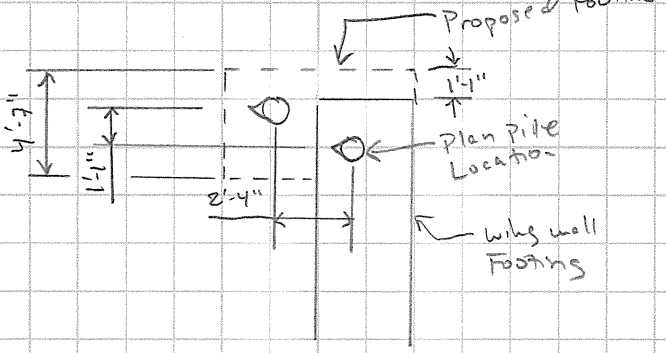
For	Bridge 13 Wingwall pile	Job no.	49633	Sheet no.	
Made by	KDG	Checked by	BTA	Backchecked by	EDC
Date	Sept 10, 2011	Date	9/12/11	Date	9-13-11

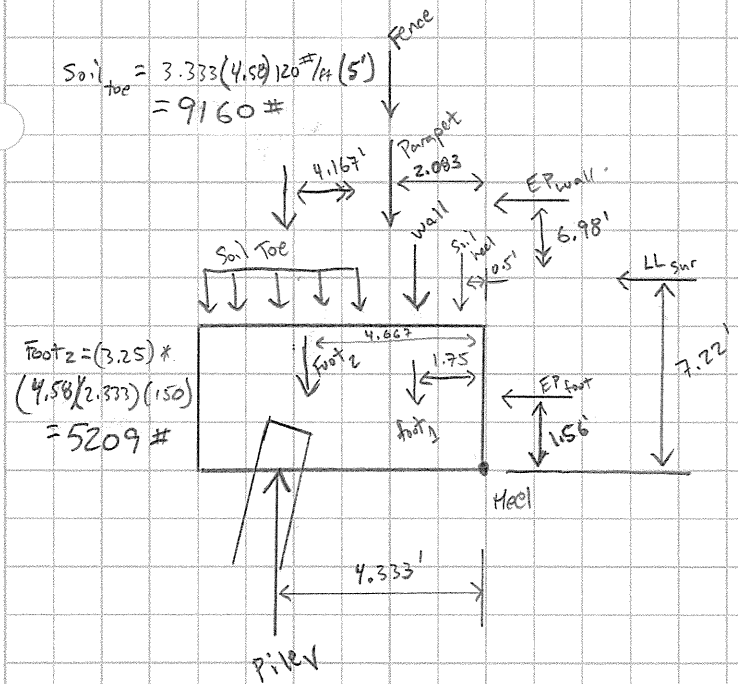
HNTB

RFI 104

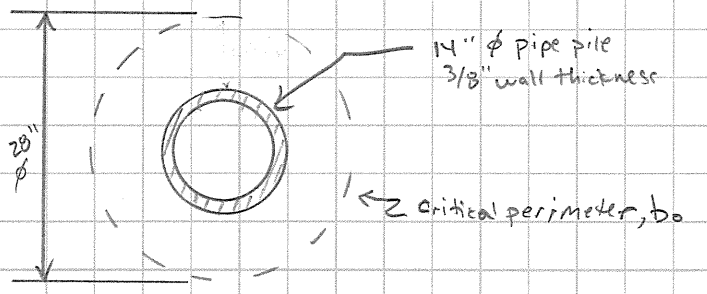
Reference RFI 95 calcs for loading

Wing wall Pile #19 was Driven out of Tolerance Enlarge Footing to Encompass Pile





Punching Shear (5.13.3.6.3)



$b_o = \pi(28") = 88"$

$d_v = 3.25' - 1' = 2.25' = 27"$

$\beta_c = 1.0$

$$V_n = \left(0.063 + \frac{0.126}{\beta_c}\right)\sqrt{f'_c}\, b_o d_v \le 0.126\sqrt{f'_c}\, b_o d_v$$

$$V_n = \left(0.063 + \frac{0.126}{\beta_c}\right)\sqrt{f'_c}\, b_o d_v = \left(0.063 + \frac{0.126}{1}\right)\sqrt{4}(88)(27)$$

$= 898\ k$

$\le$

$V_n = 0.126\sqrt{4}(88)(27) = \underline{599\ k} \leftarrow$ controls

$\phi V_n = 0.9(599) = 539\ k$

Max pile load = $125k \div \cos(14)$

$= 129\ k$

$129 < 539$ ✓ ∴ OK

HNTB	The HNTB Companies Engineers Architects Planners	Made	KDG	Date	9/10/2011	Job Number	49633
		Checked	BTA	Date	9/12/2011		
For	Cleveland Innerbelt	Backchk'd	KDG	Date	9/13/2011	Sheet No.	

