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FROELICH
ENGINEERS

Client: MGA
Project: SELLWOOD APTS
Proj. #: 12-7133
Date: 1-31-13
By: RH

HOLDOWN TYPE 1

ACI 318-05 Appendix D - Tension Failures (Page 1 of 4)

Anchor description: **ASTM A36 Embeded Bolts**

	1	**Number of Anchors**	s_1 = **0**	in. (see Fig.
	1.250	**Inch Diameter**	s_2 = **0**	RD.5.2.1)
	21	**Inch Embed**		
	3000	**psi Concrete Footing**		
N_{Design} =	**58.800**	**(kips) Concrete Factored Tension Loads (applied loads)**		

D.3 - General Requirements (ACI 318-05 Section D.3.3.3)

Are seismic loads induced into the anchor (SDC C, D, E, or F)? **Y** S_F = 0.75

D.4 - General Requirements for Anchor Strength (ACI 318-05 Section D.4.4)

Strength reduction factor Φ for anchors using load combinations from ACI 318-05 section 9.2

Will anchor be governed by brittle steel failure? **N** Anchor Φ = 0.75

Brittle failure: 0.65 *(brittle defined by tensile test elongation less than 14%)*

Ductile failure: 0.75

Is rebar present around anchor to resist blowout? **Y** Reinforcing Φ = 0.75

If rebar is present around anchor: 0.75

Otherwise, 0.70

Summary

Summary From Below	ΦN_n	$\Phi N_{n\ Wind}$ $S_W = 1.0$	$\Phi N_{n\ Seismic}$ $S_F = 0.75$	
ΦN_{sa} =	87.22	87.22	65.41	kips
ΦN_{cb} =	211.35	211.35	158.51	kips
ΦN_{pn} =	139.92	139.92	104.94	kips
ΦN_{sb} =	274.88	274.88	206.16	kips
Minimum ΦN_n =	87.22	87.22	65.41	kips

N_{design}	<	$\Phi N_{Allowable}$
58.800	<	**65.41**

Therefore, Anchor Design OK

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Tension Design Calculations

D.5.1 - Steel Strength for Anchor in Tension

d_o (Anchor Diameter) =	1.250	inches
n =	1	# of anchors
n_t =	7	Number of Threads per inch
A_{se} =	0.97	in.^{2}- (effective cross-sectional area of anchor)
f_{uta} =	**120.00**	ksi - (tensile strength of anchor material (not the yield strength) not exceed 1.9f_y or 125 ksi)
N_{sa} =	116.29	kips - (Eqn. D-3)
Anchor Φ =	0.75	
ΦN_{sa} =	**87.22**	**kips**

$$N_{sa} = nA_{se}f_{uta}$$

D.5.2 - Concrete Breakout Strength of Anchor in Tension

s_1 =	0	inches (see Fig. RD.5.2.1)
s_2 =	0	inches (see Fig. RD.5.2.1)
A_{nc} (for single anchor) =	**8100**	in.^{2} (see Figure RD.5.2.1)
A_{nc} (for group anchor) =	**8100**	in.^{2} (see Figure RD.5.2.1)
A_{Nco} (for single anchor) =	3969	in.^{2} (see Figure RD.5.2.1)
A_{Nco} (for group anchor) =	3969	in.^{2} (see Figure RD.5.2.1)
$\Psi_{ec,N}$ =	**0.9**	Eqn. D-9 (Anchors not Eccentrically Loaded, Ψ_1=1.0) Section D.5.2.4
$\Psi_{ed,N}$ =	0.986	Eqn. D-10 & D-11
$\Psi_{c,N}$ =	**1**	1.0 for cracked concrete, for uncracked see Section D.5.2.6
k_c =	**24**	(24 for cast anchors, 17 for post-installed) Section D.5.2.2
f'c =	3000	psi
h_{ef} =	21	inches
c_{min} =	**30**	in - distance to closest edge of concrete
N_b =	126.50	kips - (Eqn. D-7)
$N_b \leq$	140.08	kips - (Eqn. D-8) - For h_{ef} between 11" and 25"
N_b to use for design:	140.08	kips
N_{cb} =	281.80	kips - (Eqn. D-4)
N_{cbg} =	0.00	kips - (Eqn. D-5)
Reinforcing Φ =	0.75	
ΦN_{cbg} =	**211.35**	**kips**

