CPRA Contract No. 2503-11-63

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STATE OF LOUISIANA
COASTAL PROTECTION AND
RESTORATION AUTHORITY
COASTAL ENGINEERING DIVISION

RIVER REINTRODUCTION INTO MAUREPAS SWAMP

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

Head Works
95% Structural Calculations Submittal (Volume 1 of 2)

September 2013

RIVER REINTRODUCTION INTO MAUREPAS SWAMP: HEAD WORKS STRUCTURAL CALCULATIONS

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SECTION 1

U-FRAME DESIGN GENERAL INFORMATION

URS Quality - It's Good Business

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

IE QMS - Americas

Detail Check - Calculations

Project Name	Maurepas Freshwater Diversion	**Client**	OCPR / USACE
ProjectLocation	St John Parish, LA	**PM**	Naveen Chillara
Project Number	10001876	**PIC**	Mike Patorno

IDENTIFYING INFORMATION

(This section is to be completed by the Originator.)

Calculation Medium: *(Select as appropriate)*
☐ Electronic
☒ Hard-copy

File Name:
Unique Identification:
Number of pages*(including cover sheet)*:

Discipline:	Structural
Title of Calculation:	Structural Design & Detailing of Inflow Monoliths U-1, U-2 & U-3
Calculation Originator:	Leah B. Read, PE
Calculation Contributors:	N/A
Calculation Checker:	Jaya Yerubandi, PE

DESCRIPTION & PURPOSE

Calculations design the pile foundation, slabs & walls for the three inflow U-frame monoliths.

BASIS / REFERENCE / ASSUMPTIONS

Most references noted in Structural Design Criteria or on calculations package. Main references used are EM 1110-2-2104 (incl. Change 1), EM 1110-2-2502, EM 1110-2-2906, ETL 1110-2-355, ACI318-08, ASCE7-10

ISSUE / REVISION RECORD

Checker comments, if any, provided on: ☒hard-copy ☐electronic file ☐Form 3-5

No.	Description	P	S	F	Originator Initials	Date	Checker Initials	Date
0	No issues of note	☐	☐	☒	LBR	7/26/13	JY	7/29/13
1	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.
2	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.
3	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.

For a given Revision, indicate either P (Preliminary), S (Superseding) or F (Final). If there are no revisions to the Initial Issue, check F (Final).

APPROVAL and DISTRIBUTION

☒ The below individuals assert that the Detail Check – Calculations is complete.

Leah Read — August 12, 2013
OriginatorSignature — **Date**

Y. Jayakeerthi — August 12, 2013
Checker Signature — **Date**

[illegible] — 9/26/2013
Project Manager (or Designee) Signature — **Date**

Distribution:

Project Central File – Quality File Folder
Other – Specify:

URS | Quality - It's Good Business

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

IE QMS - Americas

Detail Check - Calculations

Project Name	Maurepas Freshwater Diversion	**Client**	OCPR / USACE
Project Location	St John Parish, LA	**PM**	Naveen Chillara
Project Number	10001876	**PIC**	Mike Patorno

IDENTIFYING INFORMATION

(This section is to be completed by the Originator.)

Calculation Medium: *(Select as appropriate)*

☐ Electronic
☒ Hard-copy

File Name: Enter File Name.

Unique Identification: Enter Unique ID.

Number of pages *(including cover sheet)*: Enter number of pages.

Discipline:	Structural
Title of Calculation:	Structural Design & Detailing of Outflow Monoliths U-4, U-5 & U-6
Calculation Originator:	Leah B. Read, PE
Calculation Contributors:	N/A
Calculation Checker:	Bryan Beckner, PE

DESCRIPTION & PURPOSE

Calculations design the pile foundation, slabs & walls for the three outflow U-frame monoliths.

BASIS / REFERENCE / ASSUMPTIONS

Most references noted in Structural Design Criteria or on calculations package. Main references used are EM 1110-2-2104 (incl. Change 1), EM 1110-2-2502, EM 1110-2-2906, ETL 1110-2-355, ACI318-08, ASCE7-10

ISSUE / REVISION RECORD

Checker comments, if any, provided on: ☒ hard-copy ☐ electronic file ☐ Form 3-5

No.	Description	P	S	F	Originator Initials	Date	Checker Initials	Date
0	No issues of note	☐	☐	☒	LBR	8/26/13	BCB	8/28/13
1	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.
2	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.
3	Click here to enter text.	☐	☐	☐	XXX	Date.	XXX	Date.

For a given Revision, indicate either P (Preliminary), S (Superseding) or F (Final). If there are no revisions to the Initial Issue, check F (Final).

APPROVAL and DISTRIBUTION

☒ The below individuals assert that the Detail Check – Calculations is complete.

Leah Read — **Originator Signature** — Click here to enter a date. 8/28/13 — **Date**

Bryan Beckner — **Checker Signature** — Click here to enter a date. 8/28/13 — **Date**

[illegible] — **Project Manager (or Designee) Signature** — Click here to enter a date. 9/26/2013 — **Date**

Distribution:

Project Central File – Quality File Folder

Other – Specify: Enter names here.

Three independent 2-D SAP2000 models have been created to design the Inflow Monoliths U-1, U-2 & U-3. The models are made of frame elements of thicknesses matching their member sizes and widths equaling the largest tributary width between the pile rows. The U-1 model has a tributary width of 10'-8"; the U-2 and U-3 models have tributary widths of 12'-0".

Joints connecting the frame elements are stiffened as per ETL 1110-2-355, which states that, "Rigid links are short members at joints that are stiffened to represent the behavior of wide supports. They are used to approximate real behavior at the intersections of thick concrete members. The length of the rigid link is generally half the distance between the joint and the face of the supporting concrete…A link should have a stiffness of at least ten times greater than that of the intersecting flexible member." The pertinent portions of the ETL explaining the rigid link method are included at the end of this section.

Piles are modeled with springs that are calculated with supplied geotechnical data. Axial springs are based on the equation:

$$b_{33} = c_{33} * (A * E) / L$$

where, b_{33} = axial pile stiffness spring (k/in)
c_{33} = axial stiffness modifier coefficient (supplied by geotechnical analysis)
A = cross-sectional area of the pile
E = modulus of elasticity of the pile
L = length of the pile

Lateral springs are based on the LPile Lateral Load vs. Displacement curve provided by the geotechnical analysis. For these springs, a lateral deflection is assumed (based on initial model runs or an engineering assumption) and the associated load is found. The calculated lateral spring is equivalent to this load divided by the correlated deflection. An iterative procedure is then used to calibrate the spring value so that the spring's source deflection is equivalent to the deflection of the model's piles. LPile information for up to a 30kip lateral load is available for use. For pile structural checks, the moment curve used is also taken from LPile output data.

Three independent 3-D SAP2000 models have been created to design the Inflow Monoliths U-4, U-5 & U-6. 3-D models were created because the shapes of the U-frames produce forces in two directions, whereas the shapes of the inflow U-frames generally have forces in only one direction. The models are made of 4000psi concrete area elements with thicknesses of 2'-6".

Joints connecting the area elements are stiffened as per ETL 1110-2-355, which states that, "Rigid links are short members at joints that are stiffened to represent the behavior of wide supports. They are used to approximate real behavior at the intersections of thick concrete members. The length of the rigid link is generally half the distance between the joint and the face of the supporting concrete…A link should have a stiffness of at least ten times greater than that of the intersecting flexible member." The pertinent portions of the ETL explaining the rigid link method are included at the end of this section.

