December 9, 2024

Mr. Anderson Bowers

Sign Structure Foundation Retrofit (Signs #30, #31A, & #31B)
Carolina Crossroads Phase 1
Richland County, SC
SCDOT Project No. P039719

Mr. Bowers,

United Infrastructure Group (UIG) Engineering has been tasked with designing foundation extensions and verifying the capacity of the above-mentioned overhead sign foundations after survey data shows that the top of footing elevations are below plan.

The proposed retrofit is to chip down the concrete to limits shown in attached sketches below the as-built top of pedestal/foundation elevation, splice same sized vertical bars to extend the reinforcing to the correct plan top of pedestal/foundation elevations, adjust and add hoop bars to match plan spacing, reset the anchor bolts to plan location, and finally pour back the concrete to the plan top of pedestal/foundation elevation with the approved 4,000 psi concrete mix.

After reviewing the original design of the sign structure foundations performed by Walpar, it has been determined that the extension of the cylindrical footing for OH-30 is OK by inspection as the side shear capacity will only increase with the increased length of the foundation and the moment in the foundation will not be increased.

UIG performed its own design calculations to confirm the adequacy of the spread footings for OH-31A and OH-31B with the pedestal extensions.

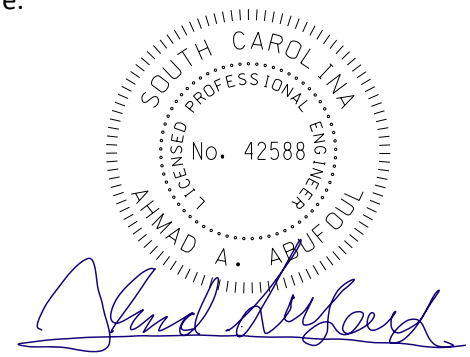
It was determined that OH-31A was adequate for the pedestal extension when accounting for the increased concrete strengths from cylinder breaks which indicated a minimum concrete compressive strength of 6,780 psi. 4,000 psi concrete was used for the design checks for conservatism since that is the strength of the proposed retrofit concrete mix.

OH-31B was determined to be adequate for the pedestal extension based off the original footing plans.

Please see the attached drawings highlighting the proposed retrofit procedure.

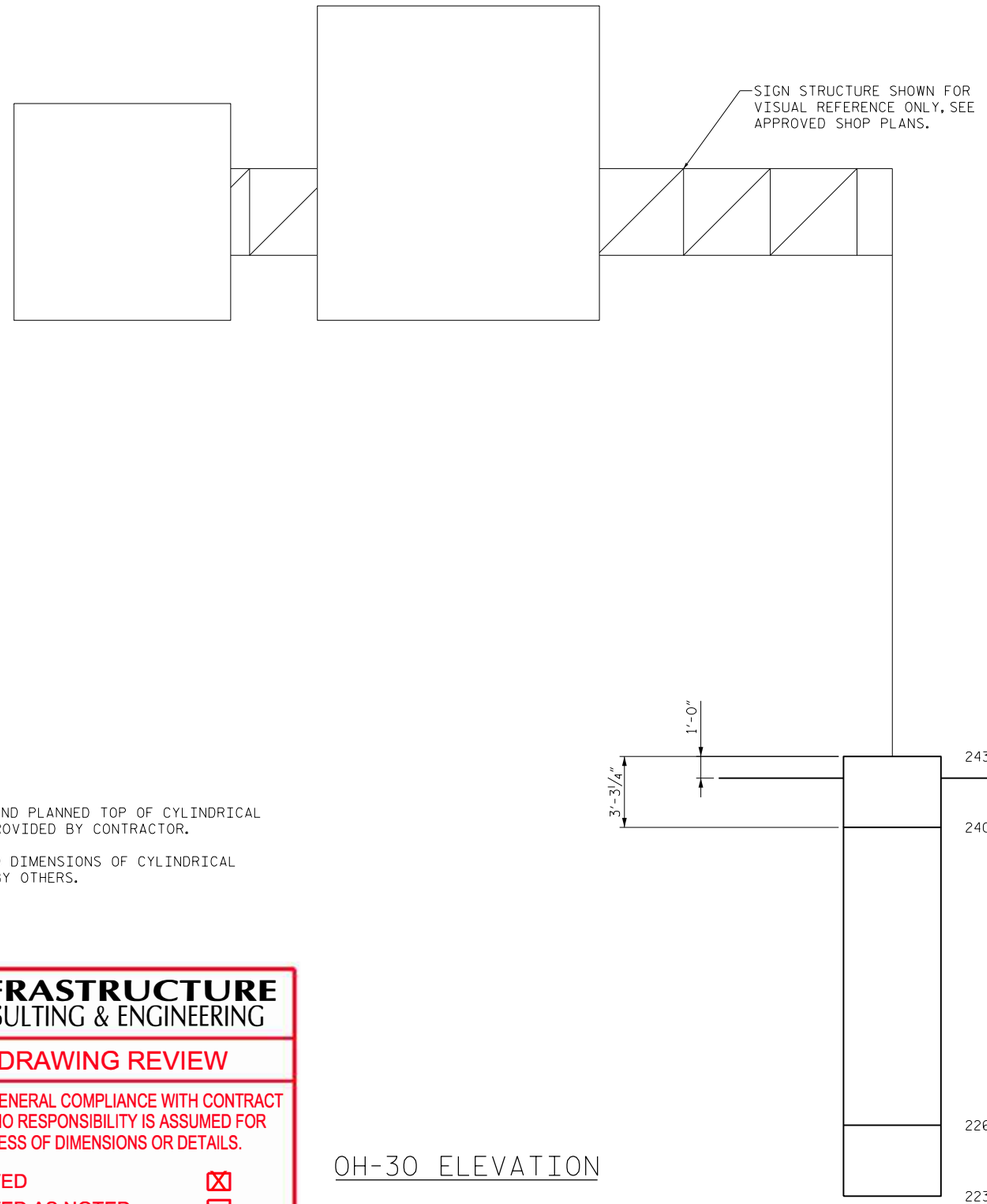
Feel free to reach out to me if you have any questions.

Thanks,



Date: 01/02/2025

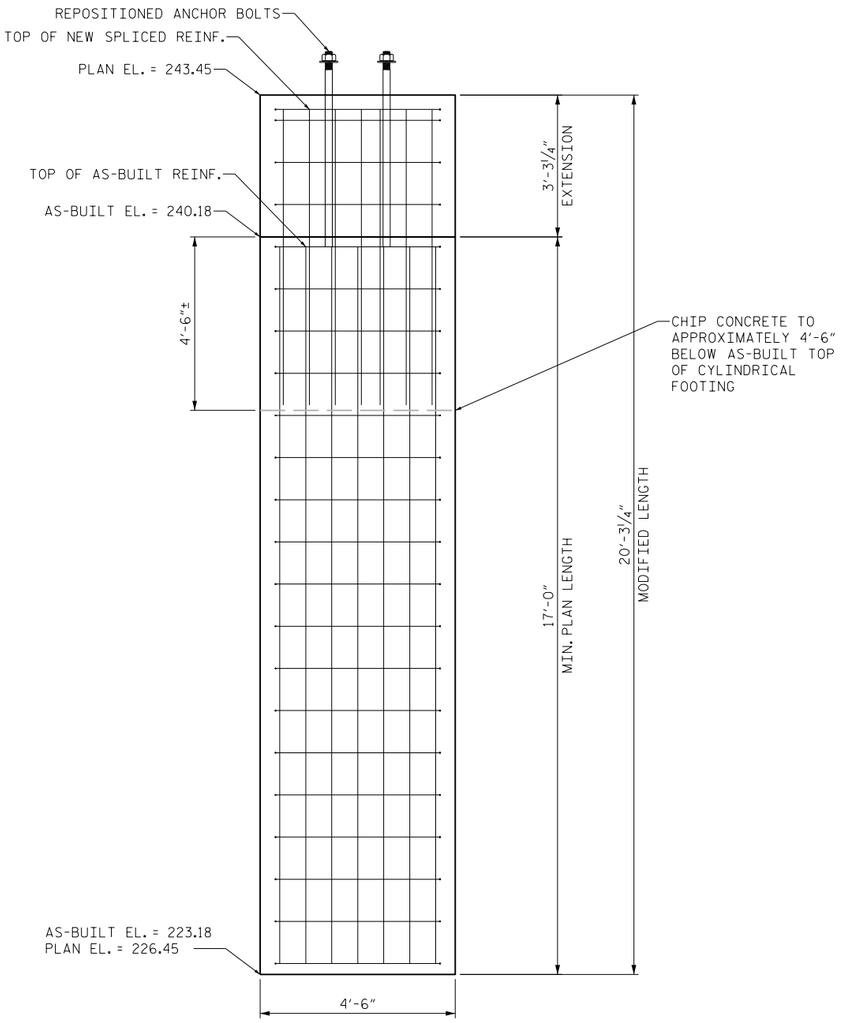
Ahmad Abufoul, PE
Construction Engineer
United Infrastructure Group, Inc.



OH-30 ELEVATION

NOTES:

1. AS-BUILT AND PLANNED TOP OF CYLINDRICAL FOOTING PROVIDED BY CONTRACTOR.
2. DESIGN AND DIMENSIONS OF CYLINDRICAL FOOTINGS BY OTHERS.



FOOTING 30 RETROFIT DETAIL

RETROFIT PROCEDURE:

1. CHIP DOWN CONCRETE TO APPROXIMATELY 4'-6" BELOW AS-BUILT TOP OF FOOTING (TO BELOW ANCHOR BOLTS).
2. REPOSITION REINFORCEMENT TO CORRECT LOCATIONS BASED OFF ORIGINAL PROJECT PLANS.
3. RESET ANCHOR BOLTS TO CORRECT ELEVATION. EXISTING ANCHOR BOLTS MAY BE REUSED AS LONG AS THEY ARE NOT DAMAGED WHILE THE CONCRETE IS BEING CHIPPED OUT.
4. POUR BACK 4,000 PSI DRILLED SHAFT MIX TO CORRECT TOP OF FOOTING ELEVATION.
5. MINIMUM SPLICE LENGTH FOR VERTICAL #10 BARS IS 48".

INFRASTRUCTURE CONSULTING & ENGINEERING

SHOP DRAWING REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS.

APPROVED	☒
APPROVED AS NOTED	☐
REVISE AND RESUBMIT	☐
REJECTED	☐

BY: PLC DATE: 1/13/25

UNITED INFRASTRUCTURE GROUP, INC.
5562 PENDERGRASS BLVD
GREAT FALLS, SC 29055
803-581-6000
www.uig.net

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 42588 LICENSED AHMAD A. ABUFOUL
Date: 01/02/2025

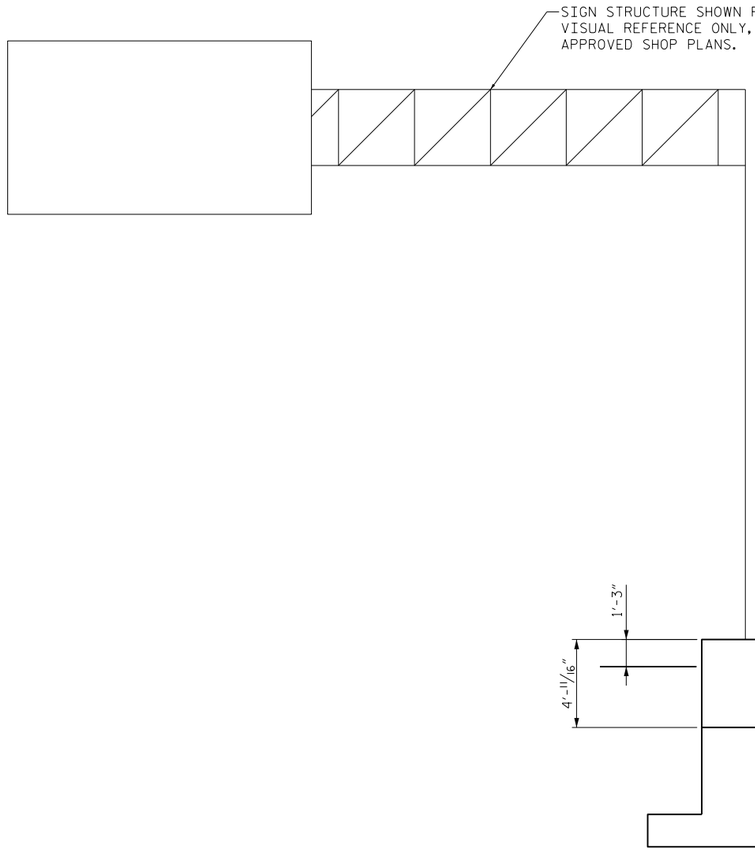
SIGN #30

CAROLINA CROSSROADS

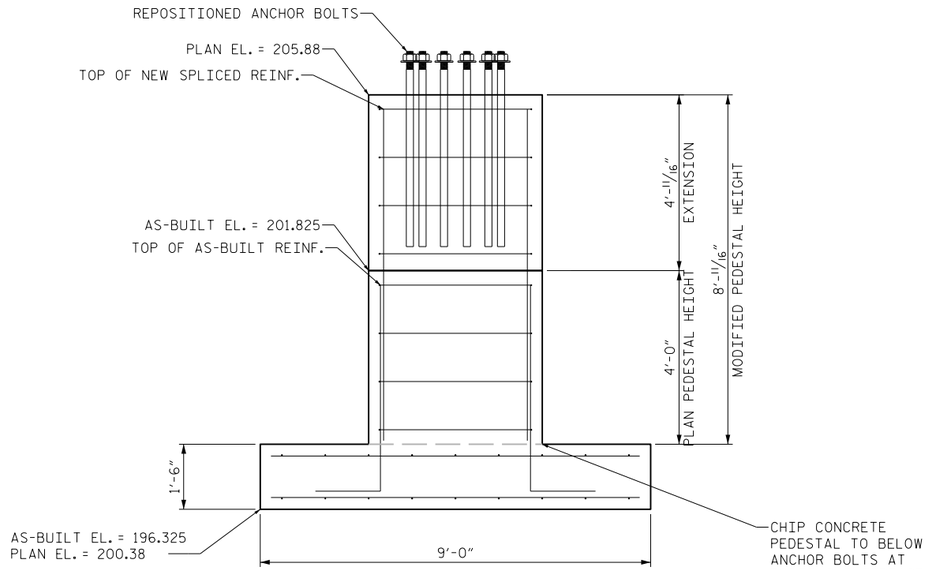
RICHLAND COUNTY, SC
SCDOT PROJECT NO: P039719 UIG PROJECT 2107

DES. BY :	CKD. BY :	DATE :	SCALE :	SHEET NO.:
AAA	SML	12/24	NONE	3 OF 5

$$USERNAME$$1/2/2025 C:\Users\AhmadAbufoul\Box\UIG-ENGR\2107 - CCR\Sign Structure Retrofit\CADD\Sign Structure.dgn



OH-31A ELEVATION



FOOTING 31A RETROFIT DETAIL

(END VIEW)

RETROFIT PROCEDURE:

1. CHIP DOWN CONCRETE TO THE INTERFACE BETWEEN THE FOOTING AND PEDESTAL (TO BELOW ANCHOR BOLTS).
2. REPOSITION REINFORCEMENT TO CORRECT LOCATIONS BASED OFF ORIGINAL PROJECT PLANS.
3. RESET ANCHOR BOLTS TO CORRECT ELEVATION.
4. POUR BACK 4,000 PSI DRILLED SHAFT MIX TO CORRECT TOP OF FOOTING ELEVATION.
5. MINIMUM SPLICE LENGTH OF VERTICAL #8 BARS IS 38".

INFRASTRUCTURE CONSULTING & ENGINEERING

SHOP DRAWING REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS.

APPROVED [X]
APPROVED AS NOTED [ ]
REVISE AND RESUBMIT [ ]
REJECTED [ ]

BY: PLC DATE: 1/13/25

UNITED INFRASTRUCTURE GROUP, INC.
5562 PENDERGRASS BLVD
GREAT FALLS, SC 29055
803-581-6000
www.uig.net

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 42588 AHMAD A. ABUFOUL
Date: 01/02/2025

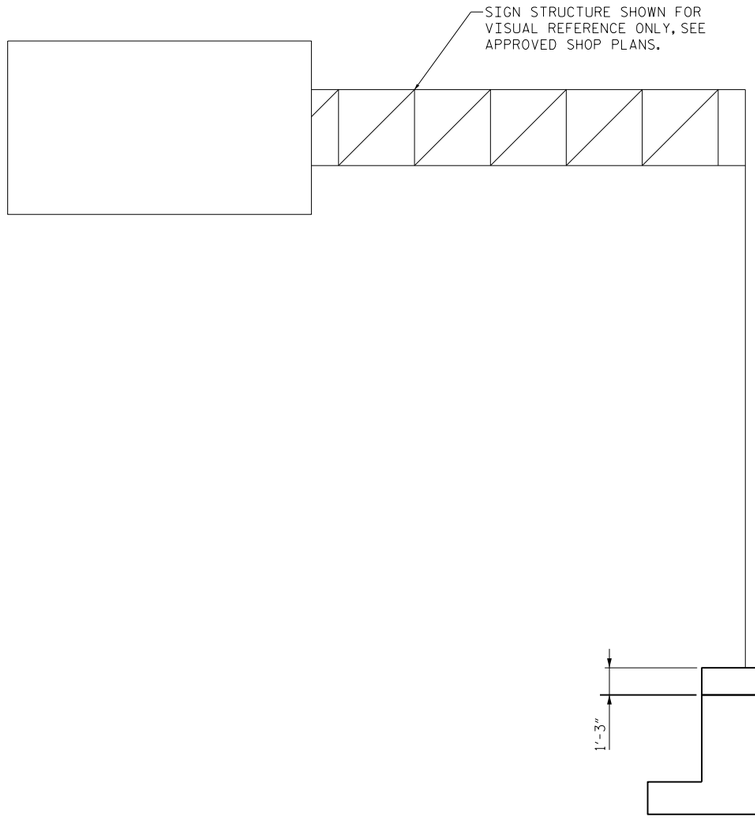
SIGN #31A

CAROLINA CROSSROADS

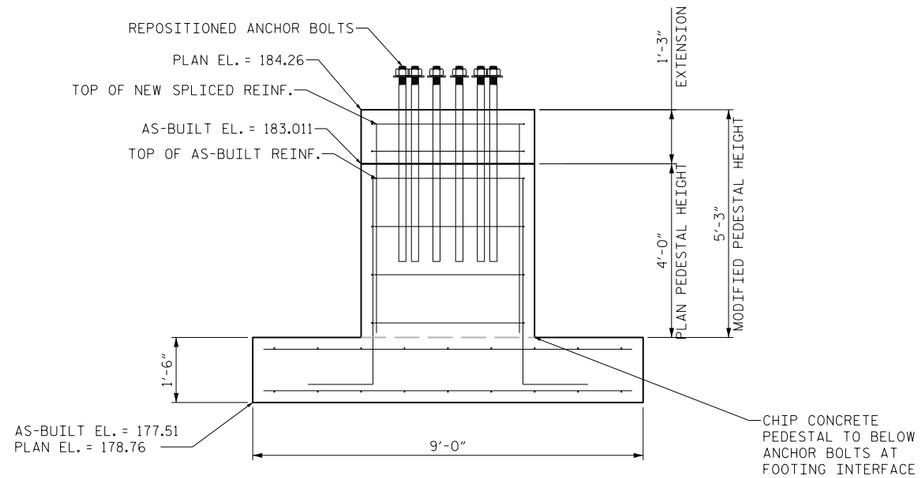
RICHLAND COUNTY, SC
SCDOT PROJECT NO: P039719 UIG PROJECT 2107

DES. BY :	CKD. BY :	DATE :	SCALE :	SHEET NO.:
AAA	SML	12/24	NONE	4 OF 5

$$USERNAME$$1/2/2025 G:\Users\AhmadAbufoul\Box\UIG-ENGR\2107 - CCR\Sign Structure Retrofit\CADD\Sign Structure.dgn



OH-31B ELEVATION



FOOTING 31B RETROFIT DETAIL

(END VIEW)

RETROFIT PROCEDURE:

1. CHIP DOWN CONCRETE TO THE INTERFACE BETWEEN THE FOOTING AND PEDESTAL (TO BELOW ANCHOR BOLTS).
2. REPOSITION REINFORCEMENT TO CORRECT LOCATIONS BASED OFF ORIGINAL PROJECT PLANS.
3. RESET ANCHOR BOLTS TO CORRECT ELEVATION.
4. POUR BACK 4,000 PSI DRILLED SHAFT MIX TO CORRECT TOP OF FOOTING ELEVATION.
5. MINIMUM SPLICE LENGTH OF VERTICAL #8 BARS IS 38".

INFRASTRUCTURE CONSULTING & ENGINEERING

SHOP DRAWING REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS.

APPROVED	☒
APPROVED AS NOTED	☐
REVISE AND RESUBMIT	☐
REJECTED	☐

BY: PLC DATE: 1/13/25

UNITED INFRASTRUCTURE GROUP, INC.
5562 PENDERGRASS BLVD
GREAT FALLS, SC 29055
803-581-6000
www.uig.net

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 42588 AHMAD A. ABUFOUL
Date: 01/02/2025

SIGN #31B

CAROLINA CROSSROADS

RICHLAND COUNTY, SC
SCDOT PROJECT NO: P039719 UIG PROJECT 2107

DES. BY :	CKD. BY :	DATE :	SCALE :	SHEET NO.:
AAA	SML	12/3	NONE	5 OF 5

$$USERNAME$$ 1/2/2025 C:\Users\AhmadAbufoul\Box\UIG-ENGR\2107 - CCR\Sign Structure Retrofit\CADD\Sign Structure.dgn

OH-31A Retrofit
Design Checks

INFRASTRUCTURE CONSULTING & ENGINEERING

SHOP DRAWING REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS.

APPROVED	☒
APPROVED AS NOTED	☐
REVISE AND RESUBMIT	☐
REJECTED	☐

BY: PLC DATE: 1/13/25

United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1			2107
PROJECT			JOB NO.
Foundation Design OH-31A			1 of 10
SUBJECT			SHEET
AAA	12/03/24	DLK	12/03/24
DESIGNED	DATE	CHECKED	DATE

Loads at top of pedestal from structure (from original Walpar calculations):

Axial Load (P) =	6.25	K
Moment (ML) =	116.45	K-ft.
Shear (VL) =	5.22	K
Moment (MW) =	99.84	K-ft.
Shear (VW) =	1.05	K

Dimensions:

Pad Length (L) =	17	ft.
Pad Width (W) =	9	ft.
Pad Thickness (T) =	1.5	ft.
Pedestal Width (PW) =	4	ft.
Pedestal Length (PL) =	4	ft.
Pedestal Projection at Ctr (PE) =	1.25	ft.
Ground line to top of pad (PT) =	6.805	ft.

