



Client: ODOT District 6  
Project: FRA-70 Project 4B  
Subject: 3rd Street East Cap Rear Abutment Design  
Bridge No. FRA-33-1747C

Job No.: 2015370  
Sheet No: 1 Of 7  
Made By: MLS Date: 4/3/2019 MOJ 7/11/2022  
Chk'd By: RHC Date: 4/3/2019 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

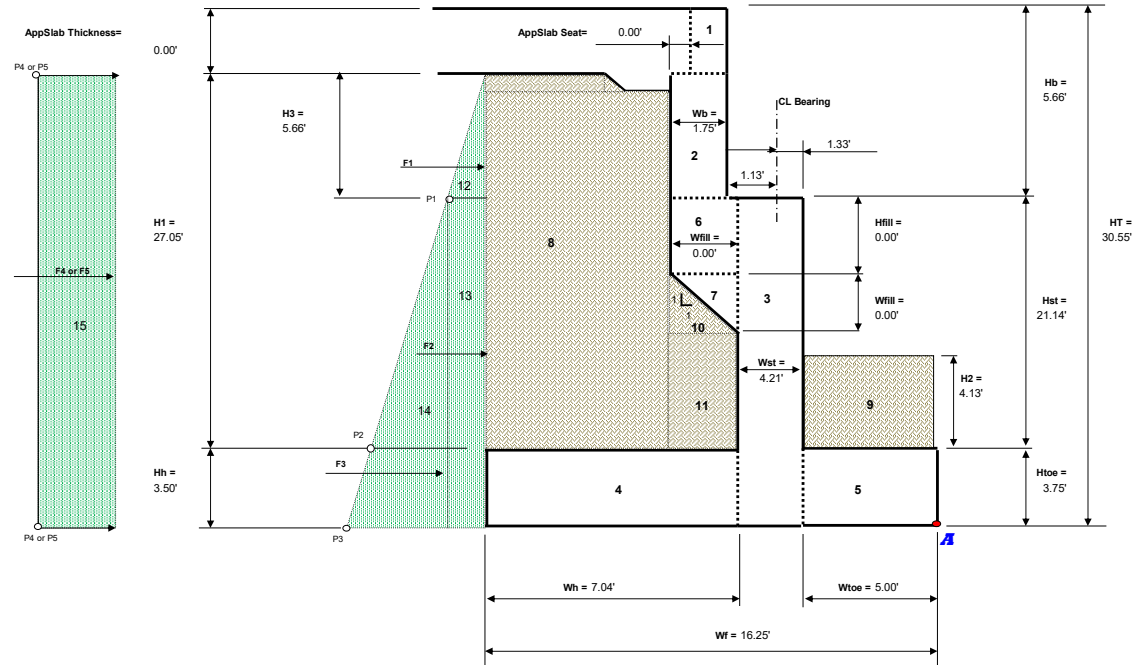
Concrete unit weight	0.15 kcf
Abutment Width	62.92 ft.
(not including wingwalls)	
Toe Height (Htoe)	3.75 ft.
Heel Height (Hh)	3.50 ft.
Stem Height (Hst)	21.14 ft.
Total Height (HT)	30.55 ft.
Soil Height over Heel (H1)	27.05 ft.
Soil Height over Toe (H2)	4.13 ft.
Abutment Backwall Height (Hb)	5.66 ft.
(Or End Diaphragm Height for Semi-Integral Abutments)	
Footing Width (Wf)	16.25 ft.
Stem Width (Wst)	4.21 ft.
Toe Width (Wtoe)	5.00 ft.
Heel Width (Wh)	7.04 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, $\gamma_{soil}$ LLS	0.125 kcf
Active or At Rest Pressure (A or R)	A
$P_{soil}$	40 pcf
$\gamma_{soil}$	0.12 kcf
Friction Factor =	0.78
Is the abutment bearing on soil or rock?(S or R) =	S (See AASHTO 10.6.1.4)
Bearing Capacity of Soil or Rock =	16.78 ksf
Equivalent Soil Height For LL Surcharge =	2.000 ft. (See AASHTO Table 3.11.6.4-1)
$P_1 = P_{soil} \cdot (H_3) / 1000 =$	0.226 ksf
$P_2 = P_{soil} \cdot (H_1) / 1000 =$	1.082 ksf
$P_3 = P_{soil} \cdot (H_1 + H_h) / 1000 =$	1.222 ksf
$P_4 = H \text{ (LLS)} \cdot \gamma \text{ (soil LLS)} \cdot k_a =$	0.083 ksf
$P_5 = (\text{App. Slab Weight}) / \gamma_{soil} \cdot P_{soil} / 1000 =$	0.000 ksf (App. Slab Weight Surcharge)
<b>Soil Sliding Forces:</b>	
$F_1 = P_1 \cdot H_3 \cdot 0.5 =$	0.641 kips
$F_2 = P_1 \cdot (H_1 + H_h - H_3) =$	5.635 kips
$F_3 = (P_3 - P_1) \cdot (H_1 + H_h - H_3) \cdot 0.5 =$	12.390 kips
$F_4 = P_4 \cdot (H_1 + H_h) =$	2.546 kips
(Note: For semi-integral abutments, $F_4 = P_4 \cdot (H_1 + H_h - H_3)$ )	
$F_5 = P_5 \cdot (H_1 + H_h) =$	0.000 kips (App. Slab Weight Surcharge)
(Note: For semi-integral abutments, $F_5 = P_5 \cdot (H_1 + H_h - H_3)$ )	





