Stabil-loc Systems, LLC. - 2.875" O.D.

Adjustable Head Assembly (Bracket)
Capacity Calculations - Galvanized

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INCORPORATED

Client:	Stabil-loc Systems, LLC.
Job Number :	FC08472
Report Date:	3/21/2019 REV2

Adjustable Head Assembly (Bracket) Design Properties

Property	Value	
Product:	6x4 Angle	A36 Steel
Thickness (in):	0.375	SPECIFIED
Angle Length (in):	15	SPECIFIED
Yield Strength (ksi):	36	SPECIFIED MINIMUM
Ultimate Strength (ksi):	58	SPECIFIED MINIMUM

Design References
AISC 14th Edition, AISC 360-16, 2017 AC358, 2015 IBC

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Capacities Summary Table

Capacity Type	Capacity (kips)	Min Cover (in)	Controlling Factor
Compression - Added Plate	113.3	16.0	Total Capacity of Adjustable Head Assembly (Bracket) with Pipe Supports (Gusset Welds)
Compression - No Plate	113.3	19.0	Total Capacity of Adjustable Head Assembly (Bracket) with Pipe Supports (Gusset Welds)
Compression - No Plate (Alt. #1 Concrete Parameters)	32.7	8.0	Concrete Two-Way Shear (Punching Shear): **Note: This requires a 24" wide footing**
Compression - No Plate (Alt. #2 Concrete Parameters)	55.6	12.0	Concrete Two-Way Shear (Punching Shear): **Note: This requires a 24" wide footing**

Note: Capacities may be limited by shaft capacities.
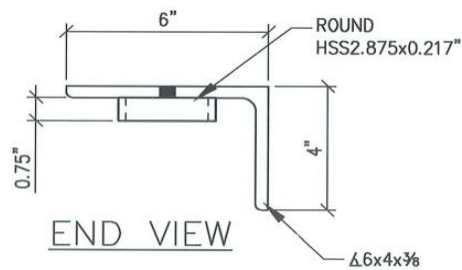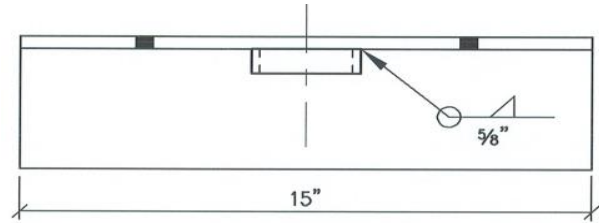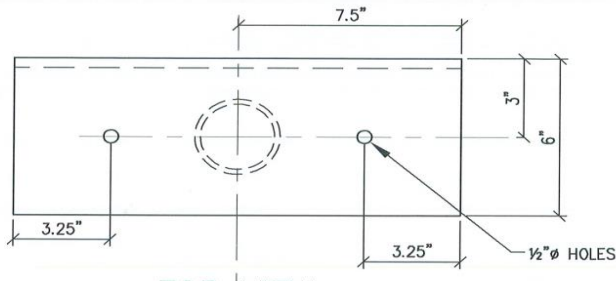
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By   **Date**

Reviewed By   **Date**

STABIL-LOC SYSTEMS, LLC.
OD2.875_ADJUSTABLE HEAD ASSEMBLY_GALVANIZED

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DIMENSIONS AND PROPERTIES

Known Head Assembly Angle Properties:

d =	6.00	Angle width (in)
b =	15.00	Angle length (in)
h =	4.00	Angle leg height (in)
t =	0.375	Angle thickness (in)
F_y =	36	Steel yield strength of angle (ksi)
F_u =	58	Steel tensile strength of angle (ksi)
t_g =	0.0034	Galvanized coating thickness (in) *[assumed min. AC358 3.9]*
t_c =	0.013	Corrosion loss (in) *[0.013 galv., 0.036 bare per AC358 3.9]*

Calculated Head Assembly Angle Properties: per AISC Table 17-27, page 17-36

d' =	5.994	Angle width with corrosion loss (in)
b' =	14.994	Angle length with corrosion loss (in)
b'_{eff} =	14.994	Effective angle length with corrosion loss (in)
h' =	3.997	Angle length with corrosion loss (in)
t' =	0.369	Angle thickness with corrosion loss (in)
A' =	89.870	Angle area with corrosion loss (in^2)
I' =	4.368	Moment of Inertia (per AutoCAD) with corrosion loss (in^2)
y' =	3.045	Distance from Neutral Axis (per AutoCAD) with corrosion loss (in^2)
S' =	1.434	Elastic Section Modulus (bracket top plate) with corrosion loss (in^2)

