

Units system: SI

## Steel connections

Connector : DG1 LRFD Example 4.1  
Connector : 1  
Design cod : AISC 360-2005 LRFD

Family : Base plate (BPI)  
Type : Column - Base (CB)  
Description : DG1 LRFD - Example 4.1

## GENERAL DATA

Design axis : Biaxial  
Cracked co : No  
Brittle stee : No  
Anchor bol : Yes  
Consider fr : No  
Pressure di : Uniform

## MEMBERS:

Column  
Section = ISHB 150  
bf = 150.00 [mm]  
d = 150.00 [mm]

k	=	17.00 [mm]
k1	=	10.70 [mm]
tf	=	9.00 [mm]
tw	=	5.40 [mm]

Material	=	S275
Fy	=	0.27 [KN/mm2]
Fu	=	0.42 [KN/mm2]

Concrete base

Longitudinal	=	1.50 [m]
Transverse	=	1.50 [m]
Thickness	=	0.60 [m]

Material	=	C 4-40
Fc	=	0.03 [KN/mm2]

CONNECTION(S):

Base plate

Plate

Length	=	400.00 [mm]
Width	=	400.00 [mm]
Thickness	=	20.00 [mm]

Material	=	S275
Fy	=	0.27 [KN/mm2]
Fu	=	0.42 [KN/mm2]

Weld	=	E70XX
D	=	7 [1/16 in]

#### Anchors

Material = S275  
Fy = 0.27 [kN/mm<sup>2</sup>]  
Fu = 0.42 [kN/mm<sup>2</sup>]

Geometry 1 = Customized  
Anchor typ = Headed  
Head type = Hexagonal  
D = 19.05 [mm]  
Effective le = 300.00 [mm]  
Total length = 345.15 [mm]

Anchor	Transverse [mm]	Longitudinal [mm]
1	150	50
2	150	150
3	150	-150
4	-150	50
5	-150	150
6	-150	-150
7	-150	-50
8	150	-50
9	50	150
10	50	-150
11	-50	-150
12	-50	150

Units system: SI

Steel connections  
Detailed report

Connector : DG1 LRFD Example 4.1  
Connector : 1  
Design cod : AISC 360-2005 LRFD

Family : Base plate (BPI)  
Type : Column - Base (CB)  
Descriptor : DG1 LRFD - Example 4.1

LOADS

Members	Load	Type	V2 [KN]	V3 [KN]	M33 [KN*m]	M22 [KN*m]	Axial [KN]	
Column	1 - DC1	Design		5	6	10	12	15

Design for major axis

Base plate (AISC 360-05 LRFD)

GEOMETRIC CONSIDERATIONS

Dimension:	Unit	Value	Min. value	Max. value	Sta.	References
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Base plate

$$f_{Mn} = f^* F_y \text{ DG1 Eq. 3.3.13}$$

Flexural yield [KN\*m/m]      24.75      8.58 1 - DC1      0.35 DG1 Eq. 3.3.13

$$M_p T = M_{strip} / B_{eff} = 3.433539 [KN*m] / 400 [mm] = 8.583849 [KN*m/m]$$

$$f_{Mn} = f * F_y \text{ DG1 Eq. 3.3.13}$$

Anchor (s) in tension for maximum moment: #4, #6, #7, #5

Column

Weld capacity [KN/m]      2559.85      69.73 1 - DC1      0.03 DG1 p. 35,  
p. 8-9,  
Sec. J2.5,  
Sec. J2.4

$$b_{eff} = 2 * L \text{ - DG1 p. 35}$$

$$\text{Maximum weld load} = T / b_{eff} = 10.694657 [KN] / 153.38 [mm] = 69.728652 [KN/m]$$

Load Angle p. 8-9

$$F_w = 0.6 * F \text{ Sec. J2.5}$$

$$A_w = (2) 1 / 2 \text{ Sec. J2.4}$$

$$f_{Rw} = f * F_w * A_w / L = 0.75 * 0.434367 [KN/mm^2] * 7857.72 [mm^2] / 1000 [mm] = 2559.85 [KN/m]$$

Elastic metal [KN/m]      1706.57      21.55 1 - DC1      0.01 p. 8-9,  
Sec. J2.5,  
Sec. J2.4

$$f_v = V / L_{shear} = 5 [KN] / 232 [mm] = 21.551724 [KN/m]$$

Load Angle p. 8-9

$$F_w = 0.6 * F \text{ Sec. J2.5}$$

$$A_w = (2) 1 / 2 \text{ Sec. J2.4}$$

$$f_{Rw} = f * F_w * A_w / L = 0.75 * 0.289578 [KN/mm^2] * 7857.72 [mm^2] / 1000 [mm] = 1706.57 [KN/m]$$

Elastic metal [KN/m]      2559.85      294.03 1 - DC1      0.11 p. 8-9,  
Sec. J2.5,  
Sec. J2.4

$$f_a = P / L = 15 [KN] / 557.2 [mm] = 26.920316 [KN/m]$$

$$f_b = M * c / I = 10 [KN*m] * 75 [mm] / 2807863200 [mm^4] = 267.11 [KN/m]$$

$$f = f_b + f_a = 267.11 [KN/m] + 26.920316 [KN/m] = 294.03 [KN/m]$$

Load Angle  $\theta$  p. 8-9

$F_w = 0.6 \cdot F$  Sec. J2.5

$A_w = (2)1/\text{Sec. J2.4}$

$f_{Rw} = f \cdot F_w \cdot A_w / L = 0.75 \cdot 0.434367 [\text{KN/mm}^2] \cdot 7857.72 [\text{mm}^2] / 1000 [\text{mm}] = 2559.85 [\text{KN/m}]$

