Bentley **Burns and McDonnell**

Current Date: 7/17/2020 7:03 PM
Units system: English
File name: C:\Users\ARSharma\Desktop\Training Anchor & base plate design\Ram file\Base Plate & Anchor design_Sample.rcnx\

Steel connections

Results

Connection name : Fixed biaxial BP
Connection ID : 2

Family: Column - Base (CB)
Type: Base plate
Description: BP
Design code: AISC 360-16 LRFD, ACI 318-11

DEMANDS

Description	Pu [Kip]	Mu22 [Kip*ft]	Mu33 [Kip*ft]	Vu2 [Kip]	Vu3 [Kip]	Load type
L1	-10.00	0.00	25.00	5.00	0.00	Design

Design for major axis
Base plate (AISC 360-16 LRFD)

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Base plate						
Distance from anchor to edge	[in]	1.12	0.25	--	✓	
Weld size	[1/16in]	3	3	--	✓	table J2.4

$w_{min} = w_{min}$

= **0.0156** table J2.4

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Pedestal						
Axial bearing	[Kip/in2]	3.54	0.72	L1	0.20	DG1 3.1.1;

$A_2 = ((B/N)*N_{cs})*N_{cs}$

= ((15[in]/15[in])*24[in])*24[in]

= **576**[in2] DG1 Sec 3.1.1

$A_1 = B*N$

= 15[in]*15[in]

= **225**[in2] DG1 Sec 3.1.1

$f_{p,max} = \phi*\min(0.85*f'_c*(A_2/A_1)^{1/2}, 1.7*f'_c)$

$= 0.65*\min(0.85*4000[lb/in2]*(2.56)^{1/2}, 1.7*4000[lb/in2])$

= **3536**[lb/in2] DG1 3.1.1

Base plate

Flexural yielding (bearing interface)	[Kip*ft/ft]	8.10	4.95	L1	0.61	DG1 Eq. 3.3.13, DG1 Sec 3.1.2

$\phi M_n = \phi * F_y * t_p^2/4$
$= 0.9*36000$[lb/in2]$*1$[in]$^2/4$
$=$ **8.1**[kip*ft/ft] — DG1 Eq. 3.3.13

m = m
= **3.7**[in] — DG1 Sec 3.1.2

n = n
= **4.3**[in] — DG1 Sec 3.1.2

$M_{pl} = \max(M_{pM}, M_{pN})$
= max(4.59[kip*ft/ft], 4.95[kip*ft/ft])
= **4.95**[kip*ft/ft]

Flexural yielding (tension interface)	[Kip*ft/ft]	8.10	6.42	L1	0.79	DG1 Eq. 3.3.13

$\phi M_n = \phi * F_y * t_p^2/4$
$= 0.9*36000$[lb/in2]$*1$[in]$^2/4$
$=$ **8.1**[kip*ft/ft] — DG1 Eq. 3.3.13

$M_{pT} = M_{strip}/B_{eff}$
= 2.3[kip*ft]/4.3[in]
= **6.42**[kip*ft/ft]

Column

Weld capacity	[Kip/ft]	75.17	20.91	L1	0.28	p. 8-9, Sec. J2.5, Sec. J2.4, DG1 p. 35

$LoadAngleFactor = 1 + 0.5*(\sin(\theta))^{1.5}$
$= 1 + 0.5*(\sin(1.57))^{1.5}$
= **1.5** — p. 8-9

$F_w = 0.6*F_{EXX}*LoadAngleFactor$
= 0.6*70000[lb/in2]*1.5
= **63000**[lb/in2] — Sec. J2.5

$A_w = (2)^{1/2}/2*D/16$ [in]$*L$
$= (2)^{1/2}/2*3/16$ [in]*12[in]
= **1.59**[in2] — Sec. J2.4

$\phi R_w = \phi*F_w*A_w/L$
= 0.75*63000[lb/in2]*1.59[in2]/12[in]
= **6.26**[kip/in]

$b_{eff} = 2*L$
= 2*2.83[in]
= **5.66**[in] — DG1 p. 35

Maximum weld load = T/b_{eff}
= 9.86[kip]/5.66[in]
= **1.74**[kip/in]

Elastic method weld shear capacity	[Kip/ft]	50.12	4.73	L1	0.09	p. 8-9, Sec. J2.5, Sec. J2.4

LoadAngleFactor = $1 + 0.5*(\sin(\theta))^{1.5}$
= $1 + 0.5*(\sin(0))^{1.5}$
= **1** — p. 8-9

$F_w = 0.6*F_{EXX}*$LoadAngleFactor
= 0.6*70000[lb/in2]*1
= **42000**[lb/in2] — Sec. J2.5

$A_w = (2)^{1/2}/2*D/16$ [in]*L
= $(2)^{1/2}/2*3/16$ [in]*12[in]
= **1.59**[in2] — Sec. J2.4

$\phi R_w = \phi*F_w*A_w/L$
= 0.75*42000[lb/in2]*1.59[in2]/12[in]
= **4.18**[kip/in]

$f_v = V/L_{shear}$
= 5[kip]/12.68[in]
= **0.394**[kip/in]

Elastic method weld axial capacity	[Kip/ft]	75.17	31.05	L1	0.41	p. 8-9, Sec. J2.5, Sec. J2.4

LoadAngleFactor = $1 + 0.5*(\sin(\theta))^{1.5}$
= $1 + 0.5*(\sin(1.57))^{1.5}$
= **1.5** — p. 8-9

