

Dongxiao Wu P. Eng.

CivilBay Concrete Anchorage Design v1.5.0 User Manual

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2.0 QUICK START

2.1 Software Installation

- After downloading the ZIP file the user can unzip the file and save it to user's computer.
- The extracted files are in 6 folders for the version of different codes as shown in the folder name. Each folder contains compiled Excel files in EXE format.

Name 🔺	Size Type
🚞 01 ACI 318-11	File Fold
🚞 02 ACI 318-08	File Fold
🛅 03 ACI 318M-11	File Fold
🛅 04 ACI 318M-08	File Fold
🛅 05 CSA A23.3-04	File Fold
🛅 06 ACI 349-06 Shear Key	File Fold

User can go to the folder and double click on the EXE file and open it just as normal Excel file.

Name 🔺
Signal Anchor Bolt ACI 318-11.exe
https://www.communication.com/studence/studenc
👫 01-03 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - PIN.exe
👫 01-04 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - PIN.exe
👫 01-05 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - MC.exe
Sign 1-06 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - MC.exe

- The 15-day trial will start the same date when user tries any of these compiled Excel files.
- During trial period the software provides full functions except that the user can not save the file, but the user can print the file to printer and get a hard copy of the calculation for verification.
- The trial period will expire after 15 days. Any time during or after trial period the user can go to <u>www.civilbay.com</u> to purchase a license.

 After placing the order, the user shall send his/her Computer ID to author for licensing. The user can get his/her Computer ID by clicking on Copy Computer ID button on the pop-up dialog box.

Civi	Bay Concrete Anchorage 1.5.0 - Trial Mode	
<u>^</u>	Your trial license is going to expire in 15 days on 2/9/2013	~
<u> </u>	Please go to <u>http://www.civilbay.com/register.htm</u> to purchase the license.	
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	Web : <u>www.civilbay.com</u> Email: <u>http://www.civilbay.com/contact.htm</u>	
	Powered by DoneEx XCell Compiler	
	Copy Computer ID Contact Author	Close

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- After receiving user's Computer ID, the author will send the user a license key to unlock the trial version.
- The user shall save the license key file at the same folder where the compiled Excel files locate.
- The user can copy, save and rename any of the compiled Excel files and use them same as the normal Excel files.
- All the compiled Excel files will fully function as long as they can find the license key in the same folder.
- The license key is created using the Computer ID sent by the user and it only works on that computer where the Computer ID is retrieved from.

2.3 Concrete Anchorage Design v1.5.0 Modules

• 01 ACI 318-11 Folder

Dist\01 Conc Anchorage\32 bit\01 ACI 318-11

Name 🔺
5 01-01 Headed Anchor Bolt ACI 318-11.exe
5 01-02 Headed Welded Stud ACI 318-11.exe
👫 01-03 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - PIN.exe
👫 01-04 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - PIN.exe
👫 01-05 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - MC.exe
🚰 01-06 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - MC.exe

01-01 Headed Anchor Bolt ACI 318-11.exe

Headed anchor bolt design using ACI 318-11 code This workbook contains 7 worksheets

Program Description		Update Logo				
This is a spreadsheet written to de	sign Headed Anchor Bolt anchorage to concrete using ACI 318-11 code.					
This workbook contains 7 workshe	This workbook contains 7 worksheets, described as followings:					
1. Doc	This worksheet.					
2. Anchor Bolt TS Reinft	Group anchor bolt under tension + shear using anchor reinft to resist breakout					
3. Anchor Bolt TSM Reinft	Group anchor bolt under tension + shear + moment using anchor reinft to resist brea	kout				
4. Anchor Bolt TS Conc	Group anchor bolt under tension + shear using concrete to resist breakout					
5. Anchor Bolt TSM Conc	Group anchor bolt under tension + shear + moment using concrete to resist breakou	t				
6. Anchor Bolt Single Reinft	Single anchor bolt under tension + shear using anchor reinft to resist breakout					
7. Anchor Bolt Single Conc	Single anchor bolt under tension + shear using concrete to resist breakout					

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01-02 Headed Welded Stud ACI 318-11.exe

Headed welded stud design using ACI 318-11 code This workbook contains 7 worksheets

Program Description		Update Logo				
This is a spreadsheet written to de	This is a spreadsheet written to design Headed Anchor Stud anchorage to concrete using ACI 318-11 code.					
This workbook contains 7 workshe	This workbook contains 7 worksheets, described as followings:					
1. Doc	This worksheet.					
2. Anchor Stud TS Reinft	Group anchor stud under tension + shear using anchor reinft to resist breakout					
3. Anchor Stud TSM Reinft	Group anchor stud under tension + shear + moment using anchor reinft to resist brea	akout				
4. Anchor Stud TS Conc	Group anchor stud under tension + shear using concrete to resist breakout					
5. Anchor Stud TSM Conc	Group anchor stud under tension + shear + moment using concrete to resist breakou	t				
6. Anchor Stud Single Reinft	Single anchor stud under tension + shear using anchor reinft to resist breakout					
7. Anchor Stud Single Conc	Single anchor stud under tension + shear using concrete to resist breakout					

01-03 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - PIN.exe

One input to design both base plate and anchor bolt using ACI 318-11 code In anchor bolt design Anchor Reinforcement is used to replace concrete tension/shear breakout strength. In base plate design the column base is assumed to be PIN connection and doesn't have moment.

01-04 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - PIN.exe

One input to design both base plate and anchor bolt using ACI 318-11 code In anchor bolt design NO Anchor Reinforcement is used. In base plate design the column base is assumed to be PIN connection and doesn't have moment.

01-05 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design With Anchor Reinft - MC.exe

One input to design both base plate and anchor bolt using ACI 318-11 code In anchor bolt design Anchor Reinforcement is used to replace concrete tension/shear breakout strength. In base plate design the column base is assumed to be Moment connection and carries moment.

01-06 Base Plate (LRFD) & Anchor Bolt (ACI 318-11) Design No Anchor Reinft - MC.exe

One input to design both base plate and anchor bolt using ACI 318-11 code

In anchor bolt design NO Anchor Reinforcement is used.

In base plate design the column base is assumed to be Moment connection and carries moment.

• 02 ACI 318-08 Folder

	Name 🔺
۲	Signal Anchor Bolt ACI 318-08.exe
	https://www.communication.com/www.communication.com/www.communication.com/www.communication.com/www.com/www.com
*	👫 02-03 Base Plate (LRFD) & Anchor Bolt (ACI 318-08) Design With Anchor Reinft - PIN.exe
~	👫 02-04 Base Plate (LRFD) & Anchor Bolt (ACI 318-08) Design No Anchor Reinft - PIN.exe
	👫 02-05 Base Plate (LRFD) & Anchor Bolt (ACI 318-08) Design With Anchor Reinft - MC.exe
	http://www.communication.com/communications/

Same as 01 ACI 318-11 folder but in ACI 318-08 code

• 03 ACI 318M-11 Folder



Same as 01 ACI 318-11 folder but in ACI 318M-11 code.

It only contains anchor bolt design spreadsheets and doesn't contain base plate design spreadsheets.

• 04 ACI 318M-08 Folder

T\04 ACI	318M-08	
-	Name 🔺	
۲	异04-01 Headed Anchor Bolt ACI 318M-08 SI Unit.exe	
	异 04-02 Headed Welded Stud ACI 318M-08 SI Unit.exe	
۲		

Same as 01 ACI 318-11 folder but in ACI 318M-08 code.

It only contains anchor bolt design spreadsheets and doesn't contain base plate design spreadsheets.

• 05 CSA A23.3-04 Folder

	Name 🔺	
۲	500 Headed Anchor Bolt CSA A23.3-04.exe	
	500 Second Stud CSA A23.3-04.exe	
\$	≒ 05-03 Base Plate & Anchor Bolt (CSA A23.3-04) Design With Anchor Reinft - PIN.exe	
	👫 05-04 Base Plate & Anchor Bolt (CSA A23.3-04) Design No Anchor Reinft - PIN.exe	
	👫 05-05 Base Plate & Anchor Bolt (CSA A23.3-04) Design With Anchor Reinft - MC.exe	
	👫 05-06 Base Plate & Anchor Bolt (CSA A23.3-04) Design No Anchor Reinft - MC.exe	

Same as 01 ACI 318-11 folder but in CSA A23.3-04 (R2010) code.

06 ACI 349-06 Shear Key Folder

I\06 ACI 349-06 Shear Key Name O6-01 Shear Key ACI 349-06.exe O6-02 Shear Key ACI 349M-06.exe

06-01 Shear Key ACI 349-06.exe

Shear lug design using ACI 349-06 code

06-02 Shear Key ACI 349M-06.exe

Shear lug design using ACI 349M-06 code (metric unit)

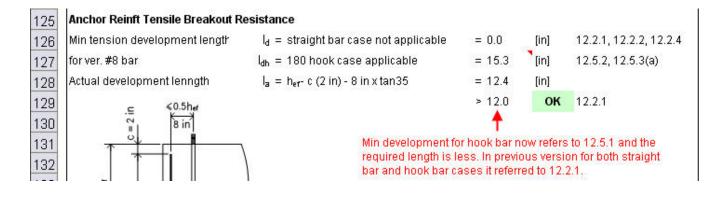
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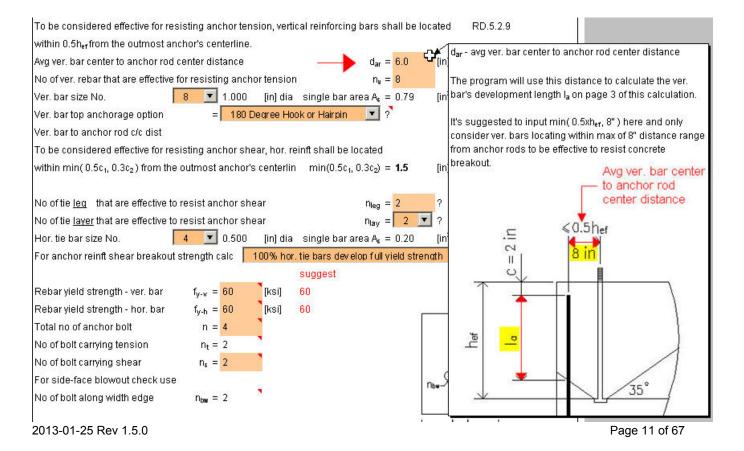
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3.0 WHAT'S NEW IN v1.5.0

- ACI 318-11 and ACI 318M-11 code version are added
- Seismic design part is completely re-written to allow users to select specific options to meet seismic design requirements.
- Min development for hook bar now refers to 12.5.1 and the required length is less. In previous version for both straight bar and hook bar cases it all referred to 12.2.1.

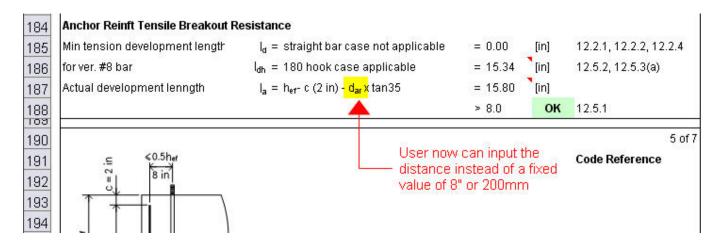


For case using vertical rebar to resist concrete tensile breakout, user now can input the average distance between
vertical rebar and anchor rod. In previous version this distance is fixed at 8" or 200mm. Many users complain they can
get a closer distance than 8" or 200mm and cannot take advantage of that. Now users have the option to input the
distance instead of a fixed value.



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• For concrete shear breakout resistance check, in previous version the program only checked perpendicular to edge case. In the new version check on parallel to edge case as per ACI 318-08 D.6.2.1 (c), or A23.3-04 (R2010) D.7.2.1 (c) is added. User can refer to page 7 and 8 of calculation for the new added check.

108	
109 Shear	
110 Anchor Rod Shear Resistance	ratio = 0.35
111 Conc. Shear Breakout Resistance - Perpendicula	r To Edge ratio = 0.45
112 Conc. Shear Breakout Resistance - Parallel To Ec	dge ratio = 0.14
113 Conc. Pryout Shear Resistance 🔶 🔶	ratio = 0.14
114	

Bug fixed

In concrete tensile breakout resistance check, the A_{NC} calculation in previous version didn't take advantage of enlarged edge distance when $s_{tb} < s_1$. In the new version, when only part of anchor bolts mobilize tensile force under moment, the A_{NC} calculation will re-calculate the bolt edge distance starting from the anchor bolts mobilizing tensile force to calculate A_{NC} .

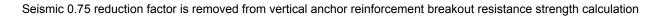
162	Conc. Tensile Breakout Resist	tance			
163		N_b = 24 $\lambda \sqrt{f_c} h_{e\tau}^{1.5}$ if $h_{e\tau} < 11^{\circ}$ or $h_{e\tau} > 25^{\circ}$	= 170.2	[kips]	D.5.2.2 (D-7)
164		16 ລ √f _c h ^{5/3} if 11'≤h _{er} ≤ 25'			D.5.2.2 (D-8)
165					
166	Projected conc failure area	1.5h _{er} =	= 32.48	[in]	
167		$A_{Nc} = [s_{tb} + min(c_1, 1.5h_e) + min(c_3, 1.5h_e)]x$	= 1720.5	[in ²]	
168		[s ₂ +min(c ₂ ,1.5h _e)+min(c ₄ ,1.5h _e)]	•		
169		$A_{Nco} = 9 h_{ef}^{2}$	= 4220.1	[in ²]	D.5.2.1 (D-6)

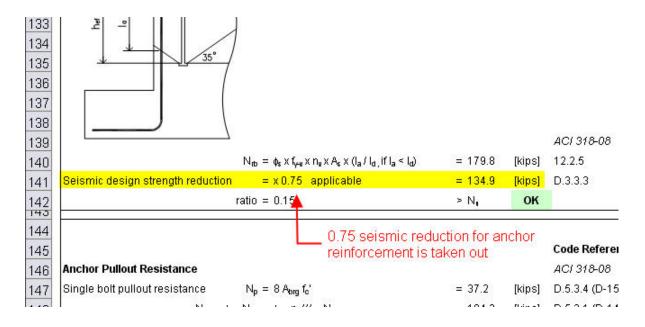
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 Add two worksheets specifically for single anchor bolt/stud design with anchor reinforcement and without anchor reinforcement

8		Update Logo
9	Program Description	Opulae Lugu
10	This is a spreadsheet written	to design Headed Anchor Bolt anchorage to concrete using ACI 318-08 code.
11	This workbook contains 7 wor	rksheets, described as followings:
12	1. Doc	This worksheet.
13		
14	2. Anchor Bolt TS Reinft	Group anchor bolt under tension + shear using anchor reinft to resist breakout
15		
16	3. Anchor Bolt TSM Reinft	Group anchor bolt under tension + shear + moment using anchor reinft to resist breakout
17		
18	4. Anchor Bolt TS Conc	Group anchor bolt under tension + shear using concrete to resist breakout
19		
20	5. Anchor Bolt TSM Conc	Group anchor bolt under tension + shear + moment using concrete to resist breakout
21		
22	6. Anchor Bolt Single Reinft	Single anchor bolt under tension + shear using anchor reinft to resist breakout
23		
24	7. Anchor Bolt Single Conc	Single anchor bolt under tension + shear using concrete to resist breakout
25		two newly added worksheets
26	How to Use	for single bolt case design
27	1. User can replace logo imag	

 For ACI 318-08, ACI 318M-08 and CSA A23.3-04 version worksheets, when using anchor reinforcement to resist concrete tensile and shear breakout, the seismic 0.75 reduction factor has been taken out from vertical and horizontal anchor reinforcement breakout resistance strength calculation





Seismic 0.75 reduction factor is removed from horizontal anchor reinforcement breakout resistance strength calculation

247						
248	Single tie bar tension resistanc	$T_r = \varphi_s \times f_{\gamma \! - \! b} ;$	κ A _s	= 9.0	(kips)	
249						
250	Total tie bar tension resistance	V _{rb} = 1.0 x n	хTr	= 72.0	[kips]	
251	Seismic design strength reduction	= x 0.75	applicable	= 54.0	[kips]	D.3.3.3
252	4	ratio = 0 📥		> V,	ок	
253				eduction for ancl	hor	
254	Conc. Pryout Shear Resistance		reinforcement	is taken out		
255	The pryout failure is only critical for s	short and stiff a	anchors. It is reason	able to assume that	for gene	ral
256	cast-in place headed anchors with I	n _{ef} > = 12d _a , th	e pryout failure will r	not govern		

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4.0 SEISMIC DESIGN REQUIREMENTS

4.1 ACI 318-11 and ACI 318M-11 Code

Seismic Design Requirements For Tension \rightarrow D.3.3.4.3

This input is requiredwhen seismic SDC >= C (D.3.3.1) and Tensile E > 0.2U (D.3.3.4.2)User can ignore this input when seismic SDC < C (D.3.3.1) or Tensile E <= 0.2U (D.3.3.4.1)

Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.3.3.4.3(a) Ductile anchor connection	 U = 1.2D + 1.0E + 1.0L + 0.2S Eq. (9-5) U = 0.9D + 1.0E Eq. (9-7) * When Option 1 is selected, user has to verify the conditions in D.3.3.4.3(a) subsections 3~6, as applicable, are met. * The program will flag OK if D.3.3.4.3(a) subsections 1 & 2 are met and the ductile anchor steel strength has the highest utilization ratio.
Option 2 D.3.3.4.3(b) Ductile attachment	 * The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the tensile load N_u user input above. * User may re-input the tensile load N_u above to satisfy this option.
Option 3 D.3.3.4.3(c) Nonyielding attachment	 * The anchor bolt's non-yielding attachments, such as wood sill plate, will go for non-ductile failure, such as crushing, before or at the time when the anchor bolt reaching the tensile load N_u user input above. * User may re-input the tensile load N_u above to satisfy this option.
Option 4 D.3.3.4.3(d) Overstrength forces	 * The tensile load N_u user input above includes the seismic load E, with E increased by multiplying overstrength factor Ω₀ * User may re-input the tensile load N_u above to satisfy this option. U = 1.2D + Ω₀ (1.0E)+ 1.0L + 0.2S Eq. (9-5) U = 0.9D + Ω₀(1.0E) Eq. (9-7)

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Seismic Design Requirements For Shear \rightarrow D.3.3.5.3

```
This input is requiredwhen seismic SDC >= C (D.3.3.1) and Shear E > 0.2U (D.3.3.5.2)User can ignore this inputwhen seismic SDC < C (D.3.3.1) or Shear E <= 0.2U (D.3.3.5.1)</td>
```

Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.3.3.5.3(a) Ductile attachment	 * The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the shear load V_u user input above. * User may re-input the shear load V_u above to satisfy this option.
Option 2 D.3.3.5.3(b) Nonyielding attachment	 * The anchor bolt's non-yielding attachments, such as wood sill plate, will go for non-ductile failure, such as crushing, before or at the time when the anchor bolt reaching the shear load V_u user input above. * User may re-input the shear load V_u above to satisfy this option.
Option 3 D.3.3.5.3(c) Overstrength forces $\Omega = \Omega $	 * The shear load V_u user input above includes the seismic load E, with E increased by multiplying overstrength factor Ωo * User may re-input the shear load V_u above to satisfy this option. U = 1.2D + Ωo (1.0E)+ 1.0L + 0.2S Eq. (9-5) U = 0.9D + Ωo(1.0E) Eq. (9-7)

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4.2 ACI 318-08 and ACI 318M-08 Code

Seismic Design Requirements For Tension \rightarrow D.3.3.4 ~ D.3.3.6

This input is required when seismic SDC >= C (D.3.3)

User can ignore this input when seismic SDC < C (D.3.3)

Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.3.3.4 Ductile anchor connection	Option 1 is satisfied if $\phi N_{sa} < 0.75 \phi (N_{cbg}, N_{pn}, N_{sbg})$ The design steel strength must be the governing design strength and having the highest utilization ratio. The program will flag NG if Option 1 is selected and this condition is not met.
Option 2 D.3.3.5 Ductile attachment	The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the tensile load N _u user input above. User may re-input the tensile load N _u above to satisfy this option.
Option 3 D.3.3.6 Non-ductile reduction factor ϕ_{nd} $\times \phi_{nd}$	Non-ductile reduction factor ϕ_{nd} will be applied to the concrete failure modes. Option 3 is satisfied if $\phi_{nd} \phi N_n > N_u$ User shall input non-ductile reduction factor ϕ_{nd} next line if Option 3 is selected.

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Seismic Design Requirements For Shear \rightarrow D.3.3.4 ~ D.3.3.6

This input is required when seismic SDC >= C (D.3.3)

User can ignore this input when seismic SDC < C (D.3.3)

Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.3.3.4 Ductile anchor connection	Option 1 is satisfied if $\phi V_{sa} < 0.75 \phi (V_{cbg}, V_{cpg})$ The design steel strength must be the governing design strength and having the highest utilization ratio. The program will flag NG if Option 1 is selected and this condition is not met.
Option 2 D.3.3.5 Ductile attachment	The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the tensile load V _u user input above. User may re-input the tensile load V _u above to satisfy this option.
Option 3 D.3.3.6 Non-ductile reduction factor ϕ_{nd} $x \phi_{nd}$	Non-ductile reduction factor ϕ_{nd} will be applied to the concrete failure modes. Option 3 is satisfied if $\phi_{nd} \phi V_n > V_u$ User shall input non-ductile reduction factor ϕ_{nd} next line if Option 3 is selected.

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Seismic Design Requirements For Tension \rightarrow D.4.3.6 ~ D.4.3.8

This input is required when seismic $I_EF_aS_a(0.2) \ge 0.35$ (D.4.3.3)

User can ignore this input when seismic $I_EF_aS_a(0.2) < 0.35$ (D.4.3.3)

Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.4.3.6 Ductile anchor connection	Option 1 is satisfied if $\phi N_{sa} < 0.75 \phi (N_{cbg}, N_{pn}, N_{sbg})$ The design steel strength must be the governing design strength and having the highest utilization ratio. The program will flag NG if Option 1 is selected and this condition is not met.
Option 2 D.4.3.7 Ductile attachment	The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the tensile load N _u user input above. User may re-input the tensile load N _u above to satisfy this option.
Option 3 D.4.3.8 Non-ductile reduction factor ϕ_{nd} x ϕ_{nd}	Non-ductile reduction factor ϕ_{nd} will be applied to the concrete failure modes. Option 3 is satisfied if $\phi_{nd} \phi N_n > N_u$ User shall input non-ductile reduction factor ϕ_{nd} next line if Option 3 is selected.