Piles are modeled with springs that are calculated with supplied geotechnical data. Axial springs are based on the equation:

$$b_{33} = c_{33} * (A * E) / L$$

where, b_{33} = axial pile stiffness spring (k/in)
c_{33} = axial stiffness modifier coefficient (supplied by geotechnical analysis)
A = cross-sectional area of the pile
E = modulus of elasticity of the pile
L = length of the pile

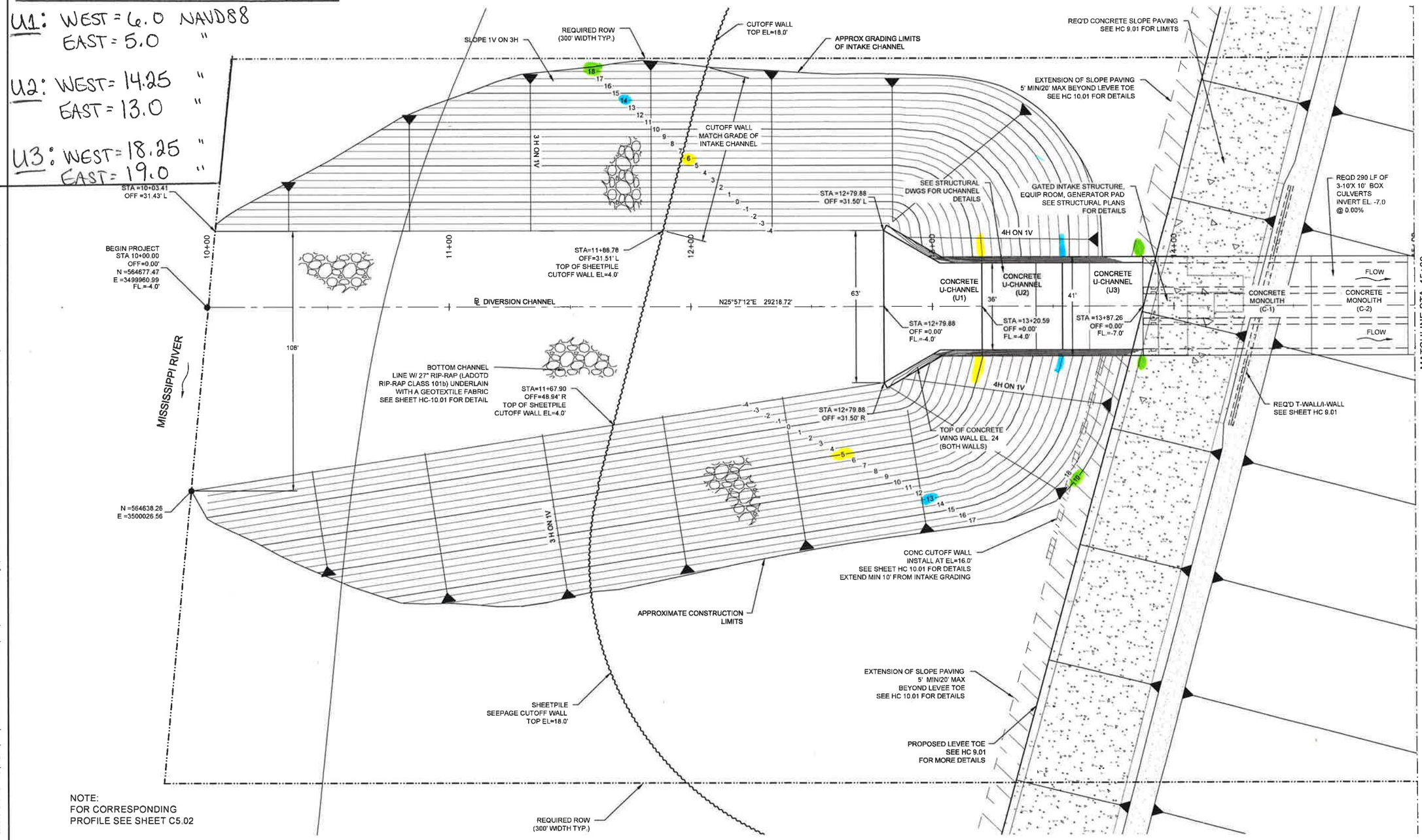
Lateral springs are based on the LPile Lateral Load vs. Displacement curve provided by the geotechnical analysis. For these springs, a lateral deflection is assumed (based on initial model runs or an engineering assumption) and the associated load is found. The calculated lateral spring is equivalent to this load divided by the correlated deflection. An iterative procedure is then used to calibrate the spring value so that the spring's source deflection is equivalent to the deflection of the model's piles. LPile information for up to a 30kip lateral load is available for use. For pile structural checks, the moment curve used is also taken from LPile output data.

SOIL LEVELS FOR DESIGNS:

U1: WEST = 6.0 NAVD88
EAST = 5.0 "

U2: WEST = 14.25 "
EAST = 13.0 "

U3: WEST = 18.25 "
EAST = 19.0 "



NOTE:
FOR CORRESPONDING PROFILE SEE SHEET C5.02

GRAPHIC SCALE
20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

AT FULL SCALE THIS BAR IS 1" LONG

REV.	DATE	DESCRIPTION	BY

URS
3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-6326

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
COASTAL ENGINEERING DIVISION
617 NORTH 3RD STREET
BATON ROUGE, LOUISIANA 70802

DRAWN BY: JAD | DESIGNED BY: DDW

MISSISSIPPI RIVER REINTRODUCTION INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA

PROJECT NUMBER:

