620	*BHS1620			150	157	20	10
LHS1650	BHS1650			180	187	50	10
-	BHS16100			-	237	100	5

***= Stock Items**

SZ HEAVY LOAD EXPANSION ANCHOR

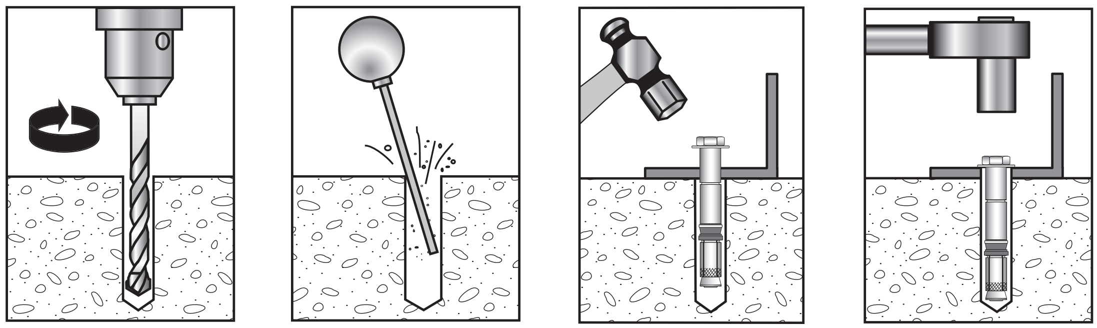
TECHNICAL DATA (ALLOWABLE STRESS DESIGN) FOR STAINLESS STEEL (A4) ANCHORS IN CRACKED AND UNCRACKED CONCRETE

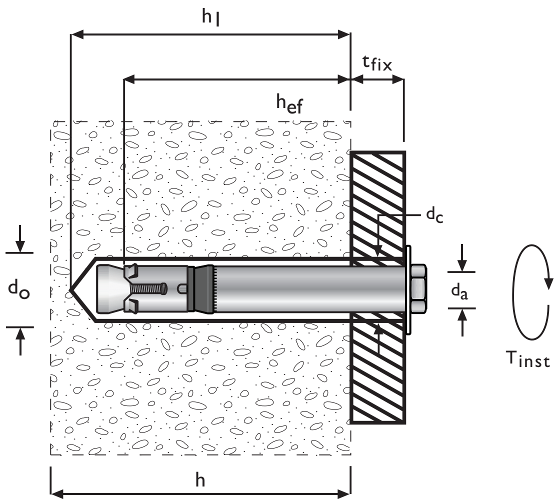
Load & Performance Data		Conc.(psi)	Symbol	Units	M8	M10	M12	M16
Cracked Concrete								
Aveg. ultimate load, tension		4,000	N_{pn}	lbs	4,676	7,459	8,781	16,240
Aveg. ultimate load shear	BHS	4,000	V_n	lbs	7,648	11,307	17,220	26,235
Aveg. ultimate load shear	LHS	4,000	V_n	lbs	7,648	11,307	17,220	26,235
Allowable Tension Loads[1]		2,500	N_{allow}	lbs	899	1,589	2,752	3,575
		4,000	N_{allow}	lbs	1,131	1,999	3,235	4,498
		6,000	N_{allow}	lbs	1,382	2,443	3,954	5,497
		8,500	N_{allow}	lbs	1,653	2,922	4,728	6,574
Uncracked Concrete								
Allowable Tension Loads[1]		2,500	N_{allow}	lbs	1,589	2,488	3,492	5,018
		4,000	N_{allow}	lbs	1,999	3,130	4,393	6,313
		6,000	N_{allow}	lbs	2,443	3,826	5,369	7,715
		8,500	N_{allow}	lbs	2,922	4,575	6,420	9,226
Uncracked Concrete								
Allowable Shear Loads[1]		2,500	V_{allow}	lbs	2,832	4,361	6,050	9,711
		4,000	V_{allow}	lbs	3,080	4,747	7,095	10,791
		6,000	V_{allow}	lbs	3,080	4,747	7,095	10,791
Spacing & Edge Distance								
Effective Anchorage Depth			h_{ef}	in. (mm)	2.36 (60)	2.80 (71)	3.15 (80)	3.93 (100)
Critical Edge Distance			C_{ac}	in. (mm)	3.54 (90)	4.89 (107)	4.72 (102)	5.9 (150)
Critical Anchor Spacing			S_{ac}	in. (mm)	7.09 (180)	8.38 (213)	8.34 (240)	11.81 (300)
Minimum Spacing for Edge Distance C			S_{min}/C	in. (mm)	2.36/3.94 (60/100)	2.76/4.72 (70/120)	3.15/6.30 (80/160)	7.08/7.08 (180/180)
Minimum Edge Distance for Spacing S			C_{min}/S	in. (mm)	2.56/4.72 (60/120)	2.76/6.89 (70/175)	3.15/7.87 (80/200)	7.08/7.08 (180/180)
Minimum Thickness of Concrete slab			h_m	in. (mm)	4.72 (120)	5.51 (140)	6.30(160)	7.87 (200)
Installation Parameters								
Drilled Hole Diameter			d_o	in. (mm)	.47 (12)	.59 (15)	.71 (18)	(24)
Diameter of Clearance Hole			d_c	in.(mm)	.55 (14)	.67 (17)	.79 (20)	(26)
Depth of Drilled Hole			h_o	in. (mm)	3.15 (80)	3.74 (95)	4.13 (105)	(130)
Installation Torque (LHS / BHS)			T_{inst}	Nm	35/30	55/50	90/80	170/170
Wrench Size			WS	(mm)	(13)	(17)	(19)	(24)