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Seismic Design Requirements For Shear \rightarrow D.4.3.6 ~ D.4.3.8

This input is required when seismic $I_EF_aS_a(0.2) \ge 0.35$ (D.4.3.3)

User can ignore this input when seismic $I_EF_aS_a(0.2) < 0.35$ (D.4.3.3)

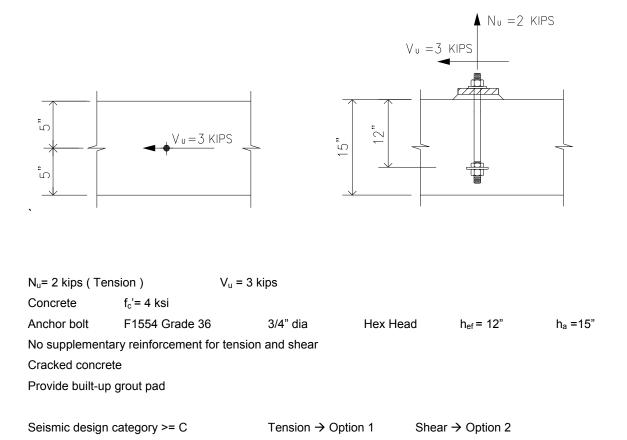
Options to Satisfy Additional Seismic Requirements	Required Strength
Option 1 D.4.3.6 Ductile anchor connection	Option 1 is satisfied if $\phi V_{sa} < 0.75 \phi (V_{cbg}, V_{cpg})$ The design steel strength must be the governing design strength and having the highest utilization ratio. The program will flag NG if Option 1 is selected and this condition is not met.
Option 2 D.4.3.7 Ductile attachment	The anchor bolt's steel attachments, such as steel base plate or column, will go for ductile yielding before or at the time when the anchor bolt reaching the tensile load V _u user input above. User may re-input the tensile load V _u above to satisfy this option.
Option 3 D.4.3.8 Non-ductile reduction factor ϕ_{nd} x ϕ_{nd}	Non-ductile reduction factor ϕ_{nd} will be applied to the concrete failure modes. Option 3 is satisfied if $\phi_{nd} \phi V_n > V_u$ User shall input non-ductile reduction factor ϕ_{nd} next line if Option 3 is selected.

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5.0 DESIGN EXAMPLES

Example 01: Single Anchor Bolt + No Anchor Reinft + Tension & Shear + ACI 318-11 Code



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ANCHOR BOLT DESIGN	Combined Tensior	n and Sh	ear				
Anchor bolt design based on							Code Abbreviation
ACI 318-11 Building Code Require		Concrete	and Commentary	y Append	ix D		ACI 318-11
PIP STE05121 Anchor Bolt Desigr	Guide-2006						PIP STE05121
Anchor Bolt Data	set N _u =	= 0 if it's c	compression				Code Reference
Factored tension for design	$N_u = 2.00$	[kips]		=	8.9	[kN]	
Factored shear	V _u = 3.00	[kips]		=	13.3	[kN]	
Concrete strength	$f_{c} = \frac{4.0}{4.0}$	[ksi]		= ;	27.6	[MPa]	
Anchor bolt material	F1554	4 Grade 3	3 <mark>6 -</mark>				
Anchor tensile strength	$f_{uta} = 58$	[ksi]		= -	400	[MPa]	ACI 318-11
	Anchor	is ductile	steel element				D.1
Anchor bolt diameter	d _a = 0.75	– [i	n]	=	19.1	[mm]	PIP STE05121
Bolt sleeve diameter	$d_{s} = 2.0$	[in]					Page A -1 Table 1
Bolt sleeve height	$h_{s} = 7.0$	[in]					
		_	min required				
Anchor bolt embedment depth	h _{ef} = 12.0	[in]	9.0		ОК		Page A -1 Table 1
Concrete thickness	h _a = <mark>15.0</mark>	[in]	15.0		ОК		
Bolt edge distance c ₁	$c_1 = 100.0$	[in]	4.5		ок		Page A -1 Table 1
Bolt edge distance c ₂	$c_2 = 5.0$	[in]	4.5		ОК		
Bolt edge distance c ₃	$c_3 = 100.0$	[in]	4.5		ОК		
Bolt edge distance c ₄	$c_4 = 5.0$	[in]	4.5		ОК		ACI 318-11
$c_i > 1.5h_{ef}$ for at least two edges to	avoid reducing of h	_{ef} when N	l _u > 0		Yes		D.5.2.3
Adjusted h _{ef} for design	h _{ef} = 12.00	[in]	9.0		ОК		D.5.2.3
Anchor head type	= Hex			?			
Anchor effective cross sect area	$A_{se} = 0.334$	[in ²]					
Bearing area of head	A _{brg} = 0.654	[in ²]					
	A _{brg}	[in ²]	not applicable				
Bolt 1/8" (3mm) corrosion allowand	e = No -	?					
Supplementary reinforcement		_					
For tension	= <u>No</u> -	Condi	tion B				D.4.3 (c)
For shear	$\Psi_{c,V} = 1$	Condit	tion B	?			D.6.2.7
Provide built-up grout pad ?	= Yes -	?	7				D.6.1.3
Concrete cracking	= crack	ed 🔽	?				D.5.2.6, D5.3.6, D.6.2.
Seismic design category SDC >= (C = Yes		?				D.3.3.1
Anchor bolt load E <= 0.2U	Tensile = No -	-	? 5	Shear =	No 🖛	·	? D.3.3.4.1 & D.3.3.5.1

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					2 0
					Code Reference
Strength reduction factors					ACI 318-11
Anchor reinforcement	$\phi_s = 0.75$				D.5.2.9 & D.6.2.9
Anchor rod - ductile steel	$\phi_{t,s} = 0.75$		$\phi_{v,s}$ = 0.65		D.4.3 (a)
Concrete	$\varphi_{t,c} = 0.70$	Cdn-B	$\phi_{v,c} = 0.70$	Cdn-B	D.4.3 (c)
Assumptions					
. Concrete is cracked					D.5.2.6, D5.3.6, D.6.2.7
2. Condition B - no supplementary	reinforcement provid	ded			D.4.3 (c)
 Load combinations shall be per 	ACI 318-11 9.2				D.4.3
 Tensile load acts through cente 	er of bolt group $\Psi_{ec,N}$	1=1.0			D.5.2.4
5. Shear load acts through center	of bolt group $\Psi_{ec,V}$ =	=1.0			D.6.2.5
CONCLUSION					
Anchor Rod Embedment, Spacing	g and Edge Distance			ОК	
Dverall			ratio = 0.97	ок	
Fension					
Anchor Rod Tensile Resistance			ratio = 0.14	ок	
Conc. Tensile Breakout Resistance	ce		ratio = 0.28	ОК	
Anchor Pullout Resistance			ratio = 0.18	ок	
Side Blowout Resistance			ratio = 0.00	ОК	
Shear					
Anchor Rod Shear Resistance			ratio = 0.50	ок	
Conc. Shear Breakout Resistance	e - Perpendicular To E	Edge	ratio = 0.89	ок	
Conc. Shear Breakout Resistance	e - Parallel To Edge		ratio = 0.34	ок	
Conc. Pryout Shear Resistance			ratio = 0.21	ок	
Fension Shear Interaction					
ension Shear Interaction			ratio = 0.97	ОК	
Seismic Design					
Tension	Applicable			NG	D.3.3.4
Option 1 is NOT satisfied	_				_
Seismic SDC>=C and E>0.2U , O	ption 1 is selected to	satisfy additional	seismic requirements as p	er D.3.3.4	4.3
				ОК	D.3.3.5
Shear	Applicable				

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CALCULATION				Code Reference	
				ACI 318-11	
Anchor Rod Tensile	$\phi_{t,s} N_{sa} = \phi_{t,s} A_{se} f_{uta}$	= 14.53	[kips]	D.5.1.2 (D-2)	
Resistance	ratio = 0.14	> N _u	ок		
Conc. Tensile Breakout Resistan	Ce				
	N_b = 24 λ $\sqrt{f_c^{'}}$ $h_{ef}^{1.5}$ if h_{ef} <11" or h_{ef} $>$	25" = 63.65	[kips]	D.5.2.2 (D-6)	
	16 $\lambda \sqrt{f_c'} h_{ef}^{5/3}$ if 11" $\leq h_{ef} \leq 25$ "			D.5.2.2 (D-7)	
Projected conc failure area	1.5h _{ef} =	= 18.0	[in]		
	$A_{Nc} = [min(c_{1}, 1.5h_{ef}) + min(c_{3}, 1.5h_{ef})] \times [min(c_{2}, 1.5h_{ef}) + min(c_{4}, 1.5h_{ef})]$	= 360.0	[in ²]		
	$A_{\rm Nco} = 9 h_{\rm ef}^2$	= 1296.0	[in ²]	D.5.2.1 (D-5)	
	$A_{Nc} = min (A_{Nc}, 1x A_{Nco})$	= 360.0	[in ²]	D.5.2.1	
Min edge distance	c _{min} = min(c ₁ , c ₂ , c ₃ , c ₄)	= 5.0	 [in]		
Eccentricity effects	$\Psi_{ec,N}$ = 1.0 for no eccentric load			D.5.2.4	
Edge effects	$\Psi_{ed,N}$ = min[(0.7+0.3c_{min}/1.5h_{ef}), 1.0]	= 0.78		D.5.2.5	
Concrete cracking	$\Psi_{c,N}$ = 1.00 for cracked concrete			D.5.2.6	
Concrete splitting	$\Psi_{cp,N}$ = 1.0 for cast-in anchor			D.5.2.7	
Concrete breakout resistance	$\phi_{t,c} \mathbf{N}_{cb} = \phi_{t,c} \frac{\mathbf{A}_{Nc}}{\mathbf{A}_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} \mathbf{N}_{b}$	= 9.69	[kips]	D.5.2.1 (D-4)	
Seismic design strength reduction	= x 0.75 applicable	= 7.27	[kips]	D.3.3.4.4	
	ratio = 0.28	> N _u	ок		
Anchor Pullout Resistance					
Single bolt pullout resistance	$N_p = 8 A_{brg} f_c'$	= 20.93	[kips]	D.5.3.4 (D-14)	
	$\phi_{t,c} N_{pn} = \phi_{t,c} \Psi_{c,p} N_{p}$	= 14.65	[kips]	D.5.3.1 (D-13)	
Seismic design strength reduction	= x 0.75 applicable	= 10.99	[kips]	D.3.3.4.4	
	ratio = 0.18	> N _u	ОК		
	$\Psi_{c,p}$ = 1.00 for cracked concrete			D.5.3.6	
	$\phi_{t,c} = 0.70$ pullout strength is always	s Condition B		D.4.3(c)	
Side Blowout Resistance					
	$c = min (c_1, c_2, c_3, c_4)$	= 5.0	[in]		
Check if side blowout applicable	h _{ef} = 12.0 [in]				
	< 2.5c side bowout is h	NOT applicable		D.5.4.1	
SB resistance	$\phi_{\rm t,c} \mathbf{N}_{\rm sb} = \phi_{\rm t,c} \left(160 \mathrm{c} \sqrt{\mathbf{A}_{\rm brg}} \right) \lambda \sqrt{\mathbf{f'_c}}$	= 0.00	[kips]	D.5.4.1 (D-16)	
Edge reduction factor	= (1+ c _{a2} / c _{a1}) / 4	= 1.00		D.5.4.1	
SB resistance after edge reduction		= 0.00	[kips]		
Seismic design strength reduction	= x 0.75 applicable	= 0.00	[kips]	D.3.3.4.4	
	ratio = 0.00	> N _u	ок		

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				Code Reference	
Govern Tensile Resistance	$\mathbf{N_r} = \min(\phi N_{sa}, \phi N_{cb}, \phi N_{pn}, \phi N_{sb})$	= 7.27	[kips]	ACI 318-11	
Note: Anchor bolt sleeve portion m	ust be tape wrapped and grouted to resist shea	ar			
Anchor Rod Shear	$\phi_{v,s} V_{sa} = \phi_{v,s} 0.6 A_{se} f_{uta}$	= 7.56	[kips]	D.6.1.2 (b) (D-29)	
Resistance		0.04	flain a l	D 0 4 0	
Reduction due to built-up grout pad	ls = x 0.8 , applicable ratio = 0.50	= 6.04 > V _u	[kips] OK	D.6.1.3	
Conc. Shear Breakout Resistanc	e - Perpendicular To Edge				
C2 C4 C4 C4 C4 C4 C4 C4 C4 C4 C4 C4 C4 C4	Cat		Vu M		
C1 Ca1	C3 dc	C1 k c dc	23 >		
	Shear Breakout ndicular To Edge	Conc Shear Br Parallel To Edg			
Bolt edge distance	$c_{a1} = c_1$	= 100.0	[in]		
Limiting c _{a1} when anchors are influe	enced by 3 or more edges	= Yes		D.6.2.4	
Bolt edge distance - adjusted	\mathbf{c}_{a1} = ca1 needs to be adjusted	= 10.0	[in]	D.6.2.4	
	1.5c _{a1} =	= 15.0	[in]		
	$A_{Vc} = [min(c_2, 1.5c_1) + min(c_4, 1.5c_1)] x$ min(1.5c_1, h_a)	= 150.0	[in ²]	D.6.2.1	
	$A_{Vco} = 4.5 c_{a1}^2$	= 450.0	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = min (A_{Vc}, 1 \times A_{Vco})$	= 150.0	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 6.0	[in]	D.6.2.2	
	$V_{b1} = \left[7\left(\frac{I_e}{d_a}\right)^{0.2}\sqrt{d_a}\right]\lambda\sqrt{f_c^{'}} c_{a1}^{1.5}$	= 18.38	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c} c_{a1}^{1.5}$	= 18.00	[kips]	D.6.2.2 (D-34)	
	$V_{b} = min(V_{b1}, V_{b2})$	= 18.00	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of g	group		D.6.2.5	
Edge effects	$\Psi_{ed,v}$ = min[(0.7+0.3c ₂ /1.5c ₁), 1.0]	= 0.80		D.6.2.6	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.00		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_1 / h_a) , 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout resistance - perpendicular to edge	$\phi_{v,c} V_{cb} = \phi_{v,c} \frac{A_{vc}}{A_{vco}} \Psi_{ec,v} \Psi_{ed,v} \Psi_{c,v} \Psi_{h,v} V_{t}$	= 3.36	[kips]	D.6.2.1 (D-31)	
	ratio = 0.89	> V _u	ОК		

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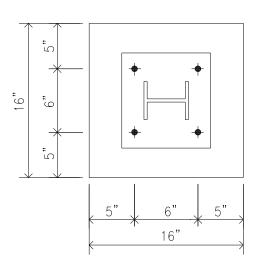
					5 of
				Code Reference	
Conc. Shear Breakout Resistanc	e - Parallel To Edge			ACI 318-11	
Bolt edge distance	$c_{a1} = min(c_2, c_4)$	= 5.0	[in]		
Limiting c _{a1} when anchors are influ	enced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted	c _{a1} = ca1 needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
	1.5c _{a1} =	= 7.5	[in]		
	$A_{Vc} = [min(c_1, 1.5c_{a1}) + min(c_3, 1.5c_{a1})] x$ min(1.5c _{a1} , h _a)	= 112.5	[in ²]	D.6.2.1	
	$A_{Vco} = 4.5c_{a1}^2$	= 112.5	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = min (A_{Vc}, 1x A_{Vco})$	= 112.5	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 6.0	[in]	D.6.2.2	
	$V_{b1} = \left[7 \left(\frac{I_e}{d_a}\right)^{0.2} \sqrt{d_a}\right] \lambda \sqrt{f_c} c_{a1}^{1.5}$	= 6.50	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_{\rm b} = \min(V_{\rm b1}, V_{\rm b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group			D.6.2.5	
Edge effects	$\Psi_{ed,v} =$	= 1.00		D.6.2.1 (c)	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.00		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_{a1} / h_a), 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout resistance - parallel to edge	$\phi_{v,c} V_{cb-p} = 2 x \phi_{v,c} \frac{A_{vc}}{A_{vco}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 8.91	[kips]	D.6.2.1 (D-31) D.6.2.1 (c)	
	ratio = 0.34	> V _u	ОК		
Conc. Pryout Shear Resistance	k = 20			D 6 2 1	
Factored obser privat resistance	$k_{cp} = 2.0$	- 10.20	[kino]	D.6.3.1	
Factored shear pryout resistance	$ \phi_{v,c} V_{cp} = \phi_{v,c} k_{cp} N_{cbg} $ $ \phi_{v,c} = 0.70 $ pryout strength is always Cor	= 19.39 Idition B	[kips]	D.6.3.1 (D-41) D.4.3 (c)	
Seismic design strength reduction	= x 0.75 applicable	= 14.54	[kips]	D.3.3.4.4	
	ratio = 0.21	> V _u	ОК		
Govern Shear Resistance	$\mathbf{V_r}$ = min (ϕV_{sa} , ϕV_{cb} , ϕV_{cb-p} , ϕV_{cp})	= 3.36	[kips]		
Tension Shear Interaction					
Check if $N_u > 0.2\phi N_n$ and $V_u > 0.2\phi$	V _n Yes			D.7.1 & D.7.2	
	$N_u / \phi N_n + V_u / \phi V_n$	= 1.17		D.7.3 (D-42)	

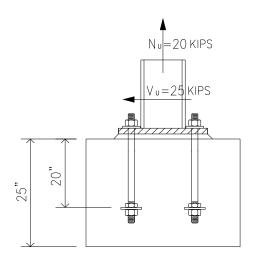
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Seismic Design	-					Code Reference	
Tension	Applicable				NG	ACI 318-11	
Steel and concrete-governed	$1.2N_{sa} = 23.25$	[kips]	N _{cb}	= 13.85	[kips]		
nominal strength	$N_{pn} = 20.93$	[kips]	N _{sb}	= 0.00	[kips]		
N _u / min(N _{ct}	$_{\rm b},{\rm N}_{\rm pn},{\rm N}_{\rm sb})=0.14$		N _u / 1.2N _{sa}	= 0.09			
	/			< 0.14	NG		
Option 1 is NOT satisfied							
Seismic SDC>=C and E>0.2U , (Option 1 is selected to	satisfy additio	nal seismic requir	ements as	per D.3.3.4	4.3	
Shear	Applicable				ОК		
Seismic SDC>=C and E>0.2U,	Option 3 is selected to	satisfy addition	nal seismic requir	ements as	per D.3.3.5	5.3	

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Example 02: Group Anchor Bolt + No Anchor Reinft + Tension & Shear + ACI 318-11 Code

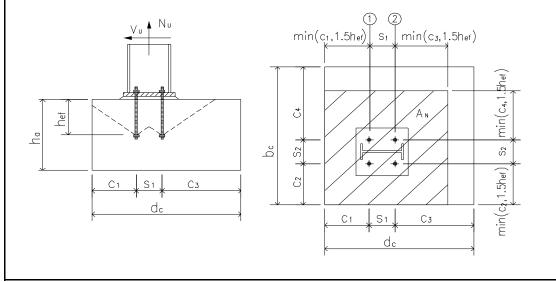




N _u = 20 kips (Te	ension)	V _u = 25 kips			
Concrete	f _c '= 4 ksi				
Pedestal size	16" x 16"				
Anchor bolt	F1554 Grade 36	1.0" dia He	ex Head	h _{ef} = 20"	h _a =25"
Supplementary	Reinforcement				
Tensio	$n \rightarrow Yes$ Shear \rightarrow	Ψ _{c,v} =1.2			
Cracked concre	te				
Provide built-up	grout pad				
Seismic design	category >= C	Tension \rightarrow Option 4	Shear ·	→ Option 3	

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ANCHOR BOLT DESIGN C	ombined Tension	and She	ar			
Anchor bolt design based on						Code Abbreviation
ACI 318-11 Building Code Requirem	ents for Structural (Concrete	and Commentary Appen	dix D		ACI 318-11
PIP STE05121 Anchor Bolt Design G	Guide-2006					PIP STE05121
Anchor Bolt Data	set N _u =	0 if it's co	ompression			Code Reference
Factored <u>tension</u> for design	N _u = 20.00	[kips]	=	89.0	[kN]	
Factored shear	V _u = 25.00	[kips]	=	111.2	[kN]	
Factored shear for design	$V_{u} = 25.00$	[kips]	V _u = 0 if shear key is p	rovided		
Concrete strength	f' _c = 4.0	[ksi]	=	27.6	[MPa]	
Anchor bolt material	F1554	Grade 3	6 🔽			
Anchor tensile strength	$f_{uta} = 58$	[ksi]	=	400	[MPa]	ACI 318-11
	Anchor i	s ductile	steel element			D.1
Anchor bolt diameter	d _a = 1	💌 (in] =	25.4	[mm]	PIP STE05121
Bolt sleeve diameter	$d_{s} = 3.0$	[in]				Page A -1 Table 1
Bolt sleeve height	$h_{s} = 10.0$	[in]				
			min required			
Anchor bolt embedment depth	h _{ef} = 20.0	[in]	12.0	ок		Page A -1 Table 1
Concrete thickness	h _a = 25.0	[in]	23.0	ОК		
Bolt edge distance c ₁	$c_1 = 5.0$	[in]	4.5	ок		Page A -1 Table 1
Bolt edge distance c ₂	$c_2 = 5.0$	[in]	4.5	ок		
Bolt edge distance c ₃	$c_3 = 5.0$	[in]	4.5	ок		
Bolt edge distance c ₄	$c_4 = 5.0$	[in]	4.5	ок		ACI 318-11
$c_i > 1.5h_{ef}$ for at least two edges to a		_f when N		No		D.5.2.3
Adjusted h _{ef} for design	h _{ef} = 3.33	[in]	12.0	Warn		D.5.2.3
Outermost bolt line spacing s ₁	$s_1 = 6.0$	[in]	4.0	ок		PIP STE05121
Outermost bolt line spacing s_2	$s_2 = 6.0$	[in]	4.0	ок		Page A -1 Table 1