Anchors (ACI 318-08)

#### GEOMETRIC CONSIDERATIONS

Dimension: Unit	Value	Min. value	Max. value	Sta.	References
Anchors					
Anchor spacing [mm] $s_{\min} = 4 \cdot d$ Sec. D.8.1	100	76.2	--		Sec. D.8.1
Distance from edge [mm] $c_{a,\min} = 3 \cdot d$ Sec. D.7.7.1	600	76.2	--		Sec. D.7.7.1
Effective length [mm]	312.38	--	587.62		

#### DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Steel strength [KN]						
$f_{uta} = \min(f_{uta}, 1.9 \cdot f_{ya}, 125 [\text{ksi}]) = \min(0.415 [\text{KN/mm}^2], 1.9 \cdot 0.275 [\text{KN/mm}^2], 125 [\text{ksi}]) = 0.415 [\text{KN/mm}^2]$ Sec. D.5.1.2		67.07	13.01	1 - DC1	0.19	Eq. D-3
$f_{Nsa} = f \cdot n$ Eq. D-3						
Breakout strength [KN]		241.26	13.01	1 - DC1	0.05	Eq. D-4,

### Sec. D.3.3.3

ca1Left<1.5\*hef ® 600[mm]<1.5\*300[mm] ® False

ca1Left = 1 Sec. D.5.2.1

ca1Right<1.5\*hef ® 900[mm]<1.5\*300[mm] ® False

ca1Right = Sec. D.5.2.1

ca2Top<1.5\*hef ® 600[mm]<1.5\*300[mm] ® False

ca2Top = 1 Sec. D.5.2.1

ca2Bot<1.5\*hef ® 900[mm]<1.5\*300[mm] ® False

ca2Bot = 1. Sec. D.5.2.1

IsCloseToThreeEdges ® False

hef = hef = Sec. D.5.2.3

ANc = (ca1Left + ca1Right)\*(ca2Top + ca2Bot) = (450[mm] + 450[mm])\*(450[mm] + 450[mm]) =

810000[mm<sup>2</sup>] Sec. RD.5.2.1

ANco = 9\* $\pi$  Eq. D-6

ca,min<1.5\*hef ® 600[mm]<1.5\*300[mm] ® False

yed,N = 1 Sec. D.5.2.5

CrackedConcrete ® False

yc,N = 1.25 Sec. D.5.2.6

IsCastInPlaceAnchor ® True

ycp,N = 1 Sec. D.5.2.7

IsCastInPlaceAnchor ® True

kc = 24 Sec. D.5.2.2

(IsCastInPlaceAnchor)and(IsHeadedBolt)and(hef>=11[in])and(hef<=25[in]) ® (True)and(True)and(300[mm]>=

11[in])and(300[mm]<=25[in]) ® True

Nb = 16\* $\pi$ \*(fc/(1[psi]))<sup>1/2</sup>\*(hef/(1[in]))(5/3)[lb] = 16\*1\*(0.027579[KN/mm<sup>2</sup>]/(1[psi]))<sup>1/2</sup>\*

(300[mm])/ Eq. D-7

Ncb = (ANc/ANco)\*yed,N\*yc,N\*ycp,N\*Nb = (810000[mm<sup>2</sup>]/810000[mm<sup>2</sup>])\*1\*1.25\*1\*

275.73[KN] Eq. D-4

HighSeismicDesignCategory ® False

fNcb = f\*N<sub>c</sub> Sec. D.3.3.3

Breakout o [KN]	387.45	64.59 1 - DC1	0.17 Eq. D-5, Sec. D.3.3.3
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$AN_{co} = 9 \cdot \text{Eq. D-6}$   
 $AN_c = \min(\text{Sec. D.5.2.1}$   
 $y_{ec}, N_y = m \text{ Eq. D-9}$   
 $y_{ec}, N_x = m \text{ Eq. D-9}$   
 $y_{ec}, N = y_{ec} \text{ Eq. D-9}$   
 $ca, \min < 1.5 \cdot h_{ef} \text{ @ } 600[\text{mm}] < 1.5 \cdot 300[\text{mm}] \text{ @ False}$   
 $y_{ed}, N = 1 \text{ Sec. D.5.2.5}$   
 $\text{CrackedConcrete} \text{ @ False}$   
 $y_c, N = 1.25 \text{ Sec. D.5.2.6}$   
 $\text{IsCastInPlaceAnchor} \text{ @ True}$   
 $y_{cp}, N = 1 \text{ Sec. D.5.2.7}$   
 $\text{IsCastInPlaceAnchor} \text{ @ True}$   
 $k_c = 24 \text{ Sec. D.5.2.2}$   
 $(\text{IsCastInPlaceAnchor}) \text{ and } (\text{IsHeadedBolt}) \text{ and } (h_{ef} \geq 11[\text{in}]) \text{ and } (h_{ef} \leq 25[\text{in}]) \text{ @ } (\text{True}) \text{ and } (\text{True}) \text{ and } (300[\text{mm}] \geq 11[\text{in}]) \text{ and } (300[\text{mm}] \leq 25[\text{in}]) \text{ @ True}$   
 $N_b = 16 \cdot l \cdot (f_c / (1[\text{psi}]))^{1/2} \cdot (h_{ef} / (1[\text{in}]))^{(5/3)} [l_b] = 16 \cdot 1 \cdot (0.027579[\text{KN/mm}^2] / (1[\text{psi}]))^{1/2} \cdot (300[\text{mm}] / \text{Eq. D-7}$   
 $N_{cbg} = (AN_c / AN_{co}) \cdot y_{ec}, N \cdot y_{ed}, N \cdot y_c, N \cdot y_{cp}, N \cdot N_b = (1420000[\text{mm}^2] / 810000[\text{mm}^2]) \cdot 0.91606 \cdot 1 \cdot \text{Eq. D-5}$   
 $\text{HighSeismicDesignCategory} \text{ @ False}$   
 $f_{Ncbg} = f \cdot N \text{ Sec. D.3.3.3}$