$F_w = 0.6*F_{EXX}*$LoadAngleFactor
= 0.6*70000[lb/in2]*1.5
= **63000**[lb/in2] — Sec. J2.5

$A_w = (2)^{1/2}/2*D/16$ [in]*L
= $(2)^{1/2}/2*3/16$ [in]*12[in]
= **1.59**[in2] — Sec. J2.4

$\phi R_w = \phi*F_w*A_w/L$
= 0.75*63000[lb/in2]*1.59[in2]/12[in]
= **6.26**[kip/in]

$f_a = P/L$
= 0[kip]/29[in]
= **0**[kip/in]

$f_b = M*c/I$
= 25[kip*ft]*4[in]/463.73[in3]
= **2.59**[kip/in]

$f = f_b + f_a$
= 2.59[kip/in] + 0[kip/in]
= **2.59**[kip/in]

Ratio	0.79

Major axis
Anchors

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Anchors</u>						
Anchor spacing	[in]	12.00	3.00	--	✓	Sec. D.8.1
$s_{min} = 4*d_a$						
= 4*0.75[in]						
= **3**[in]						Sec. D.8.1
Concrete cover	[in]	5.62	2.00	--	✓	Sec. 7.7.1
IsConcreteCastAgainstEarth ⟶ **False**						
Cover = 2 [in]						Sec. 7.7.1
Effective length	[in]	20.49	--	35.51	✓	

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Anchor tension	[Kip]	14.55	9.86	L1	0.68	Eq. D-2
$A_{se} = \pi/4.0*(d_a - 0.9743\ [in]/n_t)^2$						
$= \pi/4.0*(0.75[in] - 0.9743\ [in]/10)^2$						
= **0.334**[in2]						Sec. D.5.1.1, D.6.1.2
$f_{uta} = \min(f_{uta}, 1.9*f_{ya}, 125\ [ksi])$						
= min(58000[lb/in2], 1.9*36000[lb/in2], 125 [ksi])						
= **58000**[lb/in2]						Sec. D.5.1.2
$\phi N_{sa} = \phi*A_{se,N}*f_{uta}$						
= 0.75*0.334[in2]*58000[lb/in2]						
= **14.55**[kip]						Eq. D-2
Pullout of anchor in tension	[Kip]	14.65	9.86	L1	0.67	Sec. D.3.3.4.4
$A_{brg} = 0.866025*F^2 - A_g$						
$= 0.866025*1.13[in]^2 - 0.442[in2]$						
= **0.654**[in2]						
IsHeadedBolt ⟶ **True**						
$N_p = 8*A_{brg}*f_c$						
= 8*0.654[in2]*4000[lb/in2]						
= **20.93**[kip]						Eq. D-14
CrackedConcrete ⟶ **True**						
$\psi_{c,P} = 1$						Sec. D.5.3.6
$N_{pn} = \psi_{c,P}*N_p$						
= 1*20.93[kip]						
= **20.93**[kip]						Eq. D-13

HighSeismicDesignCategory ⟶ **False**

$\phi N_{pn} = \phi * N_{pn}$
= 0.7*20.93[kip]
= **14.65**[kip] Sec. D.3.3.4.4

Side-face blowout of anchor in tension	[Kip]	18.41	9.86 L1	0.54	Sec. D.5.4.1, Sec. D.3.3.4.4

SideFaceBlowoutApply = $h_{ef} > 2.5 * c_{a1}$
= 20[in]>2.5*6[in]
= **True** Sec. D.5.4.1

$A_{brg} = 0.866025 * F^2 - A_g$
= 0.866025*1.13[in]^2 - 0.442[in2]
= **0.654**[in2]

$c_{a2} < 3.0 * c_{a1}$ ⟶ 6[in]<3.0*6[in] ⟶ **True**

$N_{sb} = ((1 + c_{a2}/c_{a1})/4) * 160 * c_{a1} * (A_{brg})^{1/2} * \lambda_a * (f_c/(1\ [psi]))^{1/2}\ [psi]$
= ((1 + 6[in]/6[in])/4)*160*6[in]*(0.654[in2])$^{1/2}$*1*(4000[lb/in2]/(1 [psi]))$^{1/2}$ [psi]
= **24.55**[kip] Sec. D.5.4.1

HighSeismicDesignCategory ⟶ **False**

$\phi N_{sb} = \phi * N_{sb}$
= 0.75*24.55[kip]
= **18.41**[kip] Sec. D.3.3.4.4

Side-face blowout of group of anchors in tension	[Kip]	49.10	19.71 L1	0.40	Eq. D-17, Sec. D.3.3.4.4

SideFaceBlowoutApply = $h_{ef} > 2.5 * c_{a1}$
= 20[in]>2.5*6[in]
= **True** Sec. D.5.4.1

$A_{brg} = 0.866025 * F^2 - A_g$
= 0.866025*1.13[in]^2 - 0.442[in2]
= **0.654**[in2]

$N_{sb} = 160 * c_{a1} * (A_{brg})^{1/2} * \lambda * (f_c/(1\ [psi]))^{1/2}\ [psi]$
= 160*6[in]*(0.654[in2])$^{1/2}$*1*(4000[lb/in2]/(1 [psi]))$^{1/2}$ [psi]
= **49.1**[kip] Eq. D-17

$N_{sbg} = (1 + s/(6 * c_{a1})) * N_{sb}$
= (1 + 12[in]/(6*6[in]))*49.1[kip]
= **65.47**[kip] Eq. D-17

