CPRA Contract No. 2503-11-63

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COASTAL ENGINEERING DIVISION

RIVER REINTRODUCTION INTO MAUREPAS SWAMP

PROJECT No. PO-29
ST. JOHN THE BAPTIST PARISH, LOUISIANA

Railroad & Highway Crossings
95% Structural Calculations Submittal

September 2013

RIVER REINTRODUCTION INTO MAUREPAS SWAMP: RAILROAD & HIGHWAY CROSSINGS STRUCTURAL CALCULATIONS

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SECTION 1

U.S. Highway 61 (Airline Highway) Crossing

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QMS Form 3-4 (MM)
Rev. 2013 QMS
Date: 28 Feb 2013

IE QMS - Americas

Detail Check

Project Name	Reintroduction to Maurepas Swamp	**Client**	CPRA / USACE
Project Location	St. John the Baptist Parish, LA	**PM**	Naveen Chillara
Project Number	10001801	**PIC**	Bruce Adams

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Assigned Checker: Ronnie Johnson Comments Required by:

Work Product Originator: Bryan Beckner

Work Product to be Checked: Airline Hwy (US 61) Crossing

☒ This Detail Check is a check for correctness, completeness and technical accuracy.

☐ This Detail Check is only a technical edit for format, spelling, grammar, pagination and readability.

Specific Instructions:

Submitted by: _____ 9/26/2013

Project Manager Signature **Date**

Comments

(This Section is to be completed by the Checker.)

Select:

A. ☐ Checker has no comments.

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B. ☒ Comments have been provided on:

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☐ Comment and Disposition Form 3-5
☐ Other; Specify: Click here to enter text.

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_____ 9/24/13

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APPROVAL and DISTRIBUTION

☒ Detail Check is complete.

_____ 9/26/2013

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1.1

Live Load Calculations

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Job: Mississippi River to Maurepas Swamp **Project #:** 10001801
Description: Airline Hwy Crossing **Computed By:** BCB **Date:** Jul-12 **Page:** of
Load Patterns for SAP Models **Checked By:** RBJ **Date:** 9/13 **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
L_surcharge	Construction surcharge load (250psf)
L_water_full	Internal pressures due to full culvert flow
U_max	Uplift due to maximum water table
U_min	Uplift due to minimum water table
H_max	Lateral load due to maximum water table
H_min	Lateral load due to minimum water table
S_vert_const	Vertical load due to dry backfill soil during construction
S_lat_const	Lateral load due to dry backfill soil during construction
S_dry_unbal	Load due to uneven dry backfill soil during construction (5ft differential)
S_vert_maxWT	Vertical load due to soil with maximum water table
S_lat_maxWT	Lateral load due to soil with maximum water table
S_vert_minWT	Vertical load due to soil with minimum water table
S_lat_minWT	Lateral load due to soil with minimum water table
T_HS20	HS 20-44 truck load

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9' x 9' Culvert - Airline Hwy

LC #	Description	Load Patterns
1a	Construction Condition	DEAD L_surcharge S_lat_const S_vert_const
1b	Uneven Construction Condition	DEAD L_surcharge S_dry_unbal
2a	Maximum Water Inside and Outside Without Live Load	DEAD L_water_full H_max U_max S_vert_maxWT S_lat_maxWT
2a_t	Maximum Water Inside and Outside With Live Load	DEAD L_water_full H_max U_max S_vert_maxWT S_lat_maxWT Lane T_HS20_Case 3
2b	Maximum Water Inside and Minimum Water Outside Without Live Load	DEAD L_water_full H_min U_min S_vert_minWT S_lat_minWT
2b_t	Maximum Water Inside and Minimum Water Outside With Live Load	DEAD L_water_full H_min U_min S_vert_minWT S_lat_minWT Lane T_HS20_Case 3

LC #	Description	Load Patterns
3a	Maximum Water Outside and Minimum Water Inside Without Live Load	DEAD H_max U_max S_vert_maxWT S_lat_maxWT
3a_t	Maximum Water Outside and Minimum Water Inside With Live Load	DEAD H_max U_max S_vert_maxWT S_lat_maxWT Lane T_HS20_Case 3
3b	Minimum Water Inside and Outside Without Live Load	DEAD H_min U_min S_vert_minWT S_lat_minWT
3b_t	Minimum Water Inside and Outside With Live Load	DEAD H_min U_min S_vert_minWT S_lat_minWT Lane T_HS20_Case 3

- The shallowest sections under roadway are **5.5'** below grade. Looking at the culvert profile, the roadway is only a small portion of the entire profile. That being said, the total average depth of culvert (5.75') and shallowest depth of culvert under roadway (5.5') will not match exactly.
- At the surface, HS-20 loads are spread over a tire area of 10" x 20" and the trucks will run perpendicular to the length of the culvert.
- HS-20 loads are 8 kips for the front axle & 32 kips for the back two axles.
- As per *AASHTO LRFD Bridge Design Specifications Section* 3.6.1.2.6, "where depth of fill is 2.0 ft. or greater, wheel loads may be considered to be uniformly distributed over a rectangular area with sides equal to the dimensions of the tire contact area…**and increased by** either 1.15 times the depth of fill in select granular backfill, or **the depth of the fill in all other cases**."
- The maximum load will be attained when the position of the wheels of two separate trucks are located 4' from each other, 2' from the same lane line, according to AASTHO 3.6.1.3.1.
- All loads will be calculated on a per foot of length of culvert. Then all loads will be multiplied by the pile spacing to determine total loads on each pile.
- With two lanes loaded simultaneously, a multiple presence factor of 1.0 will be used according to AASHTO Table 3.6.1.1.2-1.

Interaction Factor (F_e):

$$F_e = 1 + 0.20\left(\frac{H}{B_c}\right)$$

H = height of fill
B_c = outside width of culvert

$$= 1 + 0.20\left(\frac{5.75}{59.25}\right)$$

$$= 1.02 \leq 1.15 \checkmark$$

(S_vert) Design Vertical Earth Pressure (EV):

$$EV = F_e \gamma_{soil} H$$

$$= 1.02(0.11)(5.75) = 0.645 \text{ ksf} \quad \& \quad 1.02(0.11)(15.94) = 1.7424 \text{ ksf on btm lip}$$

Design Lateral Earth Pressure (EH):

$$EH = K_o\left[\gamma_{soil}(H - H_w) + \gamma_{eff}(H_w)\right], \qquad \gamma_{eff} = \gamma_{soil} - \gamma_w = 0.048 \text{ kcf}$$

(S_lat)

Max Water:

EH_{min} (TOP) = 0.258 ksf
EH_{min} (BOT) = 0.692 ksf

Min Water:

EH_{max} (TOP) = 0.506 ksf
EH_{max} (BOT) = 1.50 ksf

(L-water) Inside Water Load (WA):

$$WA = \gamma_{water} D$$

$$= 0.062 \times 0 = 0 \text{ (TOP)}$$

$$= 0.062 \times 9' = 0.558 \text{ ksf (BOT)}$$

Impact Factor (IM) (Fill Below Road = 5.5', Average Fill Height everywhere else = 5.75')

$$IM = 33(1.0 - 0.125 \times H)$$

$$= 33\left[1 - 0.125(5.5)\right] = 10.3125\ \%$$

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Description: Airline Hwy | Computed by: BCB | Date: 7/12

Live Load Calculations | Checked by: RBJ | Date: 9/13

Reference

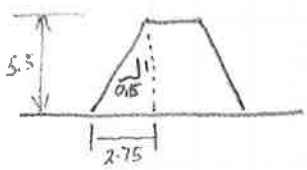
*Fill Height below the road = 5.5'.

Fatigue Impact Factor (IM_F):

$$IM_F = 15(1.0 - 0.125H)$$

$$= 15[1.0 - 0.125(5.5)] = 4.6875\ \%$$

Live Loads (LL): (Assumed influence area at 1:0.5 slope instead 1:0.57)



Single Truck:

- Influence area $= 10'' + (2.75' \times 2) = 6.33'$
  $= 20'' + (2.75' \times 2) + 6' = 13.17'$

$$w_{LL} = \frac{2(16)(1.2)}{6.33 \times 13.17} = 0.461 \text{ ksf} \quad \& \quad 0.115 \text{ ksf on front axle}$$

Two Trucks:

- Influence Area $= 6.33'$
  $= 20'' + (2.75' \times 2) + 4' + 6' + 6' = 23.17'$

$$w_{LL} = \frac{4(16)(1.0)}{6.33 \times 23.17} = 0.436 \text{ ksf} \quad \& \quad 0.109 \text{ ksf on front axle}$$

Single Lane:

- Influence Area $= 10' + (2.75' \times 2) = 15.5'$

$$w_{LL} = \frac{0.064(10')(1.20)}{15.5'} = 0.050 \text{ ksf}$$

Single Tandem:

- Influence Area $= 10'' + (2.75' \times 2) + 4' = 10.33'$
  $20'' + (2.75' \times 2) + 6' = 13.17'$

$$w_{LL} = \frac{4(12.5)(1.2)}{10.33 \times 13.17} = 0.441 \text{ ksf}$$

Two Tandems :

- Influence Area $= 10.33'$

$= 20'' + (2.75' \times 2) + 4' + 6' + 6' = 23.17'$

$$- w_{LL} = \frac{8(12.5)(1.0)}{10.33 \times 23.17} = 0.418 \text{ ksf}$$

Therefore, use single truck & single lane for Strength & Service Limit states.
Use single truck for Fatigue Check

Load Factors :

	Strength		Service		Fatigue	
	MIN	MAX	MIN	MAX	MIN	MAX
DC	0.90	1.25	1.00	1.00	—	—
EV	0.90	1.30	1.00	1.00	—	—
EH	0.90	1.35	1.00	1.00	—	—
LL	1.75	1.75	1.00	1.00	0.75	0.75
WA	1.00	1.00	1.00	1.00	—	—

Load Cases :

1. $DC_{max} + EV_{max} + EH_{min} + (LL+IM)_{max} + WA_{max}$ (similar to 2a_truck)

2. $DC_{min} + EV_{min} + EH_{max}$ (similar to 3b)

3. $DC_{max} + EV_{max} + EH_{max} + (LL+IM)_{max}$ (similar to 3b_truck)

URS

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Description: Airline Hwy | Computed by: BCB | Date: 7/12

Load Calcs | Checked by: RBJ | Date: 9/13

Reference

Single Truck

Front Axle:

LL × IM (LL+IM)

0.115 × 1.103125 = 0.127 ksf over 6.33' = 804 lbs

Rear Axles:

0.461 × 1.103125 = 0.509 ksf over 6.33' = 3,222 lbs

Fatigue Truck:

Front Axle:

0.115 × 1.046875 = 0.120 ksf over 6.33' = 760 lbs

Rear Axles:

0.461 × 1.046875 = 0.483 ksf over 6.33' = 3,057 lbs

Transformed all area loads into point loads to make modeling easier.

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Description: Airline Hwy | Computed by: BCB | Date: 7/12

Live Load Locations | Checked by: RBJ | Date: 9/13

Reference

Truck Case 1 (Axle 2 & 3 Spaced Evenly on ℄ of Culvert)

Axle 1 = 8.0625' in 1st member

Axle 2 = 2.5625' in 3rd "

Axle 3 = 6.8125' in 4th

Truck Case 2 (Max Shear on Center Column)

Axle 1 = 5.3125' in 2nd

Axle 2 = column #4

Axle 3 = 4.0625 in 5th

Truck Case 3 (Max Moment Bay 3, Max Shear Column 5)

Axle 1 = 1.0625' in 2nd

Axle 2 = 5.3125' in 3rd

Axle 3 = column #5

Truck Case 4 (Max Moment Bay 5, Max Shear Column 7

Axle 1 = 1.0625' in 4th

Axle 2 = 5.3125' in 5th

Axle 3 = column #7

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Job	Maurepas	Project No.	10001801	Page ____ of ____	
Description	Airline Hwy	Computed by	BCB	Sheet ____ of ____	Date 7/12
	LRFD Load Combinations	Checked by	RBJ		Date 9/13

Reference

Load Combinations:

Strength I:

1. $U = 1.0\left[1.25\,DC + 1.3\,EV + 0.90\,EH + 1.75(LL+IM) + 1.0\,WA\right]$
2. $U = 1.0\left[0.90\,DC + 0.90\,EV + 1.35\,EH\right]$
3. $U = 1.0\left[1.25\,DC + 1.3\,EV + 1.35\,EH + 1.75(LL+IM)\right]$

Service I:

1. $U = 1.0\left[DC + EV + EH + (LL+IM) + WA\right]$
2. $U = 1.0\left[DC + EV + EH\right]$
3. $U = 1.0\left[DC + EV + EH + (LL+IM)\right]$

Fatigue:

1. $U = 0.75\,(LL+IM)$

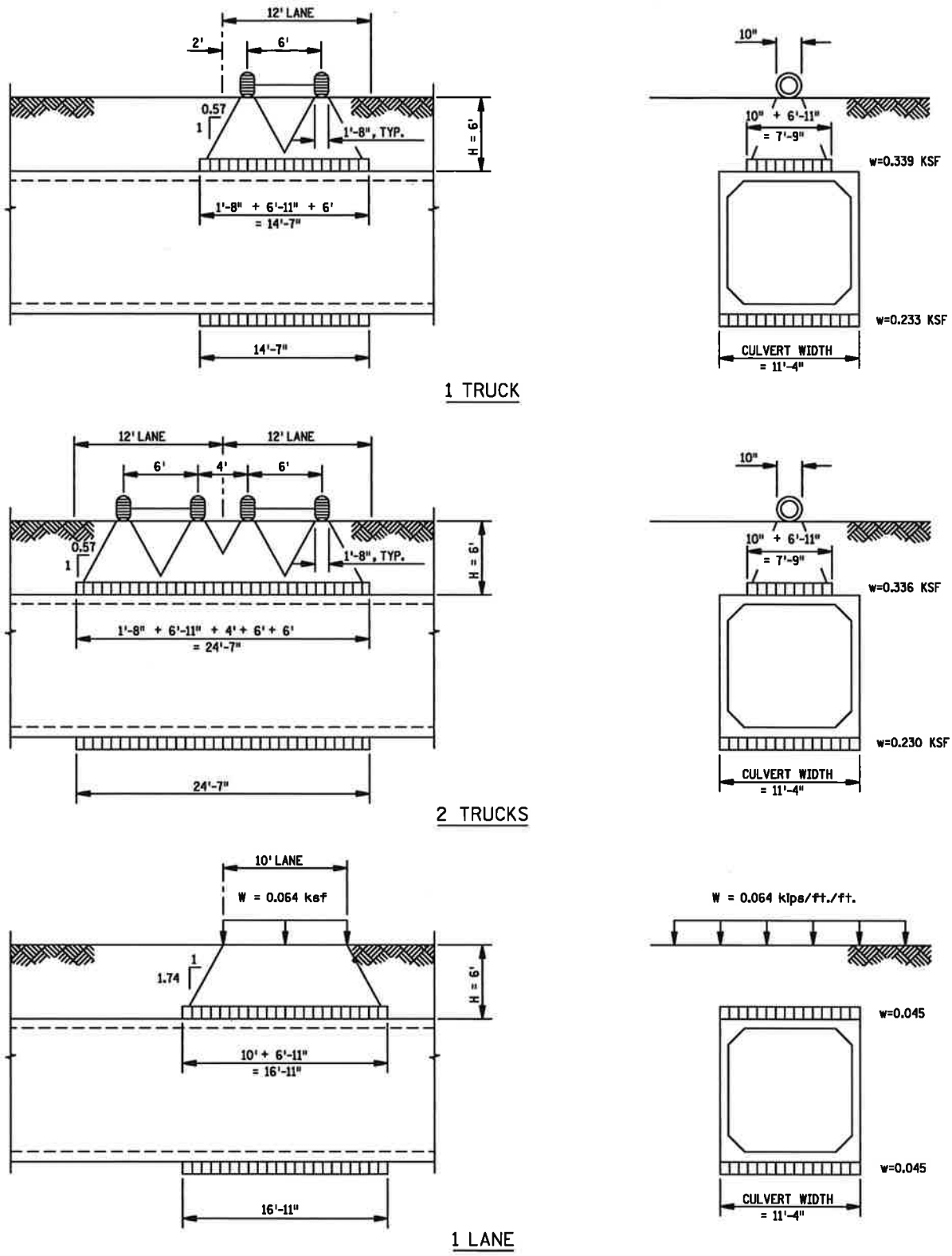

Figure 12.6.4 - Live Load Distribution

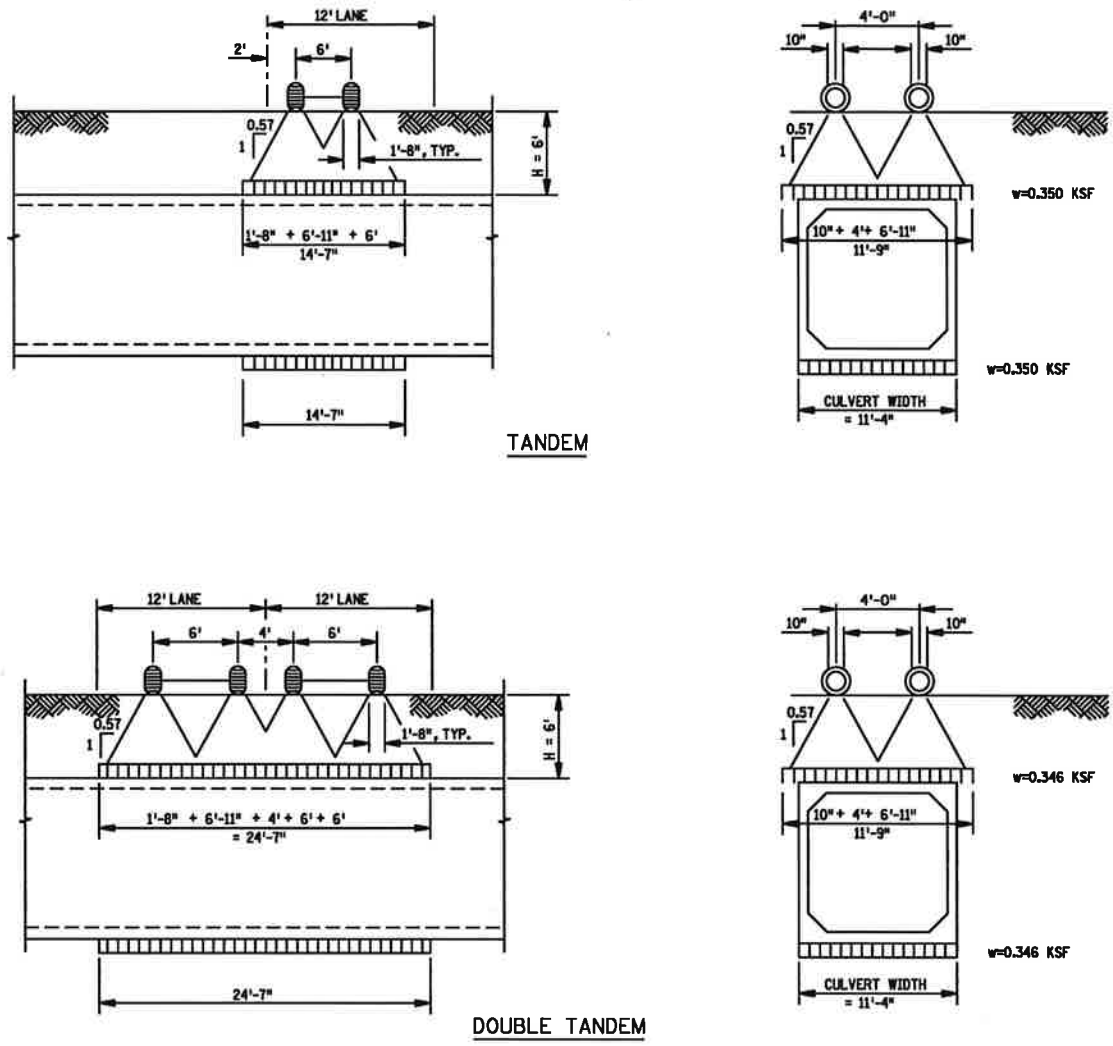

Figure 12.6.4 - Live Load Distribution (cont.)

The Strength I load combinations are:

1. $U = 1.0 \cdot [1.25 \cdot DC + 1.3 \cdot EV + 0.65 \cdot EH + 1.75 \cdot (LL + IM) + 1.0 \cdot WA]$
2. $U = 1.0 \cdot [0.9 \cdot DC + 0.9 \cdot EV + 1.35 \cdot EH]$
3. $U = 1.0 \cdot [1.25 \cdot DC + 1.3 \cdot EV + 1.35 \cdot EH + 1.75 \cdot (LL + IM)]$

The Service I load combinations are:

1. $U = 1.0 \cdot [DC + EV + 0.5 \cdot EH + (LL + IM) + WA]$
2. $U = 1.0 \cdot [DC + EV + EH]$
3. $U = 1.0 \cdot [DC + EV + EH + (LL + IM)]$

One load case is considered for the Fatigue limit state:

1. $U = 0.75 \cdot (LL + IM)$ (range)

1.2

Water & Soil Load Calculations (Under Roadway)

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Description: Airline Hwy Crossing **Computed By:** BCB **Date:** Jul-12 **Page:** of
Load Patterns for SAP Models (ROAD) **Checked By:** RBJ **Date:** 9/13 **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
L_surcharge	Construction surcharge load (250psf)
L_water_full	Internal pressures due to full culvert flow
U_max	Uplift due to maximum water table
U_min	Uplift due to minimum water table
H_max	Lateral load due to maximum water table
H_min	Lateral load due to minimum water table
S_vert_const	Vertical load due to dry backfill soil during construction
S_lat_const	Lateral load due to dry backfill soil during construction
S_dry_unbal	Load due to uneven dry backfill soil during construction (5ft differential)
S_vert_maxWT	Vertical load due to soil with maximum water table
S_lat_maxWT	Lateral load due to soil with maximum water table
S_vert_minWT	Vertical load due to soil with minimum water table
S_lat_minWT	Lateral load due to soil with minimum water table
T_HS20	HS 20-44 truck load

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Job: Mississippi River to Maurepas Swamp **Project #:** 10001801
Description: Airline Hwy Crossing **Computed By:** BCB **Date:** Jul-12 **Page:** of
Load Patterns for SAP Models (ROAD) **Checked By:** RBJ **Date:** 9/13 **Sheet:** of

9' x 9' Culvert - Airline Hwy

LC #	Description	Load Patterns
1a	Construction Condition	DEAD L_surcharge S_lat_const S_vert_const
1b	Uneven Construction Condition	DEAD L_surcharge S_dry_unbal
2a	Maximum Water Inside and Outside Without Live Load	DEAD L_water_full H_max U_max S_vert_maxWT S_lat_maxWT
2a_t	Maximum Water Inside and Outside With Live Load	DEAD L_water_full H_max U_max S_vert_maxWT S_lat_maxWT Lane T_HS20_Case 3
2b	Maximum Water Inside and Minimum Water Outside Without Live Load	DEAD L_water_full H_min U_min S_vert_minWT S_lat_minWT
2b_t	Maximum Water Inside and Minimum Water Outside With Live Load	DEAD L_water_full H_min U_min S_vert_minWT S_lat_minWT Lane T_HS20_Case 3

LC #	Description	Load Patterns
3a	Maximum Water Outside and Minimum Water Inside Without Live Load	DEAD H_max U_max S_vert_maxWT S_lat_maxWT
3a_t	Maximum Water Outside and Minimum Water Inside With Live Load	DEAD H_max U_max S_vert_maxWT S_lat_maxWT Lane T_HS20_Case 3
3b	Minimum Water Inside and Outside Without Live Load	DEAD H_min U_min S_vert_minWT S_lat_minWT
3b_t	Minimum Water Inside and Outside With Live Load	DEAD H_min U_min S_vert_minWT S_lat_minWT Lane T_HS20_Case 3

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Job:	Mississippi River to Maurepas Swamp	**Project #:**	10001801			
Description:	Airline Hwy Crossing	**Computed By:**	BCB	**Date:** Aug-12	**Page:**	of
	Load Calculations under Road	**Checked By:** RBJ		**Date:** 9/13	**Sheet:**	of

9' x 9' box from STA 111+69.25 to STA 115+80.75

* Average Soil height above culvert is 5.75 ft.
* Assuming that the maximum water table is at 5.0ft above culvert.

* Assume the minimum water table is approximately 18 feet below grade. 18 feet is chosen because it is slightly below the bottom slab of the culvert and will need to be checked if the culvert were to ever run completely dry.

* Internal Water Pressure: For image, see L_Water_Full.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Water depth in Culvert(ft)	Pressure (psf)	
0	0	
3	187.2	
6	374.4	
9	561.6	* pressure on floor of 9' x 9' box

* Maximum Water Table Forces: For image, see H_Max and U_Max.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Elevation	Water depth (ft)	Pressure (psf)	
5.30	0.00	0.0	
0.30	5.00	312.0	* pressure on roof of culvert
-0.10	5.40	336.7	
-0.29	5.59	349.1	
-9.50	14.80	923.5	* pressure on base slab
-9.88	15.18	946.9	
-10.25	15.55	970.3	
-11.00	16.30	1017.1	* uplift pressure on bottom of culvert

* Minimum Water Table Forces:

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * (depth - 17)

Elevation	Water depth (ft)	Pressure (psf)	
5.30	0.00	0.0	
0.30	5.00	0.0	* pressure on roof of culvert
-0.10	5.40	0.0	
-0.29	5.59	0.0	
-9.50	14.80	0.0	* pressure on base slab
-9.88	15.18	0.0	
-10.25	15.55	0.0	
-11.00	16.30	0.0	* uplift pressure on bottom of culvert

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Job: Mississippi River to Maurepas Swamp | **Project #:** 10001801
Description: Airline Hwy Crossing | **Computed By:** BCB | **Date:** Aug-12 | **Page:** of
Load Calculations under Road | **Checked By:** PBJ | **Date:** 9/13 | **Sheet:** of

* External Dry Soil Pressure: For image, see S_Lat_Const and S_Dry_Unbal.

$\gamma_{soil,\ dry}$ = 110 pcf

$q_{surcharge}$ = 250 psf (LL_Surcharge)

K_0 = 0.8 Geotechnical Report

Lateral Soil Pressure = $K_0 * (q_{surcharge} + \gamma_{soil,\ dry} * h)$ EM 1110-2-2502, Eq 3-43

Elevation	Soil depth (ft)	Lateral Pressure (psf)
	0	200
	3.88	541.00
	4.25	574.00
	5.00	640.00
0.30	5.75	706.00
-0.10	6.15	740.83
-0.29	6.34	758.25
-9.50	15.55	1568.40
-9.88	15.93	1601.40
-10.25	16.30	1634.40
-11.00	17.05	1700.40

Full Soil Column (S_Vert):

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$
= 632.5 psf

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$
= 1710.5 psf

5' Soil Column (S_Dry_Unbal):

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$
= 385.0 psf

* Soil Forces when water at Maximum Water Table: For image, see S_Lat_MaxWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * (h-h_w) + \gamma_{soil,\ effective} * (h_w)]$

Elevation	Soil depth (ft)	Pressure (psf)
6.05	0.00	0.0
0.30	5.75	256.4
-0.10	6.15	271.5
-0.29	6.34	279.0
-9.50	15.55	629.6
-9.88	15.93	643.9
-10.25	16.30	658.1
-11.00	17.05	686.7

Vertical Soil Pressure, roof = $\gamma_{soil,\ effective} * h$
= 273.7 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$
= 740.2 psf

* Soil Forces when water at Minimum Water Table: For image, see S_Lat_MinWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$ EM 1110-2-2502, Eq 3-40

Elevation	Soil depth (ft)	Pressure (psf)
6.05	0.00	0.0
0.30	5.75	506.0
-0.10	6.15	540.8
-0.29	6.34	558.3
-9.50	15.55	1368.4
-9.88	15.93	1401.4
-10.25	16.30	1434.4
-11.00	17.05	1500.4

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$
= 632.5 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$
= 1710.5 psf

1.3

Water & Soil Load Calculations (Under Levee)

URS

Job:	Mississippi River to Maurepas Swamp	**Project #:**	10001801				
Description:	Airline Hwy Crossing	**Computed By:**	BCB	**Date:**	Jul-12	**Page:**	of
	Load Patterns for SAP Models (LEVEE)	**Checked By:**	RBJ	**Date:**	9/13	**Sheet:**	of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
L_surcharge	Construction surcharge load (250psf)
L_water_full	Internal pressures due to full culvert flow
U_max	Uplift due to maximum water table
U_min	Uplift due to minimum water table
H_max	Lateral load due to maximum water table
H_min	Lateral load due to minimum water table
S_vert_const	Vertical load due to dry backfill soil during construction
S_lat_const	Lateral load due to dry backfill soil during construction
S_dry_unbal	Load due to uneven dry backfill soil during construction (5ft differential)
S_vert_maxWT	Vertical load due to soil with maximum water table
S_lat_maxWT	Lateral load due to soil with maximum water table
S_vert_minWT	Vertical load due to soil with minimum water table
S_lat_minWT	Lateral load due to soil with minimum water table
T_HS20	HS 20-44 truck load

9' x 9' Culvert - Airline Hwy

LC #	Description	Load Patterns
1a	Construction Condition	DEAD L_surcharge S_lat_const S_vert_const
1b	Uneven Construction Condition	DEAD L_surcharge S_dry_unbal
2a	Maximum Water Inside and Outside Without Live Load	DEAD L_water_full H_max U_max S_vert_maxWT S_lat_maxWT
2b	Maximum Water Inside and Minimum Water Outside Without Live Load	DEAD L_water_full H_min U_min S_vert_minWT S_lat_minWT

LC #	Description	Load Patterns
3a	Maximum Water Outside and Minimum Water Inside Without Live Load	DEAD H_max U_max S_vert_maxWT S_lat_maxWT
3b	Minimum Water Inside and Outside Without Live Load	DEAD H_min U_min S_vert_minWT S_lat_minWT

9' x 9' box from STA 111+69.25 to STA 115+80.75

* Soil height above culvert ranges from 6.7ft to 1.5ft, an equivalent height calculation yields h = 4 ft.
* Assuming that the maximum water table is at 5.00ft above culvert at EL. 5.30

* Assume the minimum water table is approximately 18 feet below grade. 18 feet is chosen because it is slightly below the bottom slab of the culvert and will need to be checked if the culvert were to ever run completely dry.

* Internal Water Pressure: For image, see L_Water_Full.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Water depth in Culvert(ft)	Pressure (psf)	
0	0	
3	187.2	
6	374.4	
9	561.6	* pressure on floor of 9' x 9' box

* Maximum Water Table Forces: For image, see H_Max and U_Max.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Elevation	Water depth (ft)	Pressure (psf)	
5.30	0.00	0.0	
0.30	5.00	312.0	* pressure on roof of culvert
-0.10	5.40	336.7	
-0.29	5.59	349.1	
-9.50	14.80	923.5	* pressure on base slab
-9.88	15.18	946.9	
-10.25	15.55	970.3	
-11.00	16.30	1017.1	* uplift pressure on bottom of culvert

* Minimum Water Table Forces:

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * (depth - 17)

Elevation	Water depth (ft)	Pressure (psf)	
5.30	0.00	0.0	
0.30	5.00	0.0	* pressure on roof of culvert
-0.10	5.40	0.0	
-0.29	5.59	0.0	
-9.50	14.80	0.0	* pressure on base slab
-9.88	15.18	0.0	
-10.25	15.55	0.0	
-11.00	16.30	0.0	* uplift pressure on bottom of culvert

URS

Job: Mississippi River to Maurepas Swamp		**Project #:**	10001801		
Description:	Airline Hwy Crossing	**Computed By:**	BCB	**Date:** Aug-12	**Page:** of
	Load Calculations under Levee	**Checked By:**	PRJ	**Date:** 9/13	**Sheet:** of

* External Dry Soil Pressure: For image, see S_Lat_Const and S_Dry_Unbal.

$\gamma_{soil,\ dry}$ = 110 pcf

$q_{surcharge}$ = 250 psf (LL_Surcharge)

K_0 = 0.8 Geotechnical Report

Lateral Soil Pressure = $K_0 * (q_{surcharge} + \gamma_{soil,\ dry} * h)$ EM 1110-2-2502, Eq 3-43

Elevation	Soil depth (ft)	Lateral Pressure (psf)
	0	200
	3.88	541.00
	4.25	574.00
	5.00	640.00
0.30	4.00	552.00
-0.10	4.40	586.83
-0.29	4.59	604.25
-9.50	13.80	1414.40
-9.88	14.18	1447.40
-10.25	14.55	1480.40
-11.00	15.30	1546.40

Full Soil Column (S_Vert):

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 440 psf

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 1518.0 psf

5' Soil Column (S_Dry_Unbal):

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 385.0 psf

* Soil Forces when water at Maximum Water Table: For image, see S_Lat_MaxWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * (h-h_w) + \gamma_{soil,\ effective} * (h_w)]$

Elevation	Soil depth (ft)	Pressure (psf)
4.30	0.00	0.0
0.30	4.00	152.3
-0.10	4.40	167.4
-0.29	4.59	174.9
-9.50	13.80	525.5
-9.88	14.18	539.8
-10.25	14.55	554.1
-11.00	15.30	582.6

Vertical Soil Pressure, roof = $\gamma_{soil,\ effective} * h$

= 190.4 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 656.9 psf

* Soil Forces when water at Minimum Water Table: For image, see S_Lat_MinWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$ EM 1110-2-2502, Eq 3-40

Elevation	Soil depth (ft)	Pressure (psf)
4.30	0.00	0.0
0.30	4.00	352.0
-0.10	4.40	386.8
-0.29	4.59	404.3
-9.50	13.80	1214.4
-9.88	14.18	1247.4
-10.25	14.55	1280.4
-11.00	15.30	1346.4

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 440.0 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ dry} * h$

= 1518.0 psf

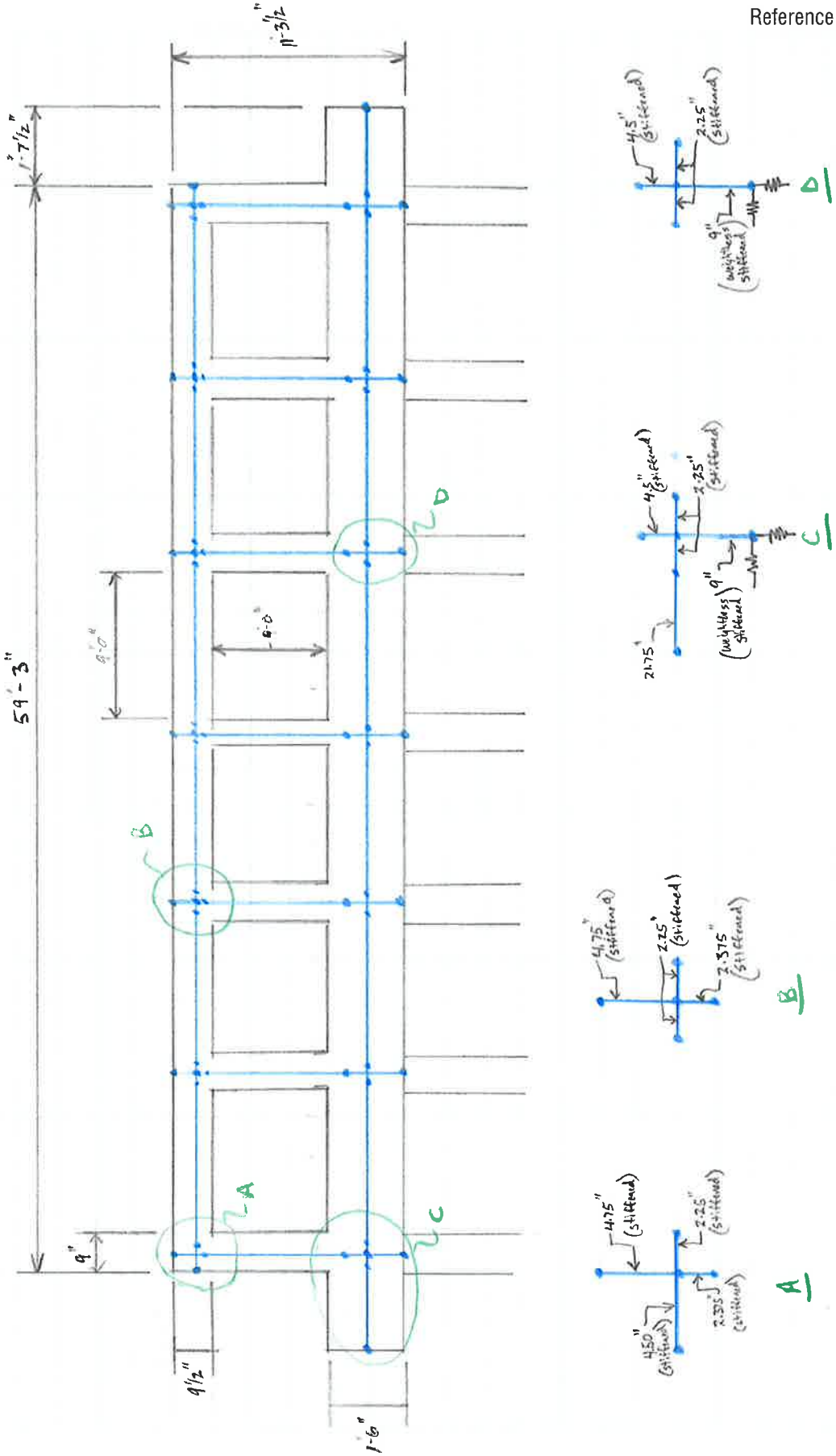
1.4

SAP Model Overview & Load Input (Roadway & Levee)

URS

Job	Mississippi R. Reintro to Maurepas	Project No.		Page ____ of ____	
Description	US Highway 61 - Airline Hwy	Computed by	BCB	Sheet ____ of ____	Date 2-25-13
	6 Barrel 9'x9' Box Culvert	Checked by	RBJ		Date 9/13

Reference



URS

Page ____ of ____

Job: Mississippi R. Reintro to Mauvecpas | Project No. ____ | Sheet ____ of ____

Description: US Highway 61 - Airline Hwy (6) Barrel 9'x9' Box Culvert | Computed by: BCB | Date: 2-25-13

Checked by: RBJ | Date: 9/13

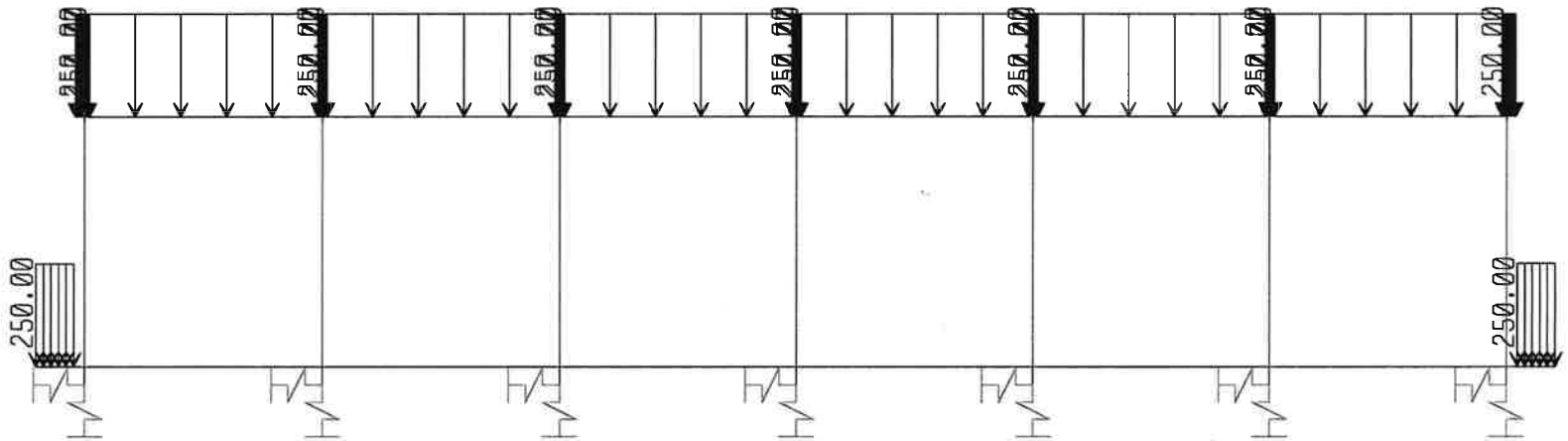
Reference

Dead Loads

Top Slab = 9.5" × 59.25' × 150 pcf	=	7,036	lbs/ft
Walls = 9" × 9.0' × 7 × 150 pcf	=	7,088	lbs/ft
Bottom Slab = 1.5' × 62.5' × 150 pcf	=	14,063	lbs/ft
		28,187	lbs/ft