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		-		2 of 1
Number of bolt at bolt line 1	n ₁ = 2			
Number of bolt at bolt line 2	n ₂ = 2			C3
Number of bolt carrying tension	$n_t = 4$	3		
Oversized holes in base plate ?	= Yes -	?		
Number of bolt carrying shear	n _s = 4			
For side-face blowout check use				5
No of bolt along width edge	n _{bw} = 2			
No of bolt along depth edge	$n_{bd} = 2$		4	C4 S2 C2
				b_c
Anchor head type	= Hex	•	?	1
Anchor effective cross sect area	$A_{se} = 0.606$	[in ²]		olt No Input for Side-Face
Bearing area of head	A _{brg} = 1.163	[in ²]	В	lowout Check Use
	A _{brg}	[in ²] not applic	able	
Bolt 1/8" (3mm) corrosion allowance	= <u>No</u>	?		Code Reference
Provide shear key ?	= No 💌	?		ACI 318-11
Supplementary reinforcement		-		
For tension	= Yes	Condition A		D.4.3 (c)
For shear	$\Psi_{c,V} = 1.2$	Condition A	?	D.6.2.7
Provide built-up grout pad ?	= Yes =	?		D.6.1.3
Concrete cracking	= crack	ed 💽 ?		D.5.2.6, D5.3.6, D.6.2.7
Seismic design category SDC >= C	= Yes	?		D.3.3.1
Anchor bolt load E <= 0.2U	Tensile = No 🔻	?	Shear = No 💌	? D.3.3.4.1 & D.3.3.5.1
Anchor bolt satisfies option T	ensile = Optior	14 ▼ ?	Shear = Option 3	3 💌 ? D.3.3.4.3 & D.3.3.5.3
Strength reduction factors				
Anchor reinforcement	$\phi_{s} = 0.75$			D.5.2.9 & D.6.2.9
Anchor rod - ductile steel	$\phi_{t,s} = 0.75$		$\phi_{v,s} = 0.65$	D.4.3 (a)
Anchor rod - ductile steel Concrete	$\phi_{t,s} = 0.75$ $\phi_{t,c} = 0.75$	Cdn-A		D.4.3 (a) Cdn-A D.4.3 (c)
Concrete		Cdn-A		
Concrete Assumptions		Cdn-A		
Concrete Assumptions 1. Concrete is cracked	$\phi_{t,c} = 0.75$	Cdn-A		Cdn-A D.4.3 (c)
Concrete Assumptions 1. Concrete is cracked 2. Condition A - supplementary reinfo	$\phi_{t,c} = 0.75$	Cdn-A		Cdn-A D.4.3 (c) D.5.2.6, D5.3.6, D.6.2.7
Concrete Assumptions 1. Concrete is cracked 2. Condition A - supplementary reinfo 3. Load combinations shall be per A0	$\phi_{t,c} = 0.75$ procement provided CI 318-11 9.2			Cdn-A D.4.3 (c) D.5.2.6, D5.3.6, D.6.2.7 D.4.3 (c)
Concrete Assumptions 1. Concrete is cracked 2. Condition A - supplementary reinfo 3. Load combinations shall be per A0 4. Tensile load acts through center o	$\phi_{t,c} = 0.75$ procement provided CI 318-11 9.2 f bolt group $\Psi_{ec,N}$	=1.0		Cdn-A D.4.3 (c) D.5.2.6, D5.3.6, D.6.2.7 D.4.3 (c) D.4.3
Anchor rod - ductile steel Concrete Assumptions 1. Concrete is cracked 2. Condition A - supplementary reinfo 3. Load combinations shall be per AC 4. Tensile load acts through center of 5. Shear load acts through center of 6. Anchor bolt washer shall be tack w	$\phi_{t,c} = 0.75$ brocement provided Cl 318-11 9.2 f bolt group $\Psi_{ec,N}$ bolt group $\Psi_{ec,V}$	=1.0	φ _{v,c} = 0.75	Cdn-A D.4.3 (c) D.5.2.6, D5.3.6, D.6.2.7 D.4.3 (c) D.4.3 D.5.2.4

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CONCLUSION				Code Reference	
				ACI 318-11	
Anchor Rod Embedment, Spacing	and Edge Distance		Warn		
Overall		ratio = 5.04	NG		
Tension					
Anchor Rod Tensile Resistance		ratio = 0.19	ОК		
Conc. Tensile Breakout Resistance	e	ratio = 1.50	NG		
Anchor Pullout Resistance		ratio = 0.26	ок		
Side Blowout Resistance		ratio = 0.27	ок		
Shear					
Anchor Rod Shear Resistance		ratio = 0.57	ОК		
Conc. Shear Breakout Resistance	- Perpendicular To Edge	ratio = 4.55	NG		
Conc. Shear Breakout Resistance	- Parallel To Edge	ratio = 1.31	NG		
Conc. Pryout Shear Resistance		ratio = 1.01	NG		
Tension Shear Interaction					
Tension Shear Interaction		ratio = 5.04	NG		
Seismic Design					
Tension	Applicable		ок	D.3.3.4	
Seismic SDC>=C and E>0.2U , Op	otion 4 is selected to satisfy additional seismic re	equirements as pe	r D.3.3.4	.3	
Shear	Applicable		ОК	D.3.3.5	
Seismic SDC>=C and E>0.2U , Op	otion 3 is selected to satisfy additional seismic re	equirements as pe	r D.3.3.5	.3	
CALCULATION					
Anchor Rod Tensile	$\phi_{t,s} N_{sa} = \phi_{t,s} n_t A_{se} f_{uta}$	= 105.44	[kips]	D.5.1.2 (D-2)	
Resistance	ratio = 0.19	> N _u	ОК		
Conc. Tensile Breakout Resistar					
	N_b = 24 $\lambda \; \sqrt{f_c^{\cdot}} \; h_{ef}^{1.5}$ if $h_{ef} < 11"$ or $h_{ef} > 1$	25" = 9.24	[kips]	D.5.2.2 (D-6)	
	16 $\lambda \sqrt{f_c^{'}} h_{ef}^{5/3}$ if 11" $\leq h_{ef} \leq 25$ "			D.5.2.2 (D-7)	
Projected conc failure area	1.5h _{ef} =	= 5.00	[in]		
	$A_{Nc} = [s_1 + min(c_1, 1.5h_{ef}) + min(c_3, 1.5h_{ef})]x$ $[s_2 + min(c_2, 1.5h_{ef}) + min(c_4, 1.5h_{ef})]$	= 256.0	[in ²]		
	$A_{Nco} = 9 h_{ef}^{2}$	= 100.0	[in ²]	D.5.2.1 (D-5)	
	$A_{Nc} = \min(A_{Nc}, n_t A_{Nco})$	= 256.0	[in ²]	D.5.2.1	
Min edge distance	$C_{min} = min(c_1, c_2, c_3, c_4)$	= 5.0	[in]	2.0.2.1	
Eccentricity effects	$\Psi_{ec,N}$ = 1.0 for no eccentric load	0.0	<u>1</u>	D.5.2.4	
				2.0.2.1	

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						Code Reference ACI 318-11	
Edge effects	$\Psi_{\text{ed},N}$	= min[(0.7+0.3c _{min} /	'1.5h _{ef}), 1.0]	= 1.00		D.5.2.5	
Concrete cracking	$\Psi_{c,N}$	= 1.00 for crac	cked concrete			D.5.2.6	
Concrete splitting	$\Psi_{cp,N}$	= 1.0 for cast-in and	chor			D.5.2.7	
Concrete breakout resistance	$\phi_{t,c} \: N_{cbg}$	$= \phi_{t,c} \frac{A_{Nc}}{A_{Nco}} \Psi_{ec,N} \Psi$	$_{\rm ed,N} \Psi_{\rm c,N} \Psi_{\rm cp,N} N_{\rm b}$	= 17.74	[kips]	D.5.2.1 (D-4)	
Seismic design strength reduction		= x 0.75 applicable	e	= 13.30	[kips]	D.3.3.4.4	
	ratio	= 1.50		< N _u	NG		
Anchor Pullout Resistance							
Single bolt pullout resistance	N _p	= 8 $A_{brg} f_c$ '		= 37.22	[kips]	D.5.3.4 (D-14)	
	$\phi_{t,c} N_{pn}$	= $\phi_{t,c} n_t \Psi_{c,p} N_p$		= 104.20	[kips]	D.5.3.1 (D-13)	
Seismic design strength reduction		= x 0.75 applicable	e	= 78.15	[kips]	D.3.3.4.4	
	ratio	= 0.26		> N _u	ок		
	$\Psi_{c,p}$	= 1.00 for crac	cked concrete			D.5.3.6	
			strength is always Co	ondition B		D.4.3(c)	
Side Blowout Resistance Failure Along Pedestal Width Edge	_	re which may cause (side fees blowout				
Tensile load carried by anchors clo	-	· -	side-face blowout	- 10.00	[king]	RD.5.4.2	
along pedestal width edge		$= N_u x n_{bw} / n_t$		= 10.00	[kips]	RD.3.4.2	
Chaok if aida blowaut applicable		$= \min(c_1, c_3)$		= 5.0	[in]		
Check if side blowout applicable	l lef	= 20.0 [in]	aida hawawi ia anali	aabla			
Obask if adapt and any work of a		> 2.5c	side bowout is appli		[i=1	D.5.4.1	
	S ₂₂	= 6.0 [in]		2 = 6.0	[in]		
a group or work individually		< 6c	edge anchors work		flain a l	D.5.4.2	
Single anchor SB resistance			λ √t [°] c	= 40.92	[kips]	D.5.4.1 (D-16)	
Multiple anchors SB resistance	φ _{t,c} IN _{sbg,w}			40.44	flain a l		
work as a group - applicable		= $(1+s/6c) \times \phi_{t,c} N_{sl}$		= 49.11	[kips]	D.5.4.2 (D-17)	
work individually - not applicable		$= n_{bw} x \phi_{t,c} N_{sb} x [1+$		= 0.00	[kips]	D.5.4.1	
Seismic design strength reduction		= x 0.75 applicable	9	= 36.83	[kips]	D.3.3.4.4	
Failure Alars Dadaatal Daath Eda		= 0.27		> N _{buw}	ОК		
Failure Along Pedestal Depth Edge	_		ida fasa blausut				
Tensile load carried by anchors clo	-	-	side-lace blowout	- 10.00	[kino]		
along pedestal depth edge		$= N_u \times n_{bd} / n_t$		= 10.00	[kips]	RD.5.4.2	
Chaoli if aida blauraut analiaabla		$= \min(c_2, c_4)$		= 5.0	[in]		
Check if side blowout applicable	l lef	= 20.0 [in]	aida hawawi ia anali	aabla			
Chook if adde anabara washing	-	> 2.5c	side bowout is appli		[i=1	D.5.4.1	
Check if edge anchors work as a	s ₁₁	= 6.0 [in]		1 = 6.0	[in]		
a group or work individually		< 6c	edge anchors work			D.5.4.2	
Single anchor SB resistance	$\phi_{t,c} \mathbf{N}_{sb}$	$= \phi_{\rm t,c} \left(160 \rm c \sqrt{A_{\rm brg}} \right) .$	ι √t'c	= 40.92	[kips]	D.5.4.1 (D-16)	

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Multiple anchors SB resistance $\phi_{t,c}N_{sbg,d}$ =			Code Reference ACI 318-11	
work as a group - applicable = $(1+s/6c) \times \phi_{t,c} N_{sb}$	= 49.11	[kips]	D.5.4.2 (D-17)	
work individually - not applicable = $n_{bd} \propto \phi_{t,c} N_{sb} \propto [1+(c_1 \text{ or } c_3)/c]/4$	= 0.00	[kips]	D.5.4.1	
Seismic design strength reduction $= x 0.75$ applicable	= 36.83	[kips]	D.3.3.4.4	
ratio = 0.27	> N _{bud}	ОК		
Group side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \min \left(\frac{N_{sbg,w}}{n_{bw}} n_t, \frac{N_{sbg,d}}{n_{bd}} n_t \right)$	= 73.66	[kips]		
Govern Tensile Resistance $\mathbf{N}_{r} = \min(\phi N_{sa}, \phi N_{cbg}, \phi N_{pn}, \phi N_{sbg})$	= 13.30	[kips]		
Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear				
Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$	= 54.83	[kips]	D.6.1.2 (b) (D-29)	
Resistance		-		
Reduction due to built-up grout pads = x 0.8 , applicable	= 43.86	[kips]	D.6.1.3	
ratio = 0.57	> V _u	ОК		
	de 3 de 1 de 1 de 3	$\begin{pmatrix} c_2 \\ c_2 \\ c_4 \end{pmatrix}$		
E de de				
Bolt edge distance c ₁ =	= 5.0	[in]		
Limiting c_{a1} when anchors are influenced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted $c_1 = ca1$ needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
c ₂ =	= 5.0	[in]		
1.5c ₁ =	= 7.5	[in]		
$A_{Vc} = [min(c_2, 1.5c_1) + s_2 + min(c_4, 1.5c_1)] x$ min(1.5c_1, h _a)	= 120.0	[in ²]	D.6.2.1	
$A_{Vco} = 4.5c_1^2$	= 112.5	[in ²]	D.6.2.1 (D-32)	
$A_{Vc} = \min(A_{Vc}, n_1 A_{Vco})$	= 120.0	[in ²]	D.6.2.1	
$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2	

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				Code Reference ACI 318-11	
	$V_{b1} = \left[7 \left(\frac{I_e}{d_a} \right)^{0.2} \sqrt{d_a} \right] \lambda \sqrt{f_c} c_1^{1.5}$	= 7.50	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_{c}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_b = min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of grou	р		D.6.2.5	
Edge effects	$\Psi_{ed,v}$ = min[(0.7+0.3c ₂ /1.5c ₁), 1.0]	= 0.90		D.6.2.6	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.20		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_1 / h_a) , 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout resistance	$V_{cbg1} = \phi_{v,c} \frac{A_{vc}}{A_{vco}} \Psi_{ec,v} \Psi_{ed,v} \Psi_{c,v} \Psi_{h,v} V_{b}$	= 5.50	[kips]	D.6.2.1 (D-31)	
Mode 3 is used for checking	$V_{cbg1} = V_{cbg1} $ x 1.0	= 5.50	[kips]		
C1 S1 C3	$\begin{array}{c c} & & & & \\ & & & & \\ & & & & \\ & & & & $	L L C2 + S2 + C4		ACI 318-11	
Bolt edge distance	$c_{a1} = c_1 + s_1$	= 11.0	[in]		
Limiting c _{a1} when anchors are influe	enced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted	\mathbf{c}_{a1} = ca1 needs NOT to be adjusted	= 11.0	[in]	D.6.2.4	
	C ₂ =	5.0	[in]		
	1.5c _{a1} =	16.5	[in]		
	$\begin{aligned} A_{Vc} &= \left[\min(c_2, 1.5c_{a1}) + s_2 + \min(c_4, 1.5c_{a1}) \right] x \\ &\min(1.5c_{a1}, h_a) \end{aligned}$	= 264.0	[in ²]	D.6.2.1	
	$A_{Vco} = 4.5 c_{a1}^{2}$	= 544.5	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = \min \left(A_{Vc}, n_2 A_{Vco} \right)$	= 264.0	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2	
	$V_{b1} = \left[7\left(\frac{I_e}{d_a}\right)^{0.2}\sqrt{d_a}\right]\lambda\sqrt{f_c^{-}} c_{a1}^{1.5}$	= 24.48	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c^{'}} c_{a1}^{1.5}$	= 20.77	[kips]	D.6.2.2 (D-34)	
	$V_{b} = \min(V_{b1}, V_{b2})$	= 20.77	[kips]	D.6.2.2	

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				Code Reference ACI 318-11	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group	р		D.6.2.5	
Edge effects	$\Psi_{\text{ed},v}$ = min[(0.7+0.3c ₂ /1.5c _{a1}), 1.0]	= 0.79		D.6.2.6	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.20		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_{a1} / h_a) , 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout resistance	$V_{cbg2} = \phi_{v,c} \frac{A_{Vc}}{A_{Vco}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 7.17	[kips]	D.6.2.1 (D-31)	
Min shear breakout resistance shear perpendicular to edge	$\phi_{v,c} V_{cbg}$ = min (V_{cbg1} , V_{cbg2})	= 5.50	[kips]		
	ratio = 4.55	< V _u	NG		
Conc. Shear Breakout Resistar	e effects e effects $\Psi_{edv} = \min[(0.7+0.3c_y/1.5c_{a1}), 1.0] = 0.79$ crete cracking $\Psi_{e,v} = \text{concrete is cracked} = 1.20$ $\Psi_{h,v} = \max[(\operatorname{seqt}(1.5c_{a1}/h_{a}), 1.0] = 1.00$ c shear breakout stance shear breakout resistance $\phi_{v,c} V_{obg} = \phi_{v,c} \frac{A_{vco}}{A_{vco}} \Psi_{ec,v} \Psi_{ec,v} \Psi_{h,v} V_{b} = 7.17$ [kips] stance shear breakout resistance $\phi_{v,c} V_{obg} = \min(V_{obg1}, V_{obg2}) = 5.50$ [kips] ar perpendicular to edge ratio = 4.55 $< V_{u}$ NG c. Shear Breakout Resistance - Parallel To Edge $MODE \ 1 \qquad MODE \ 2 \qquad MODE$ house 1 MODE 2 MODE le 1 Shear taken evenly by all anchor bolts, strength check against $0.5 \times V_{u}$ edge distance $c_{a1} = \min(C_{2}, C_{4}) = 5.0$ [in] $1.5c_{a1} = -7.5$ [in] $A_{vco} = 4.5c_{a1}^{2} = -7.5$ [in] $A_{vco} = \min(A_{vc}, n_{bd}A_{vco}) = 120.0$ [in ²] $I_{a} = \min(8d_{a}, h_{af})$ = 8.0 [in]				
				4	
				C4	
Vu/4 + Vu/4		Vu/2	_+ +_]	
				S2	
Vu/4		V ∪/2		C2	
C_1 S_1 C_3	$\begin{array}{c c} & & & \\ &$	C1	× S1 ×	<u>C3</u>	
MODE 1	MODE 2		MODE	3	
Mode 1 Shear taken evenly by al	I anchor bolts, strength check against 0.5 x V_{u}				
Delt edge distance	$a = \min(a = a)$	- 50	[im]	ACI 318-11	
			linj	D 6 2 4	
			[in]	D.6.2.4	
Boil euge distance - adjusted				D.6.2.4	
		= 120.0	[in-]	D.6.2.1	
	$A_{Vco} = 4.5 c_{a1}^{2}$	= 112.5	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = min (A_{Vc}, n_{bd} A_{Vco})$	= 120.0	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2	
	$V_{b1} = \left[7\left(\frac{I_e}{d_a}\right)^{0.2} \sqrt{d_a}\right] \lambda \sqrt{f_c} c_{a1}^{1.5}$	= 7.50	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_{c}^{-}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_{b} = \min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	

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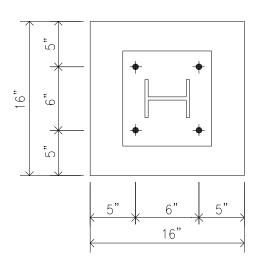
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				Code Reference	
				ACI 318-11	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group	1		D.6.2.5	
Edge effects	$\Psi_{\text{ed}, v}$ =	= 1.00		D.6.2.1 (c)	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.20		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_{a1} / h_a) , 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout	$V_{cbg-p1} = 2 x \phi_{v,c} \frac{A_{Vc}}{A_{Vc0}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 12.22	[kips]	D.6.2.1 (D-31)	
resistance - parallel to edge	A _{Vco}			D.6.2.1 (c)	
Mode 2 Shear taken evenly by b	ack anchor bolts, strength check against 0.5 x V_{u}				
Bolt edge distance	$c_{a1} = min(c_2, c_4)$	= 5.0	[in]		
Limiting c _{a1} when anchors are inf	luenced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted	c_{a1} = ca1 needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
	1.5c _{a1} =	= 7.5	[in]		
	$A_{Vc} = [min((s_1+c_1, 1.5c_{a1}) + min(c_3, 1.5c_{a1})] x$	= 93.8	[in ²]	D.6.2.1	
	$min(1.5c_{a1}, h_a)$				
	$A_{Vco} = 4.5c_{a1}^2$	= 112.5	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = min (A_{Vc}, n_{bd} A_{Vco})$	= 93.8	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2	
	$V_{b1} = \left[7\left(\frac{I_e}{d_a}\right)^{0.2}\sqrt{d_a}\right]\lambda\sqrt{f_c} c_{a1}^{1.5}$	= 7.50	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c^{'}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_b = min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group	1		D.6.2.5	
Edge effects	$\Psi_{ed,v}$ =	= 1.00		D.6.2.1 (c)	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.20		D.6.2.7	
Member thickness	$\Psi_{h,v}$ = max[(sqrt(1.5c_{a1} / h_a) , 1.0]	= 1.00		D.6.2.8	
Conc shear breakout	$V_{cbg-p2} = 2 x \phi_{v,c} \frac{A_{Vc}}{A_{Vco}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 9.55	[kips]	D.6.2.1 (D-31)	
resistance - parallel to edge	A _{Vco}			D.6.2.1 (c)	
Mode 3 Shear taken evenly by fr	ont anchor bolts, strength check against 0.5 x V_{u}				
Bolt edge distance	$c_{a1} = min(c_2, c_4)$	= 5.0	[in]		
Limiting c _{a1} when anchors are inf	luenced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted	\mathbf{c}_{a1} = ca1 needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
	1.5c _{a1} =	= 7.5	[in]		
			-		

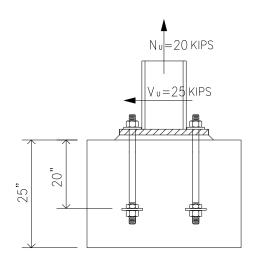
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				Code Reference ACI 318-11
	$A_{Vco} = 4.5 c_{a1}^2$	= 112.5	[in ²]	D.6.2.1 (D-32)
	A_{Vc} = min (A_{Vc} , $n_{bd} A_{Vco}$)	= 93.8	[in ²]	D.6.2.1
	$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2
	$V_{b1} = \left[7 \left(\frac{I_e}{d_a}\right)^{0.2} \sqrt{d_a}\right] \lambda \sqrt{f_c^{\cdot}} c_{a1}^{1.5}$	= 7.50	[kips]	D.6.2.2 (D-33)
	$V_{b2} = 9\lambda \sqrt{f_{c}^{'}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)
	$V_{b} = min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group	ρ		D.6.2.5
Edge effects	$\Psi_{ed,v}$ =	= 1.00		D.6.2.1 (c)
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.20		D.6.2.7
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_{a1} / h_a) , 1.0]$	= 1.00		D.6.2.8
Conc shear breakout	$V_{cbg-p3} = 2 \times \phi_{v,c} \frac{A_{Vc}}{A_{Vc0}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 9.55	[kips]	D.6.2.1 (D-31)
resistance - parallel to edge	, Vco			D.6.2.1 (c)
Min shear breakout resistance	$\phi_{v,c}V_{cbg-p}$ = min (V_{cbg-p1} , V_{cbg-p2} , V_{cbg-p3}) x 2 side	= 19.09	[kips]	
shear parallel to edge				
	ratio = 1.31	< V _u	NG	
Conc. Pryout Shear Resistance				
	$k_{cp} = 2.0$			D.6.3.1
Factored shear pryout resistance	$\phi_{v,c} V_{cpg} = \phi_{v,c} k_{cp} N_{cbg}$	= 33.11	[kips]	D.6.3.1 (D-41)
	$\phi_{v,c} = 0.70$ pryout strength is always Co	ndition B		D.4.3(c)
Seismic design strength reduction	= x 0.75 applicable	= 24.83	[kips]	D.3.3.4.4
	ratio = 1.01	< V _u	NG	
Govern Shear Resistance	$\mathbf{V_r}$ = min (ϕV_{sa} , ϕV_{cbg} , ϕV_{cbg-p} , ϕV_{cpg})	= 5.50	[kips]	
Tension Shear Interaction				
Check if $N_u > 0.2\phi N_n$ and $V_u > 0.2\phi$				D.7.1 & D.7.2
	$N_u / \phi N_n + V_u / \phi V_n$	= 6.05		D.7.3 (D-42)
	ratio = 5.04	> 1.2	NG	