HighSeismicDesignCategory ⟶ **False**

$\phi N_{sbg} = \phi * N_{sbg}$
= 0.75*65.47[kip]
= **49.1**[kip] Sec. D.3.3.4.4

Group of Anchors reinforcement in tension	[Kip]	39.60	19.71 L1	**0.50**	Sec. D.5.2.9, D.6.2.9

$\phi N_{sar} = 0.75*n*A_s*F_y$
$= 0.75*2*0.44$[in2]$*60000$[lb/in2]
$=$ **39.6**[kip] — Sec. D.5.2.9, D.6.2.9

Anchor shear	[Kip]	6.05	1.25 L1	**0.21**	Eq. D-29, Sec. D.6.1.3

$A_{se} = \pi/4.0*(d_a - 0.9743$ [in]$/n_t)^2$
$= \pi/4.0*(0.75$[in] $- 0.9743$ [in]$/10)^2$
$=$ **0.334**[in2] — Sec. D.5.1.1, D.6.1.2

$f_{uta} = \min(f_{uta}, 1.9*f_{ya}, 125$ [ksi]$)$
$= \min(58000$[lb/in2]$, 1.9*36000$[lb/in2]$, 125$ [ksi]$)$
$=$ **58000**[lb/in2] — Sec. D.5.1.2

HasGroutPad ⟶ **True**

$\phi V_{sa} = 0.8*\phi*0.6*n*A_{se,V}*f_{uta}$
$= 0.8*0.65*0.6*1*0.334$[in2]$*58000$[lb/in2]
$=$ **6.05**[kip] — Eq. D-29, Sec. D.6.1.3

Pryout of anchor in shear	[Kip]	31.68	1.25 L1	**0.04**	Eq. D-3, Table D.4.1.1, Sec. D.4.3

$h_{ef}<2.5$ [in] ⟶ 20[in]<2.5 [in] ⟶ **False**

$k_{cp} = 2$ — Sec. D.6.3.1

$c_{a1Left}<1.5*h_{ef}$ ⟶ 6[in]$<1.5*20$[in] ⟶ **True**

$c_{a1Left} = c_{a1Left}$
$=$ **6**[in] — Sec. D.5.2.1

$c_{a1Right}<1.5*h_{ef}$ ⟶ 18[in]$<1.5*20$[in] ⟶ **True**

$c_{a1Right} = c_{a1Right}$
$=$ **18**[in] — Sec. D.5.2.1

$c_{a2Top}<1.5*h_{ef}$ ⟶ 6[in]$<1.5*20$[in] ⟶ **True**

$c_{a2Top} = c_{a2Top}$
$=$ **6**[in] — Sec. D.5.2.1

$c_{a2Bot}<1.5*h_{ef}$ ⟶ 18[in]$<1.5*20$[in] ⟶ **True**

$c_{a2Bot} = c_{a2Bot}$
$=$ **18**[in] — Sec. D.5.2.1

IsCloseToThreeEdges ⟶ **True**

$h_{ef} = c_{amax}/1.5$
$= 18[in]/1.5$
$= \mathbf{12}[in]$ Sec. D.5.2.3

$c_{a1Left}<1.5*h_{ef} \longrightarrow 6[in]<1.5*12[in] \longrightarrow$ **True**

$c_{a1Left} = c_{a1Left}$
$= \mathbf{6}[in]$ Sec. D.5.2.1

$c_{a1Right}<1.5*h_{ef} \longrightarrow 18[in]<1.5*12[in] \longrightarrow$ **False**

$c_{a1Right} = 1.5*h_{ef}$
$= 1.5*12[in]$
$= \mathbf{18}[in]$ Sec. D.5.2.1

$c_{a2Top}<1.5*h_{ef} \longrightarrow 6[in]<1.5*12[in] \longrightarrow$ **True**

$c_{a2Top} = c_{a2Top}$
$= \mathbf{6}[in]$ Sec. D.5.2.1

$c_{a2Bot}<1.5*h_{ef} \longrightarrow 18[in]<1.5*12[in] \longrightarrow$ **False**

$c_{a2Bot} = 1.5*h_{ef}$
$= 1.5*12[in]$
$= \mathbf{18}[in]$ Sec. D.5.2.1

$A_{Nc} = (c_{a1Left} + c_{a1Right})*(c_{a2Top} + c_{a2Bot})$
$= (6[in] + 18[in])*(6[in] + 18[in])$
$= \mathbf{576}[in2]$ Sec. RD.5.2.1

$A_{Nco} = 9*h_{ef}^{2}$
$= 9*12[in]^{2}$
$= \mathbf{1296}[in2]$ Eq. D-5

$c_{a,min}<1.5*h_{ef} \longrightarrow 6[in]<1.5*12[in] \longrightarrow$ **True**

$\psi_{ed,N} = 0.7 + 0.3*c_{a,min}/(1.5*h_{ef})$
$= 0.7 + 0.3*6[in]/(1.5*12[in])$
$= \mathbf{0.8}$ Eq. D-10

CrackedConcrete $\longrightarrow$ **True**

$\psi_{c,N} = 1$ Sec. D.5.2.6

IsCastInPlaceAnchor $\longrightarrow$ **True**

$\psi_{cp,N} = 1$ Sec. D.5.2.7

IsCastInPlaceAnchor $\longrightarrow$ **True**

$k_c = 24$ Sec. D.5.2.2

(IsCastInPlaceAnchor) and (IsHeadedBolt) and (h_{ef}>=11 [in]) and (h_{ef}<=25 [in]) ⟶ (True) and (True) and (12[in]> = 11 [in]) and (12[in]< = 25 [in]) ⟶ **True**