$1.5*h_{ef}$ = 31.5

$0.7+0.3(c_{min}/1.5h_{ef})$ = 0.986

$$N_b = k_c\sqrt{f'c}\,h_{ef}^{1.5}$$

$$N_b \leq 16\sqrt{f'c}\,h_{ef}^{\frac{5}{3}}$$

$$N_{cbg} = \frac{A_{Nc}}{A_{Nco}}\Psi_{ec,N}\Psi_{ed,N}\Psi_{c,N}N_b$$

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D5.3 - Single Anchor Pullout - headed or embedded nut

Use Plate Washer?	**y**	
Plate Washer Width =	**3**	inches (square plate)
Nut diameter =	1.875	inches
Nut or Plate Washer Bearing Area =	9.000	in^2
Abrg =	7.77	in^2 - bearing area of embedded anchors head or nut (or plate)
$\Psi_{c,P}$ =	**1**	1.0 for cracked concrete, 1.4 for uncracked (ACI 318-05 Section D.5.3.6)
n =	1	# of anchors
N_p =	186.56	(kips) Eqn. D-15
N_{pn} =	186.56	(kips) Eqn. D-14
Reinforcing Φ =	0.75	
ΦN_{pn} =	**139.92**	**kips**

$$N_p = A_{brg} 8 f'c$$

$$N_{pn} = N_p \psi_{c,P}$$

D5.4 - Anchor side-faced blowout - Headed Anchor

(Required only if anchor is near an edge where $c_{a1} < 0.4h_{ef}$)

Anchor is not close to Edge of Concrete. Analysis below NOT Required.

c_{a2} =	**30**	distance to perp edge of concrete from anchor
c_{a1} =	30	in - distance to closest edge of concrete
N_{sb} =	733.01	(kips) Eqn. D-17
Factored N_{sb} =	366.50	
Reinforcing Φ =	0.75	
ΦN_{sb} (for single anchor) =	**274.88**	**kips**

$$N_{sb} = 160\ c_{a1} \sqrt{A_{brg}} \sqrt{f'c}$$

Bolt Group: Set of bolts along side with distance c_{a1} from edge:

n =	**1**	Number of anchors in group at c_{a1} from edge
n_2 =	**1**	Number of anchors in group away from edge
s =	**1**	in - spacing of outer anchors in group
N_{sbg} =	368.54	(kips) Eqn. D-18
Reinforcing Φ =	0.75	
ΦN_{sbg} (bolts at edge) =	**276.40**	**kips**
ΦN_{sbg} (bolts at edge) =	**276.40**	**kips/bolt**
ΦN_{sbg} (total bolt group) =	**552.81**	**kips**

$$N_{sbg} = \left(1 + \frac{s}{6c_{a1}}\right) N_{sb}$$

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Bolt Group: Set of bolts along side with distance c_{a2} from edge:

n =	**1**	Number of anchors in group at c_{a2} from edge
n_2 =	**1**	Number of anchors in group away from edge
s =	**1**	in - spacing of outer anchors in group
N_{sbg} =	368.54	(kips) Eqn. D-18
Reinforcing Φ =	0.75	
ΦN_{sbg} (bolts at edge) =	**276.40**	**kips**
ΦN_{sbg} (bolts at edge) =	**276.40**	**kips/bolt**
ΦN_{sbg} (total bolt group) =	**552.81**	**kips**