10 of 10 Code Reference Acl 318-11 ension Applicable OK teel and concrete-governed $1.2N_{sa} = 0.00$ [kips] $N_{cbg} = 0.00$ [kips] ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips] $N_u / min(N_{cbg}, N_{pn}, N_{sbg}) = 0.00$ $N_u / 1.2N_{sa} = 0.00$
ACI 318-11eismic DesignApplicableOKteel and concrete-governed $1.2N_{sa} = 0.00$ [kips] $N_{cbg} = 0.00$ [kips]ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips]
deismic DesignApplicableOKteel and concrete-governed $1.2N_{sa} = 0.00$ [kips] $N_{cbg} = 0.00$ [kips]ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips]
ensionApplicableOKteel and concrete-governed $1.2N_{sa} = 0.00$ [kips] $N_{cbg} = 0.00$ [kips]ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips]
teel and concrete-governed $1.2N_{sa} = 0.00$ [kips] $N_{cbg} = 0.00$ [kips]ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips]
ominal strength $N_{pn} = 0.00$ [kips] $N_{sbg} = 0.00$ [kips]
$N_u / min(N_{cbg}, N_{pn}, N_{sbg}) = 0.00$ $N_u / 1.2N_{sa} = 0.00$
> 0.00 NA
lot Applicable - Check Option 1 D.3.3.4.3 (a) subsections 1~2
eismic SDC>=C and E>0.2U, Option 4 is selected to satisfy additional seismic requirements as per D.3.3.4.3
······································
hear Applicable OK
eismic SDC>=C and E>0.2U, Option 3 is selected to satisfy additional seismic requirements as per D.3.3.5.3

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Example 03: Group Anchor Bolt + Anchor Reinft + Tension & Shear + ACI 318-11 Code





N _u = 20 kips (Ter	nsion)	V _u = 25	kips			
Concrete	f _c '= 4 ksi	Rebar	f _y = 60 ksi			
Pedestal size	16" x 16"					
Anchor bolt	F1554 Grade 36		1.0" dia	Hex Head	h _{ef} = 20"	h _a =25"
Anchor reinforce	ment	Tension	ightarrow 2-No 8 ver. ba	r		
		Shear -	→ 2-layer, 2-leg No	o 4 hor. bar		
Provide built-up	grout pad					
Seismic design o	ategory >= C		Tension \rightarrow Optic	on 4	Shear \rightarrow Option 3	

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						1 of 7
ANCHOR BOLT DESIGN Con	nbined Tensio	n and Sh	ear			
Anchor bolt design based on						Code Abbreviation
ACI 318-11 Building Code Requirement	s for Structural	Concrete	and Commentary	Appendix D		ACI 318-11
PIP STE05121 Anchor Bolt Design Guid	de-2006					PIP STE05121
						Code Reference
Assumptions						ACI 318-11
1. Concrete is cracked						D.5.2.6, D5.3.6, D.6.2.7
2. Condition A - supplementary reinforce	ement is provid	ed				D.4.3 (c)
3. Load combinations shall be per ACI 3	318-11 9.2					D.4.3
4. Anchor reinft strength is used to repla	ace concrete ter	nsion / sh	ear breakout stren	igth as per		
ACI 318-11 Appendix D clause D.5.2	.9 and D.6.2.9					D.5.2.9 & D.6.2.9
5. For tie reinft, only the top most 2 or 3	layers of ties (2	2" from T	OC and 2x3" after)	are effective		
6. Strut-and-Tie model is used to anlyze	the shear tran	sfer and t	o design the requi	red tie reinft		
7. Anchor reinft used in structures with S	SDC>=C shall r	neet requ	irements specified	l in D.3.3.7		D.3.3.7
8. Anchor bolt washer shall be tack weld	ded to base pla	te for all a	inchor bolts to trar	sfer shear		AISC Design Guide 1 section 3.5.3
Anchor Bolt Data	set N. =	= 0 if it's c	ompression			0.0.0
Factored tension for design	$N_u = 20.00$	[kips]		= 89.0	[kN]	
Factored shear	$V_u = 25.00$	[kips]		= 111.2	[kN]	
Factored shear for design	$V_u = 25.00$	[kips]	V _u = 0 if shear k		[]	
Concrete strength	$f'_{c} = 4.0$	[ksi]	u	= 27.6	[MPa]	
Anchor bolt material		4 Grade	36 🔻	21.0	[iiii d]	
Anchor tensile strength	f _{uta} = 58	[ksi]		= 400	[MPa]	ACI 318-11
			steel element		[0]	D.1
Anchor bolt diameter	d _a = 1	[ii		= 25.4	[mm]	PIP STE05121
Bolt sleeve diameter	d _s = 3.0	[in]				Page A -1 Table 1
Bolt sleeve height	$h_{s} = 10.0$	[in]				
	3	[]	min required			
Anchor bolt embedment depth	h _{ef} = 20.0	[in]	12.0	ОК		Page A -1 Table 1
Pedestal height	h = 25.0	[in]	23.0	ок		
Pedestal width	$b_{c} = 16.0$	[in]				
Pedestal depth	$d_{c} = 16.0$	[in]				
<=0.5 hef	0		min(0.5 C 1,0.3 C 2)		<= min	(0.5 C ₁ ,0.3 C ₂)
2=0.5 Mª		K	\rightarrow		\longleftrightarrow	
$ \begin{array}{c c} \hline \\ \hline \\$	C4			<u>► ₹.</u>		$ \begin{array}{c} c_1 \\ c_1 \\ c_3 \\ c_4 \\ c_6 \\ c_3 \\ c_3 \\ c_4 \\ c_6 $
Ver. Reinft For Tension	Hor. Tie	s For She	ear - 4 Legs	Hor. Ties F	or Shear	- 2 Legs

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		_	min required		2 of 7
Bolt edge distance c ₁	$c_1 = 5.0$	[in]	4.5	ок	Code Reference
Bolt edge distance c ₂	$c_2 = 5.0$	[in]	4.5	ок	PIP STE05121
Bolt edge distance c ₃	$c_3 = 5.0$	[in]	4.5	ок	Page A -1 Table 1
Bolt edge distance c ₄	$c_4 = 5.0$	[in]	4.5	ОК	
Outermost bolt line spacing s ₁	s ₁ = 6.0	[in]	4.0	ОК	Page A -1 Table 1
Outermost bolt line spacing s ₂	s ₂ = 6.0	[in]	4.0	ок	
					ACI 318-11
To be considered effective for resis	sting anchor tension, v	vertical re	inforcing bars shall be lo	ocated	RD.5.2.9
within 0.5h _{ef} from the outmost anch	or's centerline.				
Avg ver. bar center to anchor rod c	enter distance		d _{ar} =	4.0	[in]
No of ver. rebar that are effective for	or resisting anchor ter	nsion	n _v =	2	
Ver. bar size No.	8 🔻 1.000	[in] dia	single bar area A _s =	= 0.79	[in ²]
Ver. bar top anchorage option	= 180 De	egree Ho	ok or Hairpin 📃 ?	•	
	-				
To be considered effective for resis	sting anchor shear, ho	or. reinft s	hall be located		RD.6.2.9
within min($0.5c_1$, $0.3c_2$) from the c	outmost anchor's cent	erline	min(0.5c ₁ , 0.3c ₂) =	= 1.5	[in]
No of tie leg that are effective to	resist anchor shear		n _{lea} =	2	?
No of tie layer that are effective to	resist anchor shear			2 🔻	?
Hor. tie bar size No.	4 🔻 : 0.500	[in] dia	single bar area A _s =		[in ²]
For anchor reinft shear breakout st	rength calc 10	0% hor.	tie bars develop full yi	eld strengt	th 💌 ?
			suggest		
Rebar yield strength - ver. bar	$f_{y-v} = 60$	[ksi]	60		
Rebar yield strength - hor. bar	$f_{y-h} = 60$	[ksi]	60		
No of bolt carrying tension	$n_t = 4$			Г	
No of bolt carrying shear	n _s = 4				C
		-			• [•] ⁿ bd
For side-face blowout check use					de 13
No of bolt along width edge	$n_{bw} = 2$				n _{bw}
No of bolt along depth edge	$n_{bd} = 2$				C
		-			
Anchor head type	= Hex		• ?	¥	C4 S2 C2
Anchor effective cross sect area	$A_{se} = 0.606$	[in ²]		F	bc >
Bearing area of head	A _{brg} = 1.163	[in ²]			Dalk Na Jacob for Side Free
	A _{brg}	 [in ²]	not applicable		Bolt No Input for Side-Face Nowout Check Use
Bolt 1/8" (3mm) corrosion allowand		?		L	and a contract of the contract
Provide shear key ?	= No 💌	?			ACI 318-11
Provide built-up grout pad ?	= Yes	?			D.6.1.3
Seismic design category SDC >= (c = Yes ▼	?)		D.3.3.1
Anchor bolt load E <= 0.2U	Tensile = No -	2		No 🔻	? D.3.3.4.1 & D.3.3.5.1
Anchor bolt satisfies option	Tensile = Option				
			Ghear -		·

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					3 0
				Code Reference	
Strength reduction factors				ACI 318-11	
Anchor reinforcement	$\phi_{s} = 0.75$			D.5.2.9 & D.6.2.9	
Anchor rod - ductile steel	$\phi_{t,s} = 0.75$	$\phi_{v,s}$ = 0.65		D.4.3 (a)	
Concrete - condition A	$\phi_{t,c} = 0.75$	$\phi_{v,c} = 0.75$		D.4.3 (c)	
CONCLUSION					
Anchor Rod Embedment, Spacing	g and Edge Distance		ОК		
Min Rquired Anchor Reinft. Devel	lopment Length	ratio = 0.53	ОК	12.5.1	
Overall		ratio = 0.81	ОК		
Tension					
Anchor Rod Tensile Resistance		ratio = 0.19	ОК		
Anchor Reinft Tensile Breakout R	Resistance	ratio = 0.28	ОК		
Anchor Pullout Resistance		ratio = 0.26	ОК		
Side Blowout Resistance		ratio = 0.27	ок		
Shear					
Anchor Rod Shear Resistance		ratio = 0.57	ОК		
Anchor Reinft Shear Breakout Re	esistance				
Strut Bearing Strength		ratio = 0.59	ОК		
Tie Reinforcement		ratio = 0.69	ОК		
Conc. Pryout Not Govern When h	n _{ef} >= 12d _a		ОК		
Tension Shear Interaction					
Tension Shear Interaction		ratio = 0.81	ок		
Seismic Design					
ocionno Deorgin					
Tension	Applicable		ОК	D.3.3.4	
Tension	Applicable Dption 4 is selected to satisfy additional seism	ic requirements as p			
Tension Seismic SDC>=C and E>0.2U , C	Option 4 is selected to satisfy additional seism	ic requirements as p			
Tension Seismic SDC>=C and E>0.2U , C Shear			er D.3.3.4 OK	4.3 D.3.3.5	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C	Dption 4 is selected to satisfy additional seism Applicable		er D.3.3.4 OK	4.3 D.3.3.5	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C	Dption 4 is selected to satisfy additional seism Applicable		er D.3.3.4 OK	4.3 D.3.3.5	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C CACULATION	Dption 4 is selected to satisfy additional seism Applicable		er D.3.3.4 OK	4.3 D.3.3.5	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C CACULATION Anchor Rod Tensile	Option 4 is selected to satisfy additional seism Applicable Option 3 is selected to satisfy additional seism	ic requirements as p	er D.3.3.4 OK er D.3.3.4	4.3 D.3.3.5 5.3	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C CACULATION Anchor Rod Tensile Resistance	Dption 4 is selected to satisfy additional seism Applicable Dption 3 is selected to satisfy additional seism $\phi_{t,s} N_{sa} = \phi_{t,s} n_t A_{se} f_{uta}$ ratio = 0.19	ic requirements as p = 105.44 > N _u	er D.3.3.4 OK er D.3.3.9 [kips]	4.3 D.3.3.5 5.3	
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C CACULATION Anchor Rod Tensile Resistance Anchor Reinft Tensile Breakout	Dption 4 is selected to satisfy additional seism Applicable Dption 3 is selected to satisfy additional seism $\phi_{t,s} N_{sa} = \phi_{t,s} n_t A_{se} f_{uta}$ ratio = 0.19 t Resistance I _d = straight bar case not applicable	ic requirements as p = 105.44 > N _u	er D.3.3.4 OK er D.3.3.9 [kips]	4.3 D.3.3.5 5.3	4
Tension Seismic SDC>=C and E>0.2U , C Shear Seismic SDC>=C and E>0.2U , C CACULATION Anchor Rod Tensile Resistance Anchor Reinft Tensile Breakout Min tension development length	Dption 4 is selected to satisfy additional seism Applicable Dption 3 is selected to satisfy additional seism $\phi_{t,s} N_{sa} = \phi_{t,s} n_t A_{se} f_{uta}$ ratio = 0.19	ic requirements as p = 105.44 > N _u	er D.3.3.4 OK er D.3.3.9 [kips] OK	4.3 D.3.3.5 5.3 D.5.1.2 (D-2)	2.4
Tension Seismic SDC>=C and E>0.2U , C Shear	Dption 4 is selected to satisfy additional seism Applicable Dption 3 is selected to satisfy additional seism $\phi_{t,s} N_{sa} = \phi_{t,s} n_t A_{se} f_{uta}$ ratio = 0.19 t Resistance I _d = straight bar case not applicable	ic requirements as p = 105.44 > N _u = 0.00	er D.3.3.4 OK er D.3.3.9 [kips] OK [in]	4.3 D.3.3.5 5.3 D.5.1.2 (D-2) 12.2.1, 12.2.2, 12.2	4

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.⊆ ≪0.5hef					Code Reference
					ACI 318-11
	$\phi_s N_n = \phi_s \times f_{y-1}$, x n _v x A _s x (I_a / I_d , if $I_a < I_d$)	= 71.10	[kips]	D.3.3.4.5 & D.5.2.9 12.2.5
	ratio = 0.28		> N _u	ОК	
Anchor Pullout Resistance			0 7 00	n.:	
Single bolt pullout resistance	$N_p = 8 A_{brg}$		= 37.22	[kips]	D.5.3.4 (D-14)
<u></u>	$\phi_{t,c} N_{pn} = \phi_{t,c} n_t$		= 104.20	[kips]	D.5.3.1 (D-13)
Seismic design strength reduction		applicable	= 78.15	[kips]	D.3.3.4.4
	ratio = 0.26		> N _u	OK	
	$\Psi_{c,p} = 1$ for c				D.5.3.6
	$\phi_{t,c} = 0.70$	pullout strength is always	S Condition D		D.4.3(c)
Side Blowout Resistance					
Failure Along Pedestal Width Edge	9				
Tensile load carried by anchors close		nay cause side-face blowout			
along pedestal width edge	$N_{buw} = N_u \times n_t$	-	= 10.00	[kips]	RD.5.4.2
	c = min (c		= 5.0	[in]	
Check if side blowout applicable	h _{ef} = 20.0	[in]		[···]	
	> 2.5c	side bowout is a	oplicable		D.5.4.1
Check if edge anchors work as a	s ₂₂ = 6.0		$= s_2 = 6.0$	[in]	
a group or work individually	< 6c	edge anchors w			D.5.4.2
Single anchor SB resistance	$\phi_{t,c} N_{sb} = \phi_{t,c}$ (16	-	= 40.92	[kips]	D.5.4.1 (D-16)
-	$\phi_{t,c}N_{sbg,w} =$	V brg) V V c		[]]	,
work as a group - applicable		δc) x φ _{t.c} N _{sb}	= 49.11	[kips]	D.5.4.2 (D-17)
work individually - not applicable		$V_{t,c} N_{sb} x [1+(c_2 \text{ or } c_4) / c] / 4$	= 0.00	[kips]	D.5.4.1
Seismic design strength reduction		applicable	= 36.83	[kips]	D.3.3.4.4
	ratio = 0.27	approved	> N _{buw}	OK	
Failure Along Pedestal Depth Edge					
Tensile load carried by anchors clo		nay cause side-face blowout			
along pedestal depth edge	$N_{bud} = N_u \times n_t$	•	= 10.00	[kips]	RD.5.4.2
, `	c = min (c		= 5.0	[in]	
Check if side blowout applicable	h _{ef} = 20.0	[in]			
	> 2.5c	side bowout is a	pplicable		D.5.4.1

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							Code Reference	
							ACI 318-11	
Check if edge anchors work as a					$s = s_1 = 6.0$	[in]		
a group or work individually				-	vork as a group		D.5.4.2	
Single anchor SB resistance)c√A _{brg})λ.	√f' _c	= 40.92	[kips]	D.5.4.1 (D-16)	
	$\phi_{t,c} N_{sbg,d}$ =							
work as a group - applicable		•	c) x φ _{t,c} N _{sb}		= 49.11	[kips]	D.5.4.2 (D-17)	
work individually - not applicable				or c ₃) / c] / 4		[kips]	D.5.4.1	
Seismic design strength reduction			applicable		= 36.83	[kips]	D.3.3.4.4	
	ratio =	= 0.27			> N _{bud}	OK		
Group side blowout resistance	$\phi_{t,c} N_{sbg}$ =	= $\phi_{\rm t,c}$ min	$n\left(-\frac{N_{sbg,w}}{n_{bw}}n_{t}\right)$	$\left(\frac{N_{\text{sbg,d}}}{n_{\text{bd}}}n_{t}\right)$	= 73.66	[kips]		
Govern Tensile Resistance	N _r =	= min (_{\$}	N _{sa} , _φ N _n , _φ Ι	$N_{pn}, \phi N_{sbg}$)	= 71.10	[kips]		
Anchor Rod Shear Resistance Reduction due to built-up grout pad		= x 0.8 , a	D.6 A _{se} f _{uta} applicable		= 54.83 = 43.86 > V _u	[kips] [kips] OK	D.6.1.2 (b) (D-29) D.6.1.3	
Anchor Reinft Shear Breakout Re Strut-and-Tie model is used to anly STM strength reduction factor	ze the she	ar transfe = 0.75	er and to des	ign the require			9.3.2.6	
Vu/2 Vu/2 Tt Tt Tt Tt θ d	Tt -	dr. A p			CX7		Bda	

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			. -	Code Reference
Strut-and-Tie model geometry	$d_v = 2.250$ [in]	$d_{h} = 2.250$	[in]	ACI 318-11
	$\theta = 45$	d _t = 3.182	[in]	
Strut compression force	$C_s = 0.5 V_u / \sin \theta$	= 17.68	[kips]	
Strut Bearing Strength				
Strut compressive strength	$f_{ce} = 0.85 f'_{c}$	= 3.4	[ksi]	A.3.2 (A-3)
* Bearing of anchor bolt				
Anchor bearing length	$I_e = min(8d_a, h_{ef})$	= 8.0	[in]	D.6.2.2
Anchor bearing area	$A_{brg} = I_e \times d_a$	= 8.0	[in ²]	
Anchor bearing resistance	$C_r = n_s x \phi_{st} x f_{ce} x A_{brg}$	= 81.60	[kips]	
		> V _u	ок	
* Bearing of ver reinft bar				
Ver bar bearing area	$A_{brg} = (I_e + 1.5 \times d_t - d_a/2 - d_b/2) \times d_b$	= 11.8	[in ²]	
Ver bar bearing resistance	$C_r = \phi_{st} \times f_{ce} \times A_{brg}$	= 30.02	[kips]	
	ratio = 0.59	> C _s	OK	
Tie Reinforcement				
* For tie reinft, only the top most 2 of	or 3 layers of ties (2" from TOC and 2x3" af			
* For enclosed tie, at hook location	the tie cannot develop full yield strength $\mathbf{f}_{\mathbf{y}}$. Use the pullout res		
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as 	the tie cannot develop full yield strength f_y per ACI 318-11 Eq. (D-15) as the max force	. Use the pullout res		
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as 	the tie cannot develop full yield strength f_y per ACI 318-11 Eq. (D-15) as the max force	. Use the pullout res		
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max forc n develop full yield strength.	. Use the pullout res		
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car 	the tie cannot develop full yield strength f_y per ACI 318-11 Eq. (D-15) as the max force	. Use the pullout res e can be developed a		
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar 	the tie cannot develop full yield strength f_y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$. Use the pullout res e can be developed a = 4	at hook T	h ACI 318-11
* For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$	Use the pullout res e can be developed a = 4 = 3.04	at hook T [kips]	h
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar 	the tie cannot develop full yield strength f_y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$. Use the pullout res e can be developed a = 4	at hook T	h ACI 318-11
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$	Use the pullout res e can be developed a = 4 = 3.04	at hook T [kips]	h ACI 318-11
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars can Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\text{-}h} \times A_{s}$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00	at hook T [kips] [in] [kips]	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars can Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}^{*} e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00	at hook T [kips] [in] [kips] [kips]	h ACI 318-11
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars can Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\text{-}h} \times A_{s}$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00	at hook T [kips] [in] [kips]	A <i>CI 318-11</i> D.5.3.5 (D-15)
* For tie reinft, only the top most 2 of * For enclosed tie, at hook location	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}^{*} e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00	at hook T [kips] [in] [kips] [kips]	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars can Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance Conc. Pryout Shear Resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}^{*} e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u	at hook T [kips] [in] [kips] [kips] OK	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y-h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$ ratio = 0.69	. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u assume that for gene	at hook T [kips] [in] [kips] [kips] OK	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{ieg} (leg) \times n_{iay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$ $ratio = 0.69$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u assume that for gene	at hook T [kips] [in] [kips] [kips] OK	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{leg} (leg) \times n_{lay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$ ratio = 0.69	. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u assume that for gene ern $h_{ef} = 20.0$	at hook T [kips] [kips] [kips] OK eral	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{ieg} (leg) \times n_{iay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$ $ratio = 0.69$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u assume that for gene	at hook T [kips] [in] [kips] [kips] OK	A <i>CI 318-11</i> D.5.3.5 (D-15)
 * For tie reinft, only the top most 2 of * For enclosed tie, at hook location tension of a single hooked bolt as * Assume 100% of hor. tie bars car Total number of hor tie bar Pull out resistance at hook Single tie bar tension resistance Total tie bar tension resistance 	the tie cannot develop full yield strength f _y per ACI 318-11 Eq. (D-15) as the max force in develop full yield strength. $n = n_{ieg} (leg) \times n_{iay} (layer)$ $T_{h} = \phi_{t,c} 0.9 f_{c}' e_{h} d_{a}$ $e_{h} = 4.5 d_{b}$ $T_{r} = \phi_{s} \times f_{y\cdot h} \times A_{s}$ $\phi_{s} V_{n} = 1.0 \times n \times Tr$ $ratio = 0.69$. Use the pullout res e can be developed a = 4 = 3.04 = 2.250 = 9.00 = 36.00 > V _u assume that for gene ern $h_{ef} = 20.0$	at hook T [kips] [kips] [kips] OK eral	A <i>CI 318-11</i> D.5.3.5 (D-15)

