



Client: ODOT District 6
Project: FRA-70 Project 4H
Subject: High Street East Cap Rear Abutment Design
Bridge No. FRA-70-1405C

Job No.: 2012048
Sheet No.: 1 Of 7
Made By: MOJ Date: 8/10/2015 RSN 5/21/2018 MOJ 7/11/2022
Chk'd By: RHC Date: 8/12/2015 DGN 6/7/2018 DGN 7/11/2022

ABUTMENT DESIGN ON SPREAD FOOTING LRFD

Based on AASHTO LRFD

Input values are indicated by the Yellow colored cells

ABUTMENT DATA

Concrete unit weight	0.15 kcf
Abutment Width	60.00 ft.
(not including wingwalls)	
Toe Height (Htoe)	4.75 ft.
Heel Height (Hh)	4.50 ft.
Stem Height (Hst)	22.41 ft.
Total Height (HT)	32.84 ft.
Soil Height over Heel (H1)	28.34 ft.
Soil Height over Toe (H2)	0.00 ft.
Abutment Backwall Height (Hb)	5.68 ft.
(Or End Diaphragm Height for Semi-Integral Abutments)	
Footing Width (Wf)	22.00 ft.
Stem Width (Wst)	4.21 ft.
Toe Width (Wtoe)	7.00 ft.
Heel Width (Wh)	10.79 ft.
Abutment Backwall Width (Wb)	1.75 ft.
(Note: Wb = 0.00 for semi-integral abutments)	
Fillet Width (Wfill)	0.00 ft.
Stem Height over Fillet (Hfill)	0.00 ft.
Face of Abutment to CL Bearing	1.33 ft.
CL Brg. to Rear F/Abutment or Backwall	1.13 ft.
Approach Slab Seat =	0.00 ft.
Approach Slab Thick. =	0.00 ft.
Approach Slab Length =	0.00 ft.

Typical values for friction factor:

course grained soil w/out silt =	0.55
course grained soil w/silt =	0.45
silt =	0.35
shale =	0.55
rock =	0.7

SOIL DATA

Minimum Soil Unit Weight for LLS, γ_{soil} LLS

Active or At Rest Pressure (A or R)

P_{soil}

γ_{soil}

Friction Factor =

Is the abutment bearing on soil or rock?(S or R) =

Bearing Capacity of Soil or Rock =

Equivalent Soil Height For LL Surcharge =

$P_1 = P_{soil}(H_3)/1000 =$

$P_2 = P_{soil}(H_1)/1000 =$

$P_3 = P_{soil}(H_1+Hh)/1000 =$

$P_4 = H(LLS) * \gamma_{soil} (LLS) * k_a =$

$P_5 = (App. Slab Weight)/\gamma_{soil} * P_{soil} / 1000 =$

Soil Sliding Forces:

$F_1 = P_1 * H_3 * 0.5 =$

$F_2 = P_1 * (H_1 + Hh - H_3) =$

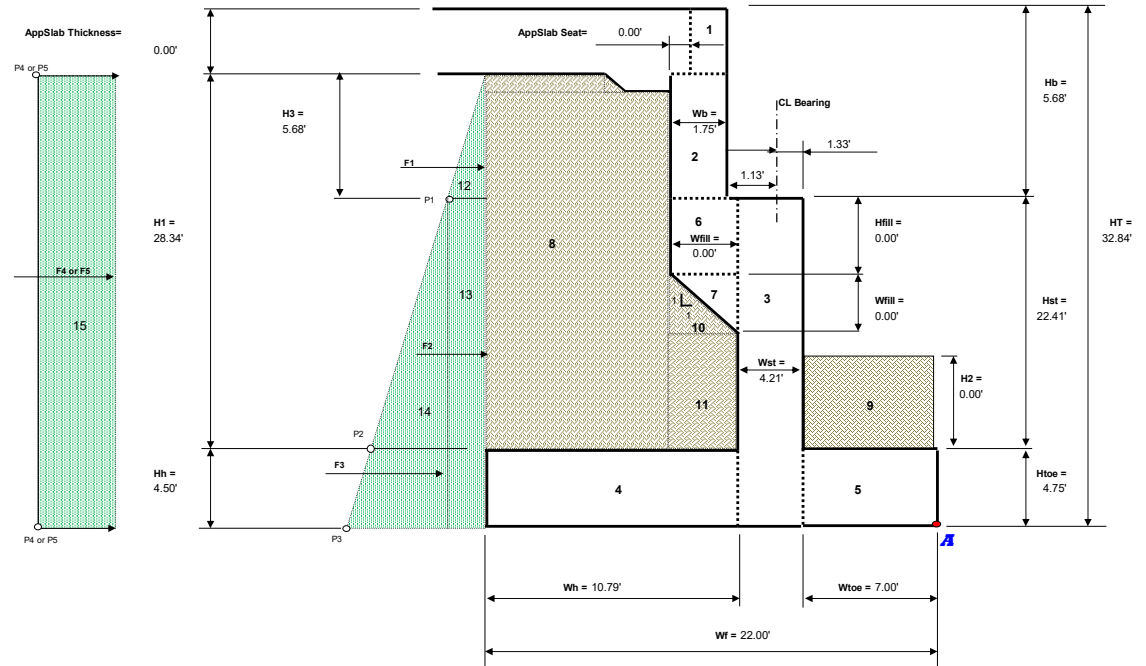
$F_3 = (P_3 - P_1) * (H_1 + Hh - H_3) * 0.5 =$

$*F_4 = P_4(H_1 + Hh) =$

*Note: For semi-integral abutments, $F_4 = P_4(H_1 + Hh - H_3)$

$*F_5 = P_5(H_1 + Hh) =$

*Note: For semi-integral abutments, $F_5 = P_5(H_1 + Hh - H_3)$



0.125 kcf
4.0 pcf
0.12 kcf
0.93 (See AASHTO 10.6.1.4)
18.09 ksf
2.000 ft. (See AASHTO Table 3.11.6.4-1)
0.227 ksf
1.134 ksf
1.314 ksf
0.083 ksf
0.000 ksf (App. Slab Weight Surcharge)
0.645 kips
6.171 kips
14.753 kips
2.737 kips
0.000 kips (App. Slab Weight Surcharge)



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SUMMARY OF LOAD EFFECTS

	MAX. BEARING PRESSURE	MIN. BEARING PRESSURE	ECCENTRICITIES MAXIMUM LF	ECCENTRICITIES MINIMUM LF	SLIDING FORCES MAXIMUM LF	VERTICAL FORCES MINIMUM LF
STRENGTH I	6.80	6.80	2.31	4.28	38.57	74.92
STRENGTH III	6.11	6.11	1.79	3.02	33.18	73.80
STRENGTH IV	6.58	6.58	1.67	2.88	32.81	73.80
STRENGTH V	6.77	6.77	2.36	4.26	38.50	74.67
SERVICE I	4.97	4.97	2.06	NA	25.89	88.84

LONGITUDINAL/TRANSVERSE FORCES FROM SUPERSTRUCTURE

Braking Force BR (AASHTO 3.6.4):

Greater of: 25% of axle weights of design truck or 5% of design truck plus lane load (located 6' above the deck slab)

note: Multiple prescence factor is taken from AASHTO 3.6.1.1.2

$$BR = NL * (0.05 \text{ or } 0.25) * (\text{Truck} + \text{Lane} * TL \text{ or Truck}) * m * 0.5 = 23.40 \text{ kips}$$

$$BR/ft. = LF / (Ws) * \cos(\theta) = 0.39 \text{ kif}$$

$$BR \text{ 6' above deck slab} = 0.56 \text{ kif}$$

Wind loading WS (AASHTO 3.8.1.2):

(Controlling Base Pressure from table)x(superstructure depth)x(superstructure Trib. length)/(o/o width of Super*sec(theta))

Is This a Truss Brige? (Y or N)