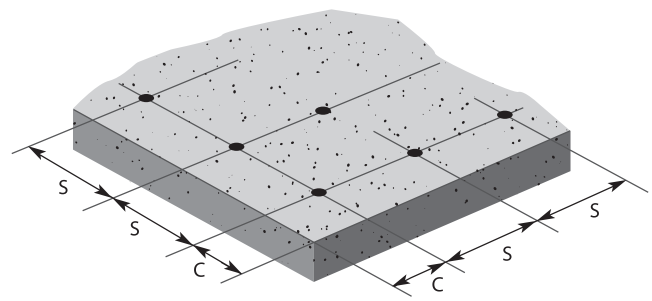
NOTES:

1) Design strengths for use with allowable stress design (ASD) are calculated in accordance with ACI 318, Appendix D

ANCHOR INSTALLATION







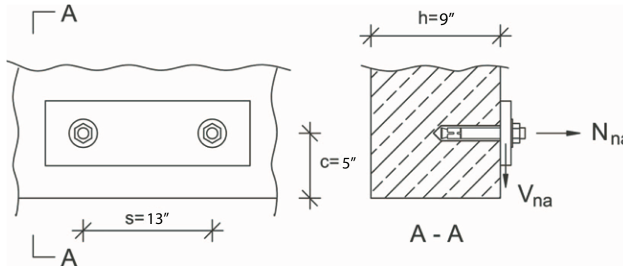
ANCHOR SPACING AND EDGE DISTANCE GUIDELINES (ALLOWABLE STRESS DESIGN)

Anchor Spacing	Reduction Factor	
	Tension	Shear
S_{ac} = 3.0 x h_{ef}	1.0	1.0
S_{min} = 1.5 x h_{ef}	0.70	0.70
Edge Distance		
C_{ac} = 1.5 x h_{ef}	1.0	1.0
C_{min} = 2.5 x h_{ef}	0.70	0.3

SZ HEAVY LOAD EXPANSION ANCHOR

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.



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

h = 9 in. ≥ h_{mi} = 7.9 in. o.k.
s = 12 in. ≥ S_{min} = 12.6 in. o.k.
$c_{a,min}$ = 5 in. ≥ c_{min} = 4.7 in. o.k.

2. Determine the Factored Tension and Shear Design Loads: 9.2.1

N_{ua} = 1.6 L = 1.6 x 4,000 = 6,400 lb.
V_{ua} = 1.6 L = 1.6 x 2000 = 3,200 lb.

3. Steel Capacity under Tension Loading: D.5.1

N_{sa} = 28,171
Φ = 0.65
n = 2 (double anchor group)
Calculating for ΦN_{sa} :
ΦN_{sa} = 0.65 x 2 x 28,171 = 36,622 lb.