Reinforcement:

Footing:		
X-Direction:		
Bar Size =	5	
Spacing =	12	in.
Y-Direction:		
Bar Size =	4	
Spacing =	12	in.
Pedestal:		
Number of bars =	32	
Bar Size =	8	

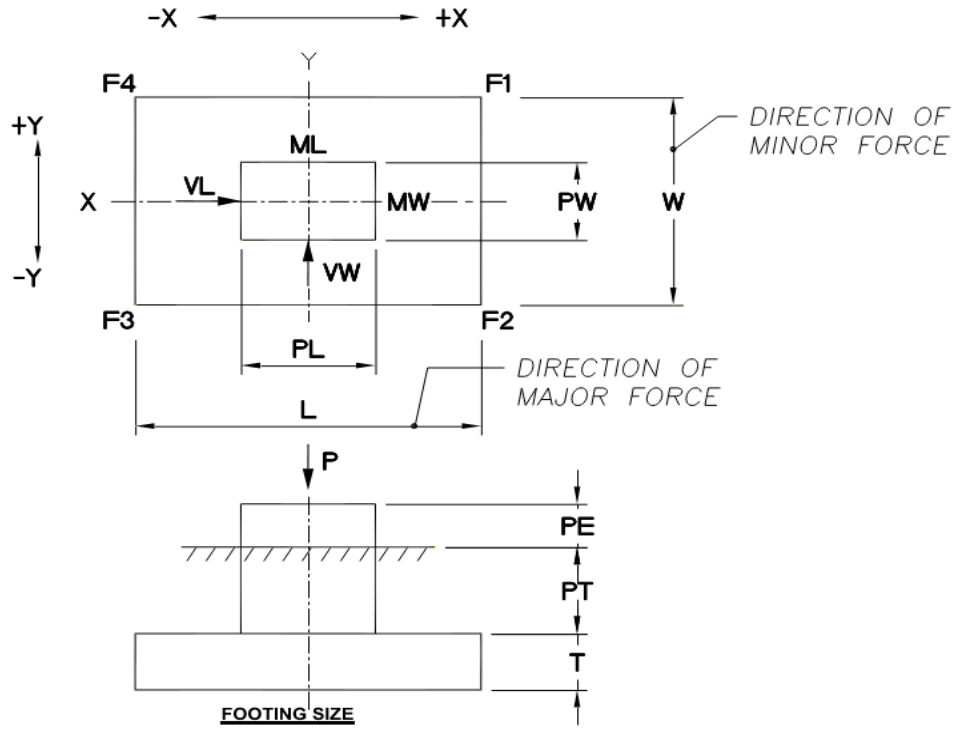
Material / Soil Specifications & Safety Factors

*Concrete f'c =	4,000	psi
Rebar yield fy =	60000	psi
Concrete weight =	150	pcf
Rebar Fs =	24000	psi
E =	29000000	psi
Soil bearing capacity =	2000	psf
Soil unit weight =	110	pcf
Load safety factor =	1.15	
d' =	4	in.
$n = \frac{E}{57{,}000\sqrt{f'c}} =$	8.04	

* Design concrete strength was 3,000 psi however concrete cylinder breaks returned an actual concrete strength of 6,780 psi. 4,000 psi concrete is proposed for the repairs, therefore is the value used for conservatism.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**2 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

Footing Corner Stresses:



Uncracked section (No Tension)

$$\mathrm{Fi} = \frac{Pt}{A} \pm \frac{Mx(y)}{Ix} \pm \frac{My(x)}{Iy}$$

Ps = weight of soil above pad = soil unit weight * (PT) *((L*W)-(PL*PW)) =	102.55	K
Pc = weight of concrete = (L*W*T)+(PW*PL*(PT+PE))*concrete weight / 1000 =	53.757	K
Pt = Total load = Ps+Pc+P =	162.56	K

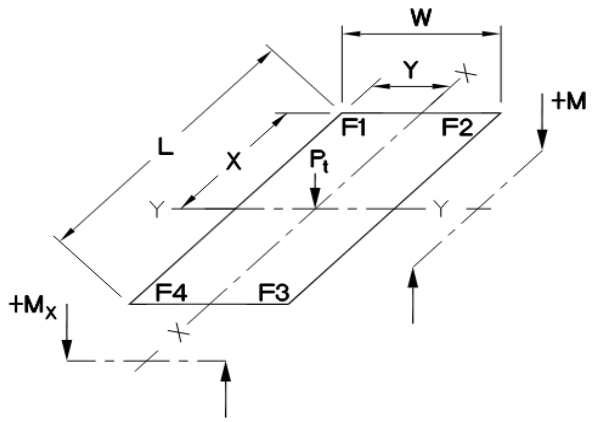
Unfactored Moments at botom of footing:

Mx = Mw + Vw(T+PT+PE) =	109.87	K-ft.
My = ML + VL (T+PT+PE) =	166.33	K-ft.

Factored Moments at botom of footing:

Mx = Load Safety Factor (Mw + Vw(T+PT+PE)) =	126.35	K-ft.
My = Load Safety Factor (ML + VL (T+PT+PE)) =	191.28	K-ft.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**3 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE



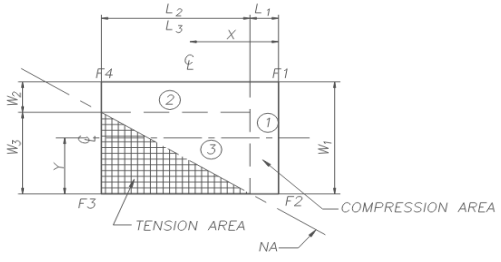
DESIGN MODEL AT BOTTOM OF FOOTING

Ix =	L*W^3/12	1032.75	ft^4
Iy =	W*L^3/12	3684.75	ft^4
A =	L*W	153	ft^2
x =	L/2	8.5	ft.
y =	W/2	4.5	ft.

	Factored	Unfactored
$F1 = \frac{Pt}{A} + \frac{Mx(y)}{Ix} + \frac{My(x)}{Iy} =$	2.05 ksf	1.92 ksf
$F2 = \frac{Pt}{A} - \frac{Mx(y)}{Ix} + \frac{My(x)}{Iy} =$	0.95 ksf	0.97 ksf
$F3 = \frac{Pt}{A} - \frac{Mx(y)}{Ix} - \frac{My(x)}{Iy} =$	0.07 ksf	0.20 ksf
$F4 = \frac{Pt}{A} + \frac{Mx(y)}{Ix} - \frac{My(x)}{Iy} =$	1.17 ksf	1.16 ksf

Cracked Section Analysis:

$$Fi = \frac{Pt}{A} \pm \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right] Y' \pm \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right] X'$$



STRESS DIAGRAM - F3 NEGATIVE
Cracked Section - Case 1
Stresses are calculated at bottom of footing

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**4 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

	Factored		Unfactored	
L1 =	15.83	ft.	14.09	ft.
L2 =	1.17	ft.	2.91	ft.
L3 =	1.17	ft.	2.91	ft.
W1 =	9.00	ft.	9.00	ft.
W2 =	8.49	ft.	7.67	ft.
W3 =	0.51	ft.	1.33	ft.
A1 =	142.44	ft.^2	126.78	ft.^2
A2 =	9.96	ft.^2	22.35	ft.^2
A3 =	0.30	ft.^2	1.93	ft.^2
A' =	152.70	ft.^2	151.07	ft.^2
X1 =	0.59	ft.	1.46	ft.
X2 =	-7.91	ft.	-7.04	ft.
X3 =	-7.72	ft.	-6.56	ft.
Y1 =	0	ft.	0	ft.
Y2 =	0.26	ft.	0.66	ft.
Y3 =	-4.16	ft.	-3.62	ft.
Xc =	0.02	ft.	0.10	ft.
Yc =	0.01	ft.	0.05	ft.
X' =	8.52	ft.	8.60	ft.
Y' =	4.51	ft.	4.55	ft.
Ix1 =	961.46	ft.^4	855.79	ft.^4
Ix2 =	59.80	ft.^4	109.69	ft.^4
Ix3 =	0.00	ft.^4	0.19	ft.^4
Iy1 =	2973.13	ft.^4	2096.64	ft.^4
Iy2 =	1.14	ft.^4	15.81	ft.^4
Iy3 =	0.02	ft.^4	0.91	ft.^4
Ixc =	1027.10	ft.^4	1000.35	ft.^4
Iyc =	3664.94	ft.^4	3572.95	ft.^4
Ixcyc =	-10.56	ft.^4	-59.56	ft.^4
Mxc =	126.35	K-ft.	109.87	K-ft.
Myc =	191.28	K-ft.	166.33	K-ft.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**5 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

$$F1 = \frac{Pt}{A} + \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' + \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

$$F2 = \frac{Pt}{A} - \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' + \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

$$F3 = \frac{Pt}{A} - \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' - \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

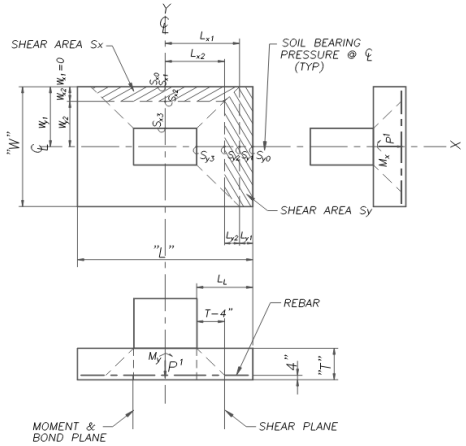
$$F4 = \frac{Pt}{A} + \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' - \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

	Factored	Unfactored
F1 =	2.07 ksf	1.99 ksf
F2 =	0.95 ksf	0.97 ksf
F3 =	0.06 ksf	0.13 ksf
F4 =	1.17 ksf	1.16 ksf

Footing Bearing Capacity:

ex = Mx/Ptotal = 0.68 ft.
ey = My/Ptotal = 1.02 ft.

Footing Shear and Moment:



FOOTING MOMENT AND SHEAR MODEL

Uniform weight of concrete and soil, Pcs = (T) (Wc) + (PT) (Ws)

UNITED INFRASTRUCTURE GROUP
United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1			2107
PROJECT			JOB NO.
Foundation Design OH-31A			6 of 10
SUBJECT			SHEET
AAA	12/03/24	DLK	12/03/24
DESIGNED	DATE	CHECKED	DATE

LL =	(L/2)-(PL/2) =	6.50	ft.
Lx1 =	(PL/2)+(WW) =	4.50	ft.
Lx2 =	(PL/2)+(Wy2-(PW/2)) =	3.17	ft.
Ly1 =	(L/2)-Lx1 =	4.00	ft.
Ly2 =	(L/2)-Lx2-Ly1 =	1.33	ft.
WW =	(W/2)-(PW/2) =	2.50	ft.
Wx1 =		0.00	ft.
Wx2 =	WW-(T-d') =	1.33	ft.
Wy1=	W/2 =	4.50	ft.
Wy2 =	Wy1-Wx2 =	3.17	ft.
sy0 (max.) =	(F1+F2)/2 =	1.51	Ksf
sy0 (min.) =	(F4+F3)/2 =	0.61	Ksf
sx0,sx1 (max.) =	(F1+F4)/2 =	1.62	Ksf
sx0,sx1 (min.) =	(F2+F3)/2	0.51	Ksf
sy1 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-ly1)	1.30	Ksf
sy2 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-ly1-ly2)	1.23	Ksf
Sy3 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-LL)	1.17	Ksf
Sx2 =	sx0(min)+((sx0(max)-(sx0(min))/W)*(W-Wx2)	1.45	Ksf
Sx3 =	sx0(min)+((sx0(max)-(sx0(min))/W)*(W-Ww)	1.31	Ksf
PCS =	T*Wc =	0.225	Ksf
DTSy =		**8.38**	**K/ft.**
DTSx =		**2.12**	**K/ft.**
Myy =		**27.14**	**K-ft./ft.**
Mxx =		**4.36**	**K-ft./ft.**

b =	12	in.	
d =	14	in.	
x =	5.25	in.	
n =	8.04		
fcr = (0.4)(f'c)(1.33) =	2128	psi	
$vc = (0.95\sqrt{f'c})(1.33) =$	79.91	psi	

	About Y-axis		About X-axis	
Ms = Myy or Mxx =	27.14	K-ft/ft.	4.36	K-ft/ft.
Vs = DTSy or DTSx =	8.38	K/ft.	2.12	K/ft.
Ast provided =	0.31	in.^2/ft.	0.2	in.^2/ft.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**8 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

$\text{Idmin} = \frac{(0.05)(db)(Fy)}{\sqrt{f'c}} =$	47.43 in.	29.65 in.
$\text{p} = \frac{Ast}{bd} =$	0.0018	0.0012
$\text{k} = \sqrt{2np - (np)^2} - np =$	0.1568	0.1285
$\text{j} = 1 - \frac{k}{3} =$	0.948	0.957

Actual stresses:

$\text{fca} = \frac{12(Ms)}{(b)(k)(j)(d)^2(0.5)} =$	**1863.74 psi** **fca<fcr** **OK**	**361.58 psi** **fca<fcr** **OK**
$\text{vca} = \frac{Vs}{(b)(j)(d)} =$	**52.65 psi** **vc<vca** **OK**	**13.17 psi** **vca<vc** **OK**

Overturning:

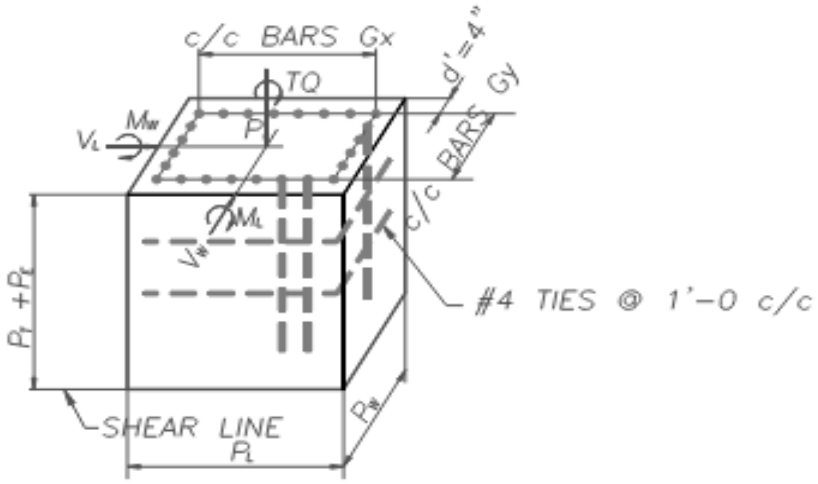
Overturning moment = Mx	109.87 K-ft.
Restoring moment = Pt*L/2	1381.75 K-ft.
Factor of safety against overturning =	**12.58**

Sliding:

Sliding friction coefficient =	0.4
Lateral force =	5.22 K
Ls (equivalent static load) =	10.00 K
Driving force =	15.22 K
Resisting force = Pt*sliding friction coefficient =	65.02 K
Factor of safety against sliding =	**4.27**

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31A SUBJECT			**9 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

Pedestal Design:



Moments at base:

My = ML + VL(PT+PE) =	**158.50**	**K-ft.**
Mx = MW + VW(PT+PE) =	**108.30**	**K-ft.**

Shear at base (acting on rebar only):

$\mathbf{V1} = \sqrt{\mathbf{VL^2} + \mathbf{VW^2}} =$	**5.32**	**K**
$\mathbf{V2} = \frac{\boldsymbol{TQ}}{\boldsymbol{Gx}} + \frac{\boldsymbol{TQ}}{\boldsymbol{Gy}} =$	**0**	
VT = V1 + V2 =	**5.32**	**K**

Combined Stress Ratio:

$$\text{CSR} = (\frac{fv}{Fv})^2 + \frac{fa}{Fa} + \frac{fbx}{Fbx} + \frac{fby}{Fby} \leq 1.0$$

Allowable stress (increased by 33%):

Fv = (0.33)(Fy)(1.33) =	**26334.00**	**psi**
Fa = Fbx = Fby = (0.4)(f'c)(1.33) =	**2128.00**	**psi**

Actual stress:

$\mathbf{fv} = \frac{\boldsymbol{Vt}}{\boldsymbol{Ast}} =$	**210.62**	**psi**
Ast = area of reinforcement used =	25.3	in^2

United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1 (PROJECT)			2107 (JOB NO.)
Foundation Design OH-31A (SUBJECT)			10 of 10 (SHEET)
AAA (DESIGNED)	12/03/24 (DATE)	DLK (CHECKED)	12/03/24 (DATE)

$$\mathbf{fa} = \frac{\boldsymbol{P}}{\boldsymbol{Ag}} = \quad \mathbf{2.71\ psi}$$

Ag = gross area of pedestal (PW*PL)*144 = 2304 in^2

$$\mathbf{fbx} = \frac{(\boldsymbol{Mx})(\boldsymbol{Cx})}{\boldsymbol{Ix}} = \quad \mathbf{56.62\ psi}$$

Cx = PL/2 = 24 in.

$$\mathrm{Ix} = \frac{(PW)(PL)^3}{12} + \frac{(2n)(Ast)(Gx)^2}{6} = \quad 550{,}828 \text{ in^4}$$

Gx = PL - 2*d' = 40 in.

$$\mathbf{fby} = \frac{(\boldsymbol{My})(\boldsymbol{Cy})}{\boldsymbol{Iy}} = \quad \mathbf{82.87\ psi}$$

Cy = Pw/2 = 24 in.

$$\mathrm{Iy} = \frac{(PL)(PW)^3}{12} + \frac{(2n)(Ast)(Gy)^2}{6} = \quad 550{,}828 \text{ in^4}$$

Gy = Pw - 2*d' = 40 in.

$$\mathbf{CSR} = (\frac{\boldsymbol{fv}}{\boldsymbol{Fv}})^2 + \frac{\boldsymbol{fa}}{\boldsymbol{Fa}} + \frac{\boldsymbol{fbx}}{\boldsymbol{Fbx}} + \frac{\boldsymbol{fby}}{\boldsymbol{Fby}} \leq \mathbf{1.0} = \quad \mathbf{0.07\ OK}$$

Since the pedestal is almost in pure bending (P load is negligible), the following stress ratio must be used.

$$\mathrm{CSM} = \frac{Mx}{Mox} + \frac{My}{Moy} \leq 1.0$$

Mox = (0.40)(As)(Fy)(1.33)(PW-2d') = 672,448 Lb-ft.
Moy = (0.4)(As)(Fy)(1.33)(PL-2d') = 672,448 lb-ft.

As = tension steel = Ast/4 = 6.32 in.^2

$$\mathbf{CSM} = \frac{\boldsymbol{Mx}}{\boldsymbol{Mox}} + \frac{\boldsymbol{My}}{\boldsymbol{Moy}} \leq \mathbf{1.0} = \quad \mathbf{0.40\ OK}$$

Pedestal is adquate in moment and shear

OH-31B Retrofit
Design Checks

INFRASTRUCTURE CONSULTING & ENGINEERING

SHOP DRAWING REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OR DETAILS.

APPROVED	☒
APPROVED AS NOTED	☐
REVISE AND RESUBMIT	☐
REJECTED	☐

BY: PLC DATE: 1/13/25

United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1			2107
PROJECT			JOB NO.
Foundation Design OH-31B			1 of 10
SUBJECT			SHEET
AAA	12/03/24	DLK	12/03/24
DESIGNED	DATE	CHECKED	DATE

Loads at top of pedestal from structure (from original Walpar calculations):

Axial Load (P) =	6.37	K
Moment (ML) =	130.96	K-ft.
Shear (VL) =	5.69	K
Moment (MW) =	102.77	K-ft.
Shear (VW) =	1.12	K

Dimensions:

Pad Length (L) =	17	ft.
Pad Width (W) =	9	ft.
Pad Thickness (T) =	1.5	ft.
Pedestal Width (PW) =	4	ft.
Pedestal Length (PL) =	4	ft.
Pedestal Projection at Ctr (PE) =	1.25	ft.
Ground line to top of pad (PT) =	4	ft.

Reinforcement:

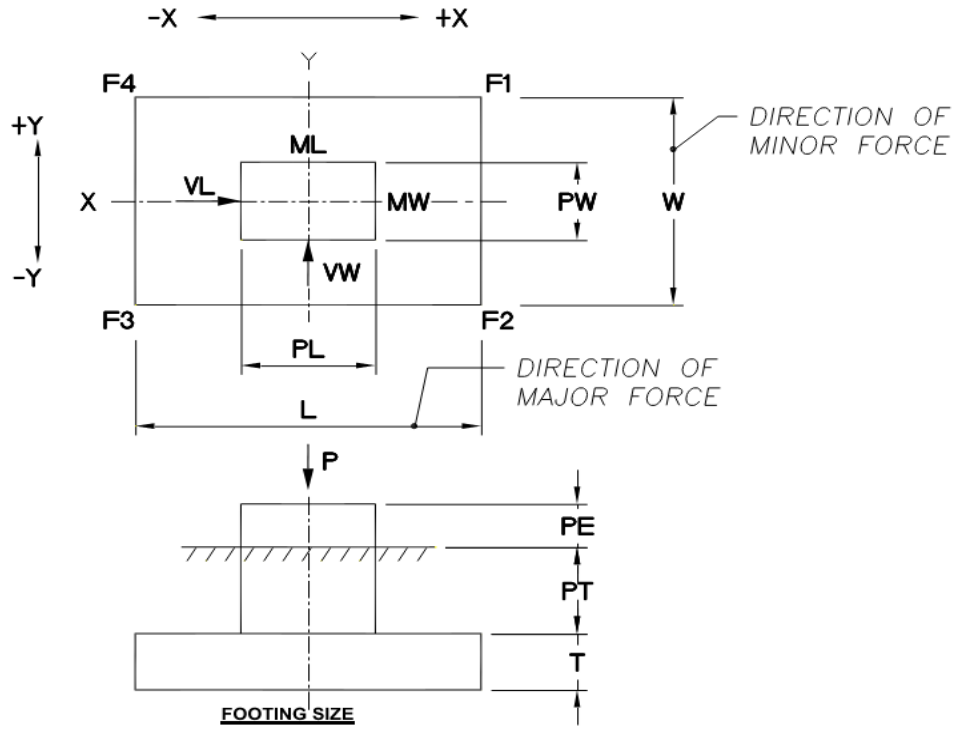
Footing:		
X-Direction:		
Bar Size =	5	
Spacing =	12	in.
Y-Direction:		
Bar Size =	4	
Spacing =	12	in.
Pedestal:		
Number of bars =	32	
Bar Size =	8	

Material / Soil Specifications & Safety Factors

Concrete f'c =	3000	psi
Rebar yield fy =	60000	psi
Concrete weight =	150	pcf
Rebar Fs =	24000	psi
E =	29000000	psi
Soil bearing capacity =	2000	psf
Soil unit weight =	110	pcf
Load safety factor =	1.15	
d' =	4	in.
$n = \frac{E}{57{,}000\sqrt{f'c}} =$	9.29	

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	Carolina Cross Roads Phase 1 PROJECT			2107 JOB NO.
	Foundation Design OH-31B SUBJECT			2 of 10 SHEET
	AAA DESIGNED	12/03/24 DATE	DLK CHECKED	12/03/24 DATE

Footing Corner Stresses:



Uncracked section (No Tension)

$$\mathrm{Fi} = \frac{Pt}{A} \pm \frac{Mx(y)}{Ix} \pm \frac{My(x)}{Iy}$$

Ps = weight of soil above pad = soil unit weight * (PT) *((L*W)-(PL*PW)) =	60.28	K
Pc = weight of concrete = (L*W*T)+(PW*PL*(PT+PE))*concrete weight / 1000 =	47.025	K
Pt = Total load = Ps+Pc+P =	113.68	K

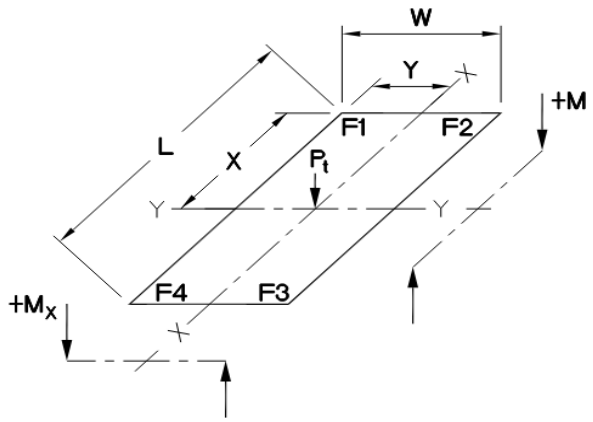
Unfactored Moments at botom of footing:

Mx = Mw + Vw(T+PT+PE) =	110.33	K-ft.
My = ML + VL (T+PT+PE) =	169.37	K-ft.