SAP Model Dead Load per Foot = 28,244 lbs/ft

= 0.38% difference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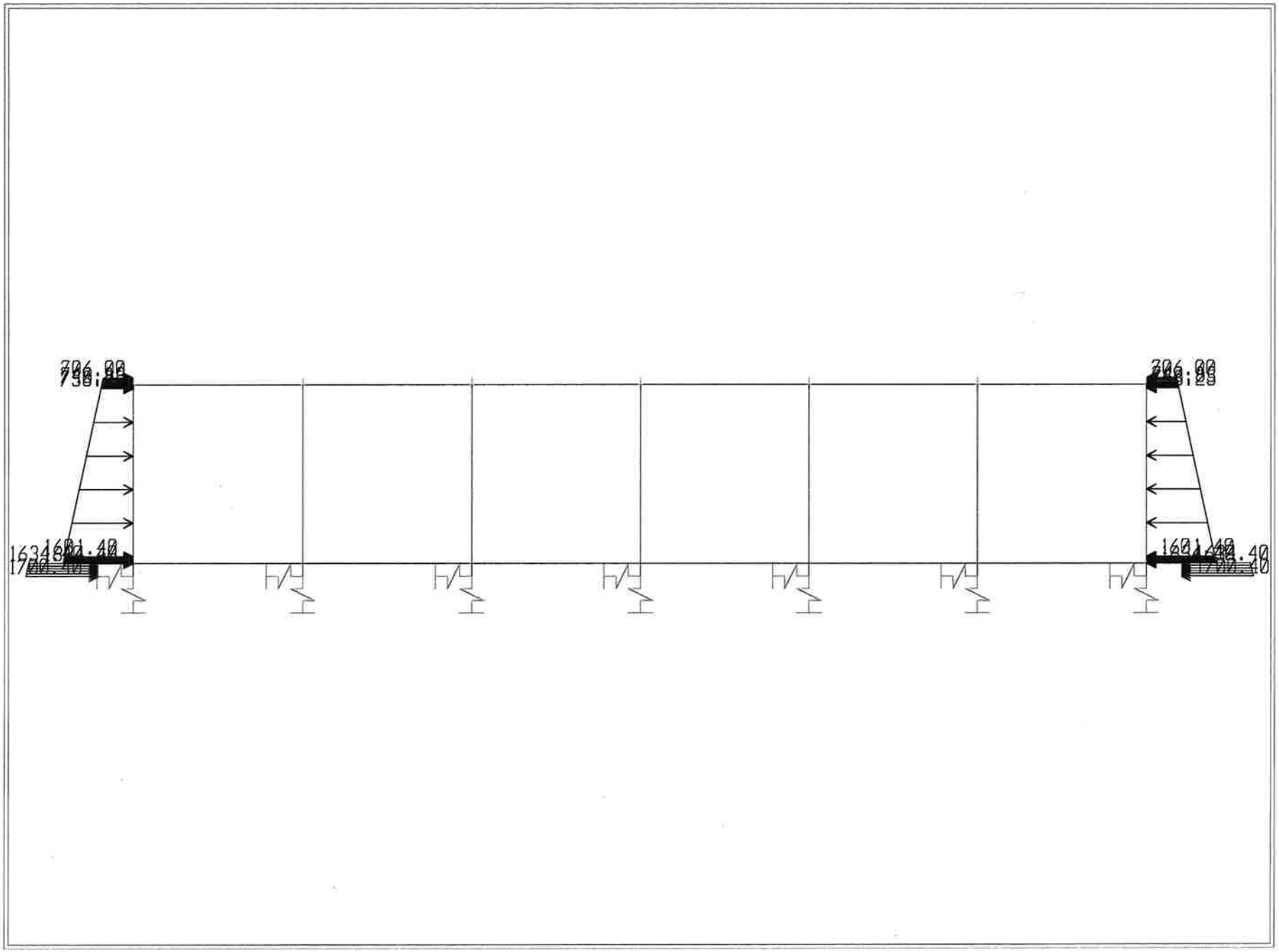
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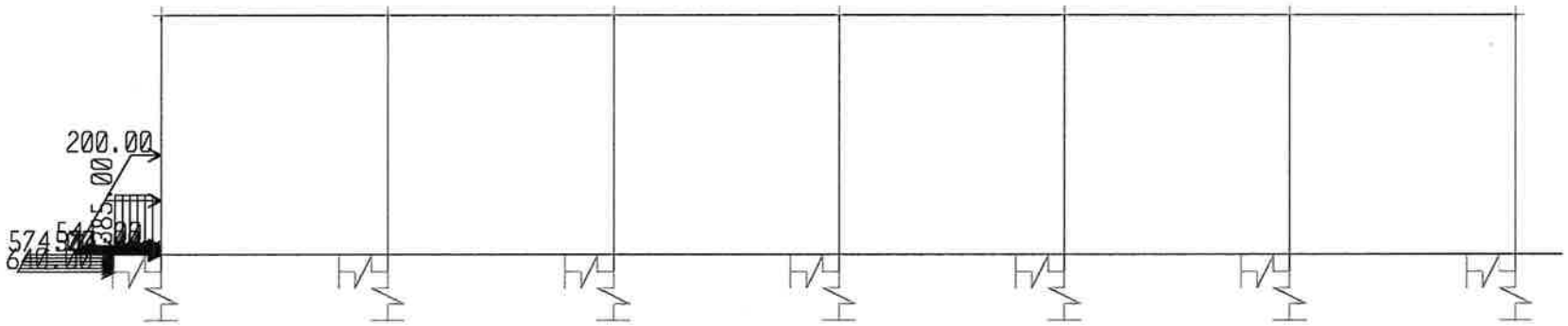
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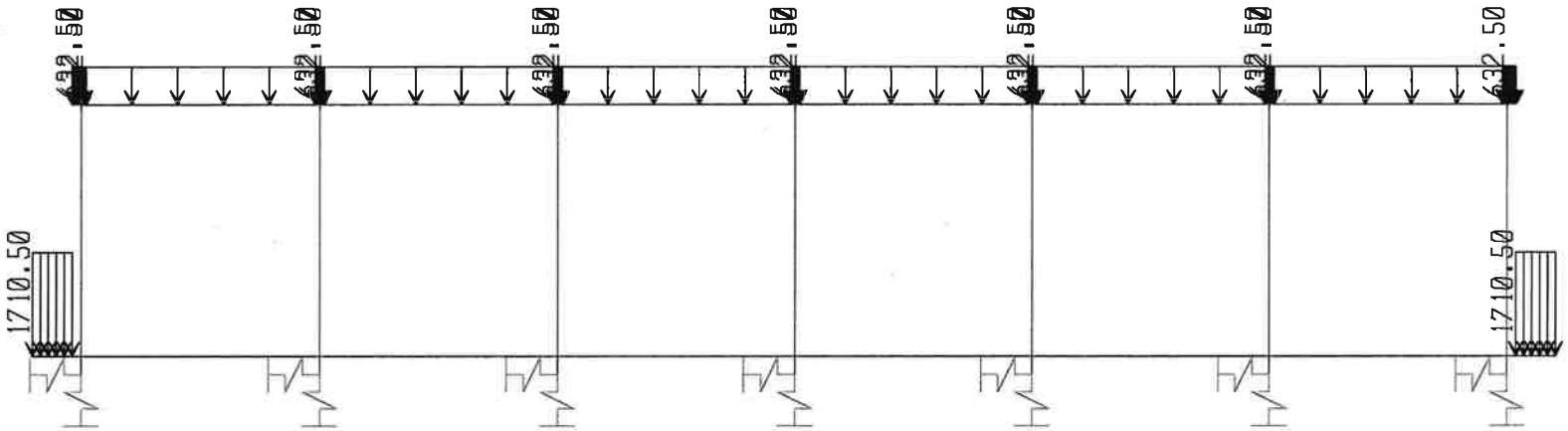
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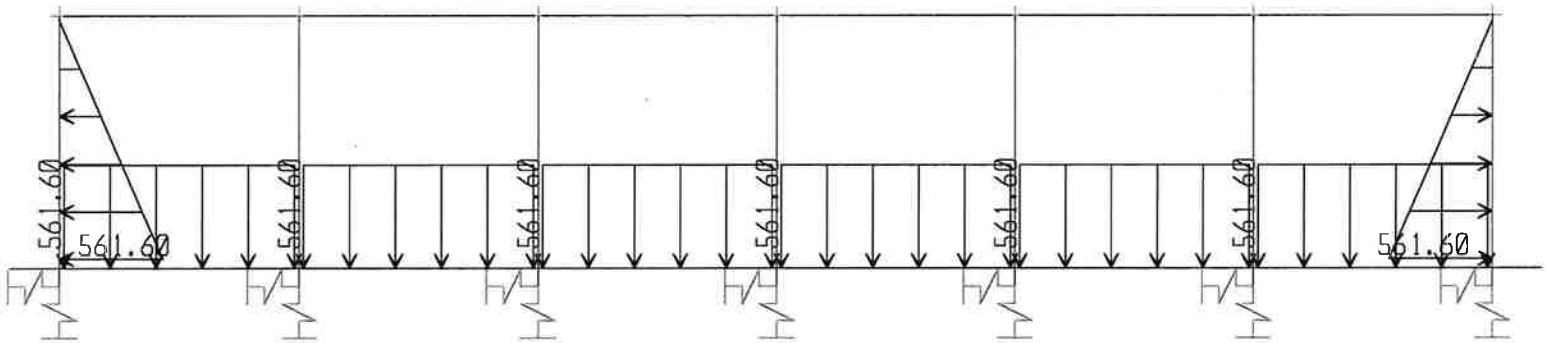
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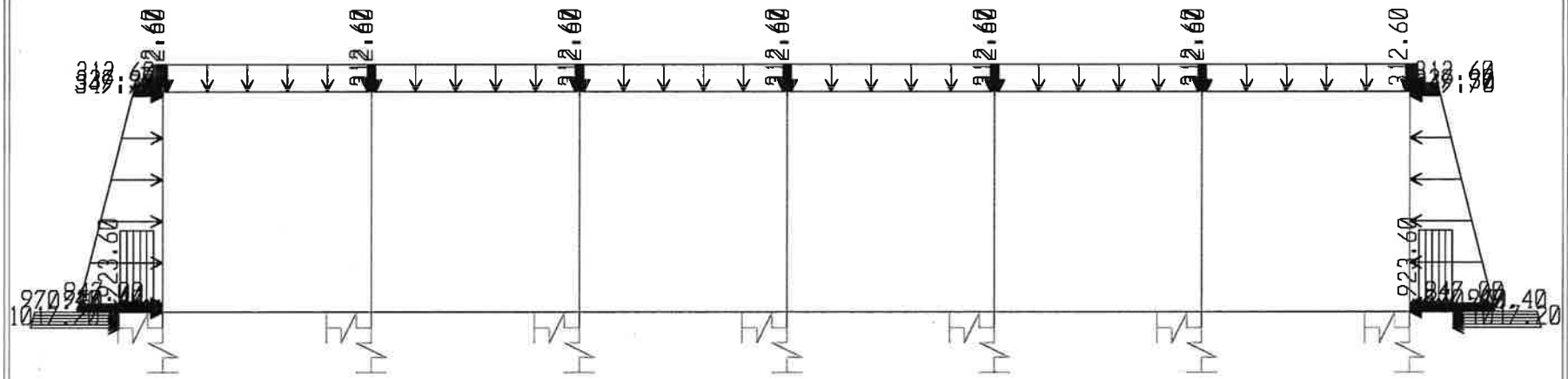
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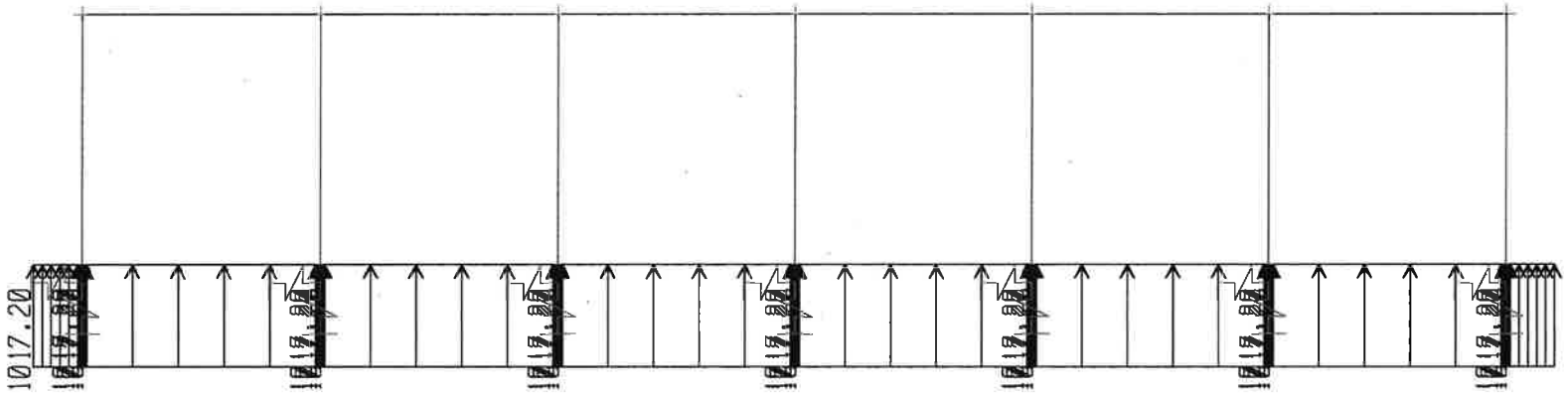
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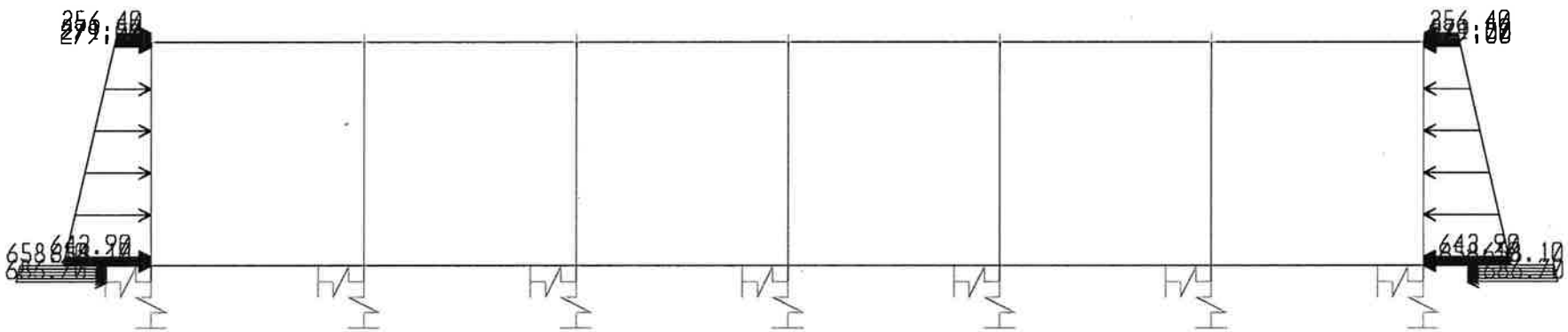
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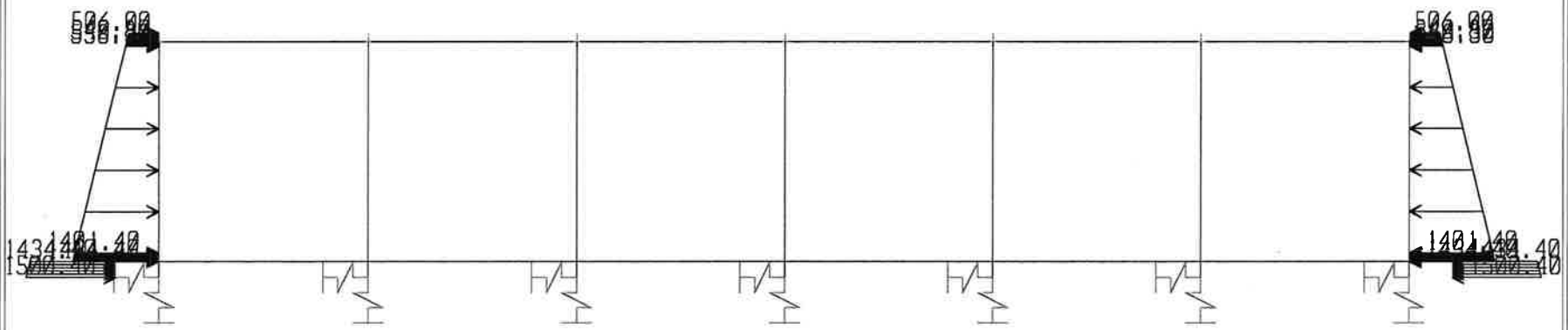
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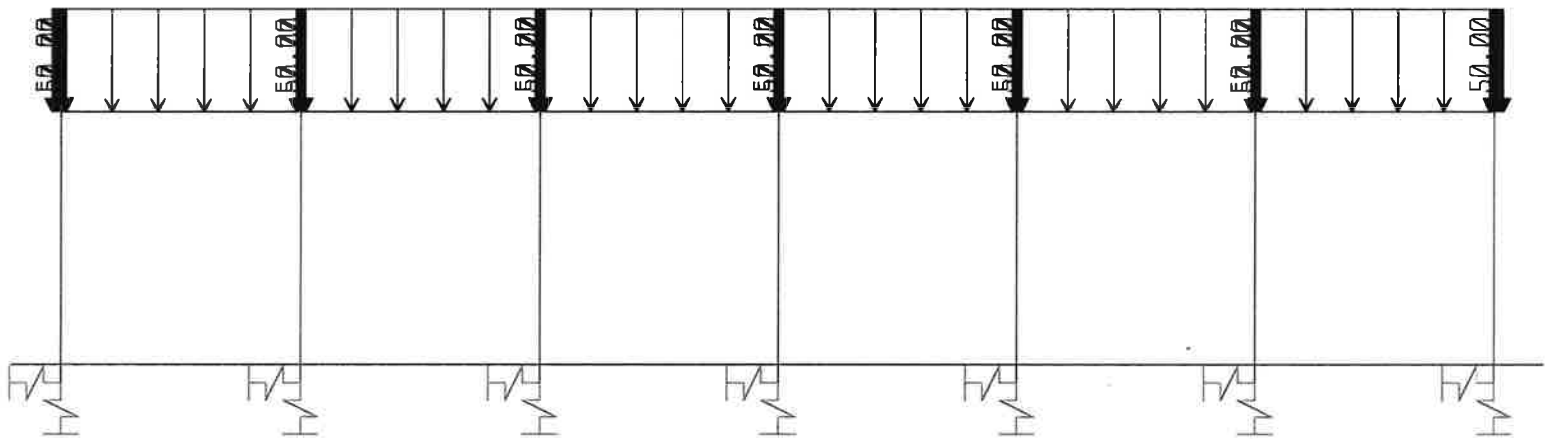
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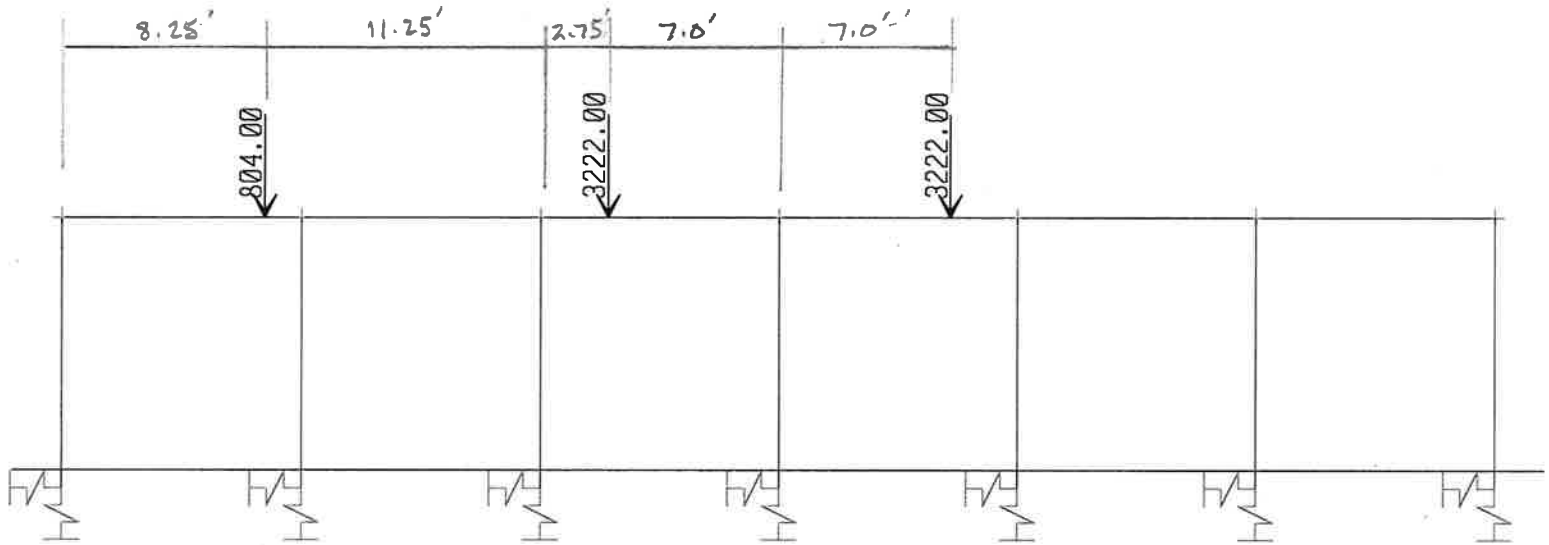
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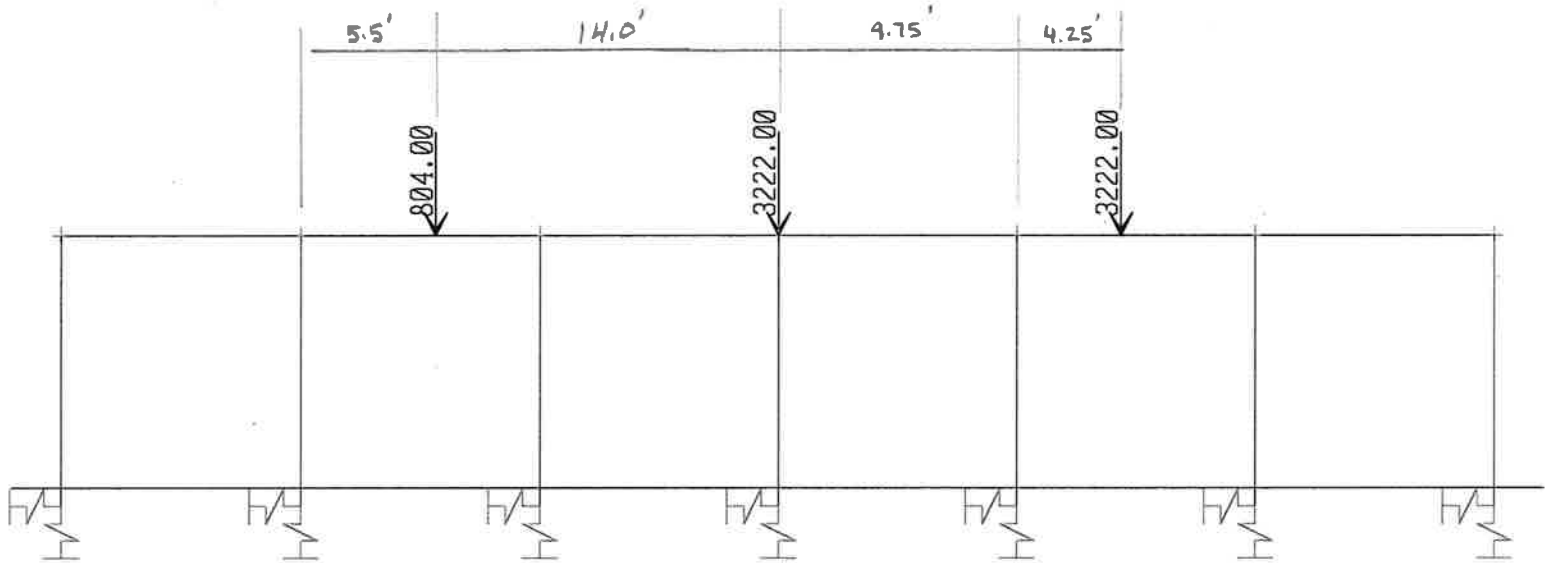
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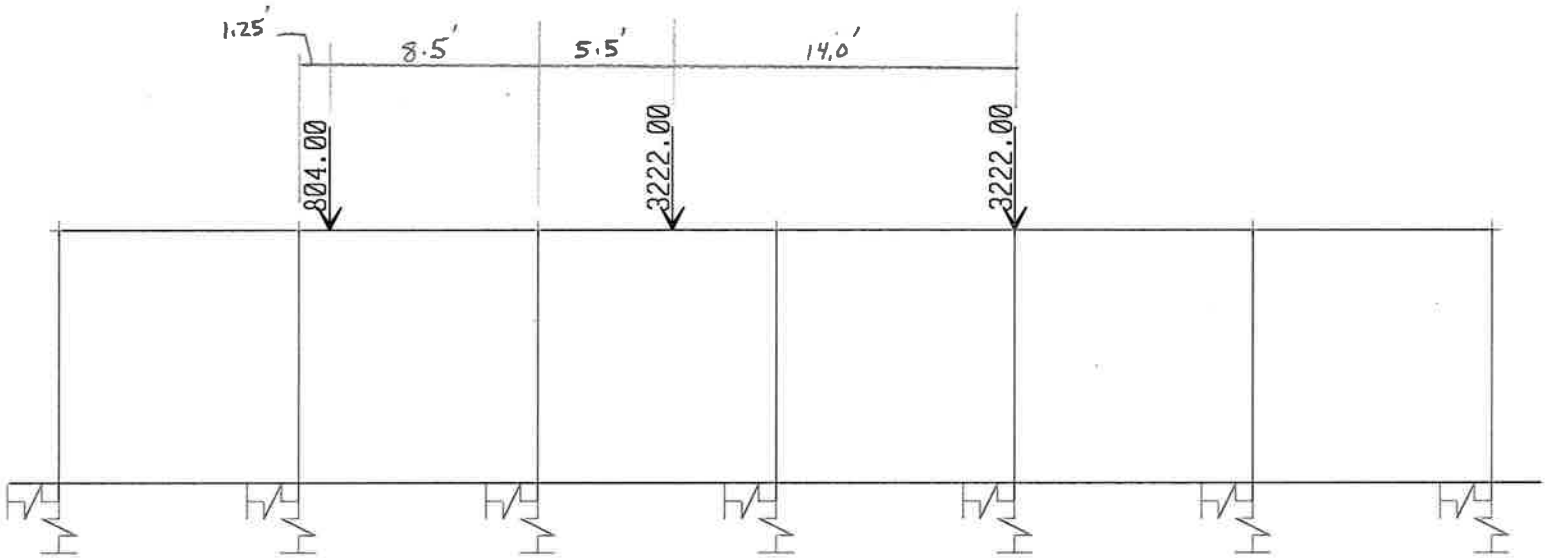
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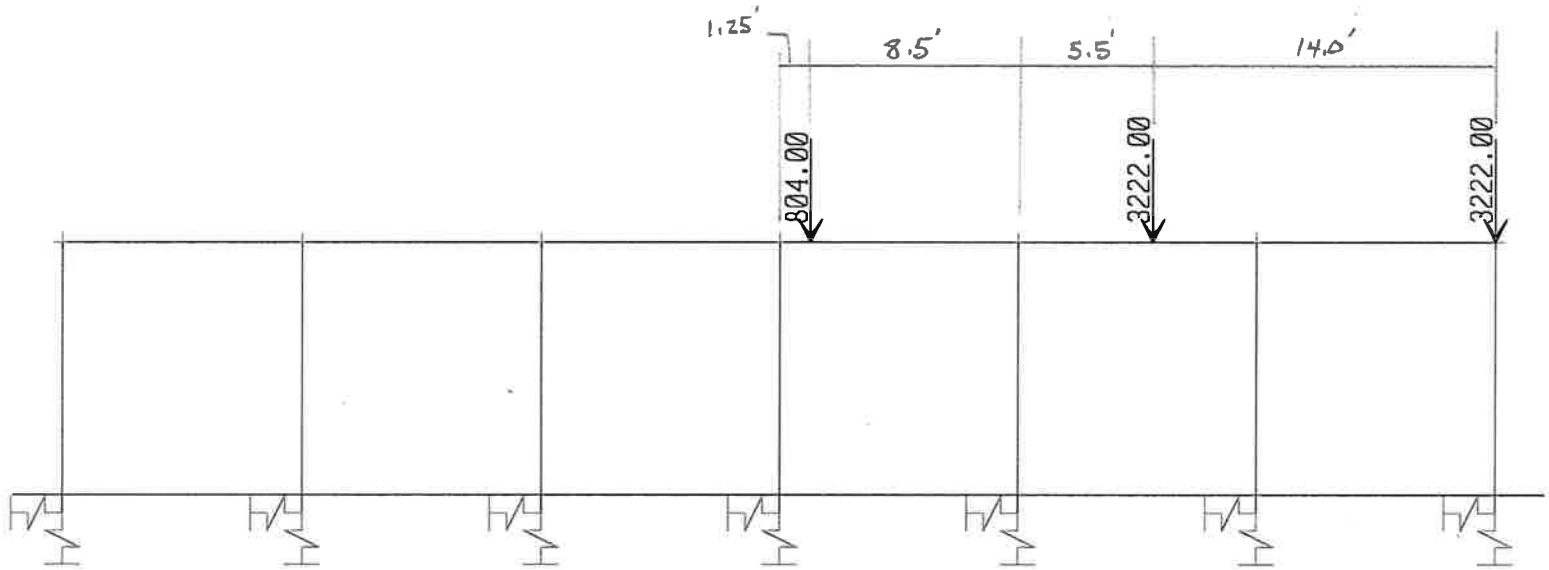
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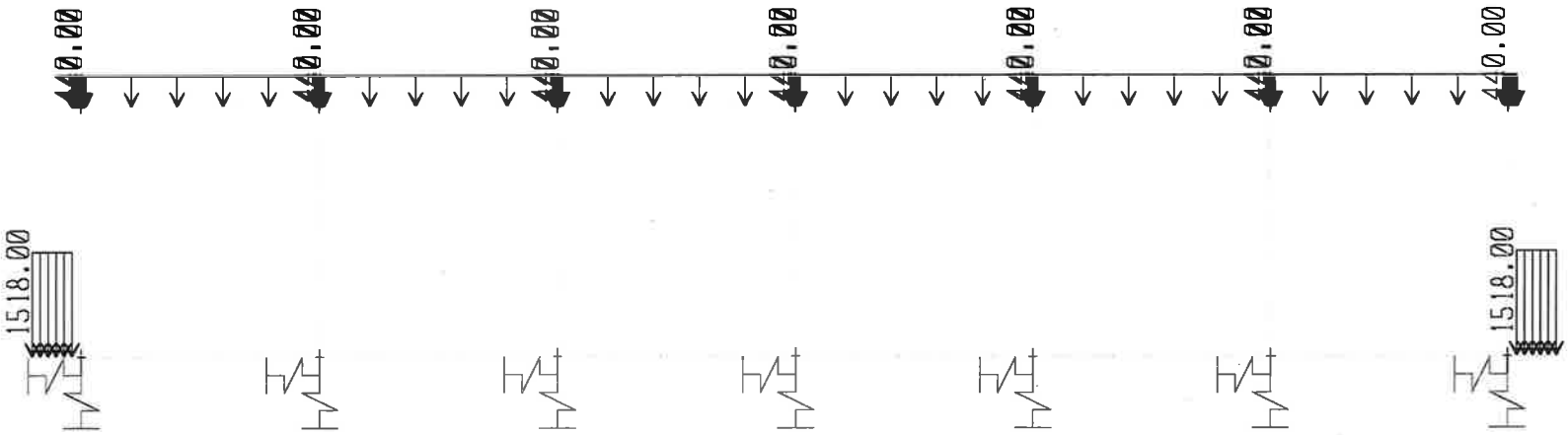
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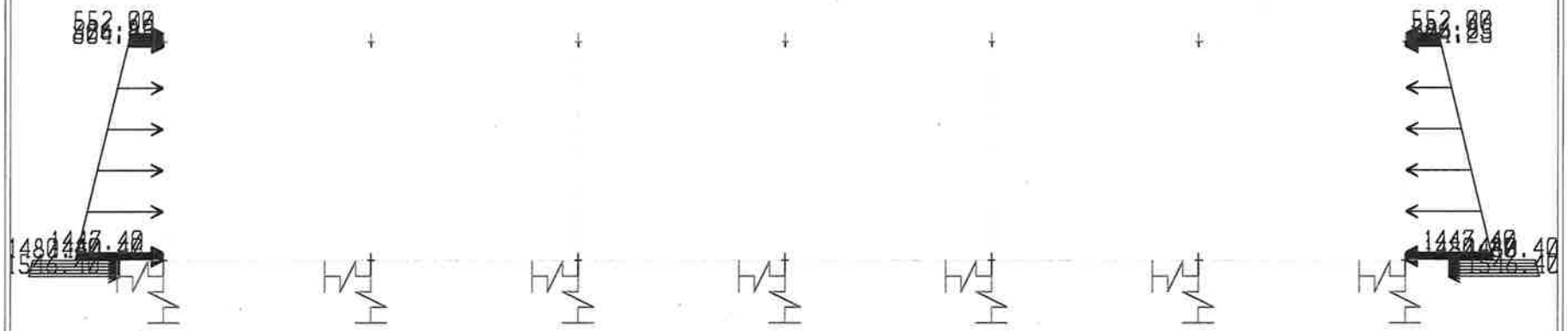
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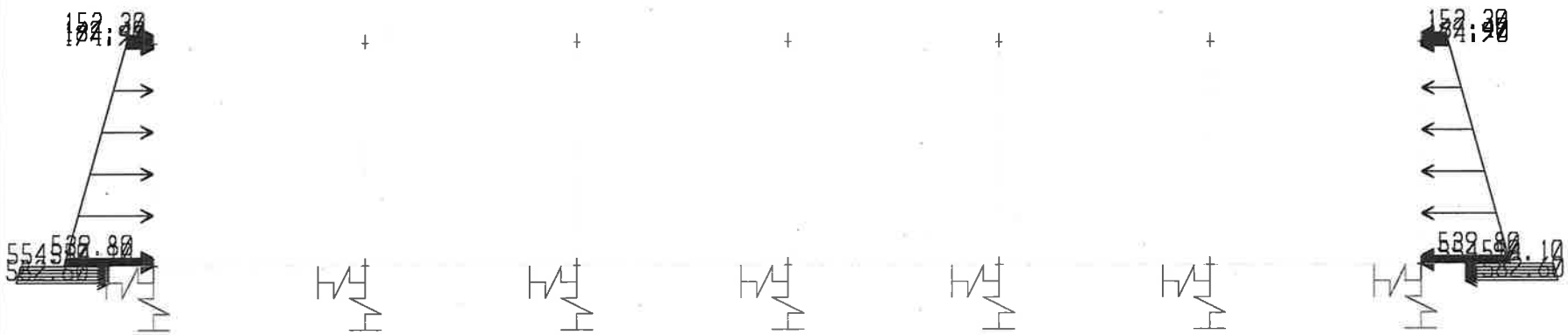

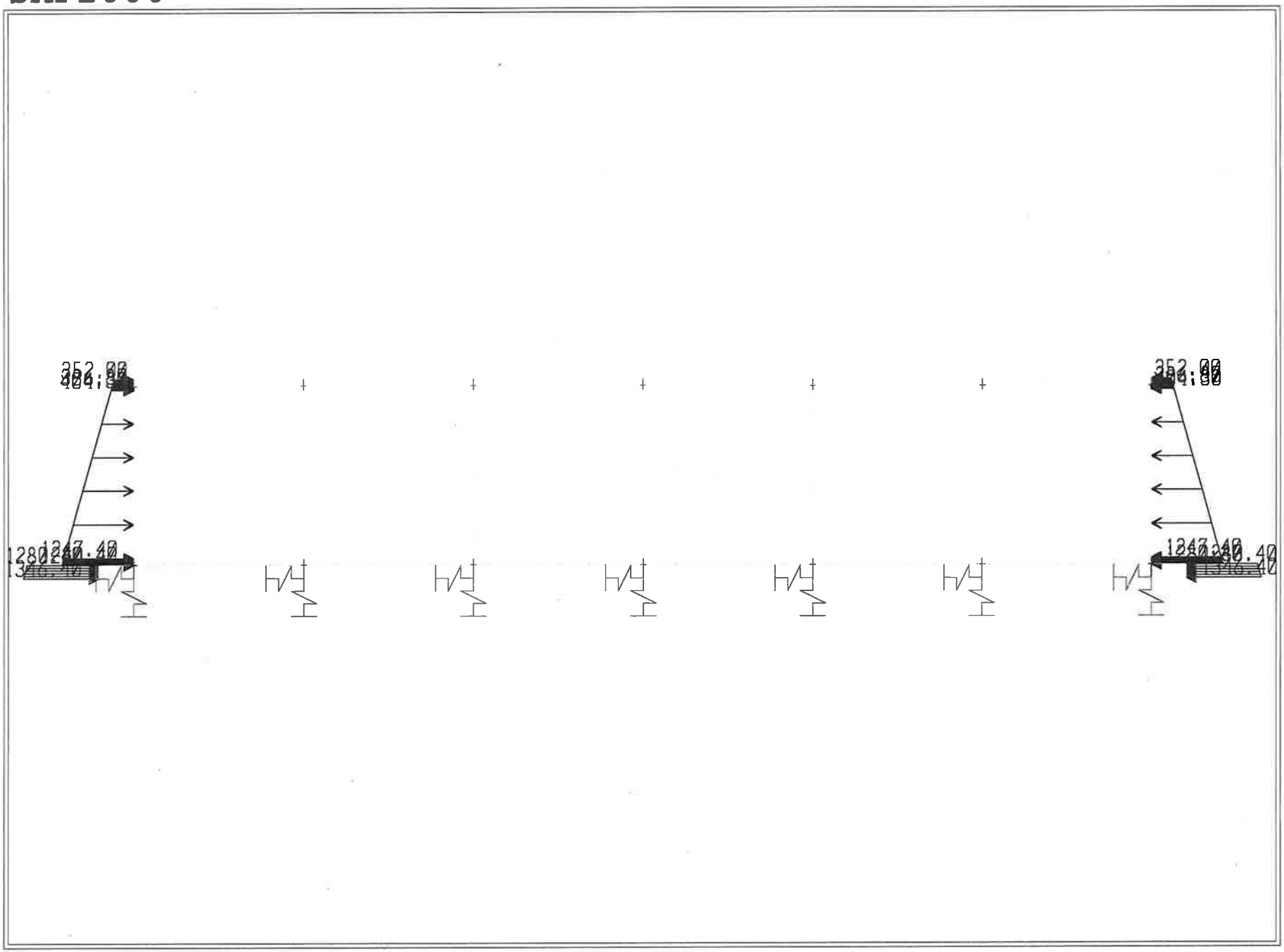

TABLE: Case - Static 1 - Load Assignments

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
DEAD	Load pattern	DEAD	1
Surcharge	Load pattern	L_surcharge	1
Vert Soil	Load pattern	S_vert	1
Lat Soil Surcharge	Load pattern	S_lat_const	1
Unbal Constr.	Load pattern	S_dry_unbal	1
Lat Soil Max WT	Load pattern	S_lat_maxWT	1
Lat Soil Min WT	Load pattern	S_lat_minWT	1
Full Flow	Load pattern	L_water_full	1
Max WT	Load pattern	H_max	1
Uplift (Max)	Load pattern	U_max	1
Lane	Load pattern	Lane	1
Truck Case 1	Load pattern	T_HS20_Case 1	1
Truck Case 2	Load pattern	T_HS20_Case 2	1
Truck Case 3	Load pattern	T_HS20_Case 3	1
Truck Case 4	Load pattern	T_HS20_Case 4	1
1a	Load pattern	DEAD	1
1a	Load pattern	L_surcharge	1
1a	Load pattern	S_lat_const	1
1a	Load pattern	S_vert	1
1b	Load pattern	DEAD	1
1b	Load pattern	L_surcharge	1
1b	Load pattern	S_dry_unbal	1
2a	Load pattern	DEAD	1
2a	Load pattern	L_water_full	1
2a	Load pattern	H_max	1
2a	Load pattern	U_max	1
2a	Load pattern	S_lat_maxWT	1
2a	Load pattern	S_vert	1
2b	Load pattern	DEAD	1
2b	Load pattern	L_water_full	1
2b	Load pattern	S_lat_minWT	1
2b	Load pattern	S_vert	1
3a	Load pattern	DEAD	1
3a	Load pattern	H_max	1
3a	Load pattern	U_max	1
3a	Load pattern	S_lat_maxWT	1
3a	Load pattern	S_vert	1
3b	Load pattern	DEAD	1
3b	Load pattern	S_lat_minWT	1
3b	Load pattern	S_vert	1
2a_truck3	Load pattern	DEAD	1
2a_truck3	Load pattern	L_water_full	1
2a_truck3	Load pattern	H_max	1
2a_truck3	Load pattern	U_max	1
2a_truck3	Load pattern	S_lat_maxWT	1
2a_truck3	Load pattern	Lane	1
2a_truck3	Load pattern	T_HS20_Case 3	1
2a_truck3	Load pattern	S_vert	1

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2b_truck3	Load pattern	DEAD	1
2b_truck3	Load pattern	L_water_full	1
2b_truck3	Load pattern	S_lat_minWT	1
2b_truck3	Load pattern	Lane	1
2b_truck3	Load pattern	T_HS20_Case 3	1
2b_truck3	Load pattern	S_vert	1
3a_truck3	Load pattern	DEAD	1
3a_truck3	Load pattern	H_max	1
3a_truck3	Load pattern	U_max	1
3a_truck3	Load pattern	S_lat_maxWT	1
3a_truck3	Load pattern	Lane	1
3a_truck3	Load pattern	T_HS20_Case 3	1
3a_truck3	Load pattern	S_vert	1
3b_truck3	Load pattern	DEAD	1
3b_truck3	Load pattern	S_lat_minWT	1
3b_truck3	Load pattern	Lane	1
3b_truck3	Load pattern	T_HS20_Case 3	1
3b_truck3	Load pattern	S_vert	1
1a-LRFD	Load pattern	DEAD	1.25
1a-LRFD	Load pattern	L_surcharge	1.75
1a-LRFD	Load pattern	S_lat_const	1.35
1a-LRFD	Load pattern	S_vert	1.3
1b-LRFD	Load pattern	DEAD	1.25
1b-LRFD	Load pattern	L_surcharge	1.75
1b-LRFD	Load pattern	S_dry_unbal	1.35
2a-LRFD	Load pattern	DEAD	1.25
2a-LRFD	Load pattern	L_water_full	1
2a-LRFD	Load pattern	H_max	1
2a-LRFD	Load pattern	U_max	1
2a-LRFD	Load pattern	S_lat_maxWT	1.35
2a-LRFD	Load pattern	S_vert	1.3
2b-LRFD	Load pattern	DEAD	1.25
2b-LRFD	Load pattern	L_water_full	1
2b-LRFD	Load pattern	S_lat_minWT	1.35
2b-LRFD	Load pattern	S_vert	1.3
3a-LRFD	Load pattern	DEAD	1.25
3a-LRFD	Load pattern	H_max	1
3a-LRFD	Load pattern	U_max	1
3a-LRFD	Load pattern	S_lat_maxWT	1.35
3a-LRFD	Load pattern	S_vert	1.3
3b-LRFD	Load pattern	DEAD	1.25
3b-LRFD	Load pattern	S_lat_minWT	1.35
3b-LRFD	Load pattern	S_vert	1.3

TABLE: Case - Static 1 - Load Assignments

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2a_truck3-LRFD	Load pattern	DEAD	1.25
2a_truck3-LRFD	Load pattern	L_water_full	1
2a_truck3-LRFD	Load pattern	H_max	1
2a_truck3-LRFD	Load pattern	U_max	1
2a_truck3-LRFD	Load pattern	S_lat_maxWT	1.35
2a_truck3-LRFD	Load pattern	Lane	1.75
2a_truck3-LRFD	Load pattern	T_HS20_Case 3	1.75
2a_truck3-LRFD	Load pattern	S_vert	1.3
2b_truck3-LRFD	Load pattern	DEAD	1.25
2b_truck3-LRFD	Load pattern	L_water_full	1
2b_truck3-LRFD	Load pattern	S_lat_minWT	1.35
2b_truck3-LRFD	Load pattern	Lane	1.75
2b_truck3-LRFD	Load pattern	T_HS20_Case 3	1.75
2b_truck3-LRFD	Load pattern	S_vert	1.3
3a_truck3-LRFD	Load pattern	DEAD	1.25
3a_truck3-LRFD	Load pattern	H_max	1
3a_truck3-LRFD	Load pattern	U_max	1
3a_truck3-LRFD	Load pattern	S_lat_maxWT	1.35
3a_truck3-LRFD	Load pattern	Lane	1.75
3a_truck3-LRFD	Load pattern	T_HS20_Case 3	1.75
3a_truck3-LRFD	Load pattern	S_vert	1.3
3b_truck3-LRFD	Load pattern	DEAD	1.25
3b_truck3-LRFD	Load pattern	S_lat_minWT	1.35
3b_truck3-LRFD	Load pattern	Lane	1.75
3b_truck3-LRFD	Load pattern	T_HS20_Case 3	1.75
3b_truck3-LRFD	Load pattern	S_vert	1.3
2a_truck1	Load pattern	DEAD	1
2a_truck1	Load pattern	L_water_full	1
2a_truck1	Load pattern	H_max	1
2a_truck1	Load pattern	U_max	1
2a_truck1	Load pattern	S_lat_maxWT	1
2a_truck1	Load pattern	Lane	1
2a_truck1	Load pattern	T_HS20_Case 1	1
2a_truck1	Load pattern	S_vert	1
2a_truck2	Load pattern	DEAD	1
2a_truck2	Load pattern	L_water_full	1
2a_truck2	Load pattern	H_max	1
2a_truck2	Load pattern	U_max	1
2a_truck2	Load pattern	S_lat_maxWT	1
2a_truck2	Load pattern	Lane	1
2a_truck2	Load pattern	T_HS20_Case 2	1
2a_truck2	Load pattern	S_vert	1
2a_truck4	Load pattern	DEAD	1
2a_truck4	Load pattern	L_water_full	1
2a_truck4	Load pattern	H_max	1
2a_truck4	Load pattern	U_max	1
2a_truck4	Load pattern	S_lat_maxWT	1
2a_truck4	Load pattern	Lane	1
2a_truck4	Load pattern	T_HS20_Case 4	1
2a_truck4	Load pattern	S_vert	1

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2b_truck1	Load pattern	DEAD	1
2b_truck1	Load pattern	L_water_full	1
2b_truck1	Load pattern	S_lat_minWT	1
2b_truck1	Load pattern	Lane	1
2b_truck1	Load pattern	T_HS20_Case 1	1
2b_truck1	Load pattern	S_vert	1
2b_truck2	Load pattern	DEAD	1
2b_truck2	Load pattern	L_water_full	1
2b_truck2	Load pattern	S_lat_minWT	1
2b_truck2	Load pattern	Lane	1
2b_truck2	Load pattern	T_HS20_Case 2	1
2b_truck2	Load pattern	S_vert	1
2b_truck4	Load pattern	DEAD	1
2b_truck4	Load pattern	L_water_full	1
2b_truck4	Load pattern	S_lat_minWT	1
2b_truck4	Load pattern	Lane	1
2b_truck4	Load pattern	T_HS20_Case 4	1
2b_truck4	Load pattern	S_vert	1
3a_truck1	Load pattern	DEAD	1
3a_truck1	Load pattern	H_max	1
3a_truck1	Load pattern	U_max	1
3a_truck1	Load pattern	S_lat_maxWT	1
3a_truck1	Load pattern	Lane	1
3a_truck1	Load pattern	T_HS20_Case 1	1
3a_truck1	Load pattern	S_vert	1
3a_truck2	Load pattern	DEAD	1
3a_truck2	Load pattern	H_max	1
3a_truck2	Load pattern	U_max	1
3a_truck2	Load pattern	S_lat_maxWT	1
3a_truck2	Load pattern	Lane	1
3a_truck2	Load pattern	T_HS20_Case 2	1
3a_truck2	Load pattern	S_vert	1
3a_truck4	Load pattern	DEAD	1
3a_truck4	Load pattern	H_max	1
3a_truck4	Load pattern	U_max	1
3a_truck4	Load pattern	S_lat_maxWT	1
3a_truck4	Load pattern	Lane	1
3a_truck4	Load pattern	T_HS20_Case 4	1
3a_truck4	Load pattern	S_vert	1
3b_truck1	Load pattern	DEAD	1
3b_truck1	Load pattern	S_lat_minWT	1
3b_truck1	Load pattern	Lane	1
3b_truck1	Load pattern	T_HS20_Case 1	1
3b_truck1	Load pattern	S_vert	1
3b_truck2	Load pattern	DEAD	1
3b_truck2	Load pattern	S_lat_minWT	1
3b_truck2	Load pattern	Lane	1
3b_truck2	Load pattern	T_HS20_Case 2	1
3b_truck2	Load pattern	S_vert	1

TABLE: Case - Static 1 - Load Assignments

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
3b_truck4	Load pattern	DEAD	1
3b_truck4	Load pattern	S_lat_minWT	1
3b_truck4	Load pattern	Lane	1
3b_truck4	Load pattern	T_HS20_Case 4	1
3b_truck4	Load pattern	S_vert	1
2a_truck1LRFD	Load pattern	DEAD	1.25
2a_truck1LRFD	Load pattern	L_water_full	1
2a_truck1LRFD	Load pattern	H_max	1
2a_truck1LRFD	Load pattern	U_max	1
2a_truck1LRFD	Load pattern	S_lat_maxWT	1.35
2a_truck1LRFD	Load pattern	Lane	1.75
2a_truck1LRFD	Load pattern	T_HS20_Case 1	1.75
2a_truck1LRFD	Load pattern	S_vert	1.3
2a_truck2LRFD	Load pattern	DEAD	1.25
2a_truck2LRFD	Load pattern	L_water_full	1
2a_truck2LRFD	Load pattern	H_max	1
2a_truck2LRFD	Load pattern	U_max	1
2a_truck2LRFD	Load pattern	S_lat_maxWT	1.35
2a_truck2LRFD	Load pattern	Lane	1.75
2a_truck2LRFD	Load pattern	T_HS20_Case 2	1.75
2a_truck2LRFD	Load pattern	S_vert	1.3
2a_truck4LRFD	Load pattern	DEAD	1.25
2a_truck4LRFD	Load pattern	L_water_full	1
2a_truck4LRFD	Load pattern	H_max	1
2a_truck4LRFD	Load pattern	U_max	1
2a_truck4LRFD	Load pattern	S_lat_maxWT	1.35
2a_truck4LRFD	Load pattern	Lane	1.75
2a_truck4LRFD	Load pattern	T_HS20_Case 4	1.75
2a_truck4LRFD	Load pattern	S_vert	1.3
2b_truck1LRFD	Load pattern	DEAD	1.25
2b_truck1LRFD	Load pattern	L_water_full	1
2b_truck1LRFD	Load pattern	S_lat_minWT	1.35
2b_truck1LRFD	Load pattern	Lane	1.75
2b_truck1LRFD	Load pattern	T_HS20_Case 1	1.75
2b_truck1LRFD	Load pattern	S_vert	1.3
2b_truck2LRFD	Load pattern	DEAD	1.25
2b_truck2LRFD	Load pattern	L_water_full	1
2b_truck2LRFD	Load pattern	S_lat_minWT	1.35
2b_truck2LRFD	Load pattern	Lane	1.75
2b_truck2LRFD	Load pattern	T_HS20_Case 2	1.75
2b_truck2LRFD	Load pattern	S_vert	1.3
2b_truck4LRFD	Load pattern	DEAD	1.25
2b_truck4LRFD	Load pattern	L_water_full	1
2b_truck4LRFD	Load pattern	S_lat_minWT	1.35
2b_truck4LRFD	Load pattern	Lane	1.75
2b_truck4LRFD	Load pattern	T_HS20_Case 4	1.75
2b_truck4LRFD	Load pattern	S_vert	1.3
3a_truck1LRFD	Load pattern	DEAD	1.25
3a_truck1LRFD	Load pattern	H_max	1
3a_truck1LRFD	Load pattern	U_max	1
3a_truck1LRFD	Load pattern	S_lat_maxWT	1.35
3a_truck1LRFD	Load pattern	Lane	1.75
3a_truck1LRFD	Load pattern	T_HS20_Case 1	1.75
3a_truck1LRFD	Load pattern	S_vert	1.3

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
3a_truck2LRF	Load pattern	DEAD	1.25
3a_truck2LRF	Load pattern	H_max	1
3a_truck2LRF	Load pattern	U_max	1
3a_truck2LRF	Load pattern	S_lat_maxWT	1.35
3a_truck2LRF	Load pattern	Lane	1.75
3a_truck2LRF	Load pattern	T_HS20_Case 2	1.75
3a_truck2LRF	Load pattern	S_vert	1.3
3a_truck4LRF	Load pattern	DEAD	1.25
3a_truck4LRF	Load pattern	H_max	1
3a_truck4LRF	Load pattern	U_max	1
3a_truck4LRF	Load pattern	S_lat_maxWT	1.35
3a_truck4LRF	Load pattern	Lane	1.75
3a_truck4LRF	Load pattern	T_HS20_Case 4	1.75
3a_truck4LRF	Load pattern	S_vert	1.3
3b_truck1LRF	Load pattern	DEAD	1.25
3b_truck1LRF	Load pattern	S_lat_minWT	1.35
3b_truck1LRF	Load pattern	Lane	1.75
3b_truck1LRF	Load pattern	T_HS20_Case 1	1.75
3b_truck1LRF	Load pattern	S_vert	1.3
3b_truck2LRF	Load pattern	DEAD	1.25
3b_truck2LRF	Load pattern	S_lat_minWT	1.35
3b_truck2LRF	Load pattern	Lane	1.75
3b_truck2LRF	Load pattern	T_HS20_Case 2	1.75
3b_truck2LRF	Load pattern	S_vert	1.3
3b_truck4LRF	Load pattern	DEAD	1.25
3b_truck4LRF	Load pattern	S_lat_minWT	1.35
3b_truck4LRF	Load pattern	Lane	1.75
3b_truck4LRF	Load pattern	T_HS20_Case 4	1.75
3b_truck4LRF	Load pattern	S_vert	1.3
Str-1-Truck 1	Load pattern	DEAD	1.25
Str-1-Truck 1	Load pattern	S_vert	1.3
Str-1-Truck 1	Load pattern	S_lat_maxWT	0.9
Str-1-Truck 1	Load pattern	Lane	1.75
Str-1-Truck 1	Load pattern	T_HS20_Case 1	1.75
Str-1-Truck 1	Load pattern	L_water_full	1
Str-1-Truck 1	Load pattern	U_max	1
Str-1-Truck 1	Load pattern	H_max	1
Str-1-Truck 2	Load pattern	DEAD	1.25
Str-1-Truck 2	Load pattern	S_vert	1.3
Str-1-Truck 2	Load pattern	S_lat_maxWT	0.9
Str-1-Truck 2	Load pattern	Lane	1.75
Str-1-Truck 2	Load pattern	T_HS20_Case 2	1.75
Str-1-Truck 2	Load pattern	L_water_full	1
Str-1-Truck 2	Load pattern	H_max	1
Str-1-Truck 2	Load pattern	U_max	1
Str-1-Truck 3	Load pattern	DEAD	1.25
Str-1-Truck 3	Load pattern	S_vert	1.3
Str-1-Truck 3	Load pattern	S_lat_maxWT	0.9
Str-1-Truck 3	Load pattern	Lane	1.75
Str-1-Truck 3	Load pattern	T_HS20_Case 3	1.75
Str-1-Truck 3	Load pattern	L_water_full	1
Str-1-Truck 3	Load pattern	H_max	1
Str-1-Truck 3	Load pattern	U_max	1

TABLE: Case - Static 1 - Load Assignments

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
Str-1-Truck 4	Load pattern	DEAD	1.25
Str-1-Truck 4	Load pattern	S_vert	1.3
Str-1-Truck 4	Load pattern	S_lat_maxWT	0.9
Str-1-Truck 4	Load pattern	Lane	1.75
Str-1-Truck 4	Load pattern	T_HS20_Case 4	1.75
Str-1-Truck 4	Load pattern	L_water_full	1
Str-1-Truck 4	Load pattern	H_max	1
Str-1-Truck 4	Load pattern	U_max	1
Str-2	Load pattern	DEAD	0.9
Str-2	Load pattern	S_vert	0.9
Str-2	Load pattern	S_lat_maxWT	0.9
Str-3-Truck 1	Load pattern	DEAD	1.25
Str-3-Truck 1	Load pattern	S_vert	1.3
Str-3-Truck 1	Load pattern	S_lat_minWT	1.35
Str-3-Truck 1	Load pattern	Lane	1.75
Str-3-Truck 1	Load pattern	T_HS20_Case 1	1.75
Str-3-Truck 2	Load pattern	DEAD	1.25
Str-3-Truck 2	Load pattern	S_vert	1.3
Str-3-Truck 2	Load pattern	S_lat_minWT	1.35
Str-3-Truck 2	Load pattern	Lane	1.75
Str-3-Truck 2	Load pattern	T_HS20_Case 2	1.75
Str-3-Truck 3	Load pattern	DEAD	1.25
Str-3-Truck 3	Load pattern	S_vert	1.3
Str-3-Truck 3	Load pattern	S_lat_minWT	1.35
Str-3-Truck 3	Load pattern	Lane	1.75
Str-3-Truck 3	Load pattern	T_HS20_Case 3	1.75
Str-3-Truck 4	Load pattern	DEAD	1.25
Str-3-Truck 4	Load pattern	S_vert	1.3
Str-3-Truck 4	Load pattern	S_lat_minWT	1.35
Str-3-Truck 4	Load pattern	Lane	1.75
Str-3-Truck 4	Load pattern	T_HS20_Case 4	1.75
Ser-1-Truck 1	Load pattern	DEAD	1
Ser-1-Truck 1	Load pattern	S_vert	1
Ser-1-Truck 1	Load pattern	S_lat_maxWT	1
Ser-1-Truck 1	Load pattern	Lane	1
Ser-1-Truck 1	Load pattern	T_HS20_Case 1	1
Ser-1-Truck 1	Load pattern	L_water_full	1
Ser-1-Truck 1	Load pattern	U_max	1
Ser-1-Truck 1	Load pattern	H_max	1
Ser-1-Truck 2	Load pattern	DEAD	1
Ser-1-Truck 2	Load pattern	S_vert	1
Ser-1-Truck 2	Load pattern	S_lat_maxWT	1
Ser-1-Truck 2	Load pattern	Lane	1
Ser-1-Truck 2	Load pattern	T_HS20_Case 2	1
Ser-1-Truck 2	Load pattern	L_water_full	1
Ser-1-Truck 2	Load pattern	U_max	1
Ser-1-Truck 2	Load pattern	H_max	1

Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
Ser-1-Truck 3	Load pattern	DEAD	1
Ser-1-Truck 3	Load pattern	S_vert	1
Ser-1-Truck 3	Load pattern	S_lat_maxWT	1
Ser-1-Truck 3	Load pattern	Lane	1
Ser-1-Truck 3	Load pattern	T_HS20_Case 3	1
Ser-1-Truck 3	Load pattern	L_water_full	1
Ser-1-Truck 3	Load pattern	U_max	1
Ser-1-Truck 3	Load pattern	H_max	1
Ser-1-Truck 4	Load pattern	DEAD	1
Ser-1-Truck 4	Load pattern	S_vert	1
Ser-1-Truck 4	Load pattern	S_lat_maxWT	1
Ser-1-Truck 4	Load pattern	Lane	1
Ser-1-Truck 4	Load pattern	T_HS20_Case 4	1
Ser-1-Truck 4	Load pattern	L_water_full	1
Ser-1-Truck 4	Load pattern	U_max	1
Ser-1-Truck 4	Load pattern	H_max	1
Ser-2	Load pattern	DEAD	1
Ser-2	Load pattern	S_vert	1
Ser-2	Load pattern	S_lat_maxWT	1
Ser-3-Truck 1	Load pattern	DEAD	1
Ser-3-Truck 1	Load pattern	S_vert	1
Ser-3-Truck 1	Load pattern	S_lat_minWT	1
Ser-3-Truck 1	Load pattern	Lane	1
Ser-3-Truck 1	Load pattern	T_HS20_Case 1	1
Ser-3-Truck 2	Load pattern	DEAD	1
Ser-3-Truck 2	Load pattern	S_vert	1
Ser-3-Truck 2	Load pattern	S_lat_minWT	1
Ser-3-Truck 2	Load pattern	Lane	1
Ser-3-Truck 2	Load pattern	T_HS20_Case 2	1
Ser-3-Truck 3	Load pattern	DEAD	1
Ser-3-Truck 3	Load pattern	S_vert	1
Ser-3-Truck 3	Load pattern	S_lat_minWT	1
Ser-3-Truck 3	Load pattern	Lane	1
Ser-3-Truck 3	Load pattern	T_HS20_Case 3	1
Ser-3-Truck 4	Load pattern	DEAD	1
Ser-3-Truck 4	Load pattern	S_vert	1
Ser-3-Truck 4	Load pattern	S_lat_minWT	1
Ser-3-Truck 4	Load pattern	Lane	1
Ser-3-Truck 4	Load pattern	T_HS20_Case 4	1
Fat-Truck 1	Load pattern	T_HS20_Case 1	0.75
Fat-Truck 2	Load pattern	T_HS20_Case 2	0.75
Fat-Truck 3	Load pattern	T_HS20_Case 3	0.75
Fat-Truck 4	Load pattern	T_HS20_Case 4	0.75

TABLE: Combination Definitions					
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
LRFD-Comb w/truck	Envelope	No	Linear Static	1a-LRFD	1
LRFD-Comb w/truck			Linear Static	1b-LRFD	1
LRFD-Comb w/truck			Linear Static	2a_truck3-LRFD	1
LRFD-Comb w/truck			Linear Static	2b_truck3-LRFD	1
LRFD-Comb w/truck			Linear Static	3a_truck3-LRFD	1
LRFD-Comb w/truck			Linear Static	3b_truck3-LRFD	1
LRFD-Comb w/truck			Linear Static	2a_truck1LRFD	1
LRFD-Comb w/truck			Linear Static	2a_truck2LRFD	1
LRFD-Comb w/truck			Linear Static	2a_truck4LRFD	1
LRFD-Comb w/truck			Linear Static	2b_truck1LRFD	1
LRFD-Comb w/truck			Linear Static	2b_truck2LRFD	1
LRFD-Comb w/truck			Linear Static	2b_truck4LRFD	1
LRFD-Comb w/truck			Linear Static	3a_truck1LRFD	1
LRFD-Comb w/truck			Linear Static	3a_truck2LRFD	1
LRFD-Comb w/truck			Linear Static	3a_truck4LRFD	1
LRFD-Comb w/truck			Linear Static	3b_truck1LRFD	1
LRFD-Comb w/truck			Linear Static	3b_truck2LRFD	1
LRFD-Comb w/truck			Linear Static	3b_truck4LRFD	1
LRFD-Comb NoTruck	Envelope	No	Linear Static	1a-LRFD	1
LRFD-Comb NoTruck			Linear Static	1b-LRFD	1
LRFD-Comb NoTruck			Linear Static	2a-LRFD	1
LRFD-Comb NoTruck			Linear Static	2b-LRFD	1
LRFD-Comb NoTruck			Linear Static	3a-LRFD	1
LRFD-Comb NoTruck			Linear Static	3b-LRFD	1
Service Comb w/truck	Envelope	No	Linear Static	1a	1
Service Comb w/truck			Linear Static	1b	1
Service Comb w/truck			Linear Static	2a_truck3	1
Service Comb w/truck			Linear Static	2b_truck3	1
Service Comb w/truck			Linear Static	3a_truck3	1
Service Comb w/truck			Linear Static	3b_truck3	1
Service Comb w/truck			Linear Static	2a_truck1	1
Service Comb w/truck			Linear Static	2a_truck2	1
Service Comb w/truck			Linear Static	2a_truck4	1
Service Comb w/truck			Linear Static	2b_truck1	1
Service Comb w/truck			Linear Static	2b_truck2	1
Service Comb w/truck			Linear Static	2b_truck4	1
Service Comb w/truck			Linear Static	3a_truck1	1
Service Comb w/truck			Linear Static	3a_truck2	1
Service Comb w/truck			Linear Static	3a_truck4	1
Service Comb w/truck			Linear Static	3b_truck1	1
Service Comb w/truck			Linear Static	3b_truck2	1
Service Comb w/truck			Linear Static	3b_truck4	1

TABLE: Combination Definitions					
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
Service Comb No Truck	Envelope	No	Linear Static	1a	1
Service Comb No Truck			Linear Static	1b	1
Service Comb No Truck			Linear Static	2a	1
Service Comb No Truck			Linear Static	2b	1
Service Comb No Truck			Linear Static	3a	1
Service Comb No Truck			Linear Static	3b	1
Strength 1	Envelope	No	Linear Static	Str-1-Truck 1	1
Strength 1			Linear Static	Str-1-Truck 2	1
Strength 1			Linear Static	Str-1-Truck 3	1
Strength 1			Linear Static	Str-1-Truck 4	1
Strength 1			Linear Static	Str-2	1
Strength 1			Linear Static	Str-3-Truck 1	1
Strength 1			Linear Static	Str-3-Truck 2	1
Strength 1			Linear Static	Str-3-Truck 3	1
Strength 1			Linear Static	Str-3-Truck 4	1
Service 1	Envelope	No	Linear Static	Ser-1-Truck 1	1
Service 1			Linear Static	Ser-1-Truck 2	1
Service 1			Linear Static	Ser-1-Truck 3	1
Service 1			Linear Static	Ser-1-Truck 4	1
Service 1			Linear Static	Ser-2	1
Service 1			Linear Static	Ser-3-Truck 1	1
Service 1			Linear Static	Ser-3-Truck 2	1
Service 1			Linear Static	Ser-3-Truck 3	1
Service 1			Linear Static	Ser-3-Truck 4	1
Fatigue	Envelope	No	Linear Static	Fat-Truck 1	1
Fatigue			Linear Static	Fat-Truck 2	1
Fatigue			Linear Static	Fat-Truck 3	1
Fatigue			Linear Static	Fat-Truck 4	1

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SAP Results (Roadway & Levee)

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 1	1a	LinStatic		-0.036	10.217
Pile 1	1b	LinStatic		-0.301	5.247
Pile 1	2a	LinStatic		-0.044	7.716
Pile 1	2b	LinStatic		-0.005037	11.193
Pile 1	3a	LinStatic		-0.07	5.153
Pile 1	3b	LinStatic		-0.031	8.631
Pile 1	2a_truck3	LinStatic		-0.042	7.973
Pile 1	2b_truck3	LinStatic		-0.003433	11.45
Pile 1	3a_truck3	LinStatic		-0.069	5.41
Pile 1	3b_truck3	LinStatic		-0.03	8.887
Pile 1	2a_truck1	LinStatic		-0.043	8.051
Pile 1	2a_truck2	LinStatic		-0.042	7.945
Pile 1	2a_truck4	LinStatic		-0.044	7.957
Pile 1	2b_truck1	LinStatic		-0.004245	11.528
Pile 1	2b_truck2	LinStatic		-0.00316	11.422
Pile 1	2b_truck4	LinStatic		-0.005343	11.434
Pile 1	3a_truck1	LinStatic		-0.07	5.489
Pile 1	3a_truck2	LinStatic		-0.069	5.382
Pile 1	3a_truck4	LinStatic		-0.071	5.394
Pile 1	3b_truck1	LinStatic		-0.031	8.966
Pile 1	3b_truck2	LinStatic		-0.03	8.86
Pile 1	3b_truck4	LinStatic		-0.032	8.872
Pile 1	Ser-1-Truck 1	LinStatic		-0.043	8.051
Pile 1	Ser-1-Truck 2	LinStatic		-0.042	7.945
Pile 1	Ser-1-Truck 3	LinStatic		-0.042	7.973
Pile 1	Ser-1-Truck 4	LinStatic		-0.044	7.957
Pile 1	Ser-2	LinStatic		-0.017	8.985
Pile 1	Ser-3-Truck 1	LinStatic		-0.031	8.966
Pile 1	Ser-3-Truck 2	LinStatic		-0.03	8.86
Pile 1	Ser-3-Truck 3	LinStatic		-0.03	8.887
Pile 1	Ser-3-Truck 4	LinStatic		-0.032	8.872
Pile 1	Service Comb w/truck	Combination	Max	-0.00316	11.528
Pile 1	Service Comb w/truck	Combination	Min	-0.301	5.247
Pile 1	Service Comb No Truck	Combination	Max	-0.005037	11.193
Pile 1	Service Comb No Truck	Combination	Min	-0.301	5.153
Pile 1	Service 1	Combination	Max	-0.017	8.985
Pile 1	Service 1	Combination	Min	-0.044	7.945

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 2	1a	LinStatic		-0.055	13.788
Pile 2	1b	LinStatic		-0.304	7.024
Pile 2	2a	LinStatic		-0.037	9.219
Pile 2	2b	LinStatic		-0.033	16.523
Pile 2	3a	LinStatic		-0.051	3.942
Pile 2	3b	LinStatic		-0.048	11.246
Pile 2	2a_truck3	LinStatic		-0.034	10.334
Pile 2	2b_truck3	LinStatic		-0.03	17.638
Pile 2	3a_truck3	LinStatic		-0.048	5.057
Pile 2	3b_truck3	LinStatic		-0.045	12.361
Pile 2	2a_truck1	LinStatic		-0.032	10.436
Pile 2	2a_truck2	LinStatic		-0.036	10.002
Pile 2	2a_truck4	LinStatic		-0.037	9.694
Pile 2	2b_truck1	LinStatic		-0.029	17.74
Pile 2	2b_truck2	LinStatic		-0.032	17.306
Pile 2	2b_truck4	LinStatic		-0.034	16.998
Pile 2	3a_truck1	LinStatic		-0.046	5.159
Pile 2	3a_truck2	LinStatic		-0.05	4.725
Pile 2	3a_truck4	LinStatic		-0.051	4.417
Pile 2	3b_truck1	LinStatic		-0.043	12.463
Pile 2	3b_truck2	LinStatic		-0.047	12.029
Pile 2	3b_truck4	LinStatic		-0.048	11.721
Pile 2	Ser-1-Truck 1	LinStatic		-0.032	10.436
Pile 2	Ser-1-Truck 2	LinStatic		-0.036	10.002
Pile 2	Ser-1-Truck 3	LinStatic		-0.034	10.334
Pile 2	Ser-1-Truck 4	LinStatic		-0.037	9.694
Pile 2	Ser-2	LinStatic		-0.019	10.835
Pile 2	Ser-3-Truck 1	LinStatic		-0.043	12.463
Pile 2	Ser-3-Truck 2	LinStatic		-0.047	12.029
Pile 2	Ser-3-Truck 3	LinStatic		-0.045	12.361
Pile 2	Ser-3-Truck 4	LinStatic		-0.048	11.721
Pile 2	Service Comb w/truck	Combination	Max	-0.029	17.74
Pile 2	Service Comb w/truck	Combination	Min	-0.304	4.417
Pile 2	Service Comb No Truck	Combination	Max	-0.033	16.523
Pile 2	Service Comb No Truck	Combination	Min	-0.304	3.942
Pile 2	Service 1	Combination	Max	-0.019	12.463
Pile 2	Service 1	Combination	Min	-0.048	9.694

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 3	1a	LinStatic		-0.024	12.963
Pile 3	1b	LinStatic		-0.302	6.85
Pile 3	2a	LinStatic		-0.018	8.964
Pile 3	2b	LinStatic		-0.015	15.844
Pile 3	3a	LinStatic		-0.024	3.634
Pile 3	3b	LinStatic		-0.021	10.514
Pile 3	2a_truck3	LinStatic		-0.018	10.967
Pile 3	2b_truck3	LinStatic		-0.015	17.847
Pile 3	3a_truck3	LinStatic		-0.024	5.638
Pile 3	3b_truck3	LinStatic		-0.021	12.518
Pile 3	2a_truck1	LinStatic		-0.018	11.72
Pile 3	2a_truck2	LinStatic		-0.015	10.252
Pile 3	2a_truck4	LinStatic		-0.019	9.48
Pile 3	2b_truck1	LinStatic		-0.015	18.6
Pile 3	2b_truck2	LinStatic		-0.012	17.132
Pile 3	2b_truck4	LinStatic		-0.015	16.36
Pile 3	3a_truck1	LinStatic		-0.024	6.391
Pile 3	3a_truck2	LinStatic		-0.021	4.922
Pile 3	3a_truck4	LinStatic		-0.024	4.15
Pile 3	3b_truck1	LinStatic		-0.021	13.271
Pile 3	3b_truck2	LinStatic		-0.017	11.802
Pile 3	3b_truck4	LinStatic		-0.021	11.03
Pile 3	Ser-1-Truck 1	LinStatic		-0.018	11.72
Pile 3	Ser-1-Truck 2	LinStatic		-0.015	10.252
Pile 3	Ser-1-Truck 3	LinStatic		-0.018	10.967
Pile 3	Ser-1-Truck 4	LinStatic		-0.019	9.48
Pile 3	Ser-2	LinStatic		-0.009597	10.576
Pile 3	Ser-3-Truck 1	LinStatic		-0.021	13.271
Pile 3	Ser-3-Truck 2	LinStatic		-0.017	11.802
Pile 3	Ser-3-Truck 3	LinStatic		-0.021	12.518
Pile 3	Ser-3-Truck 4	LinStatic		-0.021	11.03
Pile 3	Service Comb w/truck	Combination	Max	-0.012	18.6
Pile 3	Service Comb w/truck	Combination	Min	-0.302	4.15
Pile 3	Service Comb No Truck	Combination	Max	-0.015	15.844
Pile 3	Service Comb No Truck	Combination	Min	-0.302	3.634
Pile 3	Service 1	Combination	Max	-0.009597	13.271
Pile 3	Service 1	Combination	Min	-0.021	9.48

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 4	1a	LinStatic		-5.414E-09	12.983
Pile 4	1b	LinStatic		-0.299	6.805
Pile 4	2a	LinStatic		-1.105E-09	8.939
Pile 4	2b	LinStatic		-5.852E-09	15.8
Pile 4	3a	LinStatic		1.635E-10	3.686
Pile 4	3b	LinStatic		-4.584E-09	10.548
Pile 4	2a_truck3	LinStatic		0.003115	11.64
Pile 4	2b_truck3	LinStatic		0.003115	18.502
Pile 4	3a_truck3	LinStatic		0.003115	6.388
Pile 4	3b_truck3	LinStatic		0.003115	13.249
Pile 4	2a_truck1	LinStatic		0.0001198	11.358
Pile 4	2a_truck2	LinStatic		0.002538	12.074
Pile 4	2a_truck4	LinStatic		0.001289	10.047
Pile 4	2b_truck1	LinStatic		0.0001198	18.22
Pile 4	2b_truck2	LinStatic		0.002538	18.936
Pile 4	2b_truck4	LinStatic		0.001289	16.908
Pile 4	3a_truck1	LinStatic		0.0001198	6.106
Pile 4	3a_truck2	LinStatic		0.002538	6.822
Pile 4	3a_truck4	LinStatic		0.001289	4.794
Pile 4	3b_truck1	LinStatic		0.0001198	12.967
Pile 4	3b_truck2	LinStatic		0.002538	13.683
Pile 4	3b_truck4	LinStatic		0.001289	11.656
Pile 4	Ser-1-Truck 1	LinStatic		0.0001198	11.358
Pile 4	Ser-1-Truck 2	LinStatic		0.002538	12.074
Pile 4	Ser-1-Truck 3	LinStatic		0.003115	11.64
Pile 4	Ser-1-Truck 4	LinStatic		0.001289	10.047
Pile 4	Ser-2	LinStatic		-1.476E-09	10.537
Pile 4	Ser-3-Truck 1	LinStatic		0.0001198	12.967
Pile 4	Ser-3-Truck 2	LinStatic		0.002538	13.683
Pile 4	Ser-3-Truck 3	LinStatic		0.003115	13.249
Pile 4	Ser-3-Truck 4	LinStatic		0.001289	11.656
Pile 4	Service Comb w/truck	Combination	Max	0.003115	18.936
Pile 4	Service Comb w/truck	Combination	Min	-0.299	4.794
Pile 4	Service Comb No Truck	Combination	Max	1.635E-10	15.8
Pile 4	Service Comb No Truck	Combination	Min	-0.299	3.686
Pile 4	Service 1	Combination	Max	0.003115	13.683
Pile 4	Service 1	Combination	Min	-1.476E-09	10.047

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 5	1a	LinStatic		0.024	12.963
Pile 5	1b	LinStatic		-0.296	6.877
Pile 5	2a	LinStatic		0.018	8.964
Pile 5	2b	LinStatic		0.015	15.844
Pile 5	3a	LinStatic		0.024	3.634
Pile 5	3b	LinStatic		0.021	10.514
Pile 5	2a_truck3	LinStatic		0.015	12.095
Pile 5	2b_truck3	LinStatic		0.012	18.975
Pile 5	3a_truck3	LinStatic		0.021	6.766
Pile 5	3b_truck3	LinStatic		0.018	13.645
Pile 5	2a_truck1	LinStatic		0.017	11.661
Pile 5	2a_truck2	LinStatic		0.015	11.673
Pile 5	2a_truck4	LinStatic		0.017	10.964
Pile 5	2b_truck1	LinStatic		0.014	18.541
Pile 5	2b_truck2	LinStatic		0.012	18.553
Pile 5	2b_truck4	LinStatic		0.014	17.844
Pile 5	3a_truck1	LinStatic		0.023	6.332
Pile 5	3a_truck2	LinStatic		0.021	6.344
Pile 5	3a_truck4	LinStatic		0.023	5.635
Pile 5	3b_truck1	LinStatic		0.019	13.212
Pile 5	3b_truck2	LinStatic		0.018	13.224
Pile 5	3b_truck4	LinStatic		0.02	12.514
Pile 5	Ser-1-Truck 1	LinStatic		0.017	11.661
Pile 5	Ser-1-Truck 2	LinStatic		0.015	11.673
Pile 5	Ser-1-Truck 3	LinStatic		0.015	12.095
Pile 5	Ser-1-Truck 4	LinStatic		0.017	10.964
Pile 5	Ser-2	LinStatic		0.009597	10.576
Pile 5	Ser-3-Truck 1	LinStatic		0.019	13.212
Pile 5	Ser-3-Truck 2	LinStatic		0.018	13.224
Pile 5	Ser-3-Truck 3	LinStatic		0.018	13.645
Pile 5	Ser-3-Truck 4	LinStatic		0.02	12.514
Pile 5	Service Comb w/truck	Combination	Max	0.024	18.975
Pile 5	Service Comb w/truck	Combination	Min	-0.296	5.635
Pile 5	Service Comb No Truck	Combination	Max	0.024	15.844
Pile 5	Service Comb No Truck	Combination	Min	-0.296	3.634
Pile 5	Service 1	Combination	Max	0.02	13.645
Pile 5	Service 1	Combination	Min	0.009597	10.576

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 6	1a	LinStatic		0.055	13.788
Pile 6	1b	LinStatic		-0.298	6.866
Pile 6	2a	LinStatic		0.037	9.219
Pile 6	2b	LinStatic		0.033	16.523
Pile 6	3a	LinStatic		0.051	3.942
Pile 6	3b	LinStatic		0.048	11.246
Pile 6	2a_truck3	LinStatic		0.033	10.04
Pile 6	2b_truck3	LinStatic		0.029	17.344
Pile 6	3a_truck3	LinStatic		0.047	4.763
Pile 6	3b_truck3	LinStatic		0.044	12.067
Pile 6	2a_truck1	LinStatic		0.032	9.805
Pile 6	2a_truck2	LinStatic		0.036	11.112
Pile 6	2a_truck4	LinStatic		0.038	11.832
Pile 6	2b_truck1	LinStatic		0.029	17.109
Pile 6	2b_truck2	LinStatic		0.032	18.416
Pile 6	2b_truck4	LinStatic		0.035	19.136
Pile 6	3a_truck1	LinStatic		0.046	4.528
Pile 6	3a_truck2	LinStatic		0.05	5.835
Pile 6	3a_truck4	LinStatic		0.053	6.555
Pile 6	3b_truck1	LinStatic		0.043	11.832
Pile 6	3b_truck2	LinStatic		0.047	13.139
Pile 6	3b_truck4	LinStatic		0.049	13.859
Pile 6	Ser-1-Truck 1	LinStatic		0.032	9.805
Pile 6	Ser-1-Truck 2	LinStatic		0.036	11.112
Pile 6	Ser-1-Truck 3	LinStatic		0.033	10.04
Pile 6	Ser-1-Truck 4	LinStatic		0.038	11.832
Pile 6	Ser-2	LinStatic		0.019	10.835
Pile 6	Ser-3-Truck 1	LinStatic		0.043	11.832
Pile 6	Ser-3-Truck 2	LinStatic		0.047	13.139
Pile 6	Ser-3-Truck 3	LinStatic		0.044	12.067
Pile 6	Ser-3-Truck 4	LinStatic		0.049	13.859
Pile 6	Service Comb w/truck	Combination	Max	0.055	19.136
Pile 6	Service Comb w/truck	Combination	Min	-0.298	4.528
Pile 6	Service Comb No Truck	Combination	Max	0.055	16.523
Pile 6	Service Comb No Truck	Combination	Min	-0.298	3.942
Pile 6	Service 1	Combination	Max	0.049	13.859
Pile 6	Service 1	Combination	Min	0.019	9.805

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	StepType	F1	F3
Text	Text	Text	Text	Kip	Kip
Pile 7	1a	LinStatic		0.036	10.217
Pile 7	1b	LinStatic		-0.3	4.841
Pile 7	2a	LinStatic		0.044	7.716
Pile 7	2b	LinStatic		0.005037	11.193
Pile 7	3a	LinStatic		0.07	5.153
Pile 7	3b	LinStatic		0.031	8.631
Pile 7	2a_truck3	LinStatic		0.043	7.897
Pile 7	2b_truck3	LinStatic		0.004385	11.374
Pile 7	3a_truck3	LinStatic		0.07	5.334
Pile 7	3b_truck3	LinStatic		0.031	8.812
Pile 7	2a_truck1	LinStatic		0.044	7.914
Pile 7	2a_truck2	LinStatic		0.039	7.889
Pile 7	2a_truck4	LinStatic		0.043	10.973
Pile 7	2b_truck1	LinStatic		0.005142	11.392
Pile 7	2b_truck2	LinStatic		0.0003081	11.366
Pile 7	2b_truck4	LinStatic		0.003822	14.45
Pile 7	3a_truck1	LinStatic		0.071	5.352
Pile 7	3a_truck2	LinStatic		0.066	5.326
Pile 7	3a_truck4	LinStatic		0.069	8.411
Pile 7	3b_truck1	LinStatic		0.032	8.829
Pile 7	3b_truck2	LinStatic		0.027	8.803
Pile 7	3b_truck4	LinStatic		0.03	11.888
Pile 7	Ser-1-Truck 1	LinStatic		0.044	7.914
Pile 7	Ser-1-Truck 2	LinStatic		0.039	7.889
Pile 7	Ser-1-Truck 3	LinStatic		0.043	7.897
Pile 7	Ser-1-Truck 4	LinStatic		0.043	10.973
Pile 7	Ser-2	LinStatic		0.017	8.985
Pile 7	Ser-3-Truck 1	LinStatic		0.032	8.829
Pile 7	Ser-3-Truck 2	LinStatic		0.027	8.803
Pile 7	Ser-3-Truck 3	LinStatic		0.031	8.812
Pile 7	Ser-3-Truck 4	LinStatic		0.03	11.888
Pile 7	Service Comb w/truck	Combination	Max	0.071	14.45
Pile 7	Service Comb w/truck	Combination	Min	-0.3	4.841
Pile 7	Service Comb No Truck	Combination	Max	0.07	11.193
Pile 7	Service Comb No Truck	Combination	Min	-0.3	4.841
Pile 7	Service 1	Combination	Max	0.044	11.888
Pile 7	Service 1	Combination	Min	0.017	7.889

TABLE: Joint Reactions				
Joint	OutputCase	CaseType	F1	F3
Text	Text	Text	Kip	Kip
Pile 1	2b_truck4	LinStatic	-0.005343	11.434
Pile 1	3b_truck4	LinStatic	-0.032	8.872
Pile 1	Ser-3-Truck 4	LinStatic	-0.032	8.872
Pile 2	2b_truck4	LinStatic	-0.034	16.998
Pile 2	3b_truck4	LinStatic	-0.048	11.721
Pile 2	Ser-3-Truck 4	LinStatic	-0.048	11.721
Pile 3	2b_truck4	LinStatic	-0.015	16.36
Pile 3	3b_truck4	LinStatic	-0.021	11.03
Pile 3	Ser-3-Truck 4	LinStatic	-0.021	11.03
Pile 4	2b_truck4	LinStatic	0.001289	16.908
Pile 4	3b_truck4	LinStatic	0.001289	11.656
Pile 4	Ser-3-Truck 4	LinStatic	0.001289	11.656
Pile 5	2b_truck4	LinStatic	0.014	17.844
Pile 5	3b_truck4	LinStatic	0.02	12.514
Pile 5	Ser-3-Truck 4	LinStatic	0.02	12.514
Pile 6	2b_truck4	LinStatic	0.035	19.136 → MAX
Pile 6	3b_truck4	LinStatic	0.049	13.859
Pile 6	Ser-3-Truck 4	LinStatic	0.049	13.859
Pile 7	2b_truck4	LinStatic	0.003822	14.45
Pile 7	3b_truck4	LinStatic	0.03	11.888
Pile 7	Ser-3-Truck 4	LinStatic	0.03	11.888

All reactions are calculated on per foot basis with respect to the longitudinal pile spacing. Therefore we must multiply the vertical reaction by the longitudinal pile spacing. The smallest pile spacing under Airline Hwy is 5'-0". the anticipated maximum pile reaction is then going to be 19.136 x 5 = 95.68 kips

Using a Factor of Safety = 2.0, Ultimate Pile Capacity Required = 192 kips

TABLE: Joint Reactions					
Joint	OutputCase	StepType	F1	F3	
Text	Text	Text	Lb	Lb	
Pile 1	SERVICE-Comb	Max	-1.88	9958.05	
Pile 1	SERVICE-Comb	Min	-316.16	3889.06	
Pile 2	SERVICE-Comb	Max	-27.79	14565.02	
Pile 2	SERVICE-Comb	Min	-318.85	2018.24	
Pile 3	SERVICE-Comb	Max	-12.44	13958.78	
Pile 3	SERVICE-Comb	Min	-316.09	1743.9	
Pile 4	SERVICE-Comb	Max	5.114E-07	13924.61	
Pile 4	SERVICE-Comb	Min	-312.87	1812.23	
Pile 5	SERVICE-Comb	Max	22.06	13958.78	
Pile 5	SERVICE-Comb	Min	-310.35	1743.9	
Pile 6	SERVICE-Comb	Max	49.26	14565.02	→ max
Pile 6	SERVICE-Comb	Min	-312.01	2018.24	
Pile 7	SERVICE-Comb	Max	68.19	9958.05	
Pile 7	SERVICE-Comb	Min	-313.8	3889.06	
	Maximum		68.19	14565.02	
	Minimum		-318.85	1743.9	

* All reactions are calculated on per foot basis with respect to the longitudinal pile spacing. Therefore, the vertical reaction must be multiplied by the pile spacing. The pile spacing under the tower is 8'-0". The anticipated maximum pile reaction is then going to be 14.565 × 8' = 116.52 kips

Using a Factor of Safety = 2.0, the Ultimate Pile Capacity required = 233 kips.

Use pile length = 65' ∴ Tip Elevation = -76.00

TABLE 1

Canadian National Rail Road Crossing

Concrete Piles with butt elevation +4.0 ft. actual butt elevation = - 9.75

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	105	120	135	150	181
60	147	170	195	218	265
70	173	199	230	258	316
80	211	243	279	312	380

$\alpha = 0.65$

-	22.6	27.4	31.0	38.1
	220.4	251.6	281	341.9

=> use 18" pile

TABLE 2

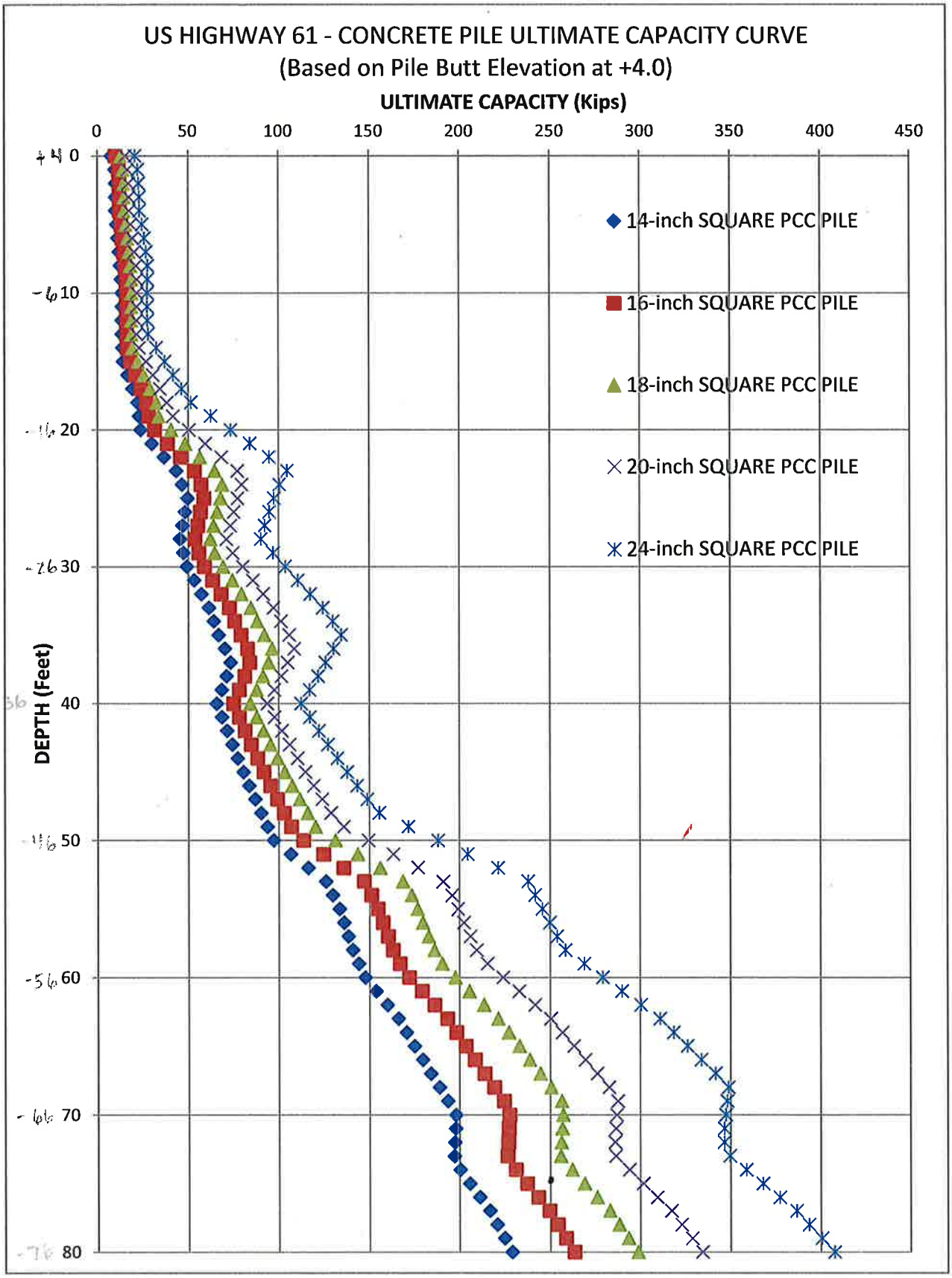
US HWY. 61

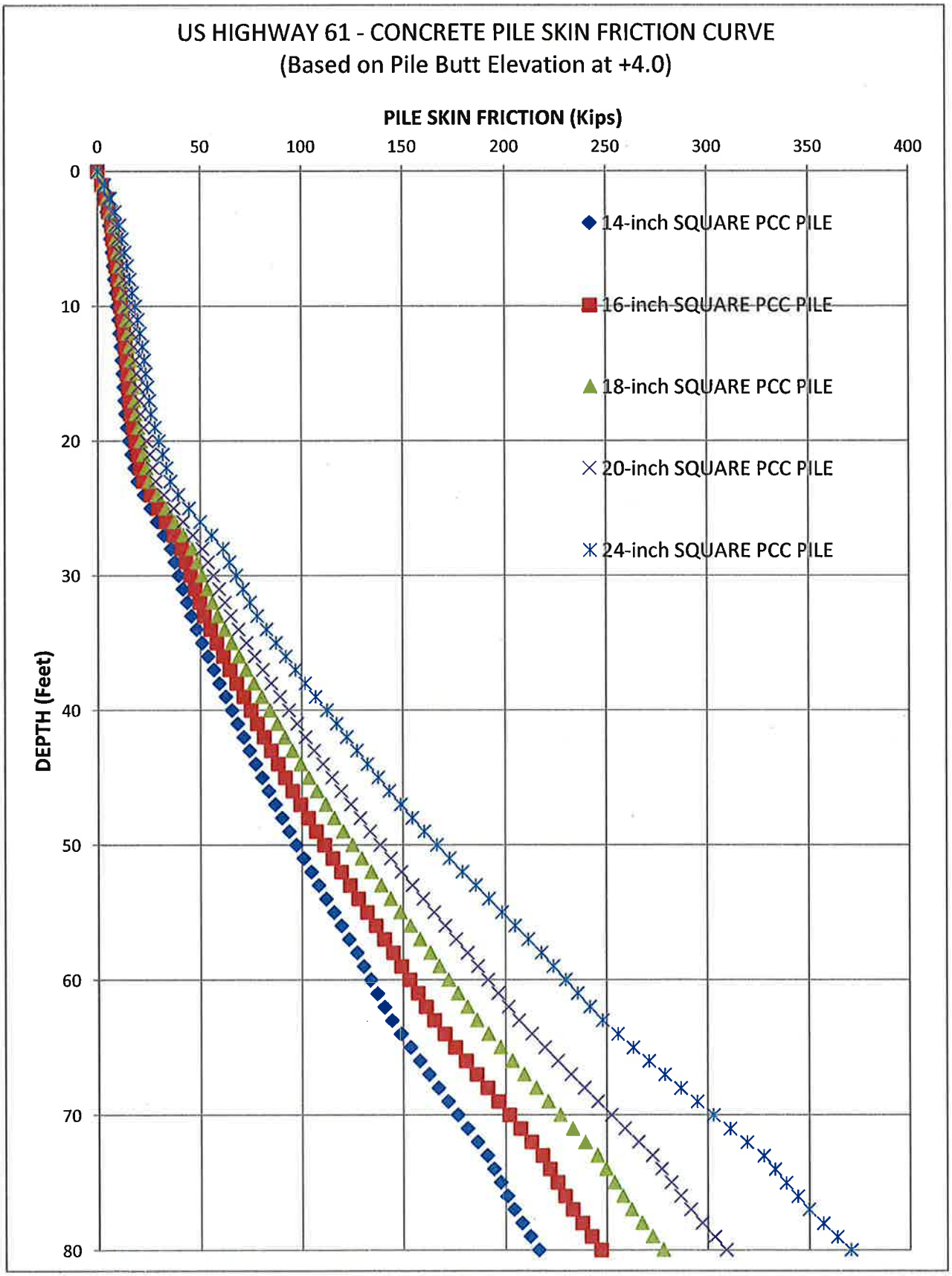
Concrete Piles with butt elevation +4.0 ft. actual butt elevation = -11.0

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	96	113	131	149	188
60	146	171	198	224	279
70	197	226	257	287	347
80	227	261	299	334	407

-	14.3	16.7	19.0	23.8
	246.7	282.3	315	383.2

=> use 18" pile


US HIGHWAY 61 - CONCRETE PILE ULTIMATE CAPACITY CURVE
(Based on Pile Butt Elevation at +4.0)
ULTIMATE CAPACITY (Kips)
0
50
100
150
200
250
300
350
400
450
DEPTH (Feet)
0
10
20
30
40
50
60
70
80
14-inch SQUARE PCC PILE
16-inch SQUARE PCC PILE
18-inch SQUARE PCC PILE
20-inch SQUARE PCC PILE
24-inch SQUARE PCC PILE


US HIGHWAY 61 - CONCRETE PILE SKIN FRICTION CURVE
(Based on Pile Butt Elevation at +4.0)
PILE SKIN FRICTION (Kips)
0
50
100
150
200
250
300
350
400
DEPTH (Feet)
0
10
20
30
40
50
60
70
80
14-inch SQUARE PCC PILE
16-inch SQUARE PCC PILE
18-inch SQUARE PCC PILE
20-inch SQUARE PCC PILE
24-inch SQUARE PCC PILE

mixing field treatment procedures, techniques, and equipment are to be determined by a specialized geotechnical contractor, such as Hayward Baker. Information about the deep soil mixing process is included in Appendix J for your review.

Earth Retaining Structures - Excavations should be designed to consider lateral earth pressures plus any surcharge loadings. An additional component for hydrostatic pressures should also be included if applicable. Recommended coefficients for calculating lateral earth pressures are summarized below:

CLEAN SAND BACKFILL	
Coefficient of Lateral Earth Pressure	
Ka (active)	0.32
Kp (passive)	3.12
Ko (at-rest)	0.48

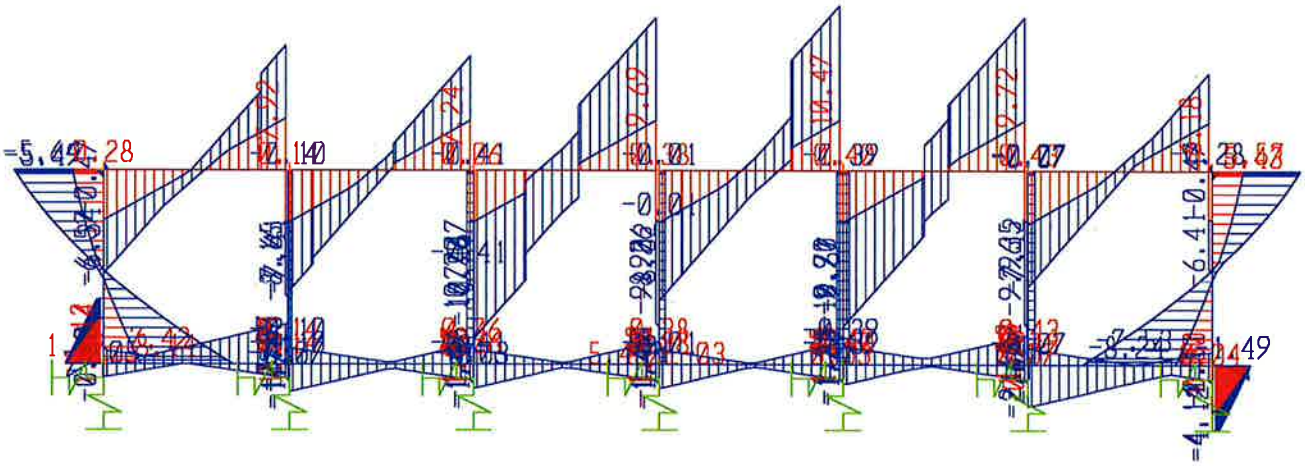
CLAY BACKFILL	
Coefficient of Lateral Earth Pressure	
Ka (active)	0.50
Kp (passive)	0.80
Ko (at-rest)	0.80

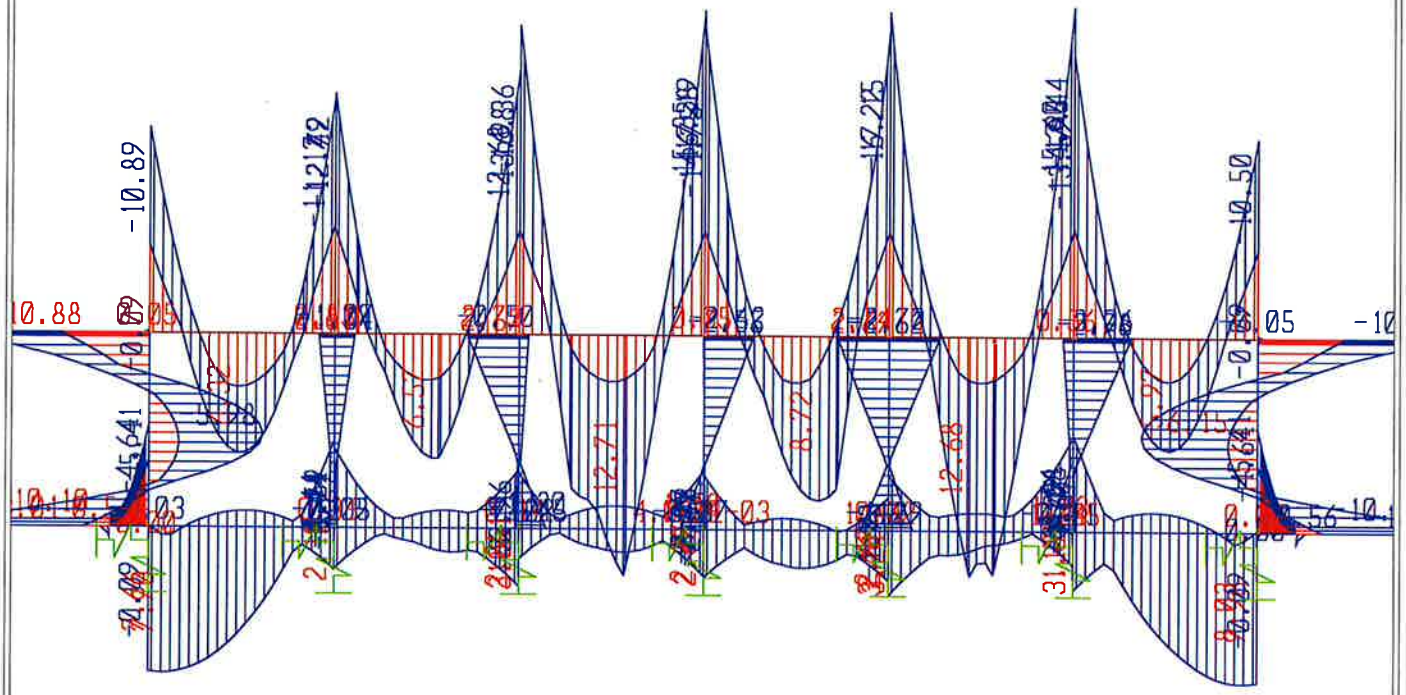
Care should be exercised to brace walls during placement of compacted fill, particularly clays behind the wall. Compaction equipment should not be allowed too close to the walls such that large horizontal forces are applied to the walls. Fill placed within 18 inches of the wall should be compacted with a small hand tamper such as a wacker. The lift thickness during hand tamping should be limited to between 4 inches and 6 inches. The fill and its placement should meet the requirements and those noted under the site preparation and earth work sections.

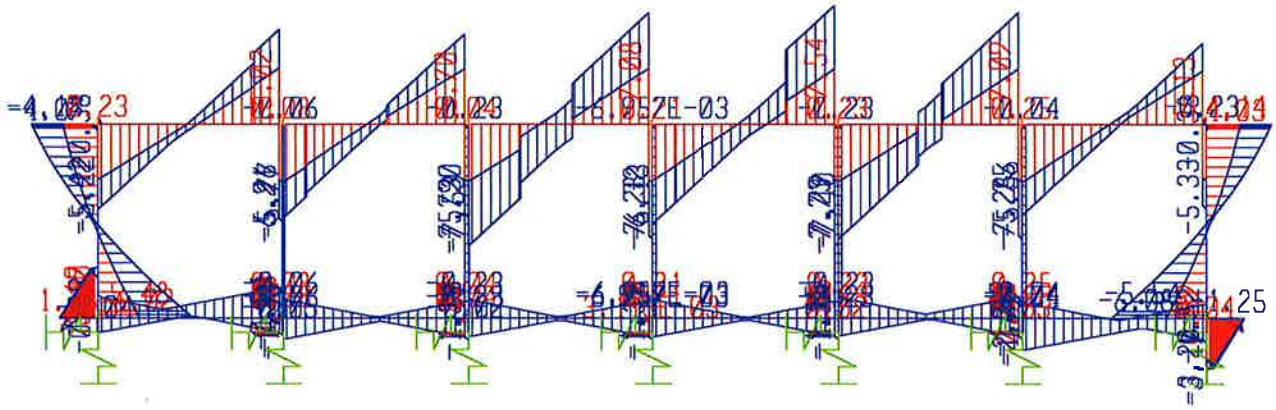
Settlements - The conveyance channels north of US 61 will incorporate containment levees having a final grade at elevation 6.5 feet, requiring the placement of up to 5 feet of fill material. Total long term settlements associated with this fill placement are estimated to be on the order of about 15-20 inches. Future settlements should be considered when determining levee overbuild elevation.

Underseepage - Steel sheet pile cutoff walls will be required beneath the inlet structure to provide protection against hazardous seepage. Sheet pile cutoff walls should be driven to a tip elevation of -44.0 feet.

Drainage and Construction Dewatering – Adequate site drainage should be provided throughout construction. Excavations should be left open for the shortest possible duration to




-10.89
10.88
12.71
8.72
12.68
10.50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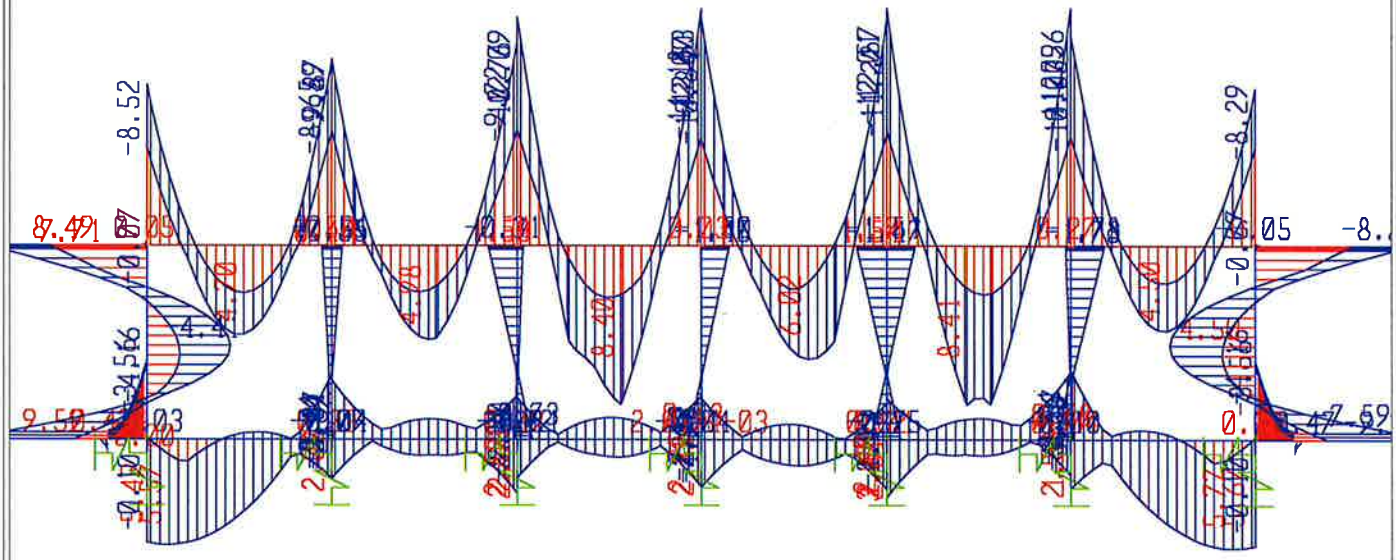
-5.330
-5.330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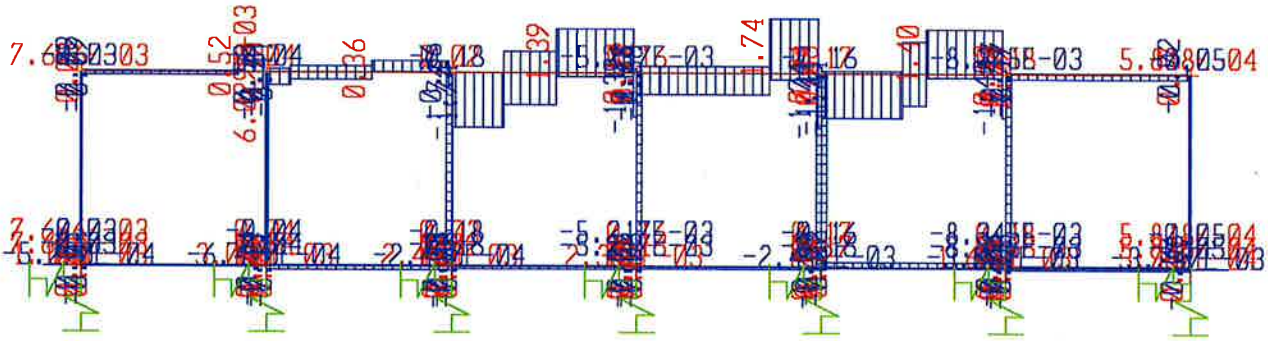
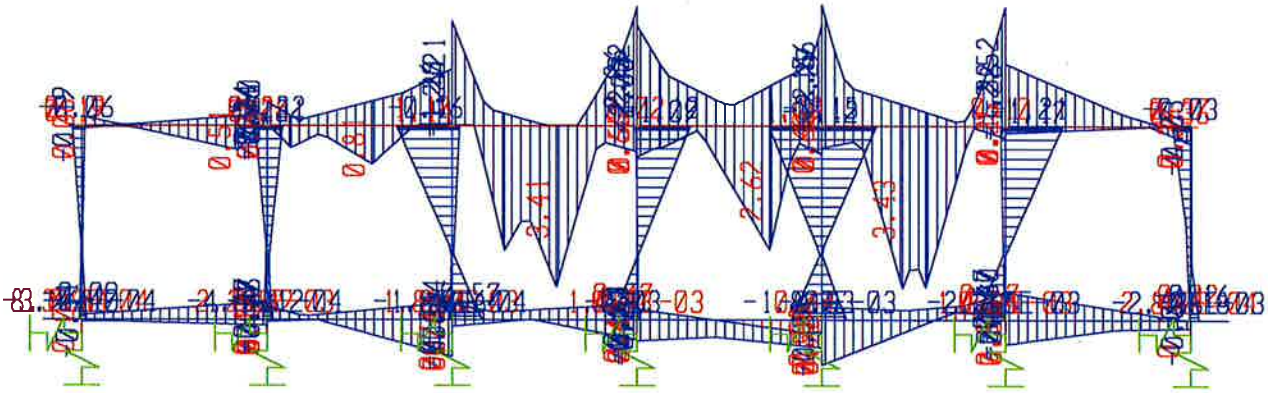
-8.
7.491
4.4
9.50
0.
-7.59





Top Slab						
	Thrust (kip)		Shear (kip)		Moment (kip-ft)	
	Max.	Min.	Max.	Min.	Max.	Min.
Strength 1	-2.04	-6.26	9.20 *	-9.20 *	12.71	-15.60
Service 1	-2.26	-7.53	7.54	-7.53	8.41	-11.22
Fatigue	0.05	-0.18	1.74	-1.74	3.43	-2.29

Walls						
	Thrust (kip)		Shear (kip)		Moment (kip-ft)	
	Max.	Min.	Max.	Min.	Max.	Min.
Strength 1	-3.41	-19.64	6.58 *	-6.58 *	10.10	-10.37
Service 1	-3.78	-14.77	5.48	-5.54	7.71	-7.59
Fatigue	0.15	-2.24	0.18	-0.18	1.14	-1.17

Bottom Slab						
	Thrust (kip)		Shear (kip)		Moment (kip-ft)	
	Max.	Min.	Max.	Min.	Max.	Min.
Strength 1	-0.45	-9.69	4.12	-4.12	8.03	-4.64
Service 1	-0.50	-7.15	3.19	-3.19	5.77	-3.57
Fatigue	0.17	-0.05	0.16	-0.11	0.92	-0.57

* Value was taken a distance "d" from the face of the wall or slab.