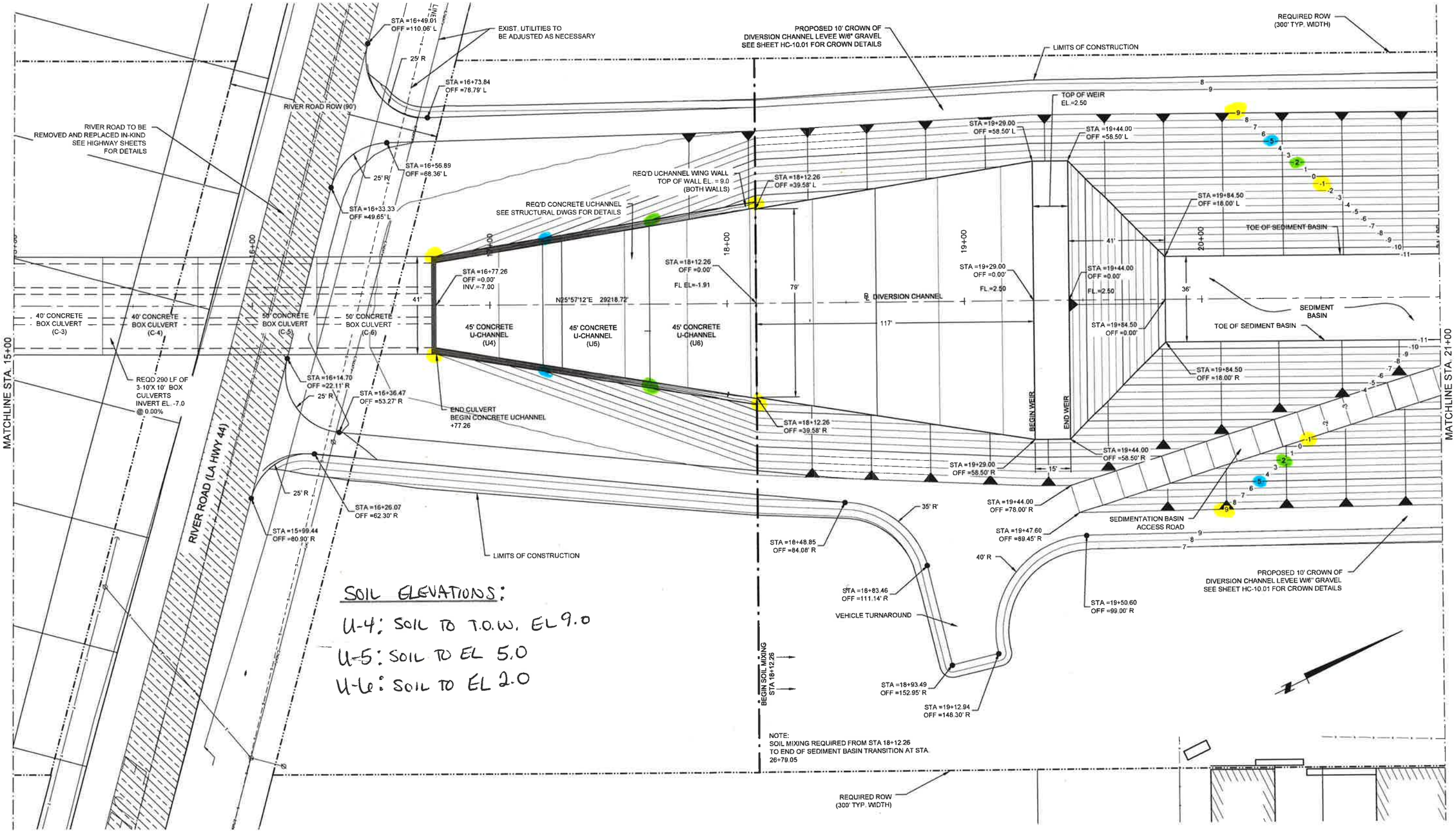
APPROVED BY: CL

INTAKE STRUCTURE PLAN
STA. 10+00 TO STA. 15+00

DATE: MAY 2013

SHEET HC-7.01

K:\URS METAIRIE\10001801-MAUREPAS PUMPING STA-HD WKS\00200\Civil\CIVIL-STRUCT-IN PROGRESS\DWG\Production Drawings\Section HC Meadow\HC-7.01 to HC 7.06 Channel-P&P_20 Scale.dwg, Jun 14, 2013 - 11:05:24AM, james_defolco



SOIL ELEVATIONS:

U-4: SOIL TO T.O.W. EL 9.0

U-5: SOIL TO EL 5.0

U-6: SOIL TO EL 2.0

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

AT FULL SCALE THIS BAR IS 1" LONG

REV.	DATE	DESCRIPTION	BY

URS

3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-6326

LOUISIANA DEPARTMENT OF NATURAL RESOURCES
COASTAL ENGINEERING DIVISION
617 NORTH 3RD STREET
BATON ROUGE, LOUISIANA 70802

DRAWN BY: JAD | DESIGNED BY: DDW

MISSISSIPPI RIVER REINTRODUCTION
INTO MAUREPAS SWAMP
ST. JOHN THE BAPTIST PARISH, LOUISIANA

PROJECT NUMBER:

APPROVED BY: CL

SEDIMENT BASIN PLAN
STA. 15+00 TO STA. 21+00

DATE: MAY 2013

SHEET HC-7.03

K:\URS METAIRIE\10001801-MAUREPAS PUMPING STA-HD WKS\00200\Civil\CIVIL-STRUCT-IN PROGRESS\DWG\Production Drawings\Section HC Headwork\HC-7.01 - HC 7.06 Channel-P&P_20 Scale.dwg, Jun 14, 2013 - 11:06:35AM, james_defalco

Table XX
Levee Area
Earth Pressure Parameters

Soil Type	Elevation		Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg)	Ko	Ka
	Top	Bottom					
Fill	–	–	115	600	0	0.95	1.0
Clay	20.0	0.0	112.5	600-900	0	0.95	1.0
Clay	0.0	-10.0	112.5	900-950	0	0.95	1.0
Clay	-10.0	-22.0	107.0	950	0	0.95	1.0
Silt	-22.0	-25.0	107.0	200	15	0.95	1.0
Clay	-25.0	-35.0	107.0	950-1070	0	0.95	1.0
Clay	-35.0	-52.0	120.0	1070-1250	0	0.95	1.0
Clay	-52.0	-60.0	120.0	1250-1334	0	0.95	1.0
Clay	-60.0	-73.0	112.5	1334-1470	0	0.95	1.0
Clay	-73.0	-92.0	112.5	1470-1600	0	0.95	1.0
Clay	-92.0	-120.0	112.5	1600-2210	0	0.95	1.0
Sand	-120.0	-140.0	112.5	0	32	0.47	0.32
Clay	-140.0	-160.0	112.5	2430-2650	0	0.95	1.0

Note: Ko is utilized to design rigid (concrete) walls, and Ka is utilized to design flexible (steel) walls.

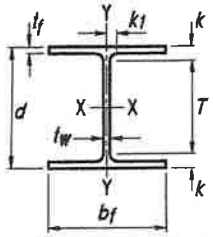


Table 1–4
HP Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k	k_1	T	Workable Gage
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.
HP14×117[f]	34.4	14.2	14 1/4	0.805	13/16	7/16	14.9	14 7/8	0.805	13/16	1 1/2	1 1/16	11 1/4	5 1/2
×102[f]	30.0	14.0	14	0.705	11/16	3/8	14.8	14 3/4	0.705	11/16	1 3/8	1		
×89[f]	26.1	13.8	13 7/8	0.615	5/8	5/16	14.7	14 3/4	0.615	5/8	1 5/16	15/16		
×73[c,f]	21.4	13.6	13 5/8	0.505	1/2	1/4	14.6	14 5/8	0.505	1/2	1 3/16	7/8		
HP12×84	24.6	12.3	12 1/4	0.685	11/16	3/8	12.3	12 1/4	0.685	11/16	1 3/8	1	9 1/2	5 1/2
×74[f]	21.8	12.1	12 1/8	0.605	5/8	5/16	12.2	12 1/4	0.610	5/8	1 5/16	15/16		
×63[f]	18.4	11.9	12	0.515	1/2	1/4	12.1	12 1/8	0.515	1/2	1 1/4	7/8		
×53[f]	15.5	11.8	11 3/4	0.435	7/16	1/4	12.0	12	0.435	7/16	1 1/8	7/8		
HP10×57[f]	16.8	9.99	10	0.565	9/16	5/16	10.2	10 1/4	0.565	9/16	1 1/4	15/16	7 1/2	5 1/2
×42[f]	12.4	9.70	9 3/4	0.415	7/16	1/4	10.1	10 1/8	0.420	7/16	1 1/8	13/16	7 1/2	5 1/2
HP8×36[f]	10.6	8.02	8	0.445	7/16	1/4	8.16	8 1/8	0.445	7/16	1 1/8	7/8	5 3/4	5 1/2

[c] Shape is slender for compression with $F_y = 50$ ksi.
[f] Shape exceeds compact limit for flexure with $F_y = 50$ ksi.