$N_b = 16*\lambda_a*(f_c/(1 \text{ [psi]}))^{1/2}*(h_{ef}/(1 \text{ [in]}))^{(5/3)}$ [lb]
$= 16*1*(4000\text{[lb/in2]}/(1 \text{ [psi]}))^{1/2}*(12\text{[in]}/(1 \text{ [in]}))^{(5/3)}$ [lb]
= **63.65**[kip] Eq. D-7

$N_{cb} = (A_{Nc}/A_{Nco})*\psi_{ed,N}*\psi_{c,N}*\psi_{cp,N}*N_b$
= (576[in2]/1296[in2])*0.8*1*1*63.65[kip]
= **22.63**[kip] Eq. D-3

$V_{cp} = k_{cp}*N_{cb}$
= 2*22.63[kip]
= **45.26**[kip] Eq. D-40

$\phi V_{cp} = \phi*V_{cp}$
= 0.7*45.26[kip]
= **31.68**[kip] Table D.4.1.1, Sec. D.4.3

Pryout of group of anchors in shear	[Kip]	31.68	2.50	L1	**0.08**	Eq. D-4, Table D.4.1.1, Sec. D.4.3

h_{ef}<2.5 [in] ⟶ 20[in]<2.5 [in] ⟶ **False**

$k_{cp} = 2$ Sec. D.6.3.1

$A_{Nco} = 9*h_{ef}^2$
$= 9*12\text{[in]}^2$
= **1296**[in2] Eq. D-5

$A_{Nc} = \min(A_{Nc}, n*A_{Nco})$
= min(576[in2], 2*1296[in2])
= **576**[in2] Sec. D.5.2.1

$\psi_{ec,Ny} = \min(1/(1 + 2*e'_N/(3*h_{ef})), 1)$
= min(1/(1 + 2*0[in]/(3*12[in])), 1)
= **1** Eq. D-8

$\psi_{ec,Nx} = \min(1/(1 + 2*e'_N/(3*h_{ef})), 1)$
= min(1/(1 + 2*0[in]/(3*12[in])), 1)
= **1** Eq. D-8

$\psi_{ec,N} = \psi_{ec,Nx}*\psi_{ec,Ny}$
= 1*1
= **1** Eq. D-8

$c_{a,min}<1.5*h_{ef}$ ⟶ 6[in]<1.5*12[in] ⟶ **True**

$\psi_{ed,N} = 0.7 + 0.3*c_{a,min}/(1.5*h_{ef})$
= 0.7 + 0.3*6[in]/(1.5*12[in])
= **0.8** Eq. D-10

CrackedConcrete ⟶ **True**

$\psi_{c,N}$ = 1 Sec. D.5.2.6

IsCastInPlaceAnchor ⟶ **True**

$\psi_{cp,N}$ = 1 Sec. D.5.2.7

IsCastInPlaceAnchor ⟶ **True**

k_c = 24 Sec. D.5.2.2

(IsCastInPlaceAnchor) and (IsHeadedBolt) and (h_{ef}>=11 [in]) and (h_{ef}<=25 [in]) ⟶ (True) and (True) and (12[in]> = 11 [in]) and (12[in]< = 25 [in]) ⟶ **True**

$N_b = 16*\lambda_a*(f_c/(1\ [psi]))^{1/2}*(h_{ef}/(1\ [in]))^{(5/3)}\ [lb]$
$= 16*1*(4000[lb/in2]/(1\ [psi]))^{1/2}*(12[in]/(1\ [in]))^{(5/3)}\ [lb]$
= **63.65**[kip] Eq. D-7

$N_{cbg} = (A_{Nc}/A_{Nco})*\psi_{ec,N}*\psi_{ed,N}*\psi_{c,N}*\psi_{cp,N}*N_b$
= (576[in2]/1296[in2])*1*0.8*1*1*63.65[kip]
= **22.63**[kip] Eq. D-4

$V_{cpg} = k_{cp}*N_{cbg}$
= 2*22.63[kip]
= **45.26**[kip] Eq. D-41

$\phi V_{cpg} = \phi*V_{cpg}$
= 0.7*45.26[kip]
= **31.68**[kip] Table D.4.1.1, Sec. D.4.3

Group of Anchors reinforcement in shear	[Kip]	18.00	5.00	L1	**0.28**	Sec. D.5.2.9, D.6.2.9

$\phi N_{sar} = 0.75*n*A_s*F_y$
= 0.75*2*0.2[in2]*60000[lb/in2]
= **18**[kip] Sec. D.5.2.9, D.6.2.9

Interaction of tensile and shear forces	[Kip]	1.20	0.88	L1	**0.74**	Eq. D-2, Sec. D.3.3.4.4, Sec. D.5.4.1, Eq. D-17, Eq. D-29, Sec. D.6.1.3, Eq. D-3, Table D.4.1.1, Sec. D.4.3, Eq. D-4, Eq. D-42

$A_{se} = \pi/4.0*(d_a - 0.9743\ [in]/n_t)^2$
$= \pi/4.0*(0.75[in] - 0.9743\ [in]/10)^2$
= **0.334**[in2] Sec. D.5.1.1, D.6.1.2

$f_{uta} = \min(f_{uta}, 1.9*f_{ya}, 125\ [ksi])$
$= \min(58000[lb/in2], 1.9*36000[lb/in2], 125\ [ksi])$
$= \mathbf{58000}[lb/in2]$ Sec. D.5.1.2