- All SAP Models for the Road controlled over the levee condition. The levee condition was run to maximize the spacing of the piles outside the "road region."

1.6

Member Designs (Roadway & Levee)

URS

Job:	Mississippi River to Maurepas Swamp	**Project #:**	10001801				
Description:	Airline Hwy Crossing	**Computed By:**	BCB	**Date:**	Aug-12	**Page:**	of
	LRFD Member Design 6 Barrel 9'x9'	**Checked By:**	RBJ	**Date:**	9/13	**Sheet:**	of

*** Given information:** Notes / References

Top Slab Thickness =	9.5	in	
Bottom Slab Thickness =	18	in	
Wall Thickness =	9	in	
Tributary Width =	5	ft	tributary width = pile spacing
f'_c =	4	ksi	
f_y =	60	ksi	
φ, shear =	0.85		EM 1110-2-2104
φ, moment =	0.90		EM 1110-2-2104
ρ_{bal} =	0.0285		For f'_c = 4000 psi & f_y = 60,000 psi

*** BOTTOM SLAB:**

Max. Shear = 4.12 kip
Max. Moment = 8.03 kip-ft (controls bottom reinforcement)
Min. Moment = -4.64 kip-ft (controls top reinforcement)

For images, see sheets _____.

* Reinforcing Limits:

A_{gross} = 18in * 12in strip = 216 in^2

d = 18in - 3in cover - 1/2 bar diameter = 14.63 in — #6 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 2.309 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 0.605 in^2 — EM 1110-2-2104, 2-8a, temp. & shrinkage

(3 * √(f'_c) * b * d) / f_y = 0.555 in^2 — ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 0.585 in^2 — ACI 318-02, 10.5, flexural member min.

Summary:	**Max. Rebar =**	**2.309 in^2**	- half each face
	Min. T&S Rebar =	**0.605 in^2**	- half each face
	Min. Flexure Rebar =	**0.585 in^2**	- per face

* Section Design:

Shear

Shear Capacity (φV_c) = φ * 2 * √(f'_c) * b * d
= 0.85 * 2 * √(4000) * 12in * 14.625in
= 18,869 lbs

φVc = 18.9kip > Vu = 4.1kip → Section OK

Moment

T = A_s * f_y * C = 0.85 * f'_c * a * b

Assuming Tension = Compression → φMn = φ * T * (d - (a / 2)) = φ * As * fy * (d - (a / 2))

Minimum rebar area = 0.605 in^2

Maximum overall moment = 8.03 kip-ft

Will try #5 @ 6" to start: As, #5 @ 6" = 0.62 in^2

a = A_s * f_y / (0.85 * f'_c * b) = 0.62in² * 60ksi / (0.85 * 4ksi * 12in) = 0.912 in

φMn = 0.9 * 0.62in² * 60ksi * (14.63in - 0.91in / 2)
= 474.38 kip-in/ft
= 39.53 kip-ft/ft

φMn = 39.5k-ft > Mu = 8k-ft → Use #5 @ 6" Each Face

*** TOP SLAB:**

Max. Shear = 9.20 kip
Max. Moment = 12.71 kip-ft (controls bottom reinforcement)
Min. Moment = -15.60 kip-ft (controls top reinforcement)

* Reinforcing Limits:

A_{gross} = 9.5in * 12in strip = 114 in^2
d = 9.5in - 1.875in cover - 1/2 bar dia. = 7.25 in #6 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 1.218 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 0.319 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * $\sqrt{f'_c}$ * b * d) / f_y = 0.275 in^2 ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 0.29 in^2 ACI 318-02, 10.5, flexural member min.

Summary:	**Max. Rebar =**	**1.218 in^2**	- half each face
	Min. T&S Rebar =	**0.319 in^2**	- half each face
	Min. Flexure Rebar =	**0.290 in^2**	- per face

* Section Design:

Shear

Shear Capacity (φV_c) = φ * 2 * $\sqrt{f'_c}$ * b * d
= 0.85 * 2 * $\sqrt{4000}$ * 12in * 7.25in
= 9,354 lbs

φVc = 9.4kip > Vu = 9.2kip → Section OK

Moment

T = A_s * f_y * C = 0.85 * f'_c * a * b
Assuming Tension = Compression → φMn = φ * T * (d - (a / 2)) = φ * As * fy * (d - (a / 2))

Minimum rebar area = 0.319 in^2
Maximum overall moment = 15.60 kip-ft

Will try **#6 @ 5.5"** to start: As, #6 @ 5.5" = 0.96 in^2

a = A_s * f_y / (0.85 * f'_c * b) = 0.96in² * 60ksi / (0.85 * 4ksi * 12in) = 1.412 in

φMn = 0.9 * 0.96in² * 60ksi * (7.25in - 1.41in / 2)
= 339.25 kip-in/ft
= 28.27 kip-ft/ft

φMn = 28.3k-ft > Mu = 15.6k-ft → Use #6 @ 5.5" Each Face

*** WALLS:**

Max. Shear = 6.58 kip
Max. Moment = 10.10 kip-ft (controls interior reinforcement)
Min. Moment = -10.37 kip-ft (controls exterior reinforcement)

* Reinforcing Limits:

A_{gross} = 9in * 12in strip = 108 in^2
d = 9in - 1.8125in cover - 1/2 bar dia. = 6.813 in #6 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 1.154 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 0.302 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * $\sqrt{f'_c}$ * b * d) / f_y = 0.259 in^2 ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 0.273 in^2 ACI 318-02, 10.5, flexural member min.

in Summary:	**Max. Rebar =**	**1.154 in^2**	- half each face
	Min. T&S Rebar =	**0.302 in^2**	- half each face
	Min. Flexure Rebar =	**0.273 in^2**	- per face

* Section Design:

Shear

Shear Capacity (φV_c) = φ * 2 * $\sqrt{f'_c}$ * b * d
= 0.85 * 2 * $\sqrt{4000}$ * 12in * 6.8125in
= 8,790 lbs

φVc = 8.8kip > Vu = 6.6kip → Section OK

Moment

* T = A_s * f_y * C = 0.85 * f'_c * a * b
* Assuming Tension = Compression → φMn = φ * T * (d - (a / 2)) = φ * As * fy * (d - (a / 2))

* Minimum rebar area = 0.302 in^2
* Maximum overall moment = 10.37 kip-ft

* Exterior Reinforcement:

* Will try **#6 @ 10.5"** to start: As, #6 @ 10.5" = 0.50 in^2 Mu = 10.37 kip-ft
d = 6.8125 in

a = A_s * f_y / (0.85 * f'_c * b) = 0.5in² * 60ksi / (0.85 * 4ksi * 12in) = 0.742 in

φMn = 0.9 * 0.5in² * 60ksi * (6.81in - 0.74in / 2)
= 175.62 kip-in/ft
= 14.63 kip-ft/ft

φMn = 14.6k-ft > Mu = 10.4k-ft → Use #6 @ 10.5" Exterior Face

* Interior Reinforcement:

* Will try **#6 @ 10.5"** to start: As, #6 @ 10.5" = 0.50 in^2 Mu = 10.10 kip-ft
d = 6.8125 in

a = A_s * f_y / (0.85 * f'_c * b) = 0.5in² * 60ksi / (0.85 * 4ksi * 12in) = 0.742 in

φMn = 0.9 * 0.5in² * 60ksi * (6.81in - 0.74in / 2)
= 175.62 kip-in/ft
= 14.63 kip-ft/ft

φMn = 14.6k-ft > Mu = 10.1k-ft → Use #6 @ 10.5" Interior Face

URS

Page ____ of ____

Job: Mississippi R. to Maurepas Swamp | Project No. 10001801 | Sheet ____ of ____

Description: Airline Hwy Crossing | Computed by: BCB | Date: 11-27-12

Bottom Slab Rebar Calculations | Checked by: RBJ | Date: 9/13

Reference

401

No = 61.83 + 1 = 63 bars × 2 (Top & Bottom) × 4 (segments) = 504 bars

Length = 40'-0" − 2×3" = 39'-6"

402

No = 63 × 2 (Top & Bot) = 126 bars

Length = 29'-6" − 2×3" = 29'-0"

403

No = 63 × 2 (Top & Bot) × 5 (segments) = 630 bars

Length = 44'-0" − 2×3" = 43'-6"

501

No = (40+1)×4 + (29+1) + (49+1)×5 = 419 bars × 2 = 838 bars

Length = A = 1'-6" − 3" − 2" = 1'-1"

B = 2'-7"

Total = 1'-1" + 2(2'-7") = 6'-3"

602

No = 838 bars

Length = A = 1'-7½" + 9" − 3" − 2" = 1'-11½"

B = 1'-10" + 6" + 1'-2" = 3'-6"

Total = 5'-5½"

603

No = 838 × 5 (int walls) = 4190

Length = A = 2'-7"

B = 3'-6"

Total = 6'-1"

URS

Page ____ of ____

Job: Mississippi R. to Manuepas Swamp | Project No. 10001801 | Sheet ____ of ____

Description: Airline Hwy Crossing | Computed by: BCB | Date: 11-27-12

Bottom Slab Rebar Calculations | Checked by: RBJ | Date: 9/13

Reference

504

No = 419 bars

Length = 62'-6" − 2(4") = 61'-10"

505

No = 419 bars

Length = 61'-10"

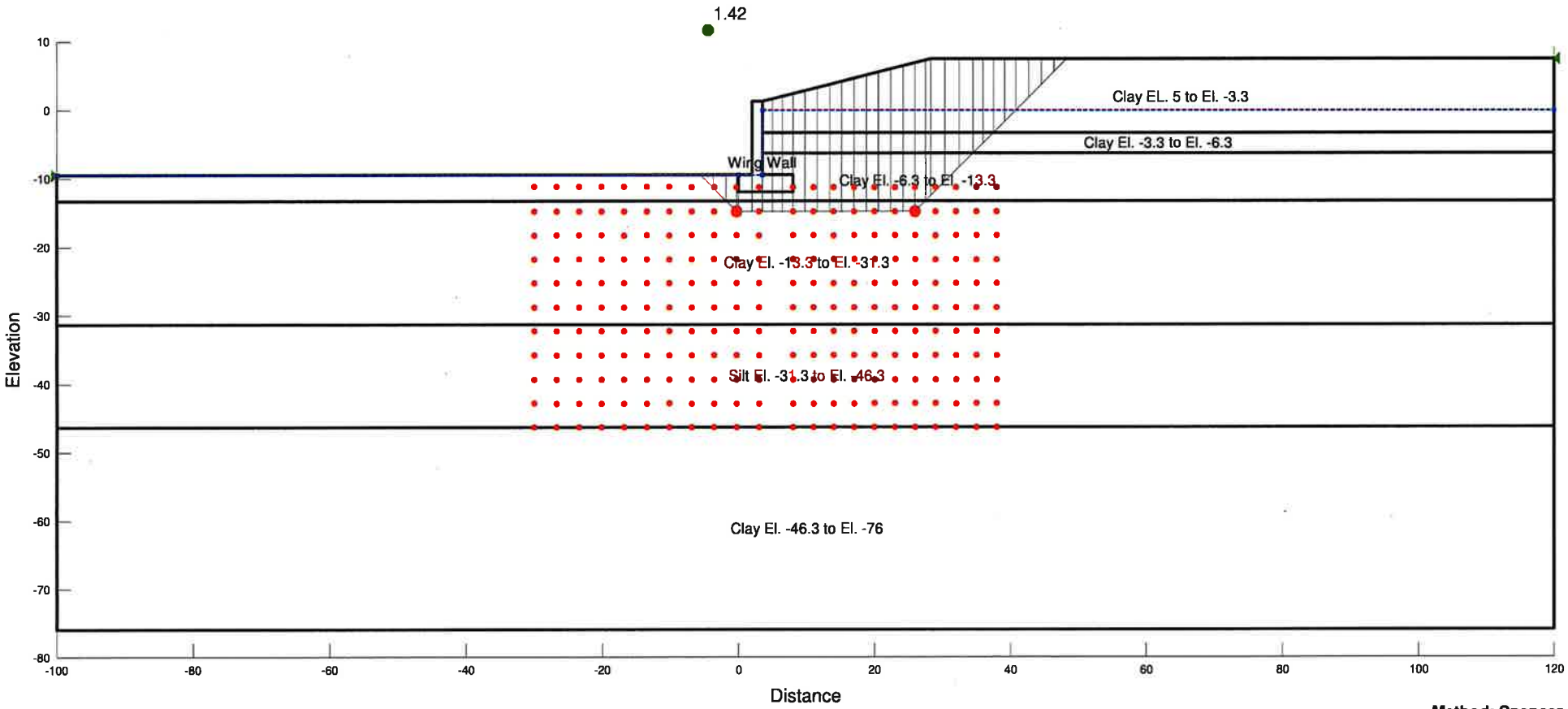
506

No = 8 bars/pile × 539 piles = 4312

Length = 146" + 2(6") − 2(3") = 2'-0"

1.7

Wingwall Design



Method: Spencer

Name: Wing Wall Model: Mohr-Coulomb Unit Weight: 150 pcf Cohesion: 4000 psf Phi: 0 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay EL. 5 to El. -3.3 Model: Mohr-Coulomb Unit Weight: 102 pcf Cohesion: 640 psf Phi: 0 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay El. -3.3 to El. -6.3 Model: Mohr-Coulomb Unit Weight: 102 pcf Cohesion: 300 psf Phi: 0 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay El. -6.3 to El. -13.3 Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 300 psf Phi: 0 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay El. -13.3 to El. -31.3 Model: S=f(depth) Unit Weight: 120 pcf C-Top of Layer: 300 psf C-Rate of Change: 58.72 psf/ft Limiting C: 1375 psf Piezometric Line: 1
Name: Silt El. -31.3 to El. -46.3 Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 200 psf Phi: 15 ° Phi-B: 0 ° Piezometric Line: 1
Name: Clay El. -46.3 to El. -76 Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1375 psf Phi: 0 ° Phi-B: 0 ° Piezometric Line: 1

URS GROUP
7389 Florida Boulevard
Suite 300
Baton Rouge, LA 70806

US 61 Wing Wall
Global Stability Analysis
Block Failure

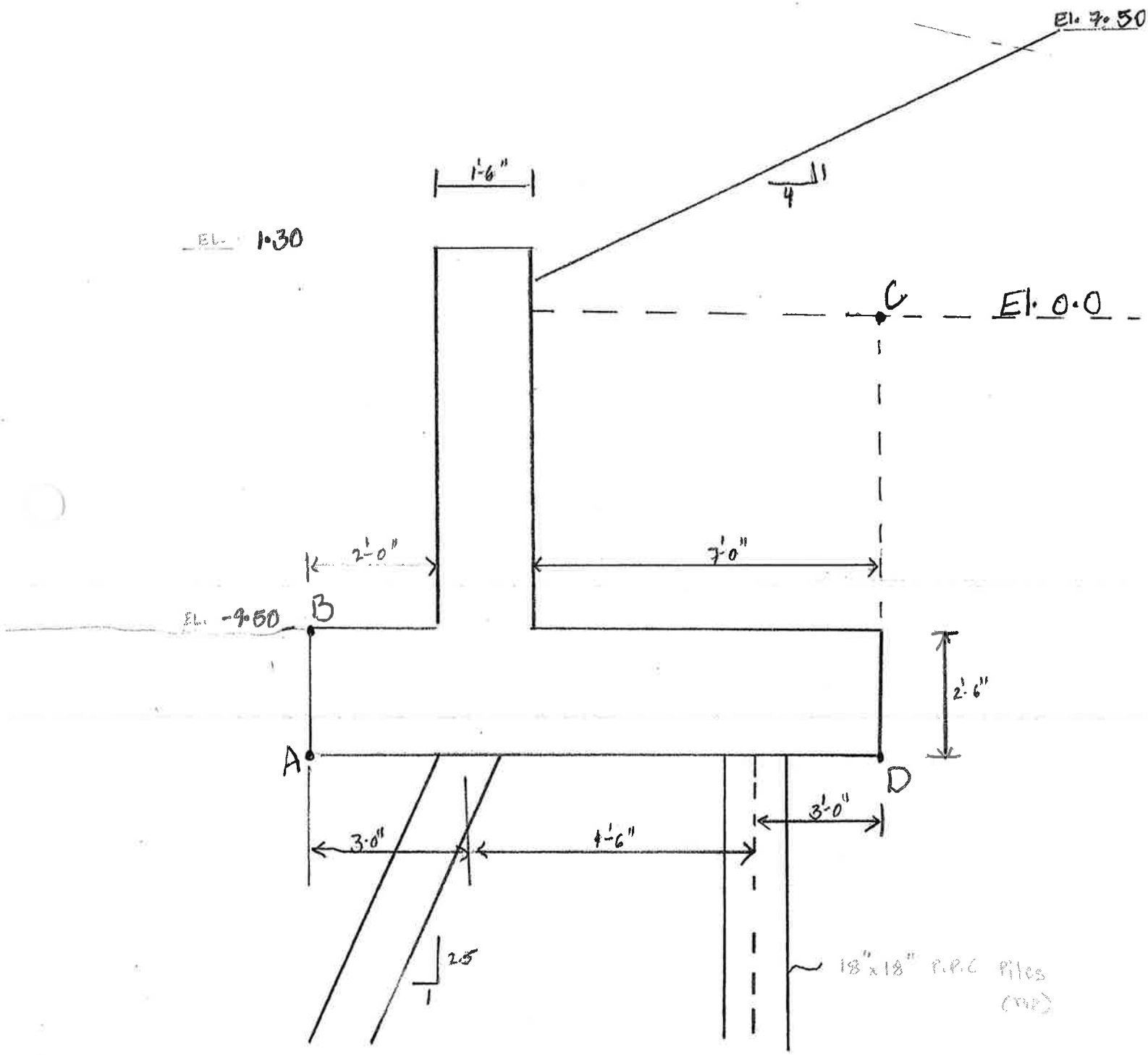
Directory: C:\Users\ananth_bukkapatnam\Desktop\Wing Wall Stability Analyses\

URS

Job: Lake Maurepas
Description: Heave Calculations
US 61 Wing wall

Project No. 10001903
Computed by: ANANTH
Checked by: MS

Page 1 of 6
Sheet ___ of ___
Date: 09-17-2013
Date: 09/18/13
Reference



From Boring B-07 & CPT-15, Ground Water Table is approximated at El. 0.0'.

Assume Point A :- El. -12.00

Unit Weight of soil, γ_{sat} = 120 pcf @ El. -12.0

$$FOS_{Heave} = \frac{\gamma_{sat} * \text{Depth to Point A}}{\gamma_w * \text{Height of Water above Point A}}$$

$$FOS_{Heave} = \frac{120 * 2.5}{64 * 2.5}$$

$$FOS_{Heave} = 1.875 > 1.20$$

Note :- Refer EM 1110-2-1913 - Appendix B-5 - Section b - Case 2a

* A 15-feet thick clay layer exists under the excavation.

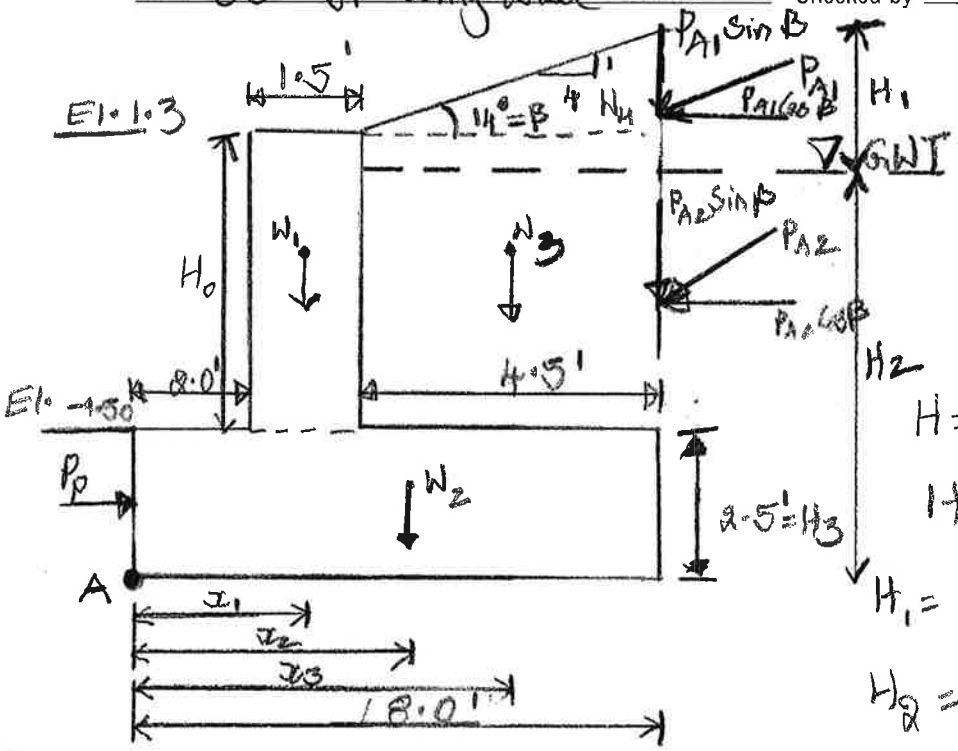
URS

Job: Lake Mauropas | Project No. 10001903 | Page 3 of 6 | Sheet ___ of ___

Description: Overturning Moment Calculations | Computed by: ANANTH | Date: 9-18-2013

US 61 Wing Wall | Checked by: MS | Date: 09/19/13

Reference



$\gamma = 120$ pcf

$\phi' = 0$

$H = H_0 + 2.5 + 4.5 \tan \beta$

$H = 14.12'$

$H_1 = 2.18'$ (Above GWT)

$H_2 = 12.0'$ (Below GWT)

$H_3 = 2.5'$ (Slab Thickness)

$$K_a = \cos\beta \left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi'}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi'}} \right) \quad (\because \phi' = 0)$$

Assuming, $K_a = 1$

$$K_p = \frac{1}{K_a} = 1$$

$W_1 = 150 * 1.5 * 10.8 = 2430$ lb/ft @ 2.75' from A

$W_2 = 150 * 8 * 2.5 = 3000$ lb/ft @ 4.0' from A

URS

Job: Lake Mauropas | Project No. 10001903 | Page 4 of 6 | Sheet ___ of ___

Description: Overturning Moment Calculations US 61 Wingwall | Computed by: ANANTH | Date: 09-18-2013

Checked by: MS | Date: 09/19/2013

Reference

$W_3 = 120 * 4.5 * 10.8 = 5832 \frac{lb}{ft}$ @ 5.75' from A

$W_4 = \frac{1}{2} * 120 * 4.5 * 4.5 \tan\beta = 303 \frac{lb}{ft}$ @ 6.5' from A

$P_{A1} \sin\beta = \frac{1}{2} * K_a \gamma' H_1^2 \sin\beta = \frac{1}{2} * 1 * 120 * 8.12^2 * \sin 14$

$= 65.2 \frac{lb}{ft}$ @ 8.0' from A

$P_{A1} \cos\beta = \frac{1}{2} * 1 * 120 * 8.12^2 * \cos 14 = 861.7 \frac{lb}{ft}$ @ 12.7' from A

$P_{A2} \sin\beta = \frac{1}{2} * 1 * 56 * 12^2 * \sin 14 = 975.4 \frac{lb}{ft}$ @ 8.0' from A

$P_{A2} \cos\beta = \frac{1}{2} * 1 * 56 * 12^2 * \cos 14 = 3912.2 \frac{lb}{ft}$ @ 4.0' from A

$P_H = \frac{1}{2} * 1 * 64 * 12^2 = 4608 \frac{lb}{ft}$ @ 4.0' from A

$P_P = \frac{1}{2} K_p \gamma' H_3^2 = \frac{1}{2} * 1 * 56 * 2.5^2 = 175 \frac{lb}{ft}$ @ 0.83' from

$P_{WP} = \frac{1}{2} K_p \gamma_w H_3^2 = \frac{1}{2} * 1 * 64 * 2.5^2 = 200 \frac{lb}{ft}$ @ 0.83' from

URS

Job: Lake Mauvrepas | Project No. 10001903 | Sheet ___ of ___

Description: Overturning Moment Calculations US 61 Wing Wall | Computed by: ANANTH | Date: 09-18-2013

Checked by: MS | Date: 09/19/2013

Reference

Clockwise Moments (Resisting Moments) about A:

$$M_R = (2430 * 2.75) + (3000 * 4) + (5832 * 5.75) + (303 * 6.5) + (65.2 * 8) + (975.4 * 8) + (175 * 0.83) + (200 * 0.83)$$

$$= 6682.5 + 12000 + 33534 + 1969.5 + 521.6 + 7803.2 + 145.25 + 166$$

$$M_R = 62822 \ \frac{lbs}{ft} - ft$$

Anti-clockwise Moments (Driving Moments) about A:

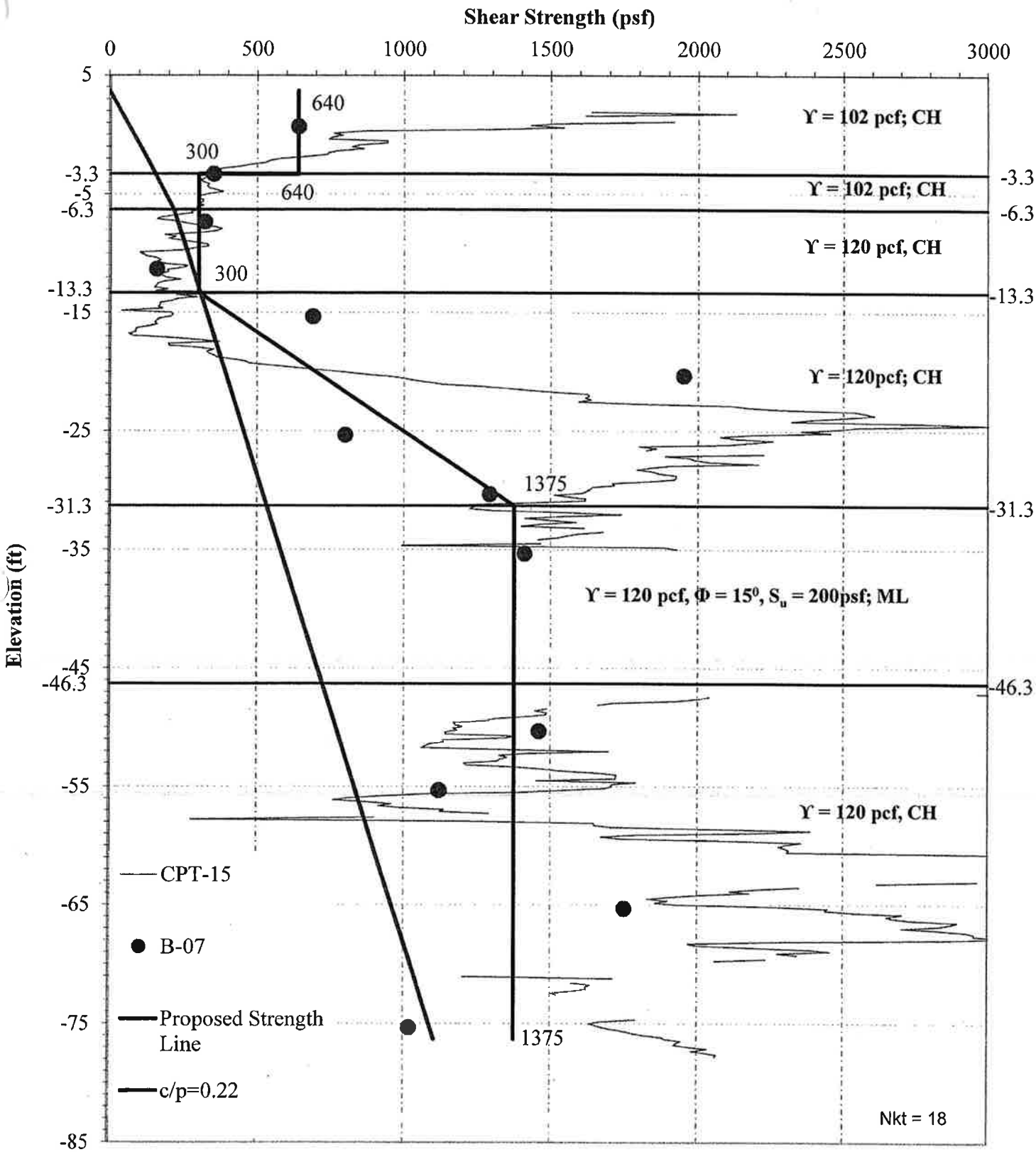
$$M_A = (861.7 * 12.7) + (3912.2 * 4) + (4608 * 4)$$

$$= 3323.59 + 15648.8 + 18432$$

$$M_A = 37404 \ \frac{lbs}{ft} - ft$$

$$(FOS)_{Overturning} = \frac{M_R}{M_A} = \frac{62822}{37404} \simeq 1.68 \text{ ok}$$

US61 Strength Plot - For Pile Capacities Calculation



URS CORP.

SECTION 2

Canadian National Railroad Crossing

URS | Quality - It's Good Business

QMS Form 3-4 (MM)
Rev. 2013 QMS
Date: 28 Feb 2013

IE QMS - Americas

Detail Check

Project Name	Reintroduction to Maurepas Swamp	**Client**	CPRA / USACE
Project Location	St. John the Baptist Parish, LA	**PM**	Naveen Chillara
Project Number	10001801	**PIC**	Bruce Adams

Identifying Information

(This section is to be completed by the Project Manager or the PM's Designee.)

Assigned Checker: Ronnie Johnson Comments Required by:

Work Product Originator: Bryan Beckner

Work Product to be Checked: Canadian National Railroad Crossing

☒ This Detail Check is a check for correctness, completeness and technical accuracy.

☐ This Detail Check is only a technical edit for format, spelling, grammar, pagination and readability.

Specific Instructions:

Submitted by: _____ 9/26/2013

Project Manager Signature **Date**

Comments

(This Section is to be completed by the Checker.)

Select:

A. ☐ Checker has no comments.

or

B. ☒ Comments have been provided on:

- ☒ Marked directly on work product
- ☐ Comment and Disposition Form 3-5
- ☐ Other; Specify: Click here to enter text.

_____ 9/23/13

Checker Signature **Date**

Verification

(This section is to be completed by the Checker after verification of comment incorporation, if box B is checked off above.)

Select:

C. ☒ Verification of comment incorporation has been performed by Checker. There are no outstanding issues.

or

D. ☐ Verification of comment incorporation has been performed by Checker. Unresolved issues have been submitted to the Project Manager or Designee for final resolution.

and

E. ☒ Checker asserts that the work product review is complete.

_____ 9/23/13

Checker Signature **Date**

APPROVAL and DISTRIBUTION

☒ Detail Check is complete.

_____ 9/26/2013

Project Manager or Designee Signature **Date** (Click here to enter a date.)

Distribution:

Project Central File – Quality File Folder

Other – Specify: Enter names here.

2.1

Live Load Calculations

URS

Job: Mississippi River to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Jul-12 **Page:** of
Load Patterns under Rail **Checked By:** RB.) **Date:** 9/23/13 **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
LL_surcharge_vert	Construction surcharge load (250psf)
L_water_full	Internal pressures due to full culvert flow
U_max	Uplift due to maximum water table
H_max	Lateral load due to maximum water table
S_lat_const	Lateral load due to dry backfill soil during construction
S_vert_dry	Vertical load due to dry backfill soil during construction
S_dry_unbal	Load due to uneven dry backfill soil during construction (5ft differential)
S_lat_maxWT	Lateral load due to soil with maximum water table
S_lat_minWT	Lateral load due to soil with minimum water table
RR_vert_DL	Dead Load of Railroad Tracks
RR_vert_LL	Cooper E 80
RR_Lat_surcharge	Lateral Surcharge Load due to Live Load

Canadian National Crossing

LC #	Description	Load Patterns
1a	Construction Condition	DEAD LL_surcharge_vert S_lat_const S_vert_dry
1b	Uneven Construction Condition	DEAD LL_surcharge_vert S_dry_unbal
2a	Maximum Water Inside and Outside Without Live Load	DEAD L_water_full H_max U_max S_vert_dry S_lat_maxWT RR_vert_DL
2a_t	Maximum Water Inside and Outside With Live Load	DEAD L_water_full H_max U_max S_vert_dry S_lat_maxWT RR_vert_DL RR_Lat_surcharge RR_vert_LL
2b	Maximum Water Inside and Minimum Water Outside Without Live Load	DEAD L_water_full S_lat_minWT S_vert_dry RR_vert_DL
2b_t	Maximum Water Inside and Minimum Water Outside With Live Load	DEAD L_water_full S_lat_minWT S_vert_dry RR_vert_DL RR_Lat_surcharge RR_vert_LL

LC #	Description	Load Patterns
3a	Maximum Water Outside and Minimum Water Inside Without Live Load	DEAD H_max U_max S_vert_dry S_lat_maxWT RR_vert_DL
3a_t	Maximum Water Outside and Minimum Water Inside With Live Load	DEAD H_max U_max S_vert_dry S_lat_maxWT RR_vert_DL RR_Lat_surcharge RR_vert_LL
3b	Minimum Water Inside and Outside Without Live Load	DEAD S_lat_minWT S_vert_dry RR_vert_DL
3b_t	Minimum Water Inside and Outside With Live Load	DEAD S_lat_minWT S_vert_dry RR_vert_DL RR_Lat_surcharge RR_vert_LL

URS

Job	Maurepas	Project No.	16001801	Page ____ of ____	
Description	Canadian National	Computed by	BCB	Sheet ____ of ____	
	2-Rail Model Loading	Checked by	RBJ	Date	10-11-12
				Date	9/23/13

Reference

Rail Live Load (SAP MODEL LOAD PATTERN RR_Vert_LL) (AREMA 8.16.4.3)

Base of Rail to Top of Box = 12.25 - 6" - 2.25 = 9.5' = H

$$W_{LL} = \frac{2(80{,}000)}{5L_d}$$ (AREMA 8.2.2.3.c)

$$L_d = 17'\text{-}0'' + 2\left(\frac{H}{2}\right)$$
$$= 17 + 9$$
$$= 26'\text{-}0''$$

$$W_{LL} = \frac{2(80{,}000)}{5(26)}$$

$$= 1230.8 \text{ psf}$$

$$I = (H - 10) \times \frac{60-0}{1.5-10} \ \%$$

$$= 7.06\ \%$$

$$= \frac{7.06}{100}(1230.8)$$

$$= 86.89 \text{ psf}$$

$$W_{LL_I} = 1230.8 + 86.89 = 1317.69 \text{ psf}$$

Base of Rail to Lip of Base Slab = 12.25 - 6" - (7.25) = 19.0'

$$L_d = 17'\text{-}0'' + 2\left(\frac{19}{2}\right)$$
$$= 36.0'$$

$$W_{LL} = \frac{2(80{,}000)}{5(36)}$$

$$= 888.89 \text{ psf}$$

there is no impact because H > 10 ft.

URS

Page ____ of ____

Job: Maurepas | Project No. ____ | Sheet ____ of ____

Description: Canadian National Crossing | Computed by: BCB | Date: 10-11-12

2- Rail Model Loading | Checked by: RBJ | Date: 9/23/13

Reference

Rail Lateral Surcharge (SAP Model Load Pattern RR_Lat_Surcharge)

$$P_s = k_s \frac{2(80{,}000)}{5L_d} \qquad k_s = 0.80 \text{ (Geotech Report)}$$

$$= 0.8\left(\frac{160{,}000}{5(26)}\right)$$

$$= 984.62 \text{ psf}$$ uniformly distributed over entire height (AREMA 8.16.4.2e)

Rail Dead Load (SAP Model Load Pattern RR_vert_DL)

$$DL = \frac{200 \text{ lb/ft} \times 2 \text{ tracks}}{\text{tributary width of piles}}$$ (AREMA 8.2.2.3b)

$$= \frac{200 \times 2}{5} = 80 \text{ psf}$$

16.4.3 LIVE LOAD (2006)[1]

a. Determine live load for each track in accordance with Part 2, Reinforced Concrete Design. Distribution of the live load to the culvert shall be in accordance with Figure 8-16-2.

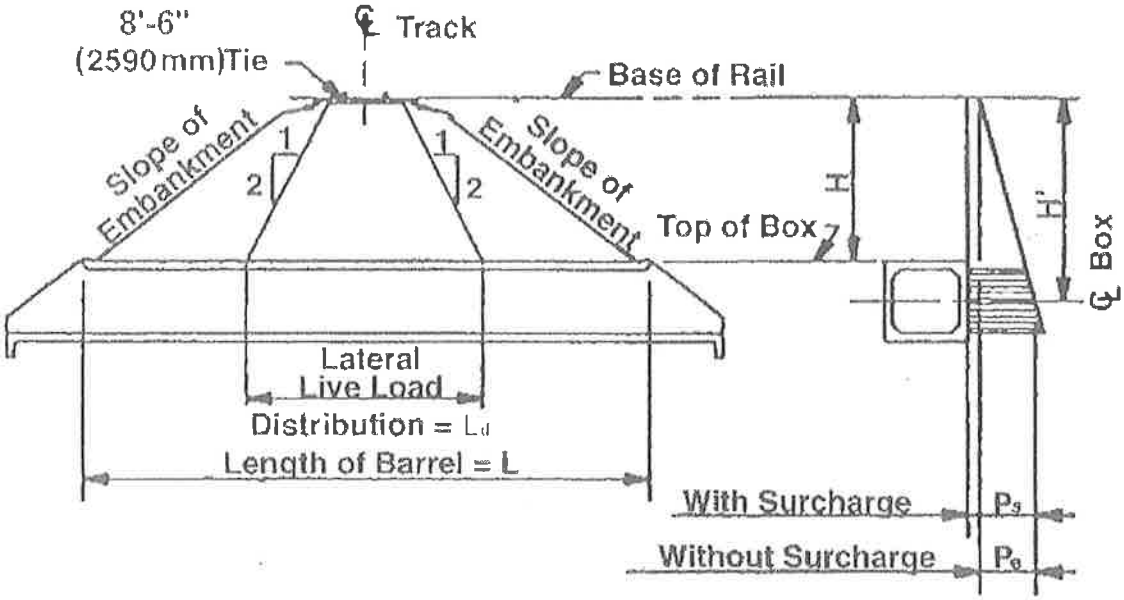


Figure 8-16-2. Distribution of Loads

b. No increase in live load shall be used for multiple track loadings.

c. Calculate the minimum lateral pressure induced from live load on the sides of the box using the earth pressure coefficient determined by Article 16.4.2.

d. The maximum lateral pressures that may be generated on the sides of the box shall be considered in the design, except that the earth pressure coefficient of Article 16.4.2 c need not be applied to live loads. If the provisions of Article 16.4.2 d are used with respect to dead loads, then they shall be used for the calculation of maximum pressures from live loads also.

[1] See Commentary

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Design Constraints Used in Equations

Live Load: E80

Loads on Top Slab:

$$W = W_{LL}\left(1 + \frac{I}{100}\right) + W_{DL} = \text{Uniform Load} = \text{psf}$$

$$W_{LL} = \frac{80000}{5 \times L_d} = \text{Uniform Load} = \text{psf}$$

$$W_{DL} = W_e H + \frac{200}{L_d} + W_s = \text{Uniform Load} = \text{psf}$$

I (Impact) = From 60% at H = 18 inches

To 0% at H = 10 feet

Load on Walls:

$$P_e = k_e W_e H' = \text{Uniform Load} = \text{psf}$$

$$P_s = k_s W_e\left(H' + \frac{80000}{5 W_e L_d}\right) = \text{Uniform Load} = \text{psf}$$

k_e = 0.33 min., 1.0 max.

k_s = 0.33

Design Equations for Single Box (per Foot of Culvert Length)

$$\text{Max. } M_B = \frac{Wb^2}{24}\left(\frac{1+3k}{1+k}\right) - \frac{P_e h^2}{12}\left(\frac{k}{1+k}\right) = \text{lb. ft. use min. value of } P_e$$

$$\text{Max. } M_A = \frac{Wb^2}{12}\left(\frac{1}{1+k}\right) + \frac{P_s h^2}{12}\left(\frac{k}{1+k}\right) = \text{lb. ft. use max. value of } P_e \text{ or } P_s$$

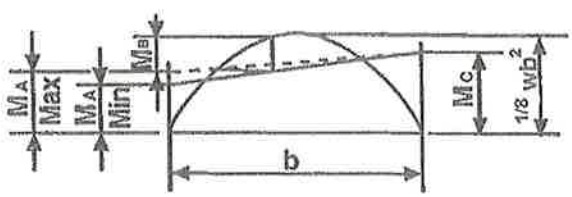
$$V_A = \frac{Wb}{2} = \text{lbs}$$

Design Equations for Double Box (per Foot of Culvert Length)

$$\text{Max. } M_A = \frac{Wb^2}{12}\left(\frac{1}{1+2k}\right) + \frac{P_s h^2}{6}\left(\frac{k}{1+2k}\right) = \text{lb. ft. use max. value of } P_e \text{ or } P_s$$

$$\text{Min. } M_A = \frac{Wb^2}{12}\left(\frac{1}{1+2k}\right) + \frac{P_e h^2}{6}\left(\frac{k}{1+2k}\right) = \text{lb. ft. use min. value of } P_e$$

$$\text{Max. } M_C = \frac{Wb^2}{12}\left(\frac{1+3k}{1+2k}\right) - \frac{P_e h^2}{12}\left(\frac{k}{1+2k}\right) = \text{lb. ft. use min. value of } P_e$$



ASSUME M_C SAME FOR M_A Max and M_A Min

$$V_A = \frac{Wb}{4}\left(\frac{2+3k}{1+2k}\right) + \frac{P_s h^2}{4b}\left(\frac{k}{1+2k}\right) = \text{lbs. use max. value of } P_e \text{ or } P_s$$

$$V_c = \frac{Wb}{4}\left(\frac{2+5k}{1+2k}\right) - \frac{P_e h^2}{4b}\left(\frac{k}{1+2k}\right) = \text{lbs. use min. value of } P_e$$

Figure 8-16-4. Design Equations U.S. Customary Units

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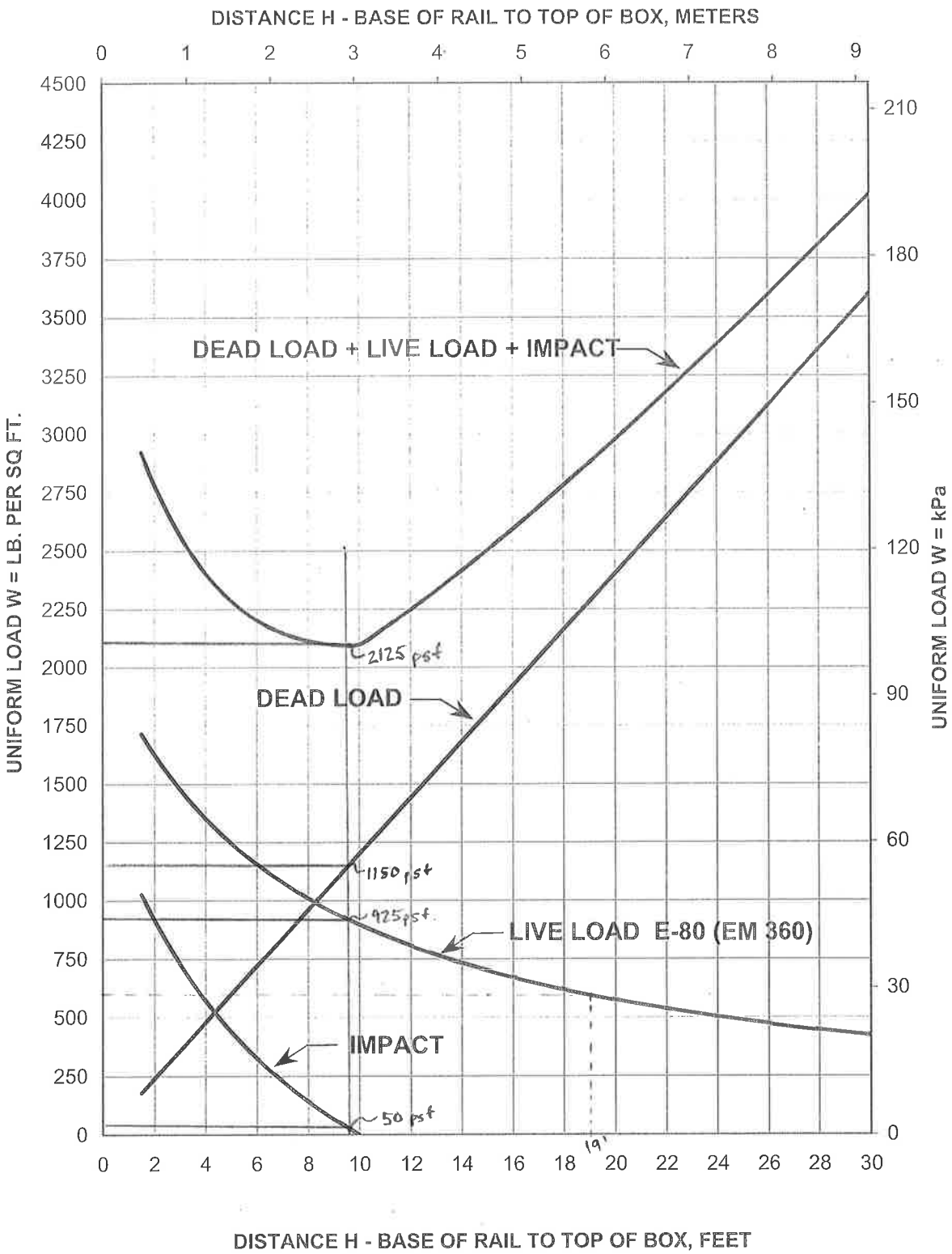

Figure 8-16-1. Uniformly Distributed Load to Top of Box

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URS

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Job Maurepas | Project No. ____ | Sheet ____ of ____

Description Canadian National | Computed by BCB | Date ____

Load Combinations | Checked by RBJ | Date 9/23/13

Reference

Load Combinations (AREMA 8.2.2.4)

* According to 16.4.5, centrifugal, wind, and other longitudinal forces need to be considered

Service:

Group I: Dead + Live + Impact + Earth + Buoyancy

- group II thru VIII will not be necessary because group I will control

LFD:

Group I: 1.4 (Dead + 5/3 (Live + Impact) + Earth + Buoyancy)

Group IA: 1.8 (Dead + Live + Impact + Earth + Buoyancy)

- by inspection, Group II through 9 will not control

2.2

Water & Soil Load Calculations (Under Railroad)

8' x 12' box from STA 36+65.72 to STA 39+18.62

* Soil height above culvert ranges from 9.0ft to 1ft (Use height = 9.0ft as top of ballast)
* Assuming that the maximum water table is at 5.25ft above culvert at EL. 8.00

* Assume the minimum water table is approximately 22 feet below grade. 22 feet is chosen because it is slightly below the bottom slab of the culvert and will need to be checked if the culvert were to ever run completely dry.

* Internal Water Pressure: For image, see L_Water_Full.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Water depth in Culvert(ft)	Pressure (psf)	
0	0	
2	124.8	
4	249.6	
6	374.4	
8	499.2	* pressure on floor of 8' x 12' box

* Maximum Water Table Forces: For image, see H_Max and U_Max.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Elevation	Water depth (ft)	Pressure (psf)	
8.00	0.00	0.0	
2.75	5.25	327.6	* pressure on roof of culvert
1.75	6.25	390.0	
1.25	6.75	421.2	
-7.25	15.25	951.6	* pressure on base slab
-7.88	15.88	990.6	
-8.50	16.50	1029.6	
-9.75	17.75	1107.6	* uplift pressure on bottom of culvert

* Minimum Water Table Forces:

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * (depth-22)

Elevation	Water depth (ft)	Pressure (psf)	
8.00	0.00	0.0	
2.75	5.25	0.0	* pressure on roof of culvert
1.75	6.25	0.0	
1.25	6.75	0.0	
-7.25	15.25	0.0	* pressure on base slab
-7.88	15.88	0.0	
-8.50	16.50	0.0	
-9.75	17.75	0.0	* uplift pressure on bottom of culvert

* External Dry Soil Pressure: For image, see S_Lat_Const and S_Dry_Unbal.