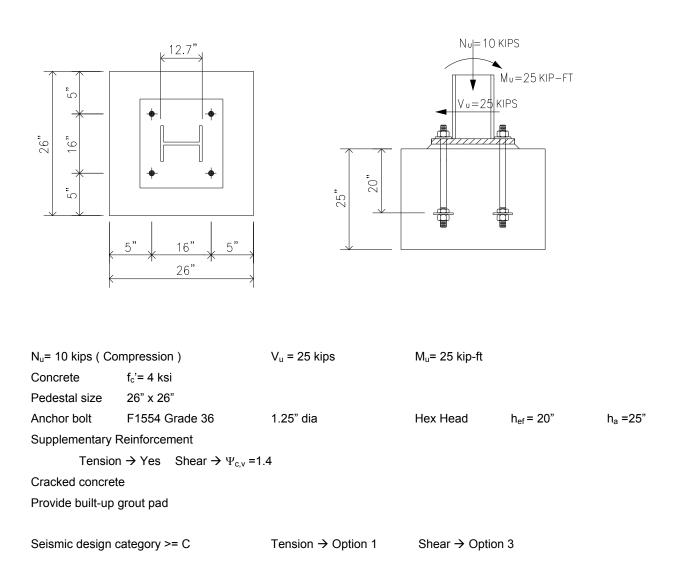


oncrete Anchorage Desig	n v1.5.0 User Manu	ıal			Dongxiao V	Vu P. I
					Code Reference	7 of
ension Shear Interaction						
Check if $N_u > 0.2\phi N_n$ and $V_u > 0.2\phi$	2. Vn Yes				D.7.1 & D.7.2	
		$J_n + V_u / \phi V_n$	= 0.98		D.7.3 (D-42)	
	ratio = 0.81		< 1.2	ОК		
Seismic Design						
Tension	Applicable			ок		
Steel nominal strength x 1.2	$1.2N_{sa} = 0.00$	[kips]				
Concrete-governed nominal	$N_{pn} = 0.00$	[kips]	$N_{sbg} = 0.00$	[kips]		
-	$(N_{pn}, N_{sbg}) = 0.00$		N _u / 1.2N _{sa} = 0.00			
ŭ	(pir/ obg /		> 0.00			
Not Applicable - Check Option	T D.3.3.4.3 (a) Subsec					
Shear	Applicable			ОК		
Seismic SDC>=C and E>0.2U ,	Option 3 is selected to	satisfy additior	nal seismic requirements	as per D.3.3.	5.3	

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Example 04: Group Anchor Bolt + No Anchor Reinft + Tension Shear & Moment + ACI 318-11 Code



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	nbined Tension	, Shear and Moment		
Anchor bolt design based on				Code Abbreviation
ACI 318-11 Building Code Requirement		Concrete and Commentary	Appendix D	ACI 318-11
PIP STE05121 Anchor Bolt Design Gui	de-2006			PIP STE05121
				Code Reference
Assumptions				ACI 318-11
1. Concrete is cracked				D.5.2.6, D5.3.6, D.6.2.7
2. Condition A - supplementary reinforc	•			D.4.3 (c)
3. Load combinations shall be per ACI				D.4.3
4. Shear load acts through center of bo				D.6.2.5
5. For anchor group subject to moment			-	D.3.1
and there is no redistribution of the fo				
6. For anchor tensile force calc in ancho				
resultant is at the outside edge of the			s rigid-body	
rotation. This simplified approach yie			. .	
7. Anchor bolt washer shall be tack wel	ded to base plate	e for all anchor bolts to trans	ster shear	AISC Design Guide 1
				section 3.5.3
Anchor Bolt Data	M - 05.00	Ilden 60	- 22.0 [kb]m]	
Factored moment	$M_u = 25.00$	[kip-ft]	= 33.9 [kNm]	
Factored tension /compression	$N_u = -10.00$	[kips] in compression	= -44.5 [kN]	
Factored shear	$V_u = 25.00$	[kips]	= 111.2 [kN]	
Factored shear for bolt design	$V_{u} = 25.00$	[kips] $V_u = 0$ if shear ke		
	S2	$\begin{array}{c} \bullet & \bullet \\ \bullet & \bullet \\$		
$S_{tb} = 0$ M_u	- - -	Stb Nu Vu T2 T2 Sb1 Sb1 Sb1	T1 Sb1 Sb2 S1	Ми Ми Т 3 S b1
2 BOLT LINE		3 BOLT LINE	4 BOLT I	lne
No of bolt line for resisting moment	= 2 Bolt	Line 💌		
No of bolt along outermost bolt line	= 2			
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							Code Reference
No of bolt along side edge	n _{bd} = 2						
		_	min required				PIP STE05121
Outermost bolt line spacing s ₁	s ₁ = 16.0	[in]	5.0		OK		Page A -1 Table 1
Outermost bolt line spacing s ₂	s ₂ = 16.0	[in]	5.0		OK		
Internal bolt line spacing s _{b1}	$s_{b1} = 6.0$	[in]	5.0		ОК		
Internal bolt line spacing s_{b2}	$s_{b2} = 0.0$	[in]	5.0		ок		
Max spacing between anchors in tension	on = 16.0	[in]					
Column depth	d = 12.7	[in]					
Concrete strength	f' _c = 4.0	[ksi]		=	27.6	[MPa]	
Anchor bolt material	= F155	4 Grade 3	36 🔽				
Anchor tensile strength	f _{uta} = 58	[ksi]		= -	400	[MPa]	ACI 318-11
	Anchor	is ductile	steel element				D.1
Anchor bolt diameter	d _a = 1.25		n]	=	31.8	[mm]	PIP STE05121
Bolt sleeve diameter	$d_{s} = 3.0$	[in]					Page A -1 Table 1
Bolt sleeve height	$h_{s} = 10.0$	[in]					
	h 00.0	r. 1	min required		01/		
Anchor bolt embedment depth	$h_{ef} = 20.0$	[in]	15.0		OK		Page A -1 Table 1
Concrete thickness	h _a = 25.0	[in]	23.0		ОК		
Bolt edge distance c₁	c ₁ = 5.0	[in]	5.0		ОК		Page A -1 Table 1
Bolt edge distance c_2	$c_2 = 5.0$	[in]	5.0		ок		0
Bolt edge distance c_3	$c_3 = 5.0$	[in]	5.0		ок		
Bolt edge distance c_4	$c_4 = 5.0$	[in]	5.0		ок		ACI 318-11
$c_i > 1.5h_{ef}$ for at least two edges to ave			J ₁₁ > 0		No		D.5.2.3
Adjusted h _{ef} for design	h _{ef} = 5.33	[in]	15.0		Warn		D.5.2.3
$C_{1} = C_{1}$	ů Ď	min(c1 C3 C3 C3 C4 C4 C4 C4 C4 C4 C4 C4 C4 C4	,1.5her) $min(c_3 + s_1, 1.$		min(c2,1.5het) s2 min(c4,1.5het)		

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Number of bolt at bolt line 1	n ₁ = 2				Code Reference
Number of bolt at bolt line 2	n ₂ = 2				ACI 318-11
Number of bolt carrying tension	$n_t = 2$	-			
Oversized holes in base plate ?	= No ᆍ	?			
Total no of anchor bolt	n = 4				
Number of bolt carrying shear	n _s = 4				
Anchor head type	= Hex	Ŧ	?		
Anchor effective cross sect area	$A_{se} = 0.969$	[in ²]			
Bearing area of head	A _{brg} = 1.817	[in ²]			
	A _{brg}	[in ²] not appl	icable		
Bolt 1/8" (3mm) corrosion allowanc	e No -	?			
Provide shear key ?	No 🔽	?			
Supplementary reinforcement					
For tension	Yes 🛨	Condition A			D.4.3 (c)
For shear	Ψ _{c,V} = 1.4 •	Condition A	?		D.6.2.7
Provide built-up grout pad ?	Yes 🔽	?			D.6.1.3
Concrete cracking	= cracke	d 💌 ?			D.5.2.6, D5.3.6, D.6.2.7
Seismic design category SDC >= C	c = Yes	?			D.3.3.1
Anchor bolt load E <= 0.2U	Tensile = No 💌	?	Shear = No 💌	?	D.3.3.4.1 & D.3.3.5.1
Anchor bolt satisfies option	Tensile = Option	1 🔻 ?	Shear = Option	3 🔻 ?	D.3.3.4.3 & D.3.3.5.3
Strength reduction factors					
Anchor reinforcement	$\phi_{s} = 0.75$				D.5.2.9 & D.6.2.9
Anchor rod - ductile steel	$\varphi_{t,s} = 0.75$		$\phi_{v,s} = 0.65$		D.4.3 (a)
Concrete	$\phi_{t,c} = 0.75$	Cdn-A	$\phi_{v,c} = 0.75$	Cdn-A	D.4.3 (c)
CONCLUSION					
Anchor Rod Embedment, Spacing	and Edge Distance			Warn	
Overall			ratio = 2.41	NG	
Tension					
Anchor Rod Tensile Resistance			ratio = 0.20	ок	
Conc. Tensile Breakout Resistance)		ratio = 1.34	NG	
Anchor Pullout Resistance			ratio = 0.27	ок	
Side Blowout Resistance			ratio = 0.28	ок	
Shear					
Anchor Rod Shear Resistance			ratio = 0.36	ОК	
Conc. Shear Breakout Resistance	- Perpendicular To Ed	ge	ratio = 1.56	NG	
Conc. Shear Breakout Resistance	- Parallel To Edge		ratio = 1.12	NG	
Conc. Pryout Shear Resistance			ratio = 1.09	NG	

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Tension Shear Interaction	1			Code Reference	
Tension Shear Interaction	ratio	9 = 2.41	NG	ACI 318-11	
Seismic Design					
Tension	Applicable		NG	D.3.3.4	
Option 1 is NOT satisfied	-			_	
Seismic SDC>=C and E>0.2U , O	ption 1 is selected to satisfy additional seismic requir	rements as p	er D.3.3.4	4.3	
Shear	Applicable		ок	D.3.3.5	
	ption 3 is selected to satisfy additional seismic requir	ements as r			
ocisinic 0202 -0 and 220.20, 0					
CALCULATION					
Anchor Tensile Force					
Single bolt tensile force	$T_1 = 8.24$ [kips] No of bolt for $T_1 n_T$.				
	$T_2 = 0.00$ [kips] No of bolt for $T_2 n_{T2}$	$_{2} = 0$			
	$T_3 = 0.00$ [kips] No of bolt for $T_3 n_{T_3}$	$_{3} = 0$			
Sum of bolt tensile force	$\mathbf{N}_{\mathbf{u}} = \sum n_i T_i$	= 16.48	[kips]		
Tensile bolts outer distance s _{tb}	s _{tb} = 0.0 [in]				
Eccentricity e' _N distance betwe	een resultant of tensile load and centroid of and	chors			
loaded in tension	e' _N = 0.00 [in]			Fig. RD.5.2.4 (b)	
Eccentricity modification factor	$\Psi_{ec,N} = \frac{1}{\left(1 + \frac{2e_{N}}{3h_{ef}}\right)}$	= 1.00		D.5.2.4 (D-8)	
Anchor Rod Tensile	$\phi_{t,s} N_{sa} = \phi_{t,s} A_{se} f_{uta}$	= 42.15	[kips]	D.5.1.2 (D-2)	
Resistance	ratio = 0.20	> T ₁	ок		
Conc. Tensile Breakout Resista	nce				
	N_b = 24 λ $\sqrt{f_c^{'}}$ $h_{ef}^{1.5}$ if h_{ef} <11" or h_{ef} >25"	= 18.70	[kips]	D.5.2.2 (D-6)	
	16 $\lambda \sqrt{f_c^{'}} h_{ef}^{5/3}$ if 11" $\leq h_{ef} \leq 25$ "			D.5.2.2 (D-7)	
Projected conc failure area	1.5h _{ef} =	= 8.00	[in]		
	$A_{Nc} = [s_{tb} + min(c_1, 1.5h_{ef}) + min(c_3, 1.5h_{ef})]x$ [s_2+min(c_2, 1.5h_{ef}) + min(c_4, 1.5h_{ef})]	= 338.0	[in ²]		
	$A_{\rm Nco} = 9 h_{\rm ef}^2$	= 256.0	[in ²]	D.5.2.1 (D-5)	
	$A_{Nc} = min (A_{Nc}, n_t A_{Nco})$	= 338.0	[in ²]	D.5.2.1	
Min edge distance	$c_{min} = min(c_1, c_2, c_3, c_4)$	= 5.0	[in]		
Eccentricity effects	$\Psi_{ec,N}$ =	= 1.00		D.5.2.4 (D-8)	
Edge effects	$\Psi_{ed,N}$ = min[(0.7+0.3c _{min} /1.5h _{ef}), 1.0]	= 0.89		D.5.2.5	
Concrete cracking	$\Psi_{c,N}$ = 1.00 for cracked concrete			D.5.2.6	