Known Allthread Properties:

D=	1.320	Diameter - Root of Allthread
F_u =	125.000	Steel tensile strength of allthread (ksi)
t_g =	0.003	Galvanized coating thickness (in) *[assumed min. AC358 3.9]*
t_c =	0.013	Corrosion loss (in) *[0.013 galv., 0.036 bare per AC358 3.9]*
E =	29000	Modulus of elasticity (ksi)

Calculated Allthread Properties: *per AISC Table 17-27, page 17-39*

D'=	1.221	Diameter with corrosion loss (in) - (7% reduction per AISC Part 1)

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DIMENSIONS AND PROPERTIES - CONT'D

Known Concrete Properties (No Plate):

X1 =	N/A	Bottom clear dist. (in)	*[Post-Contruction Application]*
X2 =	19.0	Top clear distance (in)	*[Assumed min.]*
c =	19.0	Side clear distance (in)	*[Min. 4" per IBC 1810.3.11]*
f_c' =	3,000	Concrete compressive strength (psi)	

Calculated Concrete Properties :

B =	44.0	Concrete width (in)

Known Concrete Properties (Added Plate):

X1 =	N/A	Bottom clear dist. (in)	*[Post-Contruction Application]*
X2 =	16.0	Top clear distance (in)	*[Assumed min.]*
c =	16.0	Side clear distance (in)	*[Min. 4" per IBC 1810.3.11]*
f_c' =	3,000	Concrete compressive strength (psi)	
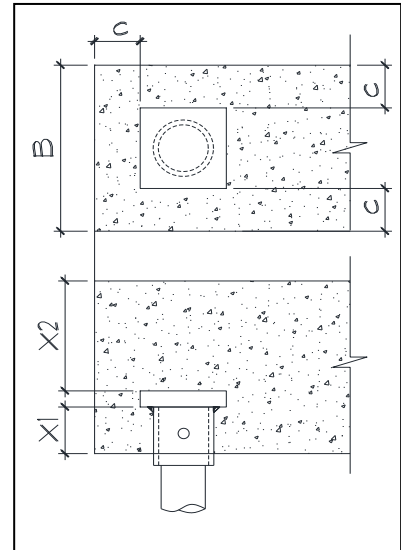
Calculated Concrete Properties :

B =	42.0	Concrete width (in)

*Note: Clear distances are to either a concrete edge or to reinforcement.

Known Head Assembly Sleeve Properties:

D=	3.500	Sleeve Diameter
M=	0.188	Sleeve Wall Thickness (in)
A=	8.500	Length of Sleeve (in)
F_y =	42	Steel yield strength of sleeve (ksi)
F_u =	58	Steel tensile strength of sleeve (ksi)
t_g =	0.0034	Galvanized coating thickness (in) *[assumed min. AC358 3.9]*
t_c =	0.013	Corrosion loss (in) *[0.013 galv., 0.036 bare per AC358 3.9]*
E =	29000	Modulus of elasticity (ksi)
D'=	3.494	Sleeve outer diameter with corrosion loss (in)
M'=	0.169	Sleeve wall thickness with corrosion loss (in) - (7% reduction per AISC pg. 1-5)

Known Head Assembly Gusset Plate Properties:

d =	6.00	Gusset length (in)
b =	5.00	Gusset depth (in)
t =	0.25	Gusset thickness (in)
F_y =	36	Steel yield strength of gusset (ksi)
F_u =	58	Steel tensile strength of gusset (ksi)
t_g =	0.0034	Galvanized coating thickness (in) *[assumed min. AC358 3.9]*
t_c =	0.013	Corrosion loss (in) *[0.013 galv., 0.036 bare per AC358 3.9]*
d' =	5.997	Gusset length with corrosion loss (in)
b' =	4.997	Gusset depth with corrosion loss (in)
M'=	0.244	Gusset thickness with corrosion loss (in)

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DIMENSIONS AND PROPERTIES - CONT'D

Note: Top plate may be added in the field between the footing and the adjustable head assembly angle.