Factored Moments at botom of footing:

Mx = Load Safety Factor (Mw + Vw(T+PT+PE)) =	126.88	K-ft.
My = Load Safety Factor (ML + VL (T+PT+PE)) =	194.77	K-ft.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	Carolina Cross Roads Phase 1 PROJECT			2107 JOB NO.
	Foundation Design OH-31B SUBJECT			3 of 10 SHEET
	AAA DESIGNED	12/03/24 DATE	DLK CHECKED	12/03/24 DATE



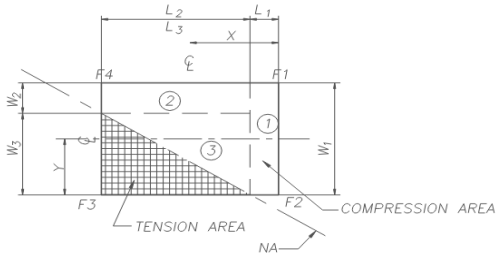
DESIGN MODEL AT BOTTOM OF FOOTING

Ix =	L*W^3/12	1032.75	ft^4
Iy =	W*L^3/12	3684.75	ft^4
A =	L*W	153	ft^2
x =	L/2	8.5	ft.
y =	W/2	4.5	ft.

	Factored	Unfactored
$F1 = \frac{Pt}{A} + \frac{Mx(y)}{Ix} + \frac{My(x)}{Iy} =$	1.75 ksf	1.61 ksf
$F2 = \frac{Pt}{A} - \frac{Mx(y)}{Ix} + \frac{My(x)}{Iy} =$	0.64 ksf	0.65 ksf
$F3 = \frac{Pt}{A} - \frac{Mx(y)}{Ix} - \frac{My(x)}{Iy} =$	-0.26 ksf	-0.13 ksf
$F4 = \frac{Pt}{A} + \frac{Mx(y)}{Ix} - \frac{My(x)}{Iy} =$	0.85 ksf	0.83 ksf

Cracked Section Analysis:

$$Fi = \frac{Pt}{A} \pm \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right] Y' \pm \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right] X'$$



STRESS DIAGRAM - F3 NEGATIVE
Cracked Section - Case 1
Stresses are calculated at bottom of footing

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	Carolina Cross Roads Phase 1 PROJECT			2107 JOB NO.
	Foundation Design OH-31B SUBJECT			4 of 10 SHEET
	AAA DESIGNED	12/03/24 DATE	DLK CHECKED	12/03/24 DATE

	Factored		Unfactored	
L1 =	12.10	ft.	14.21	ft.
L2 =	4.90	ft.	2.79	ft.
L3 =	4.90	ft.	2.79	ft.
W1 =	9.00	ft.	9.00	ft.
W2 =	6.89	ft.	7.80	ft.
W3 =	2.11	ft.	1.20	ft.
A1 =	108.87	ft.^2	127.85	ft.^2
A2 =	33.79	ft.^2	21.79	ft.^2
A3 =	5.17	ft.^2	1.68	ft.^2
A' =	147.83	ft.^2	151.32	ft.^2
X1 =	2.45	ft.	1.40	ft.
X2 =	-6.05	ft.	-7.10	ft.
X3 =	-5.23	ft.	-6.64	ft.
Y1 =	0	ft.	0	ft.
Y2 =	1.05	ft.	0.60	ft.
Y3 =	-3.09	ft.	-3.70	ft.
Xc =	0.24	ft.	0.08	ft.
Yc =	0.13	ft.	0.05	ft.
X' =	8.74	ft.	8.58	ft.
Y' =	4.63	ft.	4.55	ft.
Ix1 =	734.88	ft.^4	862.96	ft.^4
Ix2 =	133.67	ft.^4	110.42	ft.^4
Ix3 =	1.28	ft.^4	0.13	ft.^4
Iy1 =	1327.61	ft.^4	2149.79	ft.^4
Iy2 =	67.69	ft.^4	14.19	ft.^4
Iy3 =	6.91	ft.^4	0.73	ft.^4
Ixc =	954.31	ft.^4	1004.07	ft.^4
Iyc =	3425.52	ft.^4	3586.70	ft.^4
Ixcyc =	-138.05	ft.^4	-52.56	ft.^4
Mxc =	126.88	K-ft.	110.33	K-ft.
Myc =	194.77	K-ft.	169.37	K-ft.

United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1 PROJECT			**2107** JOB NO.
Foundation Design OH-31B SUBJECT			**5 of 10** SHEET
AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

$$F1 = \frac{Pt}{A} + \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' + \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

$$F2 = \frac{Pt}{A} - \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' + \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

$$F3 = \frac{Pt}{A} - \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' - \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

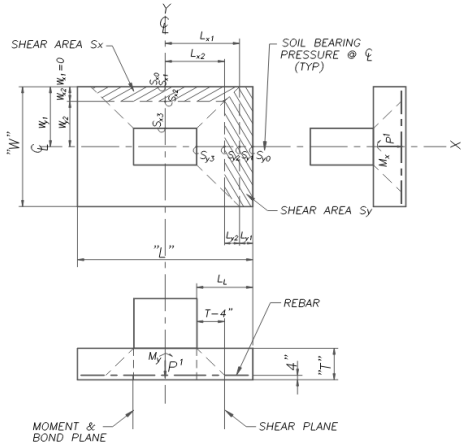
$$F4 = \frac{Pt}{A} + \left[\frac{Mxc - Myc\left(\frac{Ixcyc}{Iyc}\right)}{Ixc - \frac{Ixcyc^2}{Iyc}}\right]Y' - \left[\frac{Myc - Mxc\left(\frac{Ixcyc}{Ixc}\right)}{Iyc - \frac{Ixcyc^2}{Ixc}}\right]X'$$

	Factored		Unfactored	
F1 =	1.95	ksf	1.67	ksf
F2 =	0.63	ksf	0.65	ksf
F3 =	-0.46	ksf	-0.19	ksf
F4 =	0.85	ksf	0.83	ksf

Footing Bearing Capacity:

ex = Mx/Ptotal = 0.97 ft.
ey = My/Ptotal = 1.49 ft.

Footing Shear and Moment:



FOOTING MOMENT AND SHEAR MODEL

Uniform weight of concrete and soil, Pcs = (T) (Wc) + (PT) (Ws)

UNITED INFRASTRUCTURE GROUP
United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1			2107
PROJECT			JOB NO.
Foundation Design OH-31B			6 of 10
SUBJECT			SHEET
AAA	12/03/24	DLK	12/03/24
DESIGNED	DATE	CHECKED	DATE

LL =	(L/2)-(PL/2) =	6.50	ft.
Lx1 =	(PL/2)+(WW) =	4.50	ft.
Lx2 =	(PL/2)+(Wy2-(PW/2)) =	3.17	ft.
Ly1 =	(L/2)-Lx1 =	4.00	ft.
Ly2 =	(L/2)-Lx2-Ly1 =	1.33	ft.
WW =	(W/2)-(PW/2) =	2.50	ft.
Wx1 =		0.00	ft.
Wx2 =	WW-(T-d') =	1.33	ft.
Wy1=	W/2 =	4.50	ft.
Wy2 =	Wy1-Wx2 =	3.17	ft.
sy0 (max.) =	(F1+F2)/2 =	1.29	Ksf
sy0 (min.) =	(F4+F3)/2 =	0.20	Ksf
sx0,sx1 (max.) =	(F1+F4)/2 =	1.40	Ksf
sx0,sx1 (min.) =	(F2+F3)/2	0.09	Ksf
sy1 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-ly1)	1.03	Ksf
sy2 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-ly1-ly2)	0.95	Ksf
Sy3 =	sy0(min)+((sy0(max)-(sy0(min))/L)*(L-LL)	0.87	Ksf
Sx2 =	sx0(min)+((sx0(max)-(sx0(min))/W)*(W-Wx2)	1.21	Ksf
Sx3 =	sx0(min)+((sx0(max)-(sx0(min))/W)*(W-Ww)	1.04	Ksf
PCS =	T*Wc =	0.225	Ksf
DTSy =		**6.56**	**K/ft.**
DTSx =		**1.74**	**K/ft.**
Myy =		**22.50**	**K-ft./ft.**
Mxx =		**3.67**	**K-ft./ft.**

b =	12	in.	
d =	14	in.	
x =	5.25	in.	
n =	9.29		
fcr = (0.4)(f'c)(1.33) =	1596	psi	
$vc = (0.95\sqrt{f'c})(1.33) =$	69.20	psi	

	About Y-axis		About X-axis	
Ms = Myy or Mxx =	22.50	K-ft/ft.	3.67	K-ft/ft.
Vs = DTSy or DTSx =	6.56	K/ft.	1.74	K/ft.
Ast provided =	0.31	in.^2/ft.	0.2	in.^2/ft.

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	Carolina Cross Roads Phase 1 PROJECT			2107 JOB NO.
	Foundation Design OH-31B SUBJECT			8 of 10 SHEET
	AAA DESIGNED	12/03/24 DATE	DLK CHECKED	12/03/24 DATE

$\text{Idmin} = \frac{(0.05)(db)(Fy)}{\sqrt{f'c}} =$	54.77 in.	34.23 in.
$\text{p} = \frac{Ast}{bd} =$	0.0018	0.0012
$\text{k} = \sqrt{2np - (np)^2} - np =$	0.1672	0.1372
$\text{j} = 1 - \frac{k}{3} =$	0.944	0.954

Actual stresses:

$\text{fca} = \frac{12(Ms)}{(b)(k)(j)(d)^2(0.5)} =$	**1453.91 psi** **fca<fcr** **OK**	**286.30 psi** **fca<fcr** **OK**
$\text{vca} = \frac{Vs}{(b)(j)(d)} =$	**41.33 psi** **vc<vca** **OK**	**10.86 psi** **vca<vc** **OK**

Overturning:

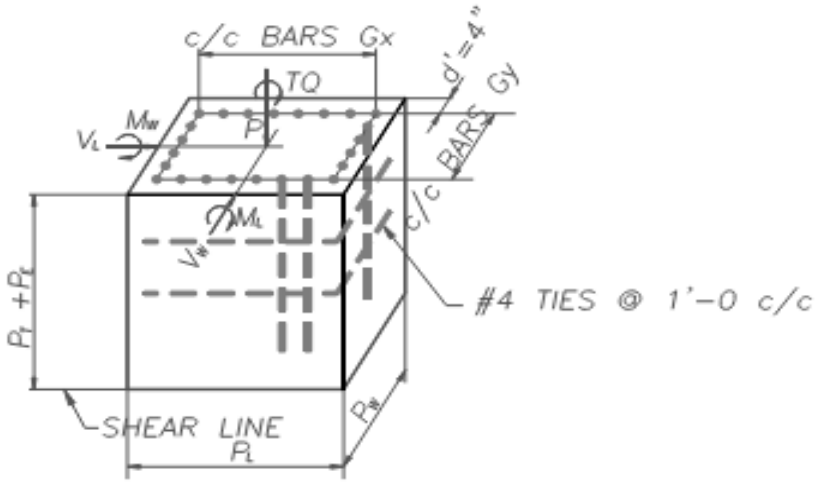
Overturning moment = Mx		110.33 K-ft.
Restoring moment = Pt*L/2		966.24 K-ft.
Factor of safety against overturning =		**8.76**

Sliding:

Sliding friction coefficient =		0.4
Lateral force =		5.69 K
Ls (equivalent static load) =		10.00 K
Driving force =		15.69 K
Resisting force = Pt*sliding friction coefficient =		45.47 K
Factor of safety against sliding =		**2.90**

United Infrastructure Group, Inc. 5562 Pendergrass Blvd, Great Falls, SC 803-581-6000	**Carolina Cross Roads Phase 1** PROJECT			**2107** JOB NO.
	Foundation Design OH-31B SUBJECT			**9 of 10** SHEET
	AAA DESIGNED	**12/03/24** DATE	**DLK** CHECKED	**12/03/24** DATE

Pedestal Design:



Moments at base:

My = ML + VL(PT+PE) =	**160.83**	**K-ft.**
Mx = MW + VW(PT+PE) =	**108.65**	**K-ft.**

Shear at base (acting on rebar only):

$\mathbf{V1} = \sqrt{\mathbf{VL^2} + \mathbf{VW^2}} =$	**5.80**	**K**
$\mathbf{V2} = \frac{\boldsymbol{TQ}}{\boldsymbol{Gx}} + \frac{\boldsymbol{TQ}}{\boldsymbol{Gy}} =$	**0**	
VT = V1 + V2 =	**5.80**	**K**

Combined Stress Ratio:

$$\text{CSR} = (\frac{fv}{Fv})^2 + \frac{fa}{Fa} + \frac{fbx}{Fbx} + \frac{fby}{Fby} \leq 1.0$$

Allowable stress (increased by 33%):

Fv = (0.33)(Fy)(1.33) =	**26334.00**	**psi**
Fa = Fbx = Fby = (0.4)(f'c)(1.33) =	**1596.00**	**psi**

Actual stress:

$\mathbf{fv} = \frac{\boldsymbol{Vt}}{\boldsymbol{Ast}} =$	**229.40**	**psi**
Ast = area of reinforcement used =	25.3	in^2

UNITED INFRASTRUCTURE GROUP
United Infrastructure Group, Inc.
5562 Pendergrass Blvd,
Great Falls, SC
803-581-6000

Carolina Cross Roads Phase 1 PROJECT			2107 JOB NO.
Foundation Design OH-31B SUBJECT			10 of 10 SHEET
AAA DESIGNED	12/03/24 DATE	DLK CHECKED	12/03/24 DATE

$$\mathbf{fa} = \frac{\boldsymbol{P}}{\boldsymbol{Ag}} = \quad \mathbf{2.76\ psi}$$

Ag = gross area of pedestal (PW*PL)*144 = 2304 in^2

$$\mathbf{fbx} = \frac{(\boldsymbol{Mx})(\boldsymbol{Cx})}{\boldsymbol{Ix}} = \quad \mathbf{55.13\ psi}$$

Cx = PL/2 = 24 in.

$$\mathrm{Ix} = \frac{(PW)(PL)^3}{12} + \frac{(2n)(Ast)(Gx)^2}{6} = \quad 567{,}607 \text{ in^4}$$

Gx = PL - 2*d' = 40 in.

$$\mathbf{fby} = \frac{(\boldsymbol{My})(\boldsymbol{Cy})}{\boldsymbol{Iy}} = \quad \mathbf{81.61\ psi}$$

Cy = Pw/2 = 24 in.

$$\mathrm{Iy} = \frac{(PL)(PW)^3}{12} + \frac{(2n)(Ast)(Gy)^2}{6} = \quad 567{,}607 \text{ in^4}$$

Gy = Pw - 2*d' = 40 in.

$$\mathbf{CSR} = (\frac{\boldsymbol{fv}}{\boldsymbol{Fv}})^2 + \frac{\boldsymbol{fa}}{\boldsymbol{Fa}} + \frac{\boldsymbol{fbx}}{\boldsymbol{Fbx}} + \frac{\boldsymbol{fby}}{\boldsymbol{Fby}} \leq \mathbf{1.0} = \quad \mathbf{0.09\ OK}$$

Since the pedestal is almost in pure bending (P load is negligible), the following stress ratio must be used.

$$\mathrm{CSM} = \frac{Mx}{Mox} + \frac{My}{Moy} \leq 1.0$$

Mox = (0.40)(As)(Fy)(1.33)(PW-2d') = 672,448 Lb-ft.
Moy = (0.4)(As)(Fy)(1.33)(PL-2d') = 672,448 lb-ft.

As = tension steel = Ast/4 = 6.32 in.^2

$$\mathbf{CSM} = \frac{\boldsymbol{Mx}}{\boldsymbol{Mox}} + \frac{\boldsymbol{My}}{\boldsymbol{Moy}} \leq \mathbf{1.0} = \quad \mathbf{0.40\ OK}$$

Pedestal is adquate in moment and shear

Revisions to the SCDOT Bridge Design Manual

Reinforcing Tension Development Lengths, and Splice Lengths Revised per AASHTO LRFD Bridge Design Specifications 8th Edition, November 2017

Due to changed reinforcing steel development and splice lengths required by updates to AASHTO LRFD Bridge Design Specifications, the Bridge Design Manual Figure 15.3-4 – Development Lengths For Straight Bars In Tension (4 ksi), Figure 15.3-5 – Development Lengths For Hooked Bars In Tension (4 ksi), and Figure 15.3-6 – Splice Lengths For Bars In Tension (4 ksi) shall be superseded by the Tables included in this Design Memorandum:

- Table 1: Straight Bar Development Length, ℓ_d [in], for Horizontal Bars with > 12" Concrete Cast Below; $f'_c = 4$ ksi.; $f_y = 60$ ksi.
- Table 2: Straight Bar Development Length, ℓ_d [in], for Horizontal Bars with ≤ 12" Concrete Cast Below, or Other Bars; $f'_c = 4$ ksi.; $f_y = 60$ ksi.
- Table 3: Tension Lap Splice Length, ℓ_{st} [in], for Horizontal Bars with > 12" Concrete Cast Below; $f'_c = 4$ ksi.; $f_y = 60$ ksi.
- Table 4: Tension Lap Splice Length, ℓ_{st} [in], for Horizontal Bars with ≤ 12" Concrete Cast Below, or Other Bars; $f'_c = 4$ ksi.; $f_y = 60$ ksi.
- Table 5: Hooked Bar Development Length, ℓ_{dh} [in]; $f'_c = 4$ ksi.; $f_y = 60$ ksi.
- Note:

  Tables include modification factors for reinforcement location, normal weight concrete, and reinforcement confinement as specified in AASHTO Articles 5.10.8.2.1b and 5.10.8.2.1c. Reinforcement confinement is conservatively calculated by taking transverse reinforcement index as 0. Excess reinforcement factor is taken conservatively as 1.0. Tension lap splice lengths are based on AASHTO Article 5.10.8.4. Tension hook development lengths are based on AASHTO Article 5.10.8.2.4. Concrete cover is defined as the cover to the bar being considered. For concrete cover or bar spacing that falls between table values, conservatively use lap splice shown in the table for smaller concrete cover or bar spacing, or calculate more precise length using AASHTO Article 5.10.8.2 for guidance. Bundled bars are based on AASHTO Article 5.10.8.2.3 and SCDOT BDM 15.3.1.8.

SCDOT BDM 15.3.1.7.2: For tension splices, the length of a lap splice, $\ell_{st,}$ between bars of different sizes shall be governed by the smaller bar.

Table 1: Straight Bar Development Length, ℓd [in], for Horizontal Bars with > 12" Concrete Cast Below; f'c = 4 ksi.; fy = 60 ksi.												
Clear Cover	Bar Size US [M]	Reinforcement Spacing										
		4"	4 ½"	5"	5 ½"	6"	6 ½"	7"	7 ½"	8"	8 ½"	≥ 9"
1"	#3 [10]	15	15	15	15	15	15	15	15	15	15	15
	#4 [13]	19	19	19	19	19	19	19	19	19	19	19
	#5 [16]	28	28	28	28	28	28	28	28	28	28	28
	#6 [19]	39	39	39	39	39	39	39	39	39	39	39
	#7 [22]	50	50	50	50	50	50	50	50	50	50	50
	#8 [25]	63	63	63	63	63	63	63	63	63	63	63
	#9 [29]	77	77	77	77	77	77	77	77	77	77	77
	#10 [32]	93	93	93	93	93	93	93	93	93	93	93
	#11 [36]	110	110	110	110	110	110	110	110	110	110	110
	#14 [43]	N/A	146	146	146	146	146	146	146	146	146	146
	#18 [57]	N/A	N/A	N/A	N/A	212	212	212	212	212	212	212
1 ½"	#3 [10]	15	15	15	15	15	15	15	15	15	15	15
	#4 [13]	19	19	19	19	19	19	19	19	19	19	19
	#5 [16]	24	24	24	24	24	24	24	24	24	24	24
	#6 [19]	29	29	29	29	29	29	29	29	29	29	29
	#7 [22]	37	37	37	37	37	37	37	37	37	37	37
	#8 [25]	47	47	47	47	47	47	47	47	47	47	47
	#9 [29]	60	58	58	58	58	58	58	58	58	58	58
	#10 [32]	76	71	71	71	71	71	71	71	71	71	71
	#11 [36]	94	85	85	85	85	85	85	85	85	85	85
	#14 [43]	N/A	120	115	115	115	115	115	115	115	115	115
	#18 [57]	N/A	N/A	N/A	N/A	182	182	182	182	182	182	182
2"	#3 [10]	15	15	15	15	15	15	15	15	15	15	15
	#4 [13]	19	19	19	19	19	19	19	19	19	19	19
	#5 [16]	24	24	24	24	24	24	24	24	24	24	24
	#6 [19]	29	29	29	29	29	29	29	29	29	29	29
	#7 [22]	36	33	33	33	33	33	33	33	33	33	33
	#8 [25]	47	42	38	38	38	38	38	38	38	38	38
	#9 [29]	60	53	48	47	47	47	47	47	47	47	47
	#10 [32]	76	68	61	58	58	58	58	58	58	58	58
	#11 [36]	94	83	75	69	69	69	69	69	69	69	69
	#14 [43]	N/A	120	108	98	95	95	95	95	95	95	95
	#18 [57]	N/A	N/A	N/A	N/A	159	153	153	153	153	153	153
2 ½"	#3 [10]	15	15	15	15	15	15	15	15	15	15	15
	#4 [13]	19	19	19	19	19	19	19	19	19	19	19
	#5 [16]	24	24	24	24	24	24	24	24	24	24	24
	#6 [19]	29	29	29	29	29	29	29	29	29	29	29
	#7 [22]	36	33	33	33	33	33	33	33	33	33	33
	#8 [25]	47	42	38	38	38	38	38	38	38	38	38
	#9 [29]	60	53	48	44	43	43	43	43	43	43	43
	#10 [32]	76	68	61	55	51	49	49	49	49	49	49
	#11 [36]	94	83	75	68	63	59	59	59	59	59	59
	#14 [43]	N/A	120	108	98	90	83	81	81	81	81	81
	#18 [57]	N/A	N/A	N/A	N/A	159	147	137	132	132	132	132
≥ 3"	#3 [10]	15	15	15	15	15	15	15	15	15	15	15
	#4 [13]	19	19	19	19	19	19	19	19	19	19	19
	#5 [16]	24	24	24	24	24	24	24	24	24	24	24
	#6 [19]	29	29	29	29	29	29	29	29	29	29	29
	#7 [22]	36	33	33	33	33	33	33	33	33	33	33
	#8 [25]	47	42	38	38	38	38	38	38	38	38	38
	#9 [29]	60	53	48	44	43	43	43	43	43	43	43
	#10 [32]	76	68	61	55	51	48	48	48	48	48	48
	#11 [36]	94	83	75	68	63	58	54	53	53	53	53
	#14 [43]	N/A	120	108	98	90	83	77	72	70	70	70
	#18 [57]	N/A	N/A	N/A	N/A	159	147	137	128	120	116	116

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	LEXINGTON RICHLAND	P039718	I-26	SN6

NOTE:
REMOVE ALL EXISTING DIRECTIONAL SIGNS ALONG BUSH RIVER RD TO I-26 W
I-26 E
FOR

OH-30

ERECT NEW DIRECTIONAL SIGNS TO I-26 WEST SPARTANBURG AND I-26 EAST CHARLESTON VIA COLONIAL AVE.