Table 1–4 (continued)
HP Shapes
Properties

HP S

Nominal Wt.	Compact Section Criteria $\frac{b_f}{2t_f}$	$\frac{h}{t_w}$	Axis X-X I	S	r	Z	Axis Y-Y I	S	r	Z	r_{ts}	h_o	$\frac{J}{S_x h_o}$	Torsional Properties J	C
lb/ft			in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.^{3}	in.	in.		in.^{4}	in
117	9.25	14.2	1220	172	5.96	194	443	59.5	3.59	91.4	4.15	13.41	0.00348	8.02	199
102	10.5	16.2	1050	150	5.92	169	380	51.4	3.56	78.8	4.10	13.31	0.00270	5.39	168
89	11.9	18.5	904	131	5.88	146	326	44.3	3.53	67.7	4.05	13.22	0.00207	3.59	142
73	14.4	22.6	729	107	5.84	118	261	35.8	3.49	54.6	4.00	13.11	0.00143	2.01	112
84	8.97	14.2	650	106	5.14	120	213	34.6	2.94	53.2	3.41	11.60	0.00345	4.24	71
74	10.0	16.1	569	93.8	5.11	105	186	30.4	2.92	46.6	3.38	11.52	0.00276	2.98	61
63	11.8	18.9	472	79.1	5.06	88.3	153	25.3	2.88	38.7	3.33	11.43	0.00202	1.83	50
53	13.8	22.3	393	66.7	5.03	74.0	127	21.1	2.86	32.2	3.29	11.35	0.00148	1.12	40
57	9.05	13.9	294	58.8	4.18	66.5	101	19.7	2.45	30.3	2.84	9.43	0.00355	1.97	22
42	12.0	18.9	210	43.4	4.13	48.3	71.7	14.2	2.41	21.8	2.77	9.28	0.00202	0.813	15
36	9.16	14.2	119	29.8	3.36	33.6	40.3	9.88	1.95	15.2	2.26	7.58	0.00341	0.770	5

Axial Pile Stiffness

The axial pile stiffness, b_{33}, is essentially the secant modulus of the linear portion of the pile load settlement curve. It can also be calculated by multiplying the AE/Le term by the axial stiffnes modifier coefficient, c_{33}. Using the secant modulus, the modifier can be calculated as follows:

Given

$E_{steel} := 30000000 \cdot psi$ *Modulus of elasticity of steel*

$f'_c := 4000$ *Compressive strength of concrete*

$E_{conc} := 57000 \cdot \sqrt{f'_c} \cdot psi = 3.6 \times 10^6\ psi$ *Modulus of elasticity of concrete*

14X73

$A_{14X73} := 196 \cdot in^2$ *Area of pile*

$Le_{14X73} := 150 \cdot ft$ *Pile length*

$b_{33\_14X73} := 5597.1 \cdot \frac{kip}{in}$ *Slope of tangent line of linear portion of load vs. deflection curve*

$$c_{33\_14X73} := \frac{b_{33\_14X73} \cdot Le_{14X73}}{A_{14X73} \cdot E_{steel}} = 1.71$$

14X89

$A_{14X89} := 196 \cdot in^2$

$Le_{14X89} := 150 \cdot ft$

$b_{33\_14X89} := 5683.6 \cdot \frac{kip}{in}$

$$c_{33\_14X89} := \frac{b_{33\_14X89} \cdot Le_{14X89}}{A_{14X89} \cdot E_{steel}} = 1.74$$

HP 14x89 LPILE ANALYSIS - 2 RUNS. FOR FULL OUTPUT, SEE GEOTECH CALCS. HERE, ONLY RUN INFO & OUTPUT PRESENTED.

==========

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

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IH
URS

Serial Number of Security Device: 362999691
Company Name Stored in Security Device: URS Corporation

Files Used for Analysis

Path to file locations: C:\Ignacio Harrouch\Lake Maurepas Diversion Canal\2013\Pile Capacity Intake\L-Pile\
Name of input data file: LM-HP14 x 89.lp6d
Name of output report file: LM-HP14 x 89.lp6o
Name of plot output file: LM-HP14 x 89.lp6p
Name of runtime messeage file: LM-HP14 x 89.lp6r

Date and Time of Analysis

RUN 1

Date: June 20, 2013 Time: 17:47:27

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians
1	1	V = 1000.0000	M = 0.000	275000.	0.00102520	14702.	1000.0000	-0.00002792
2	1	V = 2000.0000	M = 0.000	275000.	0.00409452	41727.	2000.0000	-0.00009282
3	1	V = 3000.0000	M = 0.000	275000.	0.00977514	74687.	3000.0000	-0.00019171
4	1	V = 4000.0000	M = 0.000	275000.	0.01819810	113767.	4000.0000	-0.00032059
5	1	V = 5000.0000	M = 0.000	275000.	0.02923616	155378.	5000.0000	-0.00047648
6	1	V = 6000.0000	M = 0.000	275000.	0.04343006	198520.	6000.0000	-0.00066167
7	1	V = 7000.0000	M = 0.000	275000.	0.06008830	251398.	7000.0000	-0.00087077
8	1	V = 8000.0000	M = 0.000	275000.	0.08048453	304990.	8000.0000	-0.00110551
9	1	V = 9000.0000	M = 0.000	275000.	0.10348752	361114.	9000.0000	-0.00136495
10	1	V = 10000.0000	M = 0.000	275000.	0.12881121	419316.	10000.	-0.00164480

The analysis ended normally.

==========

LPile Plus for Windows, Version 6 (6.0.28)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

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Serial Number of Security Device: 362999691
Company Name Stored in Security Device: URS Corporation

Files Used for Analysis

Path to file locations: C:\Ignacio Harrouch\Lake Maurepas Diversion Canal\2013\Pile Capacity Intake\L-Pile\
Name of input data file: LM-HP14 x 89 Revised 7-25-13.lp6d
Name of output report file: LM-HP14 x 89 Revised 7-25-13.lp6o
Name of plot output file: LM-HP14 x 89 Revised 7-25-13.lp6p
Name of runtime messeage file: LM-HP14 x 89 Revised 7-25-13.lp6r

---

Date and Time of Analysis

Date: July 25, 2013 Time: 9:34:43

RUN 2

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

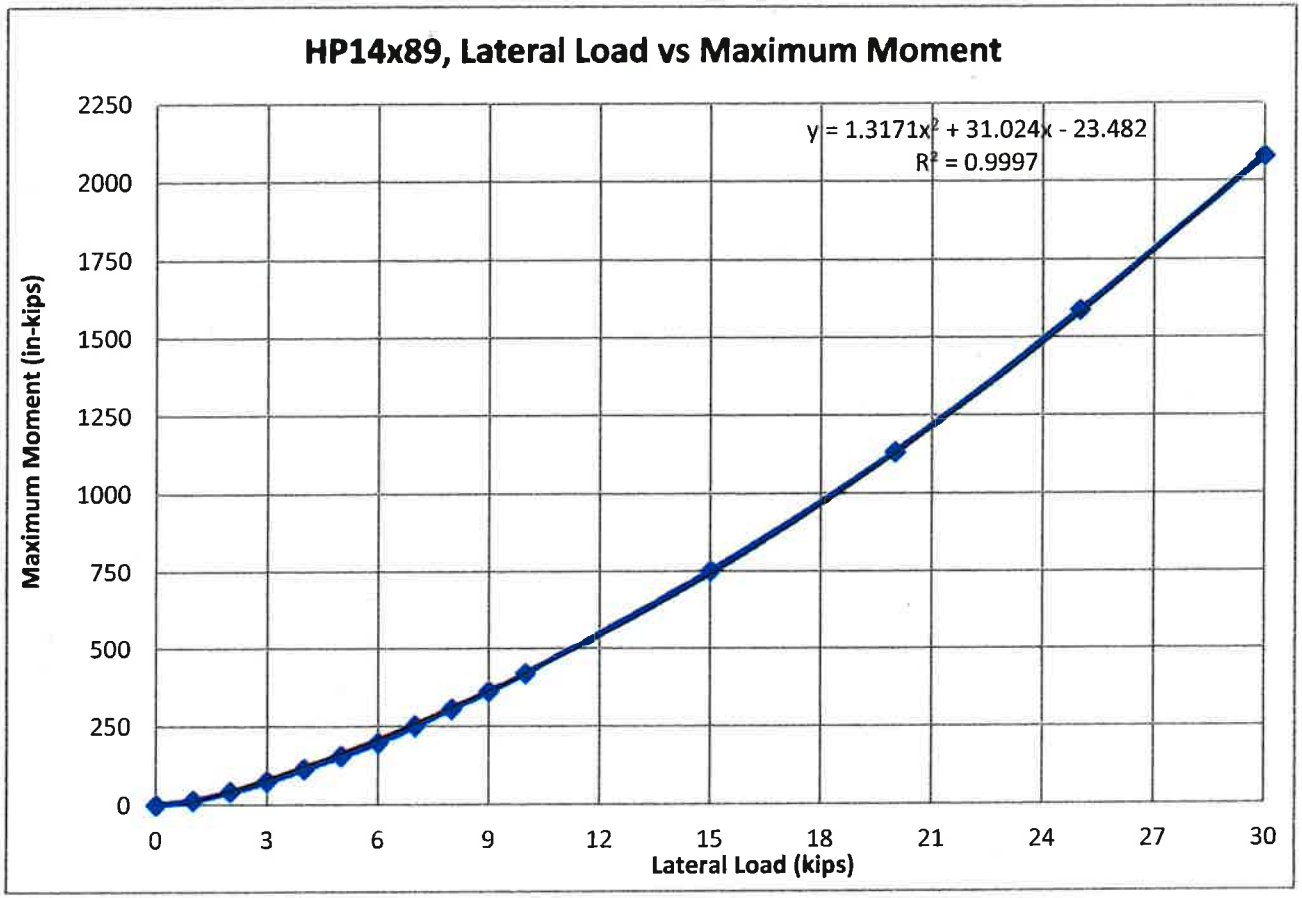
Load Case No.	Load Type No.	Pile-head Condition 1 V(lbs) or y(inches)	Pile-head Condition 2 in-lb, rad., or in-lb/rad.	Axial Loading lbs	Pile-head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-head Rotation radians
1	1	V = 5000.00	M = 0.000	275000.	0.02923616	155378.	5000.0	-0.00047648
2	1	V = 10000.00	M = 0.000	275000.	0.12881121	419316.	10000.	-0.00164480
3	1	V = 15000.	M = 0.000	275000.	0.30790796	751755.	15000.	-0.00339663
4	1	V = 20000.	M = 0.000	275000.	0.57012002	1131070.	20000.	-0.00569857
5	1	V = 25000.	M = 0.000	275000.	0.89728176	1587535.	25000.	-0.00844471
6	1	V = 30000.	M = 0.000	275000.	1.27460397	2079189.	30000.	-0.01153556