$\gamma_{soil,\ dry}$ = 110 pcf

$q_{surcharge}$ = 250 psf (LL_Surcharge_Vert)

K_0 = 0.8 Geotechnical Report

Lateral Soil Pressure = $K_0 * (q_{surcharge} + \gamma_{soil,\ dry} * h)$ EM 1110-2-2502, Eq 3-43

Elevation	Soil depth (ft)	Lateral Pressure (psf)
	0	200
	3.13	475.00
	3.75	530.00
	5.00	640.00
2.75	9.00	992.00
1.75	10.00	1080.00
1.25	10.50	1124.00
-7.25	19.00	1872.00
-7.88	19.63	1927.00
-8.50	20.25	1982.00
-9.75	21.50	2092.00

Full Soil Column (S_Vert):

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 990 psf

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 2090.0 psf

5' Soil Column (S_Dry_Unbal):

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 275.0 psf

* Soil Forces when water at Maximum Water Table: For image, see S_Lat_MaxWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$

Elevation	Soil depth (ft)	Pressure (psf)
11.75	0.00	0.0
2.75	9.00	505.0
1.75	10.00	543.0
1.25	10.50	562.1
-7.25	19.00	885.8
-7.88	19.63	909.6
-8.50	20.25	933.4
-9.75	21.50	981.0

Vertical Soil Pressure, roof = $\gamma_{soil,\ effective} * h$

= 428.4 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 904.4 psf

* Soil Forces when water at Minimum Water Table: For image, see S_Lat_MinWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$ EM 1110-2-2502, Eq 3-40

Elevation	Soil depth (ft)	Pressure (psf)
11.75	0.00	0.0
2.75	9.00	792.0
1.75	10.00	880.0
1.25	10.50	924.0
-7.25	19.00	1672.0
-7.88	19.63	1727.0
-8.50	20.25	1782.0
-9.75	21.50	1892.0

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 990.0 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 2090.0 psf

2.3

Water & Soil Load Calculations (Under Levee)

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

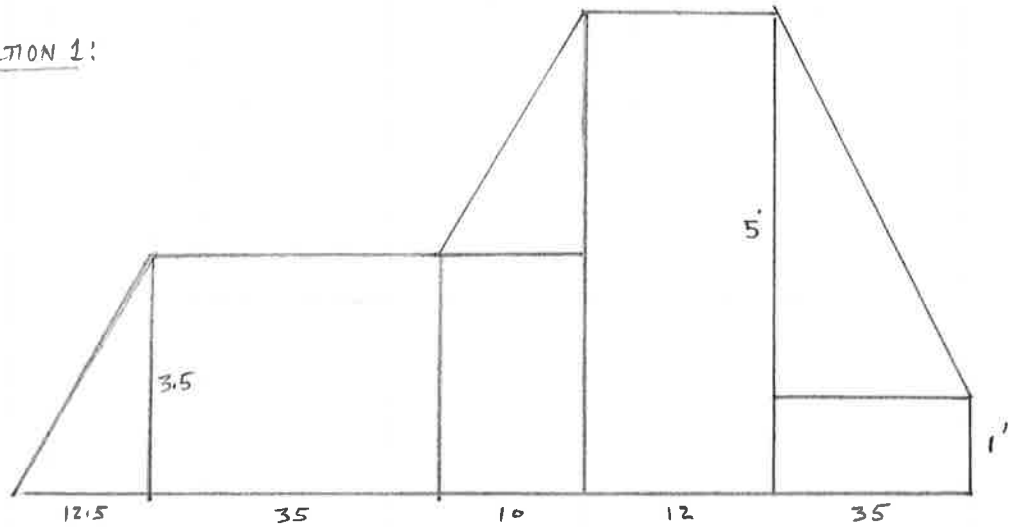
Description Canadian National Railroad Computed by BCB Date ____

LOAD CALCULATIONS UNDER LEVEE Checked by RBJ Date 9/23/13

Reference

AVERAGE LEVEE HEIGHT FOR DEAD LOAD DUE TO LEVEE SOIL:

LEVEE SECTION 1:



$A = \frac{1}{2}(12.5 \times 3.5) + (3.5 \times 35) + (3.5 \times 10) + \frac{1}{2}(2.5 \times 10) + (12 \times 6) + \frac{1}{2}(5 \times 35) + (35 \times 1)$

$= 386.38 \text{ ft}^2$

$L = = 104.5'$

Equivalent Height $= \frac{386.38}{104.5} = 3.70'$ above top slab

use 4.25', so $\frac{4.25 \times 104.5 \times 120}{386.38 \times 120} = 1.149$, 14.9 % overload ± 7k

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

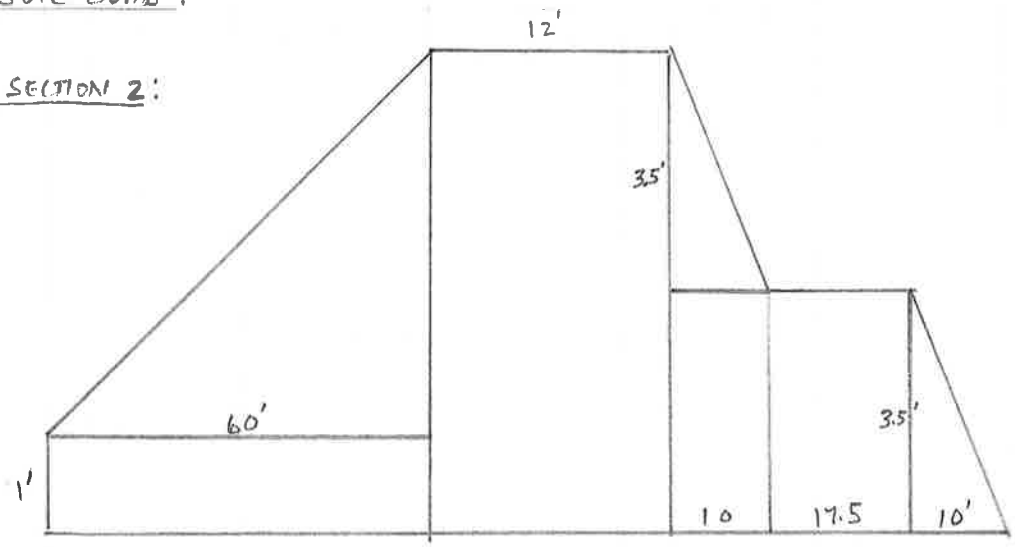
Description Canadian National Railroad Computed by BCB Date ____

LOAD CALCULATIONS UNDER LEVEE Checked by RBJ Date 9/23/13

Reference

ACTUAL SOIL LOAD:

LEVEE SECTION 2:



$$A = (1' \times 60') + \tfrac{1}{2}(60' \times 6') + (12' \times 7') + \tfrac{1}{2}(3.5' \times 10') + (10' \times 3.5') + (17.5' \times 3.5') + \tfrac{1}{2}(3.5' \times 10')$$

$$= 455.25 \text{ ft}^2$$

$$L = 109.5'$$

$$\text{Equivalent Height} = \frac{455.25'}{109.5'} = 4.16' \text{ above top slab}$$

use 4.25', so $\dfrac{4.25 \times 109.5 \times 120}{455.25 \times 120} = 1.022$ 2.22% overload ≈ 1.2K

HEIGHT OF LEVEE USED IN SOIL LOAD CALCULATION = 4.25'

URS

Job: Mississippi River to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Jul-12 **Page:** of
Load Patterns under Levee **Checked By:** RBJ **Date:** 9/23/13 **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
LL_surcharge_vert	Construction surcharge load (250psf)
L_water_full	Internal pressures due to full culvert flow
U_max	Uplift due to maximum water table
H_max	Lateral load due to maximum water table
S_lat_const	Lateral load due to dry backfill soil during construction
S_vert_dry	Vertical load due to dry backfill soil during construction
S_dry_unbal	Load due to uneven dry backfill soil during construction (5ft differential)
S_lat_maxWT	Lateral load due to soil with maximum water table
S_lat_minWT	Lateral load due to soil with minimum water table

Canadian National Crossing

LC #	Description	Load Patterns Included
1a	Construction Condition	DEAD LL_surcharge_vert S_lat_const S_vert_dry
1b	Uneven Construction Condition	DEAD LL_surcharge_vert S_dry_unbal
2a	Maximum Water Inside and Outside	DEAD L_water_full H_max U_max S_vert_dry S_lat_maxWT
2b	Maximum Water Inside and Minimum Water Outside	DEAD L_water_full S_lat_minWT S_vert_dry
3a	Maximum Water Outside and Minimum Water Inside	DEAD H_max U_max S_vert_dry S_lat_maxWT
3b	Minimum Water Inside and Outside	DEAD S_lat_minWT S_vert_dry

8' x 12' box from STA 36+65.72 to STA 39+18.62

* Soil height above culvert ranges from 7ft to 1ft, an equivalent height calculation yields h = 4.25 ft.
* Assuming that the maximum water table is at 5.75ft above culvert at EL. 8.00

* Assume the minimum water table is approximately 21 feet below grade. 21 feet is chosen because it is slightly below the bottom slab of the culvert and will need to be checked if the culvert were to ever run completely dry.

* Internal Water Pressure: For image, see L_Water_Full.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Water depth in Culvert(ft)	Pressure (psf)	
0	0	
2	124.8	
4	249.6	
6	374.4	
8	499.2	* pressure on floor of 8' x 12' box

* Maximum Water Table Forces: For image, see H_Max and U_Max.

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * h

Elevation	Water depth (ft)	Pressure (psf)	
8.00	0.00	0.0	
2.25	5.75	358.8	* pressure on roof of culvert
1.50	6.50	405.6	
1.13	6.88	429.0	
-7.25	15.25	951.6	* pressure on base slab
-7.63	15.63	975.0	
-8.00	16.00	998.4	
-8.75	16.75	1045.2	* uplift pressure on bottom of culvert

* Minimum Water Table Forces:

γ_{water} = 62.4 pcf

Water Pressure = γ_{water} * (depth - 21)

Elevation	Water depth (ft)	Pressure (psf)	
8.00	0.00	0.0	
2.25	5.75	0.0	* pressure on roof of culvert
1.50	6.50	0.0	
1.13	6.88	0.0	
-7.25	15.25	0.0	* pressure on base slab
-7.63	15.63	0.0	
-8.00	16.00	0.0	
-8.75	16.75	0.0	* uplift pressure on bottom of culvert

* External Dry Soil Pressure: For image, see S_Lat_Const and S_Dry_Unbal.

$\gamma_{soil,\ dry}$ = 110 pcf

$q_{surcharge}$ = 250 psf

K_0 = 0.8 Geotechnical Report

Lateral Soil Pressure = $K_0 * (q_{surcharge} + \gamma_{soil,\ dry} * h)$ EM 1110-2-2502, Eq 3-43

Elevation	Soil depth (ft)	Lateral Pressure (psf)
	0	200
	3.88	541.00
2.25	4.25	574.00
1.50	5.00	640.00
1.13	5.38	673.44
-7.25	13.75	1410.00
-7.63	14.13	1443.44
-8.00	14.50	1476.00
-8.75	15.25	1542.00

Full Soil Column (S_Vert):

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 467.5 psf

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 1512.5 psf

5' Soil Column (S_Dry_Unbal):

Vertical Soil Pressure, base slab = $\gamma_{soil,\ dry} * h$

= 385.0 psf

* Soil Forces when water at Maximum Water Table: For image, see S_Lat_MaxWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * (h-h_w) + \gamma_{soil,\ effective} * (h_w)]$

Elevation	Soil depth (ft)	Pressure (psf)
6.50	0.00	0.0
2.25	4.25	161.8
1.50	5.00	190.4
1.13	5.38	204.7
-7.25	13.75	523.6
-7.63	14.13	537.9
-8.00	14.50	552.2
-8.75	15.25	580.7

Vertical Soil Pressure, roof = $\gamma_{soil,\ effective} * h$

= 202.3 psf

Vertical Soil Pressure, slab lip = $\gamma_{soil,\ effective} * h$

= 654.5 psf

* Soil Forces when water at Minimum Water Table: For image, see S_Lat_MinWT.

$\gamma_{soil,\ dry}$ = 110 pcf

$\gamma_{soil,\ effective}$ = 47.6 pcf

K_0 = 0.8

Lateral Soil Pressure = $K_0 * [\gamma_{soil,\ dry} * h_w + \gamma_{soil,\ effective} * (h-h_w)]$ EM 1110-2-2502, Eq 3-40

Elevation	Soil depth (ft)	Pressure (psf)
6.50	0.00	0.0
2.25	4.25	374.0
1.50	5.00	440.0
1.13	5.38	473.0
-7.25	13.75	1122.6
-7.63	14.13	1136.9
-8.00	14.50	1151.2
-8.75	15.25	1179.8

Vertical Soil Pressure, roof = $\gamma_{soil,\ dry} * h$

= 467.5 psf

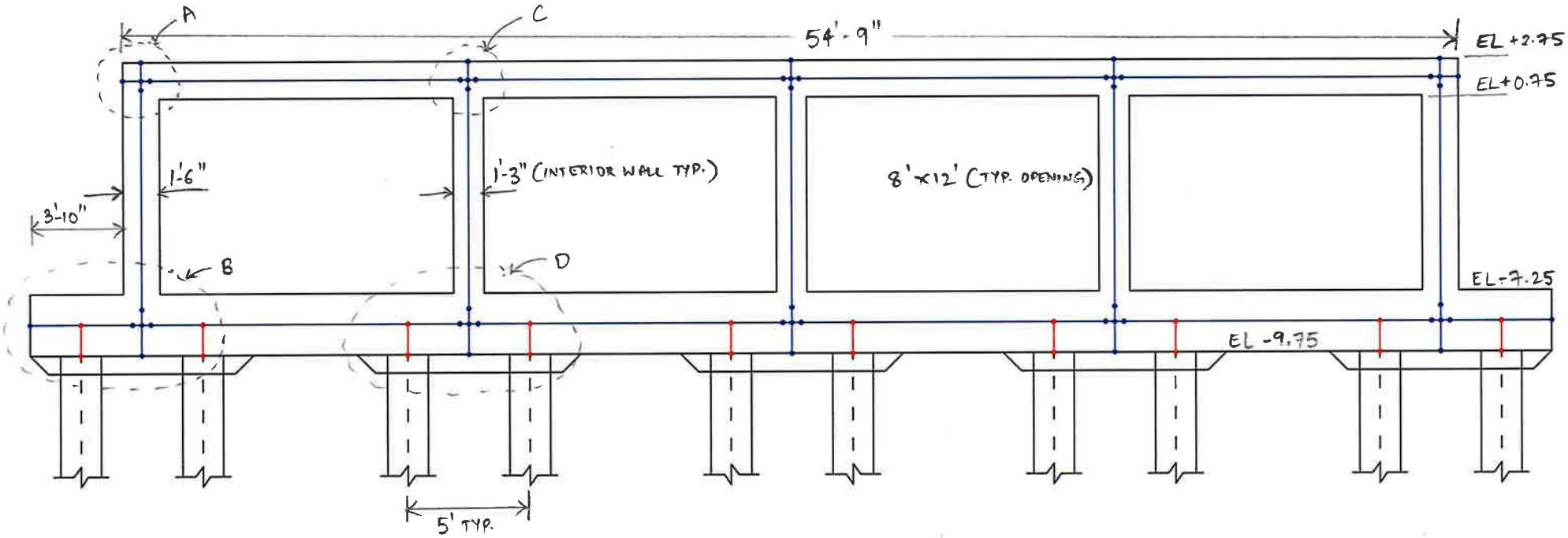
Vertical Soil Pressure, slab lip = $\gamma_{soil,\ dry} * h$

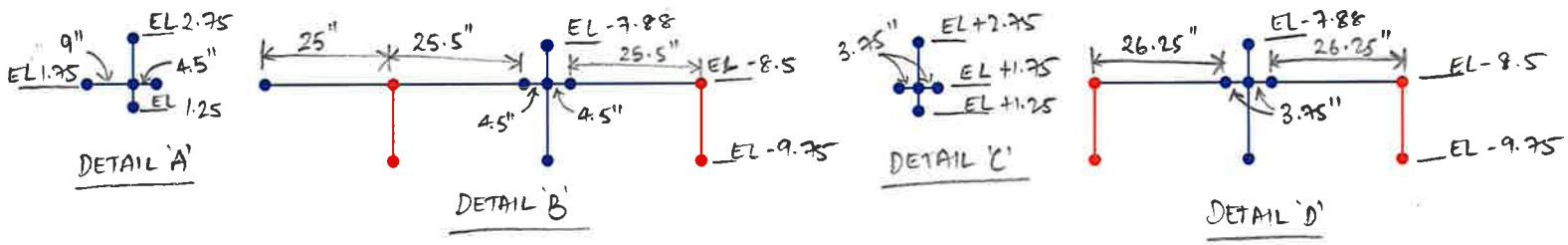
= 1512.5 psf

2.4

SAP Model Overview & Load Input (Railroad)

ILLINOIS CENTRAL RAILROAD CROSSING 4-8'-12' BARREL BOX CULVERT:
CULVERT SECTION UNDER RAILROAD: (SAP MODEL FRAME)





JY 10/2012
PBJ 7/23/13

URS

Page ____ of ____

Job MISSISSIPPI RIVER TO MAUREPAS SWAMP | Project No. 10001801 | Sheet ____ of ____

Description SAP MODEL CHECK | Computed by BCB | Date ____

Checked by RBJ | Date 9/23/13

Reference

Dead Load Check

Rail Section:

Top Slab	= 2.0 × 54.75 × 150	=	16425 lbs/ft
Walls	= 2×(8×1.5×150) + 3×(8×1.25×150)	=	8100.00 lbs/ft
Bot. Slab	= 2.5 × 62.42' × 150	=	23407.50 lbs/ft
			47,933 lbs/ft

DEAD LOAD OF THE STRUCTURE IN SAP MODEL = 52,939.19 lb/ft

[SEE ATTACHED 'BASE REACTIONS' SPREADSHEET]

∴ CALCULATED VALUES IN SAP MODEL ARE CONSERVATIVE

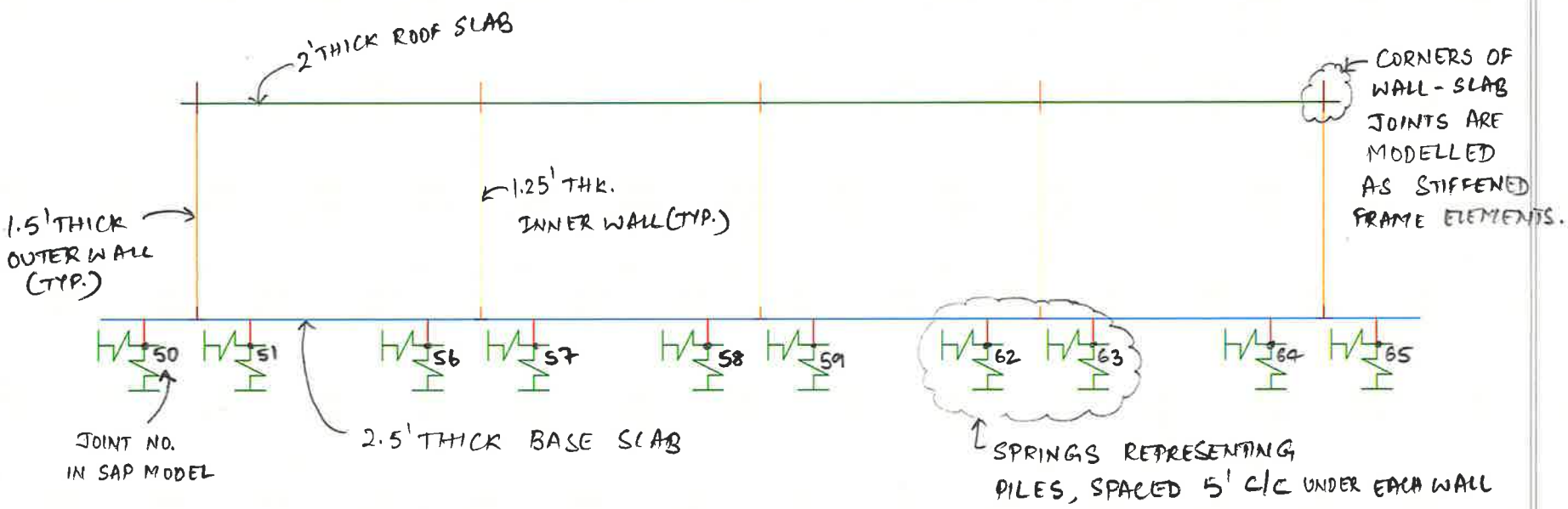
Levee Section:

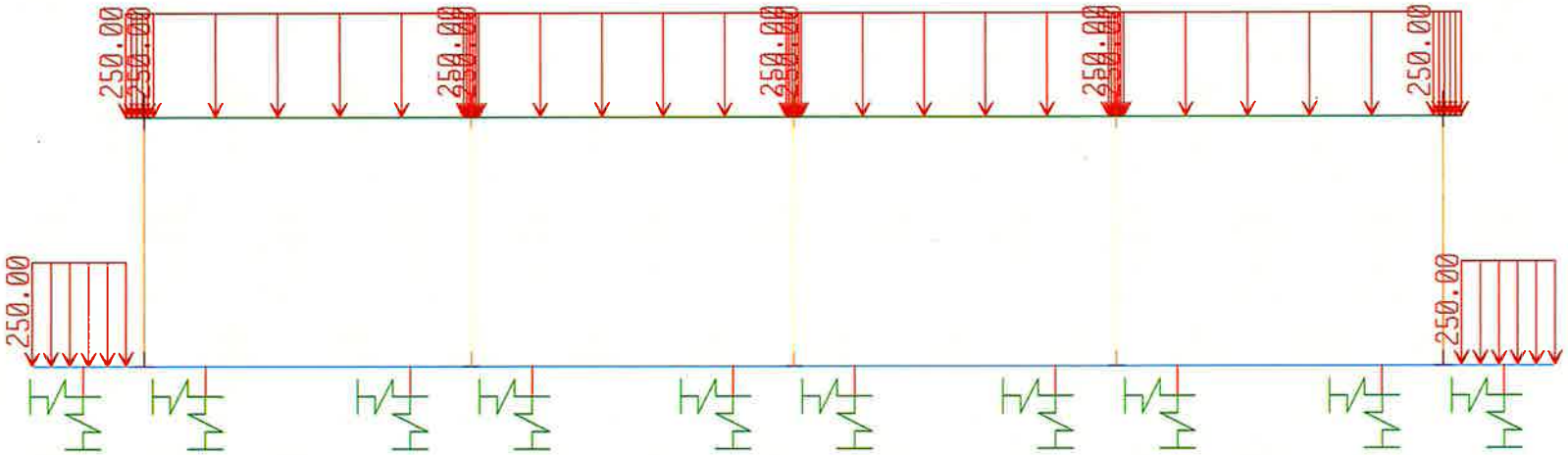
Top Slab	= 1.5 × 54.75 × 150	=	12318.75 lbs/ft
Walls	= 2×(8×1.5×150) + 3×(8×1.25×150)	=	8100 lbs/ft
Bot Slab	= 1.5 × 57.25 × 150	=	12881.25 lbs/ft
			33,300 lbs/ft

Dead Load of Structure in SAP Model = 33,939 lbs/ft

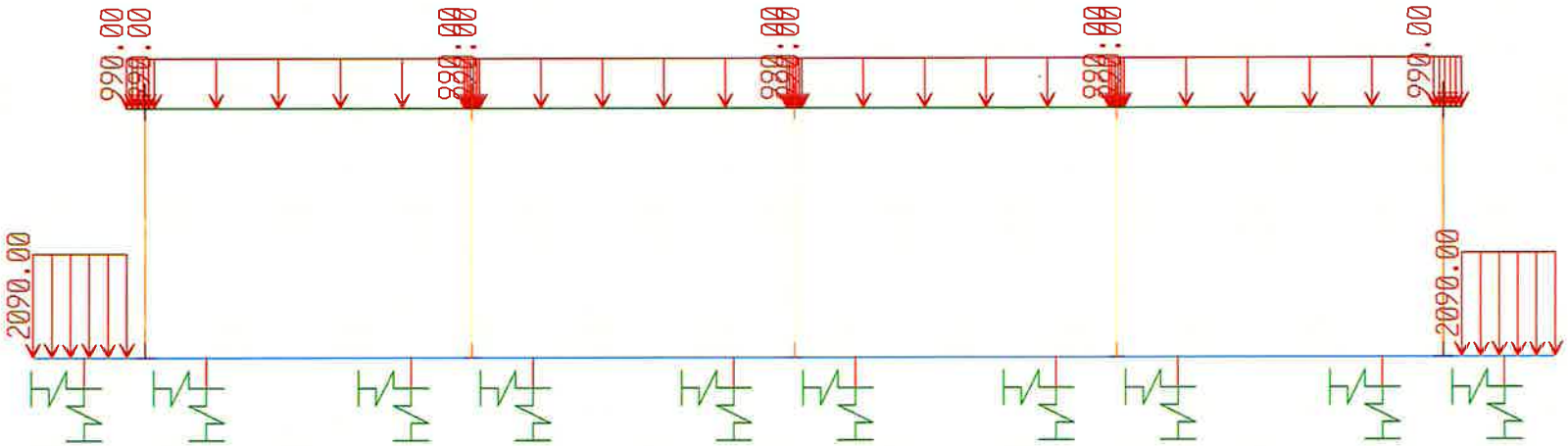
∴ calculated values in SAP Model are conservative

SAP 2D FRAME MODEL - 4-8'x12' CELL CULVERT UNDER RAIL ROAD





- SEE SPREADSHEET IN FRONT FOR LOAD CALCULATIONS FOR THE LOADS SHOWN ON THIS SHEET & THE FOLLOWING SHEETS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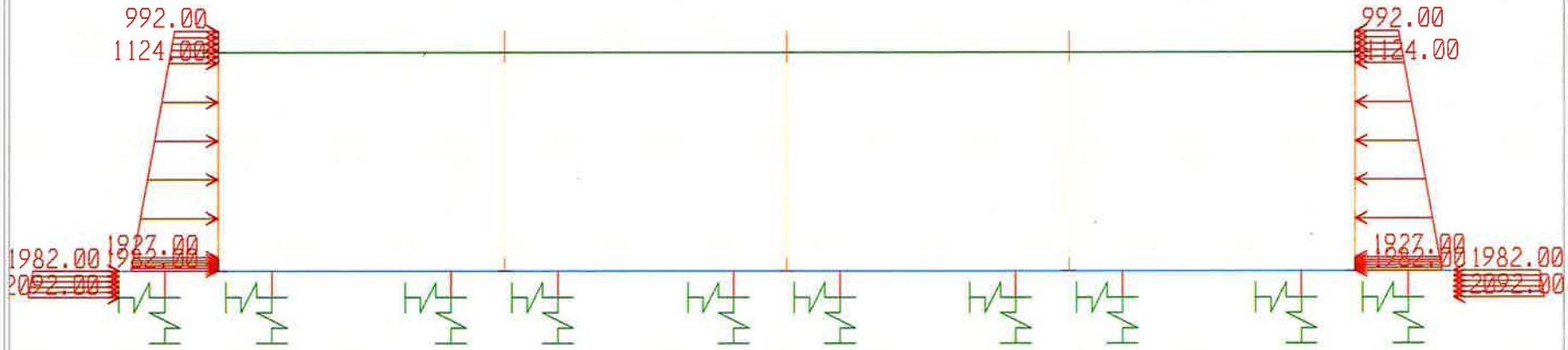
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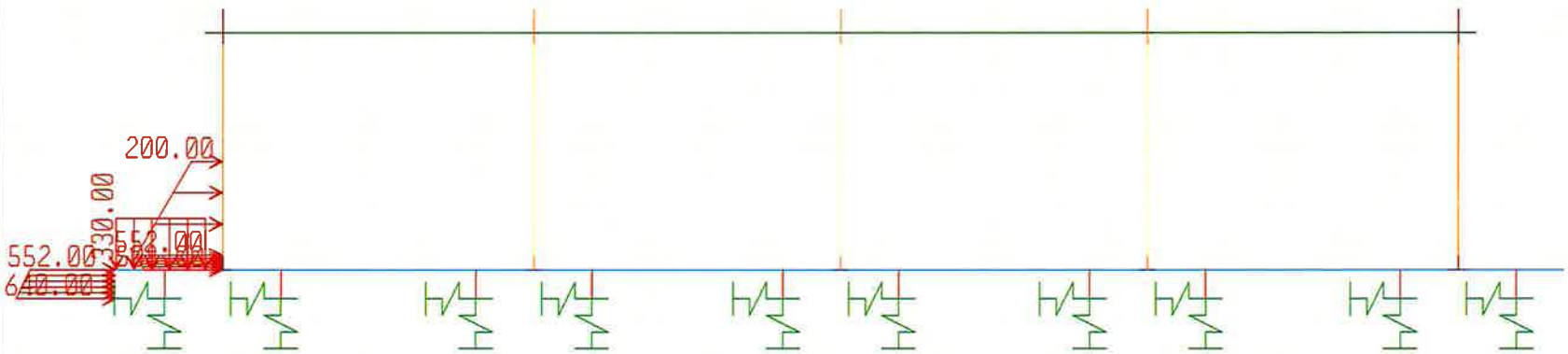
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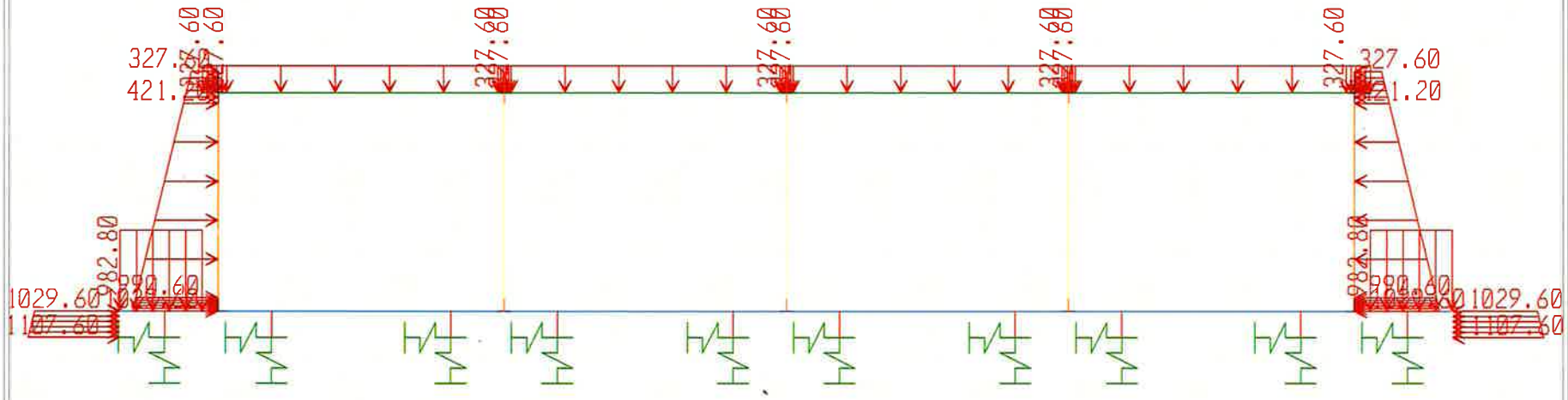
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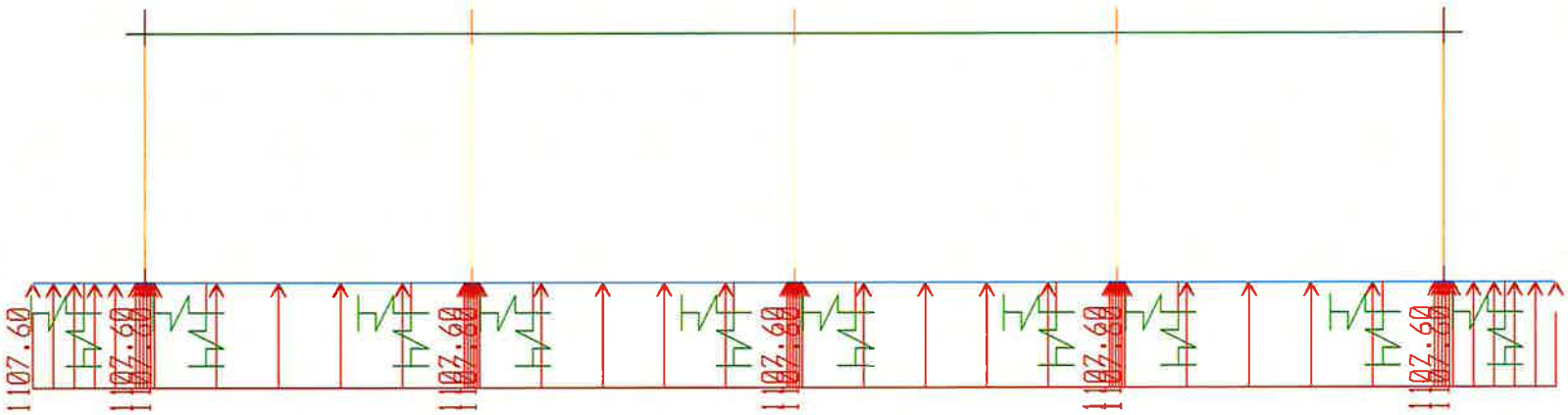
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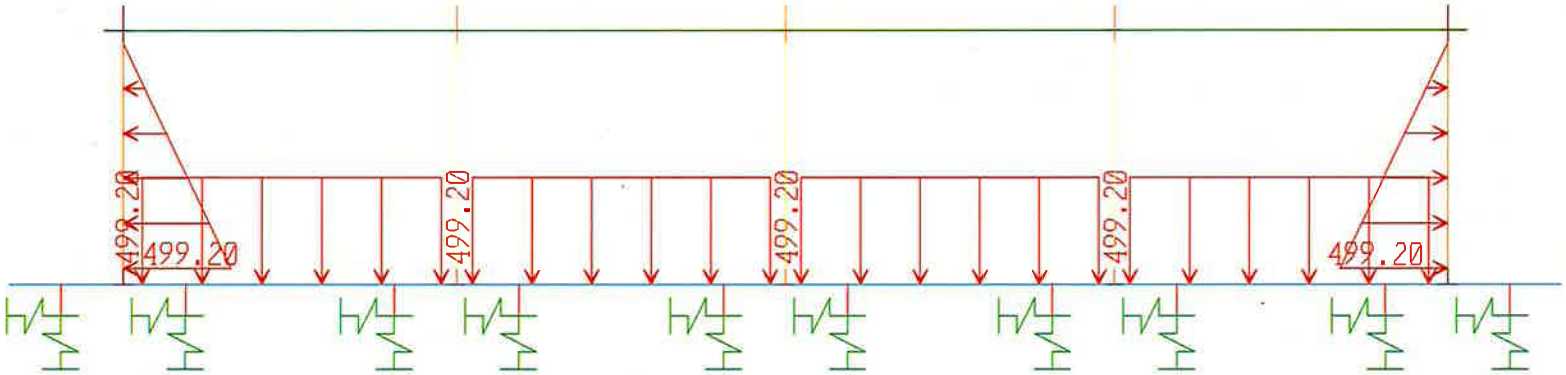
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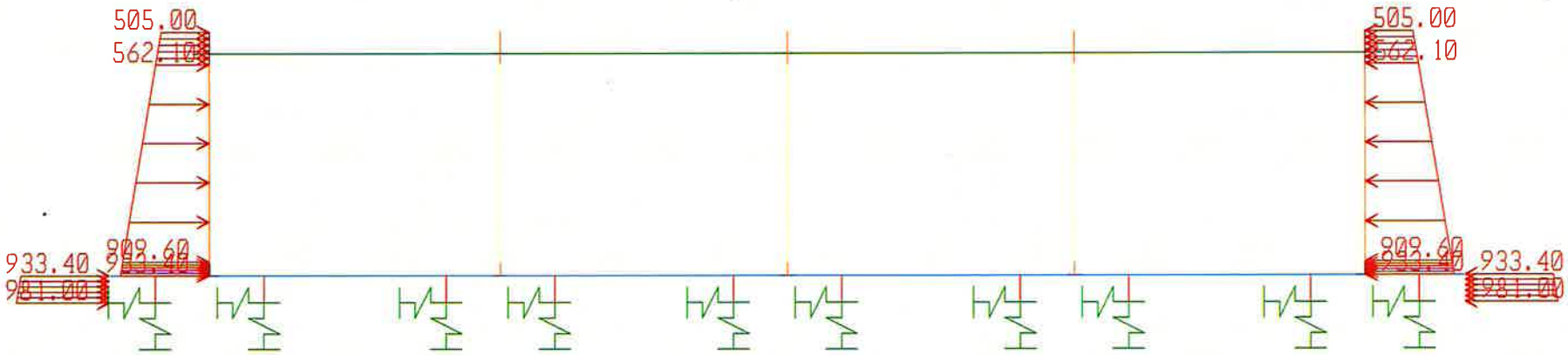
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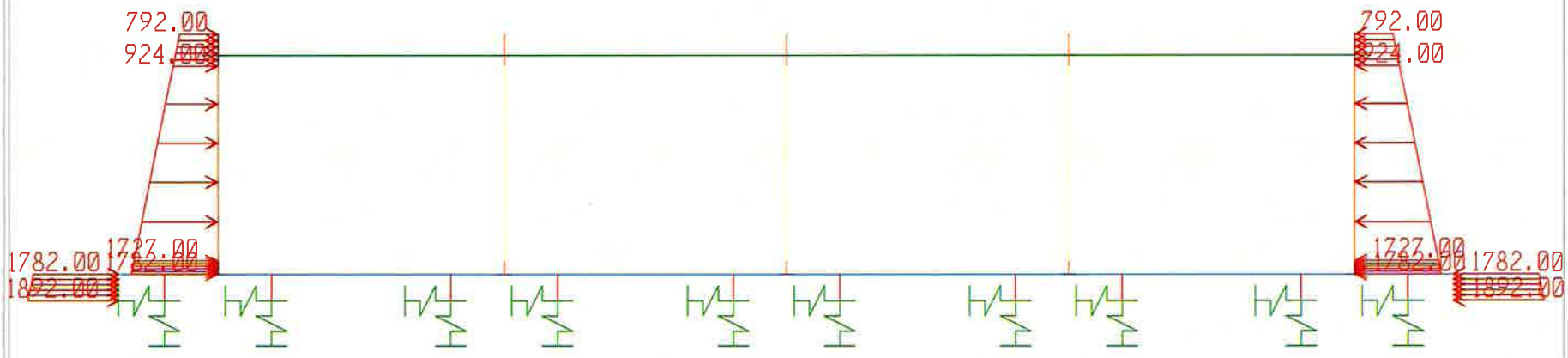
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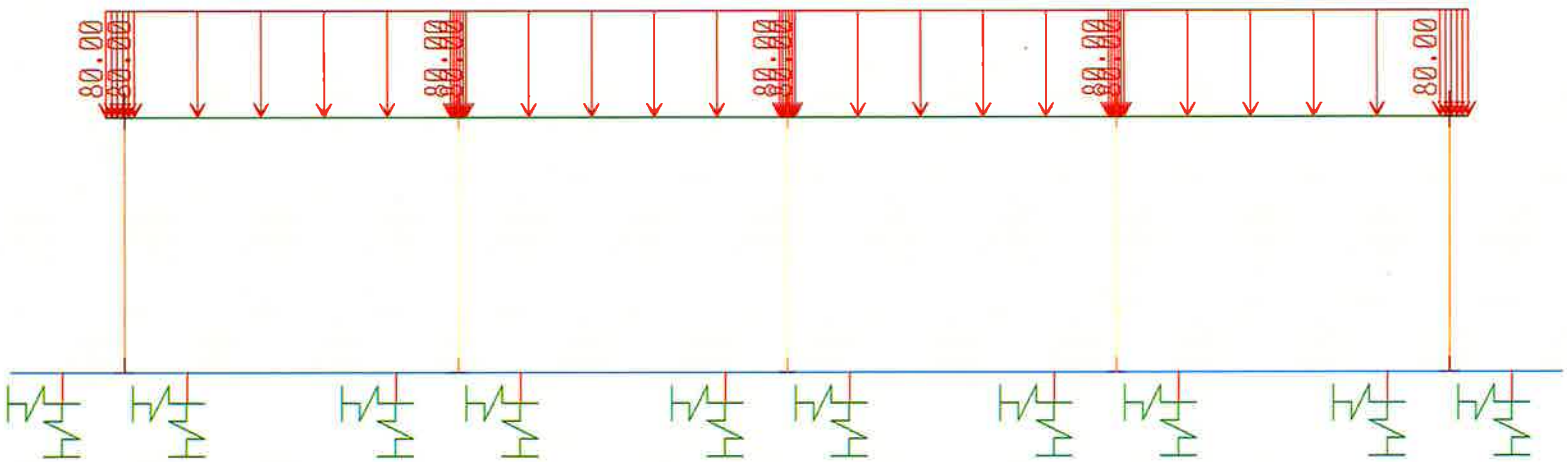
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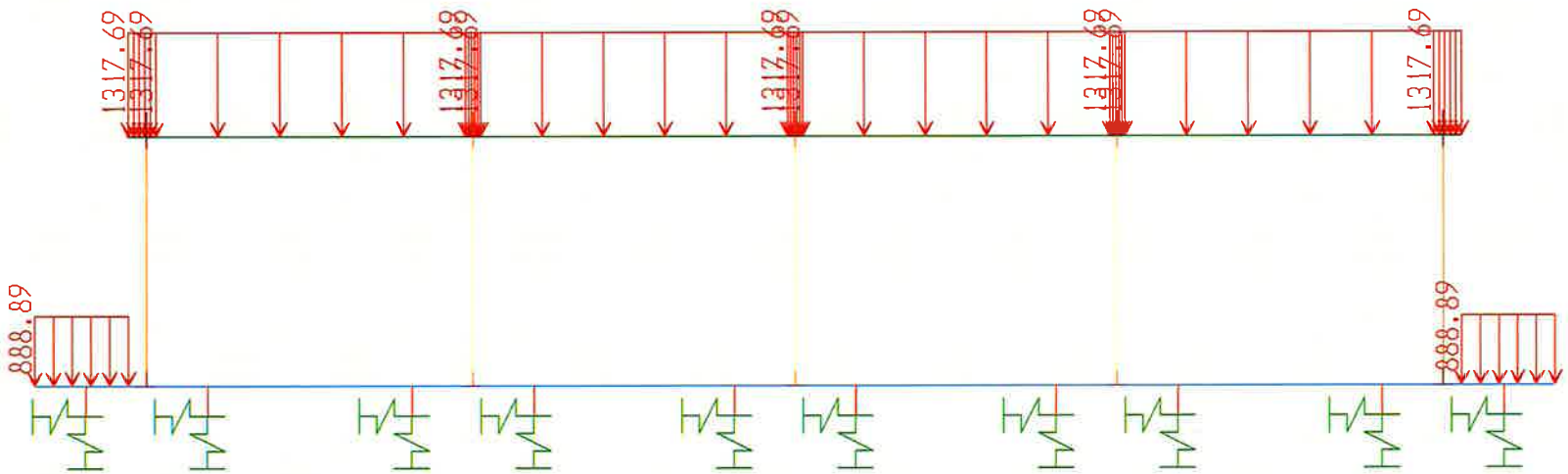
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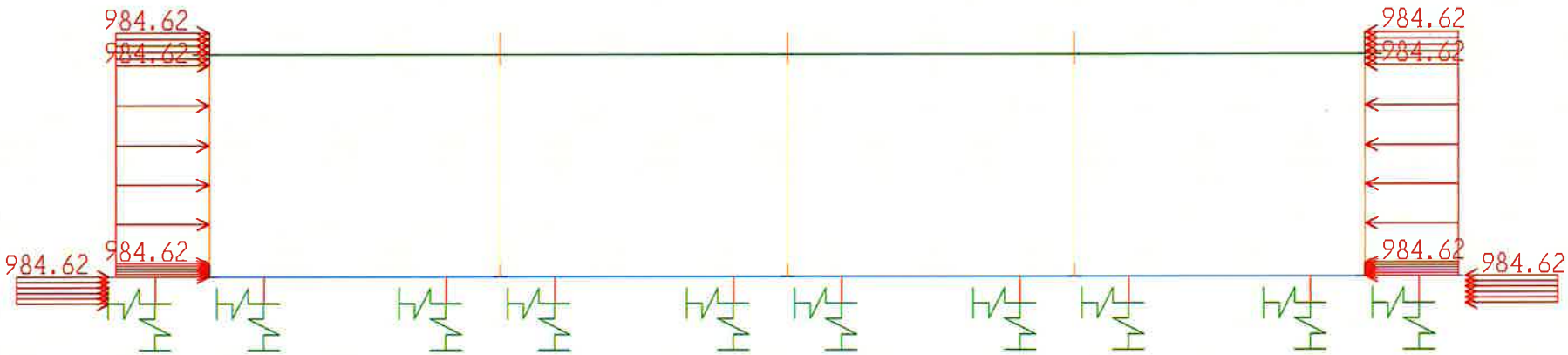
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RAILROAD

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
DEAD	Load pattern	DEAD	1
Surcharge	Load pattern	LL_surcharge_vert	1
Full Flow	Load pattern	L_water_full	1
Uplift (Max)	Load pattern	U_max	1
Max WT	Load pattern	H_max	1
Lat Soil Surcharge	Load pattern	S_lat_const	1
Vert Soil Load	Load pattern	S_vert_Dry	1
Unbalanced Constr.	Load pattern	S_dry_unbal	1
Lat Soil Max WT	Load pattern	S_lat_maxWT	1
Lat Soil Min WT	Load pattern	S_lat_minWT	1
RR_vert_DL	Load pattern	RR_vert_DL	1
RR_vert_LL	Load pattern	RR_vert_LL	1
RR_lat_surcharge	Load pattern	RR_lat_surcharge	1
1a	Load pattern	DEAD	1
1a	Load pattern	LL_surcharge_vert	1
1a	Load pattern	S_lat_const	1
1a	Load pattern	S_vert_Dry	1
1a	Load pattern	RR_vert_DL	1
1b	Load pattern	DEAD	1
1b	Load pattern	LL_surcharge_vert	1
1b	Load pattern	S_dry_unbal	1
2a	Load pattern	DEAD	1
2a	Load pattern	L_water_full	1
2a	Load pattern	H_max	1
2a	Load pattern	U_max	1
2a	Load pattern	S_vert_Dry	1
2a	Load pattern	S_lat_maxWT	1
2a	Load pattern	RR_vert_DL	1
2b	Load pattern	DEAD	1
2b	Load pattern	L_water_full	1
2b	Load pattern	S_lat_minWT	1
2b	Load pattern	S_vert_Dry	1
2b	Load pattern	RR_vert_DL	1
3a	Load pattern	DEAD	1
3a	Load pattern	H_max	1
3a	Load pattern	U_max	1
3a	Load pattern	S_vert_Dry	1
3a	Load pattern	S_lat_maxWT	1
3a	Load pattern	RR_vert_DL	1
3b	Load pattern	DEAD	1
3b	Load pattern	S_lat_minWT	1
3b	Load pattern	S_vert_Dry	1
3b	Load pattern	RR_vert_DL	1

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2a_Train	Load pattern	DEAD	1
2a_Train	Load pattern	L_water_full	1
2a_Train	Load pattern	H_max	1
2a_Train	Load pattern	U_max	1
2a_Train	Load pattern	S_vert_Dry	1
2a_Train	Load pattern	S_lat_maxWT	1
2a_Train	Load pattern	RR_vert_DL	1
2a_Train	Load pattern	RR_lat_surcharge	1
2a_Train	Load pattern	RR_vert_LL	1
2b_Train	Load pattern	DEAD	1
2b_Train	Load pattern	L_water_full	1
2b_Train	Load pattern	S_lat_minWT	1
2b_Train	Load pattern	RR_vert_DL	1
2b_Train	Load pattern	RR_lat_surcharge	1
2b_Train	Load pattern	S_vert_Dry	1
2b_Train	Load pattern	RR_vert_LL	1
3a_Train	Load pattern	DEAD	1
3a_Train	Load pattern	H_max	1
3a_Train	Load pattern	U_max	1
3a_Train	Load pattern	S_vert_Dry	1
3a_Train	Load pattern	S_lat_maxWT	1
3a_Train	Load pattern	RR_vert_DL	1
3a_Train	Load pattern	RR_lat_surcharge	1
3a_Train	Load pattern	RR_vert_LL	1
3b_Train	Load pattern	DEAD	1
3b_Train	Load pattern	S_lat_minWT	1
3b_Train	Load pattern	RR_vert_DL	1
3b_Train	Load pattern	RR_lat_surcharge	1
3b_Train	Load pattern	RR_vert_LL	1
3b_Train	Load pattern	S_vert_Dry	1
1a-LFD I	Load pattern	DEAD	1.4
1a-LFD I	Load pattern	LL_surcharge_vert	2.33
1a-LFD I	Load pattern	S_lat_const	1.4
1a-LFD I	Load pattern	S_vert_Dry	1.4
1a-LFD I	Load pattern	RR_vert_DL	1.4
1b-LFD I	Load pattern	DEAD	1.4
1b-LFD I	Load pattern	LL_surcharge_vert	2.33
1b-LFD I	Load pattern	S_dry_unbal	1.4
2a-LFD I	Load pattern	DEAD	1.4
2a-LFD I	Load pattern	L_water_full	1.4
2a-LFD I	Load pattern	H_max	1.4
2a-LFD I	Load pattern	U_max	1.4
2a-LFD I	Load pattern	S_vert_Dry	1.4
2a-LFD I	Load pattern	S_lat_maxWT	1.4
2a-LFD I	Load pattern	RR_vert_DL	1.4
2b-LFD I	Load pattern	DEAD	1.4
2b-LFD I	Load pattern	L_water_full	1.4
2b-LFD I	Load pattern	S_lat_minWT	1.4
2b-LFD I	Load pattern	S_vert_Dry	1.4
2b-LFD I	Load pattern	RR_vert_DL	1.4