MATCHLINE STA 353+50 SEE SHEET SN5

MATCHLINE STA 36+00 SEE SHEET SN7

MATCHLINE STA 7403+00 SEE SHEET SN8

RETAIN EXISTING SIGNS AND RETAIN OH STRUCTURE

EXIT 107 B EAST Florence EXIT ONLY

EXIT 107 A WEST Augusta ½ MILE

BRIDGE MOUNTED RETAIN EXISTING SIGNS AND EXISTING OH STRUCTURE

Airport Charleston

REMOVE EXISTING SIGN AND EXISTING STRUCTURE

EAST Charleston ONLY

REMOVE EXISTING SIGN AND OVERHEAD EXISTING STRUCTURE

WEST Spartanburg

I-20 St Andrews Rd 1¼ Piney Grove Rd 3

RETAIN EXISTING SIGNS AND EXISTING OH STRUCTURE

OH-18B EXIT 107 Florence Augusta EXIT ONLY

OH-18A WEST Spartanburg

REMOVE EXISTING SIGNS INSTALL NEW SIGN ON EXISTING OH STRUCTURE

OH-22B EAST Charleston

ERECT NEW OH STRUCTURE & SIGNS

OH-22A WEST Florence Augusta

ERECT NEW OH STRUCTURE & SIGNS

OH-29A Downtown Columbia

OH-29B Spartanburg Florence Augusta Charleston

OH-30A Downtown Columbia

OH-30B Spartanburg Florence Augusta Charleston

REMOVE EXISTING SIGN INSTALL NEW SIGN ON EXISTING OH STRUCTURE

14 SPACE @ 100' SINGLE UNIT CLEAR DELINEATORS

REMOVE EXISTING SIGN INSTALL NEW SIGN ON EXISTING OH STRUCTURE

REMOVE EXISTING SIGN INSTALL NEW SIGN ON EXISTING OH STRUCTURE

RETAIN EXISTING SIGN AND POST

EAST

ERECT BREAKAWAY POST INSTALL NEW SIGN

Col. Life Blvd To Bush River Road ¼ MILE

EXIT 108 A

Q-7 STA 227+76.78 SURVEY I-126 PEC = 25

EXIT 108 B Columbia EXIT ONLY

REMOVE EXISTING SIGNS

OH-6A EXITS 108 B-A I-126 / Columbia Col. Life Blvd TO Bush River Rd ONLY

ROUTE I-126 Downtown Columbia ONLY

OH-3 EXITS 108 B-A I-126 / Columbia Col. Life Blvd TO Bush River Rd ONLY

ROUTE I-126 Downtown Columbia ONLY

OH-4 EXITS 108 B-A I-126 / Columbia Col. Life Blvd TO Bush River Rd ONLY

Airport Charleston

RETAIN EXISTING SIGN AND EXISTING OH STRUCTURE

RETAIN EXISTING SIGN AND EXISTING OH STRUCTURE

RETAIN EXISTING SIGN AND EXISTING OH STRUCTURE

REMOVE EXISTING SIGN

Bush River Road EXIT 108

EXIT 108 A Bush River Road

REMOVE EXISTING SIGNS AND EXISTING OH STRUCTURE

EXIT 108 B Columbia EXIT ONLY

REMOVE EXISTING SIGNS

ERECT BREAKAWAY POST INSTALL NEW SIGN

HOSPITAL Lexington West Columbia ¾ MILE EXIT 378 EXIT 10

Q-8 STA 388+50 PEC = 25

Saluda River Lexington County

RETAIN EXISTING SIGN

ERECT BREAKAWAY POST INSTALL NEW SIGN

Q-9 STA 7400+43 PEC = 25

Saluda River Richland County

ERECT BEAM POSTS INSTALL NEW SIGN

FUTURE SIGN PHASE 3 DO NOT INSTALL

EXITS 107 B-A Florence Augusta ¾ MILE

OH-9A

ERECT NEW OH STRUCTURE DESIGNED FOR PHASE 3 ERECT NEW SIGN

EXITS 108 B-A EAST Columbia Colonial Life Blvd To Bush River Rd EXIT ONLY

OH-9B

Greystone Blvd. Riverbanks Zoo EXIT 1½ MILES

Col. Life Blvd. To Bush River Road EXIT 108 A

OH-19A

OH-19B

ERECT NEW OH STRUCTURE & SIGNS

EXIT 107 Florence Augusta EXIT ONLY

REMOVE EXISTING SIGNS AND EXISTING OH STRUCTURE

OH-20A EXIT 108 A Col. Life Blvd To Bush River Road

ERECT BREAKAWAY POST INSTALL NEW SIGN

ERECT NEW OH STRUCTURE & SIGNS

OH-20B EXIT 108 B Columbia EAST

Q-21 STA 24+65 PEC = 25

Col. Life Blvd To Bush River Road EXIT 108 A

OH-23A

OH-23B EXIT 108 B Columbia EAST

ERECT NEW OH STRUCTURE & SIGNS

Lester Bates Freeway

Q-24 STA 34+00 PEC = 25

EAST Charleston EXIT ONLY

EXIT 107 Florence Augusta EXIT ONLY

WEST Spartanburg

ERECT BREAKAWAY POST INSTALL NEW SIGN

REMOVE EXISTING SIGNS AND EXISTING OH STRUCTURE

SCALE : 1" = 200'

ARCHER UNITED JOINT VENTURE UNITED

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

2022.11.16 15:48:48-05'00'

SCALE: 1" = 200'

REV.NO.	BY	DATE	DESCRIPTION OF REVISION
6			
5			
4			
3			
2			
1			
0	AOL	11-16-22	RELEASED FOR CONSTRUCTION

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

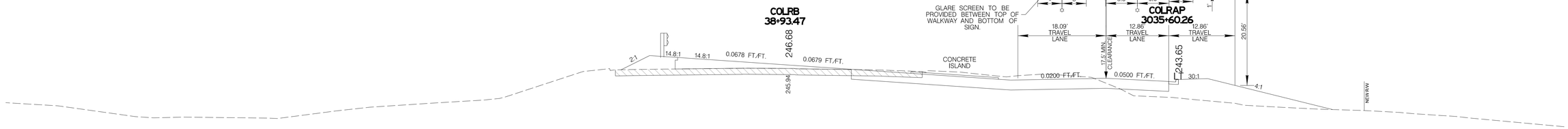
CAROLINA CROSSROADS PHASE 1

SIGNING PLAN SHEET

Z:\Projects\20-6\CCR Ph I\Roadway\PLANS\SN Plans\006_0I_P039718_Signing_Plan_Sheet_SN6.dgn
11/16/2022

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	RICHLAND	P039718	I-26	SN37

NOTE: CONTRACTOR SHALL FIELD VERIFY VERTICAL SUPPORT LENGTHS AND HORIZONTAL DIMENSIONS AFTER FINAL GRADING BEFORE FABRICATION



LUMINAIRE

DESIGN WIND SPEED = 100 MPH

ERECT NEW OH STRUCTURE & SIGNS

OVERHEAD STRUCTURE NO. 30
COL. LIFE BLVD RAMP B STA. 38+93.47
SOUTHBOUND
DIRECTION OF TRAVEL

SCALE: 1" = 10'

ARCHER UNITED JOINT VENTURE

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

2022.11.16 15:48:56-05'00'

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
6			
5			
4			
3			
2			
1			
0	AOL	11-16-22	RELEASED FOR CONSTRUCTION

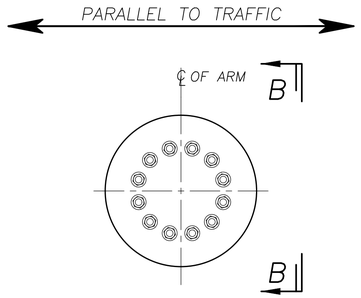
SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

CAROLINA CROSSROADS PHASE 1

OVERHEAD STRUCTURE ELEVATION VIEW

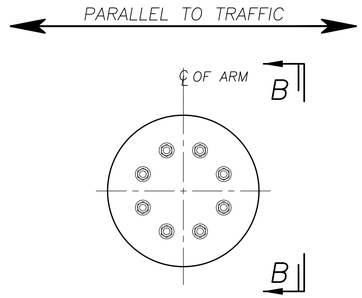
Z:\Projects\20-6\CCR Ph I\Roadway\PLANS\SN Plans\04I_0I_P039718_Signing_Plan_XS_Sheet_SN37.dgn
11/16/2022

STRUCTURE	STATION	"A"			"D"	BARS "E"	HOOPS "F" (SEE ✱ NOTE)			CONC/FTG (cu yds)	REINF/FTG (lbs)	"Z" @ ℄
OH–29	209+50.04(SB)	4'–6			18'–0	19 – #10 @ 7 3/16in.	20 – #5 @ 1'–0			10.60	1696	1'–0
✱ OH–30	38+93.47(SB)	4'–6			17'–0	19 – #10 @ 7 3/16in.	19 – #5 @ 1'–0			10.01	1601	1'–0
✱ OH–31A	51+00(EB)	4'–0			14'–0	19 – #9 @ 6 1/4in.	16 – #4 @ 1'–0			6.52	992	1'–3
✱ OH–31B	66+00(EB)	4'–0			15'–0	19 – #9 @ 6 1/4in.	17 – #4 @ 1'–0			6.98	1064	1'–3



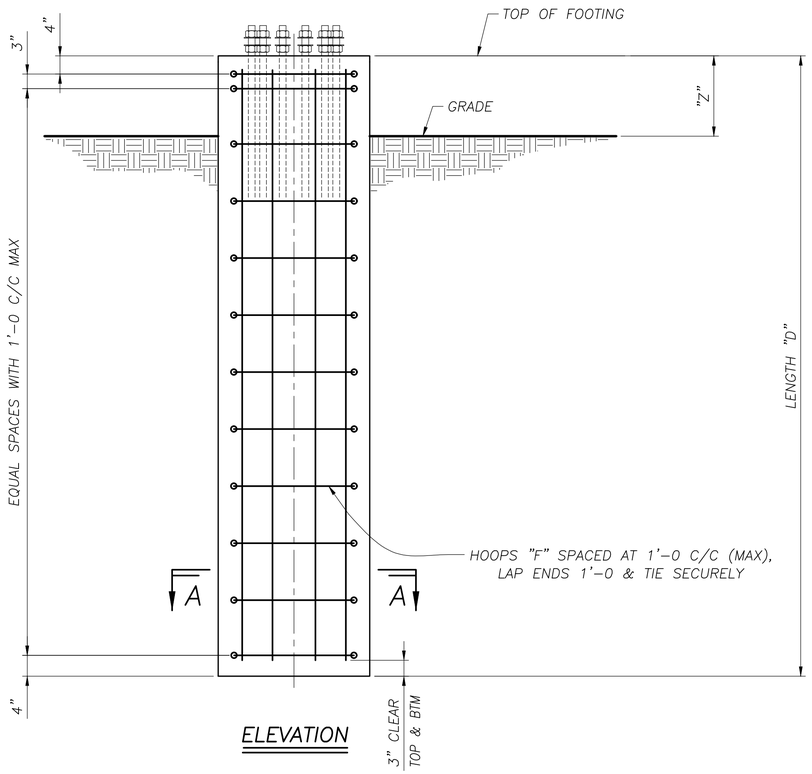
(12) ANCHOR BOLTS

(OH–29 ONLY)



✱(8) ANCHOR BOLTS

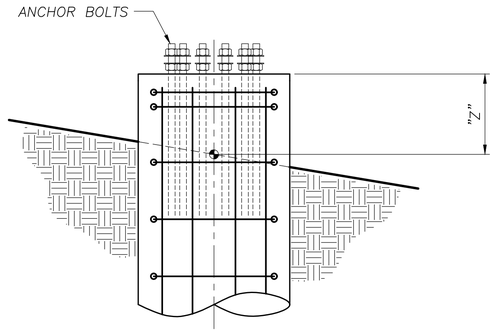
(OH–30, OH–31A & OH–31B only)



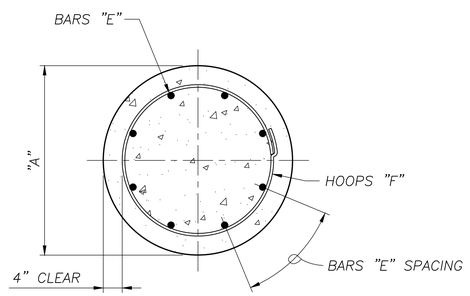
ELEVATION

SINGLE POLE FOOTING

(CANTILEVER/BUTTERFLY)



SECTION B–B



SECTION A–A

NOTE:

SEE GENERAL NOTES DRAWING FOR MATERIAL SPECIFICATIONS, FOUNDATION AND STANDARD NOTES

GROUP 2

AASHTO 6th Edition Spec's

SEALED BY:

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 38665 DAVID A LALLONE

Oct 25 2023

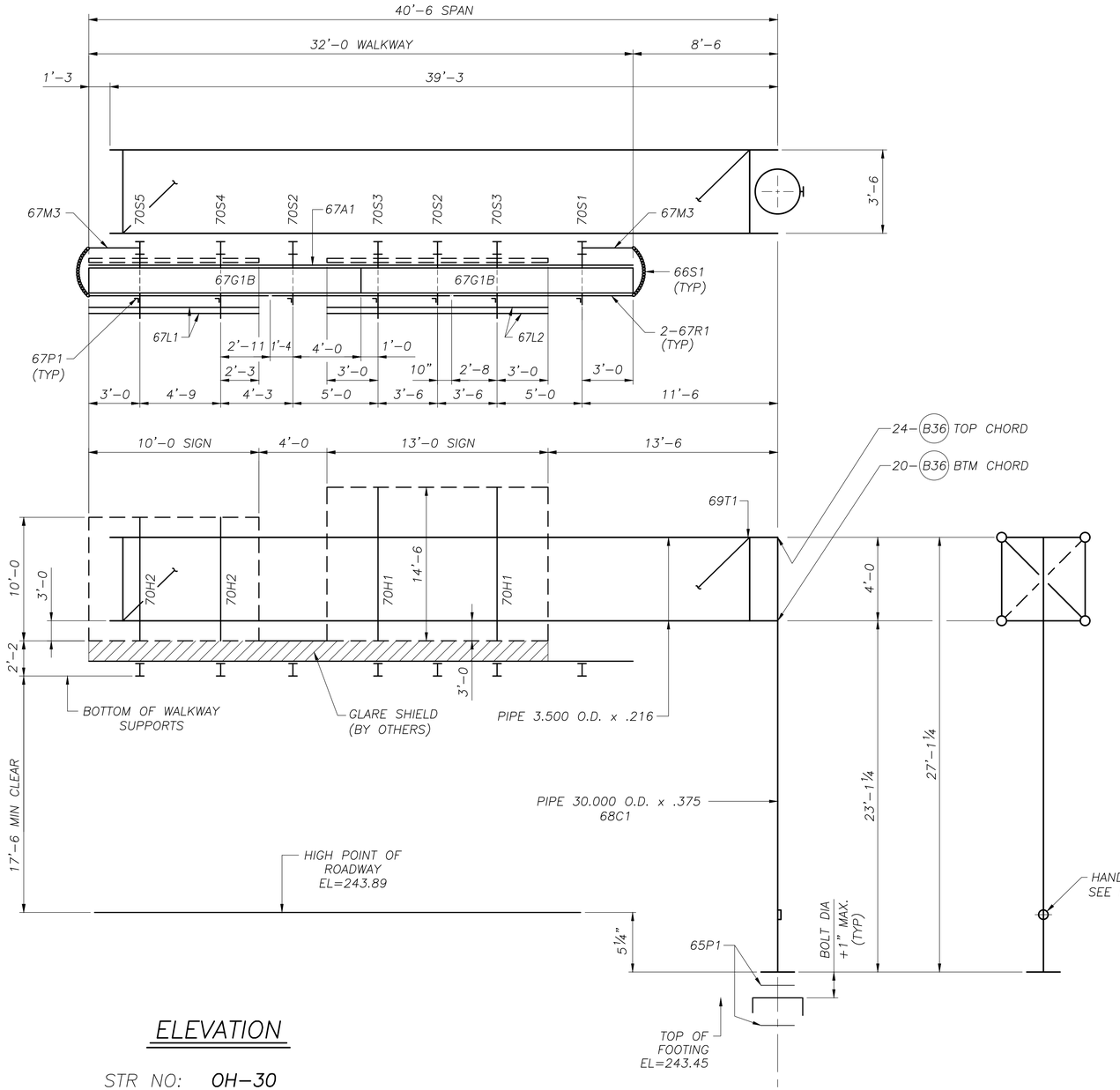
walpar
A valmont COMPANY
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

NO:	REVISIONS	DATE	MADE	CHECKED
0	CHECK COMPLETE	10/24/23	IWL	RRW

STATE:	South Carolina
FED PROJ:	Carolina Crossroads Phase 1 & 2
ST PROJ:	P039718
COUNTY:	Lexington & Richland
ROUTE:	I–26 & I–126
SUBJECT:	OVERHEAD SIGN SUPPORT
	CANTILEVER/BUTTERFLY CYLINDRICAL FOOTING DESIGN
FOR:	Archer–United Joint Venture
DRAWN BY:	IWL DATE: 8/24/23
CHECKED BY:	RRW DATE: 10/24/23
DWG NO:	C3546–D12

CCF–D

NAME: E:\acad\Djobs\SC\3546\3546–D12.dwg DATE: OCT 24, 2023 TIME: 1:51 PM rw706292



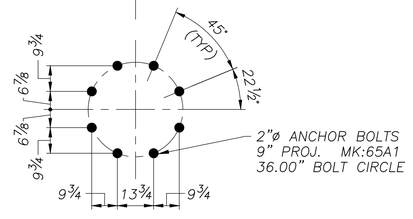
ELEVATION

STR NO: OH-30

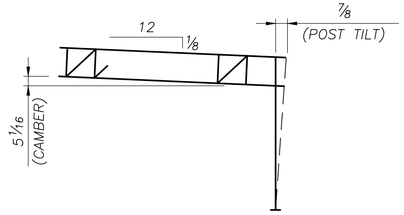
STA NO: 38+93.47(SB)

(LOOKING IN DIRECTION OF TRAFFIC FLOW)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS, SIGN HGR'S OR A SUITABLE VIBRATION DAMPER



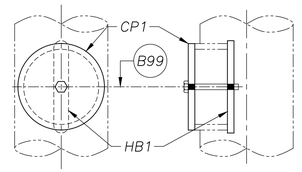
ANCHOR BOLT PLAN



CAMBER DIAGRAM

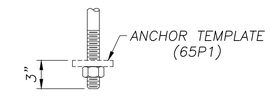
ERECTION NOTE

1) TILT POST AWAY FROM ROADWAY AT ERECTION BY ADJUSTING LEVELING NUTS.
2) 1" MINIMUM PERMANENT CAMBER AFTER DEFLECTION.



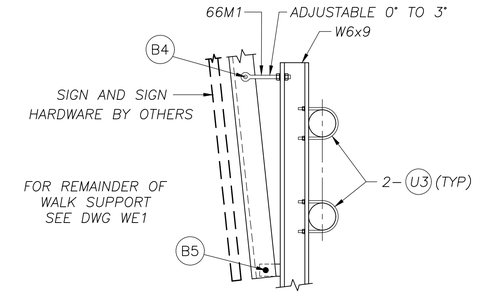
HANDHOLE DETAIL

PRE ASSEMBLE CP1 TO HB1 WITH B99 BOLT. DISTURB THREADS SO HB1 CAN NOT BE REMOVED. INSTALL COVER ASSEMBLY INTO HANDHOLE OPENING AND TIGHTEN BOLT TO SECURE.