$\phi N_{sa} = \phi*A_{se,N}*f_{uta}$
$= 0.75*0.334[in2]*58000[lb/in2]$
$= \mathbf{14.55}[kip]$ Eq. D-2

$A_{brg} = 0.866025*F^2 - A_g$
$= 0.866025*1.13[in]^2 - 0.442[in2]$
$= \mathbf{0.654}[in2]$

IsHeadedBolt $\longrightarrow$ **True**

$N_p = 8*A_{brg}*f_c$
$= 8*0.654[in2]*4000[lb/in2]$
$= \mathbf{20.93}[kip]$ Eq. D-14

CrackedConcrete $\longrightarrow$ **True**

$\psi_{c,P} = 1$ Sec. D.5.3.6

$N_{pn} = \psi_{c,P}*N_p$
$= 1*20.93[kip]$
$= \mathbf{20.93}[kip]$ Eq. D-13

HighSeismicDesignCategory $\longrightarrow$ **False**

$\phi N_{pn} = \phi*N_{pn}$
$= 0.7*20.93[kip]$
$= \mathbf{14.65}[kip]$ Sec. D.3.3.4.4

SideFaceBlowoutApply = $h_{ef}>2.5*c_{a1}$
$= 20[in]>2.5*6[in]$
= **True** Sec. D.5.4.1

$A_{brg} = 0.866025*F^2 - A_g$
$= 0.866025*1.13[in]^2 - 0.442[in2]$
$= \mathbf{0.654}[in2]$

$c_{a2}<3.0*c_{a1} \longrightarrow 6[in]<3.0*6[in] \longrightarrow$ **True**

$N_{sb} = ((1 + c_{a2}/c_{a1})/4)*160*c_{a1}*(A_{brg})^{1/2}*\lambda_a*(f_c/(1\ [psi]))^{1/2}\ [psi]$
$= ((1 + 6[in]/6[in])/4)*160*6[in]*(0.654[in2])^{1/2}*1*(4000[lb/in2]/(1\ [psi]))^{1/2}\ [psi]$
$= \mathbf{24.55}[kip]$ Sec. D.5.4.1

HighSeismicDesignCategory $\longrightarrow$ **False**

$\phi N_{sb} = \phi*N_{sb}$
$= 0.75*24.55[kip]$
$= \mathbf{18.41}[kip]$ Sec. D.3.3.4.4

$SideFaceBlowoutApply = h_{ef}>2.5*c_{a1}$
$= 20[in]>2.5*6[in]$
= **True** Sec. D.5.4.1

$A_{brg} = 0.866025*F^2 - A_g$
$= 0.866025*1.13[in]^2 - 0.442[in2]$
= **0.654**[in2]

$N_{sb} = 160*c_{a1}*(A_{brg})^{1/2}*\lambda*(f_c/(1\ [psi]))^{1/2}\ [psi]$
$= 160*6[in]*(0.654[in2])^{1/2}*1*(4000[lb/in2]/(1\ [psi]))^{1/2}\ [psi]$
= **49.1**[kip] Eq. D-17

$N_{sbg} = (1 + s/(6*c_{a1}))*N_{sb}$
$= (1 + 12[in]/(6*6[in]))*49.1[kip]$
= **65.47**[kip] Eq. D-17

HighSeismicDesignCategory $\longrightarrow$ **False**

$\phi N_{sbg} = \phi*N_{sbg}$
$= 0.75*65.47[kip]$
= **49.1**[kip] Sec. D.3.3.4.4

$A_{se} = \pi/4.0*(d_a - 0.9743\ [in]/n_t)^2$
$= \pi/4.0*(0.75[in] - 0.9743\ [in]/10)^2$
= **0.334**[in2] Sec. D.5.1.1, D.6.1.2

$f_{uta} = \min(f_{uta}, 1.9*f_{ya}, 125\ [ksi])$
$= \min(58000[lb/in2], 1.9*36000[lb/in2], 125\ [ksi])$
= **58000**[lb/in2] Sec. D.5.1.2

HasGroutPad $\longrightarrow$ **True**

$\phi V_{sa} = 0.8*\phi*0.6*n*A_{se,V}*f_{uta}$
$= 0.8*0.65*0.6*1*0.334[in2]*58000[lb/in2]$
= **6.05**[kip] Eq. D-29, Sec. D.6.1.3

$h_{ef}<2.5\ [in] \longrightarrow 20[in]<2.5\ [in] \longrightarrow$ **False**

$k_{cp} = 2$ Sec. D.6.3.1

$c_{a1Left}<1.5*h_{ef} \longrightarrow 6[in]<1.5*20[in] \longrightarrow$ **True**

$c_{a1Left} = c_{a1Left}$
= **6**[in] Sec. D.5.2.1

$c_{a1Right}<1.5*h_{ef} \longrightarrow 18[in]<1.5*20[in] \longrightarrow$ **True**