N

$$WS \text{ longitudinal} = WS \text{ Long.} / (Ws) * \cos(\theta) = 0.26 \text{ kif}$$

$$WS \text{ transverse} = WS \text{ Lateral} / (Ws) * \sin(\theta) = 0.01 \text{ kif}$$

$$WS \text{ Total} = 0.27 \text{ kif}$$

AASHTO Table 3.8.1.2.2-1

Skew angle of wind Degrees	Trusses, Columns or Arches		Beams/Girders	
	Lateral Load ksf	Longitudinal Load ksf	Lateral Load ksf	Longitudinal Load ksf
0.00	0.075	0.000	0.050	0.000
15.00	0.070	0.012	0.044	0.006
30.00	0.065	0.028	0.041	0.012
45.00	0.047	0.041	0.033	0.016
60.00	0.024	0.050	0.017	0.019

Total WS

Total Lateral

Total Long.

0.90

0.90

0.00

5.76

0.79

4.97

10.67

0.74

9.93

13.84

0.60

13.24

16.04

0.31

15.73

Wind load on vehicles WL (AASHTO 3.8.1.3):

(located 6' above the deck slab)

$$WL \text{ longitudinal} = WL \text{ Parallel} / (Ws) * \cos(\theta) = 0.03 \text{ kif}$$

$$WL \text{ transverse} = WL \text{ Normal} * \sin(\theta) = 0.00 \text{ kif}$$

$$WLL \text{ Total 6' above deck slab} = 0.04 \text{ kif}$$

AASHTO Table 3.8.1.3-1

Skew angle of wind Degrees	Normal Component kif	Parallel Component kif
0.00	0.100	0.000
15.00	0.088	0.012
30.00	0.082	0.024
45.00	0.066	0.032
60.00	0.034	0.038

Total WL

Total Normal

Total Parallel

0.10

0.10

0.00

0.64

0.09

0.55

1.19

0.08

1.10

1.54

0.07

1.47

1.78

0.03

1.75

Temperature and shrinkage TU, CR & SH (AASHTO 3.12):

$$T = NB * F / (Ws) * \cos(\theta) = 0.91 \text{ kif}$$



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Centrifugal Forces CE (AASHTO 3.6.3):

Axle weights of design truck times C factor times # of design lanes w/multiple presence factor (located 6' above the deck slab)

Angle between radius of curve and C/L Bearings at the abutment (thetar)=

0.00 degrees

Highway design speed (v) =

ft./sec.

Note: 1.0 ft./sec. = 0.682 mph

f =

g =

Radius of Curvature of traffic lanes (R) =

ft./sec^2

ft.

$$C = f \cdot v^2 / (g \cdot R) =$$

0.00

$$CE/ft. = C \cdot (\text{Truck axles}) \cdot NL \cdot m / (Ws) \cdot \sin(\text{thetar}) =$$

0.00 klf

$$CE \text{ 6' above deck slab} =$$

0.00 klf

LOAD MODIFICATION FACTORS (SEE AASHTO 1.3.3, 1.3.4, 1.3.5 & ODOT BDM 1001)

Ductility η_D =

1.00 (use 1.00 for all limit states)

Redundancy η_R =

1.00 (use 1.00 for redundant structures and 1.05 for non-redundant structures)

Operational importance η_I =

1.00 (use 1.00 for all limit states)

STRENGTH I LOAD COMBINATION

OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

ΣM about point "A"

*Note: For semi-integral abutments, the force from area 12 will be zero

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft)		
			Max. Load Factor		
12	0.97	29.05	28.12		Forces From Soil
13	9.26	13.58	125.70		
14	22.13	9.05	200.35		
15	4.79	16.42	78.84		
BR	0.98	27.16	26.50		Forces From Superstructure
WS	0.00	27.16	0.00		
WL	0.00	27.16	0.00		
TU	0.45	27.16	12.34		
CE	0.00	27.16	0.00		
Σ Forces =	38.57 kips		Σ Moments =	471.64 k*ft.	

RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	Force (k)		Moment Arm (ft)	Moment (k-ft)		
	Max. Load Factor	Min. Load Factor		Max. Load Factor	Min. Load Factor	
1	0.00	0.00	10.33	0.00	0.00	Dead Load From Concrete
2	1.86	1.34	10.33	19.26	13.87	
3	21.44	15.44	9.11	195.21	140.55	
4	9.10	6.55	16.61	151.17	108.84	
5	6.23	4.49	3.50	21.82	15.71	
6	0.00	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.00	0.00	
8	49.54	36.69	16.61	822.57	609.31	Forces From Soil
9	0.00	0.00	3.50	0.00	0.00	
10	0.00	0.00	0.00	0.00	0.00	
11	0.00	0.00	0.00	0.00	0.00	
AppSlab	0.00	0.00	16.605	0.00	0.00	Forces From superstructure
LL Surcharge	4.72	0	16.605	78.39	0.00	
DW FWS	11.37	0.00	8.33	94.76	0.00	
DW other	0.00	0.00	8.33	0.00	0.00	
DC	12.90	9.29	8.33	107.50	77.40	
LL	1.12	1.12	8.33	9.30	9.30	
Σ Forces =	118.29 kips	74.92 kips		Σ Moments =	1499.98 k*ft.	974.98 k*ft.

Max. Load Factor

Overtuning moment = 471.64 k-ft.
Resisting moment = 1499.98 k-ft.
Sliding Force = 38.57 k-ft.
Net moment = 1028.34 k-ft.
Total vertical force = 118.29 kips
Distance from point A = 8.69 ft.
Eccentricity "e" = 2.31 ft.
Maximum bearing pressure = 6.80 ksf
Minimum bearing pressure = 6.80 ksf

Min. Load Factor

Overtuning moment = 471.64 k-ft.
Resisting moment = 974.98 k-ft.
Sliding Force = 38.57 k-ft.
Net moment = 503.34 k-ft.
Total vertical force = 74.92 kips
Distance from point A = 6.72 ft.
Eccentricity "e" = 4.28 ft.



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STRENGTH III LOAD COMBINATION

OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

ΣM about point "A"

*Note: For semi-integral abutments, the force from area 12 will be zero

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft) Max. Load Factor	Forces From Soil Forces Form Super-structure
12	0.97	29.05	28.12	
13	9.26	13.58	125.70	
14	22.13	9.05	200.35	
15	0.00	16.42	0.00	
BR	0.00	27.16	0.00	Forces Form Super-structure
WS	0.37	27.16	10.16	
WL	0.00	27.16	0.00	
TU	0.45	27.16	12.34	
CE	0.00	27.16	0.00	
Σ Forces =	33.18 kips		Σ Moments = 376.66 k*ft.	

RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	This is column for stability		Moment Arm (ft)	This is column for stability		Dead Load From Concrete Forces From Soil Forces Form Superstructure
	Force (k) Max. Load Factor	Force (k) Min. Load Factor		Moment (k-ft) Max. Load Factor	Moment (k-ft) Min. Load Factor	
1	0.00	0.00	10.33	0.00	0.00	
2	1.86	1.34	10.33	19.26	13.87	
3	21.44	15.44	9.11	195.21	140.55	
4	9.10	6.55	16.61	151.17	108.84	Dead Load From Concrete
5	6.23	4.49	3.50	21.82	15.71	
6	0.00	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.00	0.00	
8	49.54	36.69	16.61	822.57	609.31	Forces From Soil
9	0.00	0.00	3.50	0.00	0.00	
10	0.00	0.00	0.00	0.00	0.00	
11	0.00	0.00	0.00	0.00	0.00	
AppSlab	0.00	0.00	16.605	0.00	0.00	Forces Form Superstructure
LL Surcharge	0	0	16.605	0.00	0.00	
DW FWS	11.37	0.00	8.33	94.76	0.00	
DW other	0.00	0.00	8.33	0.00	0.00	
DC	12.90	9.29	8.33	107.50	77.40	
LL	0.00	0.00	8.33	0.00	0.00	
Σ Forces =	112.45 kips	73.80 kips		Σ Moments = 1412.29 k*ft.	965.68 k*ft.	