ANCHOR DETAIL

(TYPICAL)



TYP SECTION THRU SIGN SUPPORT & SIGN HANGER

SHIPPING LIST		C3546-E10
QTY	MARK	DESCRIPTION
8	65A1	ANCHOR BOLTS
2	65P1	ANCHOR TEMPLATES
1	69T1	CANTILEVER TRUSS 3.9' x 4.4' x 40.9'
1	68C1	CANTILEVER POST 3.4' x 3.4' x 27.1'
1	70S1	WALK SUPPORTS
2	70S2	WALK SUPPORTS
2	67M3	SAFETY CHAIN SUPPORT
2	66S1	SAFETY CHAIN
7	66P1	HINGE PIN ASSEMBLIES
14	67M1	CLAMP PLATES
2	67M2	SPLICE PLATES
7	67P1	HANDRAIL POSTS
6	67R1	HANDRAILS
1	67A1	SAFETY ANGLES
2	67G1B	GRATING
2	70S3	SIGN/WALK/LIGHT SUPPORTS
1	70S4	SIGN/WALK/LIGHT SUPPORT
1	70S5	SIGN/WALK/LIGHT SUPPORT
2	70H1	SIGN HANGERS (ANGLE ARM)
2	70H2	SIGN HANGERS (ANGLE ARM)
4	66M1	EYEBOLT ASSEMBLIES
2	67L1	LIGHT SUPPORTS
2	67L2	LIGHT SUPPORTS
1	CP1	COVER PLATE ASSEMBLY
1	HB1	HANDHOLE BAR
34	(B1)	3/8" x 1 1/4" BOLT w/HN/LW (A307 GALV)
14	(B3)	1 3/8" OD x 14 GA WASHER (A307 GALV)
4	(B4)	3/4" x 2 1/2" HHB w/HN/FW/LW (A325 GALV)
4	(B5)	3/4" x 2" HHB w/HN/LW (A325 GALV)
7	(B6)	1/2" x 1 1/2" HHB w/HN/LW (A325 GALV)
44	(B36)	3/4" x 2 1/2" HHB w/HN/FW/DTI (A325 GALV)
1	(B99)	1/4" x 4" HHB (A307 GALV)
14	(U1)	5/16" U-Bolts w/(2 ea) HN/LW (ZINC PL)
28	(U3)	1/2" U-Bolts w/(2 ea) HN/LW/FW (GALV)

NOTE:
SEE GENERAL NOTES DRAWING FOR MATERIAL SPECIFICATIONS, FOUNDATION AND STANDARD NOTES

OH-30

DESIGN DWGS: D10, D12, D14 DESIGN NO: BC4 **AASHTO 6th Edition Spec's**

SEALED BY:

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 38665 DAVID A LALLONE

Oct 25 2023

walpar
A valmont COMPANY
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE:	South Carolina
FED PROJ:	Carolina Crossroads Phase 1 & 2
ST PROJ:	P039718
COUNTY:	Lexington & Richland
ROUTE:	I-26 & I-126
SUBJECT:	CANTILEVER SIGN SUPPORT ERECTION DRAWING
FOR:	Archer-United Joint Venture
DRAWN BY:	DLK DATE: 9/29/23
CHECKED BY:	DLJ DATE: 10/16/23
DWG NO:	C3546-E10

NO:	REVISIONS	DATE	MADE	CHECKED
0	CHECK COMPLETE	10/16/23	DLK	DLJ

NAME: E:\acad\JobsNPrg\3546\3546-E10.dwg DATE: OCT 16, 2023 TIME: 3:38 AM dj706290

CANT-E

Box Truss Cantilever Structure Design

Reference Walpar Job Number : C3546
Reference Design Information Sheet Number : C4 Structure : OH-30 Station : 38+93.47(SB)
State : SC
AASHTO Specification : 6th Edition Fatigue Category : II
Design Wind Velocity (V) : 100 mph

Structure Dimensions

Span (S)	43.00 ft	Truss Hgt (U)	4.00 ft	Truss Depth (Y)	3.50 ft
Post Hgt (H)	25.17 ft	Coeff of Hgt (Kz)	1.00		

Sign Information

Actual Sign Area: 315.50 sq ft

Sign	Load (i)	Lgth (B_i)	Hgt (D_i)	Location (a_i)	Unit wgt	Depth	C_d	Z Ecc	Area	Exit Panel
1	2	13.00	15.50	22.50	7.00		1.13	6.00	201.50	
2	4	10.00	11.00	38.00	7.00		1.13	6.00	114.00	X

Walkway Information

	Lgth	Location	Width	Unit wgt	Y Ecc
WW1	34.50	25.75	2.54	60	5.07
WW2					

Load Summary Estimate

Weight of truss only	2617 lbs
Weight of truss with signs	4826 lbs
Post weight †	4041 lbs

† includes additonal wgt from base plate



Jul 3 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-30 Station : 38+93.47(SB)

Loads

Unit wind load on sign(s)/C_d: 29.18 psf Unit wind load on exposed truss: 35.02 psf Unit wgt of truss: 50.93 plf Unit ice wgt on truss: 20.92 plf

Truss Area for Wind Load (A_t): 0.91 sq ft / ft ***All loads in charts in lbs, ft or ft-lbs unless noted**

Truss Load Summary For Actual Sign & WW Condition

	Load (i)	Dead	Wind (W_p & W_h)	Ice
Sign and Truss Loads	1	815	510	335
	2	2073	6665	876
	3	204	128	84
	4	1307	3773	551
WW Loads	WW1	2070	737	921
Post Reaction (R_L)		6469	11813	2767
Truss Moments (M)		162448	320348	69644

** WW/Equipment Loads are incorporated into Sign and Truss Loads to determine Reactions and Moments.

Post Loads

Dead	Wind	Ice	Group II t_c	Group III t_c
3723	892	640	178	268

Load Combinations for Design Sign Area (Max Condition)

Truss Member Loads	DL	DL +WL	DL+1/2 WL+IL
Truss Chords (Pc)	20306	66070	51893
Vertical Diagonals (Pv)	11225	11225	17234
Horizontal Diagonals (Ph)	4236	10144	5715
Vertical Struts (Psv)	7745	9306	11890
Horizontal Struts (Psh)	3947	5906	6364

	Post Loads					
	M_N	M_{tc}	M_z/Torsion	V_N	V_{tc}	Axial
Group II Comb. 1 (DL+WL)	325226	226395	326692	12839	2541	10192
Group III Comb. 1 (DL+1/2WL+IL)	165361	263032	163346	6487	1270	13599
Group II Comb. 2 (DL+WL)	200685	255269	214896	7757	3811	10192
Group III Comb. 2 (DL+1/2WL+IL)	101148	278502	107448	3946	1906	13599

Serviceability Requirements

Truss DL Deflection	0.87 in.
Total DL Deflection	3.61 in.
Limit for Deflection	3.44 in.
Camber Used (Cu)	5.38 in.
Permanent Camber (Cp)	4.50 in.
Post Tilt	0.93 in.
Post Deflection Limits	8.15 in.
D^2/400 Limit	5.67 in.
Horizontal WL Deflection	3.94 in.
Horizontal Defl Limits	12.90 in.



Jul 3 2024

1

C4 - 2 of 6

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-30 Station : 38+93.47(SB)

Material Information

	Pipe Size (Min Yield)	Unbraced Lgth	CSR Group II	CSR Group III
Truss Chords	3.500 x 0.216 (52 ksi)	8.39 ft	0.95	0.75
Vertical Diagonals	1.660 x 0.140 (52 ksi)	5.80 ft	0.54	0.83
Vertical Struts	1.660 x 0.140 (52 ksi)	4.00 ft	0.60	0.77
Horizontal Diagonals	1.900 x 0.200 (52 ksi)	5.46 ft	0.56	0.32
Horizontal Struts	1.900 x 0.200 (52 ksi)	3.50 ft	0.19	0.21
Post	30.000 x 0.375 (52 ksi)	27.17 ft	0.57	0.38

Structure Detail Information

Truss to Post Connection

Connection Bolt Qty & Size	10 - ¾" ø A325
Connection Plate Weld "A"	¼ fillet
Connection Plate Weld "B"	3/16 fillet
Connection Plate Welds "C"&"D"	3/16 fillet

Post Detail

Maximum Anchor Bolt Pullout	64574 lbs
Anchor Bolt Circle	36 in. Dia
Anchor Bolt Yield	55 ksi
Anchor Bolt Qty & Size	8 - 2" ø
Anchor Bolt Length (Embed Used)	4.50 ft (3.5 ft)
Anchor Bolt CSR	0.70
Base Plate Thickness	2 in.
Base Plate Weld	5/16 fillet
Gusset Plates at Base	8-¾" x 12"

Truss Chord Splices

Maximum Design Load at Splice	71276 lbs
Splice Moment (per in. of circum)	4051 in-lbs
Splice Bolt Circle	6.5 in.
Splice Bolt Qty & Size	4 - 7/8" ø A325
Splice Plate Thickness	0.75 in.
Splice Plate Weld	¼ fillet

ACI 318 App D checked with Min. Req'd Embed 2.32 ft

Sign Hanger Detail

Design hanger spacing 9.00 ft

Sign Hanger U-Bolt type ASTM-A307

SIGN	Max UBL at End	Max Spacing	Hanger U-Bolt	Sign Hanger	Hanger Support
1	4.00 ft	9.00 ft	2 - ½" ø	L5x3x5/16	W6x9
2	4.00 ft	9.00 ft	2 - ½" ø	L5x3x5/16	W6x9

Structure Input (For Foundation Designs)

Sign DL React (DLS)	4.28 k
Truss DL React (DLT)	2.19 k
Post DL React (DLP)	3.72 k
Truss WL React (Wh)	0.64 k
Truss WL React (Wp)	11.07 k
Post WL React (Wv)	0.89 k
Dist. To DLS & Wp (L1)	28.10 ft
Distance To Wh (L2)	21.50 ft
Distance To Rh (H1)	25.17 ft
Distance To Wv (H2)	13.58 ft
Torque at Base (Mt)	326.7 k-ft
Min Ped Wth (PL & PW)	4.50 ft



Jul 3 2024

1

C4 - 3 of 6

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-30 Station : 38+93.47(SB)

Vibration and Fatigue (Per AASHTO 6th Edition)

Natural Wind Gust Load on Signs/C_d 4.42 psf
Natural Wind Gust Load on Truss 5.30 psf

Truck Induced Gust Load on Truss 16.37 psf
Extent of Truck Induced Gust 12.00 ft
Truss Area for Truck Induced Gust 0.90 sq ft / ft
Location of Center of Truck Induced Gust 37.00 ft

Truss Load Summary for Vibration and Fatigue

Loads (i)	NWG(i)	TIG(i)
1	77	
2	1009	
3	19	
4	571	177
WW1	349	561
Post Reaction	2026	738
Maximum Moments	54623	27324

Member Forces for Vibration and Fatigue

Truss Members	P_{NWG}	P_{TG}
Truss Chords	7803	3415
Vertical Diagonals	-	535
Horizontal Diagonals	1582	-
Vertical Struts	-	369
Horizontal Struts	1013	-

	Post Loads at Base				
	M_N	M_Y	M_z/Torsion	V_N	Axial
Natural Wind	55477	-	54623	2356	-
Truck Induced Gust	-	27324	-	-	738

Vibration and Fatigue Stresses

	NWG (ksi)	TIG (ksi)	Allowable (ksi)
Post/Truss Connection	1.38	0.61	2.60
Truss Vertical Diagonals	-	0.55	1.20
Truss Horizontal Diagonals	0.95	-	1.20
Truss Vertical Struts	-	0.55	1.20
Truss Horizontal Struts	0.95	-	1.20
Post Base Connection	1.17	0.58	7.00
Base Stiffener Termination	2.61	1.29	7.00
Anchor bolts	6.00	3.03	7.00



Jul 3 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-30 Station : 38+93.47(SB)

Foundation Design

Boring Type SPT Boring Designation G-217
Major Soil Type Cohesive Depth to Water NA Surcharge (Frost) Depth 2 ft
Ground Slope 4:1 Consider slope stability? Y

SOIL TYPES	
01-GP	07-SM
02-GW	08-ML
03-GM	09-MH
04-GC	10-SC
05-SP	11-CL
06-SW	12-CH

Soil Properties

Depth	N Value	γ' (pcf)	Φ (deg)	S_u (lbf/ft^2)	α	β	f_{SN} (lbf/ft^2)	$(N_1)_{60}$	Soil Type
**0 - 4	19	124	30	2375	0.55		1306	38	11
4 - 6	40	145	33	4000	0.55		2200	80	11
6 - 8	27	123	31	3375	0.55		1856	54	09
8 - 13.5	34	134	31	4000	0.55		2200	68	09
13.5 - 18.5	28	125	29	3500	0.55		1925	46	09
18.5 - 20	17	108	27	2125				30	09
20 - 35	17	108	25	2125				18	09

* Soil Type 13 indicates rock layer with N>60 for cohesionless soil or N>40 for cohesive soils
**Top 2.0 ft will not contibute to any load resistance + 1 diameter at bottom will not contribute to frictional load resistance.



Jul 3 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-30 Station : 38+93.47(SB)

Cantilever Cylindrical Footing Design

Material/Soil Specifications and Safety Factors

Concrete f '$_c$:	3000 psi	Concrete wgt :	150 pcf
Rebar yield f_y :	60000 psi	Min safety factor for torsion :	1.13
Reinforcement Clear :	4 in	Min safety factor for lateral load :	2.86

Loads and Locations From Structure

Sign DL React (DLS)	4.28 k	Dist. To DLS & Wp (L1)	28.10 ft
Truss DL React (DLT)	2.19 k	Distance To Wh (L2)	21.50 ft
Post DL React (DLP)	3.72 k	Distance To Rh (H1)	25.17 ft
Truss WL React (Wh)	0.64 k	Distance To Wv (H2)	13.58 ft
Truss WL React (Wp)	11.07 k	Footing Projection (H3)	1.00 ft
Post WL React (Wv)	0.89 k	Torque at Base (M_t)	326.7 ft-k

Loads at Top of Cylinder from Structure

Dead Load Moment (MDL)	230.72 ft-k	Effective height (Heff)	24.35 ft
Wind Load Moment (MWL)	306.68 ft-k	Lateral load from MDL (PDL)	2.52 k
Resultant Moment (MR)	395.09 ft-k	Resultant Lateral Load (PRL)	16.23 k
Wind Load Shear at Base (PWL)	12.60 k	Total Dead Load at Column Base (TDL)	10.19 k
Transverse Load (t_c)	2.52 k		

Torsion Calculation Results
(from Beta Method)

Cylinder Embedment	11.50 ft
Axial load	10.19 k
Torsional load	326.69 ft-k
Weight of shaft	40.56 k
Max Allow Torque on reinf CYL	418.62 ft-k
Side Resist. Capacity	260.5 k
Allowable side resist. torque	586.07 ft-k
Avg Su for Tip Resist. (ksf)	3.75
Tip Resist. Capacity	536.77 k
Allowable Tip Resist. Torque	38.6 ft-k
	0.0 ft-k
Total Allowable Torque	624.7 ft-k
Calc'd Torsional safety factor	1.91

Lateral Load Calculation Results
(from Brom's Method)

Soil friction angle Φ	31.4 deg
Soil unit weight γ	132 pcf
AVG $(N_1)_{60}$ over req'd dp (BPF)	88
Lateral load from structure	16.2 k
Moment from structure	395.1 ft-k
Rankine Passive Pressure Coeff. K_P	11.75
Ultimate soil resistance P_{ult}	1319 k
Allowable soil resistance P_{max}	614 k
Ultimate soil mom cap M_{ult}	5313 ft-k
Allowable soil mom cap M_{max}	2471 ft-k
Ground line moment	411 ft-k
Dist GL to 0 shear pt in CYL	3.24 ft
Maximum moment in shaft	444 ft-k

Final Cylindrical Footing Design Sizes

Req'd A_s	12.78 in²	Rebar Cage Dia (D1)	43.48 in
1% Cyl Area Min A_m	22.90 in²	Vertical bar spacing	7.19 in
Reinf Area Provided A_p	24.13 in²		

USE 54 in DIA x 17'-0 CYLINDER
w/ 19- # 10 VERT. BARS & 19 - #5 HOOPS
Extra Hoop 3 inches below top hoop

Serviceability

Calculated torsional / axial safety factors = 1.91 / 15.71
Calculated lateral safety factor = 11.97

Quantities

1601 lbs of reinforcement
10.01 cyd of concrete

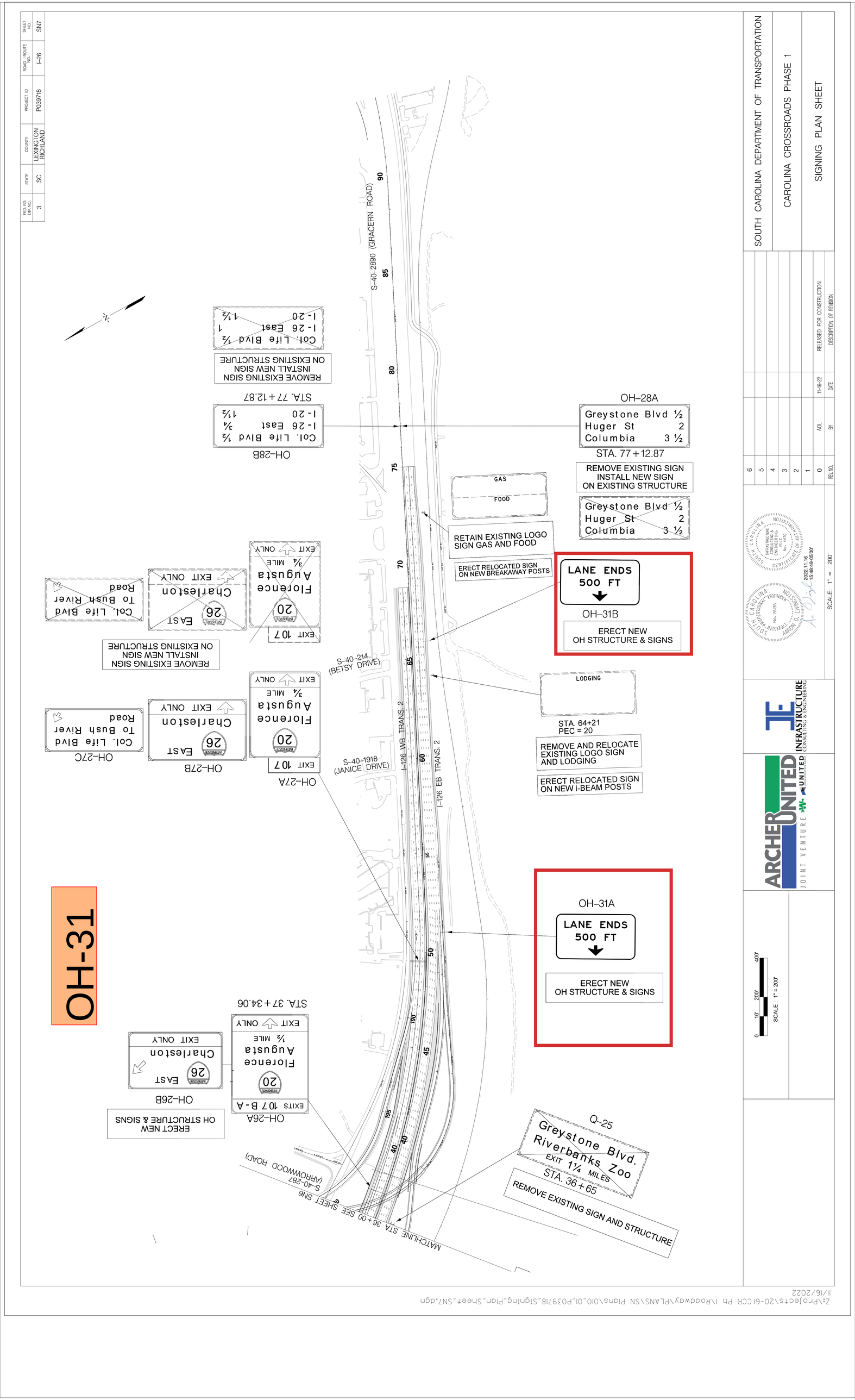


Jul 3 2024

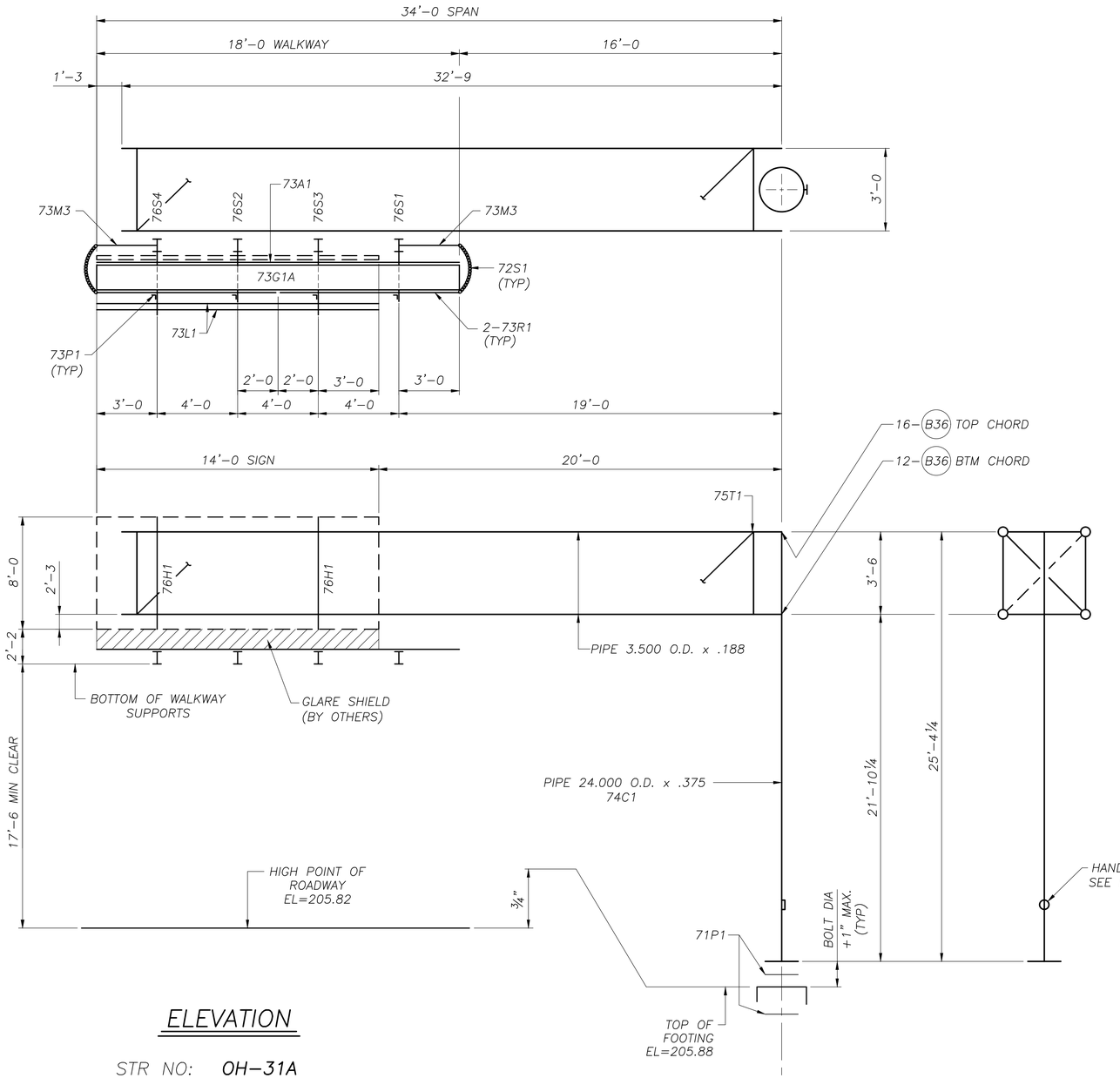
1

C4 - 6 of 6

Walpar (c) 2014



Z:\Projects\20-61CCR Ph I\Roadway\PLANS\SN Plans\010_01_P039718_Signing_Plan_Sheet_SN7.dgn
11/16/2022



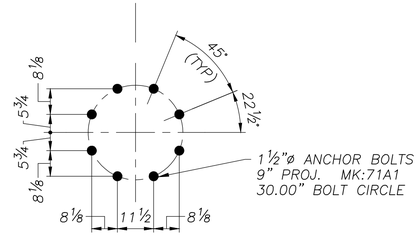
ELEVATION

STR NO: OH-31A

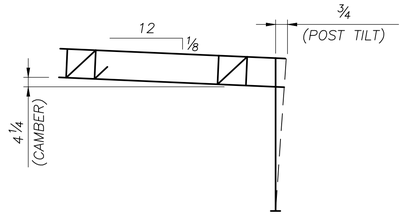
STA NO: 51+00(EB)

(LOOKING IN DIRECTION OF TRAFFIC FLOW)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS, SIGN HGR'S OR A SUITABLE VIBRATION DAMPER



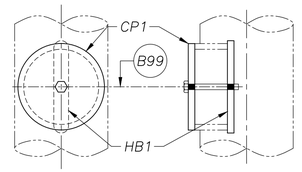
ANCHOR BOLT PLAN



CAMBER DIAGRAM

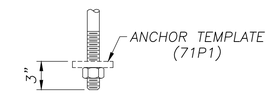
ERECTION NOTE

1) TILT POST AWAY FROM ROADWAY AT ERECTION BY ADJUSTING LEVELING NUTS.
2) 1" MINIMUM PERMANENT CAMBER AFTER DEFLECTION.



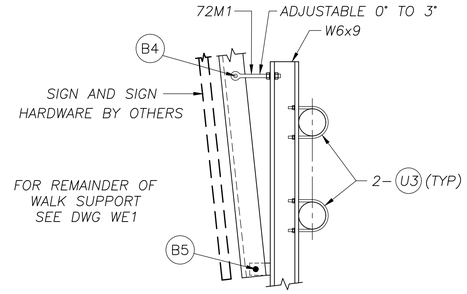
HANDHOLE DETAIL

PRE ASSEMBLE CP1 TO HB1 WITH B99 BOLT. DISTURB THREADS SO HB1 CAN NOT BE REMOVED. INSTALL COVER ASSEMBLY INTO HANDHOLE OPENING AND TIGHTEN BOLT TO SECURE.