$$N_{sbg} = \left(1 + \frac{s}{6c_{a1}}\right) N_{sb}$$

Final value for side-faced blowout: 274.88 kips

SIMPSON Strong-Tie®

PAB *Pre-Assembled Anchor Bolt*

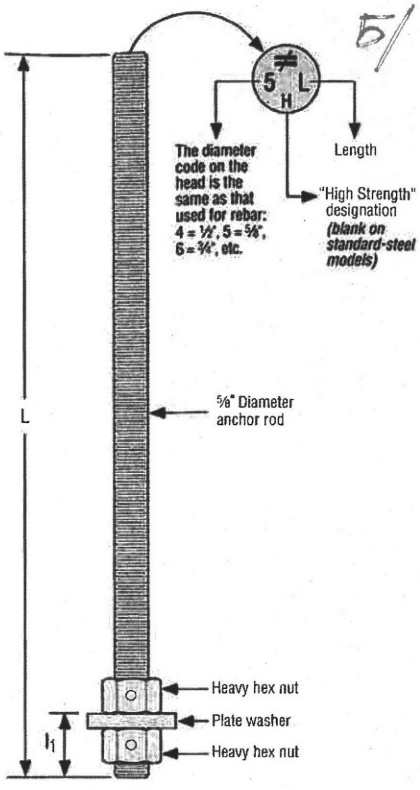
The PAB anchor bolt is a versatile cast-in-place anchor bolt ideal for high-tension-load applications. It features a plate washer at the embedded end sandwiched between two fixed hex nuts and a head stamp for easy identification after the pour.

- Available in diameters from ½" to 1¼" in lengths from 12" to 36" *(in 6" increments)*
- Available in standard and high-strength steel
- Head stamp contains the No Equal sign, diameter designation and an "HS" on high-strength rods

MATERIAL: Standard Steel – ASTM F1554 Grade 36, A36 or A307 – F_u = 58 ksi
High-Strength Steel *(up to 1" dia.)* – ASTM A449 – F_u = 120 ksi
High-Strength Steel *(1⅛" and 1¼" dia.)* – ASTM A193 B7 or F1554 Grade 105 – F_u = 125 ksi

FINISH: None

The Simpson Strong-Tie® Anchor Designer Software™ analyzes and suggests 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 anchorage solutions for numerous Simpson Strong-Tie mechanical and adhesive anchors as well as the PAB anchor bolt. With its easy-to-use graphical user interface, the software makes it easy for the Designer to identify anchorage solutions without having to perform time-consuming calculations by hand.



PAB

PAB Anchor Bolt – Standard Steel

Diameter (in.)	Plate Washer Size (in.)	l_1 (in.)	Root Model No.	Lengths (in.)
½	¼ x 1¼ x 1¼	1	PAB4-XX	12" to 36" *(in 6" increments)*
⅝	⅜ x 1½ x 1½	1¼	PAB5-XX	
¾	⅜ x 2 x 2	1⅜	PAB6-XX	
⅞	⅜ x 2¼ x 2¼	1½	PAB7-XX	
1	⅜ x 2½ x 2½	1⅝	PAB8-XX	
1⅛	⅜ x 2¾ x 2¾	1¾	PAB9-XX	
1¼	½ x 3 x3	2	PAB10-XX	

How to specify and order:

When calling out PAB anchor bolts, substitute the desired length for the "XX" in the Root Model Number.

For a ⅝"x18" anchor bolt, the model number would be PAB5-18 *(or PAB5H-18 for high strength)*.

1. Plate washers are designed to develop the capacity of the bolt.

PAB Anchor Bolt – High-Strength Steel

Diameter (in.)	Plate Washer Size (in.)	l_1 (in.)	Root Model No.	Lengths (in.)
½	¼ x 1¼ x 1¼	1	PAB4H-XX	12" to 36" *(in 6" increments)*
⅝	⅜ x 1½ x 1½	1¼	PAB5H-XX	
¾	⅜ x 2 x 2	1⅜	PAB6H-XX	
⅞	⅜ x 2¼ x 2¼	1½	PAB7H-XX	
1	⅜ x 2½ x 2½	1⅝	PAB8H-XX	
1⅛	⅜ x 2¾ x 2¾	1¾	PAB9H-XX	
1¼	½ x 3 x 3	2	PAB10H-XX	