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
3a-LFD I	Load pattern	DEAD	1.4
3a-LFD I	Load pattern	H_max	1.4
3a-LFD I	Load pattern	U_max	1.4
3a-LFD I	Load pattern	S_vert_Dry	1.4
3a-LFD I	Load pattern	S_lat_maxWT	1.4
3a-LFD I	Load pattern	RR_vert_DL	1.4
3b-LFD I	Load pattern	DEAD	1.4
3b-LFD I	Load pattern	S_lat_minWT	1.4
3b-LFD I	Load pattern	S_vert_Dry	1.4
3b-LFD I	Load pattern	RR_vert_DL	1.4
2a_Train_LFD I	Load pattern	DEAD	1.4
2a_Train_LFD I	Load pattern	L_water_full	1.4
2a_Train_LFD I	Load pattern	H_max	1.4
2a_Train_LFD I	Load pattern	U_max	1.4
2a_Train_LFD I	Load pattern	S_vert_Dry	1.4
2a_Train_LFD I	Load pattern	S_lat_maxWT	1.4
2a_Train_LFD I	Load pattern	RR_vert_DL	1.4
2a_Train_LFD I	Load pattern	RR_lat_surcharge	2.33
2a_Train_LFD I	Load pattern	RR_vert_LL	2.33
2b_Train_LFD I	Load pattern	DEAD	1.4
2b_Train_LFD I	Load pattern	L_water_full	1.4
2b_Train_LFD I	Load pattern	S_lat_minWT	1.4
2b_Train_LFD I	Load pattern	RR_vert_DL	1.4
2b_Train_LFD I	Load pattern	RR_lat_surcharge	2.33
2b_Train_LFD I	Load pattern	S_vert_Dry	1.4
2b_Train_LFD I	Load pattern	RR_vert_LL	2.33
3a_Train_LFD I	Load pattern	DEAD	1.4
3a_Train_LFD I	Load pattern	H_max	1.4
3a_Train_LFD I	Load pattern	U_max	1.4
3a_Train_LFD I	Load pattern	S_vert_Dry	1.4
3a_Train_LFD I	Load pattern	S_lat_maxWT	1.4
3a_Train_LFD I	Load pattern	RR_vert_DL	1.4
3a_Train_LFD I	Load pattern	RR_lat_surcharge	2.33
3a_Train_LFD I	Load pattern	RR_vert_LL	2.33
3b_Train_LFD I	Load pattern	DEAD	1.4
3b_Train_LFD I	Load pattern	S_lat_minWT	1.4
3b_Train_LFD I	Load pattern	RR_vert_DL	1.4
3b_Train_LFD I	Load pattern	RR_lat_surcharge	2.33
3b_Train_LFD I	Load pattern	RR_vert_LL	2.33
3b_Train_LFD I	Load pattern	S_vert_Dry	1.4
1a-LFD IA	Load pattern	DEAD	1.8
1a-LFD IA	Load pattern	LL_surcharge_vert	1.8
1a-LFD IA	Load pattern	S_lat_const	1.8
1a-LFD IA	Load pattern	S_vert_Dry	1.8
1a-LFD IA	Load pattern	RR_vert_DL	1.8
1b-LFD IA	Load pattern	DEAD	1.8
1b-LFD IA	Load pattern	LL_surcharge_vert	1.8
1b-LFD IA	Load pattern	S_dry_unbal	1.8

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2a-LFD IA	Load pattern	DEAD	1.8
2a-LFD IA	Load pattern	L_water_full	1.8
2a-LFD IA	Load pattern	H_max	1.8
2a-LFD IA	Load pattern	U_max	1.8
2a-LFD IA	Load pattern	S_vert_Dry	1.8
2a-LFD IA	Load pattern	S_lat_maxWT	1.8
2a-LFD IA	Load pattern	RR_vert_DL	1.8
2b-LFD IA	Load pattern	DEAD	1.8
2b-LFD IA	Load pattern	L_water_full	1.8
2b-LFD IA	Load pattern	S_lat_minWT	1.8
2b-LFD IA	Load pattern	S_vert_Dry	1.8
2b-LFD IA	Load pattern	RR_vert_DL	1.8
3a-LFD IA	Load pattern	DEAD	1.8
3a-LFD IA	Load pattern	H_max	1.8
3a-LFD IA	Load pattern	U_max	1.8
3a-LFD IA	Load pattern	S_vert_Dry	1.8
3a-LFD IA	Load pattern	S_lat_maxWT	1.8
3a-LFD IA	Load pattern	RR_vert_DL	1.8
3b-LFD IA	Load pattern	DEAD	1.8
3b-LFD IA	Load pattern	S_lat_minWT	1.8
3b-LFD IA	Load pattern	S_vert_Dry	1.8
3b-LFD IA	Load pattern	RR_vert_DL	1.8
2a_Train_LFD IA	Load pattern	DEAD	1.8
2a_Train_LFD IA	Load pattern	L_water_full	1.8
2a_Train_LFD IA	Load pattern	H_max	1.8
2a_Train_LFD IA	Load pattern	U_max	1.8
2a_Train_LFD IA	Load pattern	S_vert_Dry	1.8
2a_Train_LFD IA	Load pattern	S_lat_maxWT	1.8
2a_Train_LFD IA	Load pattern	RR_vert_DL	1.8
2a_Train_LFD IA	Load pattern	RR_lat_surcharge	1.8
2a_Train_LFD IA	Load pattern	RR_vert_LL	1.8
2b_Train_LFD IA	Load pattern	DEAD	1.8
2b_Train_LFD IA	Load pattern	L_water_full	1.8
2b_Train_LFD IA	Load pattern	S_lat_minWT	1.8
2b_Train_LFD IA	Load pattern	RR_vert_DL	1.8
2b_Train_LFD IA	Load pattern	RR_lat_surcharge	1.8
2b_Train_LFD IA	Load pattern	S_vert_Dry	1.8
2b_Train_LFD IA	Load pattern	RR_vert_LL	1.8
3a_Train_LFD IA	Load pattern	DEAD	1.8
3a_Train_LFD IA	Load pattern	H_max	1.8
3a_Train_LFD IA	Load pattern	U_max	1.8
3a_Train_LFD IA	Load pattern	S_vert_Dry	1.8
3a_Train_LFD IA	Load pattern	S_lat_maxWT	1.8
3a_Train_LFD IA	Load pattern	RR_vert_DL	1.8
3a_Train_LFD IA	Load pattern	RR_lat_surcharge	1.8
3a_Train_LFD IA	Load pattern	RR_vert_LL	1.8
3b_Train_LFD IA	Load pattern	DEAD	1.8
3b_Train_LFD IA	Load pattern	S_lat_minWT	1.8
3b_Train_LFD IA	Load pattern	RR_vert_DL	1.8
3b_Train_LFD IA	Load pattern	RR_lat_surcharge	1.8
3b_Train_LFD IA	Load pattern	RR_vert_LL	1.8
3b_Train_LFD IA	Load pattern	S_vert_Dry	1.8

RAILROAD

TABLE: Combination Definitions					
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
LFD I Comb	Envelope	No	Linear Static	1a-LFD I	1
LFD I Comb			Linear Static	1b-LFD I	1
LFD I Comb			Linear Static	2a_Train_LFD I	1
LFD I Comb			Linear Static	2a-LFD I	1
LFD I Comb			Linear Static	2b_Train_LFD I	1
LFD I Comb			Linear Static	2b-LFD I	1
LFD I Comb			Linear Static	3a_Train_LFD I	1
LFD I Comb			Linear Static	3b-LFD I	1
LFD IA Comb	Envelope	No	Linear Static	1a-LFD IA	1
LFD IA Comb			Linear Static	1b-LFD IA	1
LFD IA Comb			Linear Static	2a_Train_LFD IA	1
LFD IA Comb			Linear Static	2a-LFD IA	1
LFD IA Comb			Linear Static	2b_Train_LFD IA	1
LFD IA Comb			Linear Static	2b-LFD IA	1
LFD IA Comb			Linear Static	3a_Train_LFD IA	1
LFD IA Comb			Linear Static	3a-LFD IA	1
LFD IA Comb			Linear Static	3b_Train_LFD IA	1
LFD IA Comb			Linear Static	3b-LFD IA	1

2.5

SAP Model Overview & Load Input (Levee)

URS

Job	Mississippi R. Intro into Maurepas Swamp	Project No.	10001801
Description	Illinois Central Railroad Crossing 4- 8'x12' Barrel Box Culvert	Computed by	BCB
		Checked by	RBJ

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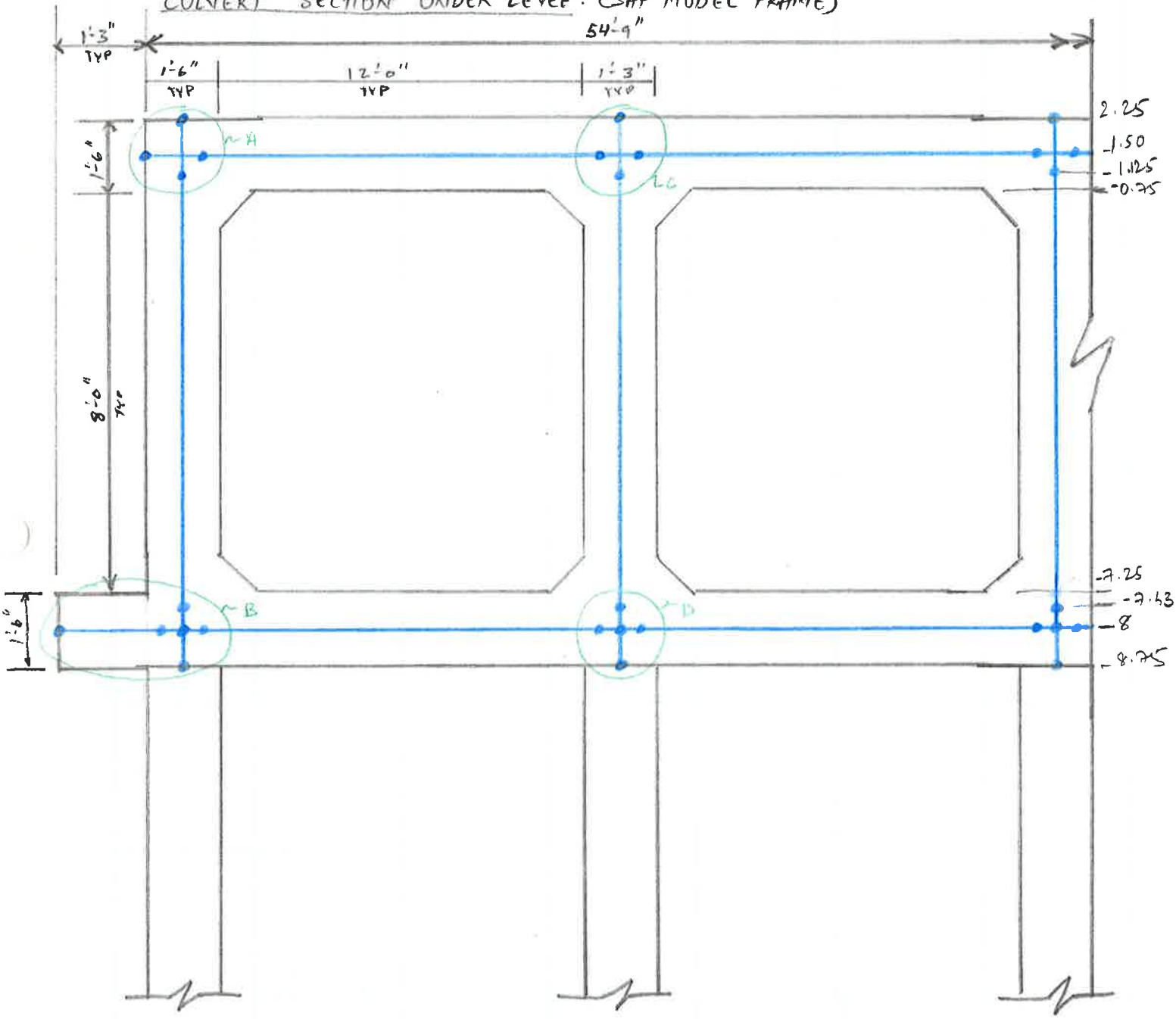
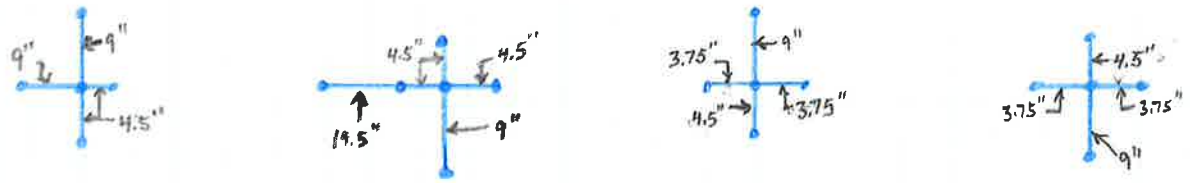
Sheet ____ of ____
Date 9-18-12
Date 9/23/13
Reference

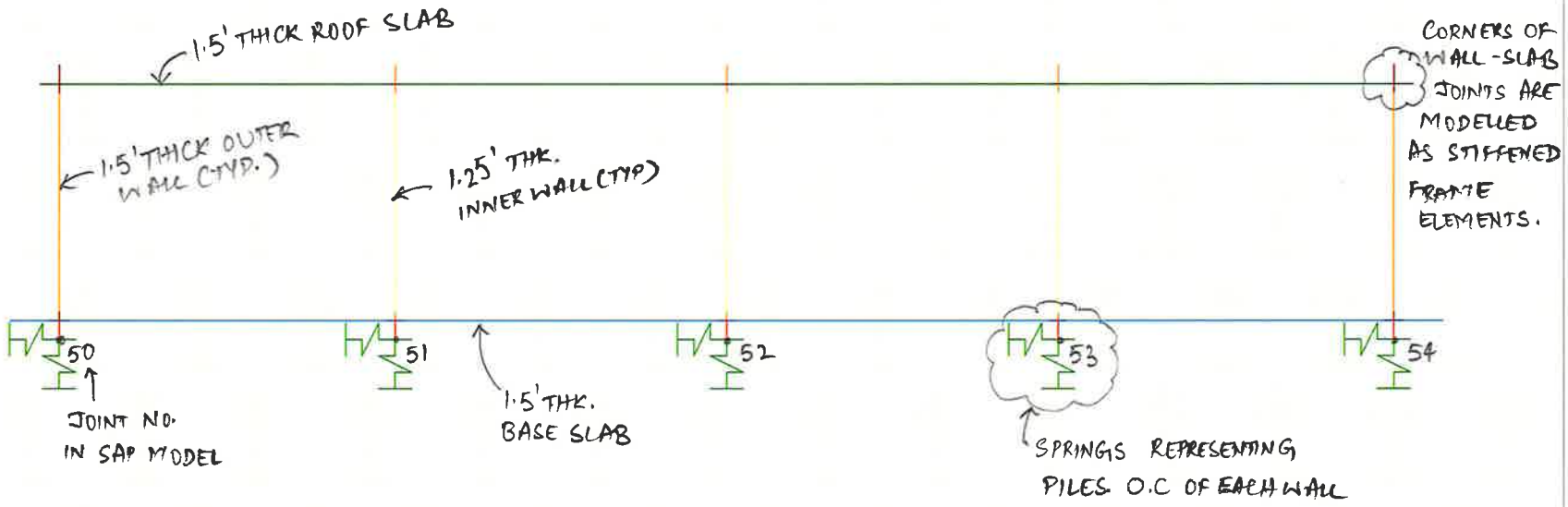
CULVERT SECTION UNDER LEVEE: (SAP MODEL FRAME)

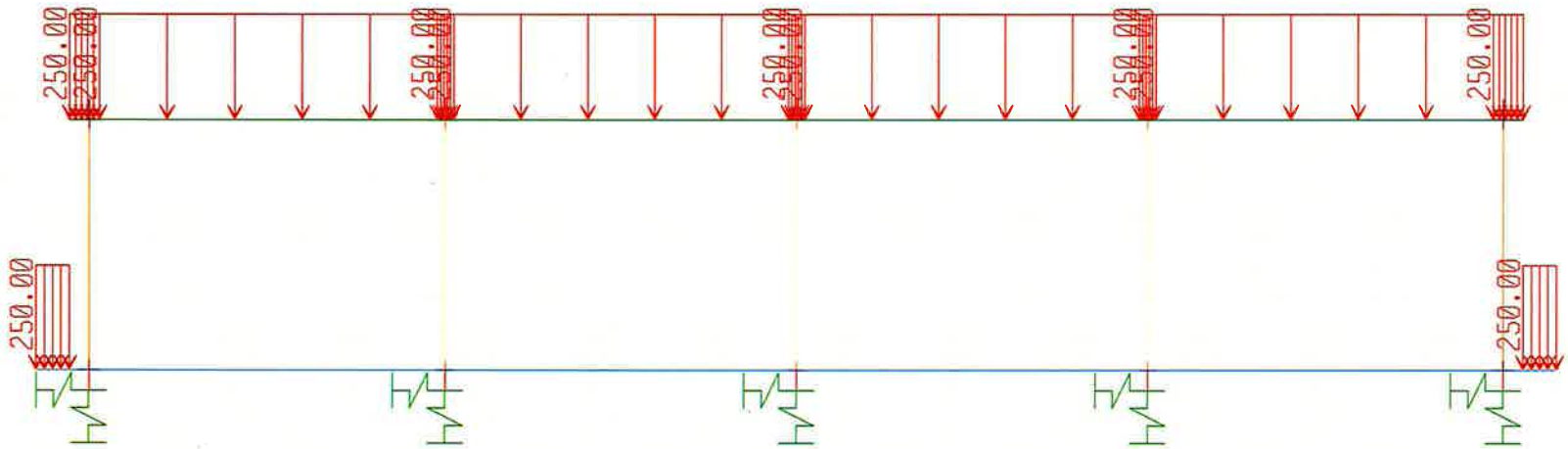




Detail A Detail B Detail C Detail D

SAP 2D FRAME MODEL - 4-8'x12' CELL CULVERT UNDER LEVEE:





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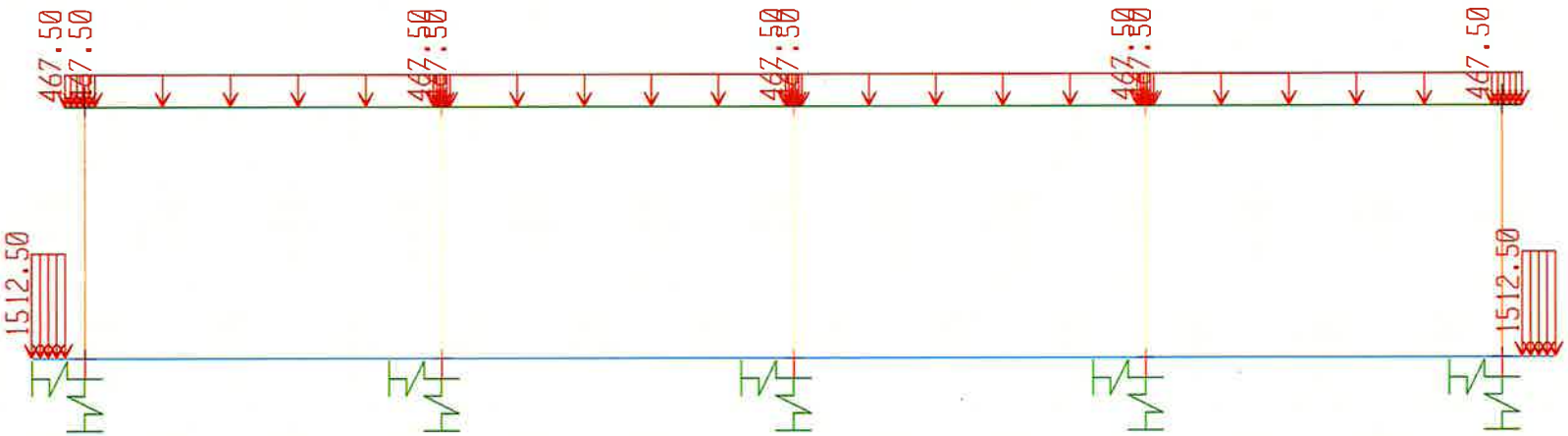
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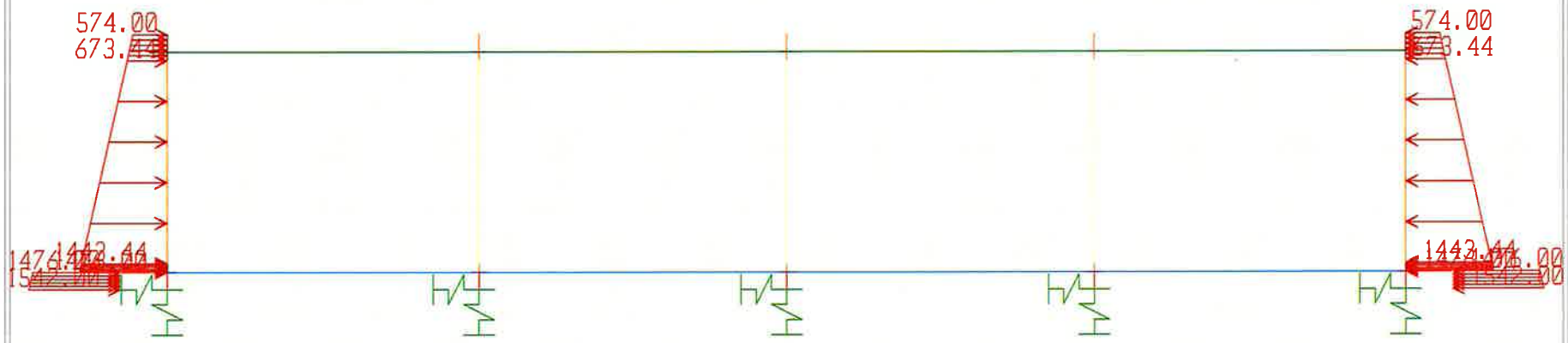
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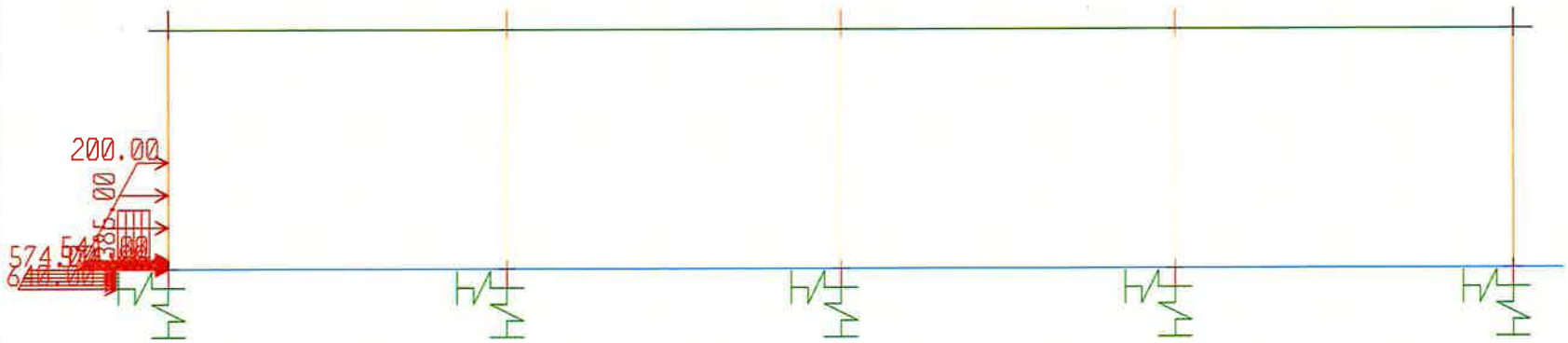
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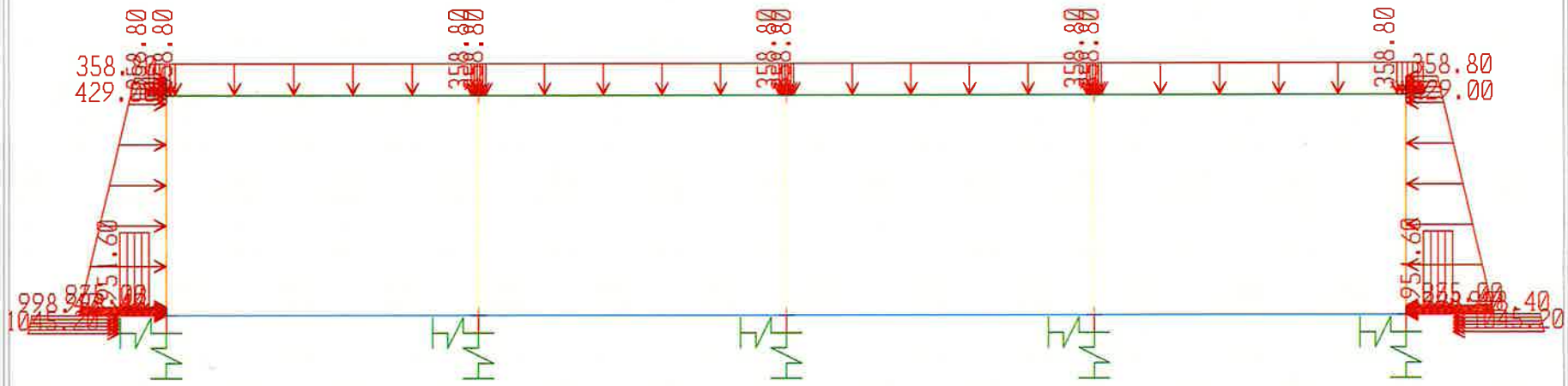
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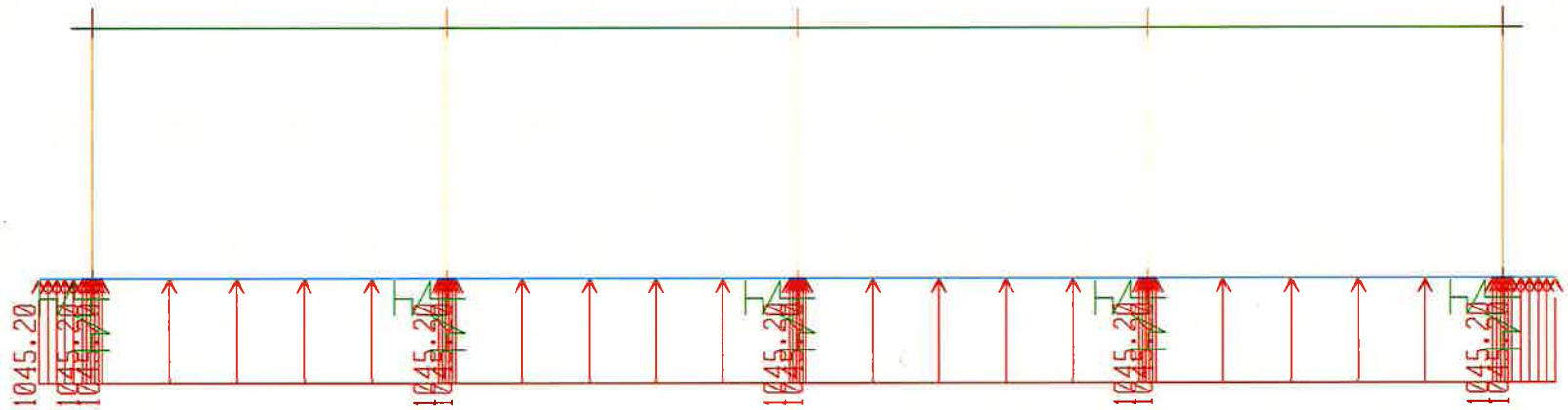
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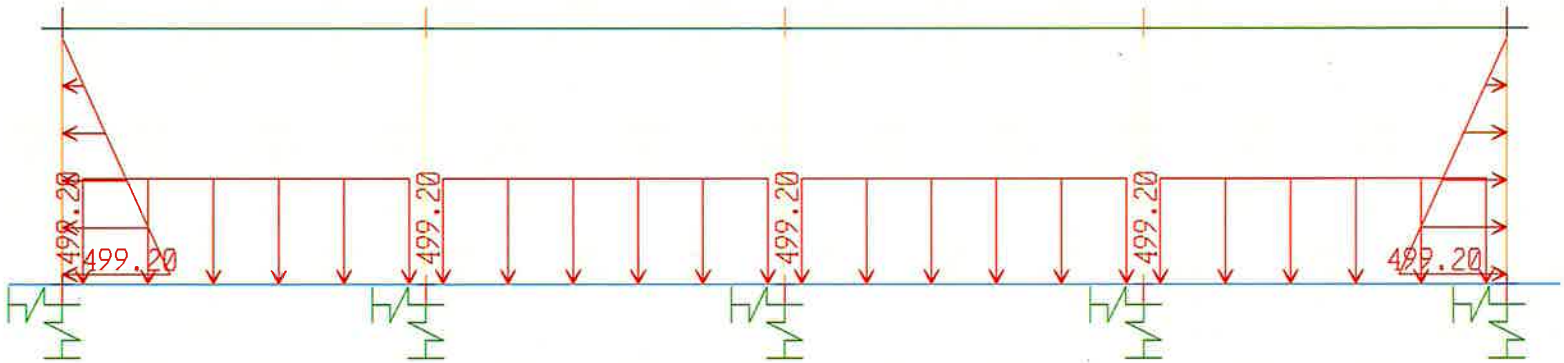
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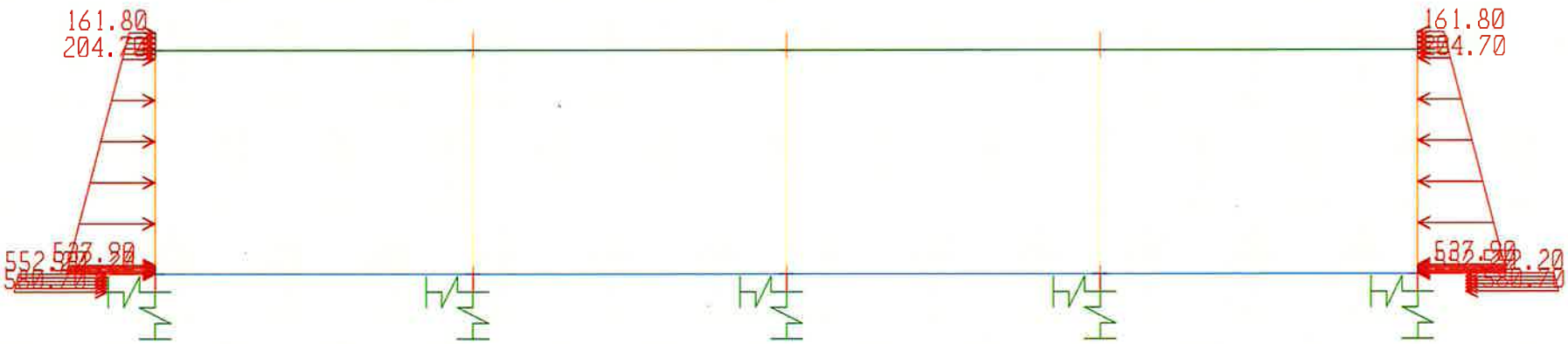
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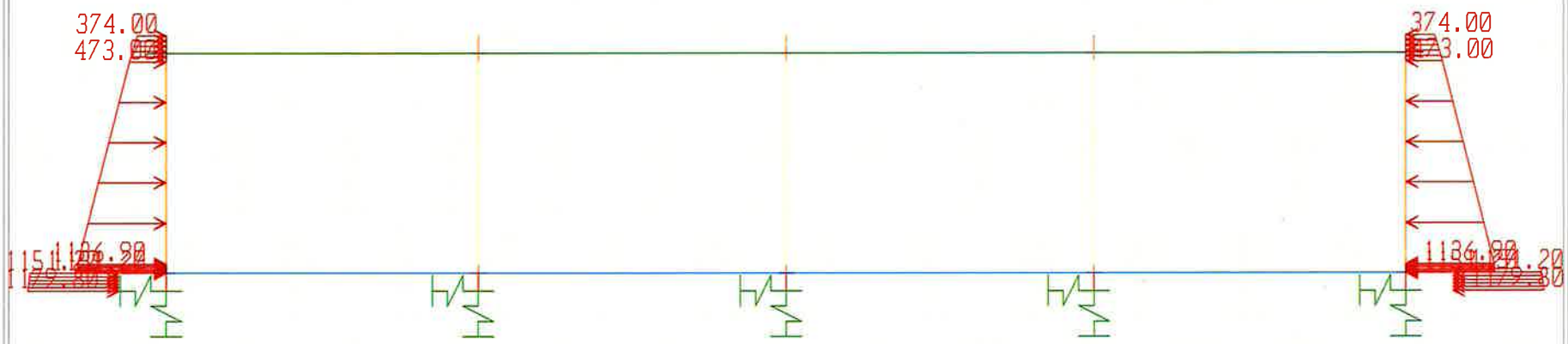
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LEVEE SECTION

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
DEAD	Load pattern	DEAD	1
Surcharge	Load pattern	LL_surcharge_vert	1
Full Flow	Load pattern	L_water_full	1
Uplift (Max)	Load pattern	U_max	1
Max WT	Load pattern	H_max	1
Lat Soil Surcharge	Load pattern	S_lat_const	1
Vert Soil Surcharge	Load pattern	S_vert	1
Unbalanced Constr.	Load pattern	S_dry_unbal	1
Lat Soil Max WT	Load pattern	S_lat_maxWT	1
Lat Soil Min WT	Load pattern	S_lat_minWT	1
1a	Load pattern	DEAD	1
1a	Load pattern	LL_surcharge_vert	1
1a	Load pattern	S_lat_const	1
1a	Load pattern	S_vert	1
1b	Load pattern	DEAD	1
1b	Load pattern	LL_surcharge_vert	1
1b	Load pattern	S_dry_unbal	1
2a	Load pattern	DEAD	1
2a	Load pattern	L_water_full	1
2a	Load pattern	H_max	1
2a	Load pattern	U_max	1
2a	Load pattern	S_lat_maxWT	1
2a	Load pattern	S_vert	1
2b	Load pattern	DEAD	1
2b	Load pattern	L_water_full	1
2b	Load pattern	S_lat_minWT	1
2b	Load pattern	S_vert	1
3a	Load pattern	DEAD	1
3a	Load pattern	H_max	1
3a	Load pattern	U_max	1
3a	Load pattern	S_lat_maxWT	1
3a	Load pattern	S_vert	1
3b	Load pattern	DEAD	1
3b	Load pattern	S_lat_minWT	1
3b	Load pattern	S_vert	1
1a-LFD I	Load pattern	DEAD	1.4
1a-LFD I	Load pattern	LL_surcharge_vert	2.33
1a-LFD I	Load pattern	S_lat_const	1.4
1a-LFD I	Load pattern	S_vert	1.4
1b-LFD I	Load pattern	DEAD	1.4
1b-LFD I	Load pattern	LL_surcharge_vert	2.33
1b-LFD I	Load pattern	S_dry_unbal	1.4

TABLE: Case - Static 1 - Load Assignments			
Case	LoadType	LoadName	LoadSF
Text	Text	Text	Unitless
2a-LFD I	Load pattern	DEAD	1.4
2a-LFD I	Load pattern	L_water_full	1.4
2a-LFD I	Load pattern	H_max	1.4
2a-LFD I	Load pattern	U_max	1.4
2a-LFD I	Load pattern	S_lat_maxWT	1.4
2a-LFD I	Load pattern	S_vert	1.4
2b-LFD I	Load pattern	DEAD	1.4
2b-LFD I	Load pattern	L_water_full	1.4
2b-LFD I	Load pattern	S_lat_minWT	1.4
2b-LFD I	Load pattern	S_vert	1.4
3a-LFD I	Load pattern	DEAD	1.4
3a-LFD I	Load pattern	H_max	1.4
3a-LFD I	Load pattern	U_max	1.4
3a-LFD I	Load pattern	S_lat_maxWT	1.4
3a-LFD I	Load pattern	S_vert	1.4
3b-LFD I	Load pattern	DEAD	1.4
3b-LFD I	Load pattern	S_lat_minWT	1.4
3b-LFD I	Load pattern	S_vert	1.4
1a-LFD IA	Load pattern	DEAD	1.8
1a-LFD IA	Load pattern	LL_surcharge_vert	1.8
1a-LFD IA	Load pattern	S_lat_const	1.8
1a-LFD IA	Load pattern	S_vert	1.8
1b-LFD IA	Load pattern	DEAD	1.8
1b-LFD IA	Load pattern	LL_surcharge_vert	1.8
1b-LFD IA	Load pattern	S_dry_unbal	1.8
2a-LFD IA	Load pattern	DEAD	1.8
2a-LFD IA	Load pattern	L_water_full	1.8
2a-LFD IA	Load pattern	H_max	1.8
2a-LFD IA	Load pattern	U_max	1.8
2a-LFD IA	Load pattern	S_lat_maxWT	1.8
2a-LFD IA	Load pattern	S_vert	1.8
2b-LFD IA	Load pattern	DEAD	1.8
2b-LFD IA	Load pattern	L_water_full	1.8
2b-LFD IA	Load pattern	S_lat_minWT	1.8
2b-LFD IA	Load pattern	S_vert	1.8
3a-LFD IA	Load pattern	DEAD	1.8
3a-LFD IA	Load pattern	H_max	1.8
3a-LFD IA	Load pattern	U_max	1.8
3a-LFD IA	Load pattern	S_lat_maxWT	1.8
3a-LFD IA	Load pattern	S_vert	1.8
3b-LFD IA	Load pattern	DEAD	1.8
3b-LFD IA	Load pattern	S_lat_minWT	1.8
3b-LFD IA	Load pattern	S_vert	1.8

TABLE: Combination Definitions					
ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor
Text	Text	Yes/No	Text	Text	Unitless
LFD I Comb	Envelope	No	Linear Static	1a-LFD I	1
LFD I Comb			Linear Static	1b-LFD I	1
LFD I Comb			Linear Static	2a-LFD I	1
LFD I Comb			Linear Static	2b-LFD I	1
LFD I Comb			Linear Static	3a-LFD I	1
LFD I Comb			Linear Static	3b-LFD I	1
LFD IA Comb	Envelope	No	Linear Static	1a-LFD IA	1
LFD IA Comb			Linear Static	1b-LFD IA	1
LFD IA Comb			Linear Static	2a-LFD IA	1
LFD IA Comb			Linear Static	2b-LFD IA	1
LFD IA Comb			Linear Static	3a-LFD IA	1
LFD IA Comb			Linear Static	3b-LFD IA	1

2.6

SAP Results (Railroad)

2 tracks

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	F1	F2	F3
Text	Text	Text	Kip	Kip	Kip
50	1a	LinStatic	-0.2	0.0	14.4
	1b	LinStatic	-0.3	0.0	6.6
	2a	LinStatic	-0.2	0.0	12.3
	2b	LinStatic	-0.1	0.0	13.8
	3a	LinStatic	-0.2	0.0	11.4
	3b	LinStatic	-0.2	0.0	13.0
	2a_Train	LinStatic	-0.2	0.0	18.7
	2b_Train	LinStatic	-0.2	0.0	20.2
	3a_Train	LinStatic	-0.3	0.0	17.8
	3b_Train	LinStatic	-0.2	0.0	19.3
51	1a	LinStatic	-0.1	0.0	14.5
	1b	LinStatic	-0.2	0.0	7.4
	2a	LinStatic	0.0	0.0	10.4
	2b	LinStatic	0.0	0.0	15.8
	3a	LinStatic	0.0	0.0	7.5
	3b	LinStatic	-0.1	0.0	12.8
	2a_Train	LinStatic	0.0	0.0	19.0
	2b_Train	LinStatic	-0.1	0.0	24.4
	3a_Train	LinStatic	-0.1	0.0	16.0
	3b_Train	LinStatic	-0.1	0.0	21.4
56	1a	LinStatic	-0.2	0.0	13.4
	1b	LinStatic	-0.3	0.0	6.5
	2a	LinStatic	-0.2	0.0	9.5
	2b	LinStatic	-0.1	0.0	14.1
	3a	LinStatic	-0.2	0.0	7.5
	3b	LinStatic	-0.1	0.0	12.1
	2a_Train	LinStatic	-0.2	0.0	16.2
	2b_Train	LinStatic	-0.2	0.0	20.8
	3a_Train	LinStatic	-0.3	0.0	14.2
	3b_Train	LinStatic	-0.2	0.0	18.8
57	1a	LinStatic	0.0	0.0	14.6
	1b	LinStatic	-0.2	0.0	7.4
	2a	LinStatic	0.0	0.0	10.7
	2b	LinStatic	0.0	0.0	15.9
	3a	LinStatic	0.0	0.0	7.7
	3b	LinStatic	0.0	0.0	12.9
	2a_Train	LinStatic	0.0	0.0	19.6
	2b_Train	LinStatic	0.0	0.0	24.8
	3a_Train	LinStatic	0.0	0.0	16.5
	3b_Train	LinStatic	0.0	0.0	21.8
58	1a	LinStatic	-0.1	0.0	14.7
	1b	LinStatic	-0.3	0.0	7.6
	2a	LinStatic	-0.1	0.0	10.9
	2b	LinStatic	-0.1	0.0	16.1
	3a	LinStatic	-0.1	0.0	7.9
	3b	LinStatic	-0.1	0.0	13.0
	2a_Train	LinStatic	-0.1	0.0	19.9
	2b_Train	LinStatic	-0.1	0.0	25.1
	3a_Train	LinStatic	-0.1	0.0	16.9

3b_Train	LinStatic	-0.1	0.0	22.0

59	1a	LinStatic	0.0	0.0	14.6
	1b	LinStatic	-0.3	0.0	7.5
	2a	LinStatic	0.0	0.0	10.7
	2b	LinStatic	0.0	0.0	15.9
	3a	LinStatic	0.0	0.0	7.7
	3b	LinStatic	0.0	0.0	12.9
	2a_Train	LinStatic	0.0	0.0	19.6
	2b_Train	LinStatic	0.0	0.0	24.8
	3a_Train	LinStatic	0.0	0.0	16.5
	3b_Train	LinStatic	0.0	0.0	21.8
62	1a	LinStatic	0.1	0.0	14.7
	1b	LinStatic	-0.2	0.0	7.6
	2a	LinStatic	0.1	0.0	10.9
	2b	LinStatic	0.1	0.0	16.1
	3a	LinStatic	0.1	0.0	7.9
	3b	LinStatic	0.1	0.0	13.0
	2a_Train	LinStatic	0.1	0.0	19.9
	2b_Train	LinStatic	0.1	0.0	25.1
	3a_Train	LinStatic	0.1	0.0	16.9
	3b_Train	LinStatic	0.1	0.0	22.0
63	1a	LinStatic	0.1	0.0	14.5
	1b	LinStatic	-0.3	0.0	7.3
	2a	LinStatic	0.0	0.0	10.4
	2b	LinStatic	0.0	0.0	15.8
	3a	LinStatic	0.0	0.0	7.5
	3b	LinStatic	0.1	0.0	12.8
	2a_Train	LinStatic	0.0	0.0	19.0
	2b_Train	LinStatic	0.1	0.0	24.4
	3a_Train	LinStatic	0.1	0.0	16.0
	3b_Train	LinStatic	0.1	0.0	21.4
64	1a	LinStatic	0.2	0.0	13.4
	1b	LinStatic	-0.3	0.0	6.1
	2a	LinStatic	0.2	0.0	9.5
	2b	LinStatic	0.1	0.0	14.1
	3a	LinStatic	0.2	0.0	7.5
	3b	LinStatic	0.1	0.0	12.1
	2a_Train	LinStatic	0.2	0.0	16.2
	2b_Train	LinStatic	0.2	0.0	20.8
	3a_Train	LinStatic	0.3	0.0	14.2
	3b_Train	LinStatic	0.2	0.0	18.7
65	1a	LinStatic	0.2	0.0	14.4
	1b	LinStatic	-0.3	0.0	5.9
	2a	LinStatic	0.2	0.0	12.3
	2b	LinStatic	0.1	0.0	13.8
	3a	LinStatic	0.2	0.0	11.4
	3b	LinStatic	0.2	0.0	12.9
	2a_Train	LinStatic	0.2	0.0	18.6
	2b_Train	LinStatic	0.2	0.0	20.2
	3a_Train	LinStatic	0.3	0.0	17.8
	3b_Train	LinStatic	0.2	0.0	19.3

Max Pile reaction (K/ft) = 25.1

URS

Job: Mississippi River intro to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Oct-12 **Page:** of
Pile Reactions under 2 Rails **Checked By:** RBJ **Date:** 9/23/13 **Sheet:** of

Load Case	Pile No.	Vertical Reaction (kips)	Allowable Overstress	Reaction with O/S (kips)
1a	P1	14.20	16.67%	14.40
	P2	14.20	16.67%	14.50
	P3	13.30	16.67%	13.40
	P4	14.30	16.67%	14.60
	P5	14.50	16.67%	14.70
	P6	14.30	16.67%	14.60
	P7	14.50	16.67%	14.70
	P8	14.20	16.67%	14.50
	P9	13.30	16.67%	13.40
	P10	14.20	16.67%	14.40
1b	P1	6.60	16.67%	6.60
	P2	7.40	16.67%	7.40
	P3	6.50	16.67%	6.50
	P4	7.40	16.67%	7.40
	P5	7.60	16.67%	7.60
	P6	7.50	16.67%	7.50
	P7	7.60	16.67%	7.60
	P8	7.30	16.67%	7.30
	P9	6.10	16.67%	6.10
	P10	5.90	16.67%	5.90
2a	P1	12.10	0%	12.30
	P2	10.20	0%	10.40
	P3	9.40	0%	9.50
	P4	10.50	0%	10.70
	P5	10.70	0%	10.90
	P6	10.50	0%	10.70
	P7	10.70	0%	10.90
	P8	10.20	0%	10.40
	P9	9.40	0%	9.50
	P10	12.10	0%	12.30
2a_t	P1	16.70	0%	18.70
	P2	16.50	0%	19.00
	P3	14.30	0%	16.20
	P4	17.00	0%	19.60
	P5	17.30	0%	19.90
	P6	17.00	0%	19.60
	P7	17.30	0%	19.90
	P8	16.50	0%	19.00
	P9	14.30	0%	16.20
	P10	16.60	0%	18.60
2b	P1	13.70	0%	13.80
	P2	15.50	0%	15.80
	P3	14.00	0%	14.10
	P4	15.70	0%	15.90
	P5	15.80	0%	16.10
	P6	15.70	0%	15.90
	P7	15.80	0%	16.10
	P8	15.50	0%	15.80
	P9	14.00	0%	14.10
	P10	13.70	0%	13.80

URS

Job: Mississippi River intro to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Oct-12 **Page:** of
Pile Reactions under 2 Rails **Checked By:** RBJ **Date:** 7/23/13 **Sheet:** of

Load Case	Pile No.	Vertical Reaction (kips)	Allowable Overstress	Reaction with O/S (kips)
2b_t	P1	18.20	0%	20.20
	P2	21.90	0%	24.40
	P3	18.80	0%	20.80
	P4	22.30	0%	24.80
	P5	22.50	0%	25.10
	P6	22.30	0%	24.80
	P7	22.50	0%	25.10
	P8	21.90	0%	24.40
	P9	18.80	0%	20.80
	P10	18.20	0%	20.20
3a	P1	11.30	0%	11.40
	P2	7.20	0%	7.50
	P3	7.40	0%	7.50
	P4	7.40	0%	7.70
	P5	7.60	0%	7.90
	P6	7.40	0%	7.70
	P7	7.60	0%	7.90
	P8	7.20	0%	7.50
	P9	7.30	0%	7.50
	P10	11.20	0%	11.40
3a_t	P1	15.80	0%	17.80
	P2	13.60	0%	16.00
	P3	12.20	0%	14.20
	P4	14.00	0%	16.50
	P5	14.30	0%	16.90
	P6	14.00	0%	16.50
	P7	14.30	0%	16.90
	P8	13.60	0%	16.00
	P9	12.20	0%	14.20
	P10	15.80	0%	17.80
3b	P1	12.80	0%	13.00
	P2	12.60	0%	12.80
	P3	11.90	0%	12.10
	P4	12.60	0%	12.90
	P5	12.80	0%	13.00
	P6	12.60	0%	12.90
	P7	12.80	0%	13.00
	P8	12.60	0%	12.80
	P9	11.90	0%	12.10
	P10	12.80	0%	12.90
3b_t	P1	17.30	0%	19.30
	P2	18.90	0%	21.40
	P3	16.80	0%	18.80
	P4	19.20	0%	21.80
	P5	19.40	0%	22.00
	P6	19.20	0%	21.80
	P7	19.40	0%	22.00
	P8	18.90	0%	21.40
	P9	16.80	0%	18.70
	P10	17.30	0%	19.30

Maximum Reaction =	25.10 kip
Minimum Reaction =	5.90 kip

* Using a tributary width of 5 feet, a capacity of 125.5 kips is required. From Table 3 in the Geotechnical Report, the Ultimate Capacity of a 18" Square Pile at an 80 foot tip depth is 279 kips. This Ultimate Capacity is based on a pile butt elevation of +4.0 ft. The actual pile butt elevation is -9.75 ft. So the Ultimate Capacity must be reduced to account for this 13.75 foot difference in butt elevations. Using the axial capacity curve provided by the geotechnical report, the top 13.75 feet of pile accounts for approximately 24 kips worth of skin friction resistance. So the actual Ultimate Pile Capacity is 255 kips. Using a Factor of Safety of 2.0, the allowable pile capacity is 127.5 kips.

* The minimum pile reaction in all load cases is only +5.90 kips. **Tension connectors do not need to be installed.**

* Lateral reactions for all load cases are negligible.