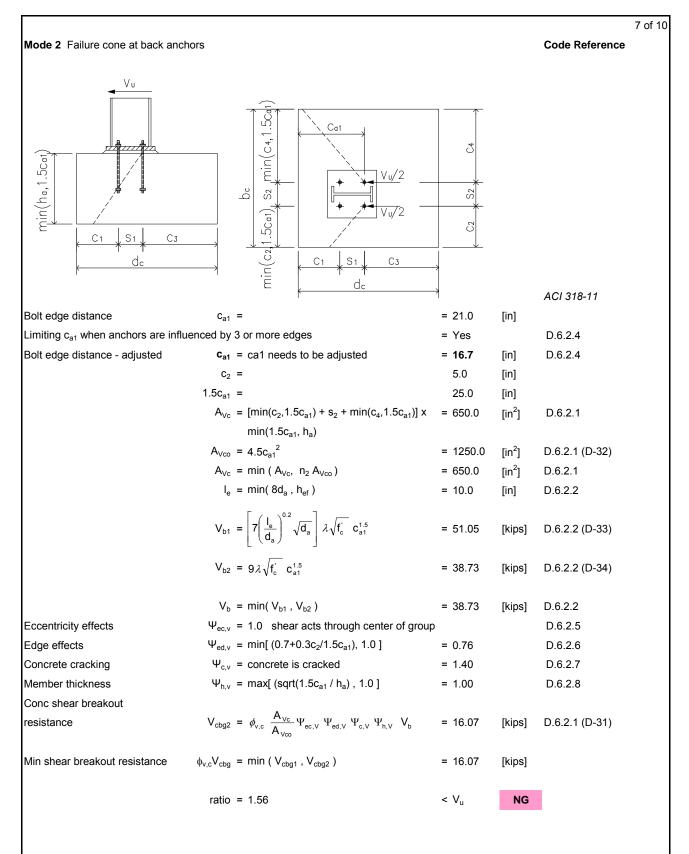
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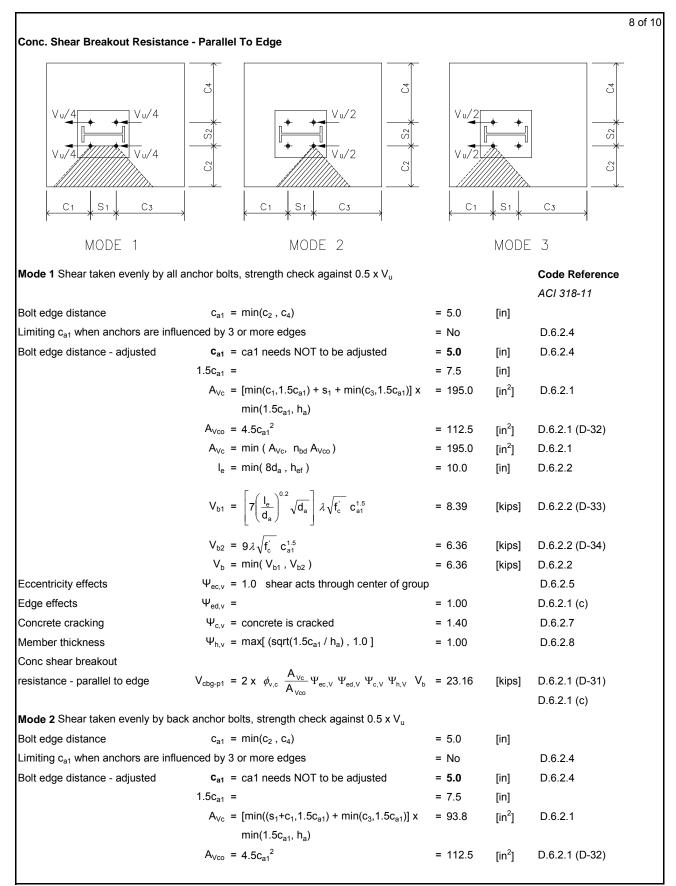
Code Reference ACI 318-11Concrete breakout resistance $\phi_{1,2}$ N_{xxy} ϕ_{xx} $\Psi_{xy,x}$ $\Psi_{xy,x}$ $\Psi_{xy,x}$ $\Psi_{xy,x}$ $\Psi_{xy,x}$ $= 16.43$ [kips] $D.5.2.1$ ($D.4$)Seismic design strength reduction $= x 0.75$ applicable $= 12.32$ [kips] $D.3.3.4$ Anchor Pullout Resistance $N_{\mu} = 8 A_{\mu 0} \int_{1}^{L}$ $= 58.14$ [kips] $D.5.3.4$ ($D.14$)Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] $D.5.3.4$ ($D.14$)Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] $D.5.3.4$ ($D.14$)Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] $D.5.3.4$ ($D.14$) $\psi_{LP} = 1.00$ for cracked concrete $D.5.3.6$ $D.4.3$ (c)Side Blowout Resistance $F_{alure} - 0.70$ pullout strength is always Condition B $D.4.3$ (c)Side Blowout Resistance $F_{alure} - 0.50$ [in] $D.5.4.2$ c = min (c_1, c_2) $= 5.0$ [in]a group proverk individually $< 6c$ edge anchors work as a group $D.5.4.2$ ing a packatial width edge $h_{x0} N_{x0} = \phi_{x0} \left[(60 c \sqrt{A_{x0}}) 2 \sqrt{f_{x0}} \right] = 78.43$ [kips] $D.5.4.1$ Check if side blowout applicable $h_{x0} N_{x0} = \phi_{x0} \left[(60 c \sqrt{A_{x0}}) 2 \sqrt{f_{x0}} \right] = 78.43$ [kips] $D.5.4.1$ Check if adge anchors work as a $S_{x2} = 16.0$ [in] $s = 58.22$ [kips] $D.5.4.1$ Check if adge anchors work as a $S_{x0} N_{x0} N_{x0} x_{x0} x_{x1} (1+c_2 or c_2)/c)//4 = 0.00$ [kips]					5 of 10	
Concrete breakout resistance $\phi_{1c} N_{abc} = \phi_{cc} \frac{A_{abc}}{A_{bc}} \psi_{wax} \psi_{wax} \psi_{wax} N_{bc} = 16.43$ [kips] D.5.2.1 (D.4) Seismic design strength reduction $= x 0.75$ applicable $= 12.32$ [kips] D.3.3.4.4 ratio $= 1.34$ $< N_{u}$ NG Anchor Pullout Resistance Single bolt pullout resistance $N_{p} = 8 A_{erg} f_{c}^{-}$ $= 58.14$ [kips] D.5.3.4 (D.14) $\phi_{1c} N_{pn} = \phi_{1c} \Psi_{cp} N_{p} = 40.70$ [kips] D.5.3.4 (D.13) Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.5.3.4 (D.13) Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.5.3.4 (D.13) Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.5.3.4 (D.13) Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.5.3.6 $\phi_{1c} = 0.70$ pullout strength is always Condition B D.4.3 (c) Side Blowout Resistance Failure Along Pedestal Width Edge Tensile load carried by anchors close to edge which may cause side-face blowout along pedestal width edge $N_{bace} = n_{T1} T_{T} = 16.48$ [kips] RD.5.4.2 $c = \min (c_{1}, c_{3}) = 5.0$ [in] Check if side blowout applicable $h_{efc} = 20.0$ [in] > 2.5C side blowout is applicable D.5.4.1 Check if side blowout applicable $\phi_{c} (h_{0} c_{\sqrt{A_{bg}}}) 2 \sqrt{T_{c}}} = 51.15$ [kips] D.5.4.1 (D.16) Multiple anchors SB resistance $\phi_{bc} N_{bc} = \phi_{c} (\frac{160 c \sqrt{A_{bg}}}{2}) 2 \sqrt{T_{c}}} = 51.15$ [kips] D.5.4.2 (D.17) work individually - not applicable $= (1 + si + 6.5) A_{bc} N_{bc} = 78.43$ [kips] D.5.4.2 (D.17) work as a group - applicable $= (1 + si + 6.5) A_{bc} N_{bc} = 78.43$ [kips] D.5.4.2 (D.17) work individually - not applicable $n_{bc} N_{bc} = h_{bc} N_{bc} = 58.82$ [kips] Group side blowout resistance $\phi_{bc} N_{bcg} = \phi_{bc} \frac{N_{bcg}}{n_{T1}} n_{T}} = 58.82$ [kips] Group side blowout resistance $h_{c} N_{bcg} = \phi_{c} \frac{N_{bcg}}{n_{T1}} n_{T}} = 58.82$ [kips] Check if side blowout resistance $h_{c} N_{bcg} = \phi_{cc} \frac{N_{bcg}}{n_{T1}} n_{T}} = 58.82$ [kips] Group side blowout resistance $h_$						
Seismic design strength reduction $= x 0.75$ applicable $= 12.32$ [kips] D.3.3.4.4 ratio $= 1.34$ $< N_u$ NG Anchor Pullout Resistance Single bolt pullout resistance $N_p = 8 A_{brg} [c]$ $= 58.14$ [kips] D.5.3.4 (D.14) $\phi_{1c} N_{pn} = \phi_{1c} \Psi_{cp} N_p$ $= 40.70$ [kips] D.5.3.4 (D.14) $\phi_{1c} N_{pn} = \phi_{1c} \Psi_{cp} N_p$ $= 40.70$ [kips] D.5.3.4 (D.14) $\varphi_{1c} = 1.00$ for cracked concrete $D.5.3.6$ [L(13) Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.5.3.4 (D.14) $\Psi_{cp} = 1.00$ for cracked concrete $D.5.3.6$ [L(13) Side Blowout Resistance Failure Along Pedestal With Edge Tensile load carried by anchors close to edge which may cause side-face blowout along pedestal width edge $N_{Now} = n_{11}, T_1$ $= 16.48$ [kips] RD.5.4.2 (In) Check if side blowout applicable $h_{e} = 20.0$ [In] > 2.5c side bowout is applicable $D.5.4.1Check if side blowout applicable h_{e} = 20.0 [In]> 2.5c$ side bowout is applicable $D.5.4.2Single anchors SB resistance \phi_{1c} N_{exp,w} = \phi_{cc} (fo0 c_{\sqrt{A_{Nop}}} > \sqrt{V_{cc}} = 51.15 [kips] D.5.4.2 (D.16)Multiple anchors SB resistance \phi_{1c} N_{exp,w} = \phi_{cc} \frac{160 c_{\sqrt{A_{Nop}}} > \sqrt{V_{cc}} = 51.15 [kips] D.5.4.2 (D.17)work individually - cot applicable n_{0w} \times \phi_{1c} N_{wax} \times [1+c_2 \circ c_2)/c] / 4 = 0.00 [kips] D.5.4.1 (D.16)Multiple anchors SB resistance \phi_{cc} N_{exp,w} = \phi_{ec} \frac{n_{exp} \times \eta_{ec} N_{exp} \times [1+c_2 \circ c_2)/c] / 4 = 0.00 [kips] D.5.4.1 (D.16)Multiple anchors SB resistance \phi_{ec} N_{exp} = \phi_{ec} \frac{n_{exp} \times \eta_{ec} N_{exp}} = 78.43 [kips] D.5.4.2 (D.17)work individually - not applicable n_{ex} \times N_{ec} N_{exp} \times [n_{ec} - c_{ec})/c] / 4 = 0.00 [kips] D.5.4.1 (D.16)Multiple anchors SB resistance N_{ec} N_{exp} = \phi_{ec} \frac{n_{exp} \times \eta_{ec} N_{exp}} (N_{exp} + 0, N_{exp}) = 12.32 [kips]Group side blowout resistance N_{ec} = m_{ec} (h_{ec} N_{exp} - h_{exp} N_{exp}) = 12.32 [kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear \phi_{$					ACI 318-11	
ratio = 1.34< NuNGAnchor Pullout ResistanceSingle bolt pullout resistance $N_p = 8 A_{erg} f_c^+$ = 58.14[kips]D.5.3.4 (D-14) $\psi_{1c} N_{Pa} = \psi_{1c} \Psi_{ca} N_b$ = 40.70[kips]D.5.3.1 (D-13)Seismic design strength reduction= x 0.75applicable= 30.53[kips]D.3.3.4.4ratio = 0.27> T ₁ OK $\Psi_{c,p} = 1.00$ for cracked concreteD.5.3.6 $\psi_{1c} = 0.70$ pullout strength is always Condition BD.4.3(c)Side Blowout ResistanceEallure Along Pedestal Wildth EdgeTensile load carried by anchors close to edge which may cause side-face blowoutalong pedestal width edge $N_{ware} = n_{T1} T_1$ = 16.48 $(kips]$ RD.5.4.2 $c = min (c_1, c_3)$ = 5.0[in]Check if side blowout applicable $h_{wl} = 20.0$ [in] $h_w = 20.0$ [in] $s = s_2 = 16.0$ [in]a group or work individually< 6c	Concrete breakout resistance	$\phi_{t,c} \mathbf{N}_{cbg} = \phi_{t,c} \frac{\mathbf{A}_{Nc}}{\mathbf{A}_{Nco}} \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N}$	$\Psi_{\rm cp,N} N_{\rm b} = 16.43$	[kips]	D.5.2.1 (D-4)	
Anchor Pullout Resistance $N_p = 8 A_{\log} f_{L}^{c}$ $= 58.14$ [kips] $D.5.3.4$ (D.14) $\phi_{1c} N_{pn} = \phi_{1c} \Psi_{cp} N_p$ $= 40.70$ [kips] $D.5.3.1$ (D.13)Seismic design strength reduction $x 0.75$ applicable $= 30.53$ [kips] $D.3.3.4$ ratio 0.27 $> T_1$ OK $\Psi_{c,p} = 1.00$ for cracked concrete $D.5.3.6$ $\phi_{1,c} = 0.70$ pullout strength is always Condition B $D.4.3(c)$ Side Blowout ResistanceEailure Along Pedestal Width EdgeTensile load carried by anchors close to edge which may cause side-face blowoutalong $n_{1,1} T_1$ $= 16.48$ [kips]RD.5.4.2C in (c_1, C_2) $= 5.0$ [in]> 2.5cside blowout is applicable $D.5.4.1$ Check if side blowout applicable $h_{eff} = 20.0$ [in] $s = s_2 = 16.0$ [in]2.5cside blowout applicable $D.5.4.2$ Sigle anchors work as a super size $\phi_{1,c} N_{hob} = \phi_{L} (160 c \sqrt{A_{hop}}) 2 \sqrt{\Gamma_v}$ $= 51.15$ [kips] $D.5.4.1$ Multiple anchors SB resistance $\phi_{1,c} N_{hob} = \phi_{L} (h_{hop}, N_{ho} X (14c_2 or c_4)/C)/4$ $= 0.00$ [kips] $D.5.4.1$ Sigle anchor so the size area $\phi_{1,c} N_{hob} = \phi_{L_c} \frac{n_{are} n}{n_1} f_1$ $= 58.82$ [kips] $D.5.4.1$ Check if side blowout resistance $\phi_{1,c} N_{hob} A_{hob} X_{hop} (n_1 N_{hob}, N_{hog}) = 12.32$ [kips] $D.5.4.2$ <td colspa<="" td=""><td>Seismic design strength reduction</td><td>= x 0.75 applicable</td><td>= 12.32</td><td>[kips]</td><td>D.3.3.4.4</td></td>	<td>Seismic design strength reduction</td> <td>= x 0.75 applicable</td> <td>= 12.32</td> <td>[kips]</td> <td>D.3.3.4.4</td>	Seismic design strength reduction	= x 0.75 applicable	= 12.32	[kips]	D.3.3.4.4
Single bolt pullou resistance $N_p = 8 A_{tog} f_c^{+}$ = 58.14 [kips] D.5.3.4 (D-14) $\phi_{1c} N_{pn} = \phi_{1c} \Psi_{cp} N_p$ = 40.70 [kips] D.5.3.1 (D-13) Seismic design strength reduction = x 0.75 applicable = 30.53 [kips] D.3.3.4.4 ratio = 0.27 > T ₁ OK $\Psi_{c,p} = 1.00$ for cracked concrete D.5.3.6 $\phi_{1c} = 0.70$ pullout strength is always Condition B D.4.3(c) Side Blowout Resistance Failure Along Pedestal Width Edge Tensile load carried by anchors close to edge which may cause side-face blowout along pedestal width edge $N_{bow} = n_{T1} T_1$ = 16.48 [kips] RD.5.4.2 $c = \min(c_r, c_3)$ = 5.0 [in] Check if side blowout applicable $h_{ef} = 20.0$ [in] > 2.5c side bowout is applicable D.5.4.1 Check if edge anchors work as $s_{22} = 16.0$ [in] $s = s_2 = 16.0$ [in] a group or work individually $< 6c$ edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{b,c} N_{abg,w} = w_{c,c} (f60c \sqrt{A_{bog}}) 2 \sqrt{T_c} = 51.15$ [kips] D.5.4.2 (D-17) work is a group - applicable $= (1+s/6c) \times \phi_{b,c} N_{ab}$ $= 78.43$ [kips] D.5.4.2 (D-17) work individually - not applicable $= n_{b,w} \times \phi_{b,c} N_{ab} \times [1+(c_2 \circ c_4)/c] / 4 = 0.00$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{b,c} N_{abg} = \phi_{b,c} \frac{N_{abg,w}}{n_{T1}} n_1 = 58.82$ [kips] D.5.4.2 (D-17) work individually - not applicable $= n_{b,w} \times \phi_{b,c} N_{ab} = h_{c,c} N_{abg} = h_{c,c} \frac{N_{abg,w}}{n_{T1}} n_1 = 58.82$ [kips] Govern Tensile Resistance $N_r = \min(\phi_{n_1} N_{as, \phi} N_{cbg, \phi} \phi_{n_1} N_{ps, \phi} \phi_{Natg}) = 12.32$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{as} = \phi_{v,s} n_{s} 0.6 A_{as} f_{vas} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3		ratio = 1.34	< N _u	NG		
	Anchor Pullout Resistance					
Seismic design strength reduction $= x 0.75$ applicable $= 30.53$ [kips] D.3.3.4.4 ratio $= 0.27$ $> T_1$ OK $\Psi_{n,p} = 1.00$ for cracked concrete D.5.3.6 $\Phi_{1,c} = 0.70$ pullout strength is always Condition B D.4.3(c) Side Blowout Resistance Failure Along Pedestal Width Edge Tensile load carried by anchors close to edge which may cause side-face blowout along pedestal width edge $N_{blow} = n_{T1}T_1 = 16.48$ [kips] RD.5.4.2 $c = \min(c_1, c_3) = 5.0$ [in] Check if side blowout applicable $h_{eff} = 20.0$ [in] 2.5c side bowout is applicable D.5.4.1 Check if edge anchors work as a $s_{22} = 16.0$ [in] $s = s_2 = 16.0$ [in] a group or work individually $< cc$ ec edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{h,c} N_{hbs} = \phi_{h,c} (160 c \sqrt{A_{brg}}) \lambda \sqrt{P_c} = 51.15$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{h,c} N_{has} = (14s/6c) X \phi_{hc} N_{ab} = 78.43$ [kips] D.5.4.2 (D-17) work individually - not applicable $= n_{box} x \phi_{h,c} N_{ab} x (14(c_2 or c_a)/c)/4 = 0.00$ [kips] D.5.4.1 Seismic design strength reduction $= x 0.75$ applicable $= 58.82$ [kips] D.3.3.4.4 ratio $= 0.28$ N_{bow} OK Group side blowout resistance $\phi_{h,c} N_{abg} = \phi_{h,c} \frac{N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}$ [kips] D.3.3.4.4 ratio $= 0.28$ N_{bow} OK Group side blowout resistance $\phi_{h,c} N_{abg} = \phi_{h,c} \frac{N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}$ [kips] Govern Tensile Resistance $\phi_{h,c} N_{abg} = \phi_{h,c} \frac{N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}, \phi_{h,c} N_{abg}$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3	Single bolt pullout resistance	$N_p = 8 A_{brg} f_c'$	= 58.14	[kips]	D.5.3.4 (D-14)	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		$\phi_{t,c} N_{pn} = \phi_{t,c} \Psi_{c,p} N_{p}$	= 40.70	[kips]	D.5.3.1 (D-13)	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Seismic design strength reduction	= x 0.75 applicable	= 30.53	[kips]	D.3.3.4.4	
		ratio = 0.27	> T ₁	ОК		
		$\Psi_{c.p}$ = 1.00 for cracked co	ncrete		D.5.3.6	
Failure Along Pedestal Width EdgeTensile load carried by anchors close to edge which may cause side-face blowoutalong pedestal width edge $N_{buw} = n_{T1}T_1$ = 16.48[kips]RD.5.4.2c = min (c ₁ , c ₃)= 5.0[in]Check if side blowout applicable $h_{ef} = 20.0$ [in]= 2.5cside bowout is applicableD.5.4.1Check if edge anchors work as a group or work individually< 6c			h is always Condition B		D.4.3(c)	
Failure Along Pedestal Width EdgeTensile load carried by anchors close to edge which may cause side-face blowoutalong pedestal width edge $N_{buw} = n_{T1}T_1$ = 16.48[kips]RD.5.4.2c = min (c ₁ , c ₃)= 5.0[in]Check if side blowout applicable $h_{ef} = 20.0$ [in]= 2.5cside bowout is applicableD.5.4.1Check if edge anchors work as a group or work individually< 6c	Side Blowout Resistance					
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$c = \min (c_{1}, c_{3}) = 5.0 $ [in] Check if side blowout applicable $h_{eff} = 20.0$ [in] > 2.5c side bowout is applicable D.5.4.1 Check if edge anchors work as a $s_{22} = 16.0$ [in] $s = s_{2} = 16.0$ [in] a group or work individually < 6c edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{t,c} N_{sb} = \phi_{t,c} (160 c \sqrt{A_{brg}}) \lambda \sqrt{t^{*}_{c}} = 51.15$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{t,c} N_{sbg,w} =$ work as a group - applicable = $(1+s/6c) \times \phi_{t,c} N_{sb} \times [1+(c_{2} \text{ or } c_{4})/c]/4 = 0.00$ [kips] D.5.4.2 (D-17) work individually - not applicable = $n_{bw} \times \phi_{t,c} N_{sb} \times [1+(c_{2} \text{ or } c_{4})/c]/4 = 0.00$ [kips] D.5.4.1 Seismic design strength reduction = $x 0.75$ applicable = 58.82 [kips] Group side blowout resistance $\phi_{t,c} N_{abg} = \phi_{t,c} \frac{N_{abg',w}}{n_{T1}} n_{t} = 58.82$ [kips] Govern Tensile Resistance $N_{r} = \min (\phi n_{t} N_{sa}, \phi N_{cbg}, \phi n_{t} N_{pn}, \phi N_{sbg}) = 12.32$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_{s} 0.6 A_{sa} f_{uta} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = $x 0.8$, applicable = 70.14 [kips] D.6.1.3	Tensile load carried by anchors clo		e blowout			
Check if side blowout applicable $h_{ef} = 20.0$ [in] > 2.5cside bowout is applicableD.5.4.1Check if edge anchors work as a group or work individually $< 6c$ edge anchors work as a groupD.5.4.2Single anchor SB resistance $\phi_{t,c} N_{sb} = \phi_{t,c} (160 c \sqrt{A_{brg}}) 2 \sqrt{f'_c}$ $= 51.15$ [kips]D.5.4.1 (D-16)Multiple anchors SB resistance $\phi_{t,c} N_{sbg,w} =$ $= (1+s/6c) \times \phi_{t,c} N_{sb}$ $= 78.43$ [kips]D.5.4.2 (D-17)work as a group - applicable $= (1+s/6c) \times \phi_{t,c} N_{sb} \times [1+(c_2 \operatorname{or} c_4)/c]/4$ $= 0.00$ [kips]D.5.4.1Seismic design strength reduction $= x 0.75$ applicable $= 58.82$ [kips]D.3.3.4.4ratio $= 0.28$ $> N_{buw}$ OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ $= 58.82$ [kips][kips]Mote: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearkips]D.6.1.2 (b) (D-29)ResistanceResistance $= x 0.8$, applicable $= 70.14$ [kips]D.6.1.3	along pedestal width edge	$N_{buw} = n_{T1} T_1$	= 16.48	[kips]	RD.5.4.2	
$\begin{array}{c c c c c c c } & > 2.5c & side bowout is applicable & D.5.4.1 \\ \hline Check if edge anchors work as a $$_{22}$ = 16.0 [in] $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$$		$c = min (c_1, c_3)$	= 5.0	[in]		
Check if edge anchors work as a $s_{22} = 16.0$ [in] $s = s_2 = 16.0$ [in] a group or work individually < 6c edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{t,c} N_{sb} = \phi_{t,c} (160 c \sqrt{A_{brg}}) \lambda \sqrt{f'_c} = 51.15$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{t,c} N_{sbg,w} =$ work as a group - applicable $= (1+s/6c) \times \phi_{t,c} N_{sb}$ $= 78.43$ [kips] D.5.4.2 (D-17) work individually - not applicable $= n_{bw} \times \phi_{t,c} N_{sb} \times [1+(c_2 \text{ or } c_4)/c]/4 = 0.00$ [kips] D.5.4.1 Seismic design strength reduction $= x 0.75$ applicable $= 58.82$ [kips] D.3.3.4.4 ratio $= 0.28$ N_{buw} OK Group side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t = 58.82$ [kips] Govern Tensile Resistance $N_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3	Check if side blowout applicable	h _{ef} = 20.0 [in]				
a group or work individually < 6c edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{t,c} N_{sb} = \phi_{t,c} (160 c \sqrt{A_{brg}}) \lambda \sqrt{f'_c} = 51.15$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{t,c} N_{sbg,w} =$ work as a group - applicable = (1+s/ 6c) x $\phi_{t,c} N_{sb}$ = 78.43 [kips] D.5.4.2 (D-17) work individually - not applicable = $n_{bw} x \phi_{t,c} N_{sb} x [1+(c_2 \text{ or } c_4)/c] / 4 = 0.00$ [kips] D.5.4.1 Seismic design strength reduction = x 0.75 applicable = 58.82 Group side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbg,w}}{n_{T1}} n_t$ = 58.82 [kips] Govern Tensile Resistance $N_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68 [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3		> 2.5c side l	powout is applicable		D.5.4.1	
Single anchor SB resistance $\phi_{t,c} N_{sb} = \phi_{t,c} (160 c \sqrt{A_{brg}}) \lambda \sqrt{f'_c} = 51.15$ [kips] D.5.4.1 (D-16) Multiple anchors SB resistance $\phi_{t,c} N_{sbg,w} =$ work as a group - applicable = $(1+s' 6c) \times \phi_{t,c} N_{sb}$ = 78.43 [kips] D.5.4.2 (D-17) work individually - not applicable = $n_{bw} \times \phi_{t,c} N_{sb} \times [1+(c_2 \text{ or } c_4)/c]/4 = 0.00$ [kips] D.5.4.1 Seismic design strength reduction = $x 0.75$ applicable = 58.82 [kips] D.3.3.4.4 ratio = 0.28 > N_{buw} OK Group side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbg',w}}{n_{T1}} n_t$ = 58.82 [kips] Govern Tensile Resistance $\mathbf{N}_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68 [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = $x 0.8$, applicable = 70.14 [kips] D.6.1.3	Check if edge anchors work as a	s ₂₂ = 16.0 [in]	s = s ₂ = 16.0	[in]		
Multiple anchors SB resistance $\phi_{t,c}N_{sbg,w}$ =work as a group - applicable= (1+s/ 6c) x $\phi_{t,c} N_{sb}$ = 78.43[kips]D.5.4.2 (D-17)work individually - not applicable= $n_{bw} x \phi_{t,c} N_{sb} x [1+(c_2 \text{ or } c_4)/c]/4$ = 0.00[kips]D.5.4.1Seismic design strength reduction= x 0.75applicable= 58.82[kips]D.3.3.4.4ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile ResistanceNr= min ($\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}$)= 12.32[kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceResistance= x 0.8, applicable= 70.14[kips]D.6.1.3	a group or work individually	< 6c edge	anchors work as a group		D.5.4.2	
Multiple anchors SB resistance $\phi_{t,c}N_{sbg,w}$ =work as a group - applicable= (1+s/ 6c) x $\phi_{t,c} N_{sb}$ = 78.43[kips]D.5.4.2 (D-17)work individually - not applicable= $n_{bw} x \phi_{t,c} N_{sb} x [1+(c_2 \text{ or } c_4)/c]/4$ = 0.00[kips]D.5.4.1Seismic design strength reduction= x 0.75applicable= 58.82[kips]D.3.3.4.4ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile ResistanceNr= min ($\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}$)= 12.32[kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceResistance= x 0.8, applicable= 70.14[kips]D.6.1.3	Single anchor SB resistance	$\phi_{t,c} N_{sb} = \phi_{t,c} \left(160 c \sqrt{A_{brg}} \right) \lambda \sqrt{f'_c}$	= 51.15	[kips]	D.5.4.1 (D-16)	
work as a group - applicable= $(1+s/6c) x \phi_{t,c} N_{sb}$ = 78.43[kips]D.5.4.2 (D-17)work individually - not applicable= $n_{bw} x \phi_{t,c} N_{sb} x [1+(c_2 \text{ or } c_4)/c]/4$ = 0.00[kips]D.5.4.1Seismic design strength reduction= x 0.75 applicable= 58.82[kips]D.3.3.4.4ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile ResistanceNr= min ($\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}$)= 12.32[kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceResistance= x 0.8, applicable= 70.14[kips]D.6.1.3	Multiple anchors SB resistance	$\phi_{t,c}N_{sbg,w} =$				
Seismic design strength reduction= x 0.75 applicable= 58.82[kips]D.3.3.4.4ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile Resistance $N_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg})$ = 12.32[kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceResistance= x 0.8, applicable= 70.14[kips]D.6.1.3			= 78.43	[kips]	D.5.4.2 (D-17)	
ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile Resistance $N_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearImage: Note is the image: N_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68[kips]Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceImage: Resistance = 70.14[kips]D.6.1.3$	work individually - not applicable	$= n_{bw} x \phi_{t,c} N_{sb} x [1+(c_2 \text{ or } c_2)]$	$(a_4) / c] / 4 = 0.00$	[kips]	D.5.4.1	
ratio= 0.28> N_{buw}OKGroup side blowout resistance $\phi_{t,c} N_{sbg} = \phi_{t,c} \frac{N_{sbgr,w}}{n_{T1}} n_t$ = 58.82[kips]Govern Tensile Resistance $N_r = \min(\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearImage: Note is the image: N_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68[kips]Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceImage: Resistance = 70.14[kips]D.6.1.3$	Seismic design strength reduction	= x 0.75 applicable	= 58.82	[kips]	D.3.3.4.4	
Govern Tensile Resistance $N_r = min (\phi n_t N_{sa}, \phi N_{cbg}, \phi n_t N_{pn}, \phi N_{sbg}) = 12.32$ [kips]Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ $= 87.68$ [kips]D.6.1.2 (b) (D-29)ResistanceReduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips]D.6.1.3			> N _{buw}	ок		
Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shearAnchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68 [kips]D.6.1.2 (b) (D-29)ResistanceReduction due to built-up grout pads= x 0.8 , applicable= 70.14 [kips]D.6.1.3	Group side blowout resistance	$\phi_{t,c} \mathbf{N}_{sbg} = \phi_{t,c} \frac{\mathbf{N}_{sbgr,w}}{\mathbf{n}_{T1}} \mathbf{n}_{t}$	= 58.82	[kips]		
Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$ = 87.68[kips]D.6.1.2 (b) (D-29)ResistanceReduction due to built-up grout pads= x 0.8 , applicable= 70.14[kips]D.6.1.3	Govern Tensile Resistance	$\mathbf{N_r}$ = min ($\phi n_t N_{sa}, \phi N_{cbg}, \phi n_{cbg}$	$h_t N_{pn}, \phi N_{sbg}) = 12.32$	[kips]		
ResistanceReduction due to built-up grout pads= x 0.8 , applicable= 70.14 [kips]D.6.1.3	Note: Anchor bolt sleeve portion m	iust be tape wrapped and grouted to r	resist shear			
Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3	Anchor Rod Shear	$\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta}$	= 87.68	[kips]	D.6.1.2 (b) (D-29)	
	Resistance					
	Reduction due to built-up grout pac	ds = x 0.8 , applicable	= 70.14	[kips]	D.6.1.3	
ratio = 0.36 > V ₁ OK		ratio = 0.36	> V _u	ок		