PAB Anchor Bolt – Anchorage Solutions

Design Criteria	Diameter (in.)	Anchor Bolt Model No.	2500 psi Concrete Dimensions (in.) de (in.)	F (in.)	Tension Load (lbs.) ASD	LRFD	3000 psi Concrete Dimensions (in.) de (in.)	F (in.)	Tension Load (lbs.) ASD	LRFD
Wind	½	PAB4	4	6	3705	6175	4	6	3705	6175
	⅝	PAB5	4	6	4030	6720	4	6	4415	7360
			5½	8½	5900	9830	5	7½	5900	9830
	¾	PAB6	5½	8½	6500	10835	5	7½	6175	10290
			7	10½	8730	14550	6½	10	8730	14550
	⅞	PAB7	6	9	7405	12345	5½	8½	7120	11870
			8½	13	12050	20085	8	12	12050	20085
		PAB7H	8½	13	12490	20815	8	12	12495	20820
			13½	20½	24935	41555	13	19½	24935	41555
	1	PAB8	8	12	11405	19005	7½	11½	11340	18900
			10	15	15810	26350	9½	14½	15810	26350
		PAB8H	10	15	15940	26565	9½	14½	16165	26945
			16	24	32710	54515	15	22½	32710	54515
	1⅛	PAB9	9	13½	13610	22680	8	12	12495	20820
			12	18	19920	33200	11	16½	19920	33200
	1¼	PAB10	12	18	21135	35225	11	16½	20025	33375
Seismic	½	PAB4	5	7½	4320	6175	4½	7	4320	6175
	⅝	PAB5	6½	10	6880	9830	6	9	6880	9830
	¾	PAB6	7½	11½	9060	12940	7	10½	8945	12780
			8½	13	10185	14550	8	12	10185	14550
	⅞	PAB7	9	13½	11905	17010	8½	13	11970	17100
			10½	16	14060	20085	9½	14½	14060	20085
		PAB7H	14½	22	25350	36215	13½	20½	24650	35215
			16	24	29090	41555	15	22½	29090	41555
	1	PAB8	11	16½	15995	22850	10½	16	16435	23480
			12	18	18445	26350	11½	17½	18445	26350
		PAB8H	17	25½	33045	47205	16	24	32720	46740
			19	28½	38160	54515	18	27	38160	54515
	1⅛	PAB9	12½	19	19795	28275	12	18	20255	28940
			14	21	23240	33200	13½	20½	23240	33200
	1¼	PAB10	14½	22	25350	36215	14	21	26190	37415
			16	24	29510	42155	15½	23½	29510	42155

HOLDOWN NUMBER ON HOLDOWN SCHEDULE

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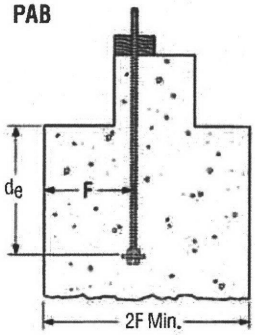

Design loads are calculated using a full shear cone. Coverage on each side of the bolt shall be a minimum of F or reductions must be taken.

Naming Scheme:

PAB5H-12

PAB Anchor Bolt — Diameter* and Grade — Length (12", 18", 24", 30" or 36")

*** Units in ⅛" Increments (Ex: 9 = ⅝" or 1⅛")**

1. Anchorage designs conform to ACI 318-11 Appendix D and assume cracked concrete with no supplementary reinforcement.
2. Seismic indicates Seismic Design Category C through F. Detached one- and two-family dwellings in SDC C may use wind anchorage solutions. Seismic anchorage designs conform to ACI 318-11 Section D3.3.4.
3. Wind includes Sesmic Design Category A and B.
4. Foundation dimensions are for anchorage only. Foundation design *(size and reinforcement)* by Designer. The registered design professional may specify alternate embedment, footing size, and anchor bolt.
5. Allowable Stress Design (ASD) values are obtained by multiplying Load Factor Resistance Design (LRFD) capacities by 0.7 for Seismic and 0.6 for Wind.

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