$c_{a1Right} = c_{a1Right}$
= **18**[in] Sec. D.5.2.1

$c_{a2Top}<1.5*h_{ef} \longrightarrow 6[in]<1.5*20[in] \longrightarrow$ **True**

$c_{a2Top} = c_{a2Top}$
= **6**[in] Sec. D.5.2.1

c_{a2Bot}<1.5*h_{ef} ⟶ 18[in]<1.5*20[in] ⟶ **True**

$c_{a2Bot} = c_{a2Bot}$
= **18**[in] Sec. D.5.2.1

IsCloseToThreeEdges ⟶ **True**

$h_{ef} = c_{amax}/1.5$
= 18[in]/1.5
= **12**[in] Sec. D.5.2.3

c_{a1Left}<1.5*h_{ef} ⟶ 6[in]<1.5*12[in] ⟶ **True**

$c_{a1Left} = c_{a1Left}$
= **6**[in] Sec. D.5.2.1

$c_{a1Right}$<1.5*h_{ef} ⟶ 18[in]<1.5*12[in] ⟶ **False**

$c_{a1Right} = 1.5*h_{ef}$
= 1.5*12[in]
= **18**[in] Sec. D.5.2.1

c_{a2Top}<1.5*h_{ef} ⟶ 6[in]<1.5*12[in] ⟶ **True**

$c_{a2Top} = c_{a2Top}$
= **6**[in] Sec. D.5.2.1

c_{a2Bot}<1.5*h_{ef} ⟶ 18[in]<1.5*12[in] ⟶ **False**

$c_{a2Bot} = 1.5*h_{ef}$
= 1.5*12[in]
= **18**[in] Sec. D.5.2.1

$A_{Nc} = (c_{a1Left} + c_{a1Right})*(c_{a2Top} + c_{a2Bot})$
= (6[in] + 18[in])*(6[in] + 18[in])
= **576**[in2] Sec. RD.5.2.1

$A_{Nco} = 9*h_{ef}^{2}$
= 9*12[in]^{2}
= **1296**[in2] Eq. D-5

$c_{a,min}$<1.5*h_{ef} ⟶ 6[in]<1.5*12[in] ⟶ **True**

$\psi_{ed,N} = 0.7 + 0.3*c_{a,min}/(1.5*h_{ef})$
= 0.7 + 0.3*6[in]/(1.5*12[in])
= **0.8** Eq. D-10

CrackedConcrete ⟶ **True**

$\psi_{c,N} = 1$ Sec. D.5.2.6

IsCastInPlaceAnchor → **True**

$\psi_{cp,N}$ = 1 Sec. D.5.2.7

IsCastInPlaceAnchor → **True**

k_c = 24 Sec. D.5.2.2

(IsCastInPlaceAnchor) and (IsHeadedBolt) and (h_{ef}>=11 [in]) and (h_{ef}<=25 [in]) → (True) and (True) and (12[in]> = 11 [in]) and (12[in]< = 25 [in]) → **True**

N_b = 16*λ_a*(f_c/(1 [psi]))$^{1/2}$*(h_{ef}/(1 [in]))$^{(5/3)}$ [lb]
= 16*1*(4000[lb/in2]/(1 [psi]))$^{1/2}$*(12[in]/(1 [in]))$^{(5/3)}$ [lb]
= **63.65**[kip] Eq. D-7

N_{cb} = (A_{Nc}/A_{Nco})*$\psi_{ed,N}$*$\psi_{c,N}$*$\psi_{cp,N}$*N_b
= (576[in2]/1296[in2])*0.8*1*1*63.65[kip]
= **22.63**[kip] Eq. D-3

V_{cp} = k_{cp}*N_{cb}
= 2*22.63[kip]
= **45.26**[kip] Eq. D-40

ϕV_{cp} = ϕ*V_{cp}
= 0.7*45.26[kip]
= **31.68**[kip] Table D.4.1.1, Sec. D.4.3

h_{ef}<2.5 [in] → 20[in]<2.5 [in] → **False**

k_{cp} = 2 Sec. D.6.3.1

A_{Nco} = 9*h_{ef}^2
= 9*12[in]^2
= **1296**[in2] Eq. D-5

A_{Nc} = min(A_{Nc}, n*A_{Nco})
= min(576[in2], 2*1296[in2])
= **576**[in2] Sec. D.5.2.1

$\psi_{ec,Ny}$ = min(1/(1 + 2*e'_N/(3*h_{ef})), 1)
= min(1/(1 + 2*0[in]/(3*12[in])), 1)
= **1** Eq. D-8

$\psi_{ec,Nx}$ = min(1/(1 + 2*e'_N/(3*h_{ef})), 1)
= min(1/(1 + 2*0[in]/(3*12[in])), 1)
= **1** Eq. D-8

$\psi_{ec,N}$ = $\psi_{ec,Nx}$*$\psi_{ec,Ny}$
= 1*1
= **1** Eq. D-8

$c_{a,min}$<1.5*h_{ef} $\longrightarrow$ 6[in]<1.5*12[in] $\longrightarrow$ **True**

$\psi_{ed,N}$ = 0.7 + 0.3*$c_{a,min}$/(1.5*h_{ef})
= 0.7 + 0.3*6[in]/(1.5*12[in])
= **0.8** Eq. D-10

CrackedConcrete $\longrightarrow$ **True**

$\psi_{c,N}$ = 1 Sec. D.5.2.6

IsCastInPlaceAnchor $\longrightarrow$ **True**

$\psi_{cp,N}$ = 1 Sec. D.5.2.7

IsCastInPlaceAnchor $\longrightarrow$ **True**

k_c = 24 Sec. D.5.2.2

(IsCastInPlaceAnchor) and (IsHeadedBolt) and (h_{ef}>=11 [in]) and (h_{ef}<=25 [in]) $\longrightarrow$ (True) and (True) and (12[in]> = 11 [in]) and (12[in]<= 25 [in]) $\longrightarrow$ **True**

$N_b = 16*\lambda_a*(f_c/(1\ [psi]))^{1/2}*(h_{ef}/(1\ [in]))^{(5/3)}\ [lb]$
$= 16*1*(4000[lb/in2]/(1\ [psi]))^{1/2}*(12[in]/(1\ [in]))^{(5/3)}\ [lb]$
= **63.65**[kip] Eq. D-7