Pullout of $\epsilon$ [KN]	91.23	13.01	1 - DC1	0.14 Sec. D.3.3.3
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$\text{IsHeadedBolt} \text{ @ True}$

$N_p = 8 \cdot A_{br} \text{ Eq D-15,}$   
 $\text{Eq D-16}$

$\text{CrackedConcrete} \text{ @ False}$

$y_c, P = 1.4 \text{ Sec. D.5.3.6}$

$N_{pn} = y_c, P \cdot \text{Eq. D-14}$

$\text{HighSeismicDesignCategory} \text{ @ False}$

$f_{Npn} = f \cdot N \text{ Sec. D.3.3.3}$

Steel stren $_i$ [KN]	34.88	0.42	1 - DC1	0.01 Eq. D.20
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$$f_{Vsa} = f \cdot 0.1 \quad \text{Eq. D.20}$$

fNcbg = f\* $\uparrow$  Sec. D.3.3.3

ca1Right = Sec. D.5.2.1

$ca2Top < 1.5 * hef$  ® 600[mm] < 1.5\*300[mm] ® False  
 $ca2Top = 1$  Sec. D.5.2.1  
 $ca2Bot < 1.5 * hef$  ® 900[mm] < 1.5\*300[mm] ® False  
 $ca2Bot = 1$ . Sec. D.5.2.1  
 $IsCloseToThreeEdges$  ® False  
 $hef = hef$  = Sec. D.5.2.3  
 $ANc = (ca1Left + ca1Right) * (ca2Top + ca2Bot) = (450[mm] + 450[mm]) * (450[mm] + 450[mm]) = 810000[mm^2]$  Sec. RD.5.2.1  
 $ANco = 9 * A_g$  Eq. D-6  
 $ca, min < 1.5 * hef$  ® 600[mm] < 1.5\*300[mm] ® False  
 $yed, N = 1$  Sec. D.5.2.5  
 $CrackedConcrete$  ® False  
 $yc, N = 1.25$  Sec. D.5.2.6  
 $IsCastInPlaceAnchor$  ® True  
 $ycp, N = 1$  Sec. D.5.2.7  
 $IsCastInPlaceAnchor$  ® True  
 $kc = 24$  Sec. D.5.2.2  
 $(IsCastInPlaceAnchor) and (IsHeadedBolt) and (hef \geq 11[in]) and (hef \leq 25[in])$  ® (True) and (True) and (300[mm] >= 11[in]) and (300[mm] <= 25[in]) ® True  
 $Nb = 16 * l * (fc / (1[psi]))^{1/2} * (hef / (1[in]))^{(5/3)} [lb] = 16 * 1 * (0.027579[KN/mm^2] / (1[psi]))^{1/2} * (300[mm] / Eq. D-7$   
 $Ncb = (ANc / ANco) * yed, N * yc, N * ycp, N * Nb = (810000[mm^2] / 810000[mm^2]) * 1 * 1.25 * 1 * 275.73[KN]$  Eq. D-4  
 $Vcp = kcp *$  Eq. D-30  
 $HighSeismicDesignCategory$  ® False  
 $fVcp = f * Vc$  Sec. D.3.3.3

Pryout of g [KN]	774.9	4.17 1 - DC1	0.01 Eq. D-5, Sec. D.3.3.3
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$hef < 2.5[in]$  ® 300[mm] < 2.5[in] ® False  
 $kcp = 2$  Sec. D.6.3.1  
 $ANco = 9 * A_g$  Eq. D-6  
 $ANc = min($  Sec. D.5.2.1

$y_{ec}, N_y = m$  Eq. D-9  
 $y_{ec}, N_x = m$  Eq. D-9  
 $y_{ec}, N = y_{ec}$  Eq. D-9  
 $ca, min < 1.5 * h_{ef} \text{ @ } 600[mm] < 1.5 * 300[mm] \text{ @ } False$   
 $y_{ed}, N = 1$  Sec. D.5.2.5  
 $CrackedConcrete \text{ @ } False$   
 $y_c, N = 1.25$  Sec. D.5.2.6  
 $IsCastInPlaceAnchor \text{ @ } True$   
 $y_{cp}, N = 1$  Sec. D.5.2.7  
 $IsCastInPlaceAnchor \text{ @ } True$   
 $k_c = 24$  Sec. D.5.2.2  
 $(IsCastInPlaceAnchor) \text{ and } (IsHeadedBolt) \text{ and } (h_{ef} \geq 11[in]) \text{ and } (h_{ef} \leq 25[in]) \text{ @ } (True) \text{ and } (True) \text{ and } (300[mm] \geq 11[in]) \text{ and } (300[mm] \leq 25[in]) \text{ @ } True$   
 $N_b = 16 * l * (f_c / (1[psi]))^{1/2} * (h_{ef} / (1[in]))^{5/3} [lb] = 16 * 1 * (0.027579[KN/mm^2] / (1[psi]))^{1/2} * (300[mm]) / Eq. D-7$   
 $N_{cbg} = (A_{Nc} / A_{Nco}) * y_{ec}, N * y_{ed}, N * y_c, N * y_{cp}, N * N_b = (1420000[mm^2] / 810000[mm^2]) * 0.91606 * 1 \text{ Eq. D-5}$   
 $V_{cpg} = k_{cp} \text{ Eq. D-31}$   
 $HighSeismicDesignCategory \text{ @ } False$   
 $f_{Vcpg} = f * v \text{ Sec. D.3.3.3}$