ANCHOR DETAIL

(TYPICAL)



TYP SECTION THRU SIGN SUPPORT & SIGN HANGER

SHIPPING LIST		C3546-E11
QTY	MARK	DESCRIPTION
8	71A1	ANCHOR BOLTS
2	71P1	ANCHOR TEMPLATES
1	75T1	CANTILEVER TRUSS 3.3' x 3.8' x 34.1'
1	74C1	CANTILEVER POST 2.9' x 2.9' x 25.3'
1	76S1	WALK SUPPORT
1	76S2	WALK SUPPORT
2	73M3	SAFETY CHAIN SUPPORT
2	72S1	SAFETY CHAIN
4	72P1	HINGE PIN ASSEMBLIES
8	73M1	CLAMP PLATES
4	73P1	HANDRAIL POSTS
4	73R1	HANDRAILS
1	73A1	SAFETY ANGLES
1	73G1A	GRATING
1	76S3	SIGN/WALK/LIGHT SUPPORT
1	76S4	SIGN/WALK/LIGHT SUPPORT
2	76H1	SIGN HANGERS (ANGLE ARM)
2	72M1	EYEBOLT ASSEMBLIES
2	73L1	LIGHT SUPPORTS
1	CP1	COVER PLATE ASSEMBLY
1	HB1	HANDHOLE BAR
16	B1	3/8" x 1 1/4" BOLT w/HN/LW (A307 GALV)
8	B3	1 3/8" OD x 14 GA WASHER (A307 GALV)
2	B4	3/4" x 2 1/2" HHB w/HN/FW/LW (A325 GALV)
2	B5	3/4" x 2" HHB w/HN/LW (A325 GALV)
4	B6	1/2" x 1 1/2" HHB w/HN/LW (A325 GALV)
28	B36	3/4" x 2 1/2" HHB w/HN/FW/DTI (A325 GALV)
1	B99	1/4" x 4" HHB (A307 GALV)
8	U1	5/16" U-Bolts w/(2 ea) HN/LW (ZINC PL)
16	U3	1/2" U-Bolts w/(2 ea) HN/LW/FW (GALV)

NOTE:

SEE GENERAL NOTES DRAWING FOR MATERIAL SPECIFICATIONS, FOUNDATION AND STANDARD NOTES

DESIGN DWGS: D10, D12, D14 DESIGN NO: BC5 AASHTO 6th Edition Spec's

OH-31A

SEALED BY:

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 38665 DAVID A LALLONE

Oct 25 2023

walpar A valmont COMPANY
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

NO:	REVISIONS	DATE	MADE	CHECKED
0	CHECK COMPLETE	10/16/23	DLK	DLJ

STATE:	South Carolina
FED PROJ:	Carolina Crossroads Phase 1 & 2
ST PROJ:	P039718
COUNTY:	Lexington & Richland
ROUTE:	I-26 & I-126
SUBJECT:	CANTILEVER SIGN SUPPORT ERECTION DRAWING
FOR:	Archer-United Joint Venture
DRAWN BY:	DLK DATE: 10/2/23
CHECKED BY:	DLJ DATE: 10/16/23
DWG NO:	C3546-E11

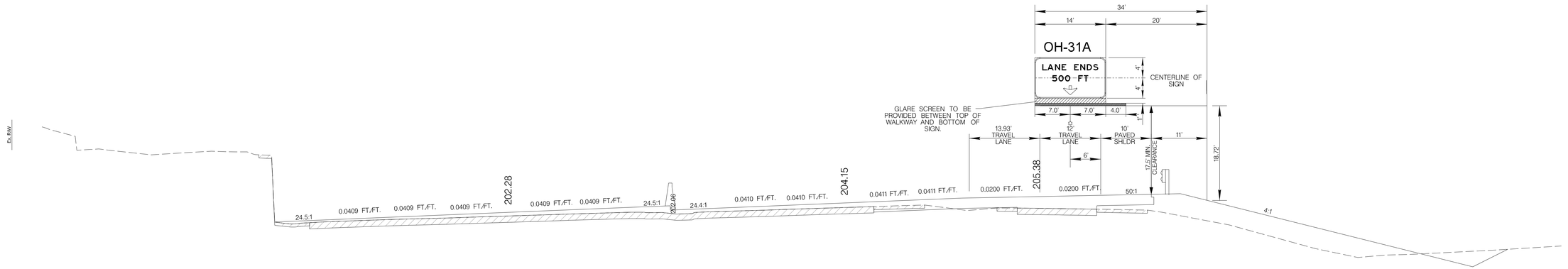
CANT-E

NAME: E:\acad\JobsNPrg\3546\3546-E11.dwg DATE: OCT 16, 2023 TIME: 3:38 AM dj706290

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	RICHLAND	P039718	I-26	SN38

NOTE: CONTRACTOR SHALL FIELD VERIFY VERTICAL SUPPORT LENGTHS AND HORIZONTAL DIMENSIONS AFTER FINAL GRADING BEFORE FABRICATION

LUMINAIRE



DESIGN WIND SPEED = 100 MPH

ERECT NEW OH STRUCTURE & SIGNS

OVERHEAD STRUCTURE NO. 31A
INTERSTATE 126 STA. 51+00.00
EASTBOUND
DIRECTION OF TRAVEL

SCALE: 1" = 10'

ARCHER UNITED JOINT VENTURE

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 MARION O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

2022.11.16 15:48:56-05'00'

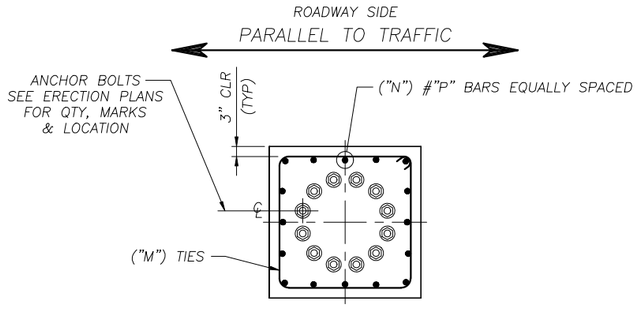
REV. NO.	BY	DATE	DESCRIPTION OF REVISION
6			
5			
4			
3			
2			
1			
0	AOL	11-16-22	RELEASED FOR CONSTRUCTION

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

CAROLINA CROSSROADS PHASE 1

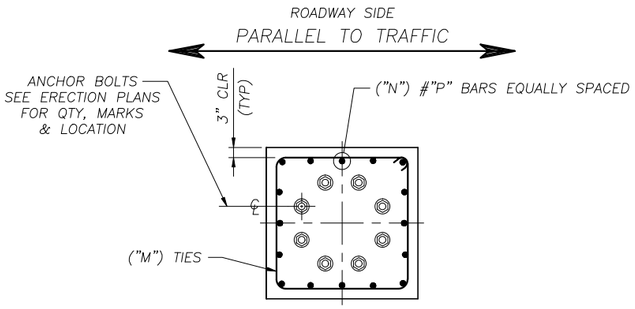
OVERHEAD STRUCTURE ELEVATION VIEW

Z:\Projects\20-6ICCR Ph I\Roadway\PLANS\SN Plans\042_0I_P039718_Signing_Plan_XS_Sheet_SN38.dgn
11/16/2022



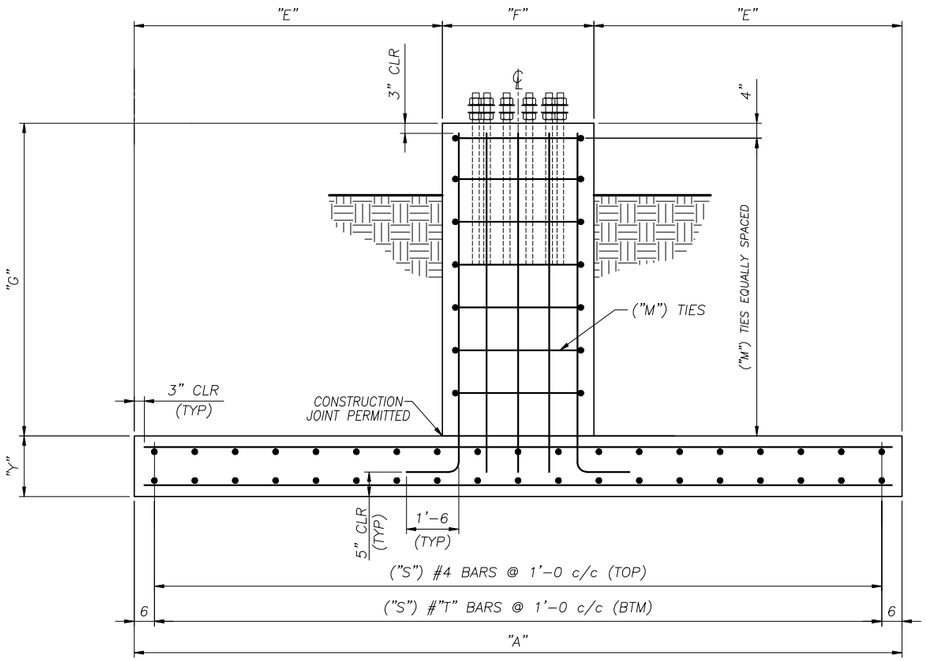
(12) ANCHOR BOLTS

(OH–29 only)

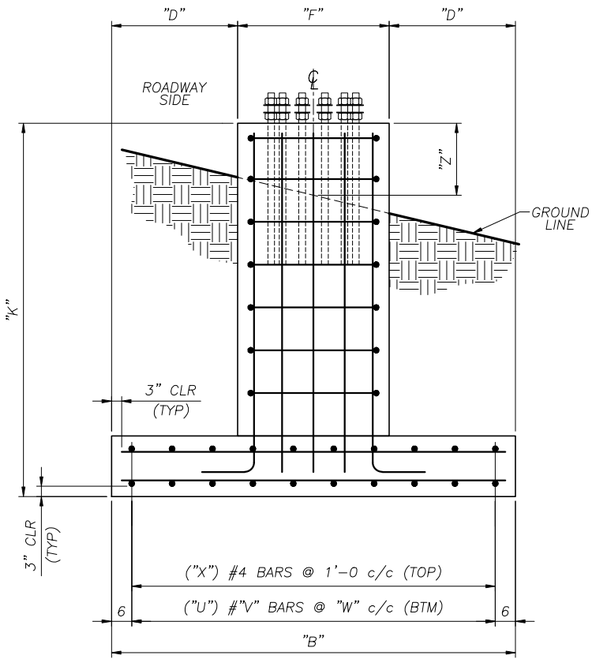


*(8) ANCHOR BOLTS

(OH–30, OH–31A & OH–31B only)



SIDE VIEW



END VIEW

STRUCTURE	STATION	"A"	"B"	"D"	"E"	"F"	"G"	"K"	"M"	"N"	"P"	"S"	"T"	"U"	"V"	"W"	"X"	"Y"	CONC/FTG (cu yds)	REINF/FTG (lbs)	"Z"
OH–29	209+50.04(SB)	23'–0	12'–0	3'–9	9'–3	4'–6	4'–0	6'–0	4–#5	40	8	23	4	12	6	1'–0	12	2'–0	23.44	1722	1'–0
* OH–30	38+93.47(SB)	21'–0	11'–0	3'–3	8'–3	4'–6	4'–0	5'–6	4–#5	40	8	21	4	11	8	1'–0	11	1'–6	15.83	1777	1'–0
* OH–31A	51+00(EB)	17'–0	9'–0	2'–6	6'–6	4'–0	4'–0	5'–6	4–#4	32	8	17	4	9	5	1'–0	9	1'–6	10.87	1014	1'–3
* OH–31B	66+00(EB)	17'–0	9'–0	2'–6	6'–6	4'–0	4'–0	5'–6	4–#4	32	8	17	4	9	5	1'–0	9	1'–6	10.87	1014	1'–3

NOTE:
SEE GENERAL NOTES DRAWING FOR MATERIAL SPECIFICATIONS, FOUNDATION AND STANDARD NOTES

GROUP 2

AASHTO 6th Edition Spec's

SEALED BY:

SOUTH CAROLINA PROFESSIONAL ENGINEER
No. 38665
DAVID A LALLONE

Oct 25 2023

walpar
A valmont COMPANY
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

NO:	REVISIONS	DATE	MADE	CHECKED
0	CHECK COMPLETE	9/14/23	IWL	RRW

STATE: South Carolina
FED PROJ: Carolina Crossroads Phase 1 & 2
ST PROJ: P039718
COUNTY: Lexington & Richland
ROUTE: I–26 & I–126

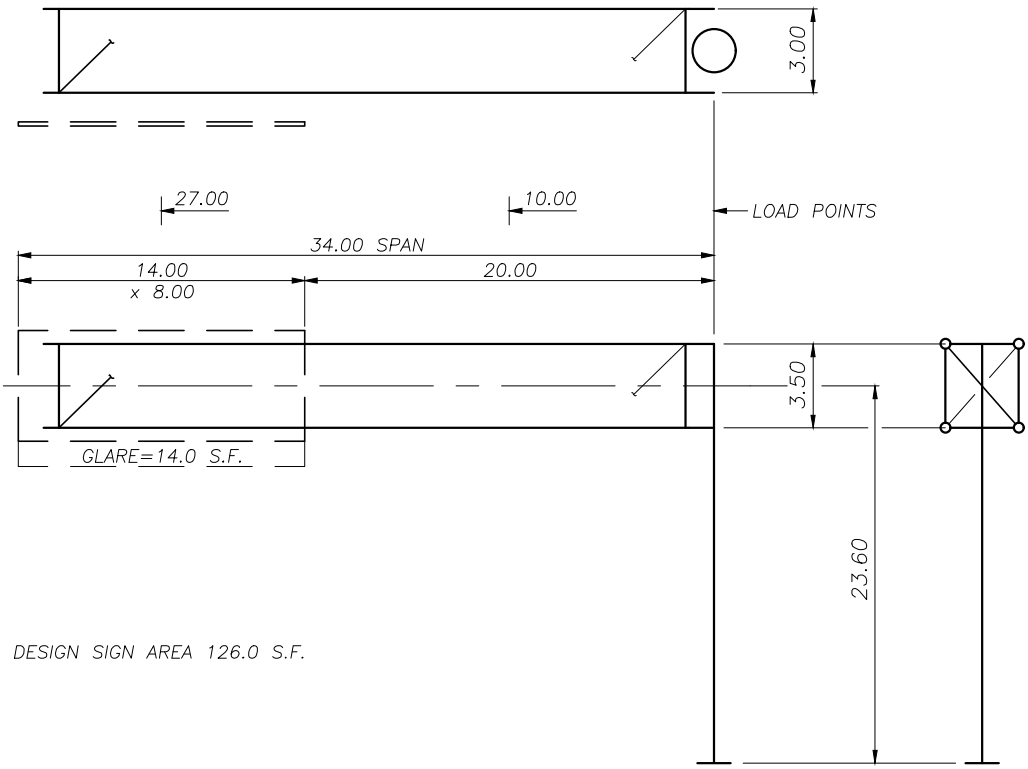
SUBJECT: OVERHEAD SIGN SUPPORT
SINGLE POLE SPREAD FOOTING DESIGN
FOR: Archer–United Joint Venture

DRAWN BY: IWL DATE: 8/24/23
CHECKED BY: RRW DATE: 9/14/23

DWG NO: C3546–D14

SP–SF–D

NAME: E:\ocad\Djobs\SC\3546\3546–D14.dwg DATE: SEP 14, 2023 TIME: 9:44 AM rw706292



DESIGN SIGN AREA 126.0 S.F.

8 – 1.50"ø ANCHOR BOLTS

STR NO: OH–31A
STA NO: 51+00(EB)

CHORDS	3.500 x 0.188
VERTICAL DIAGONALS	1.315 x 0.133
VERTICAL STRUTS	1.315 x 0.133
HORIZ STRUTS & DIAG'S	1.660 x 0.140
POST	24.000 x 0.375

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 38665
DAVID A LALLONE

Oct 25 2023

Box Truss Cantilever Structure Design

Reference Walpar Job Number : C3546
Reference Design Information Sheet Number : C5 Structure : OH-31A Station : 51+00(EB)
State : SC
AASHTO Specification : 6th Edition Fatigue Category : II
Design Wind Velocity (V) : 100 mph

Structure Dimensions

Span (S) 34.00 ft Truss Hgt (U) 3.50 ft Truss Depth (Y) 3.00 ft
Post Hgt (H) 23.60 ft Coeff of Hgt (Kz) 0.94

Sign Information

Actual Sign Area: 126.00 sq ft

Z Ecc to bottom of glare screen

Sign	Load (i)	Lgth (B_i)	Hgt (D_i)	Location (a_i)	Unit wgt	Depth	C_d	Z Ecc	Area	Exit Panel
1	2	14.00	8.00	27.00	7.00		1.17	5.00	126.00	

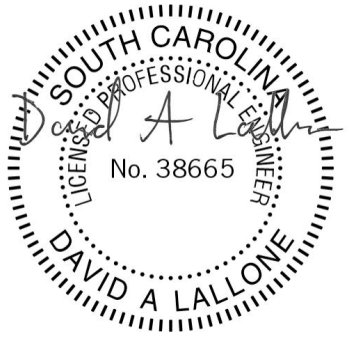
Walkway Information

	Lgth	Location	Width	Unit wgt	Y Ecc
WW1	18.00	25.00	2.54	60	4.95
WW2					

Load Summary Estimate

Weight of truss only 1623 lbs
Weight of truss with signs 2505 lbs
Post weight † 2887 lbs

† includes additonal wgt from base plate



Oct 25 2023

0

C5 - 1 of 8

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Loads

Unit wind load on sign(s)/C_d: 27.43 psf Unit wind load on exposed truss: 32.92 psf Unit wgt of truss: 40.75 plf Unit ice wgt on truss: 19.30 plf

Truss Area for Wind Load (A_t): 0.84 sq ft / ft ***All loads in charts in lbs, ft or ft-lbs unless noted**

Truss Load Summary For Actual Sign & WW Condition

	Load (i)	Dead	Wind (W_p & W_h)	Ice
Sign and Truss Loads	1	815	550	386
	2	1453	4053	648
WW Loads	WW1	1080	361	480
Post Reaction (R_1)		3348	4964	1514
Truss Moments (M)		74369	123961	33369

** WW/Equipment Loads are incorporated into Sign and Truss Loads to determine Reactions and Moments.

Post Loads

Dead	Wind	Ice	Group II t_c	Group III t_c
2899	626	478	125	188

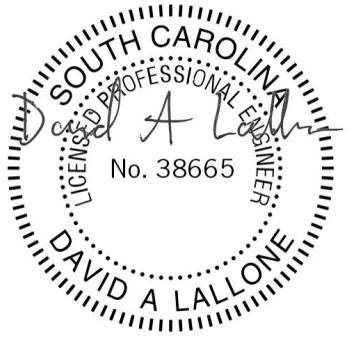
Load Combinations for Design Sign Area (Max Condition)

Truss Member Loads	DL	DL +WL	DL+1/2 WL+IL
Truss Chords (Pc)	10624	31284	25721
Vertical Diagonals (Pv)	6054	6054	9775
Horizontal Diagonals (Ph)	2162	4681	2735
Vertical Struts (Psv)	4087	5470	6599
Horizontal Struts (Psh)	2068	3254	3572

Serviceability Requirements

Truss DL Deflection	0.40 in.
Total DL Deflection	2.24 in.
Limit for Deflection	2.72 in.
Camber Used (Cu)	4.25 in.
Permanent Camber (Cp)	3.85 in.
Post Tilt	0.73 in.
Post Deflection Limits	7.61 in.
D^2/400 Limit	2.43 in.
Horizontal WL Deflection	1.90 in.
Horizontal Defl Limits	10.20 in.

	Post Loads					
	M_N	M_{tc}	M_z/Torsion	V_N	V_{tc}	Axial
Group II Comb. 1 (DL+WL)	124977	100759	126416	5670	1118	6247
Group III Comb. 1 (DL+1/2WL+IL)	64246	120249	63208	2875	559	8239
Group II Comb. 2 (DL+WL)	74933	111902	83156	3434	1677	6247
Group III Comb. 2 (DL+1/2WL+IL)	39629	126504	41578	1757	839	8239



Oct 25 2023

0

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Material Information

	Pipe Size (Min Yield)	Unbraced Lgth	CSR Group II	CSR Group III
Truss Chords	3.500 x 0.188 (52 ksi)	7.65 ft	0.51	0.42
Vertical Diagonals	1.315 x 0.133 (52 ksi)	5.19 ft	0.39	0.63
Vertical Struts	1.315 x 0.133 (52 ksi)	3.50 ft	0.56	0.68
Horizontal Diagonals	1.660 x 0.140 (52 ksi)	4.86 ft	0.41	0.24
Horizontal Struts	1.660 x 0.140 (52 ksi)	3.00 ft	0.17	0.18
Post	24.000 x 0.375 (52 ksi)	25.35 ft	0.32	0.24

Structure Detail Information

Truss to Post Connection

Connection Bolt Qty & Size	6 - ¾" ø A325
Connection Plate Weld "A"	¼ fillet
Connection Plate Weld "B"	3/16 fillet
Connection Plate Welds "C"&"D"	3/16 fillet

Post Detail

Maximum Anchor Bolt Pullout	31155 lbs		
Anchor Bolt Circle	30 in. Dia		
Anchor Bolt Yield	55 ksi		
Anchor Bolt Qty & Size	8 - 1.5" ø	ACI 318 App D checked	
Anchor Bolt Length (Embed Used)	4.50 ft (3.5 ft)	with Min. Req'd Embed	2.29 ft
Anchor Bolt CSR	0.51		
Base Plate Thickness	1.5 in.		
Base Plate Weld	5/16 fillet		
Gusset Plates at Base	8-½" x 12"		

Sign Hanger Detail

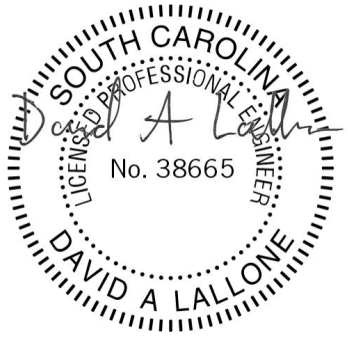
Design hanger spacing 9.00 ft

Sign Hanger U-Bolt type ASTM-A307

SIGN	Max UBL at End	Max Spacing	Hanger U-Bolt	Sign Hanger	Hanger Support
1	3.25 ft	9.00 ft	2 - ½" ø	L5x3x5/16	W6x9

Structure Input (For Foundation Designs)

Sign DL React (DLS)	1.96 k
Truss DL React (DLT)	1.39 k
Post DL React (DLP)	2.90 k
Truss WL React (Wh)	0.55 k
Truss WL React (Wp)	4.05 k
Post WL React (Wv)	0.63 k
Dist. To DLS & Wp (L1)	27.00 ft
Distance To Wh (L2)	17.00 ft
Distance To Rh (H1)	23.60 ft
Distance To Wv (H2)	12.68 ft
Torque at Base (Mt)	126.4 k-ft
Min Ped Wth (PL & PW)	4.00 ft



Oct 25 2023

0

C5 - 3 of 8

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Vibration and Fatigue (Per AASHTO 6th Edition)

Natural Wind Gust Load on Signs/C_d 4.42 psf
Natural Wind Gust Load on Truss 5.30 psf

Truck Induced Gust Load on Truss 17.54 psf
Extent of Truck Induced Gust 12.00 ft
Truss Area for Truck Induced Gust 0.83 sq ft / ft
Location of Center of Truck Induced Gust 28.00 ft

Truss Load Summary for Vibration and Fatigue

Loads (i)	NWG(i)	TIG(i)
1	89	
2	580	174
WW1	182	561
Post Reaction	851	735
Maximum Moments	21106	20592