UNFACTORED FOOTING LOAD COMPONENTS

	Horiz. (kips)	Vert. (kips)	arm (ft)	Moment (kip-ft)
Dead Load				
Footing1		10.66	1.75	18.7
Footing2		5.21	4.67	24.3
Wall		24.01	1.75	42.0
Parapet		6.19	2.08	12.9
Fence		1.33	2.08	2.8
Sum Abut. D.L. =		**47.4**		**100.6**
Earth Loads				
DL Earth (toe)		9.16	4.17	38.2
DL Earth(heel)		8.39	0.50	4.2
Sum Vert. Earth =		**17.6**		**42.4**
Horiz. Earth Footing	10.41		1.56	16.2
Horiz. Earth Wall	19.51		6.98	136.2
LL Surcharge	10.16		7.22	73.4

Factored Load Summary — **Load Factors**

CASE	Horiz. (kip)	Vert. (kip)	Arm (ft)	Moment (kip-ft)	Limit State	DC	EH	EV	LS
1	29.92	64.95	4.55	295.4	Service 1	1.00	1.00	1.00	0.00
2	40.08	64.95	5.68	368.8	Service 1	1.00	1.00	1.00	1.00
3	26.93	82.94	3.86	320.2	Strength 1	1.25	0.90	1.35	0.00
4	44.71	82.94	5.41	448.6	Strength 1	1.25	0.90	1.35	1.75
5	62.66	60.21	8.14	489.9	Strength 1	0.90	1.50	1.00	1.75
6	62.66	82.94	6.51	540.0	Strength 1	1.25	1.50	1.35	1.75

Sum Moments about the Heel to find the Pile Vertical Demand

CASE	e (ft)	P_{vert} (kip)	
1	4.33	68.18	
2	4.33	85.11	
3	4.33	73.89	
4	4.33	103.52	
5	4.33	113.07	
6	4.33	124.63	<< Controls

4 to 1 Pile batter = 14°

UBV = 124.63 / cos(14°) / 0.7 = 183.49 kips

Pile 19 was driven to the plan UBV of 322 k therefore OK

HNTB	The HNTB Companies Engineers Architects Planners	Made	KDG	Date	9/10/2011	Job Number	49633
		Checked	BTA	Date	9/12/2011		
For	Cleveland Innerbelt	Backchk'd	KDG	Date	9/13/2011	Sheet No.	

Reinforcing Design for Walls & Footing

Basic Equations for Flexure

Factored Flexural Resistance,

$M_r = \varphi M_n$ — 5.7.3.2.1-1

where φ is 0.90 for flexure in R.C. — 5.5.4.2.1

For rectangular section with mild reinforcing only,

$M_n = A_s f_y (d_s - a/2)$ — 5.7.3.2.2-1

for which

a = $\beta_1 c$

c = distance between nuetral axis and compression face

β_1 = stress block factor

a = depth of equiv. stress block

for f'_c = 4.0 ksi, β_1 = 0.85

For rectangular section with tension reinforcing only,

$c = A_s f_y / 0.85 f'_c \beta_1 b$ — 5.7.3.1.2-4

Basic Eqtns for Shear

Factored Flexural Resistance,

$V_r = \varphi V_n$ — 5.8.2.1-2

where φ is 0.90 for shear & torsion in R.C. — 5.5.4.2.1

For rectangular section with mild reinforcing only,

$V_n = V_c + V_s$ — 5.8.3.3-1

but not greater than: $0.25 f'_c b_v d_v$ — 5.8.3.3-2

(Note: for walls and footings, it is preferred to proportion the concrete section to have adequate shear resistance without shear reinforcing.)

$V_c = 0.0316 \times \beta (f'_c)^{0.5} b_v d_v$ — 5.8.3.3-3

for which

β = 2.0 — 5.8.3.4.1

b_v = effective width of concrete

d_v = effective shear depth

Reinforcement Design

Try → 10 # 6 bars

$A_{s,prov'd}$ = 4.40 $in.^2$

d_s = 31.00 in.
(3 in. bottom clear with #5 & #8 stirrup)

b = 48.00 in.

c = 1.90 in. — 5.7.3.1.2-4

a = 1.62 in.