Interaction of tensile a      1.2      0 1 - DC1      0 Eq. D-32  
 $(N_{ua} > 0.2 * f_{Nn}) \text{ and } (V_{ua} > 0.2 * f_{Vn}) \text{ @ } (13.008752[KN] > 0.2 * 67.069216[KN]) \text{ and } (2.5[KN] > 0.2 * 197.9[KN]) \text{ @ } False$   
 $TensionSh\epsilon \text{ Eq. D-32}$

Critical stre      0.68

Design for minor axis

## Base plate (AISC 360-05 LRFD)

### GEOMETRIC CONSIDERATIONS

Dimension: Unit	Value	Min. value	Max. value	Sta.	References
Base plate					
Longitudinal [mm]	400	172.22	--		
$N_{min} = d_c + 2 \cdot w = 150[\text{mm}] + 2 \cdot 11.1125[\text{mm}] = 172.22[\text{mm}]$					
Transversa [mm]	400	172.22	--		
$B_{min} = b_c + 2 \cdot w = 150[\text{mm}] + 2 \cdot 11.1125[\text{mm}] = 172.22[\text{mm}]$					
Distance from [mm]	50	31.75	--		Tables J3.4, J3.5
$L_{min} = e_d$ Tables J3.4, J3.5					
Weld size [1/16in]	7	2	--		table J2.4
$w_{min} = w_n$ table J2.4					

### DESIGN CHECK

Verification Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Concrete base					
Axial bearing [KN/mm <sup>2</sup> ]	0.02	0	1 - DC1	0.15	
$f_{p, \max} = f^* \cdot \min(0.85 \cdot f'_c \cdot (A_2/A_1)^{1/2}, 1.7 \cdot f'_c) = 0.65 \cdot \min(0.85 \cdot 0.027579[\text{KN/mm}^2] \cdot (1)^{1/2}, 1.7 \cdot 0.027579[\text{KN/mm}^2])$ DG1 3.1.1					

Base plate

Flexural $y_{ie}$ [KN*m/m]	24.75	15.6	1 - DC1	0.63	DG1 Sec 3.1.2, DG1 Eq. 3.3.13
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$m = m = 14$  DG1 Sec 3.1.2

$n = n = 128$  DG1 Sec 3.1.2

$M_{pl} = \max(M_{pM}, M_{pN}) = \max(8.518952[\text{KN*m/m}], 15.604065[\text{KN*m/m}]) = 15.604065[\text{KN*m/m}]$

$f_{Mn} = f * F_y$  DG1 Eq. 3.3.13

Flexural $y_{ie}$ [KN*m/m]	24.75	8.58	1 - DC1	0.35	DG1 Eq. 3.3.13
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$M_{pT} = M_{strip}/b_{eff} = 3.433539[\text{KN*m}]/400[\text{mm}] = 8.583849[\text{KN*m/m}]$

$f_{Mn} = f * F_y$  DG1 Eq. 3.3.13

Anchor (s) in tension for maximum moment: #4, #6, #7, #5

Column

Weld capax [KN/m]	2559.85	69.73	1 - DC1	0.03	DG1 p. 35, p. 8-9, Sec. J2.5, Sec. J2.4
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$b_{eff} = 2 * L$  : DG1 p. 35

Maximum weld load =  $T/b_{eff} = 10.694657[\text{KN}]/153.38[\text{mm}] = 69.728652[\text{KN/m}]$

LoadAngleI p. 8-9

$F_w = 0.6 * F$  Sec. J2.5

$A_w = (2)1/\text{Sec. J2.4}$

$f_{Rw} = f * F_w * A_w / L = 0.75 * 0.434367[\text{KN/mm}^2] * 7857.72[\text{mm}^2] / 1000[\text{mm}] = 2559.85[\text{KN/m}]$

Elastic met [KN/m]	1706.57	10.77	1 - DC1	0.01	p. 8-9, Sec. J2.5, Sec. J2.4
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$f_v = V/L_{shear} = 6[\text{KN}]/557.2[\text{mm}] = 10.768126[\text{KN/m}]$

LoadAngleI p. 8-9

$F_w = 0.6 * F$  Sec. J2.5

$A_w = (2)1/\text{Sec. J2.4}$

$f_{Rw} = f * F_w * A_w / L = 0.75 * 0.289578[\text{KN/mm}^2] * 7857.72[\text{mm}^2] / 1000[\text{mm}] = 1706.57[\text{KN/m}]$

Elastic met [KN/m]      2559.85      828.08 1 - DC1      0.32 p. 8-9,  
 Sec. J2.5,  
 Sec. J2.4

$$f_a = P/L = 15[\text{KN}]/557.2[\text{mm}] = 26.920316[\text{KN/m}]$$

$$f_b = M*c/I = 12[\text{KN*m}]*75[\text{mm}]/1123366609.33[\text{mm}^4] = 801.16[\text{KN/m}]$$

$$f = f_b + f_a = 801.16[\text{KN/m}] + 26.920316[\text{KN/m}] = 828.08[\text{KN/m}]$$