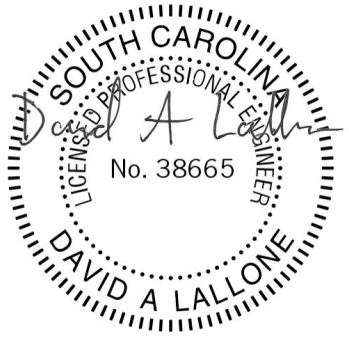
Member Forces for Vibration and Fatigue

Truss Members	P_{NWG}	P_{TG}
Truss Chords	3518	2942
Vertical Diagonals	-	545
Horizontal Diagonals	690	-
Vertical Struts	-	368
Horizontal Struts	425	-

	Post Loads at Base				
	M_N	M_Y	M_z/Torsion	V_N	Axial
Natural Wind	23212	-	21106	1098	-
Truck Induced Gust	-	20592	-	-	735

Vibration and Fatigue Stresses

	NWG (ksi)	TIG (ksi)	Allowable (ksi)
Post/Truss Connection	0.98	0.82	2.60
Truss Vertical Diagonals	-	0.74	1.20
Truss Horizontal Diagonals	0.64	-	1.20
Truss Vertical Struts	-	0.74	1.20
Truss Horizontal Struts	0.64	-	1.20
Post Base Connection	0.81	0.72	4.50
Base Stiffener Termination	1.72	1.53	7.00
Anchor bolts	4.00	3.64	7.00



Oct 25 2023

0

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Foundation Design

Boring Type SPT Boring Designation G-039
Major Soil Type Cohesionless Depth to Water NA Surcharge (Frost) Depth 2 ft
Ground Slope 4:1 Consider slope stability? Y

SOIL TYPES	
01-GP	07-SM
02-GW	08-ML
03-GM	09-MH
04-GC	10-SC
05-SP	11-CL
06-SW	12-CH

Soil Properties

Depth	N Value	γ' (pcf)	Φ (deg)	S_u (lbf/ft^2)	α	β	f_{SN} (lbf/ft^2)	$(N_1)_{60}$	Soil Type
**0 - 3	6	90	25	750	0.55		413	12	09
3 - 8	10	100	27			0.79	410	20	08
8 - 10	18	110	29			1.10	962	32	08
10 - 35	18	110	27			1.04	1190	18	08

* Soil Type 13 indicates rock layer with N>60 for cohesionless soil or N>40 for cohesive soils
**Top 2.0 ft of soil will not contribute to load resistance

Soil Bearing Capacity for Spread Footing Design

Footing width, B 9.00 ft
Footing length, L 17.00 ft
Eccentricity, e_L 1.27 ft
Eccentricity, e_B 1.09 ft
Effective ftg width, B' 6.82 ft
Effective ftg width, L' 14.46 ft

Ultimate bearing capacity, q_{ult} 10.49 ksf
Allowable Bearing Capacity 3.25 ksf
Bearing Capacity used *** 2.00 ksf

Total wgt of load, foundation and soil, Pt 91.71 k
Normal moment, ML 116.45 ft-k
Transverse moment, Mw 99.84 ft-k
Distance from ground to bottom of footing, d_{min} 3.13 ft
Distance from ground to bottom of footing, D_f 4.25 ft
Distance to ground water from bottom of ftg, z_w
Overburden pressure at base of footing, q 0.45 ksf
Weighted average soil unit weight, γ 105 pcf

***Note: Bearing capacities greater than 4.0 ksf will rarely effect spread footing pad size



Oct 25 2023

0

C5 - 5 of 8

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Cantilever Spread Footing Design

Material/Soil Specifications and Safety Factors

Concrete f'_c :	3000 psi	Concrete wgt :	150 pcf
Rebar yield f_y :	60000 psi	Rebar F_s :	24000 psi
Soil Bearing Capacity :	2000 psf	Soil unit wgt :	110 pcf

Load Safety Factor[1] : 1.15

Loads and Locations From Structure

Sign DL React (DLS)	1.96 k	Distance to DLS & Wp (L1)	27.00 ft
Truss DL React (DLT)	1.39 k	Distance to Wh (L2)	17.00 ft
Post DL React (DLP)	2.90 k	Distance to Rh (H1)	23.60 ft
Truss WL React (Wh)	0.55 k	Distance to Wv (H2)	12.68 ft
Truss WL React (Wp)	4.05 k	Torque at Base (M_t)	126.4 ft-k
Post WL React (Wv)	0.63 k	Min Ped Width (PL/PW)	4.00 ft

Loads at Top of Pedestal from Structure

Axial load (P)	6.25 k		
Moment (ML)	116.45 ft-k	Moment (Mw)	99.84 ft-k
Shear (VL)	5.22 k	Shear (Vw)	1.05 k

Final Spread Footing Design Sizes

Pad Length (L)	17.00 ft	Pedestal Width/Length	4.00 ft (PW/PL)
Pad Width (W)	9.00 ft	Pedestal Projection	1.25 ft (PE)
Pad Thickness (T)	1.50 ft	Ground line to Top of Pad	2.75 ft (PT)

Reinforcement

Pad	Pedestal
Top Each Way - #4 Bars @ 12" o.c.	32 - #8 Vertical Bars Equally Spaced
X Direction - 9 - #5 Bars @ 12" o.c.	4 - #4 Ties @ 11.25" o.c.
Y Direction - 17 - #4 Bars @ 12" o.c.	

Serviceability	Quantities
2.89% of footing in uplift	1014 lbs of reinforcement
Safety factor against overturning = 7.35	10.87 cyd of concrete

Uncracked Section Calculations

Wgt of soil above pad (Ps)	41.44 k		
Wgt of concrete (Pc)	44.03 k	Total Area (A)	153.00 ft²
Total Load (Pt)	91.71 k		
X	8.50 ft	Y	4.50 ft
Ix	1032.75 ft⁴	Iy	3684.75 ft⁴
Mx	121.44 k-ft	My	166.95 k-ft

Corner Stresses [Factored loads[1] (unfactored loads)]

F1	1.51 ksf (1.39 ksf)
F2	0.46 ksf (0.47 ksf)
F3	-0.31 ksf (-0.20 ksf)
F4	0.74 ksf (0.72 ksf)

Cracked Section Calculations [Factored loads[1] (unfactored loads)]

A1	91.00 ft² (109.86 ft²)	L1	10.11 ft (12.21 ft)	W1	9.00 ft (9.00 ft)
A2	43.83 ft² (34.29 ft²)	L2	6.89 ft (4.79 ft)	W2	6.36 ft (7.15 ft)
A3	9.08 ft² (4.42 ft²)	L3	6.89 ft (4.79 ft)	W3	2.64 ft (1.85 ft)
A'	143.92 ft² (148.58 ft²)				
Xc	0.39 ft (0.21 ft)	X1	3.44 ft (2.40 ft)	Y1	0.00 ft (0.00 ft)
Yc	0.23 ft (0.12 ft)	X2	-5.06 ft (-6.10 ft)	Y2	1.32 ft (0.92 ft)
		X3	-3.91 ft (-5.30 ft)	Y3	-2.74 ft (-3.27 ft)
Ixc	888.10 ft⁴ (958.91 ft⁴)				
Iyc	3303.73 ft⁴ (3466.46 ft⁴)				
Ixcyc	-212.32 ft⁴ (-121.01 ft⁴)				
Mxc	100.48 ft-k (94.99 ft-k)				
Myc	131.04 ft-k (126.33 ft-k)				
X'	8.89 ft (8.71 ft)				
Y'	4.73 ft (4.62 ft)				

Corner Stresses [Factored loads[1] (unfactored loads)]

F1	1.60 ksf (1.43 ksf)
F2	0.48 ksf (0.49 ksf)
F3	-0.33 ksf (-0.19 ksf)
F4	0.79 ksf (0.75 ksf)



Oct 25 2023

0

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Cantilever Spread Footing Design (cont.)

Moment and Shear Calculation Results

L_{x1}	4.50 ft	W_{x1}	0.00 ft	S_{y1}	0.85 ksf	S_{x1}	1.20 ksf
L_{x2}	3.17 ft	W_{x2}	1.33 ft	S_{y2}	0.79 ksf	S_{x2}	1.03 ksf
L_{y1}	4.00 ft	W_{y1}	4.50 ft	S_{y3}	0.73 ksf	S_{x3}	0.89 ksf
L_{y2}	1.33 ft	W_{y2}	3.17 ft	Pcs	0.53 ksf		
				DTS_y	2.86 k	DTS_x	0.95 k
				M_{YY}	8.70 ft-k	M_{XX}	1.77 ft-k

Reinforcement Calculations

f_{cr} : 1596 psi v_{cr} : 69 psi n : 9.29
b : 12.00 in d : 14.00 in x : 5.25 in

About Y Axis		About X Axis	
p :	0.0018	p :	0.0018
k :	0.17	k :	0.17
j :	0.94	j :	0.94
f_{ca} :	563 psi	f_{ca} :	115 psi
v_{ca} :	18 psi	v_{ca} :	6 psi
Mt :	190555 in-lb	Mt :	38784 in-lb
ld_r :	33.35 in	ld_r :	20.46 in
ld_a :	75.00 in	ld_a :	27.00 in
ld_{min} :	34.23 in	ld_{min} :	27.39 in
A_{sr} :	0.25 in²	A_{sr} :	0.05 in²
A_s Used :	0.31 in²	A_s Used :	0.20 in²

Torque Calculations

P_1 :	25.50 k	P_{1P} :	11.00 k
P_2 :	13.50 k	P_{2P} :	11.00 k
TQ_m :	214.33 ft-k	T_u :	126.21 ft-k
TQ_a :	126.42 ft-k	T_{uo} :	95.23 ft-k
		A_{lr} :	2.99 in²
		A_{la} :	3.16 in²

Factor of safety against sliding (μ=0.40) : 7.02

Pedestal Calculations

V_1 : 5327 lbs V_2 : 0 lbs V_t : 0 lbs

About Y Axis		About X Axis	
C_x :	24.00 in	C_y :	24.00 in
G_x :	40.00 in	G_y :	40.00 in
f_a :	2.71 psi	fa :	3211 psi
F_a :	1596 psi	Fa :	26334 psi
f_{bx} :	54 psi	f_{by} :	72 psi
F_{bx} :	1596 psi	F_{by} :	1596 psi
M_x :	104028 ft-lb	M_y :	137338 ft-lb
M_{ox} :	672448 ft-lb	M_{oy} :	672448 ft-lb
I_x :	551952 in⁴	I_y :	551952 in⁴
A_g :	2304 in²	A_{sm} :	23.04 in²
A_{st} :	22.12 in²	A_s :	6.32 in²
QTY :	32	A_b :	0.79 in²
CSR :	0.10	CSM :	0.36



Oct 25 2023

0

C5 - 7 of 8

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31A Station : 51+00(EB)

Cantilever Cylindrical Footing Design

Material/Soil Specifications and Safety Factors

Concrete f '$_c$:	3000 psi	Concrete wgt :	150 pcf
Rebar yield f_y :	60000 psi	Min safety factor for torsion :	1.13
Reinforcement Clear :	4 in	Min safety factor for lateral load :	2.86

Loads and Locations From Structure

Sign DL React (DLS)	1.96 k	Dist. To DLS & Wp (L1)	27.00 ft
Truss DL React (DLT)	1.39 k	Distance To Wh (L2)	17.00 ft
Post DL React (DLP)	2.90 k	Distance To Rh (H1)	23.60 ft
Truss WL React (Wh)	0.55 k	Distance To Wv (H2)	12.68 ft
Truss WL React (Wp)	4.05 k	Footing Projection (H3)	1.25 ft
Post WL React (Wv)	0.63 k	Torque at Base (M_t)	126.4 ft-k

Loads at Top of Cylinder from Structure

Dead Load Moment (MDL)	101.19 ft-k	Effective height (Heff)	22.29 ft
Wind Load Moment (MWL)	116.45 ft-k	Lateral load from MDL (PDL)	1.04 k
Resultant Moment (MR)	159.68 ft-k	Resultant Lateral Load (PRL)	7.16 k
Wind Load Shear at Base (PWL)	5.22 k	Total Dead Load at Column Base (TDL)	6.25 k
Transverse Load (t_c)	1.04 k		

Final Cylindrical Footing Design Sizes

Req'd A_s	6.35 in²	Rebar Cage Dia (D1)	37.87 in
1% Cyl Area Min A_m	18.10 in²	Vertical bar spacing	6.26 in
Reinf Area Provided A_p	19.00 in²		

USE 48 in DIA x 14'-0 CYLINDER
w/ 19- # 9 VERT. BARS & 16 - #4 HOOPS
Extra Hoop 3 inches below top hoop

Serviceability

Calculated torsional / axial safety factors = 1.71 / 11.27
Calculated lateral safety factor = 7.14

Quantities

992 lbs of reinforcement
6.52 cyd of concrete

Torsion Calculation Results
(from Beta Method)

Cylinder Embedment	12.75 ft
Axial load	6.25 k
Torsional load	126.42 ft-k
Weight of shaft	26.39 k
Max Allow Torque on reinf CYL	206.47 ft-k
Side Resist. Capacity	96.3 k
Allowable side resist. torque	192.56 ft-k
N for Tip Rresist. (BPF)	18.00
Tip Resist. Capacity	271.43 k
Allowable Tip Resist. Torque	23.7 ft-k
	0.0 ft-k
Total Allowable Torque	216.3 ft-k
Calc'd Torsional safety factor	1.71

Lateral Load Calculation Results
(from Brom's Method)

Soil friction angle Φ	27.0 deg
Soil unit weight γ	105 pcf
AVG $(N_1)_{60}$ over req'd dp (BPF)	21
Lateral load from structure	7.2 k
Moment from structure	159.7 ft-k
Rankine Passive Pressure Coeff. K_P	3.14
Ultimate soil resistance P_{ult}	98 k
Allowable soil resistance P_{max}	46 k
Ultimate soil mom cap M_{ult}	1370 ft-k
Allowable soil mom cap M_{max}	637 ft-k
Ground line moment	169 ft-k
Dist GL to 0 shear pt in CYL	3.90 ft
Maximum moment in shaft	192 ft-k

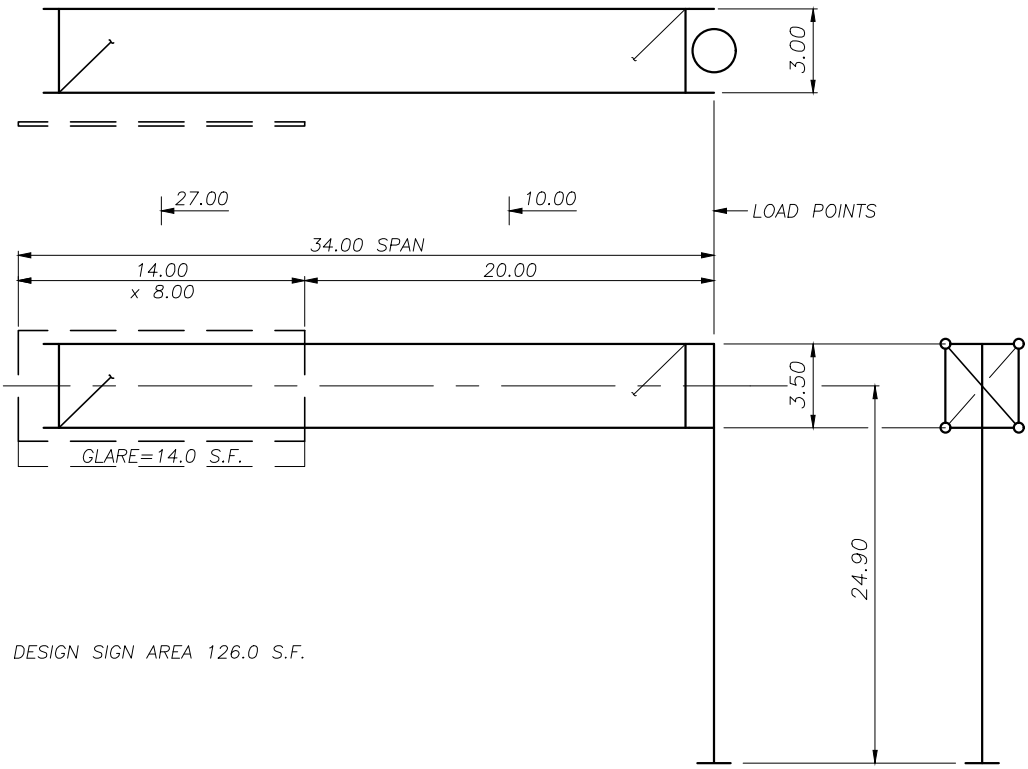


Oct 25 2023

0

C5 - 8 of 8

Walpar (c) 2014



DESIGN SIGN AREA 126.0 S.F.

8 – 1.50"ø ANCHOR BOLTS

STR NO: OH–31B
STA NO: 66+00(EB)

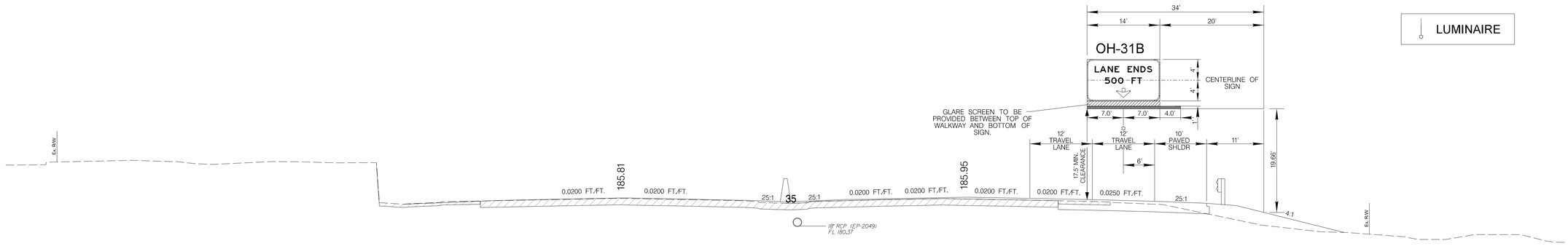
CHORDS	3.500 x 0.188
VERTICAL DIAGONALS	1.315 x 0.133
VERTICAL STRUTS	1.315 x 0.133
HORIZ STRUTS & DIAG'S	1.660 x 0.140
POST	24.000 x 0.375

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 38665
DAVID A LALLONE

Feb 7 2024

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	RICHLAND	P039718	I-26	SN39

NOTE: CONTRACTOR SHALL FIELD VERIFY VERTICAL SUPPORT LENGTHS AND HORIZONTAL DIMENSIONS AFTER FINAL GRADING BEFORE FABRICATION



DESIGN WIND SPEED = 100 MPH

ERECT NEW OH STRUCTURE & SIGNS

OVERHEAD STRUCTURE NO. 31B
INTERSTATE 126 STA. 66+00.00
EASTBOUND
DIRECTION OF TRAVEL

SCALE: 1" = 10'

ARCHER UNITED JOINT VENTURE

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

2022.11.16 15:48:56-05'00'

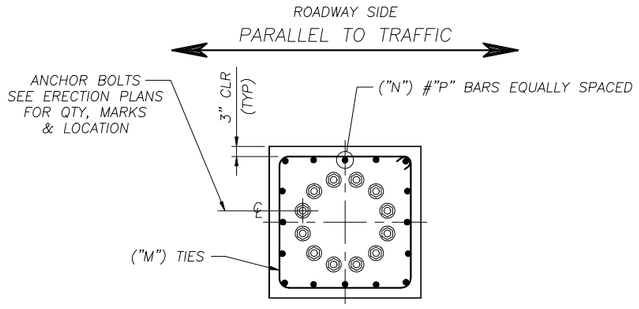
REV. NO.	BY	DATE	DESCRIPTION OF REVISION
6			
5			
4			
3			
2			
1			
0	AOL	11-16-22	RELEASED FOR CONSTRUCTION

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

CAROLINA CROSSROADS PHASE 1

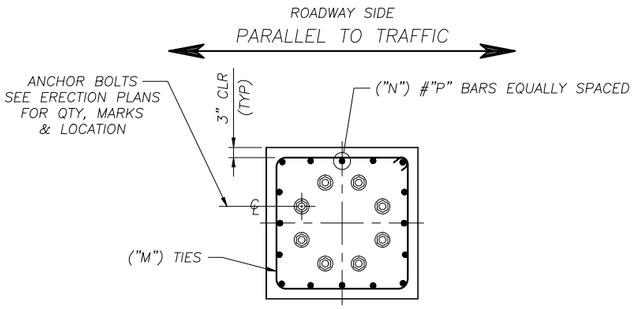
OVERHEAD STRUCTURE ELEVATION VIEW

Z:\Projects\20-6\CCR Ph I\Roadway\PLANS\SN Plans\043_01_P039718_Signing_Plan_XS_Sheet_SN39.dgn
11/16/2022



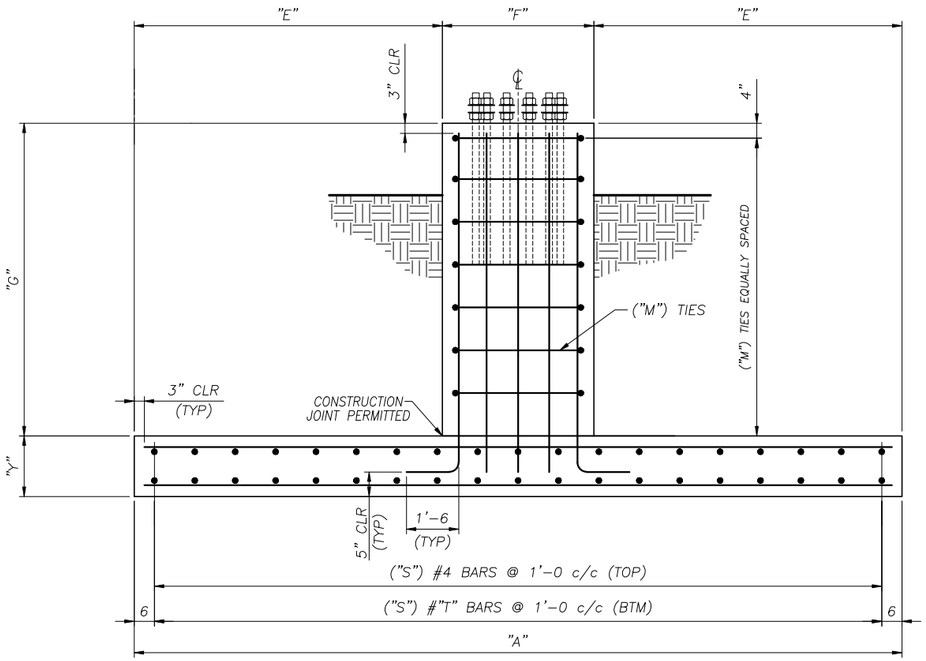
(12) ANCHOR BOLTS

(OH–29 only)