TABLE 1

Canadian National Rail Road Crossing

Concrete Piles with butt elevation +4.0 ft. actual butt elevation = -9.75

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	105	120	135	150	181
60	147	170	195	218	265
70	173	199	230	258	316
80	211	243	279	312	380
		- 22.6	27.9	31.0	38.1
		220.4	255.6	281	341.9

α = 0.65

=> use 18" pile

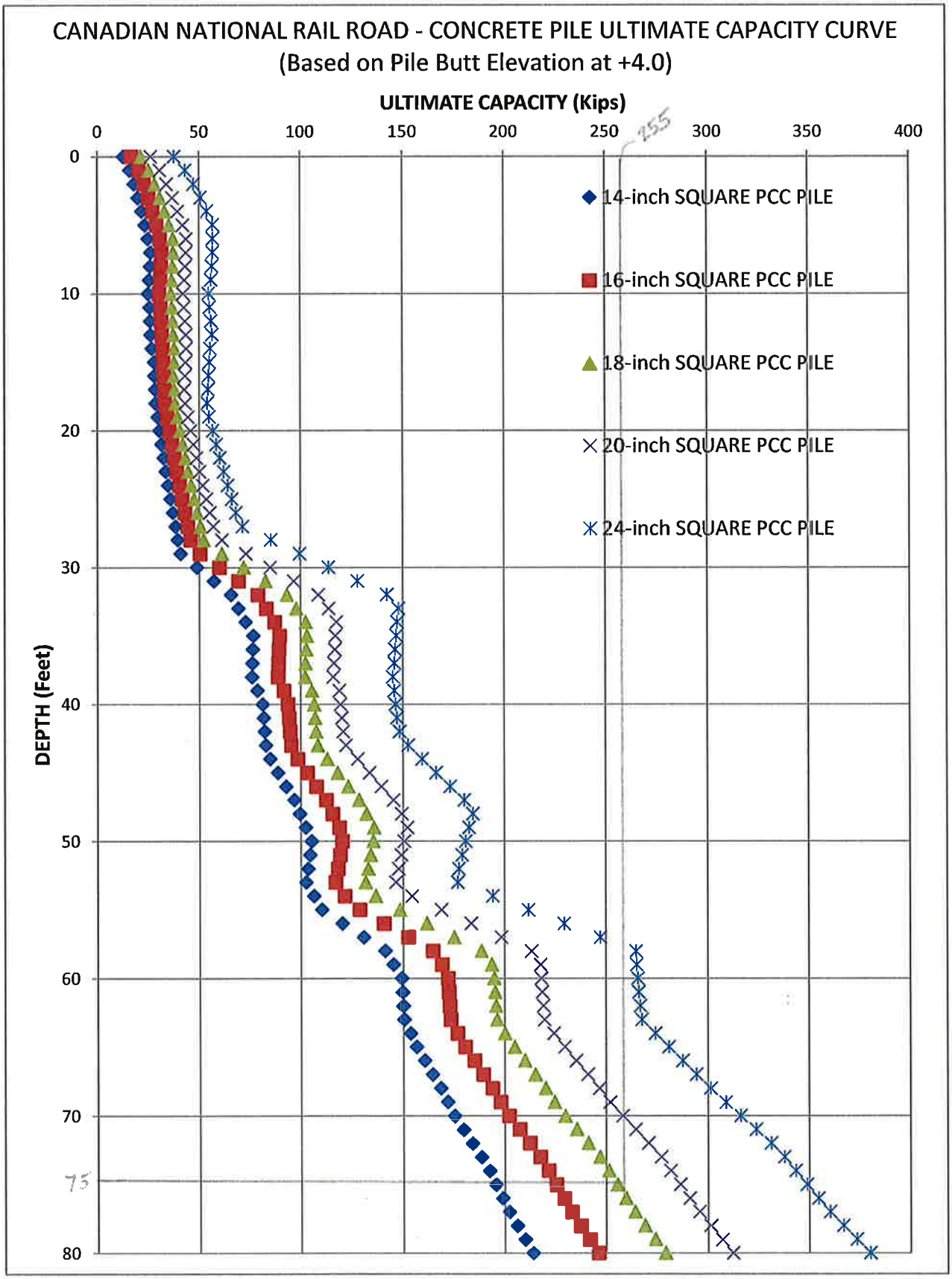
TABLE 2

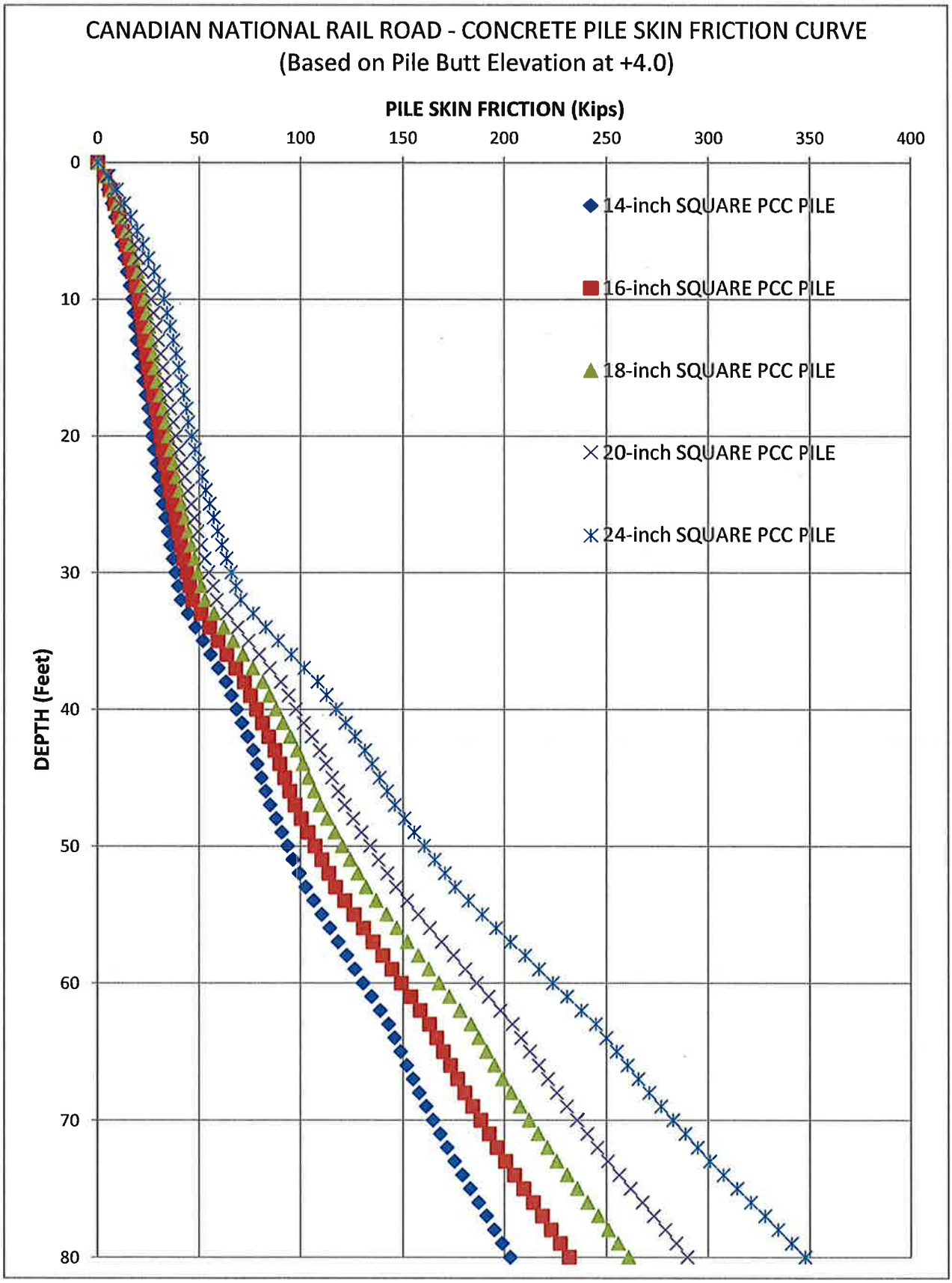
US HWY. 61

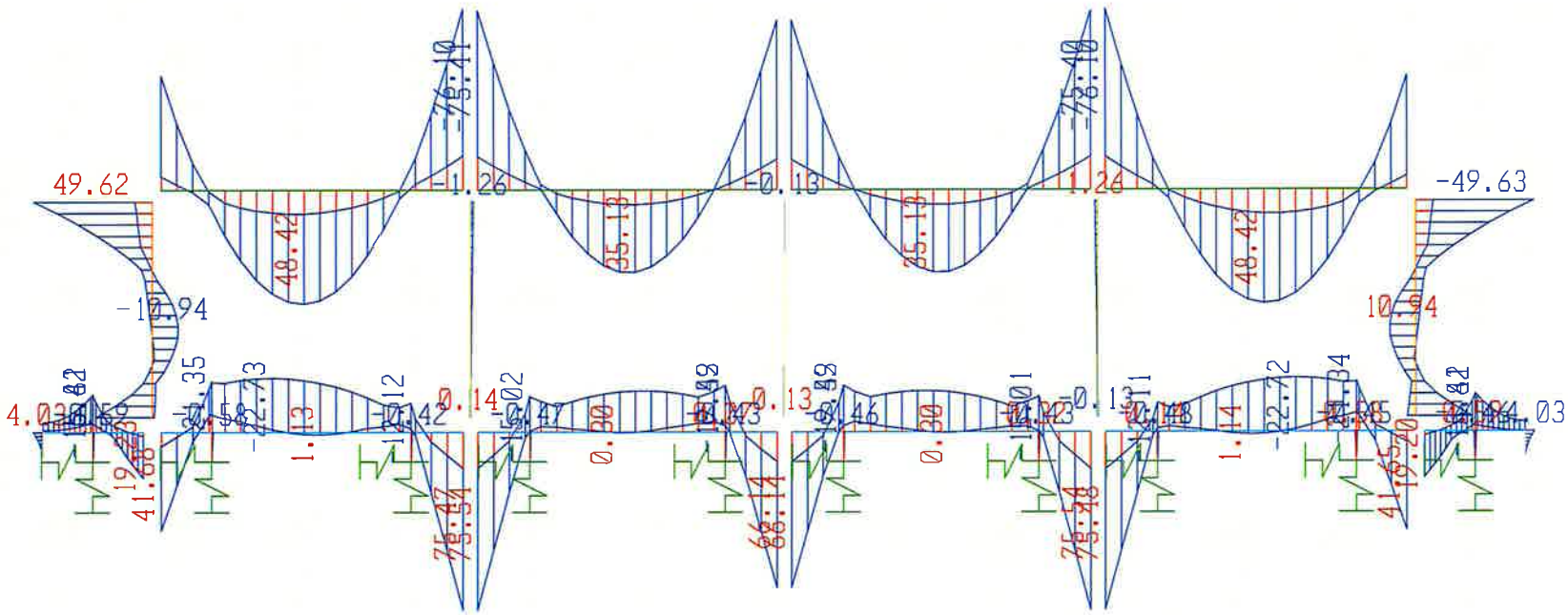
Concrete Piles with butt elevation +4.0 ft. actual butt elevation = -11.0

RECOMMENDED ULTIMATE SINGLE COMPRESSIVE CAPACITIES OF SQUARE PRECAST CONCRETE PILES (kips)					
Tip Depth (ft)	Pile Size (Inches)				
	14	16	18	20	24
50	96	113	131	149	188
60	146	171	198	224	279
70	197	226	257	287	347
80	227	261	299	334	407
		- 14.3	16.7	19.0	23.8
		244.7	282.3	315	383.2

=> use 18" pile

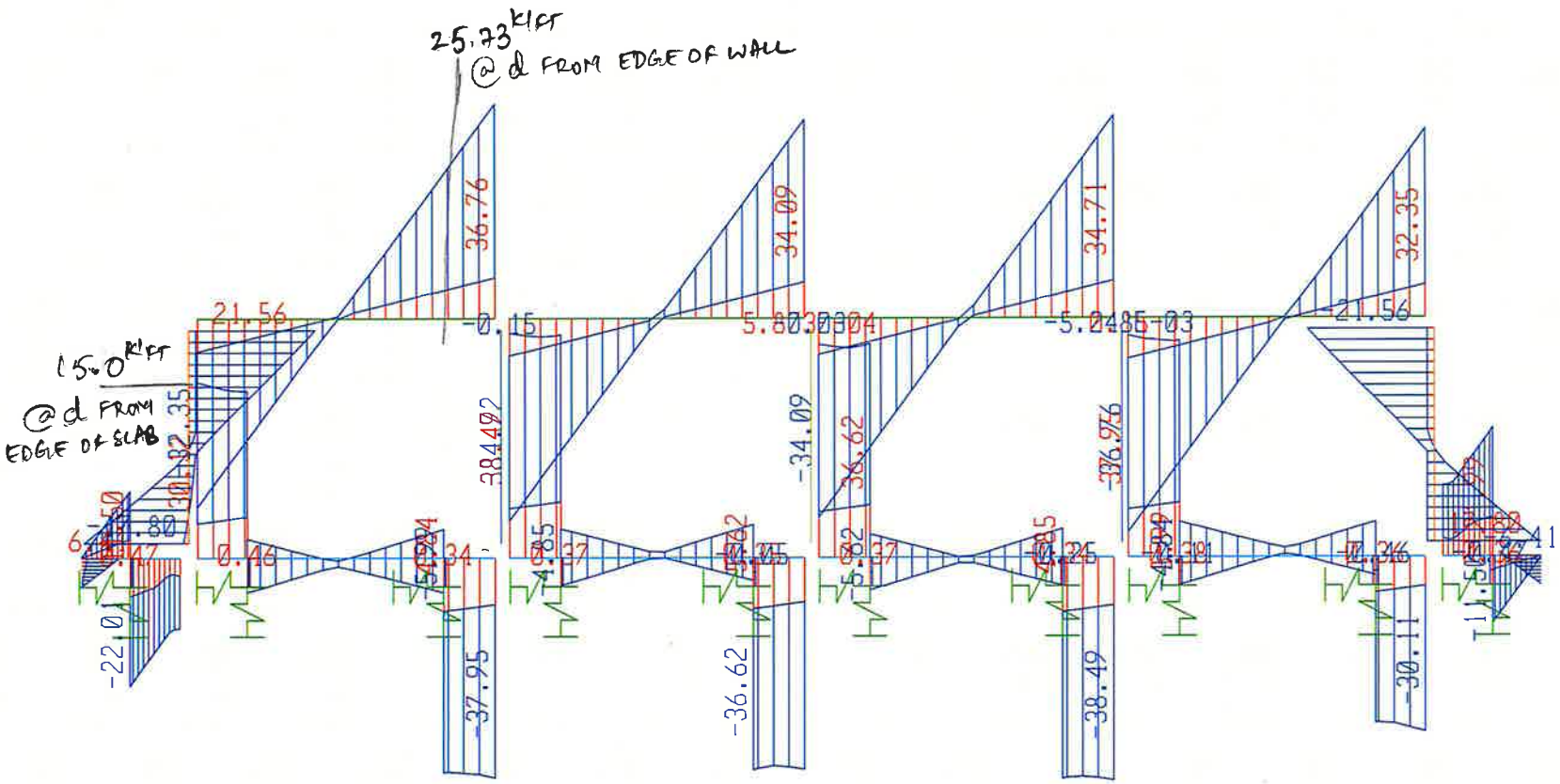

CANADIAN NATIONAL RAIL ROAD - CONCRETE PILE ULTIMATE CAPACITY CURVE
(Based on Pile Butt Elevation at +4.0)
ULTIMATE CAPACITY (Kips)
0
50
100
150
200
250
300
350
400
DEPTH (Feet)
0
10
20
30
40
50
60
70
80
14-inch SQUARE PCC PILE
16-inch SQUARE PCC PILE
18-inch SQUARE PCC PILE
20-inch SQUARE PCC PILE
24-inch SQUARE PCC PILE


CANADIAN NATIONAL RAIL ROAD - CONCRETE PILE SKIN FRICTION CURVE
(Based on Pile Butt Elevation at +4.0)
PILE SKIN FRICTION (Kips)
0
50
100
150
200
250
300
350
400
DEPTH (Feet)
0
10
20
30
40
50
60
70
80
14-inch SQUARE PCC PILE
16-inch SQUARE PCC PILE
18-inch SQUARE PCC PILE
20-inch SQUARE PCC PILE
24-inch SQUARE PCC PILE



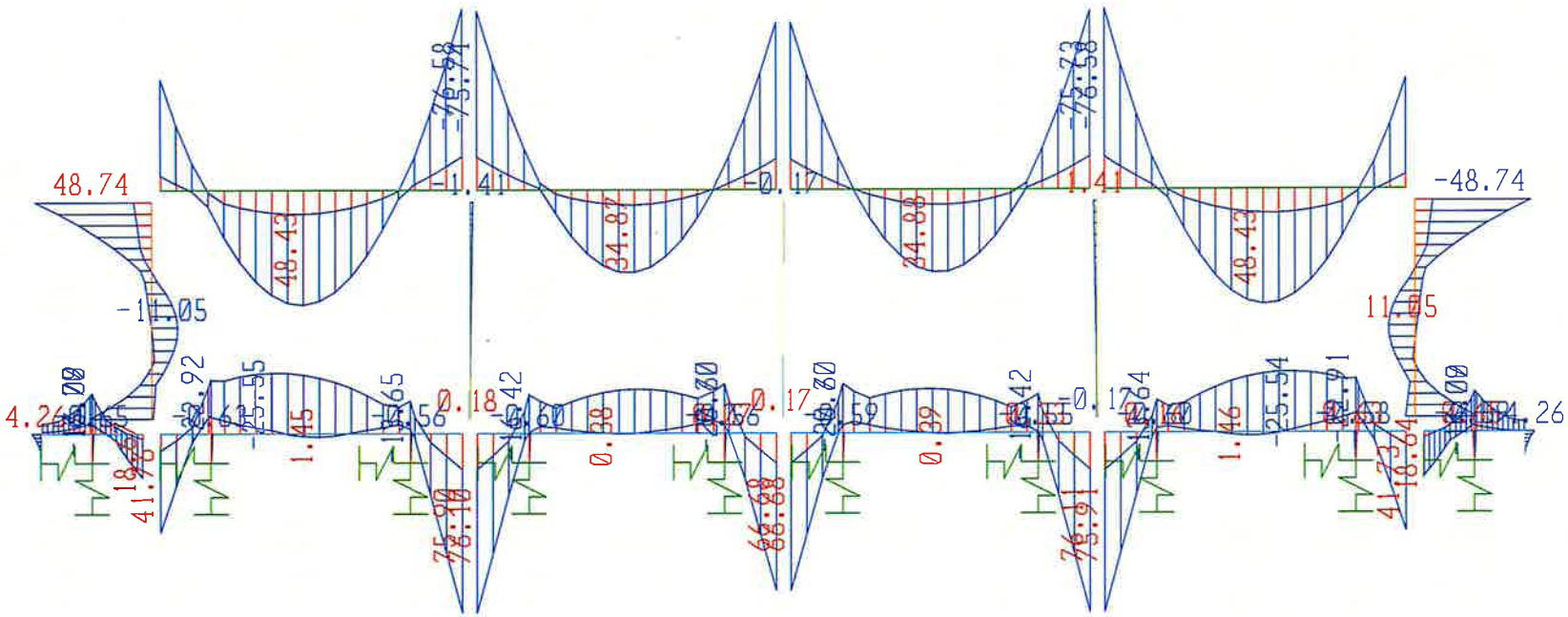
SAP2000 v14.2.4 - File:8x12 2pile 2'rfslab - Moment 3-3 Diagram (LFD I Comb) - Kip, ft, F Units

↳ 2 tracks



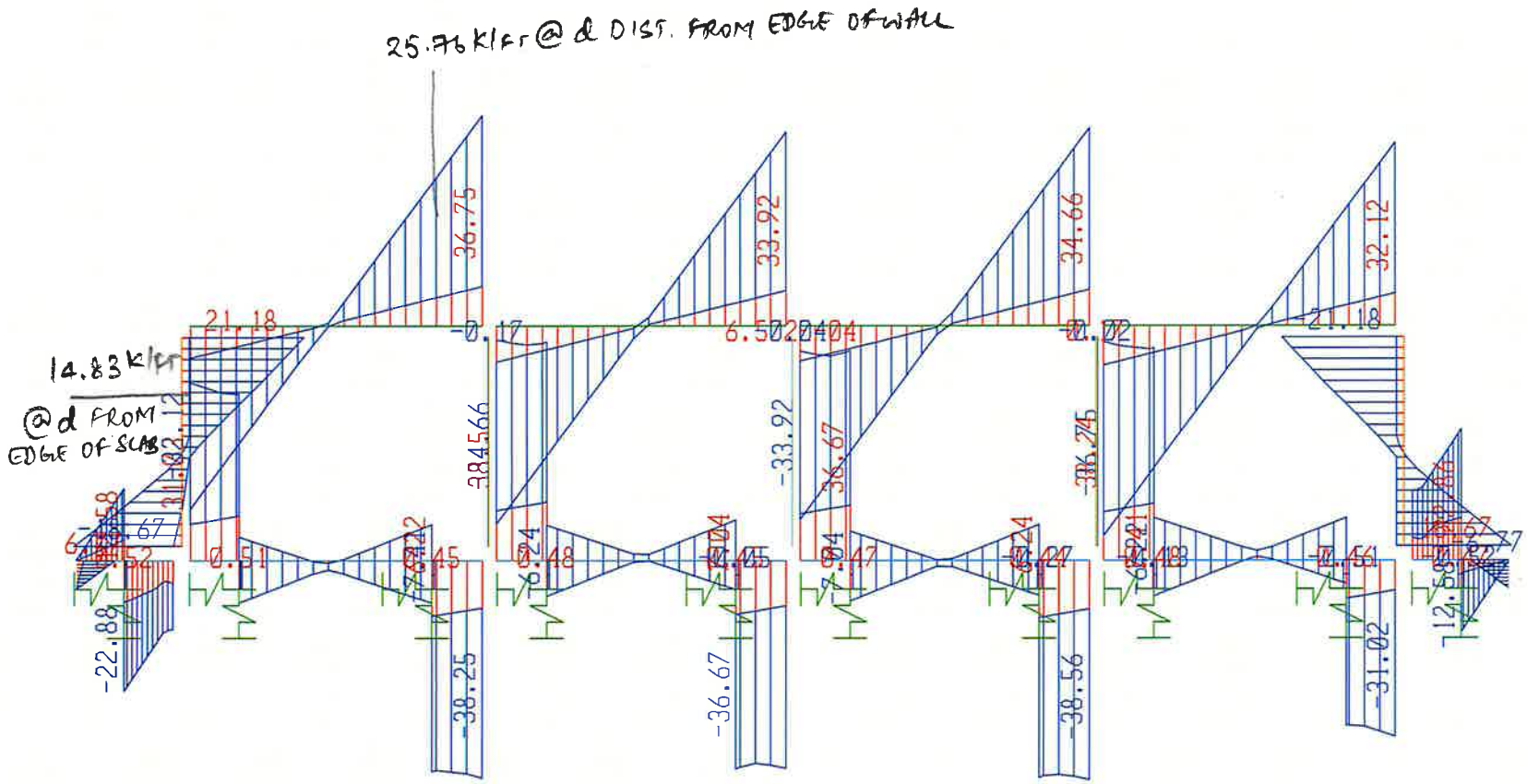
SAP2000 v14.2.4 - File:8x12 2pile 2'rfslab - Shear Force 2-2 Diagram (LFD I Comb) - Kip, ft, F Units

↳ 2 stacks



SAP2000 v14.2.4 - File:8x12 2pile 2'rfslab - Moment 3-3 Diagram (LFD IA Comb) - Kip, ft, F Units

↳ 2 tracks



SAP2000 v14.2.4 - File:8x12 2pile 2'rfslab - Shear Force 2-2 Diagram (LFD IA Comb) - Kip, ft, F Units

↳ 2 tracks

2.7

SAP Results (Levee)

TABLE: Joint Reactions					
Joint	OutputCase	CaseType	F1	F2	F3
Text	Text	Text	Kip	Kip	Kip
50	1a	LinStatic	-0.1	0.0	13.0
	1b	LinStatic	-0.4	0.0	8.0
	2a	LinStatic	-0.1	0.0	8.6
	2b	LinStatic	0.0	0.0	13.8
	3a	LinStatic	-0.2	0.0	5.6
	3b	LinStatic	-0.1	0.0	10.8
51	1a	LinStatic	-0.1	0.0	17.2
	1b	LinStatic	-0.4	0.0	11.0
	2a	LinStatic	-0.1	0.0	10.7
	2b	LinStatic	0.0	0.0	19.9
	3a	LinStatic	-0.1	0.0	4.8
	3b	LinStatic	-0.1	0.0	13.9
52	1a	LinStatic	0.0	0.0	17.2
	1b	LinStatic	-0.4	0.0	11.0
	2a	LinStatic	0.0	0.0	10.8
	2b	LinStatic	0.0	0.0	19.9
	3a	LinStatic	0.0	0.0	4.7
	3b	LinStatic	0.0	0.0	13.9
53	1a	LinStatic	0.1	0.0	17.2
	1b	LinStatic	-0.4	0.0	10.9
	2a	LinStatic	0.1	0.0	10.7
	2b	LinStatic	0.0	0.0	19.9
	3a	LinStatic	0.1	0.0	4.8
	3b	LinStatic	0.1	0.0	13.9
54	1a	LinStatic	0.1	0.0	13.0
	1b	LinStatic	-0.4	0.0	7.7
	2a	LinStatic	0.1	0.0	8.6
	2b	LinStatic	0.0	0.0	13.8
	3a	LinStatic	0.2	0.0	5.6
	3b	LinStatic	0.1	0.0	10.8

Max Pile Reaction (k/ft) = 19.9

URS

Job: Mississippi River intro to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Oct-12 **Page:** of
4 Barrel 8' x 12' Culvert Member Design **Checked By:** **Date:** **Sheet:** of

Load Case	Pile No.	Vertical Reaction (kips)	Allowable Overstress	Reaction with O/S (kips)
1a	P1	13.00	16.67%	11.14
	P2	17.20	16.67%	14.74
	P3	17.20	16.67%	14.74
	P4	17.20	16.67%	14.74
	P5	13.00	16.67%	11.14
1b	P1	8.00	16.67%	6.86
	P2	11.00	16.67%	9.43
	P3	11.00	16.67%	9.43
	P4	10.90	16.67%	9.34
	P5	7.70	16.67%	6.60
2a	P1	8.60	0%	8.60
	P2	10.70	0%	10.70
	P3	10.80	0%	10.80
	P4	10.70	0%	10.70
	P5	8.60	0%	8.60
2b	P1	13.80	0%	13.80
	P2	19.90	0%	19.90
	P3	19.90	0%	19.90
	P4	19.90	0%	19.90
	P5	13.80	0%	13.80
3a	P1	5.60	0%	5.60
	P2	4.80	0%	4.80
	P3	4.70	0%	4.70
	P4	4.80	0%	4.80
	P5	5.60	0%	5.60
3b	P1	10.80	0%	10.80
	P2	13.90	0%	13.90
	P3	13.90	0%	13.90
	P4	13.90	0%	13.90
	P5	10.80	0%	10.80

Maximum Reaction = 19.90 kip
Minimum Reaction = 4.70 kip

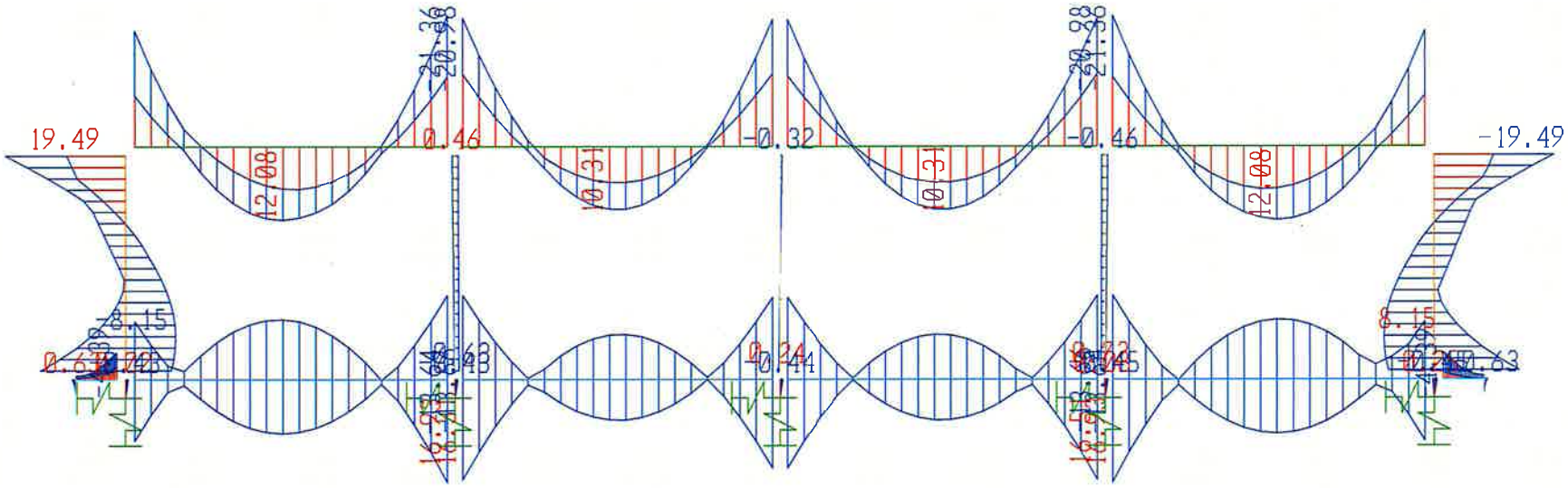
* All vertical reactions are on a per foot basis with respect to the pile spacing. Using a pile spacing of 5 feet, the maximum pile reaction will be 19.9 * 5 = **99.5 kips**.

* The minimum pile reaction in all load cases is +4.7 kips. Because no tension loads are encountered and the percentage of

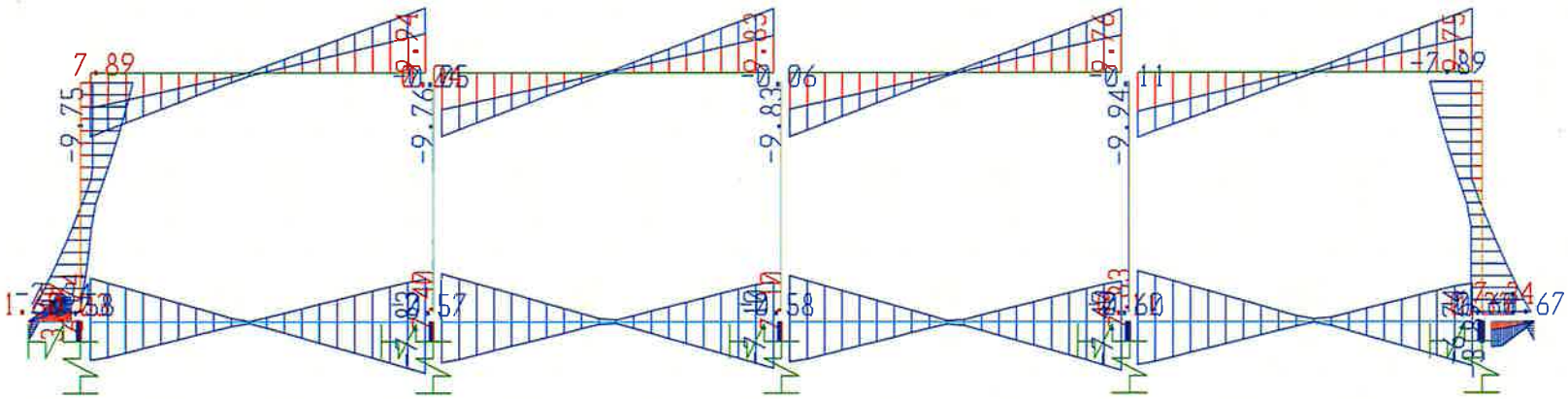
* Lateral reactions for all load cases are negligible.

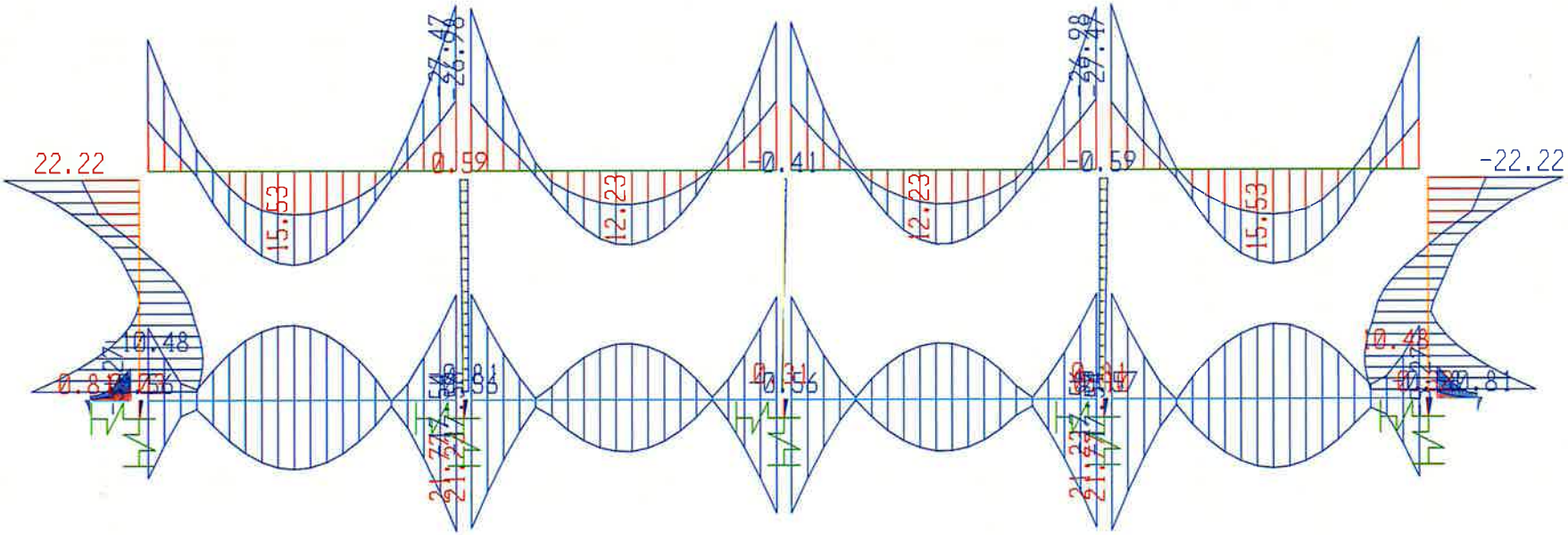
* DOES NOT CONTROL

Use same pile size and length as culvert under 2-Railroads, so there is not differential settlement.

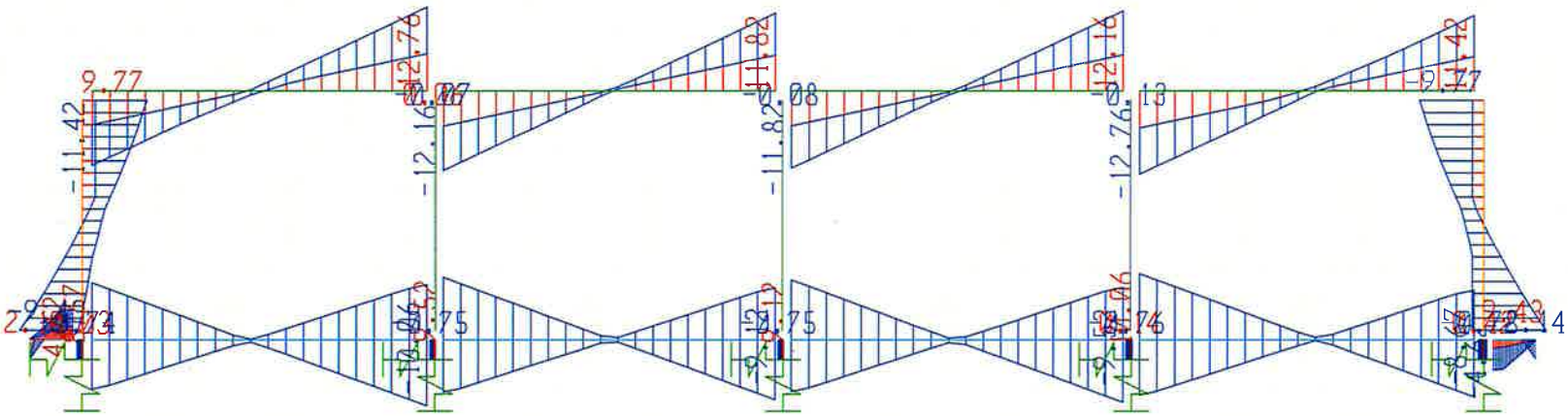


SAP2000 v14.2.4 - File:8x12 Levee - Moment 3-3 Diagram (LFD I Comb) - Kip, ft, F Units


7.89
-9.75
-9.76
-9.83
-9.97
-7.89
1.57
2.57
2.58
2.60
2.67



SAP2000 v14.2.4 - File:8x12 Levee - Moment 3-3 Diagram (LFD IA Comb) - Kip, ft, F Units



SAP2000 v14.2.4 - File:8x12 Levee - Shear Force 2-2 Diagram (LFD IA Comb) - Kip, ft, F Units

2.8

Member Designs

URS

Job:	Mississippi River intro to Maurepas Swamp	**Project #:**	10001801				
Description:	Canadian National Railroad Crossing	**Computed By:**	BCB	**Date:**	Oct-12	**Page:**	of
	Culvert Member Design under 2 Rails	**Checked By:**	RBJ	**Date:**	9/23/12	**Sheet:**	of

*** Given information:** Notes / References

Top Slab Thickness =	24	in	
Bottom Slab Thickness =	30	in	
Wall Thickness =	18	in	
Tributary Width =	5	ft	tributary width = pile spacing
f'_c =	4	ksi	
f_y =	60	ksi	
φ, shear =	0.85		AREMA 8-2.30.2
φ, moment =	0.90		AREMA 8-2.30.2
ρ_{bal} =	0.0285		For f'_c = 4000 psi & f_y = 60,000 psi
B1 =	0.85		AREMA 8-2.31.1f

*** TOP SLAB:**

Load Case	Max Shear* (kip)	Maximum Moment^ (kip-ft)	Minimum Moment^ (kip-ft)
LFD-1	25.73	48.42	-76.1
LFD-1A	25.76	48.43	-76.58

* Shear values taken at a distance 'd' = 20.56in from the face of each wall.
^ Moment values taken at faces of connections (where slab meets wall)

Max. Shear = 25.76 kip
Max. Moment = 48.43 kip-ft (controls bottom reinforcement)
Min. Moment = -76.58 kip-ft (controls top reinforcement)

For images, see sheets_____.

* Reinforcing Limits:

A_{gross} = 24in * 12in strip = 288 in^2
d = 24in - 3in cover - 1/2 bar diameter = 20.56 in — #6 bar assumed

Limit of Maximum Reinforcement = 0.25 * ρ_{bal} * A_{gross} = 2.052 in^2

Limits of Minimum Reinforcement: 0.004 x A_{gross} = 1.152 in^2 — AREMA 8-16.5.4 Longitudinal Min.
(3 * √(f'_c) * b * d) / f_y = 0.78 in^2 — ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 0.823 in^2 — ACI 318-02, 10.5, flexural member min.

24in Summary:			
	Max. Rebar =	**2.052 in^2**	- half each face
	Min. T&S Rebar =	**1.152 in^2**	- half each face
	Min. Flexure Rebar =	**0.823 in^2**	- per face

* Section Design:

Shear

Shear Capacity (φV_c) = φ * 2 * √(f'_c) * b * d — AREMA 8-2.35.2a
= 0.85 * 2 * √(4000) * 12in * 20.5625in
= 26,530 lbs

φVc = 26.5kip > Vu = 25.8kip → Section OK

Moment

* $T = A_s * f_y$ * $C = 0.85 * f'_c * a * b$
* Assuming Tension = Compression → $\varphi Mn = \varphi * T * (d - (a / 2)) = \varphi * As * fy * (d - (a / 2))$

* Minimum rebar area = 1.152 in^2
* Maximum overall moment = 76.58 kip-ft

* Will try **#6 @ 6"** to start: As, #6 @ 6" = 0.88 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.88in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 1.299 in

$\varphi Mn = 0.9 * 0.88in^2 * 60ksi * (20.56in - 1.3in / 2)$
= 950.10 kip-in/ft
= 79.17 kip-ft/ft

φMn = 79.2k-ft > Mu = 76.6k-ft → Use #6 @ 6" Each Face

*** WALLS:**

Load Case	Max Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
LFD-1	15	10.94	-49.63
LFD-1A	14.83	11.05	-48.74

* Shear values taken at a distance 'd' = 14.6in from the face of each wall.

Max. Shear = 15.00 kip
Max. Moment = 11.05 kip-ft (controls interior reinforcement)
Min. Moment = -49.63 kip-ft (controls exterior reinforcement)

For result images, see sheets 37-38.

* Reinforcing Limits:

A_{gross} = 18in * 12in strip = 216 in^2
d = 18in - 3in cover - 1/2 bar diameter = 14.6 in #6 bar assumed

Limit of Maximum Reinforcement = $0.25 * \rho_{bal} * A_{gross}$ = 1.539 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 0.605 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.553 in^2 ACI 318-02, 10.5, flexural member min.
$(200 * b * d) / f_y$ = 0.583 in^2 ACI 318-02, 10.5, flexural member min.

18in Summary:
Max. Rebar = 1.539 in^2 - half each face
Min. T&S Rebar = 0.605 in^2 - half each face
Min. Flexure Rebar = 0.583 in^2 - per face

* Section Design:

Shear

Shear Capacity $(\varphi V_c) = \varphi * 2 * \sqrt{f'_c} * b * d$ AREMA 8-2.35.2a
$= 0.85 * 2 * \sqrt{4000} * 12in * 14.5625in$
= 18,789 lbs

φVc = 18.8kip > Vu = 15kip → Section OK

Moment

* $T = A_s * f_y$ * $C = 0.85 * f'_c * a * b$
* Assuming Tension = Compression → $\varphi Mn = \varphi * T * (d - (a / 2)) = \varphi * As * fy * (d - (a / 2))$

* Minimum rebar area = 0.605 in^2
* Maximum overall moment = 49.63 kip-ft

* Exterior Reinforcement:

* Will try **#6 @ 6"** to start: As, #6 @ 6" = 0.88 in^2 Mu = 49.63 kip-ft
d = 14.436 in

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.88in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 1.299 in

$\varphi Mn = 0.9 * 0.88in^2 * 60ksi * (14.44in - 1.3in / 2)$
= 663.82 kip-in/ft
= 55.32 kip-ft/ft

φMn = 55.3k-ft > Mu = 49.6k-ft → Use #6 @ 6" Exterior Face

* Interior Reinforcement:

* Will try **#5 @ 12"** to start: As, #5 @ 12" = 0.31 in^2 Mu = 11.05 kip-ft
d = 14.563 in

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.31in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.451 in

$\varphi Mn = 0.9 * 0.31in^2 * 60ksi * (14.56in - 0.45in / 2)$
= 237.52 kip-in/ft
= 19.79 kip-ft/ft

φMn = 19.8k-ft > Mu = 11.1k-ft → Use #5 @ 12" Interior Face

*** BOTTOM SLAB:**

Load Case	Max Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
LFD-1	5.62	75.54	-22.73
LFD-1A	7.04	76.11	-25.55

* Shear values taken at a distance 'd' = 25.56in from the face of each wall or pile.

Max. Shear = 7.04 kip
Max. Moment = 76.11 kip-ft (controls bottom reinforcement)
Min. Moment = -25.55 kip-ft (controls top reinforcement)

For result images, see sheets _____.

* Reinforcing Limits:

A_{gross} = 30in * 12in strip = 360 in^2

d' = 4in cover + 1/2 bar diameter = 4.31 in #5 bar assumed

d = 30in - 4in cover - 1/2 bar diameter = 25.5625 in #7 bar assumed

Limit of Maximum Reinforcement = 0.25 * ρ_{bal} * A_{gross} = 2.565 in^2 26" section used; smallest section

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 1.008 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

(3 * $\sqrt{f'_c}$ * b * d) / f_y = 0.97 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 1.023 in^2 ACI 318-02, 10.5, flexural member min.

* Note: $d_{top\ bars}$ used to calculate minimum reinforcing area; produces higher minimum values

30in Summary:	**Max. Rebar =**	**2.565 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexure Rebar =	**1.023 in^2**	- per face

* Section Design:

Shear AREMA 8-2.35.2a

Shear Capacity (φV_c) = φ * 2 * $\sqrt{f'_c}$ * b * d
= 0.85 * 2 * $\sqrt{4000}$ * 12in * 25.5625in
= 32,981 lbs

φVc = 33kip > Vu = 7kip → Section OK

Moment

φMn = φ*[(As-A's) * fy * (d - (a / 2)) + A's * fy * (d - d')] AREMA 8-2.32.4a

T = A_s * f_y * C = 0.85 * f'_c * a * b

Assuming Tension = Compression →

φMn = φ * T * (d - (a / 2)) = φ * As * fy * (d - (a / 2)) AREMA 8-2.32.2a

* Minimum rebar area = 1.023 in^2
* Maximum overall moment = 76.11 kip-ft

* Top Reinforcing:

* Will try #5 @ 12" to start: A's, #5 @ 12" = 0.31 in^2

* Bottom Reinforcing:

* Will try #7 @ 6" to start: As, #7 @ 6" = 1.20 in^2

* Verify $\frac{(As - A's)}{b*d}$ >= $\frac{0.85 * B1 * f'c * d'}{fy * d}$ * (87000) / (87000 - fy)

Is 0.00292044 >= 0.0261835 No, use Equation from AREMA 8-2.32.2a.

AREMA 8-2.32.2a

* Top Reinforcing:

$d_{top\ bars}$ = 25.69 in Mu = 25.55 k-ft

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.31in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.451 in

$\varphi Mn = 0.9 * 0.31in^2 * 60ksi * (25.69in - 0.45in / 2)$
= 421.83 kip-in/ft
= 35.15 kip-ft/ft

φMn = 35.2k-ft > Mu = 25.6k-ft → Use #5 @ 12" Top Face

* Bottom Reinforcing:

$d_{bot\ bars}$ = 25.56 in Mu = 76.11 k-ft

$a = A'_s * f_y / (0.85 * f'_c * b) =$ $1.2in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 1.769 in

$\varphi Mn = 0.9 * 1.2in^2 * 60ksi * (25.56in - 1.77in / 2)$
= 1602.67 kip-in/ft
= 133.56 kip-ft/ft

φMn = 133.6k-ft > Mu = 76.1k-ft → Use #7 @ 6" Bot Face

URS

Job: Mississippi River intro to Maurepas Swamp | **Project #:** 10001801
Description: Canadian National Railroad Crossing | **Computed By:** BCB | **Date:** Oct-12 | **Page:** of
Culvert Member Design under Levee | **Checked By:** BBJ | **Date:** 9/23/13 | **Sheet:** of

*** Given information:** Notes / References

Top Slab Thickness =	18	in	
Bottom Slab Thickness =	18	in	
Wall Thickness =	18	in	
Tributary Width =	5	ft	tributary width = pile spacing
f'_c =	4	ksi	
f_y =	60	ksi	
φ, shear =	0.85		AREMA 8-2.30.2
φ, moment =	0.90		AREMA 8-2.30.2
ρ_{bal} =	0.0285		For f'_c = 4000 psi & f_y = 60,000 psi
B1 =	0.85		AREMA 8-2.31.1f

*** TOP SLAB:**

Load Case	Max Shear* (kip)	Maximum Moment^ (kip-ft)	Minimum Moment^ (kip-ft)
LFD-1	9.94	12.08	-21.36
LFD-1A	12.76	15.53	-27.47

^ Moment values taken at faces of connections (where slab meets wall)

Max. Shear = 12.76 kip
Max. Moment = 15.53 kip-ft (controls bottom reinforcement)
Min. Moment = -27.47 kip-ft (controls top reinforcement)

For images, see sheets _____.

* Reinforcing Limits:

A_{gross} = 18in * 12in strip = 216 in^2
d = 18in - 3in cover - 1/2 bar diameter = 14.56 in — #6 bar assumed

Limit of Maximum Reinforcement = 0.25 * ρ_{bal} * A_{gross} = 1.539 in^2

Limits of Minimum Reinforcement: 0.004 x A_{gross} = 0.864 in^2 — AREMA 8-16.5.4 Longitudinal Min.
(3 * √(f'_c) * b * d) / f_y = 0.553 in^2 — ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 0.583 in^2 — ACI 318-02, 10.5, flexural member min.

18in Summary:			
	Max. Rebar =	**1.539 in^2**	- half each face
	Min. T&S Rebar =	**0.864 in^2**	- half each face
	Min. Flexure Rebar =	**0.583 in^2**	- per face

* Section Design:

Shear

Shear Capacity (φV_c) = φ * 2 * √(f'_c) * b * d — AREMA 8-2.35.2a
= 0.85 * 2 * √(4000) * 12in * 14.5625in
= 18,789 lbs

φVc = 18.8kip > Vu = 12.8kip → Section OK

Moment

* $T = A_s * f_y$ * $C = 0.85 * f'_c * a * b$
* Assuming Tension = Compression → $\varphi Mn = \varphi * T * (d - (a / 2)) = \varphi * As * fy * (d - (a / 2))$

* Minimum rebar area = 0.864 in^2
* Maximum overall moment = 27.47 kip-ft

* Will try **#6 @ 12"** to start: As, #6 @ 12" = 0.44 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.44in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.650 in

$\varphi Mn = 0.9 * 0.44in^2 * 60ksi * (14.56in - 0.65in / 2)$
= 339.66 kip-in/ft
= 28.31 kip-ft/ft

φMn = 28.3k-ft > Mu = 27.5k-ft → Use #6 @ 12" Each Face

*** WALLS:**

Load Case	Max Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
LFD-1	7.89	8.15	-19.49
LFD-1A	9.77	10.48	-22.22

Max. Shear = 9.77 kip
Max. Moment = 10.48 kip-ft (controls interior reinforcement)
Min. Moment = -22.22 kip-ft (controls exterior reinforcement)

For result images, see sheets _____.

* Reinforcing Limits:

A_{gross} = 18in * 12in strip = 216 in^2
d = 18in - 3in cover - 1/2 bar diameter = 14.6 in #6 bar assumed

Limit of Maximum Reinforcement = $0.25 * \rho_{bal} * A_{gross}$ = 1.539 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 0.605 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.553 in^2 ACI 318-02, 10.5, flexural member min.
$(200 * b * d) / f_y$ = 0.583 in^2 ACI 318-02, 10.5, flexural member min.

18in Summary:	**Max. Rebar =**	**1.539 in^2**	- half each face
	Min. T&S Rebar =	**0.605 in^2**	- half each face
	Min. Flexure Rebar =	**0.583 in^2**	- per face

* Section Design:

Shear

Shear Capacity $(\varphi V_c) = \varphi * 2 * \sqrt{f'_c} * b * d$ AREMA 8-2.35.2a
$= 0.85 * 2 * \sqrt{4000} * 12in * 14.5625in$
= 18,789 lbs

φVc = 18.8kip > Vu = 9.8kip → Section OK

Moment

* $T = A_s * f_y$ * $C = 0.85 * f'_c * a * b$
* Assuming Tension = Compression → $\varphi Mn = \varphi * T * (d - (a / 2)) = \varphi * As * fy * (d - (a / 2))$

* Minimum rebar area = 0.605 in^2
* Maximum overall moment = 22.22 kip-ft

* Exterior Reinforcement:

* Will try **#6 @ 12"** to start: As, #6 @ 12" = 0.44 in^2 Mu = 22.22 kip-ft
d = 14.436 in

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.44in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.650 in

$\varphi Mn = 0.9 * 0.44in^2 * 60ksi * (14.44in - 0.65in / 2)$
= 339.66 kip-in/ft
= 28.31 kip-ft/ft

φMn = 28.3k-ft > Mu = 22.2k-ft → Use #6 @ 12" Exterior Face

* Interior Reinforcement:

* Will try **#5 @ 12"** to start: As, #5 @ 12" = 0.31 in^2 Mu = 10.48 kip-ft
d = 14.563 in

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.31in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.451 in

$\varphi Mn = 0.9 * 0.31in^2 * 60ksi * (14.56in - 0.45in / 2)$
= 237.52 kip-in/ft
= 19.79 kip-ft/ft

φMn = 19.8k-ft > Mu = 10.5k-ft → Use #5 @ 12" Interior Face

*** BOTTOM SLAB:**

Load Case	Max Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
LFD-1	7.81	16.93	-13.66
LFD-1A	10.06	21.77	-17.56

Max. Shear = 10.06 kip
Max. Moment = 21.77 kip-ft (controls bottom reinforcement)
Min. Moment = -17.56 kip-ft (controls top reinforcement)

For result images, see sheets _____.