LoadAngleI p. 8-9

$$F_w = 0.6*F \text{ Sec. J2.5}$$

$$A_w = (2)1/\text{; Sec. J2.4}$$

$$fR_w = f*F_w*A_w/L = 0.75*0.434367[\text{KN/mm}^2]*7857.72[\text{mm}^2]/1000[\text{mm}] = 2559.85[\text{KN/m}]$$

Anchors (ACI 318-08)

#### GEOMETRIC CONSIDERATIONS

Dimension: Unit	Value	Min. value	Max. value	Sta.	References
Anchors					
Anchor spa [mm] smin = 4*d Sec. D.8.1	100	76.2	--		Sec. D.8.1
Distance fr [mm] ca,min = 3[ Sec. D.7.7.1	600	76.2	--		Sec. D.7.7.1
Effective le [mm]	312.38	--	587.62		

#### DESIGN CHECK

Verificatio	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
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$$Nb = 16 * I * (fc / (1[\text{psi}]))^{1/2} * (hef / (1[\text{in}]))^{5/3} / [lb] = 16 * 1 * (0.027579[\text{KN/mm}^2] / (1[\text{psi}]))^{1/2} * (300[\text{mm}] / \text{Eq. D-7})$$



275.73[KN] Eq. D-4

HighSeismicDesignCategory<sup>®</sup> False

$$f_{Ncb} = f^* N \quad \text{Sec. D.3.3.3}$$

Breakout o [KN]	349.23	64.59 1 - DC1	0.18 Eq. D-5, Sec. D.3.3.3
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$$AN_{co} = 9 \times \text{Eq. D-6}$$

$$ANc = \min(\text{Sec. D.5.2.1}$$

$$y_{ec,Ny} = m \text{ Eq. D-9}$$

$$y_{ec,Nx} = m \text{ Eq. D-9}$$

$$y_{ec,N} = y_{ec} \text{ Eq. D-9}$$

ca,min<1.5\*hef ® 600[mm]<1.5\*300[mm] ® False

yed,N = 1    Sec. D.5.2.5

CrackedConcrete<sup>®</sup> False

yc,N = 1.25 Sec. D.5.2.6

IsCastInPlaceAnchor<sup>®</sup> True

ycp,N = 1    Sec. D.5.2.7

IsCastInPlaceAnchor<sup>®</sup> True

kc = 24      Sec. D.5.2.2

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(IsCastInPlaceAnchor)and(IsHeadedBolt)and(hcf>=11[in])and(hcf<=25[in]) ® (True)and(True)and(300[mm]>=11[in])and(300[mm]<=25[in]) ® True
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$$N_b = 16 * l * (f_c / (1 [\text{psi}]))^{1/2} * (h_{ef} / (1 [\text{in}]))^{(5/3)} [\text{lb}] = 16 * 1 * (0.027579 [\text{KN/mm}^2] / (1 [\text{psi}]))^{1/2} *$$

(300[mm]/ Eq. D-7

$$N_{cbg} = (A_{Nc}/A_{Nco}) \cdot y_{ec,N} \cdot y_{ed,N} \cdot y_{c,N} \cdot y_{cp,N} \cdot N_b = (1420000[\text{mm}^2]/810000[\text{mm}^2]) \cdot$$

0.825688\*: Eq. D-5

HighSeismicDesignCategory<sup>®</sup> False

$$fNcbg = f^* \upharpoonright \text{Sec. D.3.3.3}$$

Pullout of $\bar{c}$ [kN]	91.23	13.01	1 - DC1	0.14	Sec. D.3.3.3
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IsHeadedBolt ® True

Np = 8\*Abt Eq D-15,  
Eq D-16

CrackedConcrete ® False

$\gamma_c P = 1.4$  Sec. D.5.3.6

$N_{pn} = \gamma_c P$  Eq. D-14

HighSeismicDesignCategory ® False

$f_{Npn} = f^* N$  Sec. D.3.3.3

Steel stren<sub>i</sub> [KN] 34.88 0.5 1 - DC1 0.01 Eq. D.20

$f_{uta} = \min(f_{uta}, 1.9 \cdot f_{ya}, 125[\text{ksi}]) = \min(0.415[\text{KN/mm}^2], 1.9 \cdot 0.275[\text{KN/mm}^2], 125[\text{ksi}]) = 0.415[\text{KN/mm}^2]$  Sec. D.5.1.2

HasGroutPad ® False

$f_{Vsa} = f^* 0.6$  Eq. D.20

Breakout o [KN] 197.9 3 1 - DC1 0.02 Sec. D.3.3.3

$AV_{co} = 4.5$  Eq. D-23

$AV_c = LV_c$  Sec. RD.6.2.1

$AV_c = \min(\cdot)$  Sec. RD.6.2.1

$\gamma_{ec,V} = \min$  Eq. D-26

$ca_2 < 1.5 \cdot ca_1$  ® 600[mm] < 1.5 \* 400[mm] ® False

$\gamma_{ed,V} = 1$  Sec. D.6.2.6

CrackedConcrete ® False

$\gamma_{c,V} = 1.4$  Sec. D.6.2.7

$ha < 1.5 \cdot ca_1$  ® 600[mm] < 1.5 \* 400[mm] ® False

$\gamma_{h,V} = 1$  Eq. D-29

$l_e = \min(h_e)$  Sec. D.6.2.2

$V_b = (7 \cdot (l_e / d_a) 0.2 \cdot (d_a / (1[\text{in}]))^{1/2} \cdot l^* (f_c / (1[\text{psi}]))^{1/2} \cdot (ca_1 / (1[\text{in}]))^{1.5} [lb] =$   
 $(7 \cdot (152.4[\text{mm}] / 19.049999[\text{mm}]) 0.2 \cdot (19.049999[\text{mm}] / (1[\text{in}]))^{1/2} \cdot 1^* (0.027579[\text{KN/mm}^2] / (1[\text{psi}]))^{1/2} \cdot$   
 $(400[\text{mm}] / \text{Eq. D-24}$