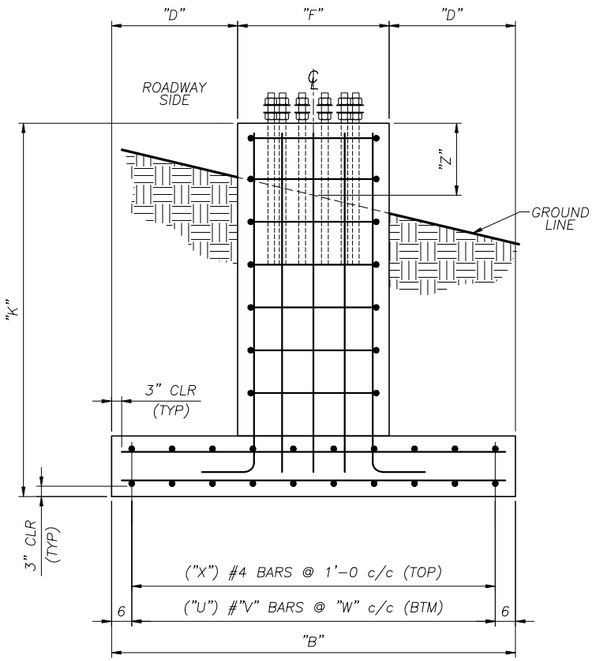


*(8) ANCHOR BOLTS

(OH–30, OH–31A & OH–31B only)



SIDE VIEW



END VIEW

STRUCTURE	STATION	"A"	"B"	"D"	"E"	"F"	"G"	"K"	"M"	"N"	"P"	"S"	"T"	"U"	"V"	"W"	"X"	"Y"	CONC/FTG (cu yds)	REINF/FTG (lbs)	"Z"
OH–29	209+50.04(SB)	23'–0	12'–0	3'–9	9'–3	4'–6	4'–0	6'–0	4–#5	40	8	23	4	12	6	1'–0	12	2'–0	23.44	1722	1'–0
* OH–30	38+93.47(SB)	21'–0	11'–0	3'–3	8'–3	4'–6	4'–0	5'–6	4–#5	40	8	21	4	11	8	1'–0	11	1'–6	15.83	1777	1'–0
* OH–31A	51+00(EB)	17'–0	9'–0	2'–6	6'–6	4'–0	4'–0	5'–6	4–#4	32	8	17	4	9	5	1'–0	9	1'–6	10.87	1014	1'–3
* OH–31B	66+00(EB)	17'–0	9'–0	2'–6	6'–6	4'–0	4'–0	5'–6	4–#4	32	8	17	4	9	5	1'–0	9	1'–6	10.87	1014	1'–3

NOTE:
SEE GENERAL NOTES DRAWING FOR MATERIAL SPECIFICATIONS, FOUNDATION AND STANDARD NOTES

GROUP 2

AASHTO 6th Edition Spec's

SEALED BY:

SOUTH CAROLINA PROFESSIONAL ENGINEER
No. 38665
DAVID A LALLONE

Oct 25 2023

walpar
A valmont COMPANY
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

NO:	REVISIONS	DATE	MADE	CHECKED
0	CHECK COMPLETE	9/14/23	IWL	RRW

STATE: South Carolina
FED PROJ: Carolina Crossroads Phase 1 & 2
ST PROJ: P039718
COUNTY: Lexington & Richland
ROUTE: I–26 & I–126

SUBJECT: OVERHEAD SIGN SUPPORT
SINGLE POLE SPREAD FOOTING DESIGN
FOR: Archer–United Joint Venture

DRAWN BY: IWL DATE: 8/24/23
CHECKED BY: RRW DATE: 9/14/23

DWG NO: C3546–D14

SP–SF–D

NAME: E:\ocad\Djobs\SC\3546\3546–D14.dwg DATE: SEP 14, 2023 TIME: 9:44 AM rw706292

Box Truss Cantilever Structure Design

Reference Walpar Job Number : C3546
Reference Design Information Sheet Number : C6 Structure : OH-31B Station : 66+00(EB)
State : SC
AASHTO Specification : 6th Edition Fatigue Category : II
Design Wind Velocity (V) : 100 mph

Structure Dimensions

Span (S) 34.00 ft Truss Hgt (U) 3.50 ft Truss Depth (Y) 3.00 ft
Post Hgt (H) 24.90 ft Coeff of Hgt (Kz) 1.00

Sign Information

Actual Sign Area: 126.00 sq ft

Z Ecc to bottom of glare screen

Sign	Load (i)	Lgth (B_i)	Hgt (D_i)	Location (a_i)	Unit wgt	Depth	C_d	Z Ecc	Area	Exit Panel
1	2	14.00	8.00	27.00	7.00		1.17	5.00	126.00	

Walkway Information

	Lgth	Location	Width	Unit wgt	Y Ecc
WW1	18.00	25.00	2.54	60	4.72
WW2					

Load Summary Estimate

Weight of truss only 1623 lbs
Weight of truss with signs 2505 lbs
Post weight † 3009 lbs

† includes additonal wgt from base plate



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Loads

Unit wind load on sign(s)/C_d: 29.18 psf Unit wind load on exposed truss: 35.02 psf Unit wgt of truss: 40.75 plf Unit ice wgt on truss: 19.30 plf

Truss Area for Wind Load (A_t): 0.84 sq ft / ft ***All loads in charts in lbs, ft or ft-lbs unless noted**

Truss Load Summary For Actual Sign & WW Condition

	Load (i)	Dead	Wind (W_p & W_h)	Ice
Sign and Truss Loads	1	815	585	386
	2	1453	4311	648
WW Loads	WW1	1080	385	480
Post Reaction (R_L)		3348	5281	1514
Truss Moments (M)		74369	131873	33369

** WW/Equipment Loads are incorporated into Sign and Truss Loads to determine Reactions and Moments.

Post Loads

Dead	Wind	Ice	Group II t_c	Group III t_c
3021	700	502	140	210

Load Combinations for Design Sign Area (Max Condition)

Truss Member Loads	DL	DL +WL	DL+1/2 WL+IL
Truss Chords (Pc)	10624	32603	26381
Vertical Diagonals (Pv)	5931	5931	9664
Horizontal Diagonals (Ph)	2088	4939	2850
Vertical Struts (Psv)	4004	5475	6523
Horizontal Struts (Psh)	1997	3259	3507

Serviceability Requirements

Truss DL Deflection	0.40 in.
Total DL Deflection	2.34 in.
Limit for Deflection	2.72 in.
Camber Used (Cu)	4.25 in.
Permanent Camber (Cp)	3.85 in.
Post Tilt	0.81 in.
Post Deflection Limits	7.99 in.
D^2/400 Limit	2.43 in.
Horizontal WL Deflection	2.16 in.
Horizontal Defl Limits	10.20 in.

	Post Loads					
	M_N	M_{tc}	M_z/Torsion	V_N	V_{tc}	Axial
Group II Comb. 1 (DL+WL)	140537	104149	134485	6057	1196	6369
Group III Comb. 1 (DL+1/2WL+IL)	72026	121817	67242	3066	598	8386
Group II Comb. 2 (DL+WL)	84217	116609	88463	3665	1794	6369
Group III Comb. 2 (DL+1/2WL+IL)	44297	128857	44232	1870	897	8386



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Material Information

	Pipe Size (Min Yield)	Unbraced Lgth	CSR Group II	CSR Group III
Truss Chords	3.500 x 0.188 (52 ksi)	7.65 ft	0.53	0.43
Vertical Diagonals	1.315 x 0.133 (52 ksi)	5.19 ft	0.38	0.63
Vertical Struts	1.315 x 0.133 (52 ksi)	3.50 ft	0.56	0.67
Horizontal Diagonals	1.660 x 0.140 (52 ksi)	4.86 ft	0.44	0.25
Horizontal Struts	1.660 x 0.140 (52 ksi)	3.00 ft	0.17	0.18
Post	24.000 x 0.375 (52 ksi)	26.65 ft	0.35	0.25

Structure Input (For Foundation Designs)

Sign DL React (DLS)	1.96 k
Truss DL React (DLT)	1.39 k
Post DL React (DLP)	3.02 k
Truss WL React (Wh)	0.59 k
Truss WL React (Wp)	4.30 k
Post WL React (Wv)	0.70 k
Dist. To DLS & Wp (L1)	27.00 ft
Distance To Wh (L2)	17.00 ft
Distance To Rh (H1)	24.90 ft
Distance To Wv (H2)	13.32 ft
Torque at Base (Mt)	134.5 k-ft
Min Ped Wth (PL & PW)	4.00 ft

Structure Detail Information

Truss to Post Connection

Connection Bolt Qty & Size	6 - ¾" ø A325
Connection Plate Weld "A"	¼ fillet
Connection Plate Weld "B"	3/16 fillet
Connection Plate Welds "C"&"D"	3/16 fillet

Post Detail

Maximum Anchor Bolt Pullout	33996 lbs		
Anchor Bolt Circle	30 in. Dia		
Anchor Bolt Yield	55 ksi		
Anchor Bolt Qty & Size	8 - 1.5" ø	ACI 318 App D checked	
Anchor Bolt Length (Embed Used)	4.50 ft (3.5 ft)	with Min. Req'd Embed	2.42 ft
Anchor Bolt CSR	0.59		
Base Plate Thickness	1.5 in.		
Base Plate Weld	5/16 fillet		
Gusset Plates at Base	8-½" x 12"		

Sign Hanger Detail

Design hanger spacing 9.00 ft

Sign Hanger U-Bolt type ASTM-A307

SIGN	Max UBL at End	Max Spacing	Hanger U-Bolt	Sign Hanger	Hanger Support
1	3.25 ft	9.00 ft	2 - ½" ø	L5x3x5/16	W6x9

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER
David A Lallone
No. 38665
DAVID A LALLONE

Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Vibration and Fatigue (Per AASHTO 6th Edition)

Natural Wind Gust Load on Signs/C_d 4.42 psf

Natural Wind Gust Load on Truss 5.30 psf

Truck Induced Gust Load on Truss 17.54 psf

Extent of Truck Induced Gust 12.00 ft

Truss Area for Truck Induced Gust 0.83 sq ft / ft

Location of Center of Truck Induced Gust 28.00 ft

Truss Load Summary for Vibration and Fatigue

Loads (i)	NWG(i)	TIG(i)
1	89	
2	580	174
WW1	182	561
Post Reaction	851	735
Maximum Moments	21106	20592

Member Forces for Vibration and Fatigue

Truss Members	P_{NWG}	P_{TG}
Truss Chords	3518	2942
Vertical Diagonals	-	545
Horizontal Diagonals	690	-
Vertical Struts	-	368
Horizontal Struts	425	-

	Post Loads at Base				
	M_N	M_Y	M_z/Torsion	V_N	Axial
Natural Wind	24638	-	21106	1110	-
Truck Induced Gust	-	20592	-	-	735

Vibration and Fatigue Stresses

	NWG (ksi)	TIG (ksi)	Allowable (ksi)
Post/Truss Connection	0.98	0.82	2.60
Truss Vertical Diagonals	-	0.74	1.20
Truss Horizontal Diagonals	0.64	-	1.20
Truss Vertical Struts	-	0.74	1.20
Truss Horizontal Struts	0.64	-	1.20
Post Base Connection	0.86	0.72	4.50
Base Stiffener Termination	1.83	1.53	7.00
Anchor bolts	4.30	3.64	7.00



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Foundation Design

Boring Type SPT Boring Designation G-042
Major Soil Type Cohesionless Depth to Water 15 ft Surcharge (Frost) Depth 2 ft
Ground Slope 4:1 Consider slope stability? Y

SOIL TYPES	
01-GP	07-SM
02-GW	08-ML
03-GM	09-MH
04-GC	10-SC
05-SP	11-CL
06-SW	12-CH

Soil Properties

Depth	N Value	γ' (pcf)	Φ (deg)	S_u (lbf/ft^2)	α	β	f_{SN} (lbf/ft^2)	$(N_1)_{60}$	Soil Type
**0 - 4	4	106	31	500	0.55		275	8	10
4 - 6.5	3	102	35			0.24	132	6	05
6.5 - 8	28	114	36			1.14	870	54	07
8 - 13.5	15	108	33			1.06	1213	24	07
13.5 - 15	6	103	29			0.40	583	9	07
15 - 18.5	6	53	29					8	07
18.5 - 20	16	58	32					21	07
20 - 35	16	58	31					16	07

* Soil Type 13 indicates rock layer with N>60 for cohesionless soil or N>40 for cohesive soils
**Top 2.0 ft of soil will not contribute to load resistance

Soil Bearing Capacity for Spread Footing Design

Footing width, B 9.00 ft
Footing length, L 17.00 ft
Eccentricity, e_L 1.43 ft
Eccentricity, e_B 1.12 ft
Effective ftg width, B' 6.76 ft
Effective ftg width, L' 14.15 ft

Total wgt of load, foundation and soil, Pt 91.84 k
Normal moment, ML 130.96 ft-k
Transverse moment, Mw 102.77 ft-k
Distance from ground to bottom of footing, d_{min} 3.13 ft
Distance from ground to bottom of footing, D_f 4.25 ft
Distance to ground water from bottom of ftg, z_w 11.88 ft
Overburden pressure at base of footing, q 0.47 ksf
Weighted average soil unit weight, γ 107 pcf

Ultimate bearing capacity, q_{ult} 27.89 ksf
Allowable Bearing Capacity 9.25 ksf
Bearing Capacity used *** 2.00 ksf

***Note: Bearing capacities greater than 4.0 ksf will rarely effect spread footing pad size



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Cantilever Spread Footing Design

Material/Soil Specifications and Safety Factors

Concrete f'_c :	3000 psi	Concrete wgt :	150 pcf
Rebar yield f_y :	60000 psi	Rebar F_s :	24000 psi
Soil Bearing Capacity :	2000 psf	Soil unit wgt :	110 pcf

Load Safety Factor[1] : 1.15

Loads and Locations From Structure

Sign DL React (DLS)	1.96 k	Distance to DLS & Wp (L1)	27.00 ft
Truss DL React (DLT)	1.39 k	Distance to Wh (L2)	17.00 ft
Post DL React (DLP)	3.02 k	Distance to Rh (H1)	24.90 ft
Truss WL React (Wh)	0.59 k	Distance to Wv (H2)	13.32 ft
Truss WL React (Wp)	4.30 k	Torque at Base (M_t)	134.5 ft-k
Post WL React (Wv)	0.70 k	Min Ped Width (PL/PW)	4.00 ft

Loads at Top of Pedestal from Structure

Axial load (P)	6.37 k		
Moment (ML)	130.96 ft-k	Moment (MW)	102.77 ft-k
Shear (VL)	5.59 k	Shear (VW)	1.12 k

Final Spread Footing Design Sizes

Pad Length (L)	17.00 ft	Pedestal Width/Length	4.00 ft (PW/PL)
Pad Width (W)	9.00 ft	Pedestal Projection	1.25 ft (PE)
Pad Thickness (T)	1.50 ft	Ground line to Top of Pad	2.75 ft (PT)

Reinforcement

Pad	Pedestal
Top Each Way - #4 Bars @ 12" o.c.	32 - #8 Vertical Bars Equally Spaced
X Direction - 9 - #5 Bars @ 12" o.c.	4 - #4 Ties @ 11.25" o.c.
Y Direction - 17 - #4 Bars @ 12" o.c.	

Serviceability	Quantities
4.10% of footing in uplift	1024 lbs of reinforcement
Safety factor against overturning = 18.60	10.87 cyd of concrete

Uncracked Section Calculations

Wgt of soil above pad (Ps)	41.44 k		
Wgt of concrete (Pc)	44.03 k	Total Area (A)	153.00 ft²
Total Load (Pt)	91.84 k		
X	8.50 ft	Y	4.50 ft
Ix	1032.75 ft⁴	Iy	3684.75 ft⁴
Mx	125.27 k-ft	My	185.94 k-ft

Corner Stresses [Factored loads[1] (unfactored loads)]

F1	1.57 ksf (1.45 ksf)
F2	0.48 ksf (0.50 ksf)
F3	-0.37 ksf (-0.25 ksf)
F4	0.72 ksf (0.70 ksf)

Cracked Section Calculations [Factored loads[1] (unfactored loads)]

A1	85.41 ft² (103.48 ft²)	L1	9.49 ft (11.50 ft)	W1	9.00 ft (9.00 ft)
A2	44.51 ft² (36.98 ft²)	L2	7.51 ft (5.50 ft)	W2	5.93 ft (6.72 ft)
A3	11.54 ft² (6.27 ft²)	L3	7.51 ft (5.50 ft)	W3	3.07 ft (2.28 ft)
A'	141.46 ft² (146.73 ft²)				
Xc	0.49 ft (0.28 ft)	X1	3.76 ft (2.75 ft)	Y1	0.00 ft (0.00 ft)
Yc	0.28 ft (0.16 ft)	X2	-4.74 ft (-5.75 ft)	Y2	1.54 ft (1.14 ft)
		X3	-3.49 ft (-4.83 ft)	Y3	-2.45 ft (-2.98 ft)

Ixc	853.42 ft⁴ (931.35 ft⁴)
Iyc	3222.19 ft⁴ (3391.95 ft⁴)
Ixcyc	-252.76 ft⁴ (-160.78 ft⁴)
Mxc	99.23 ft-k (94.26 ft-k)
Myc	141.01 ft-k (135.54 ft-k)
X'	8.99 ft (8.78 ft)
Y'	4.78 ft (4.66 ft)

Corner Stresses [Factored loads[1] (unfactored loads)]

F1	1.70 ksf (1.50 ksf)
F2	0.51 ksf (0.52 ksf)
F3	-0.41 ksf (-0.25 ksf)
F4	0.78 ksf (0.73 ksf)



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Cantilever Spread Footing Design (cont.)

Moment and Shear Calculation Results

L_{x1}	4.50 ft	W_{x1}	0.00 ft	S_{y1}	0.89 ksf	S_{x1}	1.24 ksf
L_{x2}	3.17 ft	W_{x2}	1.33 ft	S_{y2}	0.82 ksf	S_{x2}	1.07 ksf
L_{y1}	4.00 ft	W_{y1}	4.50 ft	S_{y3}	0.76 ksf	S_{x3}	0.91 ksf
L_{y2}	1.33 ft	W_{y2}	3.17 ft	Pcs	0.53 ksf		
				DTS_y	3.22 k	DTS_x	1.02 k
				M_{YY}	9.81 ft-k	M_{XX}	1.90 ft-k

Reinforcement Calculations

f_{cr} : 1596 psi v_{cr} : 69 psi n : 9.29
b : 12.00 in d : 14.00 in x : 5.25 in

About Y Axis		About X Axis	
p :	0.0018	p :	0.0018
k :	0.17	k :	0.17
j :	0.94	j :	0.94
f_{ca} :	635 psi	f_{ca} :	123 psi
v_{ca} :	20 psi	v_{ca} :	6 psi
Mt :	215057 in-lb	Mt :	41553 in-lb
ld_r :	33.36 in	ld_r :	20.47 in
ld_a :	75.00 in	ld_a :	27.00 in
ld_{min} :	34.23 in	ld_{min} :	27.39 in
A_{sr} :	0.28 in²	A_{sr} :	0.05 in²
A_s Used :	0.31 in²	A_s Used :	0.20 in²

Torque Calculations

P1 :	25.50 k	P1P :	11.00 k
P2 :	13.50 k	P2P :	11.00 k
TQ_m :	214.33 ft-k	T_u :	136.70 ft-k
TQ_a :	134.48 ft-k	T_{uo} :	95.24 ft-k
		A_{lr} :	2.99 in²
		A_{la} :	3.16 in²

Factor of safety against sliding (μ=0.40) : 6.58

Pedestal Calculations

V_1 : 5697 lbs V_2 : 0 lbs V_t : 0 lbs

About Y Axis		About X Axis	
C_x :	24.00 in	C_y :	24.00 in
G_x :	40.00 in	G_y :	40.00 in
f_a :	2.76 psi	fa :	3417 psi
F_a :	1596 psi	Fa :	26334 psi
f_{bx} :	56 psi	f_{by} :	80 psi
F_{bx} :	1596 psi	F_{by} :	1596 psi
M_x :	107251 ft-lb	M_y :	153307 ft-lb
M_{ox} :	672448 ft-lb	M_{oy} :	672448 ft-lb
I_x :	551952 in⁴	I_y :	551952 in⁴
A_g :	2304 in²	A_{sm} :	23.04 in²
A_{st} :	22.12 in²	A_s :	6.32 in²
QTY :	32	A_b :	0.79 in²
CSR :	0.10	CSM :	0.39



Feb 7 2024

1

Walpar (c) 2014

Box Truss Cantilever Structure Design

Job No : C3546 Structure No : OH-31B Station : 66+00(EB)

Cantilever Cylindrical Footing Design

Material/Soil Specifications and Safety Factors

Concrete f '$_c$:	3000 psi	Concrete wgt :	150 pcf
Rebar yield f_y :	60000 psi	Min safety factor for torsion :	1.13
Reinforcement Clear :	4 in	Min safety factor for lateral load :	2.86

Loads and Locations From Structure

Sign DL React (DLS)	1.96 k	Dist. To DLS & Wp (L1)	27.00 ft
Truss DL React (DLT)	1.39 k	Distance To Wh (L2)	17.00 ft
Post DL React (DLP)	3.02 k	Distance To Rh (H1)	24.90 ft
Truss WL React (Wh)	0.59 k	Distance To Wv (H2)	13.32 ft
Truss WL React (Wp)	4.30 k	Footing Projection (H3)	1.25 ft
Post WL React (Wv)	0.70 k	Torque at Base (M_t)	134.5 ft-k

Loads at Top of Cylinder from Structure

Dead Load Moment (MDL)	104.34 ft-k	Effective height (Heff)	23.45 ft
Wind Load Moment (MWL)	130.96 ft-k	Lateral load from MDL (PDL)	1.12 k
Resultant Moment (MR)	173.96 ft-k	Resultant Lateral Load (PRL)	7.42 k
Wind Load Shear at Base (PWL)	5.59 k	Total Dead Load at Column Base (TDL)	6.37 k
Transverse Load (t_c)	1.12 k		

Torsion Calculation Results
(from Beta Method)

Cylinder Embedment	13.75 ft
Axial load	6.37 k
Torsional load	134.48 ft-k
Weight of shaft	28.27 k
Max Allow Torque on reinf CYL	205.96 ft-k
Side Resist. Capacity	113.1 k
Allowable side resist. torque	226.19 ft-k
N for Tip Rresist. (BPF)	6.00
Tip Resist. Capacity	90.48 k
Allowable Tip Resist. Torque	30.0 ft-k
	0.0 ft-k
Total Allowable Torque	256.2 ft-k
Calc'd Torsional safety factor	1.91

Lateral Load Calculation Results
(from Brom's Method)

Soil friction angle ϕ	32.7 deg
Soil unit weight γ	107 pcf
AVG $(N_1)_{60}$ over req'd dp (BPF)	21
Lateral load from structure	7.4 k
Moment from structure	174.0 ft-k
Rankine Passive Pressure Coeff. K_P	2.65
Ultimate soil resistance P_{ult}	99 k
Allowable soil resistance P_{max}	46 k
Ultimate soil mom cap M_{ult}	1478 ft-k
Allowable soil mom cap M_{max}	687 ft-k
Ground line moment	183 ft-k
Dist GL to 0 shear pt in CYL	4.08 ft
Maximum moment in shaft	208 ft-k

Final Cylindrical Footing Design Sizes

Req'd A_s	6.89 in²	Rebar Cage Dia (D1)	37.87 in
1% Cyl Area Min A_m	18.10 in²	Vertical bar spacing	6.26 in
Reinf Area Provided A_p	19.00 in²		

USE 48 in DIA x 15'-0 CYLINDER
w/ 19- # 9 VERT. BARS & 17 - #4 HOOPS
Extra Hoop 3 inches below top hoop

Serviceability

Calculated torsional / axial safety factors = 1.91 / 5.88
Calculated lateral safety factor = 7.09

Quantities

1064 lbs of reinforcement
6.98 cyd of concrete



Feb 7 2024

1

Walpar (c) 2014