Max. Load Factor

Overturning moment = 376.66 k-ft.
Resisting moment = 1412.29 k-ft.
Sliding Force = 33.18 k-ft.
Net moment = 1035.63 k-ft.
Total vertical force = 112.45 kips
Distance from point A = 9.21 ft.
Eccentricity "e" = 1.79 ft.
Maximum bearing pressure = 6.11 ksf
Minimum bearing pressure = 6.11 ksf

Min. Load Factor

Overturning moment = 376.66 k-ft.
Resisting moment = 965.68 k-ft.
Sliding Force = 33.18 k-ft.
Net moment = 589.02 k-ft.
Total vertical force = 73.80 kips
Distance from point A = 7.98 ft.
Eccentricity "e" = 3.02 ft.

STRENGTH IV LOAD COMBINATION

OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

ΣM about point "A"

*Note: For semi-integral abutments, the force from area 12 will be zero

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft) Max. Load Factor	Forces From Soil Forces Form Super-structure
12	0.97	29.05	28.12	
13	9.26	13.58	125.70	
14	22.13	9.05	200.35	
15	0.00	16.42	0.00	
BR	0.00	27.16	0.00	Forces Form Super-structure
WS	0.00	27.16	0.00	
WL	0.00	27.16	0.00	
TU	0.45	27.16	12.34	
CE	0.00	27.16	0.00	
Σ Forces =	32.81 kips		Σ Moments = 366.50 k*ft.	



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RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	This is column for stability			This is column for stability			
	Force (k)	Force (k)	Moment Arm (ft)	Moment (k-ft)	Moment (k-ft)		
	Max. Load Factor	Min. Load Factor		Max. Load Factor	Min. Load Factor		
1	0.00	0.00	10.33	0.00	0.00		Dead Load From Concrete
2	2.24	1.34	10.33	23.11	13.87		
3	25.73	15.44	9.11	234.25	140.55		
4	10.92	6.55	16.61	181.41	108.84		
5	7.48	4.49	3.50	26.18	15.71		
6	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.00	0.00		
8	49.54	36.69	16.61	822.57	609.31		Forces From Soil
9	0.00	0.00	3.50	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.00	0.00		
AppSlab	0.00	0.00	16.605	0.00	0.00		Forces From superstructure
LL Surcharge	0	0	16.605	0.00	0.00		
DW FWS	11.37	0.00	8.33	94.76	0.00		
DW other	0.00	0.00	8.33	0.00	0.00		
DC	15.48	9.29	8.33	129.00	77.40		
LL	0.00	0.00	8.33	0.00	0.00		
Σ Forces =	122.76 kips	73.80 kips		Σ Moments = 1511.29 k*ft.	965.68 k*ft.		

Max. Load Factor

Overturning moment =	366.50	k-ft.	Overturning moment =	366.50	k-ft.
Resisting moment =	1511.29	k-ft.	Resisting moment =	965.68	k-ft.
Sliding Force =	32.81	k-ft.	Sliding Force =	32.81	k-ft.
Net moment =	1144.78	k-ft.	Net moment =	599.18	k-ft.
Total vertical force =	122.76	kips	Total vertical force =	73.80	kips
Distance from point A =	9.33	ft.	Distance from point A =	8.12	ft.
Eccentricity "e" =	1.67	ft.	Eccentricity "e" =	2.88	ft.
Maximum bearing pressure =	6.58	ksf			
Minimum bearing pressure =	6.58	ksf			

Min. Load Factor

STRENGTH V LOAD COMBINATION

OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

ΣM about point "A"

*Note: For semi-integral abutments, the force from area 12 will be zero

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft)		
			Max. Load Factor	Min. Load Factor	
12	0.97	29.05	28.12		Forces From Soil
13	9.26	13.58	125.70		
14	22.13	9.05	200.35		
15	4.79	16.42	78.64		
BR	0.75	27.16	20.44		Forces From Superstructure
WS	0.11	27.16	2.90		
WL	0.04	27.16	1.15		
TU	0.45	27.16	12.34		
CE	0.00	27.16	0.00		
Σ Forces =	38.50 kips		Σ Moments = 469.64 k*ft.		

RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	This is column for stability			This is column for stability			
	Force (k)	Force (k)	Moment Arm (ft)	Moment (k-ft)	Moment (k-ft)		
	Max. Load Factor	Min. Load Factor		Max. Load Factor	Min. Load Factor		
1	0.00	0.00	10.33	0.00	0.00		Dead Load From Concrete
2	1.86	1.34	10.33	19.26	13.87		
3	21.44	15.44	9.11	195.21	140.55		
4	9.10	6.55	16.61	151.17	108.84		
5	6.23	4.49	3.50	21.82	15.71		
6	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.00	0.00		
8	49.54	36.69	16.61	822.57	609.31		Forces From Soil
9	0.00	0.00	3.50	0.00	0.00		
10	0.00	0.00	0.00	0.00	0.00		
11	0.00	0.00	0.00	0.00	0.00		
AppSlab	0.00	0.00	16.605	0.00	0.00		Forces From superstructure
LL Surcharge	3.64	0	16.605	60.47	0.00		
DW FWS	11.37	0.00	8.33	94.76	0.00		
DW other	0.00	0.00	8.33	0.00	0.00		
DC	12.90	9.29	8.33	107.50	77.40		
LL	0.86	0.86	8.33	7.17	7.17		
Σ Forces =	116.95 kips	74.67 kips		Σ Moments = 1479.94 k*ft.	972.86 k*ft.		



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Max. Load Factor

Overtuning moment = 469.64 k-ft.
Resisting moment = 1479.94 k-ft.
Sliding Force = 38.50 k-ft.
Net moment = 1010.29 k-ft.
Total vertical force = 116.95 kips
Distance from point A = 8.64 ft.
Eccentricity "e" = 2.36 ft.
Maximum bearing pressure = 6.77 ksf
Minimum bearing pressure = 6.77 ksf

Min. Load Factor

Overtuning moment = 469.64 k-ft.
Resisting moment = 972.86 k-ft.
Sliding Force = 38.50 k-ft.
Net moment = 503.22 k-ft.
Total vertical force = 74.67 kips
Distance from point A = 6.74 ft.
Eccentricity "e" = 4.26 ft.

SERVICE I LOAD COMBINATION

OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

ΣM about point "A"

*Note: For semi-integral abutments, the force from area 12 will be zero

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft)	
			Max. Load Factor	
12	0.65	29.05	18.75	Forces From Soil
13	6.17	13.58	83.80	
14	14.75	9.05	133.57	
15	2.74	16.42	44.94	
BR	0.56	27.16	15.14	
WS	0.08	27.16	2.18	Forces From Superstructure
WL	0.04	27.16	1.15	
TU	0.91	27.16	24.67	
CE	0.00	27.16	0.00	
Σ Forces =	25.89 kips		Σ Moments = 324.19 k*ft.	

RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	Force (k)	Moment Arm (ft)	Moment (k-ft)	
1	0.00	10.33	0.00	Dead Load From Concrete
2	1.49	10.33	15.41	
3	17.15	9.11	156.16	
4	7.28	16.61	120.94	
5	4.99	3.50	17.46	
6	0.00	0.00	0.00	
7	0.00	0.00	0.00	
8	36.69	16.61	609.31	Forces From Soil
9	0.00	3.50	0.00	
10	0.00	0.00	0.00	
11	0.00	0.00	0.00	
AppSlab	0.00	16.605	0.00	Forces From superstructure
LL Surcharge	2.70	16.605	44.79	
DW FWS	7.58	8.33	63.17	
DW other	0.00	8.33	0.00	
DC	10.32	8.33	86.00	
LL	0.64	8.33	5.31	
Σ Forces =	88.84 kips		Σ Moments = 1118.56 k*ft.	

Overtuning moment = 324.19 k-ft.
Resisting moment = 1118.56 k-ft.
Sliding Force = 25.89 k-ft.
Net moment = 794.37 k-ft.
Total vertical force = 88.84 kips
Distance from point A = 8.94 ft.
Eccentricity "e" = 2.06 ft.
Maximum bearing pressure = 4.97 ksf
Minimum bearing pressure = 4.97 ksf