$V_{cbg} = (AV_c / AV_{co}) \cdot \gamma_{ec,V} \cdot \gamma_{ed,V} \cdot \gamma_{c,V} \cdot \gamma_{h,V} \cdot V_b = (900000[\text{mm}^2] / 720000[\text{mm}^2]) \cdot 1^* 1^* 1^*$

$1.4 \cdot 1^* 161$ . Eq. D-22

HighSeismicDesignCategory ® False

$f_{Ncbg} = f^* N$  Sec. D.3.3.3

Pryout of a [KN] 482.52 0.5 1 - DC1 0 Eq. D-4,

### Sec. D.3.3.3

$\text{hef} < 2.5[\text{in}] \text{ ® } 300[\text{mm}] < 2.5[\text{in}] \text{ ® False}$

$k_{cp} = 2 \quad \text{Sec. D.6.3.1}$

$\text{ca1Left} < 1.5 * \text{hef} \text{ ® } 900[\text{mm}] < 1.5 * 300[\text{mm}] \text{ ® False}$

$\text{ca1Left} = 1 \text{ Sec. D.5.2.1}$

$\text{ca1Right} < 1.5 * \text{hef} \text{ ® } 600[\text{mm}] < 1.5 * 300[\text{mm}] \text{ ® False}$

$\text{ca1Right} = \text{Sec. D.5.2.1}$

$\text{ca2Top} < 1.5 * \text{hef} \text{ ® } 600[\text{mm}] < 1.5 * 300[\text{mm}] \text{ ® False}$

$\text{ca2Top} = 1 \text{ Sec. D.5.2.1}$

$\text{ca2Bot} < 1.5 * \text{hef} \text{ ® } 900[\text{mm}] < 1.5 * 300[\text{mm}] \text{ ® False}$

$\text{ca2Bot} = 1. \text{Sec. D.5.2.1}$

$\text{IsCloseToThreeEdges} \text{ ® False}$

$\text{hef} = \text{hef} = \text{Sec. D.5.2.3}$

$\text{ANc} = (\text{ca1Left} + \text{ca1Right}) * (\text{ca2Top} + \text{ca2Bot}) = (450[\text{mm}] + 450[\text{mm}]) * (450[\text{mm}] + 450[\text{mm}]) =$

$810000[\text{mm}^2] \text{ Sec. RD.5.2.1}$

$\text{ANco} = 9 * \text{Eq. D-6}$

$\text{ca, min} < 1.5 * \text{hef} \text{ ® } 600[\text{mm}] < 1.5 * 300[\text{mm}] \text{ ® False}$

$\text{yed, N} = 1 \quad \text{Sec. D.5.2.5}$

$\text{CrackedConcrete} \text{ ® False}$

$\text{yc, N} = 1.25 \text{ Sec. D.5.2.6}$

$\text{IsCastInPlaceAnchor} \text{ ® True}$

$\text{ycp, N} = 1 \quad \text{Sec. D.5.2.7}$

$\text{IsCastInPlaceAnchor} \text{ ® True}$

$k_c = 24 \quad \text{Sec. D.5.2.2}$

$(\text{IsCastInPlaceAnchor}) \text{ and } (\text{IsHeadedBolt}) \text{ and } (\text{hef} \geq 11[\text{in}]) \text{ and } (\text{hef} \leq 25[\text{in}]) \text{ ® } (\text{True}) \text{ and } (\text{True}) \text{ and } (300[\text{mm}] \geq$

$11[\text{in}]) \text{ and } (300[\text{mm}] \leq 25[\text{in}]) \text{ ® True}$

$\text{Nb} = 16 * \text{Eq. D-7} \text{ ® } (f_c / (1[\text{psi}]))^{1/2} * (\text{hef} / (1[\text{in}]))^{5/3} [\text{lb}] = 16 * 1 * (0.027579[\text{KN}/\text{mm}^2] / (1[\text{psi}]))^{1/2} *$

$(300[\text{mm}] / \text{Eq. D-7}$

$\text{Ncb} = (\text{ANc} / \text{ANco}) * \text{yed, N} * \text{yc, N} * \text{ycp, N} * \text{Nb} = (810000[\text{mm}^2] / 810000[\text{mm}^2]) * 1 * 1.25 * 1 *$