The analysis ended normally.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	HP14x89 - Lateral Load vs. Maximum Moment	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	For Pile Structural Check	**Checked By:**		**Date:**		**Sheet:**	of

Applied Lateral Load (kips)	Maximum Moment (in-kips)
0	0
1	14.702
2	41.727
3	74.687
4	113.767
5	155.378
6	198.52
7	251.398
8	304.99
9	361.114
10	419.316
15	751.755
20	1131.07
25	1587.535
30	2079.189



SETTLEMENT LOAD REFERENCE

Read, Leah

From: Lelong, Bruce
Sent: Friday, July 26, 2013 9:58 AM
To: Read, Leah; Grubb, Bob; Yerubandi, Jaya
Subject: FW: Maurepas Freshwater Diversion Project: Design Critreria for Headworks Culvert Structures (UNCLASSIFIED)
Attachments: document2013-07-25-161833.pdf — Attachment follows e-mails

Bruce R. Lelong, P.E. • Project Manager & Structures Dept. Manager
3500 N. Causeway Blvd. • Suite 900 • Metairie, LA • 70002 Bruce.Lelong@urs.com • Office 504.837.6326 • Direct 504.218.0854

-----Original Message-----
From: Brandstetter, Charles P MVN [mailto:Charles.P.Brandstetter@usace.army.mil]
Sent: Thursday, July 25, 2013 4:27 PM
To: Lelong, Bruce
Cc: Buenano, Ariel; Chillara, Naveen
Subject: RE: Maurepas Freshwater Diversion Project: Design Critreria for Headworks Culvert Structures (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

First I want to apologize for not getting back to you sooner. Also, I called yesterday and spoke with Ariel about this and I told him to not use the formulas described for condition 3.

However, after consultation with others in the Corps, it looks like these formulas are appropriate. Darryl did use this in the design of Canarvan and Davis Pond. I have attached his description of why this applied.

Sorry for the confusion.

Charlie

-----Original Message-----
From: Lelong, Bruce [mailto:bruce.lelong@urs.com]
Sent: Thursday, July 18, 2013 10:19 AM
To: Brandstetter, Charles P MVN
Cc: Buenano, Ariel; Chillara, Naveen
Subject: RE: Maurepas Freshwater Diversion Project: Design Critreria for Headworks Culvert Structures (UNCLASSIFIED)

Thanks Charlie

Bruce R. Lelong, P.E. . Project Manager & Structures Dept. Manager
500 N. Causeway Blvd. . Suite 900 . Metairie, LA . 70002 Bruce.Lelong@urs.com . Office 504.837.6326 . Direct 504.218.0854

-----Original Message-----
From: Brandstetter, Charles P MVN [mailto:Charles.P.Brandstetter@usace.army.mil]
Sent: Thursday, July 18, 2013 9:16 AM
To: Lelong, Bruce
Cc: Buenano, Ariel; Chillara, Naveen
Subject: RE: Maurepas Freshwater Diversion Project: Design Critreria for Headworks Culvert Structures (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Bruce, I am looking into this, I didn't want you to think I was ignoring you.

-----Original Message-----
From: Lelong, Bruce [mailto:bruce.lelong@urs.com]
Sent: Tuesday, July 16, 2013 5:45 PM
To: Brandstetter, Charles P MVN
Cc: Buenano, Ariel; Chillara, Naveen
Subject: Maurepas Freshwater Diversion Project: Design Critreria for Headworks Culvert Structures

Charlie,

As I mentioned to you today when I stopped by your office, we'd like guidance on the appropriateness of EM 1110-2902 CONDUITS, CULVERTS, AND PIPES, CHANGE 1, 31 MAR 98, for applying soil loads (vertical and horizontal) to the Maurepas Headworks structures. The EM "....provides (a) guidance on the design and construction of conduits, culverts, and pipes, and (b) design procedures for trench/embankment earth loadings, highway loadings, railroad loadings, surface concentrated loadings, and internal/external fluid pressures." It seems that generally this scope would apply to the headworks monoliths, and therefore we need to carefully consider the appropriateness of the guidance and follow it unless there is a good reason not to do so. Specifically, loadings are given in Chapter 2, Cast-in-place Conduits for Dams.

The specific aspect of the EM being considered is the specified vertical and lateral soil loadings on the structures. The EM, on p. 2-4, states, "direct measurements of such [soil] pressures [from overlying fill] have been made for small diameter pipes under relatively low fill heights. Until more data are available, the following loading should be used for rigid conduits and culverts for dams and levees and outlet conduits for interior drainage." The EM then defines three basic loading conditions based on two sets of parameters: the ratio of the trench width to the conduit diameter, and the height of overlying fill above natural grade. For the Maurepas Project, based on the conditions defined, the headworks structures would meet Condition 3, which is when the conduit is located within an embankment or when the situation does not meet the criteria of Conditions 1 and 2.