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#### SUPERSTRUCTURE DATA

No. of Beams/Girders (NB) = 10  
Skew Angle (theta) = 0.274167 degrees  
COS(theta) = 1.0000  
SIN(theta) = 0.0048  
Moment from elastomeric bearing pad = 0 kip\*ft.  
Total Moment from Bearings per ft. of width = 0.0000 kip\*ft.  
Beam/Girder/Truss Spacing = 6.17 ft.  
Span Length From Abut. To Adjacent Pier (TL) = 91.17 ft.  
(To calculate tributary Length)  
Width Between Curbs = 60.17 ft.  
Out to out width = 60.17 ft.  
Out to out width Along Skew (Ws) = 60.17 ft.  
(Width of Superstructure)  
Number of lanes (NL) = 5 (AASHTO 3.6.1.1.1)  
Multiple presence factor (m) = 0.65 (AASHTO 3.6.1.1.2)  
LL Reaction For One Lane (No Impact) = 32.02 kips  
DW dead load for FWS = 890.00 kips  
DW dead load for utilities & other = 0.00 kips  
Total DC dead load = 1214.00 kips  
Total LL = 104.07 kips  
Thermal Exp. Force Per Beam (Ft) (See bearing design) = 5.40 kips  
(Use UNFACTORED Loads)  
Total Superstructure Depth (Ds) = 18.00 ft.  
(Total vertical exposure to calculate wind load)  
Total Exposed area of Truss (Ta) = 0.00 sq. ft.  
(For truss bridges only, to calculate wind load)

#### Total Unit Superstructure Loads:

DC dead load =	20.18 klf
DW dead load (FWS) =	14.79 klf
DW dead load (Utilities, other) =	0.00 klf
LL =	1.73 klf

#### CHECK BEARING STRESS

(AASHTO 11.6.3.2)

Bearing pressure at Toe = 11.71 ksf O.K.

Bearing pressure at Heel = 11.71 ksf O.K.

Effective Footing Width = 10.02 ft. (Ultimate Strength)

Effective Footing Width = 10.48 ft. (Service 1)

Max. Service 1 pressure = 8.35 ksf

#### CHECK SLIDING

(AASHTO 11.6.3.6)

Resistance factor  $\phi_s$  (Sliding) = 1.00 (See AASHTO Table 11.5.7-1)

Resistance factor  $\phi_{ep}$  (Passive pressure) = 0.50 (See AASHTO Table 10.5.5.2.2-1)

#### Additional Resistance (Sheet Piling) :

Pressure for passive resistance = 0 pcf  
Vertical Projection Below Footing = 0.00 ft.  
Pressure at Top/Sheeting = 0.000 ksf  
Pressure at Bot./Sheeting = 0.000 ksf

Total passive resistance = 0.00 kips  
Factored = 0.00 kips

Controlling Driving force = 33.97 kips

Resisting force = 52.38 kips O.K.

#### CHECK ECCENTRICITY

(AASHTO 11.6.3.3)

Maximum allowable e is B/3 = 5.4

Controlling Eccentricity = 5.2 O.K.



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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	11.71	11.71	3.11	5.21	34.10	67.85
STRENGTH III	10.00	10.00	2.56	4.01	28.81	64.82
STRENGTH IV	10.61	10.61	2.36	3.87	28.45	64.82
STRENGTH V	11.63	11.63	3.14	5.20	33.97	67.16
SERVICE I	8.35	8.35	2.88	NA	22.91	87.49

#### 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 presencence factor is taken from AASHTO 3.6.1.1.2

$$BR = NL * (0.05 \text{ or } 0.25) * (\text{Truck} + \text{Lane} * TL \text{ or Truck}) * m * 0.5 = 29.25 \text{ kips}$$

$$BR/ft. = LF / (Ws) * \cos(\theta) = 0.46 \text{ kif}$$

$$BR \text{ 6' above deck slab} = 0.68 \text{ kif}$$

##### 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

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

$$WS \text{ transverse} = WS \text{ Lateral} / (Ws) * \sin(\theta) = 0.00 \text{ kif}$$

$$WS \text{ Total} = 0.26 \text{ kif}$$

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.