Known Top Plate Properties:

d =	10.000	Top Plate width (in)
b =	20.000	Top Plate length (in)
t =	0.625	Top Plate thickness (in)
F_y =	36	Steel yield strength of plate (ksi)
F_u =	58	Steel tensile strength of plate(ksi)
t_g =	0.0034	Galvanized coating thickness (in) *[assumed min. AC358 3.9]*
t_c =	0.013	Corrosion loss (in) *[0.013 galv., 0.036 bare per AC358 3.9]*
E =	29000	Modulus of elasticity (ksi)
d' =	9.994	Plate width with corrosion loss (in)
b' =	19.994	Plate length with corrosion loss (in)
t' =	0.619	Top plate thickness with corrosion loss (in)

Known Weld Properties:

Size =	10	Weld size in 16th (in)
F_{EEX} =	70	Weld yield strength (ksi)

Known Shaft Tested Capacities:

P_s=	119.9	Max Allowable Shaft Compression Capacity (kips) - FROM TESTING
P_b=	96.9	Max Allowable Bracket Compression Capacity (kips) - FROM TESTING

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COMPRESSION CAPACITY - CONNECTION OF BRACKET TO STRUCTURE (NO PLATE)

ACI 318, Chapter 14, Section 14.5.5.1
Concrete Two-Way Shear (Punching Shear): $\phi = 0.60$

$$V_n = \left[\frac{4}{3} + \frac{8}{3\beta}\right]\sqrt{f_c'}\,b_o h \leq 2.66\sqrt{f_c'}\,b_o h \qquad \text{[ACI Table 14.5.5.1]}$$

β = ratio of long side to short side of top plate
β =   2.50

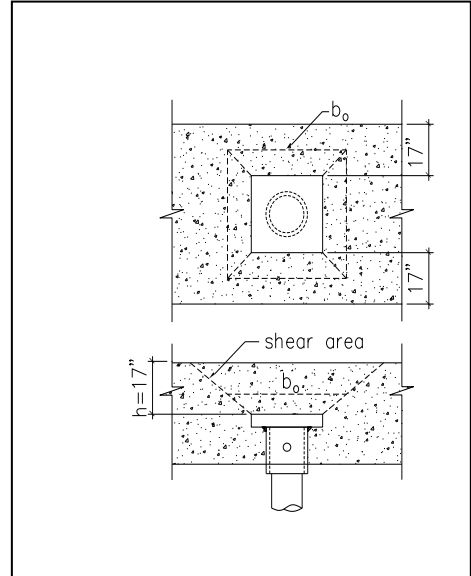b_o = shear perimeter = 2*(d'+17")+2*(b'+17")
b_o =   117.98 in

h = X2 =   19.0 in

V_n =   294.6 k

$$V' = 0.7 * \phi * V_n \qquad \text{[AC358 3.7.1.2]}$$

V' =   **123.72 k**

*Note: It is the designer's responsibility to check one way shear in concrete beam applications.

ACI 318, Chapter 14, Section 14.5.6.1
Concrete Bearing: $\phi = 0.60$

$$B_n = 0.85 * f_c' * A_1 \sqrt{\frac{A_2}{A_1}} \qquad \text{[ACI Table 14.5.6.1]} \qquad \text{Where:} \qquad \sqrt{\frac{A_2}{A_1}} \leq 2$$

A_1 = loaded area = Adjustable Head Assembly Angle Area
A_1 =   89.9 in^2

A_2 = projected area = (Adjustable Head Assembly Angle Width+17"*2)^2
A_2 =   2331.4 in^2

$$\sqrt{\frac{A_2}{A_1}} =   2.0$$

B_n =   458.3 k

$$B' = 0.7 * \phi * B_n \qquad \text{[AC358 3.7.1.2]}$$

B' =   **192.50 k**

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COMPRESSION CAPACITY - CONNECTION OF BRACKET TO STRUCTURE (ADDED PLATE)

ACI 318, Chapter 14, Section 14.5.5.1
Concrete Two-Way Shear (Punching Shear): $\phi = 0.60$

$$V_n = \left[\frac{4}{3} + \frac{8}{3\beta} \right] \sqrt{f_c'} \, b_o h \leq 2.66 \sqrt{f_c'} \, b_o h \qquad \text{[ACI Table 14.5.5.1]}$$