For Condition 3, there are two loading cases for applying soil load around the structure:
Initial Embankment Condition (Case 1) where weight of top soil is taken as 150% of the actual weight and lateral earth pressure coefficient as 0.5

* Final Embankment Condition (Case 2) where weight of top soil is taken as 100% of the actual weight and lateral earth pressure coefficient as 1.0

So the question is are these formulae appropriate or alternately should we use other loading values, such as at-rest lateral earth pressure coefficients based on surcharge from the column of soil and water at the outside face of the structure (taking sloping backfill into account as appropriate) and use a vertical surcharge pressure on top of the structure based on the column of soil and water directly over the roof of the structure? My opinion is that the EM does not apply, but please advise so we can design according to the NOD's requirements. FYI, on LA Ave Culvert Design we only applied the soil prism on top of the structure and used at-rest pressures on the walls and designed for Corps foundation and strength design criteria, but also checked the concrete structure per AASHTO LRFD Culvert Design Criteria. AASHTO has a soil interaction factor for overburden, which for the embankment condition is a maximum of 1.15 when the fill is compacted. Although we did not use a soil interaction factor when designing per Corps criteria, we found Corps criteria governed over AASHTO because the Corps load factors are larger.

Thanks in advance for you guidance,

Bruce

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Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

cut-off under the sluice gate monolith as effective. Uplift condition 2 was derived by assuming the sheet pile cut-off as ineffective.

(5) Superimposed. In addition to the primary loads on the structure, the application of the following additional loadings were considered:

(a) Soil drag loads (D). Drag load due to differential settlement of the surrounding backfill with respect to the structure was incorporated into the design. The drag load applied to those monolith walls backfilled with sand was computed to be 0.5 times the lateral earth pressure, times the tangent of 20 degrees. For monolith C-2, which was backfilled with clay material, forming an impervious plug, an adhesion of 600 PSF was applied. In addition to the above loadings, a more conservative approach was included for the culvert monoliths. Here it was assumed that a greater settlement in the backfill material adjacent the culvert set up friction forces acting downward on the fill above the culvert. In modeling this effect, a contributary area of soil extending at a 45 degree angle from the top of the culvert was added to the column of fill directly over it.

(b) Silt Loads (S). Structural components were designed for silt deposits up to 12 feet in height, where applicable.

(c) Debris loads (DI). A uniform load of 1.5 kips per foot acting at the water line was applied to the applicable structural components.

(d) Boat impact (BI). A uniform load of 5.0 kips per foot in the direction of flow was applied 1 foot above the waterline.

(e) Wind loads (WI). A wind load of 50 psf was considered in the design of applicable structural components.

(f) Highway loads (H). A Louisiana Department of Transportation and Development HST-18 truck loading was considered in the design of its applicable structural component.

(g) Train loads (T). Cooper E-80 train loads were applied to the applicable structural components for permanent work. A Cooper E-65 load was used in the design of the temporary detour.

(6) Nomenclature of design cases. The design cases were given a nomenclature, which identifies the basic loading condition. The following example illustrates the method.

1-ft-wide strip is usually sufficient. Strip selection should also consider blockouts that cause discontinuity or member property reduction in the structural framing. Some strips will have tributary load. An example of these strips/sections occurs at the culvert valve well. The walls of the well can be assumed to act as a plate fixed against rotation on three sides with reactions on upstream and downstream sections and the base slab. Wall reactions are distributed throughout the width of the upstream and downstream sections. Vertical forces are assumed to be resisted by the foundation below the wall with no transfer to adjacent sections. The wall plate must be designed to transfer the load in the assumed direction (see Figure A-4).

(2) All strips must be in static equilibrium. Strips in three-dimensional monoliths will have unbalanced vertical loads due to the foundation pressure gradient. Strip equilibrium is achieved by using vertical shears between strips with magnitudes as required to satisfy external equilibrium. This is referred to as shear transfer. Shears should be applied such that moments are not introduced into the external stability of the monolith. Shear transfer also provides redundancy in the monolith which is required to distribute the effects of small discontinuities (from blockouts/voids) in the structural framing. This permits the designer to ignore small voids in the frame analysis. Generally within a monolith, thick reinforced concrete members establish shear transfer without special details.

(3) A monolith may require several strip analyses and parametric studies in order for the designer to understand its behavior. Selecting a strip and interpretation of analysis results are challenging tasks and should be assigned to more experienced engineers.

c. Frame member. Generally, framing is modeled along member centerlines except for the very deep member that forms the culvert roof in monoliths such as the gate monoliths. This member is modeled near the top of the culvert and intersects the culvert walls at their centerlines (see Figure A-4). The block above the culvert can be modeled as a rigid body if its span-to-depth ratio is 1 to 1 or lower. If the member above the culvert is relatively thin, it behaves like a typical frame member. Member section properties are computed using member gross concrete dimensions.

d. Rigid links. Rigid links are short members at joints that are stiffened to represent the behavior of wide supports. They are used to approximate real behavior at the intersections of thick concrete members. The length of the rigid link is generally half the distance between the joint and the face of the supporting concrete. The length can be extended by half the length of a fillet if present. A link should have a stiffness of at least ten times greater than that of the intersecting flexible member. In regions of complex geometry, finite element runs can be used to calibrate the length of rigid links. For application of rigid links, see Figure A-5.

e. Foundation modeling.

(1) The foundation can usually be modeled by elastic springs (both vertical and horizontal) for soil or piles. Pile springs are attached to the base slab centerline by rigid links which model the eccentricity to the foundation. The length of the link is generally half the thickness of the base slab.

(2) Hydrostatic uplift is modeled as a load. Hydrostatic uplift reduces bearing pressures, which affects frame response.

(3) For soil-founded locks, assumed shapes of bearing pressures can be modeled as a load in lieu of using foundation springs (see paragraph 6-3*a*). Supports are still required to provide stable boundary conditions, but each support reaction should be zero. Note that displacements of the soil must be compatible with the deflections of the structure in order to accurately model the soil-structure interaction (see paragraph 6-3*b*). The use of foundation springs accommodates this requirement and is the preferred method of analysis.

(4) Pile foundation analyses should include horizontal base shears, particularly if battered piles are present. Horizontal base shear on battered piles creates a vertical component of force that will load the U-frame. Torsional moments on a monolith create horizontal base shears and should be evaluated.

(5) Due to uneven distributions of foundation bearing pressures, differential settlement between monoliths and within a monolith should be considered. Within a monolith, usually the base slab is constructed first, the subsequent load from buildup of