0.20	0.20	0.00
5.10	0.17	4.92
10.01	0.16	9.85
13.26	0.13	13.13
15.66	0.07	15.59

##### 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

0.02	0.02	0.00
0.57	0.02	0.55
1.11	0.02	1.09
1.47	0.01	1.46
1.74	0.01	1.73

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

$$T = NB * F / (Ws) * \cos(\theta) = 0.90 \text{ kif}$$



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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) =

0.00 ft./sec.

Note: 1.0 ft./sec. = 0.682 mph

f =

0.00

g =

0.00 ft./sec^2

Radius of Curvature of traffic lanes (R) =

0.00 ft.

$$C = f \cdot v^2 / (g \cdot R) = 0.00$$

$$CE/ft. = C \cdot (\text{Truck axles}) \cdot NL \cdot m / (Ws) \cdot \sin(\text{thetar}) = 0.00 \text{ klf}$$

$$CE \text{ 6' above deck slab} = 0.00 \text{ klf}$$

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

Ductility  $\eta_D$  = 1.00 (use 1.00 for all limit states)

Redundancy  $\eta_R$  = 1.00 (use 1.00 for redundant structures and 1.05 for non-redundant structures)

Operational importance  $\eta_I$  = 1.00 (use 1.00 for all limit states)

#### STRENGTH I LOAD COMBINATION

##### OVERTURNING AND SLIDING FORCES FROM SOIL AND SUPERSTRUCTURE

$\Sigma M$  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	0.96	26.78	25.73		Forces From Soil
13	8.45	12.45	105.19		
14	18.59	8.30	154.20		
15	4.46	15.28	68.05		
BR	1.19	24.89	29.73		
WS	0.00	24.89	0.00		Forces From Super-structure
WL	0.00	24.89	0.00		
TU	0.45	24.89	11.18		
CE	0.00	24.89	0.00		
$\Sigma$ Forces =	34.10 kips		$\Sigma$ Moments =	394.09 k*ft.	

##### RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

$\Sigma M$  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	8.33	0.00	0.00	Dead Load From Concrete
2	1.86	1.34	8.33	15.48	11.14	
3	19.64	14.14	7.10	139.52	100.46	
4	4.62	3.33	12.73	58.80	42.34	
5	3.52	2.53	2.50	8.79	6.33	
6	0.00	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.00	0.00	
8	30.85	22.85	12.73	392.67	290.87	Forces From Soil
9	3.35	2.48	2.50	8.36	6.20	
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	12.7283	0.00	0.00	Forces From superstructure
LL Surcharge	3.08	0	12.7283	39.20	0.00	
DW FWS	22.19	0.00	6.33	140.51	0.00	
DW other	0.00	0.00	6.33	0.00	0.00	
DC	25.22	18.16	6.33	159.72	115.00	
LL	3.03	3.03	6.33	19.17	19.17	
$\Sigma$ Forces =	117.34 kips	67.85 kips		$\Sigma$ Moments =	982.22 k*ft.	591.49 k*ft.

##### Max. Load Factor

Overtuning moment = 394.09 k-ft.  
Resisting moment = 982.22 k-ft.  
Sliding Force = 34.10 k-ft.  
Net moment = 588.13 k-ft.  
Total vertical force = 117.34 kips  
Distance from point A = 5.01 ft.  
Eccentricity "e" = 3.11 ft.  
Maximum bearing pressure = 11.71 ksf  
Minimum bearing pressure = 11.71 ksf

##### Min. Load Factor

Overtuning moment = 394.09 k-ft.  
Resisting moment = 591.49 k-ft.  
Sliding Force = 34.10 k-ft.  
Net moment = 197.40 k-ft.  
Total vertical force = 67.85 kips  
Distance from point A = 2.91 ft.  
Eccentricity "e" = 5.21 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	
12	0.96	26.78	25.73		
13	8.45	12.45	105.19		
14	18.59	8.30	154.20		
15	0.00	15.28	0.00		
BR	0.00	24.89	0.00		
WS	0.36	24.89	9.07		
WL	0.00	24.89	0.00		
TU	0.45	24.89	11.18		
CE	0.00	24.89	0.00		
Σ Forces =	28.81 kips		Σ Moments =	305.37 k*ft.	