β = ratio of long side to short side of top plate

β =   2.00
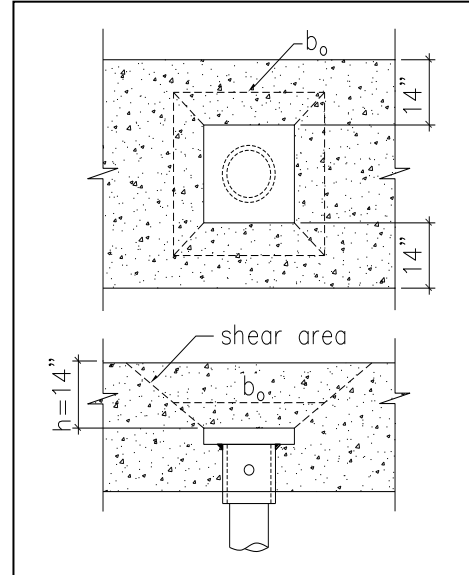
b_o = shear perimeter = 2*(d'+14")+2*(b'+14")

b_o =   123.98 in

h = X2 =   16.0 in

V_n =   289.0 k

$$V' = 0.7 * \phi * V_n \qquad \text{[AC358 3.7.1.2]}$$

V' =   **121.38 k**

*Note: It is the designer's responsibility to check one way shear in concrete beam applications.

ACI 318, Chapter 14, Section 14.5.6.1
Concrete Bearing: $\phi = 0.60$

$$B_n = 0.85 * f_c' * A_1 \sqrt{\frac{A_2}{A_1}} \qquad \text{[ACI Table 14.5.6.1]} \qquad \text{Where:} \qquad \sqrt{\frac{A_2}{A_1}} \leq 2$$

A_1 = loaded area = Adjustable Head Assembly Angle Area

A_1 =   199.8 in^2

A_2 = projected area = (Adjustable Head Assembly Angle Width+14"*2)^2

A_2 =   2183.4 in^2

$$\sqrt{\frac{A_2}{A_1}} = \qquad 2.0$$

B_n =   1019.1 k

$$B' = 0.7 * \phi * B_n \qquad \text{[AC358 3.7.1.2]}$$

B' =   **428.00 k**

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COMPRESSION CAPACITY - CONNECTION OF BRACKET TO STRUCTURE - CONT'D

AISC Section F10.1
Yielding of Adjustable Head Assembly Angle with No End Supports: $\Omega = 1.67$

$Mn = 1.5My$ where, $My = S*Fy$

$My =$ 51.63 k-in
$Mn =$ 77.45 k-in

$w = \dfrac{2Mn}{l^2}$ where, $l =$ 7.50 in (angle length/2)

$w =$ 2.76 k/in
$b' =$ 14.994 in (angle length)

$P = wb =$ 41.32 k

$\dfrac{Pn}{\Omega} =$ **24.74 k**   **GREATER CAPACITY ACHIEVED W/ END SUPPORTS**

AISC Page 14-4 to 14-6
Bending of Top Plate with No End Supports: $\Omega = 1.67$

$$\frac{P_n}{\Omega} = \frac{\left(\dfrac{t'}{l}\right)^2 F_y BN}{3.33}$$ *[AISC Page 14-6]*

B = d' =   9.99 in (top plate width)
N = b' =   19.99 in (top plate length)
D' =   1.221 in (all thread diameter)
t' =   0.619 in (top plate thickness with corrosion loss)
λ =   1 (page 14-5)

$l = \max(m, n, \lambda n')$ Where: $m = \dfrac{N - 0.95(D')}{2}$ $n = \dfrac{B - 0.8(D')}{2}$ $n' = \dfrac{\sqrt{(D')(D')}}{4}$

                                      m =   9.417   n =   4.508   n'=   0.305
l =   9.42 in

$\dfrac{P_n}{\Omega} =$ **9.33 k**

Total Capacity of Angle and Additional Top Plate: $\dfrac{P_n}{\Omega} =$ **34.07 k**   **GREATER CAPACITY ACHIEVED W/END SUPPORTS**

Note: Field cut-to-fit pipe supports are required at the ends of the angle, between the angle and head plate.

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COMPRESSION CAPACITY - INTERNAL STRENGTH OF BRACKET W/ PIPE SUPPORTS

Note: In order to prevent yielding of the adjustable head assembly angle due to bending, field cut-to-fit pipe supports must be installed on each side of the angle between the angle and the head assembly head plate. The pipe must be A500 steel with a minimum 2 3/8" diameter and have a minimum thickness of 3/16".

Note: Per AISC Section J2.2b, maximum weld size shall be not greater than the thickness of the material if material is less than 1/4" thick, or not greater than the material thickness minus 1/16" if material is greater than 1/4".