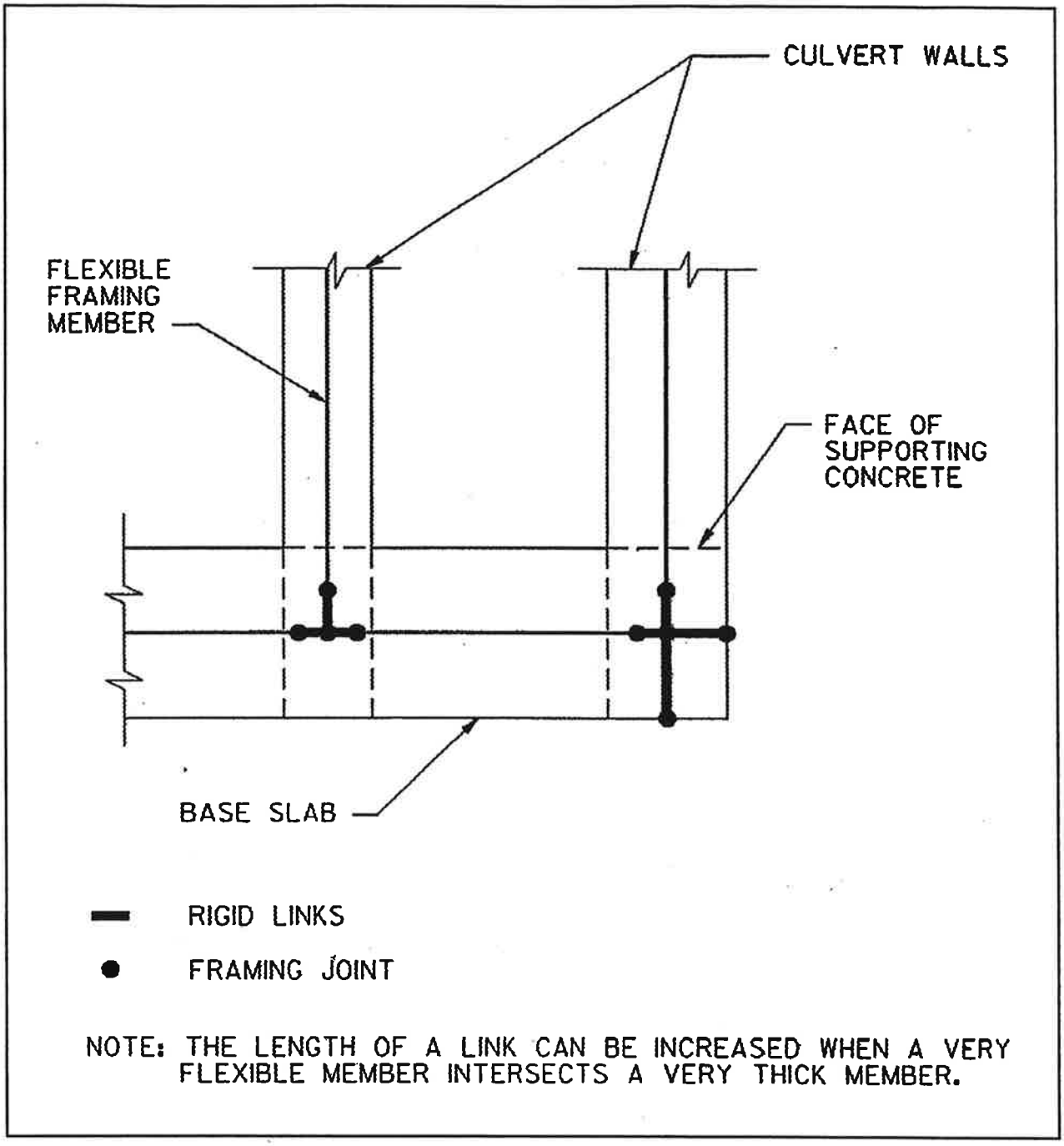


Figure A-5. Rigid link application

preparation, design for shear flow at the joint, and an adequate length of thickened section along the base member (see Figure A-6). Some thickened sections will not have sufficient length to stiffen the base slab (see related discussion on cover plated steel beams in the AISC *Manual of Steel Construction*). Alternatively, the added concrete thickness can be detailed to act independently of the rest of the base slab by segmenting it with watertight joints parallel to flow. Joint spacing should be such that composite action is not developed.

(2) Thicker slabs can stiffen adjacent thinner slabs similar to the stiffening effect that a T-beam

SECTION 2

U-1 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jun-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	Flood Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
2-ST	Flood Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)

URS

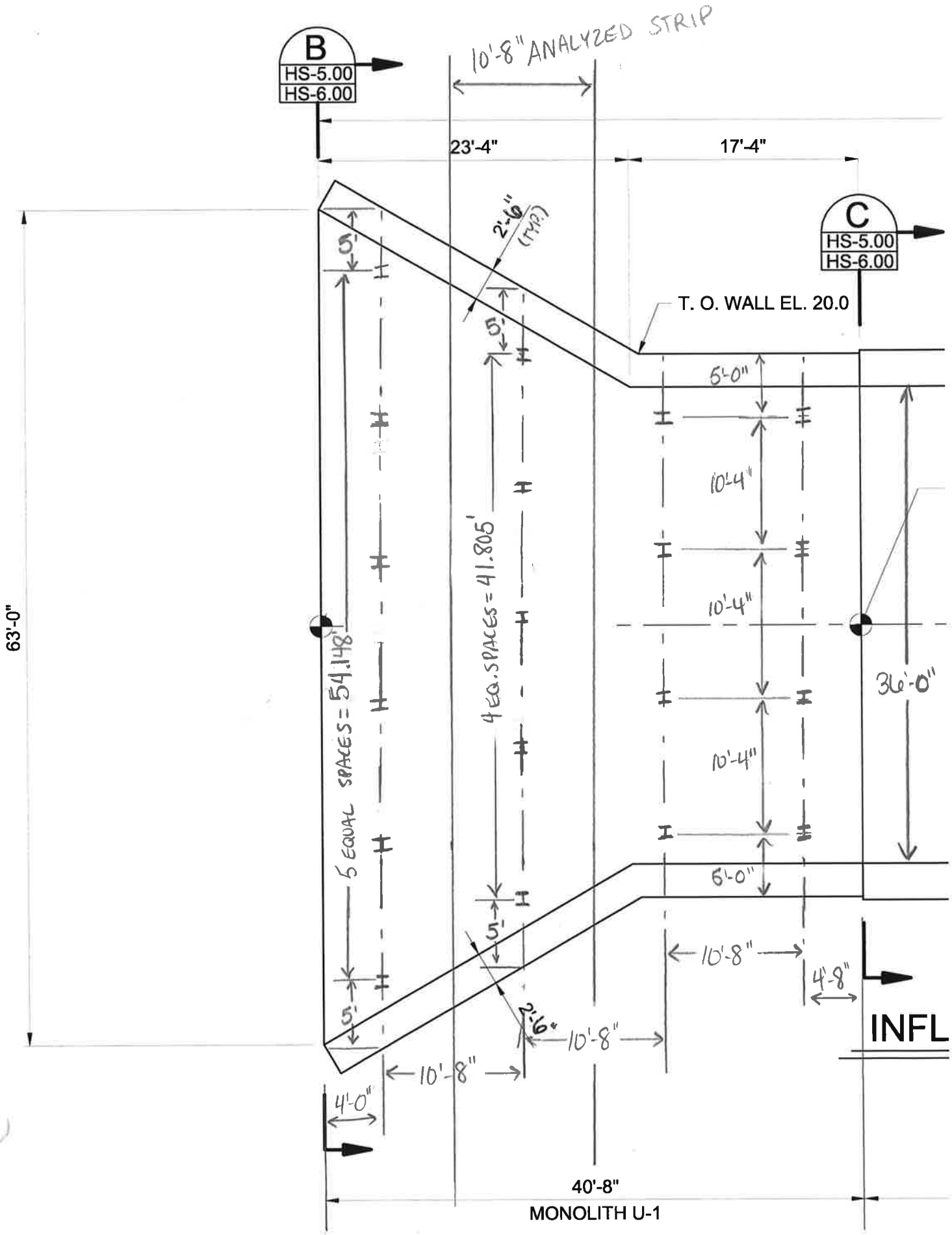
Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jun-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL31.5
U_high water	Uplift load from water to EL 31.5
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_saturated	Soil pressure from saturated soil (water to EL 31.5)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	U_high water
	S_saturated
2-ST	DEAD
	L_high water
	U_high water
	S_saturated
	ST_cohesion