M_r = 597.8 ft-kips — 5.7.3.2.1-1

598>540 **O.K.**

V_c = 188.1 kips — 5.8.3.3-3

Max V_n = 1488.0 kips — 5.8.3.3-2

V_r = 169.3 kips — 5.8.3.3-1

169>125/cos(14) **O.K.**

USE: 10 - #6 bars horizontally in top & btm. of footing
#5 stirrups at 12"

Shrinkage & Temperature Steel - Footing

$A_{s(min.)}$ = 0.23 $in.^2$ / ft — 5.10.8.1

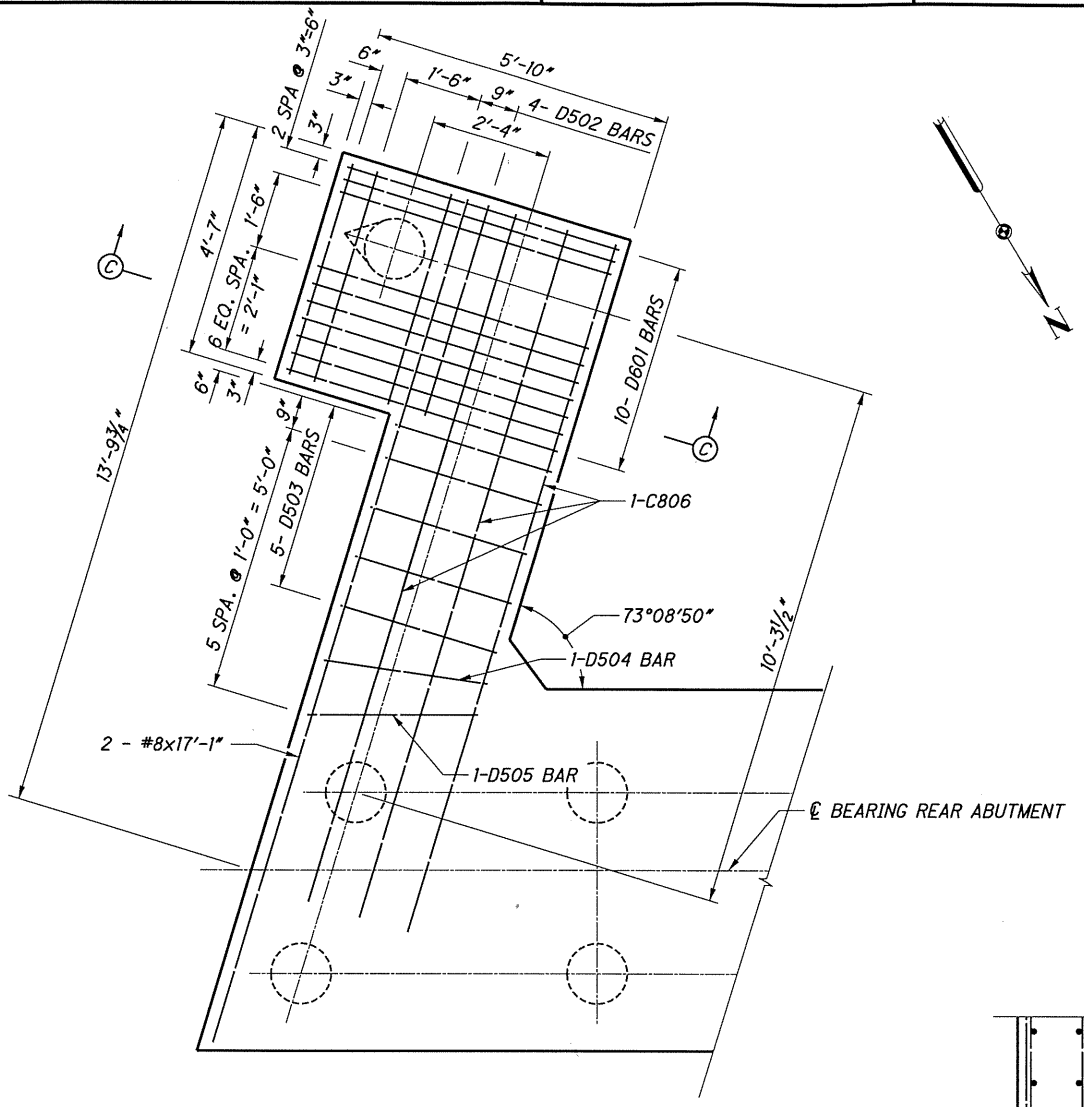
Use # 5 bars @ 12.00 in.