AISC Section J2.4

Welded Connection of Gusset Plate to Sleeve - Weld Metal: $\Omega = 2.0$

$$R_n = A_{we} F_{nw} \quad \text{[AISC Eq. J2-4]} \qquad \text{Where:} \qquad A_{we} = t_e L$$

material thickness=	0.188 "
weld size =	0.625 "
Max Weld =	0.188 "
t_e=	0.130 " (includes corrosion loss, one side of weld)
L=	4.997 " (gusset depth)
A_w=	0.649 in^2

$$F_{nw} = 0.60 F_{EXX} \left(1 + 0.5 \sin^{1.5}(\theta)\right) \qquad \text{[AISC Equation J2-5]} \qquad \theta = \qquad 90 \,°$$

F_w=	63 ksi
R_n=	40.87 k

$$\frac{R_n}{\Omega} = \qquad 20.43 \text{ k (each gusset plate)}$$

AISC Section J4.2

Welded Connection of Gusset to Sleeve - Base Metal:

Shear Yield- $\quad R_n = 0.6 F_y A_g \quad$ [AISC Equation J4-3]
$$\Omega = 1.50$$

Shear Rupture- $\quad R_n = 0.6 F_u A_{nv}$ [AISC Equation J4-4]
$$\Omega = 2.0$$

Sleeve:	A_g=	0.84 in^2		Sleeve:	A_g=	0.84 in^2
	R_n=	21.24 k			R_n=	29.33 k
Gusset:	A_g=	1.22 in^2		Gusset:	A_g=	1.22 in^2
	R_n=	26.31 k			R_n=	42.39 k

$$\frac{R_n}{\Omega} = \quad 14.16 \text{ k} \qquad\qquad\qquad \frac{R_n}{\Omega} = \quad 14.66 \text{ k}$$

$$\frac{R_n}{\Omega} = \quad 14.16 \text{ k} \qquad \text{[Min of above] - (each gusset plate)}$$

Total Capacity of Adjustable Head Assembly (Bracket) with Pipe Supports (Gusset Welds)

Bracket capacity at each end of the head assembly angle = capacity of 2 gusset plates=   28.31 kips

Assuming a uniform load across the top of the angle, the load at the center support = 2*each end support

Total Capacity of the Head Assembly (Bracket) =   113.26 kips   MECHANICAL FAILURE

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SUMMARY
For Concrete Capacity with End Supports and Added Top Plate:
Compression
113.3 k   **with $b_o h =$**   1983.60 in^2
Controlled by: **Total Capacity of Adjustable Head Assembly (Bracket) with Pipe Supports (Gusset Welds)**

For Concrete Capacity with End Supports and No Top Plate:
Compression
113.3 k   **with $b_o h =$**   2241.53 in^2
Controlled by: **Total Capacity of Adjustable Head Assembly (Bracket) with Pipe Supports (Gusset Welds)**

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ALTERNATE CONCRETE PARAMETERS - DIMENSIONS AND PROPERTIES

Concrete Properties Alt. #1 (No Plate):

$X1$ =	N/A	Bottom clear dist. (in)	*[Post-Contruction Application]*
$X2$ =	8.0	Top clear distance (in)	*[Assumed min.]*
c =	9.0	Side clear distance (in)	*[Min. 4" per IBC 1810.3.11]*
f_c' =	3,000	Concrete compressive strength (psi)	

Calculated Concrete Properties :

B =	24.0	Concrete width (in)

Concrete Properties Alt. #2 (Added Plate):

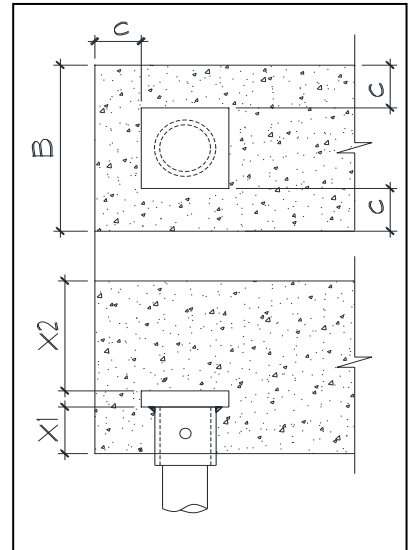|			
$X1$ =	N/A	Bottom clear dist. (in)	*[Post-Contruction Application]*
$X2$ =	12.0	Top clear distance (in)	*[Assumed min.]*
c =	9.0	Side clear distance (in)	*[Min. 4" per IBC 1810.3.11]*
f_c' =	3,000	Concrete compressive strength (psi)	

Calculated Concrete Properties :

B =	24.0	Concrete width (in)

*Note: Clear distances are to either a concrete edge or to reinforcement.