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			Code Reference	
Conc. Shear Breakout Resistance - Perpendicular To Edge				
Mode 1 Failure cone at front anchors, strength check against $0.5 \times V_u$				
Mode 3 Failure cone at front anchors, strength check against $1.0 \times V_u$, applicable whe	en oversized l	noles are	e used in base plate	
 ✓ U 				
	C4			
Vu/4 Mode 1 Vu/4 Mode 1				
	S2			
E	C2			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				
$E \qquad \begin{array}{c c c c c c c c c c c c c c c c c c c $				
Ē de				
	I		ACI 318-11	
Bolt edge distance C _{a1} =	= 5.0	[in]		
Limiting c_{a1} when anchors are influenced by 3 or more edges	= No	[]	D.6.2.4	
Bolt edge distance - adjusted $c_{a1} = ca1$ needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
C ₂ =	= 5.0	[in]		
1.5c _{a1} =	= 7.5	[in]		
$A_{Vc} = [min(c_2, 1.5c_{a1}) + s_2 + min(c_4, 1.5c_{a1})] x$	= 195.0	[in ²]	D.6.2.1	
min(1.5c _{a1} , h _a)				
$A_{Vco} = 4.5 c_{a1}^{2}$	= 112.5	[in ²]	D.6.2.1 (D-32)	
$A_{Vc} = min (A_{Vc}, n_1 A_{Vco})$	= 195.0	[in ²]	D.6.2.1	
$I_e = min(8d_a, h_{ef})$	= 10.0	[in]	D.6.2.2	
$V_{b1} = \left[7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right] \lambda \sqrt{f_c^{\cdot}} c_{a1}^{1.5}$	= 8.39	[kips]	D.6.2.2 (D-33)	
$V_{b2} = 9\lambda \sqrt{f_{c}^{1.5}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
$V_b = min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects $\Psi_{ec,v} = 1.0$ shear acts through center of group			D.6.2.5	
Edge effects $\Psi_{ed,v} = \min[(0.7+0.3c_2/1.5c_1), 1.0]$	= 0.90		D.6.2.6	
Concrete cracking $\Psi_{c,v}$ = concrete is cracked	= 1.40		D.6.2.7	
Member thickness $\Psi_{h,v} = max[(sqrt(1.5c_1 / h_a), 1.0]]$	= 1.00		D.6.2.8	
Conc shear breakout resistance $V_{cbg1} = \phi_{v,c} \frac{A_{Vc}}{A_{Vc}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 10.42	[kine]	D.6.2.1 (D-31)	
$\mathbf{v}_{cbg1} - \psi_{v,c} \overline{\mathbf{A}_{Vco}} \mathbf{r}_{ec,V} \mathbf{r}_{ed,V} \mathbf{r}_{c,V} \mathbf{r}_{h,V} \mathbf{v}_{b}$	- 10.42	[kips]	Fig. RD.6.2.1 (b)	
Mode 1 is used for checking $V_{cbg1} = V_{cbg1} = X 2.0$	= 20.85	[kips]	note	
	20.00	[inho]		

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				Code Reference	
				ACI 318-11	
	A_{Vc} = min (A_{Vc} , $n_{bd} A_{Vco}$)	= 93.8	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 10.0	[in]	D.6.2.2	
	$V_{b1} = \left[7\left(\frac{I_e}{d_a}\right)^{0.2}\sqrt{d_a}\right]\lambda\sqrt{f_c} c_{a1}^{1.5}$	= 8.39	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c^{\prime}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_b = min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group			D.6.2.5	
Edge effects	$\Psi_{\text{ed},v}$ =	= 1.00		D.6.2.1 (c)	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.40		D.6.2.7	
Member thickness	Ψ _{h,v} = max[(sqrt(1.5c _{a1} / h _a) , 1.0]	= 1.00		D.6.2.8	
Conc shear breakout					
resistance - parallel to edge	$V_{cbg-p2} = 2 x \phi_{v,c} \frac{A_{Vc}}{A_{Vco}} \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} V_{b}$	= 11.14	[kips]	D.6.2.1 (D-31)	
				D.6.2.1 (c)	
Mode 3 Shear taken evenly by	front anchor bolts, strength check against 0.5 x $V_{\rm u}$				
Bolt edge distance	$C_{a1} = min(C_2, C_4)$	= 5.0	[in]		
Limiting c_{a1} when anchors are in	fluenced by 3 or more edges	= No		D.6.2.4	
Bolt edge distance - adjusted	c _{a1} = ca1 needs NOT to be adjusted	= 5.0	[in]	D.6.2.4	
	1.5c _{a1} =	= 7.5	[in]		
	$A_{Vc} = [min(c_1, 1.5c_{a1}) + min(s_1+c_3, 1.5c_{a1})] x$ min(1.5c_{a1}, h_a)	= 93.8	[in ²]	D.6.2.1	
	$A_{Vco} = 4.5 c_{a1}^{2}$	= 112.5	[in ²]	D.6.2.1 (D-32)	
	$A_{Vc} = min (A_{Vc}, n_{bd} A_{Vco})$	= 93.8	[in ²]	D.6.2.1	
	$I_e = min(8d_a, h_{ef})$	= 10.0	[in]	D.6.2.2	
	$V_{b1} = \left[7 \left(\frac{I_e}{d_a}\right)^{0.2} \sqrt{d_a}\right] \lambda \sqrt{f_c} c_{a1}^{1.5}$	= 8.39	[kips]	D.6.2.2 (D-33)	
	$V_{b2} = 9\lambda \sqrt{f_c^{\prime}} c_{a1}^{1.5}$	= 6.36	[kips]	D.6.2.2 (D-34)	
	$V_{b} = \min(V_{b1}, V_{b2})$	= 6.36	[kips]	D.6.2.2	
Eccentricity effects	$\Psi_{ec,v}$ = 1.0 shear acts through center of group			D.6.2.5	
Edge effects	$\Psi_{\text{ed},v}$ =	= 1.00		D.6.2.1 (c)	
Concrete cracking	$\Psi_{c,v}$ = concrete is cracked	= 1.40		D.6.2.7	
Member thickness	$\Psi_{h,v} = max[(sqrt(1.5c_{a1} / h_a) , 1.0]$	= 1.00		D.6.2.8	
Conc shear breakout	$V_{cbg-p3} = 2 x \phi_{v,c} \frac{A_{vc}}{A_{vc}} \Psi_{ec,v} \Psi_{ed,v} \Psi_{c,v} \Psi_{h,v} V_{b}$	= 11.14	[kips]	D.6.2.1 (D-31)	
resistance - parallel to edge	Avco			D.6.2.1 (c)	
Min shear breakout resistance shear parallel to edge	$\phi_{v,c}V_{cbg-p}$ = min (V_{cbg-p1} , V_{cbg-p2} , V_{cbg-p3}) x 2 side	= 22.27	[kips]		
	ratio = 1.12	< V _u	NG		
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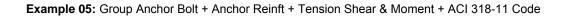
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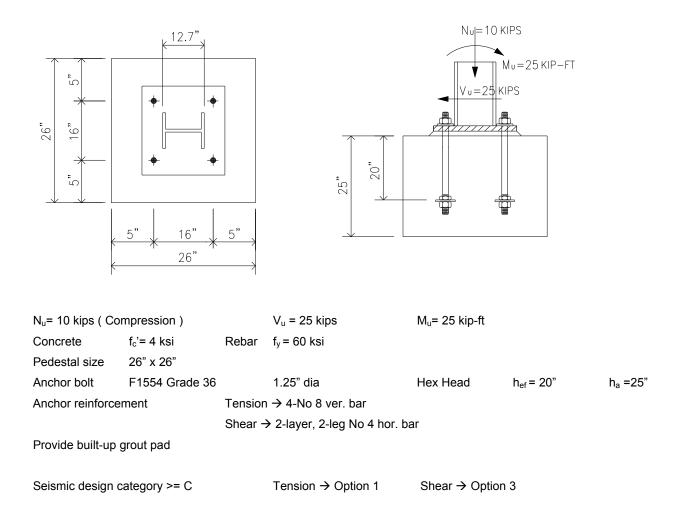
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				Code Reference
				ACI 318-11
Conc. Pryout Shear Resistance				
	$k_{cp} = 2.0$			D.6.3.1
Factored shear pryout resistance		= 30.67	[kips]	D.6.3.1 (D-41)
	$\phi_{v,c} = 0.70$ pryout streng			D.4.3(c)
Seismic design strength reduction	= x 0.75 applicable	= 23.00	[kips]	D.3.3.4.4
	ratio = 1.09	< V _u	NG	
Govern Shear Resistance	$\mathbf{V_r}$ = min (ϕV_{sa} , ϕV_{cbg} , ϕV_{cbg}	_{-p} , φV _{cpg}) = 16.07	[kips]	
Tension Shear Interaction				
Check if N_u >0.2 ϕ N_n and V_u >0.2 ϕ	V _n Yes			D.7.1 & D.7.2
	$N_u / \phi N_n + V_u / \phi V_n$	= 2.89		D.7.3 (D-42)
	ratio = 2.41	> 1.2	NG	
Seismic Design				
Tension	Applicable		NG	
Steel nominal strength x 1.2	1.2n _t N _{sa} = 134.88 [kips]	N _{cbg} = 21.91	[kips]	•
Concrete-governed nominal	n _t N _{pn} = 116.29 [kips]	N _{sbg} = 104.58	[kips]	
strength		-		
N _u / min(N _{cbg} , N	J_{pn}, N_{sbg}) = 0.75	N _u / 1.2N _{sa} = 0.12		
		< 0.75	NG	
Option 1 is NOT satisfied				-
Seismic SDC>=C and E>0.2U , O	ption 1 is selected to satisfy addition	al seismic requirements as p	er D.3.3.4	4.3
Shear	Applicable		ОК	
Seismic SDC>=C and E>0.2U , Op	ption 3 is selected to satisfy addition	al seismic requirements as p	er D.3.3.	5.3

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Concrete Anchorage Design v1.5.0 User Manual





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ANCHOR BOLT DESIGN Co	mbined Tension, Shear and Moment	
Anchor bolt design based on		Code Abbreviation
	nts for Structural Concrete and Commentary	
PIP STE05121 Anchor Bolt Design Gu	ide-2006	PIP STE05121
		Code Reference
Assumptions		ACI 318-11
1. Concrete is cracked		D.5.2.6, D5.3.6, D.6.2.7
2. Condition A - supplementary reinfore		D.4.3 (c)
3. Load combinations shall be per ACI	318-11 9.2	D.4.3
4. Anchor reinft strength is used to rep	lace concrete tension / shear breakout stre	ngth as per
ACI 318-11 Appendix D clause D.5.	2.9 and D.6.2.9	D.5.2.9 & D.6.2.9
5. For tie reinft, only the top most 2 or	3 layers of ties (2" from TOC and 2x3" after	r) are effective
6. Strut-and-Tie model is used to anlyz	te the shear transfer and to design the requ	uired tie reinft
U	t, the anchor tensile load is designed using	
and there is no redistribution of the	forces between highly stressed and less str	ressed anchors
	nor group subject to moment, assume the c	•
resultant is at the outside edge of the	ne compression flange and base plate exhit	bits rigid-body
rotation. This simplified approach y	elds conservative output	
	SDC>=C shall meet requirements specifie	
	elded to base plate for all anchor bolts to tr	ransfer shear AISC Design Guide 1
Anchor Bolt Data		section 3.5.3
Factored moment	$M_u = \frac{25.00}{[kip-ft]}$	= 33.9 [kNm]
Factored tension /compression	N _u = -10.00 [kips] in compression	n = -44.5 [kN]
Factored shear	V _u = <mark>25.00</mark> [kips]	= 111.2 [kN]
Factored shear for design	$V_u = 25.00$ [kips] $V_u = 0$ if shear	key is provided
		$ \begin{array}{c} $
$S_{tb}=0$	T 1 Sb1 Sb1 S1	$ \begin{array}{c} S_{tb}\\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$
2 BOLT LINE	3 BOLT LINE	4 BOLT LINE

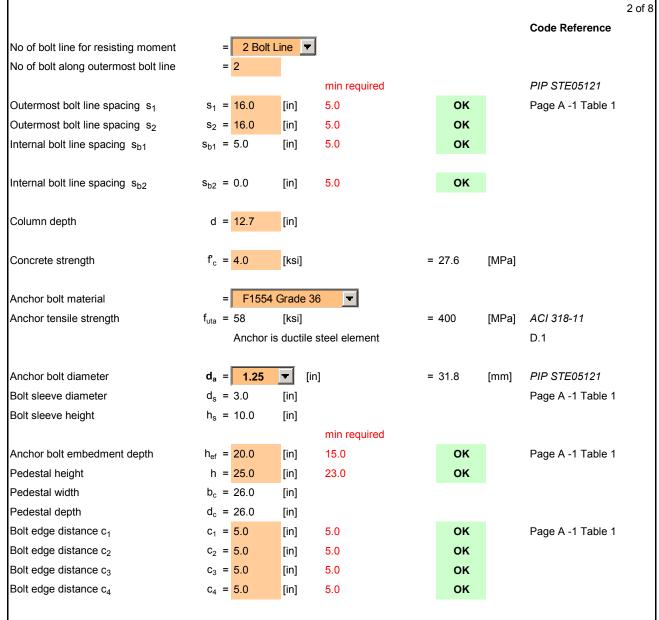
2013-01-25 Rev 1.5.0

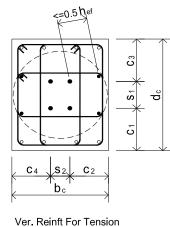
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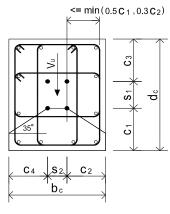
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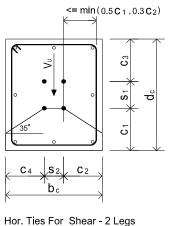
Dongxiao Wu P. Eng.





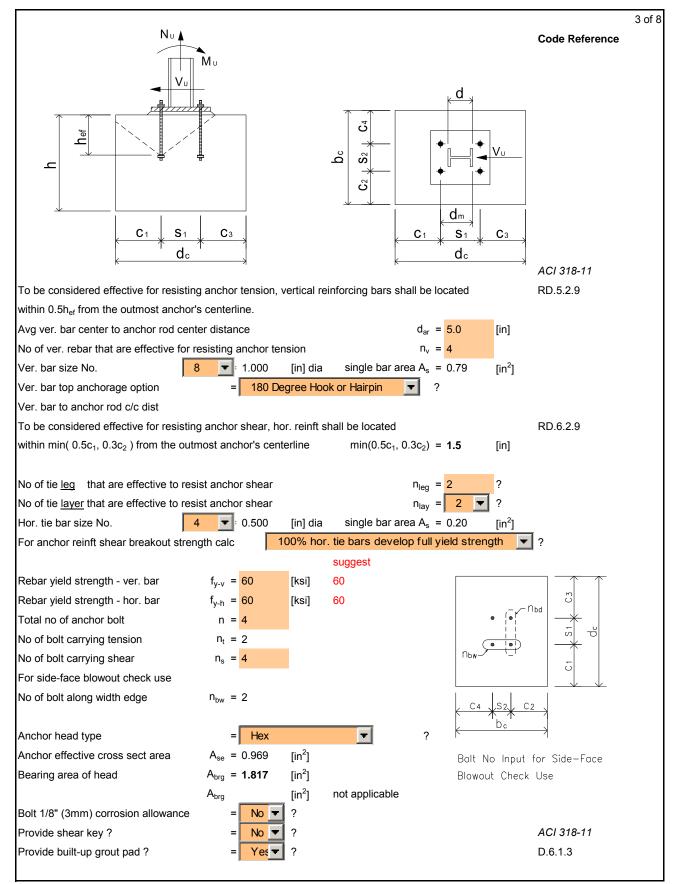


Hor. Ties For Shear - 4 Legs



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				4 o
				Code Reference
				ACI 318-11
Seismic design category SDC >	>=C = <mark>Ye</mark> s▼?			D.3.3.1
Anchor bolt load E <= 0.2U	Tensile = No = ?	Shear = No 🔻	-	2 D.3.3.4.1 & D.3.3.5.1
Anchor bolt satisfies option	Tensile = Option 1 • ?	Shear = Option 3		2 D.3.3.4.3 & D.3.3.5.3
•		, .		
Strength reduction factors				
Anchor reinforcement	$\phi_{\rm s} = 0.75$			D.5.2.9 & D.6.2.9
Anchor rod - ductile steel	$\phi_{t,s} = 0.75$	$\phi_{v,s} = 0.65$		D.4.3 (a)
Concrete - condition A	$\phi_{t,c} = 0.75$	$\phi_{\rm v,c} = 0.75$		D.4.3 (c)
CONCLUSION				
Anchor Rod Embedment, Spaci	ing and Edge Distance		ок	
Min Rquired Anchor Reinft. Dev		ratio = 0.55	ок	12.5.1
	olopinon zongan		U.	
Overall		ratio = 0.81	ок	
Tension				
Anchor Rod Tensile Resistance)	ratio = 0.20	ок	
Anchor Reinft Tensile Breakout	Resistance	ratio = 0.12	ок	
Anchor Pullout Resistance		ratio = 0.27	ок	
Side Blowout Resistance		ratio = 0.28	ок	
Shear				
Anchor Rod Shear Resistance		ratio = 0.36	ок	
Anchor Reinft Shear Breakout F	Resistance			
Strut Bearing Strength		ratio = 0.51	ок	
Tie Reinforcement		ratio = 0.69	ок	
Conc. Pryout Not Govern When	$h_{ef} >= 12d_a$		ок	
Tension Shear Interaction				
Tension Shear Interaction		ratio = 0.81	ок	
Seismic Design				_
Tension	Applicable		NG	D.3.3.4
Option 1 is NOT satisfied				
Seismic SDC>=C and E>0 2U	, Option 1 is selected to satisfy addit	tional seismic requirements as pe	r D.3.3.4	4.3
Shear	Applicable		OK	D.3.3.5

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CACULATION						Code Reference ACI 318-11
Anchor Tensile Force						
Single bolt tensile force	T ₁ = 8.24	[kips]	No of bolt for $T_1 n_{T1}$	= 2		
Ŭ	$T_2 = 0.00$	[kips]	No of bolt for $T_2 n_{T2}$			
	$T_3 = 0.00$		No of bolt for $T_3 n_{T3}$			
Sum of bolt tensile force	$\mathbf{N}_{\mathbf{u}} = \sum n_i T_i$			= 16.48	[kips]	
Anchor Rod Tensile	$\phi_{t,s} N_{sa} = \phi_{t,s} A_{se}$	f _{uta}		= 42.15	[kips]	D.5.1.2 (D-2)
Resistance	ratio = 0.20			> T ₁	ОК	
Anchor Reinft Tensile Breakout R	esistance					
Min tension development length	l _d = straight	bar case	not applicable	= 0.00	[in]	12.2.1, 12.2.2, 12.2.4
for ver. #8 bar	l _{dh} = 180 ho	ok case ap	plicable	= 13.28	[in]	12.5.2, 12.5.3(a)
Actual development lenngth	$I_a = h_{ef} - c$ (2)	2 in) - d _{ar} x	tan35	= 14.50	[in]	
.⊆ ≼0.5hef				> 8.00	ОК	12.5.1
₹ - - - - - - - - - - - - -						
	$\phi_s N_n = \phi_s x f_{y-v}$	x n _v x A _s x	: (l _a / l _d , if l _a < l _d)	= 142.20	[kips]	<i>ACI 318-11</i> D.3.3.4.5 & D.5.2.9
						12.2.5
	ratio = 0.12			> N _u	ОК	
Anchor Pullout Resistance						
Single bolt pullout resistance	$N_p = 8 A_{brg} f_c$			= 58.14	[kips]	D.5.3.4 (D-14)
N _{cpr} =	$\phi_{t,c} N_{pn} = \phi_{t,c} \Psi_{c,c}$	_p N _p		= 40.70	[kips]	D.5.3.1 (D-13)
Seismic design strength reduction	= x 0.75	applicable	9	= 30.53	[kips]	D.3.3.4.4
	ratio = 0.27			> T ₁	ок	
	$\Psi_{c,p} = 1$ for cra	acked con	с			D.5.3.6
	$\phi_{t,c} = 0.70$	pullout	strength is always Co	ndition B		D.4.3 (c)
Side Blowout Resistance						
Failure Along Pedestal Width Edge						
Tensile load carried by anchors clos	se to edge which m	ay cause s	side-face blowout			
along pedestal width edge	$N_{buw} = n_{T1} T_1$			= 16.48	[kips]	RD.5.4.2