$A_{s,prov'd}$ = 0.31 $in.^2$ / ft

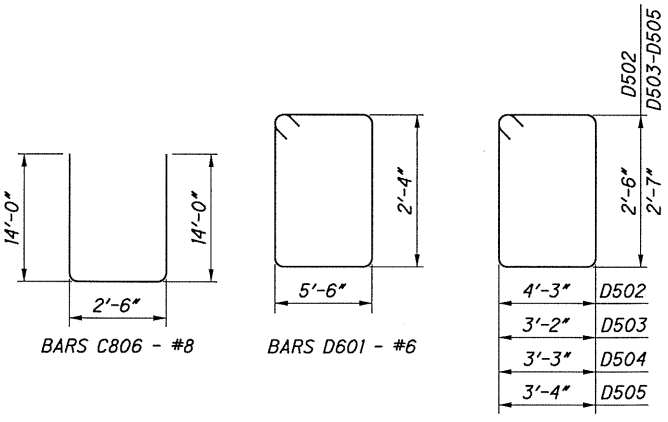
O.K.

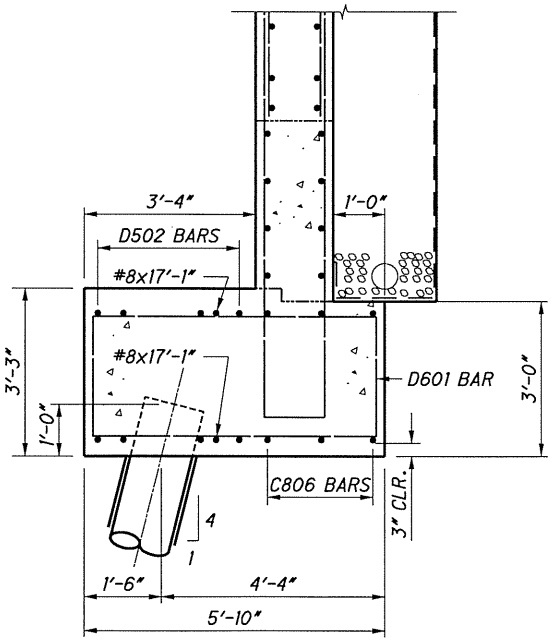
USE: #5 bars @12 inches in faces of footing

HNTB The HNTB Companies	Made by KDG	Date 09-10-11	Job Number 49633
	Checked by BTA	Date 09-12-11	Sheet Number
For Cleveland Innerbelt BL13 RFI104	Backchecked by KDG	Date 09-13-11	



PART PLAN BRIDGE 13 REAR ABUTMENT
RIGHT WINGWALL FOOTING





SECTION C-C

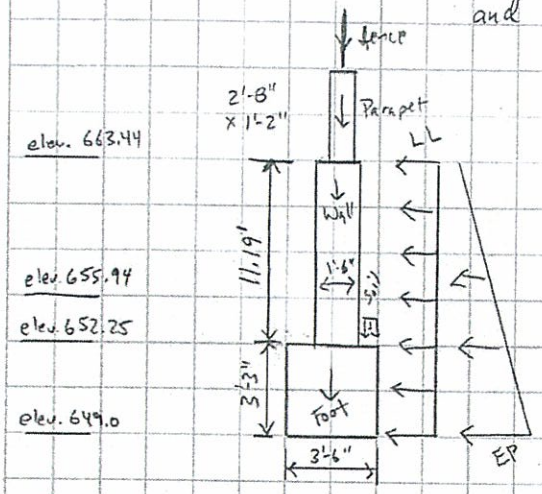
Date:13-SEP-2011
Model:WorkSheet
File:IP_PWP:dms72661\49633-S-BR-ABD02-E9SUP.dgn

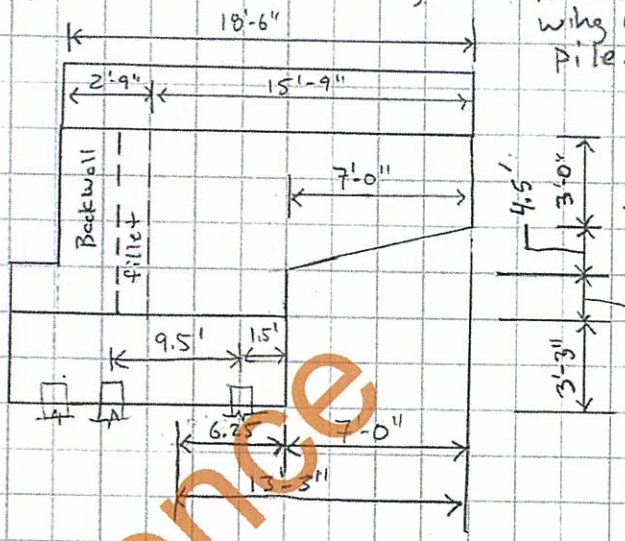
RFI 13

For	Bridge 13 Wingwall Pile	Job no.	49633	Sheet no.	1
Made by	EDGravatt	Checked by	BTA	Backchecked by	
Date	9-1-11	Date	9/2/11	Date	