$275.73[\text{KN}] \text{ Eq. D-4}$

$\text{Vcp} = k_{cp} * \text{Eq. D-30}$

$\text{HighSeismicDesignCategory} \text{ ® False}$

$\text{fVcp} = f * \text{Vc Sec. D.3.3.3}$

Pryout of g [KN]	698.45	5 1 - DC1	0.01 Eq. D-5, Sec. D.3.3.3
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hef<2.5[in] ® 300[mm]<2.5[in] ® False  
 kcp = 2 Sec. D.6.3.1  
 ANco = 9\*† Eq. D-6  
 ANc = min( Sec. D.5.2.1  
 yec,Ny = m Eq. D-9  
 yec,Nx = m Eq. D-9  
 yec,N = yec Eq. D-9  
 ca,min<1.5\*hef ® 600[mm]<1.5\*300[mm] ® False  
 yed,N = 1 Sec. D.5.2.5  
 CrackedConcrete ® False  
 yc,N = 1.25 Sec. D.5.2.6  
 IsCastInPlaceAnchor ® True  
 ycp,N = 1 Sec. D.5.2.7  
 IsCastInPlaceAnchor ® True  
 kc = 24 Sec. D.5.2.2  
 (IsCastInPlaceAnchor)and(IsHeadedBolt)and(hef>=11[in])and(hef<=25[in]) ® (True)and(True)and(300[mm]>=11[in])and(300[mm]<=25[in]) ® True  
 Nb = 16\*†\*(fc/(1[psi]))1/2\*(hef/(1[in]))(5/3)[lb] = 16\*1\*(0.027579[KN/mm2]/(1[psi]))1/2\*(300[mm]/ Eq. D-7  
 Ncbg = (ANc/ANco)\*yec,N\*yed,N\*yc,N\*ycp,N\*Nb = (1420000[mm2]/810000[mm2])\*0.825688\*· Eq. D-5  
 Vcpg = kcp· Eq. D-31  
 HighSeismicDesignCategory ® False  
 fVcpg = f\*V Sec. D.3.3.3

Interaction of tensile a	1.2	0 1 - DC1	0 Eq. D-32
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(Nua>0.2\*fNn)and(Vua>0.2\*fVn) ® (13.008752[KN]>0.2\*67.069216[KN])and(3[KN]>0.2\*197.9[KN]) ® False  
 TensionShe Eq. D-32

Critical stre      0.63

Global criti      0.68

#### Biaxial analysis

Maximum compression and tension (1 - DC1)

Maximum  $\sigma$  :      0.00230 [KN/mm<sup>2</sup>]  
Minimum  $\sigma$  :      0.00230 [KN/mm<sup>2</sup>]  
Maximum  $\tau$  :      13.00875 [KN]  
Minimum  $\tau$  :      0.00000 [KN]  
Neutral axi :      -128.097  
Bearing len :      144.53865 [mm]

#### Anchors tensions

Anchor	Transverse [mm]	Longitudinal [mm]	Shear [KN]	Tension [KN]
1	150	50	0.42	1.84
2	150	150	0.42	4.15
3	150	-150	0.42	0
4	-150	50	0.42	10.69
5	-150	150	0.42	13.01
6	-150	-150	0.42	6.07
7	-150	-50	0.42	8.38
8	150	-50	0.42	0
9	50	150	0.42	7.11
10	50	-150	0.42	0.16

11	-50	-150	0.42	3.11
12	-50	150	0.42	10.06

#### Major axis anchor groups

Results for tensile breakout (1 - DC1)

Group	Area [mm2]	Tension [KN]	Anchors
1	1420000	64.59	1, 2, 4, 5, 6, 7, 9, 10, 11, 12

Results for shear breakout (1 - DC1)

Group	Area [mm2]	Shear [KN]	Anchors
1	900	2.5	1, 2, 4, 5, 9, 12
2	900	3.33	1, 2, 4, 5, 7, 8, 9, 12
3	900	1.67	2, 5, 9, 12
4	900	5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

#### Minor axis anchor groups

Results for tensile breakout (1 - DC1)

Group	Area	Tension	Anchors
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[mm<sup>2</sup>]      [kN]

1    1420000      64.59    1, 2, 4, 5, 6, 7, 9, 10, 11, 12

Results for shear breakout (1 - DC1)

Group	Area [mm <sup>2</sup> ]	Shear [kN]	Anchors
1	900	3	1, 2, 3, 8, 9, 10
2	900	4	1, 2, 3, 8, 9, 10, 11, 12
3	900	3.5	3, 4, 6, 7, 8, 10, 11
4	900	6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

#### NOTATION

Aw:      Effective area of the weld

A2/A1:    Ratio between the concrete support area and the base plate area

bc:      Width of column section

b<sub>eff</sub>:      Effective width of the compression block

B<sub>eff</sub>:      Controlling effective width

B<sub>min</sub>:    Minimum base plate width perpendicular to moment direction

C2:      Edge distance increment

c:	Distance to weld group
dc:	Column depth
D:	Number of sixteenths of an inch in the weld size
fa:	Axial stress on welds
fb:	Bending stress on welds
f'c:	Specified compressive strength of concrete
f:	Combined stress on welds
FEXX:	Electrode classification number
fp, max:	Maximum uniformly bearing stress under base plate
fv:	Vertical shear force on weld
Fw:	Nominal strength of the weld metal per unit area
Fy:	Specified minimum yield stress
I:	Inertia of weld group
L:	Distance from the anchor rod to the column
Lemin:	Minimum edge distance
L:	Length of weld



$L_{shear}$ : Length of weld receiving shear

$LoadAngle$ : 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 Maximum weld load

$e_{min}$ : Minimum edge distance

$n$ : Base plate bearing interface cantilever direction perpendicular to moment direction