N_{cbg} = (A_{Nc}/A_{Nco})*$\psi_{ec,N}$*$\psi_{ed,N}$*$\psi_{c,N}$*$\psi_{cp,N}$*N_b
= (576[in2]/1296[in2])*1*0.8*1*1*63.65[kip]
= **22.63**[kip] Eq. D-4

V_{cpg} = k_{cp}*N_{cbg}
= 2*22.63[kip]
= **45.26**[kip] Eq. D-41

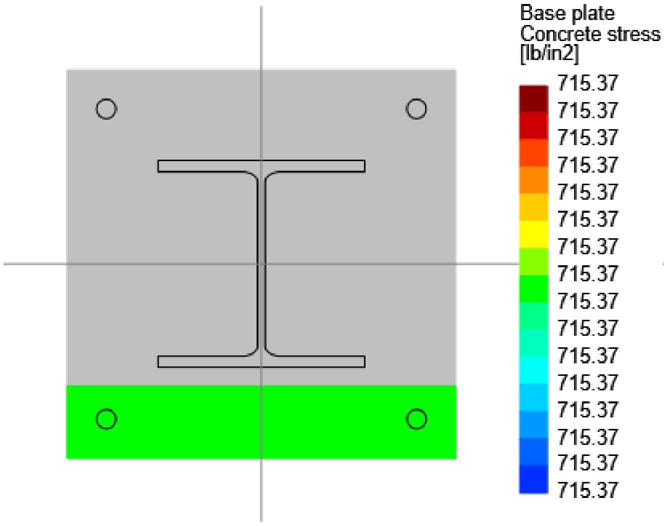
ϕV_{cpg} = ϕ*V_{cpg}
= 0.7*45.26[kip]
= **31.68**[kip] Table D.4.1.1, Sec. D.4.3

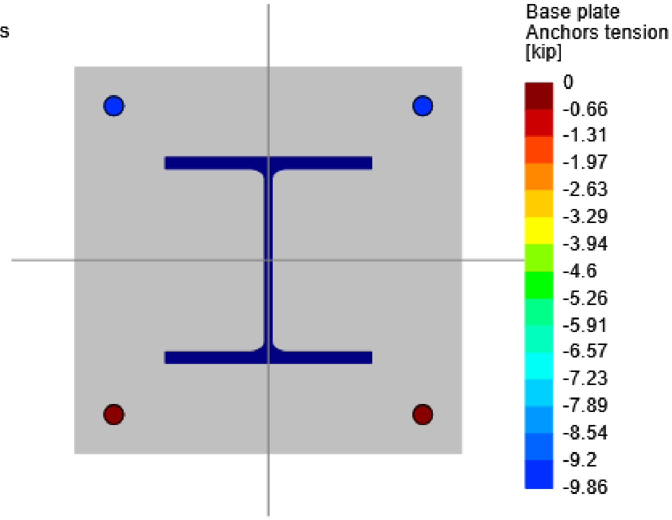
(N_{ua}>0.2*ϕN_n) and (V_{ua}>0.2*ϕV_n) $\longrightarrow$ (9.86[kip]>0.2*14.55[kip]) and (1.25[kip]>0.2*6.05[kip]) $\longrightarrow$ **True**

TensionShearInteraction = N_{ua}/ϕN_n + V_{ua}/ϕV_n
= 9.86[kip]/14.55[kip] + 1.25[kip]/6.05[kip]
= **0.884** Eq. D-42

Ratio	**0.74**
Global critical strength ratio	**0.79**

Major axis
Maximum compression and tension (L1)





Maximum bearing pressure	715.37	[psi]
Minimum bearing pressure	715.37	[psi]
Maximum anchor tension	9.86	[Kip]
Minimum anchor tension	0.00	[Kip]
Neutral axis angle	0.00	
Bearing length	2.77	[in]

Anchors tensions

Anchor	Transverse [in]	Longitudinal [in]	Shear [Kip]	Tension [Kip]
1	-6.00	-6.00	1.25	0.00
2	-6.00	6.00	1.25	9.86
3	6.00	6.00	1.25	9.86
4	6.00	-6.00	1.25	0.00

NOTATION

A_1: Base plate area
A_2: Maximum area of portion of the concrete supporting surface that is geometrically similar to and concentric with the load area
A_w: Effective area of the weld
A_2/A_1: Ratio between the concrete support area and the base plate area
B: Base plate design width
b_{eff}: Effective width of the compression block
B_{eff}: Controlling ffective width
c: Distance to weld group
D: Number of sixteenths of an inch in the weld size
f_a: Axial stress on welds
f_b: Bending stress on welds
f'_c: Specified compressive strength of concrete
f: Combined stress on welds
F_{EXX}: Electrode classification number
$f_{p,\ max}$: Maximum uniformly bearing stress under base plate
f_v: Vertical shear force on weld
F_w: Nominal strength of the weld metal per unit area
F_y: Specified minimum yield stress
I: Inertia of weld group
L: Distance from the anchor rod to the column
L: Length of weld
L_{shear}: Length of weld receiving shear
LoadAngleFactor: Load angle factor
M: Bending required
m: Base plate bearing interface cantilever direction parallel to moment direction
M_{pl}: Plate bending moment per unit width
M_{pM}: Plate bending moment per unit width at bearing interface for the cantilever m
M_{pN}: Plate bending moment per unit width at bearing interface for the cantilever n
M_{pT}: Plate bending moment per unit width at tension unstiffened strip interface
M_{strip}: Maximum bending moment at the strip