URS

Job: Mississippi River intro to Maurepas Swamp **Project #:** 10001801
Description: Canadian National Railroad Crossing **Computed By:** BCB **Date:** Oct-12 **Page:** of
Culvert Member Design under Levee **Checked By:** RBJ **Date:** 9/23/13 **Sheet:** of

* Reinforcing Limits:

A_{gross} = 18in * 12in strip = 216 in^2

d' = 3in cover + 1/2 bar diameter = 3.31 in #5 bar assumed

d = 18in - 3in cover - 1/2 bar diameter = 14.625 in #6 bar assumed

Limit of Maximum Reinforcement = 0.25 * ρ_{bal} * A_{gross} = 1.539 in^2 26" section used; smallest section

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 0.605 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

(3 * √(f'c) * b * d) / f_y = 0.126 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 0.133 in^2 ACI 318-02, 10.5, flexural member min.

* Note: $d_{top\ bars}$ used to calculate minimum reinforcing area; produces higher minimum values

18in Summary:	**Max. Rebar =**	**1.539 in^2**	- half each face
	Min. T&S Rebar =	**0.605 in^2**	- half each face
	Min. Flexure Rebar =	**0.133 in^2**	- per face

* Section Design:

Shear AREMA 8-2.35.2a

Shear Capacity (φV_c) = φ * 2 * √(f'c) * b * d
= 0.85 * 2 * √(4000) * 12in * 14.625in
= 18,869 lbs

φVc = 18.9kip > Vu = 10.1kip → Section OK

Moment

φMn = φ*[(As-A's) * fy * (d - (a / 2)) + A's * fy * (d - d')] AREMA 8-2.32.4a

T = A_s * f_y * C = 0.85 * f'_c * a * b

Assuming Tension = Compression →

φMn = φ * T * (d - (a / 2)) = φ * As * fy * (d - (a / 2)) AREMA 8-2.32.2a

* Minimum rebar area = 0.605 in^2
* Maximum overall moment = 21.77 kip-ft

* Top Reinforcing:

* Will try #5 @ 12" to start: A's, #5 @ 12" = 0.31 in^2

* Bottom Reinforcing:

* Will try #6 @ 12" to start: As, #6 @ 12" = 0.44 in^2

* Verify $\frac{(As - A's)}{b*d}$ >= $\frac{0.85 * B1 * f'c * d'}{fy * d}$ * (87000) / (87000 - fy)

Is 0.00076918 >= 0.035153 No, use Equation from AREMA 8-2.32.2a.

AREMA 8-2.32.2a

* Top Reinforcing:

$d_{top\ bars}$ = 14.69 in Mu = 17.56 k-ft

$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.31in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.451 in

$\varphi Mn = 0.9 * 0.31in^2 * 60ksi * (14.69in - 0.45in / 2)$
= 239.59 kip-in/ft
= 19.97 kip-ft/ft

φMn = 20k-ft > Mu = 17.6k-ft → Use #5 @ 12" Top Face

* Bottom Reinforcing:

$d_{bot\ bars}$ = 14.63 in Mu = 21.77 k-ft

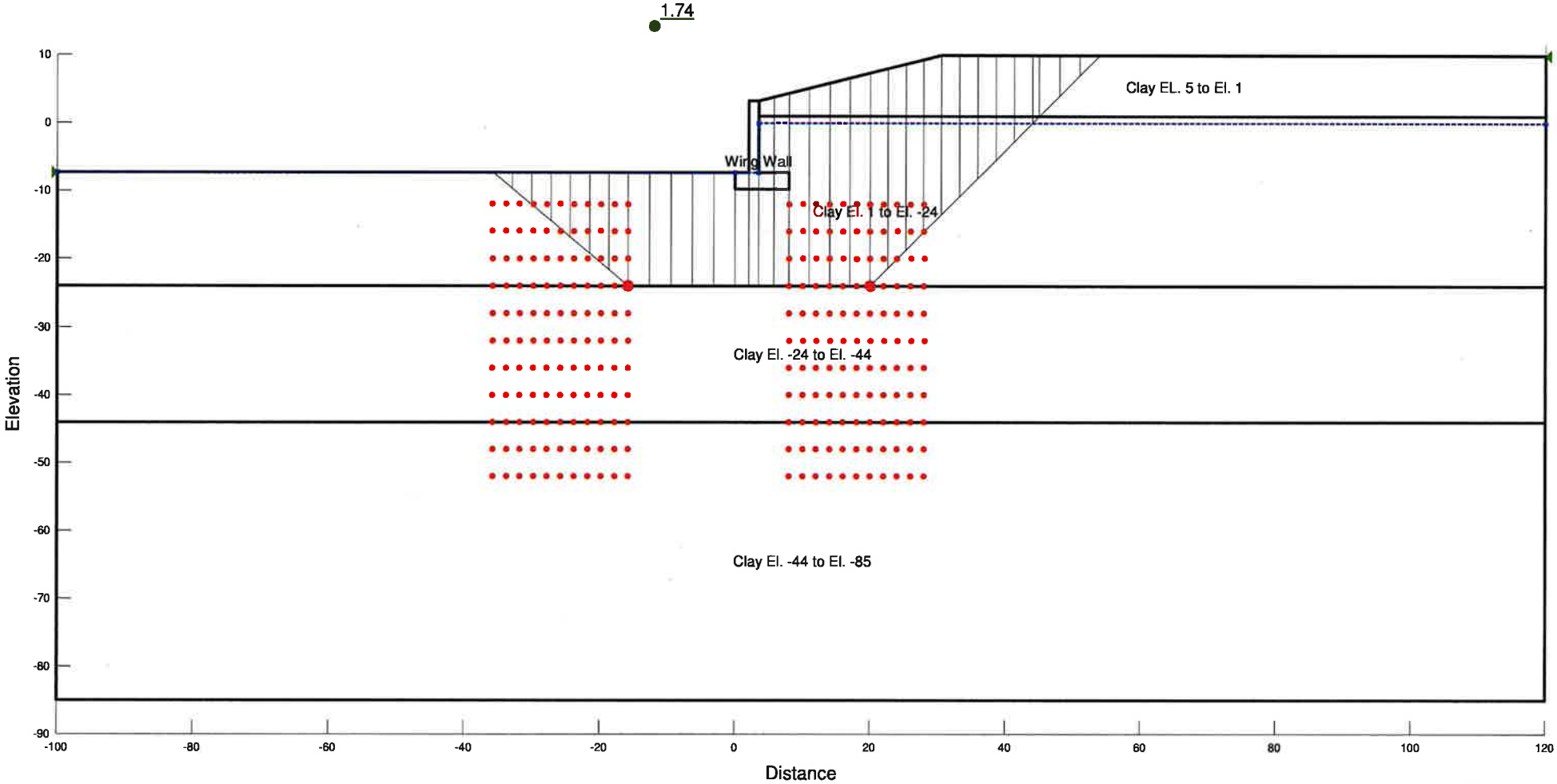
$a = A_s * f_y / (0.85 * f'_c * b) =$ $0.44in^2 * 60ksi / (0.85 * 4ksi * 12in) =$ 0.650 in

$\varphi Mn = 0.9 * 0.44in^2 * 60ksi * (14.63in - 0.65in / 2)$
= 341.15 kip-in/ft
= 28.43 kip-ft/ft

φMn = 28.4k-ft > Mu = 21.8k-ft → Use #6 @ 12" Bot Face

2.9

Wingwall Design



Method: Spencer

Name: Wing Wall Model: Mohr-Coulomb Unit Weight: 150 pcf Cohesion: 4000 psf Phi: 0 ° Piezometric Line: 1
Name: Clay EL. 5 to El. 1 Model: Mohr-Coulomb Unit Weight: 110 pcf Cohesion: 750 psf Phi: 0 ° Piezometric Line: 1
Name: Clay El. 1 to El. -24 Model: Mohr-Coulomb Unit Weight: 107 pcf Cohesion: 500 psf Phi: 0 ° Piezometric Line: 1
Name: Clay El. -24 to El. -44 Model: S=f(depth) Unit Weight: 115 pcf C-Top of Layer: 500 psf C-Rate of Change: 25 psf/ft Limiting C: 1000 psf Piezometric Line: 1
Name: Clay El. -44 to El. -85 Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 1000 psf Phi: 0 ° Piezometric Line: 1

URS GROUP
7389 Florida Boulevard
Suite 300
Baton Rouge, LA 70806

Directory: C:\Users\ananth_bukkapatnam\Desktop\Wing Wall Stability Analyses

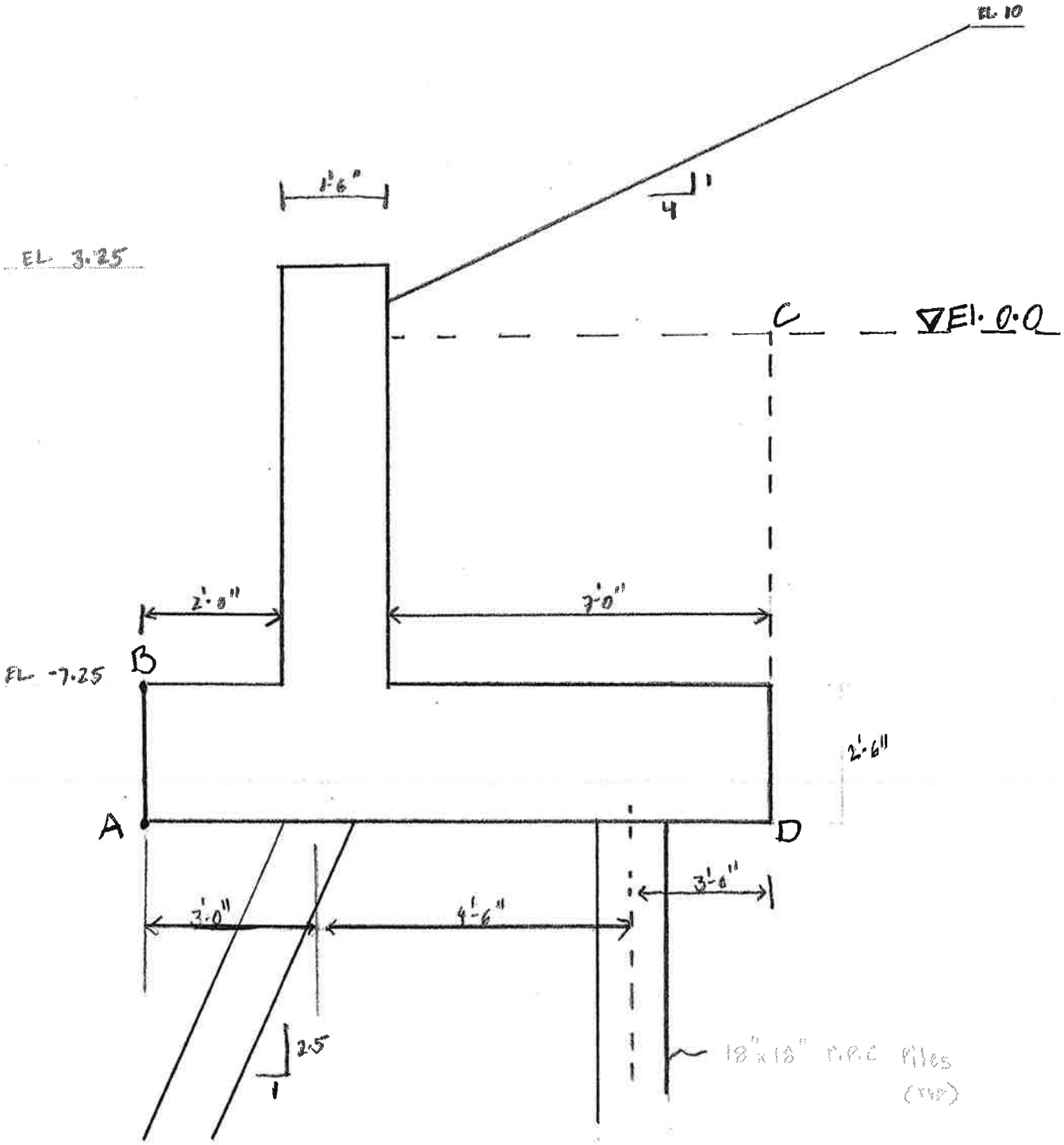
CN Rail Road Wing Wall
Stability Analysis
Block Failure

URS

Job: Lake Maurepas
Description: Heave Calculations
CNRR - Wing Walls

Project No. 10001903
Computed by: ANANTH
Checked by: MS

Page 1 of 6
Sheet ___ of ___
Date: 09-17-2013
Date: 09/18/2013
Reference



From Boring B-05 & CPT-04, Ground Water Table is approximately @ El. 0.0'

Assuming Point A :- El. -9.75

Unit Weight of Soil, γ_{sat} = 107 pcf

$$FOS_{Heave} = \frac{\gamma_{sat} * \text{Depth to Point A}}{\gamma_w * \text{Height of Water above Point A}}$$

$$FOS_{Heave} = \frac{107 * 2.5}{64 * 2.5}$$

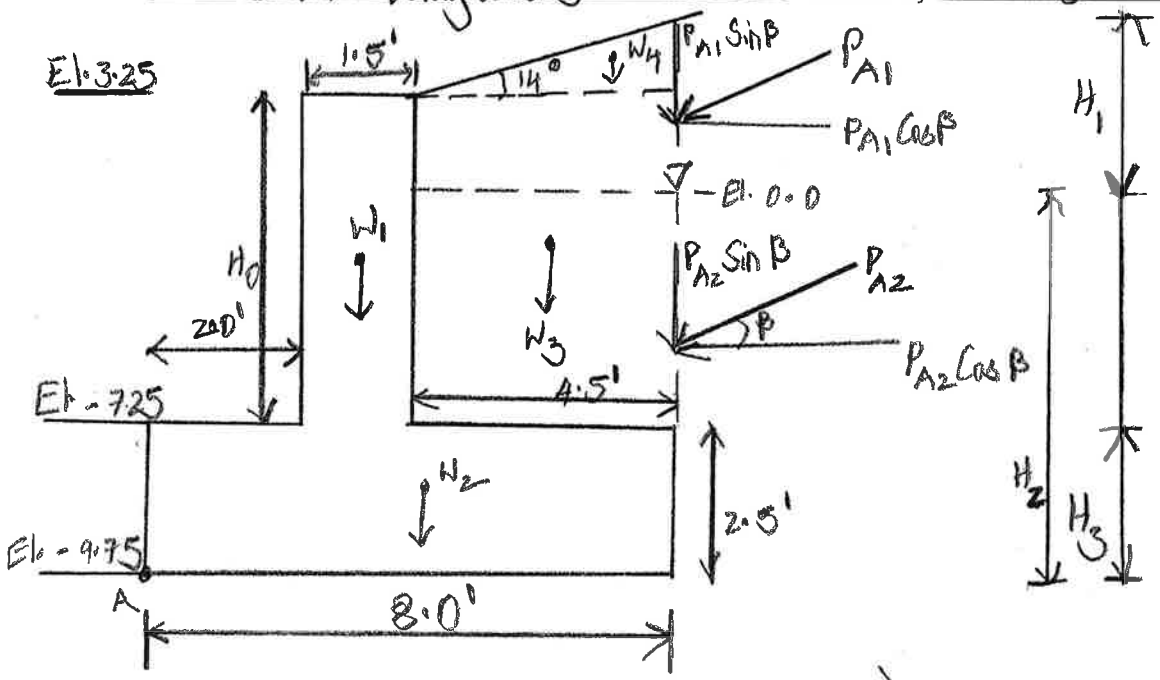
$$FOS_{Heave} = 1.67 > 1.20$$

Note :-

Please Refer EM 1110-2-1913 - Appendix B-5 - Section b - Case 2 a

URS

Job: Lake Mauvepas | Project No. 10001903 | Page 3 of 6
Description: Overturning Moment Calculations | Computed by: ANANTH | Sheet ___ of ___ | Date 9-18-2013
CNRR - Wingwalls | Checked by: MS | Date 09/19/13
Reference



$\gamma = 107$ pcf

$\phi = 0°$

$H = H_0 + 2.5 + 4.5\tan\beta$

$H = 14.12'$

$H_1 = 4.37'$ (Above GWT)

$H_2 = 9.75'$ (Below GWT)

$H_3 = 2.50'$ (Slab Thickness)

$$K_a = \cos\beta\left(\frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi'}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi'}}\right)$$

$\because \phi' = 0$, Assume $K_a = 1$

$$K_p = \frac{1}{K_a} = 1$$

Moments about Point A :-

$$P_{A1} = \frac{1}{2}K_a\gamma H_1^2 = \frac{1}{2} * 1 * 107 * (4.37)^2 = 1021.7 \frac{lb}{ft} @ 13.7'$$

$$P_{A2} = \frac{1}{2}K_a\gamma H_2^2 = \frac{1}{2} * 1 * 44.6 * (9.75)^2 = 2120 \frac{lb}{ft} @ 3.25'$$

$$P_p = \frac{1}{2}K_p\gamma H_3^2 = \frac{1}{2} * 1 * 44.6 * 2.5^2 = 139.4 \frac{lb}{ft} @ 0.83'$$

$$W_1 = 150 * 1.5 * 10.5 = 2362.5 \frac{lb}{ft} @ 2.75' \text{ from A}$$

$W_2 = 150 * 8 * 2.5 = 3000 \frac{lb}{ft}$ @ 4.0' from A

$W_3 = 107 * 4.5 * 10.5 = 5055.8 \frac{lb}{ft}$ @ 5.75' from A

$W_4 = \frac{1}{2} * 107 * 4.5 * 4.5 \tan\beta = 870 \frac{lb}{ft}$ @ 6.5' from A

$P_{A1} \sin\beta = 1081.7 * \sin 14 = 847.2 \frac{lb}{ft}$ @ 8.0' from A

$P_{A1} \cos\beta = 991.4$ lb/ft @ 13.7' from A

$P_{A2} \sin\beta = 513$ lb/ft @ 8.0' from A

$P_{A2} \cos\beta = 2057$ lb/ft @ 3.25' from A

$P_{Wa} = \frac{1}{2} K_a \gamma_w H_2^2 = \frac{1}{2} * 1 * 64 * 9.75^2$

$= 3042 \frac{lb}{ft}$ @ 3.25' from A

$P_p = 139.4 \frac{lb}{ft}$ @ 0.83' from A

$P_{WP} = \frac{1}{2} * K_p * \gamma_w * H_3^2 = 200 \frac{lb}{ft}$ @ 0.83' from A

Clockwise Moments :- (Resisting Moments)

$$M_{R_A} = (134.4 * 0.83) + (200 * 0.83) + 0 + (513 * 8) + (247.2 * 8) + (870 * 6.5) + (5058.8 * 5.95) + (3000 * 4) + (2362.5 * 2.75)$$

$$= 115.70 + 166 + 0 + 4104 + 1977.6 + 1755 + 29071 + 12000 + 6496.9$$

$$M_{R_A} = 55686 \ \frac{lb}{ft} - ft$$

Anti Clockwise Moments :- (Driving Moments)

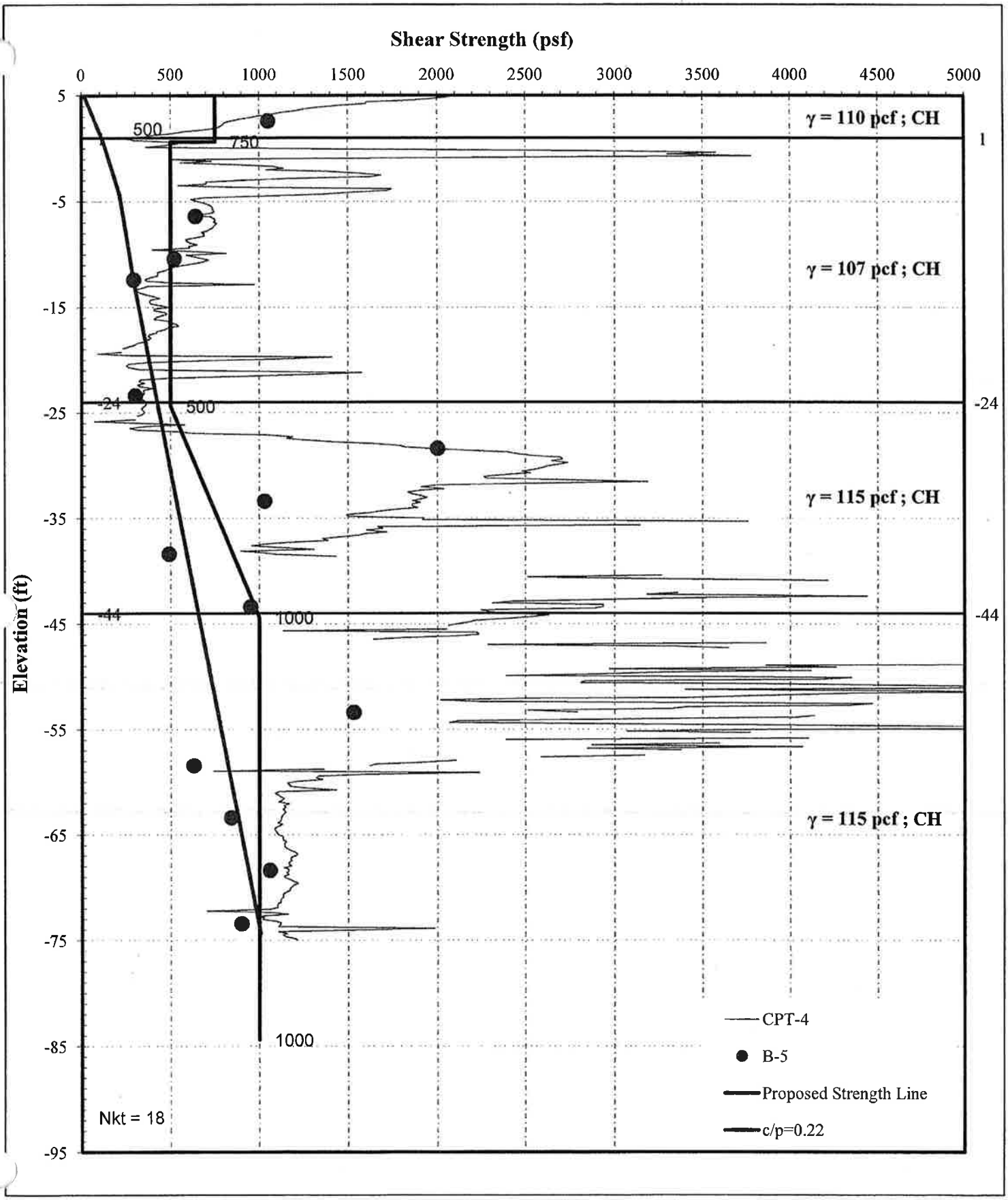
$$M_D = (3072.0 * 3.25) + (2057 * 3.25) + (991.4 * 13.7)$$

$$= 9886.5 + 6685.25 + 13852.18$$

$$M_D = 30153.9 \ \frac{lb}{ft} - ft$$

$$(FOS)_{Overturning} = \frac{M_R}{M_D} = \frac{55686}{30153.9} \approx 1.85$$

Shear Strength Plot - Canadian National Railroad



URS CORP.

SECTION 3

Kansas City Southern Railroad Crossing

URS

Page ____ of ____

Job Maurepas | Project No. 16001801 | Sheet ____ of ____

Description Kansas City Southern Pile Capacity | Computed by BCB | Date 9/13

Checked by RCK | Date 9/23/13

Reference

Kansas City Southern Railroad uses Union Pacific Bridge Standard Drawings.

- Sheet A2, "Maximum Pile Load" Table
  - 0" superelevation
  - 3-Pile Bent inside Pile Plum
  - Span = 20' => Note says use 28'

∴ End Bent = 72 tons = 144 kips

- Sheet A4, "Maximum Pile Load, Standard Bracing" Table
  - 0" Superelevation
  - 3-Pile Bent
  - Span = 20' use 28'

∴ Interior Bent = 105 tons = 210 kips

- using F.O.S = 3.0,

Ultimate Capacity minimum = 630 kips

∴ Use 24" Pile, conservatively 140' Long

PILE LAYOUT FOR END BENTS 8" BALLAST UNDER TIMBER TIES

BEAM DEPTH	END BENTS			
	℄ENDCAP	X	X2	Z
14"	4'-6¾"	5'-0"	4'-2"	1'-1¾"
16"	4'-8¾"	5'-8¾"	4'-2¾"	1'-2¼"
18"	4'-10¾"	5'-6¾"	4'-2¾"	1'-2¾"
28"	5'-8¾"	5'-4"	4'-2"	1'-3¼"
36"	5'-10¾"	5'-10¾"	4'-4¾"	1'-5¾"

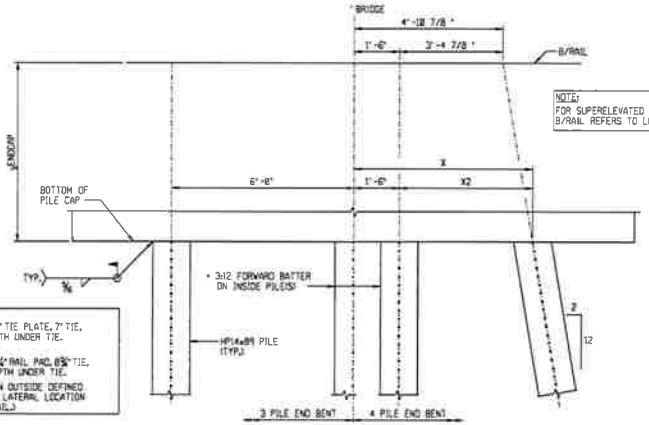
PILE LAYOUT FOR END BENTS 12" BALLAST UNDER CONCRETE TIES

BEAM DEPTH	END BENTS			
	℄ENDCAP	X	X2	Z
14"	4'-11¾"	5'-8¾"	4'-2¾"	1'-2"
16"	5'-1¾"	5'-10¾"	4'-3¾"	1'-3½"
18"	5'-3¾"	5'-10½"	4'-3½"	1'-4"
28"	5'-5¾"	5'-11¾"	4'-3¾"	1'-4½"
36"	6'-3¾"	5'-11½"	4'-5½"	1'-7"

MAXIMUM PILE LOAD

(FOR END BENTS - TONS)

EQUILIBRIUM SUPERELEVATION	3-PILE BENT INSIDE PILE PLUMB				3-PILE BENT 3x12 FORWARD BATTER ON INSIDE PILE				4-PILE BENT INSIDE PILES PLUMB				4-PILE BENT 3x12 FORWARD BATTER ON INSIDE PILES			
	SPAN L				SPAN L				SPAN L				SPAN L			
	34'	32'	30'	28'	34'	32'	30'	28'	34'	32'	30'	28'	34'	32'	30'	28'
0"	82	79	76	72	113	112	111	110	--	--	--	--	--	--	--	--
≤ 2"	89	86	82	79	113	112	111	110	--	--	--	--	--	--	--	--
≤ 3"	92	89	85	81	113	112	111	110	--	--	--	--	--	--	--	--
≤ 4"	--	--	--	--	--	--	--	--	75	72	69	67	102	95	90	86
≤ 7"	--	--	--	--	--	--	--	--	85	82	78	75	109	104	99	94



TIMBER TIES:
℄CAP IS BASED ON 1" TIE PLATE, 7" TIE, AND 8" BALLAST DEPTH UNDER TIE.

CONCRETE TIES:
℄CAP IS BASED ON ½" RAIL PAD, 8¾" TIE, AND 12" BALLAST DEPTH UNDER TIE.

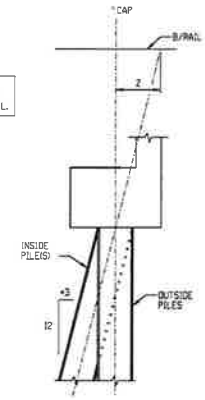
(FOR ℄CAP DIMENSION OUTSIDE DEFINED RANGE, ADJUST PILE LATERAL LOCATION DIMENSIONS AT B/RAIL.)

* NOTE:
FORWARD BATTER ON INSIDE PILE(S) NOT REQUIRED FOR BRIDGES COMPOSED ENTIRELY OF CONCRETE BEAM SPANS.

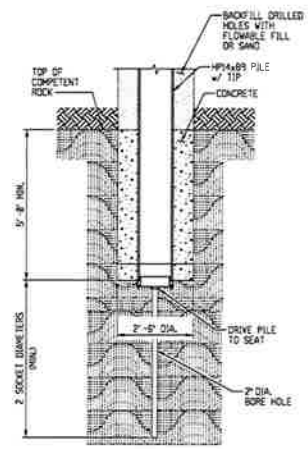
ELEVATION

END BENT PILE LAYOUT

SCALE: ½"=1'-0"



SIDE VIEW



PILE SOCKET DETAIL

SCALE: ½"=1'-0"

EST. VOLUME OF CONCRETE = 0.9 CU.YD. PER 5' SOCKET DEPTH

PILE SOCKET NOTES:

1. SEE BENT DESIGN NOTES TO DETERMINE WHEN PILE SOCKETING IS REQUIRED.
2. PILING SHALL BE SEATED IN PREDRILLED HOLES IN THE ROCK AND ENCASED IN CONCRETE WITHIN THE BEDROCK (SEE DETAIL).
3. MINIMUM DEPTH OF PILE SOCKET SHALL BE 5'-0" INTO ROCK.
4. PILING WITH TIP REINFORCEMENT SHALL BE PLACED INTO ROCK SOCKET AND DRIVEN TO ACHIEVE REQUIRED CAPACITY.
5. SEATED PILE SHALL BE ENCASED IN ROCK SOCKET WITH CONCRETE.
6. MINIMUM COMPRESSIVE STRENGTH OF CONCRETE SHALL BE 4000 LB. PER SQUARE INCH AT 28 DAYS.
7. BORE 2" DIA. HOLE IN CENTER OF PILE SEAT TO A MINIMUM DEPTH OF 2 SOCKET DIAMETERS.

GENERAL NOTES:

Longitudinal bracing between bents required in selected bays on bridges longer than 200 ft. See Sheets A6 & A7.

Pile capacities:
For required driven pile capacities, see "Maximum Pile Load" table.

Steel:
Piles - ASTM A588
Pile splices - ASTM A572 Gr. 50 or A588
Bracing - ASTM A588

Shop paint:
None

Welding:
Use shielded metal arc welding (SMAW) or flux core arc welding (FCAW) process per AWS D1.5. Acceptable filler metal is E7018 electrode for SMAW and E70T-1 or E70T-5 electrode for FCAW. For other acceptable electrodes, refer to AWS D1.5.

Splices:
Splices shall be made a sufficient distance above the ground or water that less than one foot so that the splice can be observed during driving. The number of splices shall be kept to a minimum. Splicing cut-offs or short pieces to make a mean bearing pile is not permitted. The pile shall be driven so that the upper splice is at least 18 feet below the ground surface.

Tip reinforcement:
Pile tip reinforcement shall be used where piles may be damaged by driving through heavy gravel, cobbles, boulders or formations known to contain obstructions. Tip reinforcement shall also be used when the pile will bear on rock.

Driving tolerances:
Variations greater than ¼inch per foot from vertical or batter line shall not be allowed. The deviation of the top of piles in a bent shall not exceed one inch from the plan location. Rotation of pile about its centerline shall not exceed 5 degrees from its orientation as shown in plans. Piles not meeting tolerance requirements or out of line as to impair usefulness, or piles that are damaged in driving as to impair structural capacity, shall be pulled and redriven or an additional pile shall be driven to provide added support. If any numbered pile cannot be driven to their capacity, notify the Structures Design Group, Office of AVP Engineering Design.

BENT DESIGN NOTES:

Selection of pile configuration and maximum heights based on equilibrium superelevation (regardless of actual superelevation installed). Refer to UPRR Track Standards Book, Std. Dwg. 0820 latest revision.

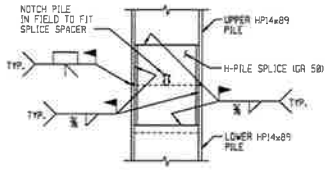
Preferred pile configuration is with 2:12 transverse pile batter on interior bents and all plumb pile for end bents.

Standard design is valid for minimum pile penetration of 10' if geotechnical investigation demonstrates that piles can be firmly seated in hard rock or shales otherwise minimum pile penetration of 25' required. If these values cannot be achieved, piles shall be socketed into rock per detail on this sheet. For any other conditions, special design is required.

For span lengths less than 28', use values shown for 28' spans.

Bent shall be driven per requirements of longer span length supported. For example, for a bent supporting 28' and 34' spans, drive per 34' span requirements.

Maximum track offset (from bridge centerline) is 6' with this bent standard.



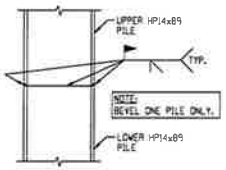
INSTALLATION INSTRUCTIONS:

(NOTE: SPLICE IS SHOWN INSTALLED ON UPPER PILE SECTION FIRST. ALTERNATIVELY, SPLICE MAY BE INSTALLED ON BOTTOM SECTION FIRST.)

1. NOTCH THE END OF H-PILE SECTION TO RECEIVE SPLICE FIRST (NOTCH TO ACCOMMODATE THE SPLICE SPACER BAR).
2. FIT SPLICE OVER NOTCHED END OF H-PILE AND FILLET WELD SPLICE END TO PILE WEB AS SHOWN.
3. PLACE THE UPPER H-PILE SECTION INTO POSITION ONTO THE LOWER SECTION.
4. COMPLETE FILLET WELD ALONG SPLICE EDGES.
5. WELD FLANGE JOINT BETWEEN UPPER AND LOWER PILE SECTIONS.

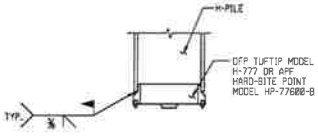
PILE SPLICE DETAIL

SCALE: 1"=1'-0"



ALTERNATE PILE SPLICE DETAIL

SCALE: 1"=1'-0"



TIP REINFORCEMENT INSTALLATION INSTRUCTIONS:

1. FIT POINT ONTO SQUARE CUT PILE.
2. WELD POINT TO THE PILE IN EITHER FLAT OR VERTICAL POSITION.
3. FILL THE AREA ACROSS BOTH FLANGES WITH WELD.

PILE TIP DETAIL

SCALE: 1"=1'-0"

REVISIONS		
DATE	LTR.	DESCRIPTION
9/07	A	REVISED SOCKET NOTES & GEN. UPDATE
/		
/		
/		
/		
/		

DESIGN BY: UPRR | DRAWN BY: UPRR | CHECKED BY: NDR

APPROVED:

George J. Meyn 4-17-2007

UPRR - MGR SPECIAL PROJECTS STRUCTURES DESIGN

UNION PACIFIC

BRIDGE STANDARDS

CONCRETE BEAM BRIDGES
H-PILE END BENT LAYOUT
END BENT LAYOUT AND PILE LOADS
PILE INSTALLATION DETAILS AND NOTES
BENT DESIGN AND GENERAL NOTES
(SHEET 1 OF 4)

FILE OWNER: UPRR | DATE:

PLAN NO.: S30000 | SHEET: A2

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INTERIOR BENT SELECTION TABLES

MAXIMUM BENT HEIGHT H FOR BENTS WITH C8x11.5 STANDARD BRACING

EQUILIBRIUM SUPERELEVATION	3-PILE BENT				4-PILE BENT			
	TRANSVERSE PILE BATTER B1:12				TRANSVERSE PILE BATTER B1:12			
	2:12	1:12	1/2:12	0:12	2:12	1:12	1/2:12	0:12
0"	17' ●	29'	18'	15'	39'	39'	39'	33'
≤2"	17'	12'	--	--	39'	39'	17'	15'
≤3"	15'	--	--	--	39'	27'	12'	--
≤4"	--	--	--	--	39'	12'	--	--
≤7"	--	--	--	--	--	--	--	--

●NOTE: FOR 28' MAXIMUM SPAN, MAXIMUM BENT HEIGHT MAY BE INCREASED TO 39'.

MAXIMUM PILE LOAD FOR BENTS WITH C8x11.5 STANDARD BRACING (TONS)

EQUILIBRIUM SUPERELEVATION	3-PILE BENT				4-PILE BENT			
	MAXIMUM SPAN L				MAXIMUM SPAN L			
	34'	32'	30'	28'	34'	32'	30'	28'
0"	123	117	111	105	95	90	85	81
≤2"	127	120	114	109	105	100	95	90
≤3"	132	125	119	113	108	103	98	93
≤4"	--	--	--	--	113	107	102	97
≤7"	--	--	--	--	--	--	--	--

MAXIMUM BENT HEIGHT H FOR BENTS WITH C10x15.3 HEAVY BRACING

EQUILIBRIUM SUPERELEVATION	3-PILE BENT				4-PILE BENT			
	TRANSVERSE PILE BATTER B1:12				TRANSVERSE PILE BATTER B1:12			
	2:12	1:12	1/2:12	0:12	2:12	1:12	1/2:12	0:12
0"	39'	39'	30'	18'	39'	39'	39'	39'
≤2"	39'	18'	--	--	39'	39'	37'	17'
≤3"	39'	--	--	--	39'	39'	17'	--
≤4"	--	--	--	--	39'	28'	--	--
≤7"	--	--	--	--	39'	--	--	--

MAXIMUM PILE LOAD FOR BENTS WITH C10x15.3 HEAVY BRACING (TONS)

EQUILIBRIUM SUPERELEVATION	3-PILE BENT				4-PILE BENT			
	MAXIMUM SPAN L				MAXIMUM SPAN L			
	34'	32'	30'	28'	34'	32'	30'	28'
0"	122	116	110	105	99	94	89	84
≤2"	129	123	117	111	111	105	101	96
≤3"	137	130	124	117	113	107	102	97
≤4"	--	--	--	--	115	109	105	99
≤7"	--	--	--	--	132	125	119	113

H = Vertical Distance from B/Rail to Ground Line

L = Horizontal Distance Centerline to Centerline of Bents

B1 = Horizontal Component of Pile Batter Transverse to Centerline Bridge, Outside Piles

NOTES:
PREFERRED PILE CONFIGURATION IS WITH 2:12 TRANSVERSE PILE BATTER ON INTERIOR BENTS.

FOR SPAN LENGTHS LESS THAN 28', USE VALUES SHOWN FOR 28' SPANS.

STANDARD INTERIOR BENTS 2:12 BATTER

PILE LAYOUT 8" BALLAST UNDER TIMBER TIES

BEAM DEPTH	INTERIOR BENTS, B1:12 = 2:12							
	℄CAP	℄S1	P	P1	P2	X	X1	X2
14"	5'-2⅝"	2'-4¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-8⅝"	4'-2⅝"
16"	5'-4⅝"	2'-7½"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-8⅝"	4'-1"
18"	5'-6⅝"	2'-9¾"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10"	1'-8⅝"	4'-1½"
20"	5'-8⅝"	2'-3¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-8⅝"	4'-1½"
30"	6'-6⅝"	1'-5¼"	4'-10⅝"	1'-6"	3'-4⅝"	6'-0"	1'-9½"	4'-2⅝"

PILE LAYOUT 12" BALLAST UNDER CONCRETE TIES

BEAM DEPTH	INTERIOR BENTS, B1:12 = 2:12							
	℄CAP	℄S1	P	P1	P2	X	X1	X2
14"	5'-7⅝"	2'-4¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-8⅝"	4'-1⅝"
16"	5'-9⅝"	2'-2¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-8⅝"	4'-1⅝"
18"	5'-11⅝"	2'-8¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-10⅝"	1'-9"	4'-1⅝"
20"	6'-1⅝"	1'-10¼"	4'-10⅝"	1'-6"	3'-4⅝"	5'-11⅝"	1'-9"	4'-2⅝"
30"	6'-11⅝"	1'-8¼"	4'-10⅝"	1'-6"	3'-4⅝"	6'-8⅝"	1'-9½"	4'-3⅝"

BRACING FOR SLAB & BOX BEAM SPANS B1:12 = 2:12

	H	℄G	G	HS	STORY HEIGHT			BRACE MEMBER LENGTH					
					y1	y2	y3	S1	C1	S2	C2	S3	C3
	43'-8"--> NO BRACING REQUIRED				--	--	--	--	--	--	--	--	--
1 STORY	11'-0"	4'-0"	2'-0"	4'-0"	2'-0"	--	--	13'-2"	--	--	--	--	--
	12'-0"	5'-0"	2'-0"	5'-0"	3'-0"	--	--	13'-2"	13'-0"	--	--	--	--
	13'-0"	6'-0"	2'-0"	6'-0"	4'-0"	--	--	13'-5"	14'-0"	--	--	--	--
	14'-0"	7'-0"	2'-0"	7'-0"	5'-0"	--	--	13'-10"	14'-4"	--	--	--	--
	15'-0"	8'-0"	2'-0"	8'-0"	6'-0"	--	--	14'-2"	14'-8"	--	--	--	--
	16'-0"	9'-0"	2'-0"	9'-0"	7'-0"	--	--	14'-9"	15'-0"	--	--	--	--
	17'-0"	10'-0"	2'-0"	10'-0"	8'-0"	--	--	15'-3"	15'-4"	--	--	--	--
	18'-0"	11'-0"	2'-0"	11'-0"	9'-0"	--	--	15'-10"	15'-8"	--	--	--	--
	19'-0"	12'-0"	2'-0"	12'-0"	10'-0"	--	--	16'-5"	16'-0"	--	--	--	--
	20'-0"	13'-0"	2'-0"	3'-0"	10'-0"	--	--	16'-5"	16'-0"	--	16'-4"	--	--
2 STORY	21'-0"	14'-0"	2'-0"	4'-0"	10'-0"	2'-0"	--	16'-5"	16'-0"	16'-5"	--	--	--
	22'-0"	15'-0"	2'-0"	5'-0"	10'-0"	3'-0"	--	16'-5"	16'-0"	16'-5"	17'-0"	--	--
	23'-0"	16'-0"	2'-0"	6'-0"	10'-0"	4'-0"	--	16'-5"	16'-0"	16'-9"	17'-4"	--	--
	24'-0"	17'-0"	2'-0"	7'-0"	10'-0"	5'-0"	--	16'-5"	16'-0"	17'-1"	17'-8"	--	--
	25'-0"	18'-0"	2'-0"	8'-0"	10'-0"	6'-0"	--	16'-5"	16'-0"	17'-5"	18'-0"	--	--
	26'-0"	19'-0"	2'-0"	9'-0"	10'-0"	7'-0"	--	16'-5"	16'-0"	17'-11"	18'-4"	--	--
	27'-0"	20'-0"	2'-0"	10'-0"	10'-0"	8'-0"	--	16'-5"	16'-0"	18'-4"	18'-8"	--	--
	28'-0"	21'-0"	2'-0"	11'-0"	10'-0"	9'-0"	--	16'-5"	16'-0"	18'-10"	19'-0"	--	--
	29'-0"	22'-0"	2'-0"	12'-0"	10'-0"	10'-0"	--	16'-5"	16'-0"	19'-5"	19'-4"	--	--
	30'-0"	23'-0"	2'-0"	3'-0"	10'-0"	10'-0"	--	16'-5"	16'-0"	19'-5"	19'-4"	--	19'-8"
3 STORY	31'-0"	24'-0"	2'-0"	4'-0"	10'-0"	10'-0"	2'-0"	16'-5"	16'-0"	19'-5"	19'-4"	19'-10"	--
	32'-0"	25'-0"	2'-0"	5'-0"	10'-0"	10'-0"	3'-0"	16'-5"	16'-0"	19'-5"	19'-4"	19'-10"	20'-4"
	33'-0"	26'-0"	2'-0"	6'-0"	10'-0"	10'-0"	4'-0"	16'-5"	16'-0"	19'-5"	19'-4"	20'-1"	20'-8"
	34'-0"	27'-0"	2'-0"	7'-0"	10'-0"	10'-0"	5'-0"	16'-5"	16'-0"	19'-5"	19'-4"	20'-4"	21'-0"
	35'-0"	28'-0"	2'-0"	8'-0"	10'-0"	10'-0"	6'-0"	16'-5"	16'-0"	19'-5"	19'-4"	20'-9"	21'-4"
	36'-0"	29'-0"	2'-0"	9'-0"	10'-0"	10'-0"	7'-0"	16'-5"	16'-0"	19'-5"	19'-4"	21'-1"	21'-8"
	37'-0"	30'-0"	2'-0"	10'-0"	10'-0"	10'-0"	8'-0"	16'-5"	16'-0"	19'-5"	19'-4"	21'-6"	22'-0"
	38'-0"	31'-0"	2'-0"	11'-0"	10'-0"	10'-0"	9'-0"	16'-5"	16'-0"	19'-5"	19'-4"	22'-0"	22'-4"
	39'-0"	32'-0"	2'-0"	12'-0"	10'-0"	10'-0"	10'-0"	16'-5"	16'-0"	19'-5"	19'-4"	22'-5"	22'-8"

REVISIONS		
DATE	LTR.	DESCRIPTION
8/11	A	UPDATED BENT SELECTION TABLES
/		
/		
/		
/		
/		

DESIGN BY: UPRR | DRAWN BY: UPRR | CHECKED BY: HDR

APPROVED:

George J. Meyer 4-17-2007

UPRR - MOW/SPECIAL/PROJECTS STRUCTURES DESIGN

BRIDGE STANDARDS

CONCRETE BOX BRIDGES
H-PILE AND BRACING LAYOUT
INTERIOR BENT SELECTION TABLES
PILE LOADS AND DIMENSIONS
(SHEET 3 OF 4)

FILE OWNER: UPRR | DATE:

PLAN NO.: 530000 | SHEET: | A4

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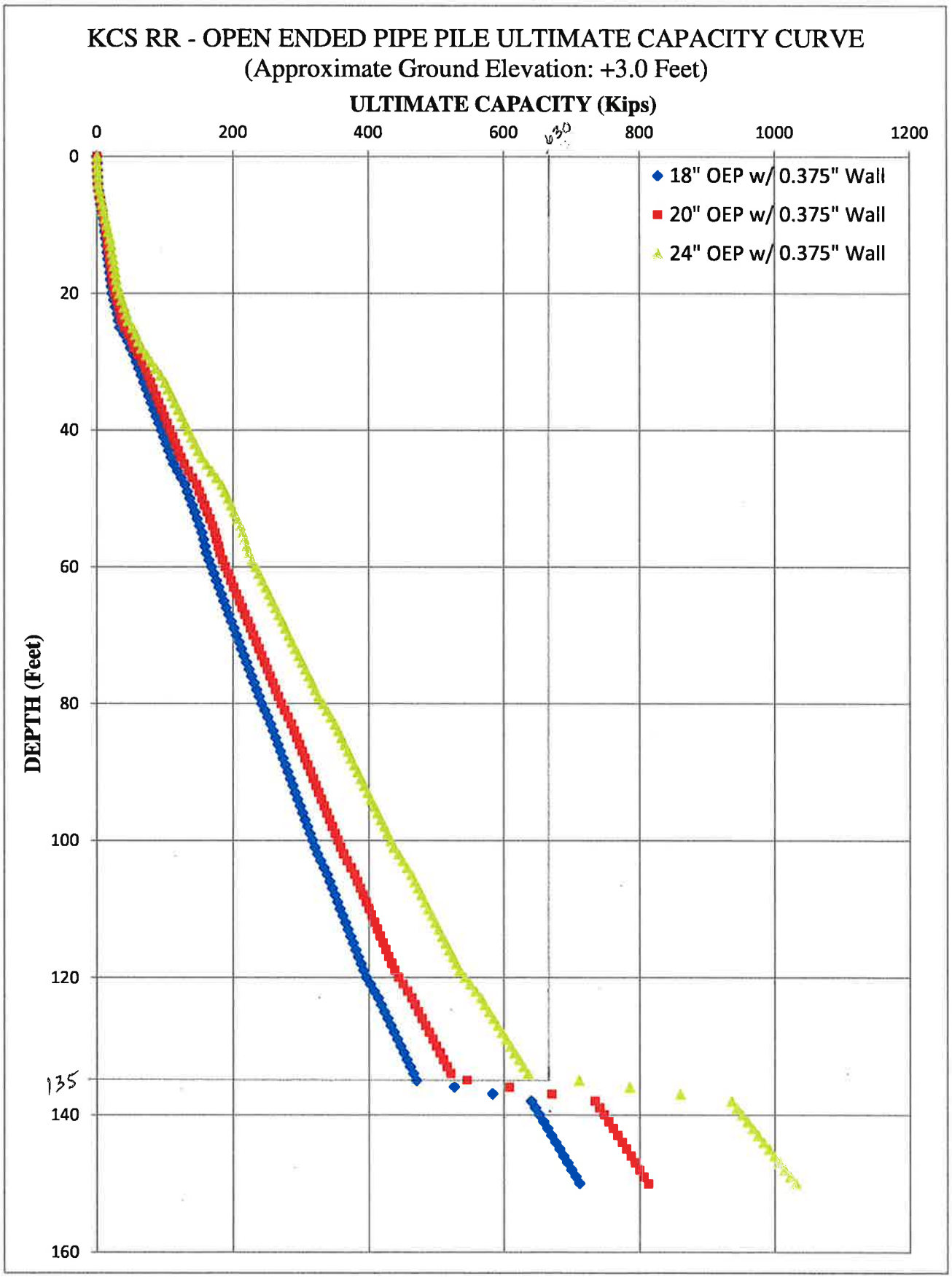
PLOTTED: ***DATE*** BY: HDR


KCS RR - OPEN ENDED PIPE PILE ULTIMATE CAPACITY CURVE
(Approximate Ground Elevation: +3.0 Feet)
ULTIMATE CAPACITY (Kips)
0
200
400
600
630
800
1000
1200
DEPTH (Feet)
0
20
40
60
80
100
120
135
140
160
18" OEP w/ 0.375" Wall
20" OEP w/ 0.375" Wall
24" OEP w/ 0.375" Wall