#### RESISTING MOMENTS AND DEAD LOAD FROM SUBSTRUCTURE & SUPERSTRUCTURE

ΣM about point "A"

Area/Force	Force (k)	This is column for stability		Moment (k-ft)		This is column for stability		
	Max. Load Factor	Force (k)	Min. Load Factor	Moment Arm (ft)	Max. Load Factor	Moment (k-ft)	Min. Load Factor	
1	0.00	0.00	0.00	8.33	0.00	0.00	0.00	
2	1.86	1.34	1.34	8.33	15.48	11.14	11.14	
3	19.64	14.14	7.10	139.52	100.46	42.34	42.34	
4	4.62	3.33	12.73	58.80	6.33	0.00	0.00	
5	3.52	2.53	2.50	8.79	0.00	0.00	0.00	
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
8	30.85	22.85	12.73	392.67	290.87	6.20	6.20	
9	3.35	2.48	2.50	8.36	0.00	0.00	0.00	
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
AppSlab	0.00	0.00	12.7283	0.00	0.00	0.00	0.00	
LL Surcharge	0	0	12.7283	0.00	0.00	0.00	0.00	
DW FWS	22.19	0.00	6.33	140.51	0.00	0.00	0.00	
DW other	0.00	0.00	6.33	0.00	0.00	0.00	0.00	
DC	25.22	18.16	6.33	159.72	115.00	0.00	0.00	
LL	0.00	0.00	6.33	0.00	0.00	0.00	0.00	
Σ Forces =	111.23 kips	64.82 kips		Σ Moments =	923.85 k*ft.	572.32 k*ft.		

#### Max. Load Factor

Overturning moment = 305.37 k-ft.  
Resisting moment = 923.85 k-ft.  
Sliding Force = 28.81 k-ft.  
Net moment = 618.48 k-ft.  
Total vertical force = 111.23 kips  
Distance from point A = 5.56 ft.  
Eccentricity "e" = 2.56 ft.  
Maximum bearing pressure = 10.00 ksf  
Minimum bearing pressure = 10.00 ksf

#### Min. Load Factor

Overturning moment = 305.37 k-ft.  
Resisting moment = 572.32 k-ft.  
Sliding Force = 28.81 k-ft.  
Net moment = 266.96 k-ft.  
Total vertical force = 64.82 kips  
Distance from point A = 4.12 ft.  
Eccentricity "e" = 4.01 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	
12	0.96	26.78	25.73		
13	8.45	12.45	105.19		
14	18.59	8.30	154.20		
15	0.00	15.28	0.00		
BR	0.00	24.89	0.00		
WS	0.00	24.89	0.00		
WL	0.00	24.89	0.00		
TU	0.45	24.89	11.18		
CE	0.00	24.89	0.00		
Σ Forces =	28.45 kips		Σ Moments =	296.30 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	8.33	0.00	0.00		Dead Load From Concrete
2	2.23	1.34	8.33	18.57	11.14		
3	23.57	14.14	7.10	167.43	100.46		
4	5.54	3.33	12.73	70.57	42.34		
5	4.22	2.53	2.50	10.55	6.33		
6	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.00	0.00		
8	30.85	22.85	12.73	392.67	290.87		Forces From Soil
9	3.35	2.48	2.50	8.36	6.20		
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	12.7283	0.00	0.00		Forces From superstructure
LL Surcharge	0	0	12.7283	0.00	0.00		
DW FWS	22.19	0.00	6.33	140.51	0.00		
DW other	0.00	0.00	6.33	0.00	0.00		
DC	30.26	18.16	6.33	191.66	115.00		
LL	0.00	0.00	6.33	0.00	0.00		
Σ Forces =	122.20 kips	64.82 kips		Σ Moments = 1000.31 k*ft.	572.32 k*ft.		

#### Max. Load Factor

Overtuning moment = 296.30 k-ft.  
Resisting moment = 1000.31 k-ft.  
Sliding Force = 28.45 k-ft.  
Net moment = 704.01 k-ft.  
Total vertical force = 122.20 kips  
Distance from point A = 5.76 ft.  
Eccentricity "e" = 2.36 ft.  
Maximum bearing pressure = 10.61 ksf  
Minimum bearing pressure = 10.61 ksf

#### Min. Load Factor

Overtuning moment = 296.30 k-ft.  
Resisting moment = 572.32 k-ft.  
Sliding Force = 28.45 k-ft.  
Net moment = 276.02 k-ft.  
Total vertical force = 64.82 kips  
Distance from point A = 4.26 ft.  
Eccentricity "e" = 3.87 ft.