HNTB

Assume Everything from half way between the Abut. and wingwall pile to the end of the wing wall Acts on the wing wall pile.





Vertical

↓ Foot = (3.25)(3.5)(6.25)(150) = 10,664 #

↓ Wall = $\left[(11.19)(1.5)(13.25) - (7)(1.5)(4.50)\left(\frac{1}{2}\right) - 3.69(7)(1.5)\right](150)$ = 24,005 #

↓ Parapet = 2.667(1.167)(13.25)(150) = 6186 #

↓ Fence = 13.25(100 #/ft) = 1325 #

↓ Soil on Foot = (1')(11.19)(6.25)(120 #/ft³) = 8,393 #

Total Vertical = ↓ 50,573 #

Horizontal

Active EP: $K_a = \tan^2\left(45 - \frac{30}{2}\right) = 0.33$; $\sigma_A = 0.33(120) = 40$ #/ft³

← LL surcharge = $2'(40)\left(11.19 + 3.25\right)(6.25) + 2(40)\left(3 + \frac{4.5}{2}\right)(7)$ = 10,160 #

← EP_{Foot} = $\frac{1}{2}\left(11.19(40) + (11.19+3.25)(40)\right)(3.25)(6.25)$ = 10,412 #

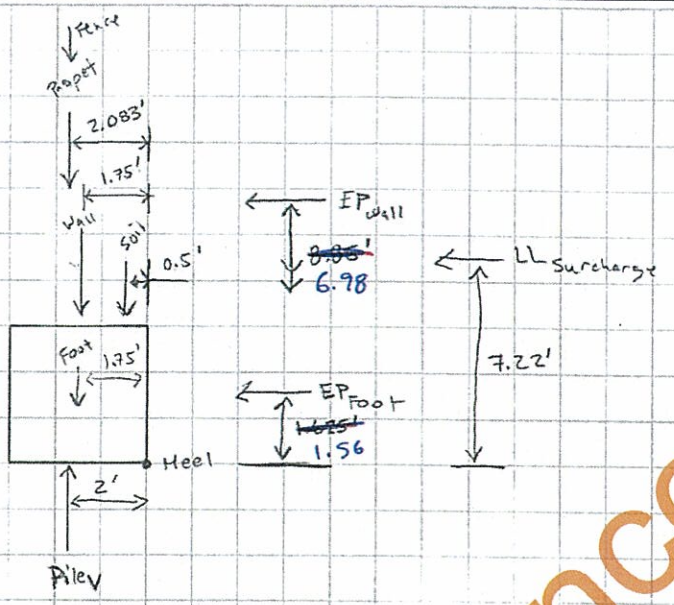
← EP_{wall} = $\frac{1}{2}(40)(11.19)(11.19)(6.25) + \frac{1}{2}(40)\left(3 + \frac{4.50}{2}\right)\left(3 + \frac{4.50}{2}\right)(7)$ = 19,511 #

Total Horizontal = 40,083 # ←

RFI 95

For	BL 13 Wing Wall Pile	Job no.	49633	Sheet no.	2
Made by	EDG	Checked by	BTA	Backchecked by	
Date	9-6-11	Date	9/6/11	Date	

HNTB



Σ Moment about Heel $= 0 = (-10664 - 24005)(1.75) - (6186 + 1325)(2.083) - 8393(0.5) + Pile_V(2)$
$+ (-1951)(\overset{\cancel{8.85}}{6.98}) + (-10412)(\overset{\cancel{1.625}}{1.56}) + (-10160)(7.22)$

$Pile_V = \overset{\cancel{343,460}}{306,297} \div 2' = \overset{\cancel{172}}{153}$ k

$Pile_{Result} = 153\text{ k}/\cos 14° = 158$ k

$\overset{\cancel{172}}{158} \div 0.7 = \overset{\cancel{246\text{ k}}}{225\text{ k}}$ $\overset{\cancel{\text{UBV}}}{\text{UBU}}$