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ALT. #1 CONCRETE COMPRESSION CAPACITY - BRACKET TO STRUCTURE (NO PLATE)

ACI 318, Chapter 14, Section 14.5.5.1
Concrete Two-Way Shear (Punching Shear): $\phi = 0.60$

$$V_n = \left[\frac{4}{3} + \frac{8}{3\beta}\right]\sqrt{f_c'}\, b_o h \le 2.66\sqrt{f_c'}\, b_o h \qquad \text{[ACI Table 14.5.5.1]}$$

β = ratio of long side to short side of top plate
β =   2.50

b_o = shear perimeter = 2*(d'+8")+2*(b'+8")
b_o =   73.98 in

h = X2 =   8.0 in

V_n =   77.8 k

$$V' = 0.7 * \phi * V_n \quad \text{[AC358 3.7.1.2]}$$

V' =   **32.66 k**

*Note: It is the designer's responsibility to check one way shear in concrete beam applications.

ACI 318, Chapter 14, Section 14.5.6.1
Concrete Bearing: $\phi = 0.60$

$$B_n = 0.85 * f_c' * A_1 \sqrt{\frac{A_2}{A_1}} \qquad \text{[ACI Table 14.5.6.1]} \qquad \text{Where:} \qquad \sqrt{\frac{A_2}{A_1}} \le 2$$

A_1 = loaded area = Adjustable Head Assembly Angle Area
A_1 =   89.9 in^2

A_2 = projected area = (Adjustable Head Assembly Angle Width+17"*2)^2
A_2 =   681.7 in^2

$$\sqrt{\frac{A_2}{A_1}} = \qquad 2.0$$

B_n =   458.3 k

$$B' = 0.7 * \phi * B_n \qquad \text{[AC358 3.7.1.2]}$$

B' =   **192.50 k**

ALT. #2 CONCRETE COMPRESSION CAPACITY - BRACKET TO STRUCTURE (NO PLATE)

ACI 318, Chapter 14, Section 14.5.5.1
Concrete Two-Way Shear (Punching Shear): $\phi = 0.60$

$$V_n = \left[\frac{4}{3} + \frac{8}{3\beta}\right]\sqrt{f_c'}\, b_o h \le 2.66\sqrt{f_c'}\, b_o h \quad \text{[ACI Table 14.5.5.1]}$$

β = ratio of long side to short side of top plate

β =   2.50

b_o = shear perimeter = 2*(d'+9")+2*(b'+12")

b_o =   83.98 in

h = X2 =   12.0 in

V_n =   132.4 k

$$V' = 0.7 * \phi * V_n \quad \text{[AC358 3.7.1.2]}$$

V' =   **55.62 k**

*Note: It is the designer's responsibility to check one way shear in concrete beam applications.

ACI 318, Chapter 14, Section 14.5.6.1
Concrete Bearing: $\phi = 0.60$

$$B_n = 0.85 * f_c' * A_1\sqrt{\frac{A_2}{A_1}} \quad \text{[ACI Table 14.5.6.1]} \qquad \text{Where:} \qquad \sqrt{\frac{A_2}{A_1}} \le 2$$

A_1 = loaded area = Adjustable Head Assembly Angle Area

A_1 =   89.9 in^2

A_2 = projected area = (Adjustable Head Assembly Angle Width+14"*2)^2

A_2 =   989.6 in^2

$$\sqrt{\frac{A_2}{A_1}} = \qquad 2.0$$

B_n =   458.3 k

$$B' = 0.7 * \phi * B_n \quad \text{[AC358 3.7.1.2]}$$

B' =   **192.50 k**

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ALTERNATE CONCRETE PARAMETERS - SUMMARY
For Concrete Capacity with Alternate #1 Concrete Parameters:
Compression
32.7 k   **With footing width =**   **24.0 in.**   **and footing thickness =**   **8.0 in.**
Controlled by: **Concrete Two-Way Shear (Punching Shear):**

For Concrete Capacity with Alternate #2 Concrete Parameters:
Compression
55.6 k   **With footing width =**   **24.0 in.**   **and footing thickness =**   **12.0 in.**
Controlled by: **Concrete Two-Way Shear (Punching Shear):**