#### 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	0.96	26.78	25.73		Forces From Soil
13	8.45	12.45	105.19		
14	18.59	8.30	154.20		
15	4.46	15.28	68.05		
BR	0.92	24.89	22.94		Forces From Super-structure
WS	0.10	24.89	2.59		
WL	0.04	24.89	1.06		
TU	0.45	24.89	11.18		
CE	0.00	24.89	0.00		
Σ Forces =	33.97 kips		Σ Moments = 390.94 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	8.33	0.00	0.00		Dead Load From Concrete
2	1.86	1.34	8.33	15.48	11.14		
3	19.64	14.14	7.10	139.52	100.46		
4	4.62	3.33	12.73	58.80	42.34		
5	3.52	2.53	2.50	8.79	6.33		
6	0.00	0.00	0.00	0.00	0.00		
7	0.00	0.00	0.00	0.00	0.00		
8	30.85	22.85	12.73	392.67	290.87		Forces From Soil
9	3.35	2.48	2.50	8.36	6.20		
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	12.7283	0.00	0.00		Forces From superstructure
LL Surcharge	2.38	0	12.7283	30.24	0.00		
DW FWS	22.19	0.00	6.33	140.51	0.00		
DW other	0.00	0.00	6.33	0.00	0.00		
DC	25.22	18.16	6.33	159.72	115.00		
LL	2.33	2.33	6.33	14.79	14.79		
Σ Forces =	115.95 kips	67.16 kips		Σ Moments = 968.88 k*ft.	587.11 k*ft.		



Client: ODOT District 6  
Project: FRA-70 Project 4B  
Subject: 3rd Street East Cap Rear Abutment Design  
Bridge No. FRA-33-1747C

Job No.: 2015370  
Sheet No: 1 Of 7 Revised  
Made By: MLS Date: 4/3/2019 MOJ 7/11/2022  
Chk'd By: RHC Date: 4/3/2019 DGN 7/11/2022

#### Max. Load Factor

Overtuning moment = 390.94 k-ft.  
Resisting moment = 968.88 k-ft.  
Sliding Force = 33.97 k-ft.  
Net moment = 577.94 k-ft.  
Total vertical force = 115.95 kips  
Distance from point A = 4.98 ft.  
Eccentricity "e" = 3.14 ft.  
Maximum bearing pressure = 11.63 ksf  
Minimum bearing pressure = 11.63 ksf

#### Min. Load Factor

Overtuning moment = 390.94 k-ft.  
Resisting moment = 587.11 k-ft.  
Sliding Force = 33.97 k-ft.  
Net moment = 196.17 k-ft.  
Total vertical force = 67.16 kips  
Distance from point A = 2.92 ft.  
Eccentricity "e" = 5.20 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	0.64	26.78	17.16		Forces From Soil
13	5.64	12.45	70.13		
14	12.39	8.30	102.80		
15	2.55	15.28	38.89		
BR	0.88	24.89	16.99		Forces From Super-structure
WS	0.08	24.89	1.94		
WL	0.04	24.89	1.06		
TU	0.90	24.89	22.35		
CE	0.00	24.89	0.00		
Σ Forces =	22.91 kips		Σ Moments =	271.31 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	8.33	0.00	Dead Load From Concrete
2	1.49	8.33	12.38	
3	15.71	7.10	111.62	
4	3.70	12.73	47.04	
5	2.81	2.50	7.03	
6	0.00	0.00	0.00	
7	0.00	0.00	0.00	
8	22.85	12.73	290.87	Forces From Soil
9	2.48	2.50	6.20	
10	0.00	0.00	0.00	
11	0.00	0.00	0.00	
AppSlab	0.00	12.7283	0.00	Forces From superstructure
LL Surcharge	1.76	12.7283	22.40	
DW FWS	14.79	6.33	93.67	
DW other	0.00	6.33	0.00	
DC	20.18	6.33	127.77	
LL	1.73	6.33	10.95	
Σ Forces =	87.49 kips		Σ Moments =	729.94 k*ft.

Overtuning moment = 271.31 k-ft.  
Resisting moment = 729.94 k-ft.  
Sliding Force = 22.91 k-ft.  
Net moment = 458.62 k-ft.  
Total vertical force = 87.49 kips  
Distance from point A = 5.24 ft.  
Eccentricity "e" = 2.88 ft.  
Maximum bearing pressure = 8.35 ksf  
Minimum bearing pressure = 8.35 ksf