Maximum weld load: Maximum weld load
N: Base plate design length
n: Base plate bearing interface cantilever direction perpendicular to moment direction
N_{cs}: Length of the concrete supporting surface or pier parallel to moment design direction
P: Required axial force
ϕ: Design factors
ϕM_n: Design or allowable strength per unit length
ϕR_w: Fillet weld capacity per unit length
T: Anchor rod tensile strength required
t_p: Plate thickness
θ: Load angle
V: Shear load
w_{min}: Minimum weld size required
A_{brg}: Net bearing area of the head of stud or anchor bolt
A_g: Gross area of anchor
A_{Nc}: Projected concrete failure area of a single anchor or group of anchors, for calculation of strength in tension
A_{Nco}: Projected concrete failure area of a single anchor, for calculation of strength in tension if not limited by edge distance or spacing
A_s: Effective cross-sectional area of anchor reinforcement
A_{se}: Effective cross-sectional area of anchor
$A_{se,N}$: Effective cross-sectional area of anchor in tension
$A_{se,V}$: Effective cross-sectional area of anchor in shear
c_{a1}: Distance from the anchor center to the concrete edge
c_{a1Left}: Distance from the anchor center to the left edge of the concrete base
$c_{a1Right}$: Distance from the anchor center to the right edge of the concrete base
c_{a2}: Distance from the anchor center to the concrete edge in perpendicular direction
c_{a2Bot}: Distance from the anchor center to the bottom edge of the concrete base
c_{a2Top}: Distance from the anchor center to the top edge of the concrete base
c_{amax}: Maximum distance from center of an anchor shaft to the edge of concrete
$c_{a,min}$: Minimum distance from center of an anchor shaft to the edge of concrete
Cover: Concrete cover
CrackedConcrete: Cracked concrete at service loads
d_a: Outside diameter of anchor or shaft diameter of headed stud, headed bolt, or hooked bolt
e'_N: Distance between resultant tension load on a group of anchors loaded in tension and the centroid of the group of anchors loaded in tension
F: Distance between head flat sides
f_c: Specified compressive strength of concrete
f_{uta}: Specified tensile strength of anchor steel
F_y: Specified minimum yield stress
f_{ya}: Specified yield strength of anchor steel
h_{ef}: Effective embedment depth of anchor
HasGroutPad: Has grout pad
HighSeismicDesignCategory High seismic design category (i.e. C, D, E or F)
IsCastInPlaceAnchor: Is cast in place anchor
IsCloseToThreeEdges: Anchor is close to three or more edges
IsConcreteCastAgainstEarth Is concrete cast against and permanently exposed to earth
IsHeadedBolt: Is anchor headed stud
k_c: Coefficient for concrete pry out basic strength
k_{cp}: Coefficient for pry out strength
λ: Lightweight concrete modification factor
λ_a: Lightweight concrete modification factor
n: Number of anchors in the group
N_b: Basic concrete breakout strength in tension of a single anchor in cracked concrete
N_{cb}: Nominal concrete breakout strength in tension of a single anchor
N_{cbg}: Nominal concrete breakout strength in tension of a group of anchors
N_p: Pullout strength in tension of a single anchor in cracked concrete
N_{pn}: Nominal pullout strength of a single anchor in tension
n: Number of anchor reinforcement bars
N_{sb}: Nominal side-face blowout strength of a single anchor
N_{sbg}: Nominal side-face blowout strength of a group of anchors
n_t: Number of threads per inch
N_{ua}: Factored tensile force applied to anchor or group of anchors
ϕ: Strength reduction factor
ϕN_n: Tension strength
ϕN_{pn}: Pullout strength in tension of a single anchor
ϕN_{sa}: Strength of a single anchor or group of anchors in tension
ϕN_{sar}: Strength of a single anchor reinforcement or group of anchors reinforcements in tension
ϕN_{sb}: Side-face blowout strength of a single anchor
ϕN_{sbg}: Side-face blowout strength of a group of anchors

ϕV_{cp}: Concrete pryout strength of a single anchor
ϕV_{cpg}: Concrete pryout strength of a group of anchors
ϕV_{n}: Shear strength
ϕV_{sa}: Strength in shear of a single anchor or group of anchors as governed by the steel strength
$\psi_{c,N}$: Factor used to modify tensile strength of anchors based on presence or absence of cracks in concrete
$\psi_{c,P}$: Factor used to modify pullout strength of anchors based on presence or absence of cracks in concrete
$\psi_{cp,N}$: Factor used to modify tensile strength of postinstalled anchors intended for use in uncracked concrete without supplementary reinforcement
$\psi_{ec,N}$: Factor used to modify tensile strength of anchors based on eccentricity of applied loads
$\psi_{ec,Nx}$: Factor used to modify tensile strength of anchors based on eccentricity in x axis of applied loads
$\psi_{ec,Ny}$: Factor used to modify tensile strength of anchors based on eccentricity in y axis of applied loads
$\psi_{ed,N}$: Factor used to modify tensile strength of anchors based on proximity to edges of concrete member
s: Center-to-center anchor spacing
s_{min}: Center-to-center anchor minimum spacing
SideFaceBlowoutApply: Side-face blowout apply
TensionShearInteraction: Result from tension-shear interaction
V_{cp}: Nominal pryout strength of a anchor in shear
V_{cpg}: Nominal pryout strength of a group of anchor in shear
V_{ua}: Factored shear force applied to anchor or group of anchors