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Check if side blowout applicable $h_{rr} = 20.0$ [in] > 2.5c side bowout is applicable $D.5.4.1Check if edge anchors work as a s_{22} = 16.0 [in] s = s_2 = 16.0 [in]a group or work individually< 6c$ edge anchors work as a group $D.5.4.2Single anchor SB resistance \phi_{cL} N_{abcg.w} = \phi_{cL} (160 c \sqrt{A_{bcg}}) \times \sqrt{\Gamma_c} = 51.15 [kips] D.5.4.2 (D-17)work as a group - applicable = (1+s' 6c) \times \phi_{cL} N_{abcg} = 78.43 [kips] D.5.4.2 (D-17)work individually - not applicable = 10.8 \times \Phi_{cL} N_{abc} = \sqrt{C} (160 c \sqrt{A_{bcg}}) \times \sqrt{\Gamma_c} = 58.82 [kips] D.5.4.2 (D-17)work individually - not applicable = 10.8 \times \Phi_{cL} N_{abc} = \sqrt{C} (1+s' 6c) \times \phi_{cL} N_{abc} = 78.43 [kips] D.5.4.2 (D-17)work individually - not applicable = 0.28 N_{abcg} = 0.28 N_{abcg} = 0.28Group side blowout resistance \Phi_{cL} N_{abg} = \phi_{cL} \frac{N_{abg.w}}{n_{r1}} n_{r} = 58.82 [kips]Govern Tensile Resistance \Phi_{cL} N_{abg} = \phi_{cL} \frac{N_{abg.w}}{n_{r1}} n_{r} = 58.82 [kips]Note: Anchor Rod Shear \phi_{v,w} V_{ab} = \phi_{v,w} n_{h} 0.6 A_{abc} f_{vab} = 87.68 [kips] D.6.1.2 (b) (D-29)ResistanceReduction due to built-up group pads = x 0.8, applicable = 70.14 [kips] D.6.1.2 (b) (D-29)ResistanceStrut-and-Tie model is used to anlyze the shear transfer and to design the required the reint!STM strength reduction factor \phi_{at} = 0.75 9.32.6Context strut for the struct ResistanceThe struct of factor \phi_{at} = 0.75 9.32.6$								Code Reference	
$ \begin{array}{c} > 2.5c \qquad \text{side bowout is applicable} \\ \text{Check if edge anchors work as a } \\ \text{support work individually} \\ < 6c \qquad \text{edge anchors work as a group } \\ \text{bigge anchors SB resistance} \\ \phi_{0.5} N_{0.9} & \phi_{0.5} \left(\left(60.2 \sqrt{A_{0.5}} \right) \downarrow \sqrt{F_{c}} \\ = 51.15 \\ \text{(if ps]} \\ \text{D5.4.1 (D-16)} \\ \text{Multiple anchors SB resistance} \\ \phi_{0.5} N_{0.9} & \phi_{0.5} \left(\left(60.2 \sqrt{A_{0.5}} \right) \downarrow \sqrt{F_{c}} \\ = 61.15 \\ \text{(if ps]} \\ \text{D5.4.1 (D-16)} \\ \text{Work as a group - applicable} \\ = (1+9' 6c) \times \phi_{0.5} N_{0.5} \\ = 78.43 \\ \text{(if ps]} \\ \text{D5.4.1 (D-16)} \\ \text{work individually - not applicable} \\ = n_{0.6} \times \phi_{0.5} N_{0.5} \\ \text{(1+9' 6c)} \\ \text{(1+9' 6c)}$		с	= min (o	c ₁ , c ₃)		= 5.0	[in]	ACI 318-11	
Check if edge anchors work as a $s_{22} = 16.0$ [in] $s = s_2 = 16.0$ [in] a group or work individually $< 6c$ edge anchors work as a group $0.5.4.2$ Single anchors SB resistance $\phi_{1c} N_{00} = \phi_{4c} (160 c \sqrt{h_{00}}) 2 \sqrt{\Gamma_{c}} = 51.15$ [kips] $0.5.4.1$ (D-16) Multiple anchors SB resistance $\phi_{1c} N_{00} = \phi_{4c} (160 c \sqrt{h_{00}}) 2 \sqrt{\Gamma_{c}} = 78.43$ [kips] $0.5.4.2$ (D-17) work individually - not applicable $= n_{00} \times \phi_{1c} N_{00} = 78.43$ [kips] $0.5.4.1$ Seismic design strength reduction $= x 0.75$ applicable $= 58.82$ [kips] Group side blowout resistance $\phi_{1c} N_{00} = \phi_{1c} \frac{N_{00} + n}{n_{11}} n_{1} = 58.82$ [kips] Group side blowout resistance $h_{x} N_{00} = \phi_{x,c} \frac{N_{00} + n}{n_{11}} n_{1} = 58.82$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{x,x} V_{x0} = \phi_{x,x} n_{0} 0.6 A_{x0} f_{x0} = 70.14$ [kips] $0.6.1.2$ (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] $0.6.1.3$ ratio $= 0.36$ $> V_{u}$ OK Anchor Rod Shear $\phi_{x,x} = 0.75$ $9.32.6$ Characteristic framework is a single to the single the required the result of the single	Check if side blowout applicable	h _{ef}	= 20.0	[in]					
a group or work individually < 6c edge anchors work as a group D.5.4.2 Single anchor SB resistance $\phi_{1c} N_{ag_{1}} = \phi_{c} (160 c \sqrt{A_{ag_{1}}}) \lambda \sqrt{\Gamma_{c}} = 51.15 [kips] D.5.4.1 (D-16) Multiple anchors SB resistance \phi_{1c} N_{ag_{2}} = (1+s/6c) \times \phi_{1c} N_{ab} = 78.43 [kips] D.5.4.2 (D-17) work as a group - applicable = n_{bw} \times \phi_{1c} N_{ab} \times [1+(c_{2} \text{ or } c_{1})/c]/4 = 0.00 [kips] D.5.4.1 Seismic design strength reduction = x 0.75 applicable = 58.82 [kips] Group side blowout resistance \phi_{1c} N_{abg} = \phi_{cc} \frac{N_{abg} \times \pi}{n_{11}} n_{1} = 58.82 [kips] Govern Tensile Resistance h_{c} = N_{abg} = \phi_{ac} \frac{N_{abg} \times \pi}{n_{1}} n_{1} = 58.82 [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear \phi_{v,a} V_{ag} = \phi_{v,a} n_{g} 0.6 A_{se} f_{abc} = 70.14 [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V_{U} OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor \phi_{al} = 0.75 9.3.2.6$			> 2.5c		side bowout is a	applicable		D.5.4.1	
Single anchor SB resistance $\phi_{cc} N_{ab} = \phi_{cc} (160 c \sqrt{A_{bm}}) 2 \sqrt{F_c} = 51.15 [klps] D.5.4.1 (D-16) Multiple anchors SB resistance \phi_{cc} N_{ab,p,w} =work as a group - applicable = (1+5/6) \times \phi_{bc} N_{ab} = 78.43 [klps] D.5.4.2 (D-17)work individually - not applicable = n_{aw} \times \phi_{bc} N_{ab,c} N_{ab,c} (1+5/6) \times \phi_{bc} N_{ab,c} N_{ab,c$	Check if edge anchors work as a	S ₂₂	= 16.0	[in]	S	= s ₂ = 16.0	[in]		
Multiple anchors SB resistance $\phi_{k,2}N_{k20,w} =$ work as a group - applicable = $(1+s)^{2} 6_{1} \times \phi_{k,2} N_{ab} \times [1+(c_{2} \text{ or } c_{a})/c]/4 = 0.00 [kips] D.5.4.2 (D-17) work individually - not applicable = n_{w} \times \phi_{k,2} N_{ab} \times [1+(c_{2} \text{ or } c_{a})/c]/4 = 0.00 [kips] D.5.4.1Seismic design strength reduction = \times 0.75 applicable = 58.82 [kips] D.3.3.4.4ratio = 0.28 > N_{buw} OKGroup side blowout resistance \phi_{k,2} N_{abg} = \phi_{k,2} \frac{N_{abg} \times n}{n_{\tau_{\tau}}} n_{\tau} = 58.82 [kips]Govern Tensile Resistance N_{v} = \min(\phi_{n_{1}} N_{w_{2}}, \phi_{n_{n_{1}}} \phi_{n_{1}} \phi_{n_{2}} \phi_{N_{abg}}) = 58.82 [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear \phi_{v,x} V_{aa} = \phi_{v,a} n_{b} 0.6 A_{ab} f_{uta} = 87.68 [kips] D.6.1.2 (b) (D-29)ResistanceReduction due to built-up grout pads = \times 0.3, applicable = 70.14 [kips] D.6.1.3ratio = 0.36 > V_{u} OKAnchor Reinft Shear Breakout ResistanceStrut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinftSTM strength reduction factor \phi_{st} = 0.75 9.3.2.6$	a group or work individually		< 6c		edge anchors w	ork as a group		D.5.4.2	
work as a group - applicable = $(1+s^{1} 6c) \times \phi_{1c} N_{4b}$ = 78.43 [klps] D.5.4.2 (D-17) work individually - not applicable = $n_{bw} \times \phi_{1c} N_{bs} \times (1+(c_{2} \text{ or } c_{4})/c]/4$ = 0.00 [klps] D.5.4.1 Seismic design strength reduction = $\times 0.75$ applicable = 58.82 [klps] D.3.3.4.4 ratio = 0.28 > N_{bcw} OK Group side blowout resistance $\phi_{1c} N_{bbg} = \phi_{1c} \frac{N_{abg.*}}{n_{11}} n_{1}$ = 58.82 [klps] Govern Tensile Resistance N_{r} = min ($\phi n_{1} N_{ss}, \phi N_{n}, \phi n_{1} N_{pr}, \phi N_{abg}$) = 58.82 [klps] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{ss} = \phi_{v,s} n_{s} 0.6 A_{ss} f_{uts}$ = 87.68 [klps] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = $\times 0.8$, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V_{u} OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	Single anchor SB resistance	$\phi_{t,c} \; N_{sb}$	$= \phi_{t,c} (16)$	$50 \mathrm{c} \sqrt{\mathrm{A}_{\mathrm{brg}}} $	$1\sqrt{f'_c}$	= 51.15	[kips]	D.5.4.1 (D-16)	
work individually - not applicable = $n_{bv} x \phi_{bc} N_{abx} x [1+(c_2 \text{ or } c_4)/c]/4$ = 0.00 [kips] D.5.4.1 Seismic design strength reduction = x 0.75 applicable = 58.82 [kips] D.3.3.4.4 ratio = 0.28 > N_{buw} OK Group side blowout resistance $\phi_{cc} N_{abg} = \phi_{bc} \frac{N_{abg} x}{n_{rt}} n_{t}$ = 58.82 [kips] Govern Tensile Resistance $N_r = \min(\phi n_t N_{abs}, \phi N_n, \phi n_t N_{pn}, \phi N_{abg})$ = 58.82 [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{as} = \phi_{v,s} n_s 0.6 A_{as} f_{ubs}$ = 87.68 [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V_u OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{at} = 0.75$ 9.3.2.6	Multiple anchors SB resistance	$\phi_{t,c} N_{\text{sbg},w}$	=						
Seismic design strength reduction $= x 0.75$ applicable $= 58.82$ [kips] D.3.3.4.4 ratio = 0.28 $> N_{bow}$ OK Group side blowout resistance $\phi_{cc} N_{bog} = \phi_{cc} \frac{N_{bog}}{n_{r_1}} n_r = 58.82$ [kips] Govern Tensile Resistance $N_r = \min(\phi n_1 N_{so}, \phi N_{n}, \phi n_1 N_{po}, \phi N_{sbg}) = 58.82$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} N_{sa} = \phi_{v,s} n_s 0.6 A_{sa} f_{ula} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3 ratio = 0.36 $> V_u$ OK Anchor Relinf Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reint STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	work as a group - applicable		= (1+s/6	δc) x φ _{t,c} N _{st})	= 78.43	[kips]	D.5.4.2 (D-17)	
ratio = 0.28 $> N_{bow}$ OK Group side blowout resistance $\phi_{Lc} N_{sbg} = \phi_{Lc} \frac{N_{sbg,w}}{n_{r_1}} n_1$ = 58.82 [kips] Govern Tensile Resistance $N_r = \min(\phi n_1 N_{so}, \phi N_n, \phi n_1 N_{po}, \phi N_{sbg})$ = 58.82 [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{ss} = \phi_{v,s} n_s 0.6 A_{so} f_{uta}$ = 87.68 [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 $> V_u$ OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	work individually - not applicable	!	= n _{bw} x ¢	o _{t,c} N _{sb} x [1+	(c ₂ or c ₄) / c] / 4	= 0.00	[kips]	D.5.4.1	
Group side blowout resistance $\phi_{t,c} N_{abg} = \phi_{t,c} \frac{N_{abg}}{n_{T_{1}}} n_{t} = 58.82$ [kips] Govern Tensile Resistance $N_{r} = \min(\phi n_{t} N_{sev} \phi N_{n}, \phi n_{t} N_{prv}, \phi N_{abg}) = 58.82$ [kips] Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} V_{as} = \phi_{v,s} n_{v} 0.6 A_{be} f_{uta} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3 ratio = 0.36 $> V_{u}$ OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	Seismic design strength reduction		= x 0.75	applicable	9	= 58.82	[kips]	D.3.3.4.4	
$\mathbf{R}_{r} = \min(\phi n_{t} N_{sa}, \phi N_{n}, \phi n_{t} N_{pn}, \phi N_{abg}) = 58.82 [kips]$ Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear $\mathbf{Anchor Rod Shear} \qquad \phi_{v,s} V_{sa} = \phi_{v,a} n_{b} 0.6 A_{as} f_{uta} \qquad = 87.68 [kips] D.6.1.2 (b) (D-29)$ Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 Tatio = 0.36 $> V_{u}$ OK $\mathbf{Anchor Reinft Shear Breakout Resistance}$ Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\mathbf{V}_{u} = \frac{\mathbf{V}_{u}}{\mathbf{V}_{u}} \mathbf{V}_{u} \mathbf{V}_{u}$		ratio	= 0.28			> N _{buw}	ОК		
$\mathbf{R}_{r} = \min(\phi n_{t} N_{sa}, \phi N_{n}, \phi n_{t} N_{pn}, \phi N_{abg}) = 58.82 [kips]$ Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear $\mathbf{Anchor Rod Shear} \qquad \phi_{v,s} V_{sa} = \phi_{v,a} n_{b} 0.6 A_{as} f_{uta} \qquad = 87.68 [kips] D.6.1.2 (b) (D-29)$ Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 Tatio = 0.36 $> V_{u}$ OK $\mathbf{Anchor Reinft Shear Breakout Resistance}$ Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\mathbf{V}_{u} = \frac{\mathbf{V}_{u}}{\mathbf{V}_{u}} \mathbf{V}_{u} \mathbf{V}_{u}$	Group side blowout resistance	φ _{t c} N _{sba}	$= \phi_{tc} \frac{N_s}{N_s}$	^{.bgr,w} .n.		= 58.82	[kips]		
Note: Anchor bolt sleeve portion must be tape wrapped and grouted to resist shear Anchor Rod Shear $\phi_{v,s} v_{ss} = \phi_{v,s} n_s 0.6 A_{ss} f_{uta} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads $= x 0.8$, applicable $= 70.14$ [kips] D.6.1.3 ratio $= 0.36$ $> V_u$ OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required the reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\psi_{v,v}^{2} \psi_{v,v}^{2} \psi_{v,v}$		11,0 359	ľ	ו _{ד1} נ					
Anchor Rod Shear $\phi_{v,s} V_{sa} = \phi_{v,s} n_s 0.6 A_{se} f_{uta} = 87.68$ [kips] D.6.1.2 (b) (D-29) Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V_u OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\psi_{u/2} V_{u/2} V_$	Govern Tensile Resistance	N _r	= min (¢	ο n _t N _{sa} , φ N	_n , φ n _t N _{pn} , φ N _{sbg}) = 58.82	[kips]		
Resistance Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V _u OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\psi_{u/2} = \sqrt{\frac{1}{2}} \sqrt{\frac{1}{2}$	Note: Anchor bolt sleeve portion m	iust be ta	pe wrappe	ed and grou	ted to resist shea	r			
Reduction due to built-up grout pads = x 0.8, applicable = 70.14 [kips] D.6.1.3 ratio = 0.36 > V _u OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\int \frac{V_u/2}{V_u/2} \sqrt{V_u/2} V_u/$	Anchor Rod Shear	$\phi_{v,s}V_{sa}$	= $\phi_{v,s} n_s$	0.6 A _{se} f _{uta}		= 87.68	[kips]	D.6.1.2 (b) (D-29)	
ratio = 0.36 $> V_u$ OK Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6 $\downarrow \downarrow $	Resistance								
Anchor Reinft Shear Breakout Resistance Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	Reduction due to built-up grout pac			applicable				D.6.1.3	
Strut-and-Tie model is used to anlyze the shear transfer and to design the required tie reinft STM strength reduction factor $\phi_{st} = 0.75$ 9.3.6 $v_{u/2}$ $v_{u/2}$ $v_{u/$		ratio	= 0.36			> V _u	OK		
STM strength reduction factor $\phi_{st} = 0.75$ 9.3.2.6	Anchor Reinft Shear Breakout Re	esistance)						
Vu/2 Vu/2 Tt Tt T	Strut-and-Tie model is used to anly	ze the sh	ear transf	fer and to d	esign the required	I tie reinft			
$Vu/2 Vu/2 \\ Vu/2 Vu/2 \\ \downarrow \\ $	STM strength reduction factor	$\phi_{\rm st}$	= 0.75					9.3.2.6	
Tt Tt Tt Tt Tt Tt Tt Tt Tt Tt						K dt	+		
Tt Tt Tt Tt Tt Tt Tt Tt Tt Tt									
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$\begin{bmatrix} T_t & T_t & T_t \\ C_s & C_s \\ \theta & 0 \end{bmatrix} \begin{bmatrix} C_s & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} T_t & T_t & T_t \\ 0 & $	Vu/2 Vu/2	×			-	\ast			
C_{s}		т.	197		. ا			—	
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				Code Reference ACI 318-11	
Strut-and-Tie model geometry	d _v = 2.250 [in]	d _h = 2.250	[in]		
	θ = 45	d _t = 3.182	[in]		
Strut compression force	$C_s = 0.5 V_u / sin\theta$	= 17.68	[kips]		
Strut Bearing Strength					
Strut compressive strength	$f_{ce} = 0.85 f'_{c}$	= 3.4	[ksi]	A.3.2 (A-3)	
* Bearing of anchor bolt					
Anchor bearing length	$I_e = min(8d_a, h_{ef})$	= 10.0	[in]	D.6.2.2	
Anchor bearing area	$A_{brg} = I_e \times d_a$	= 12.5	[in ²]		
Anchor bearing resistance	$C_r = n_s x \phi_{st} x f_{ce} x A_{brg}$	= 127.50	[kips]		
		> V _u	ОК		
* Bearing of ver reinft bar					
Ver bar bearing area	$A_{brg} = (I_e + 1.5 \times d_t - d_a/2 - d_b/2) \times d_b$	= 13.6	[in ²]		
Ver bar bearing resistance	$C_r = \phi_{st} \times f_{ce} \times A_{brg}$	= 34.80	[kips]		
	ratio = 0.51	> C _s	ОК		
Tie Reinforcement					
	or 3 layers of ties (2" from TOC and 2x3" aft				
	the tie cannot develop full yield strength f_y .				
	s per ACI 318-11 Eq. (D-15) as the max force	e can be developed a	at hook I	h	
* Assume 100% of hor. tie bars car	n develop full yield strength.			101210 11	
Total number of hor tie bar	n = n (log) x n (lover)	- 4		ACI 318-11	
Pull out resistance at hook	n = n _{leg} (leg) x n _{lay} (layer) T _h = $\phi_{t,c} 0.9 f_c' e_h d_a$	= 4 = 3.04	[kino]	D = 2 = (D = 1 = 1)	
Full out resistance at nook	$\mathbf{e}_{h} = \mathbf{\psi}_{t,c} 0.5 \mathbf{f}_{c} \mathbf{e}_{h} \mathbf{d}_{a}$ $\mathbf{e}_{h} = 4.5 \mathbf{d}_{b}$	= 3.04 = 2.250	[kips] [in]	D.5.3.5 (D-15)	
	e _h – 4.3 d _b	- 2.230	[111]		
Single tie bar tension resistance	$T_r = \phi_s x f_{y\text{-}h} x A_s$	= 9.00	[kips]		
Total tie bar tension resistance	$\phi_{\rm s}V_{\rm n} = 1.0 {\rm x} {\rm n} {\rm x} {\rm Tr}$	= 36.00	[kips]	D.3.3.5.4 & D.6.2.9)
	ratio = 0.69	> V _u	ок		
Conc. Pryout Shear Resistance					
The pryout failure is only critical for	r short and stiff anchors. It is reasonable to a	assume that for gene	ral		
cast-in place headed anchors with	$h_{ef} > = 12d_a$, the pryout failure will not gover	m			
	12d _a = 15.0 [in]	$h_{ef} = 20.0$	[in]		
		> 12d _a	ок		
Govern Shear Resistance	$\mathbf{V_r}$ = min ($\phi_{v,s} V_{sa}$, $\phi_s V_{n}$)	= 36.00	[kips]		

							8 of
						Code Reference	
Tension Shear Interaction						ACI 318-11	
Check if $N_u > 0.2\phi N_n$ and $V_u > 0.2\phi$						D.7.1 & D.7.2	
		+ $V_u / \phi V_n$		= 0.97		D.7.3 (D-42)	
	ratio = 0.81			< 1.2	OK		
Seismic Design							
Fension	Applicable				NG		
Steel nominal strength x 1.2	$1.2n_t N_{sa} = 134.88$	[kips]			NO		
Concrete-governed nominal	$n_t N_{pn} = 116.29$	[kips] [kips]	Ν.	= 104.58	[kips]		
	$n_t n_{pn} = 110.29$	[kibə]	l ∿ sbg	- 104.50	[kibə]		
strength	N _{pn} , N _{sbg}) = 0.16		N _u / 1.2N _{sa}	= 0.12			
	•pn, ••sbg) = 0.10			< 0.12	NG		
Option 1 is NOT satisfied				< 0.10	NG		
option his NOT satisfied							
Seismic SDC>=C and E>0.2U , O	ption 1 is selected to s	satisfy additiona	al seismic requir	ements as n	er D 3 3 4	3	
					01 2.0.0.1		
Shear	Applicable				OK		

Concrete Anchorage Design v1.5.0 User Manual

6.0 REFERENCES

- 1. ACI 318-11 Building Code Requirements for Structural Concrete and Commentary
- 2. ACI 318M-11 Metric Building Code Requirements for Structural Concrete and Commentary
- 3. ACI 349-06 Code Requirements for Nuclear Safety-Related Concrete Structures & Commentary
- 4. ACI 349.2R-07 Guide to the Concrete Capacity Design (CCD) Method Embedment Design Examples
- 5. ACI 355.3R-11 Guide for Design of Anchorage to Concrete: Examples Using ACI 318 Appendix D
- 6. Design of Anchor Reinforcement in Concrete Pedestals by Widianto, Chandu Patel, and Jerry Owen
- 7. CSA A23.3-04 (R2010) Design of Concrete Structures
- 8. AISC Design Guide 1: Base Plate and Anchor Rod Design 2nd Edition
- 9. PIP STE05121 Anchor Bolt Design Guide-2006