$N_{min}$ : Minimum base plate length parallel to moment direction

$P$ : Required axial force

$f$ : Design factors

$fMn$ : Design or allowable strength per unit length

$f_{Rw}$ :	Fillet weld capacity per unit length
T:	Anchor rod tensile strength required
tp:	Plate thickness
q:	Load angle
V:	Shear load
w <sub>min</sub> :	Minimum weld size required
w:	Weld size
A <sub>brg</sub> :	Net bearing area of the head of stud or anchor bolt
A <sub>Nc</sub> :	Projected concrete failure area of a single anchor or group of anchors, for calculation of strength in tension
A <sub>Nco</sub> :	Projected concrete failure area of a single anchor, for calculation of strength in tension if not limited by edge distance or spacing
A <sub>se,N</sub> :	Effective cross-sectional area of anchor in tension
A <sub>se,V</sub> :	Effective cross-sectional area of anchor in shear
A <sub>Vc</sub> :	Projected concrete failure area of a single anchor or group of anchors , for calculation of strength in shear
A <sub>Vco</sub> :	Projected concrete failure area of a single anchor, for calculation of strength in shear, if not limited by corner influences, spacing, or member thickness
ca1:	Distance from the anchor center to the concrete edge
ca2:	Distance from the anchor center to the concrete edge in perpendicular direction

ca1Left: Distance from the anchor center to the left edge of the concrete base

ca1Right: Distance from the anchor center to the right edge of the concrete base

ca2Top: Distance from the anchor center to the top edge of the concrete base

ca2Bot: Distance from the anchor center to the bottom edge of the concrete base

ca,min: Minimum distance from center of an anchor shaft to the edge of concrete

CrackedC: Cracked concrete at service loads

da: 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

e'V: Resultant shear load on a group of anchors loaded in shear in the same direction, and the centroid of the group of anchors loaded in shear in the

futa: Specified tensile strength of anchor steel

fya: Specified yield strength of anchor steel

ha: Thickness of member in which an anchor is located, measured parallel to anchor axis

hef: Effective embedment depth of anchor

IsHeaded: Is anchor headed stud

kc: Coefficient for concrete pry out basic strength

kcp: Coefficient for pry out strength

n:	Number of anchors in the group
Nb:	Basic concrete breakout strength in tension of a single anchor in cracked concrete
Ncb:	Nominal concrete breakout strength in tension of a single anchor
Ncbg:	Nominal concrete breakout strength in tension of a group of anchors
Np:	Pullout strength in tension of a single anchor in cracked concrete
Npn:	Nominal pullout strength of a single anchor in tension
Nsb:	Nominal side-face blowout strength of a single anchor
Nua:	Factored tensile force applied to anchor or group of anchors
f:	Strength reduction factor
fNcb:	Concrete breakout strength in tension of a single anchor
fNcbg:	Concrete breakout strength in tension of a group of anchors
fNn:	Tension strength
fNpn:	Pullout strength in tension of a single anchor
fNsa:	Strength of a single anchor or group of anchors in tension
fNsb:	Side-face blowout strength of a single anchor
fVcp:	Concrete pryout strength of a single anchor

$f_{Vcpg}$ :	Concrete pryout strength of a group of anchors
$f_{Vn}$ :	Shear strength
$f_{Vsa}$ :	Strength in shear of a single anchor or group of anchors as governed by the steel strength
$\gamma_{c,N}$ :	Factor used to modify tensile strength of anchors based on presence or absence of cracks in concrete
$\gamma_{c,P}$ :	Factor used to modify pullout strength of anchors based on presence or absence of cracks in concrete
$\gamma_{cp,N}$ :	Factor used to modify tensile strength of postinstalled anchors intended for use in uncracked concrete without supplementary reinforcement
$\gamma_{c,V}$ :	Factor used to modify shear strength of anchors based on presence or absence of cracks in concrete and presence or absence of supplementary reinforcement
$\gamma_{ec,N}$ :	Factor used to modify tensile strength of anchors based on eccentricity of applied loads
$\gamma_{ec,V}$ :	Factor used to modify shear strength of anchors based on eccentricity of applied loads
$\gamma_{ed,N}$ :	Factor used to modify tensile strength of anchors based on proximity to edges of concrete member
$\gamma_{ed,V}$ :	Factor used to modify shear strength of anchors based on proximity to edges of concrete member
$\gamma_{h,V}$ :	Factor used to modify shear strength of anchors located in concrete members with $h_a < 1.5c_{a1}$
$s_{min}$ :	Center-to-center anchor minimum spacing
$TensionS_{tr}$ :	Result from tension-shear interaction
$V_b$ :	Basic concrete breakout strength in shear of a single anchor in cracked concrete
$V_{ua}$ :	Factored shear force applied to anchor or group of anchors

$f_c$ : Specified compressive strength of concrete

$l_e$ : Load-bearing length of the anchor for shear

HighSeisr: High seismic design category (i.e. C, D, E or F)

HasGroutI: Has grout pad

$\lambda$ : Lightweight concrete modification factor

IsCastInPl: Is cast in place anchor

IsCloseTo: Anchor is close to three or more edges

$V_{cbg}$ : Concrete nominal breakout strength in shear of a group of anchors

$V_{cp}$ : Nominal pryout strength of a anchor in shear

$V_{cpg}$ : Nominal pryout strength of a group of anchor in shear

$L_{Vc}$ : Projected concrete failure length of a single anchor or group of anchors , for calculation of strength in shear

$\gamma_{ec,Nx}$ : Factor used to modify tensile strength of anchors based on eccentricity in x axis of applied loads

$\gamma_{ec,Ny}$ : Factor used to modify tensile strength of anchors based on eccentricity in y axis of applied loads

SideFaceB: Side-face blowout apply