4. Concrete Breakout Capacity under Tension Loading D.5.2

$N_{cbg} = \frac{A_{Nc}}{A_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ Eq.(D-5)

where:

$N = K_b \sqrt{f'_c} h_{ef}^{1.5}$ Eq.(D-7)

with $K_c = K_{cr} = 21$

$\Psi_{ec,N}$ = 1.0 since eccentrically e_N= 0 Eq.(D-9)

$\Psi_{ed,N} = 0.7+0.3 \frac{C_{a,min}}{1.5h_{ef}}$ when $C_{a,min} \leq 1.5h_{ef}$ Eq.(D-11)

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

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

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

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

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

$A_{Nco} = 9h_{ef}^2 = 9(3.94)^2$ = 139.71 In^2 Eq. (D-6)

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

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

Calculation for N_b and N_{cbg}:

$N_b = 21 \times 1.0 \times \sqrt{3{,}000} \times (3.94)^{1.5}$ = 8,995 lb.
N_{cbg} = 1.94 x 1.0 x 0.95 x 1.0 x 1.0 x 8,995 = 16,576 lb.
Φ = 0.65 for Condition B
(no supplementary reinforcement provided)

ΦN_{cb} = 0.65 x 16,576 = 10,776 lb.

5. Pullout Capacity D.5.3

not decisive

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

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

7. Steel Capacity under Shear Loading: D.6.1

Calculating for ΦV_{sa}:
V_{sa} = 2 x 19,100 = 38,200 lb.
Φ = 0.65
ΦV_{sa} = 0.65 x 38,262 = 24,870 lb.

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8. Concrete Breakout Capacity under Shear Loading: D.6.2

$V_{cbg} = \frac{A_{vc}}{A_{vco}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} V_b$ Eq.(D-24)

where:

$V_b = 7\left(\frac{l_e}{d_o}\right)^{0.2} \sqrt{d_o} \sqrt{f'_c}\, c_{a1}^{1.5}$ Eq. (D-24)

$\Psi_{ec,V} = 1.0$ since eccentricity $e'_V = 0$ Eq.(D-26)

$\Psi_{ed,V} = 1.0$ 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

calculating for $\frac{A_{Vc}}{A_{Vc0}}$

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

$A_{Vc} = (2(1.5c_{a1}) + s_1)\ 1.5c_{a1}$ Fig.

$= (2 \times 1.5 \times 5 + 13) \times 1.5 \times 5$ RD.6.2.1b

$= 210$ in.^{2}

$A_{Vc0} = 4.5\ (c_{a1})^2 = 4.5 \times 5^2 = 112.5$ in.^{2} Eq.(D-23)

$\frac{A_{Vc}}{A_{Vc0}} = \frac{210}{112.5} = 1.87$ D.6.2.1

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

$d_o = 0.93$ in.

$l_e = 2_{da} = 1.85$ in. D.6.2.2

$c_{a1} = 5$ in.

$\Phi = 0.70$ for Condition B

(no supplementary reinforcement provided)

$Vb = 7 \times \left(\frac{1.85}{0.93}\right)^{0.2} \times \sqrt{0.93} \times \sqrt{3{,}000} \times (5)^{1.5} = 4{,}749$ lb.

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

9. Concrete Pryout Strength: D.6.3

$V_{cpg} = K_{cp}\ N_{cbg}$

Where:

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

$\Phi = 0.70$ for Condition B

$\Phi V_{cpg} = 0.70 \times 2.0 \times 16{,}579 = 23{,}211$ lb.

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10. Check all Failure Modes under Shear Loading: D.4.1.2

Summary:

Steel Capacity = 24,830 lb.
Concrete Breakout Capacity = 6,216 lb. ← **Controls**
Pryout Capacity = 23,211 not decisive

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 tension design strength is permitted. D.7.2
By observation, this is not the case.

Therefore:

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

$\frac{6{,}400}{10{,}776} + \frac{3{,}200}{6{,}216} = 0.59 + 0.51 = 1.10 < 1.2$ - 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 and 2,000 lb., respectively.