In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

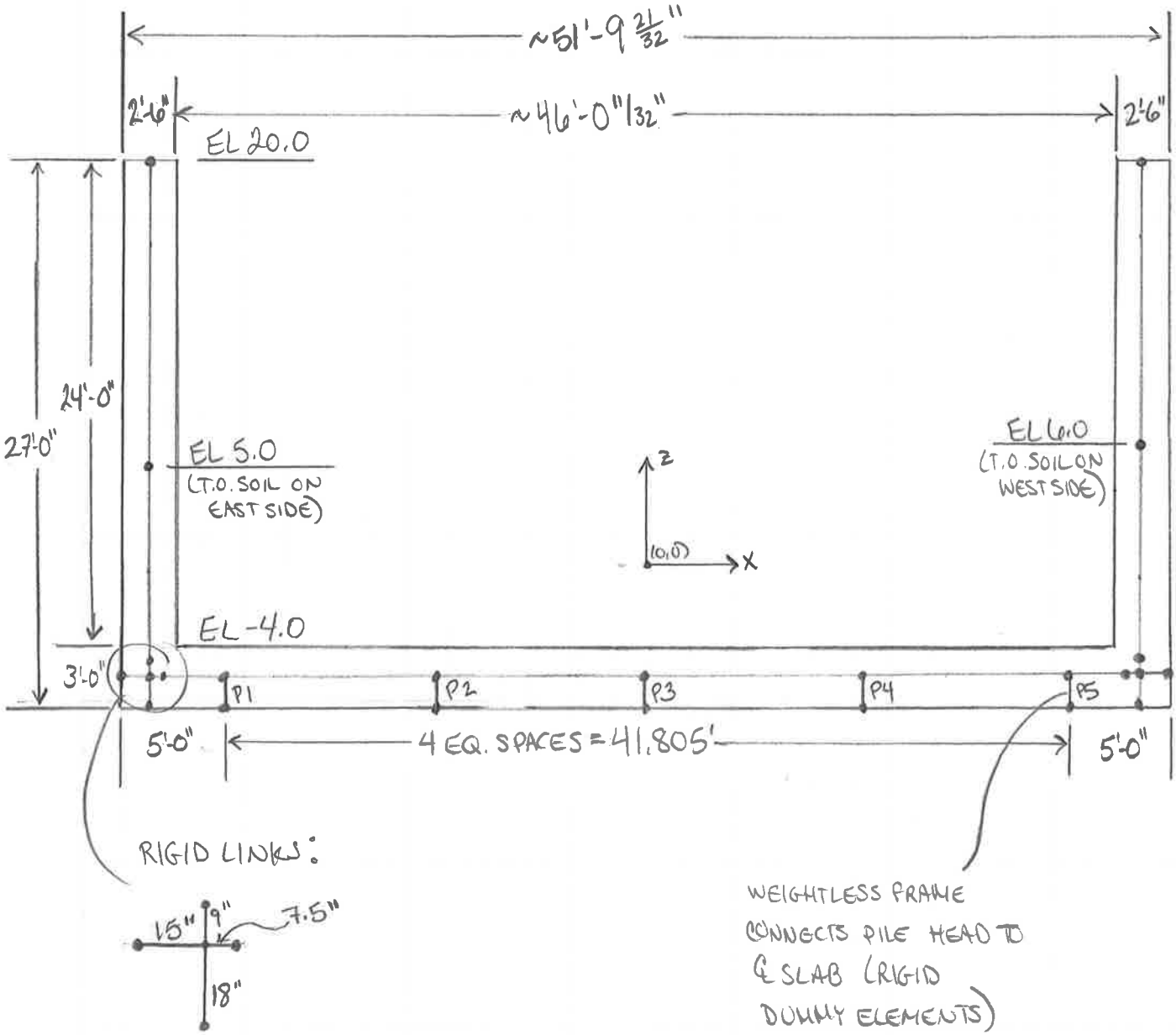

B
HS-5.00
HS-6.00
10'-8" ANALYZED STRIP
23'-4"
17'-4"
C
HS-5.00
HS-6.00
T. O. WALL EL. 20.0
2'-6" (TYP.)
5'
5'
5'
5'
5'
5'-0"
10'-4"
10'-4"
10'-4"
5'-0"
36'-0"
63'-0"
5 EQUAL SPACES = 54.148'
4 EQ. SPACES = 41.805'
10'-8"
4'-8"
2'-6"
10'-8"
10'-8"
4'-0"
INFL
40'-8"
MONOLITH U-1

URS

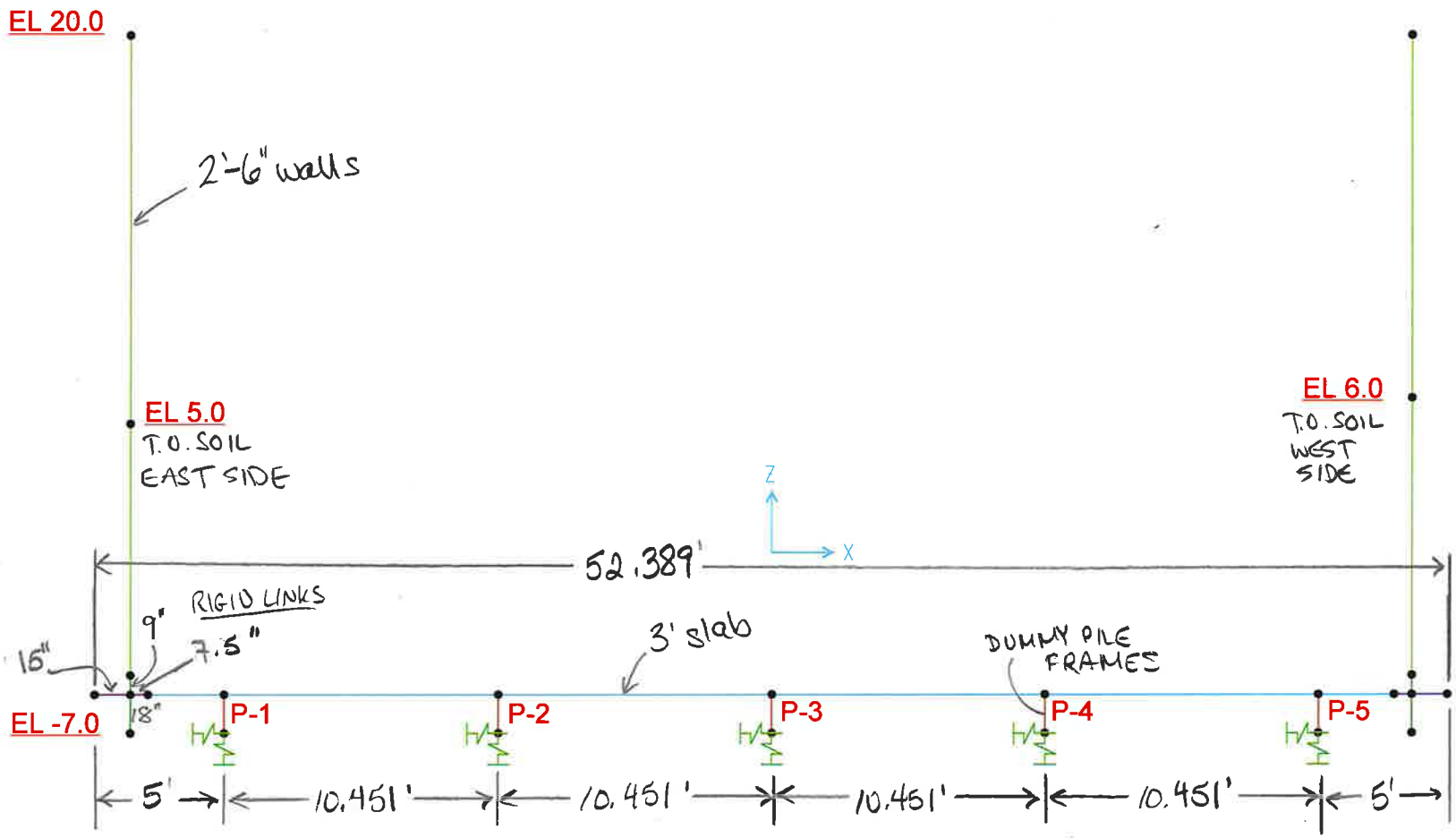
Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: MONOLITH U-1 | Computed by: LBR | Sheet ___ of ___
SAP MODEL LAYOUT | Checked by: ___ | Date: 7/2013

Reference

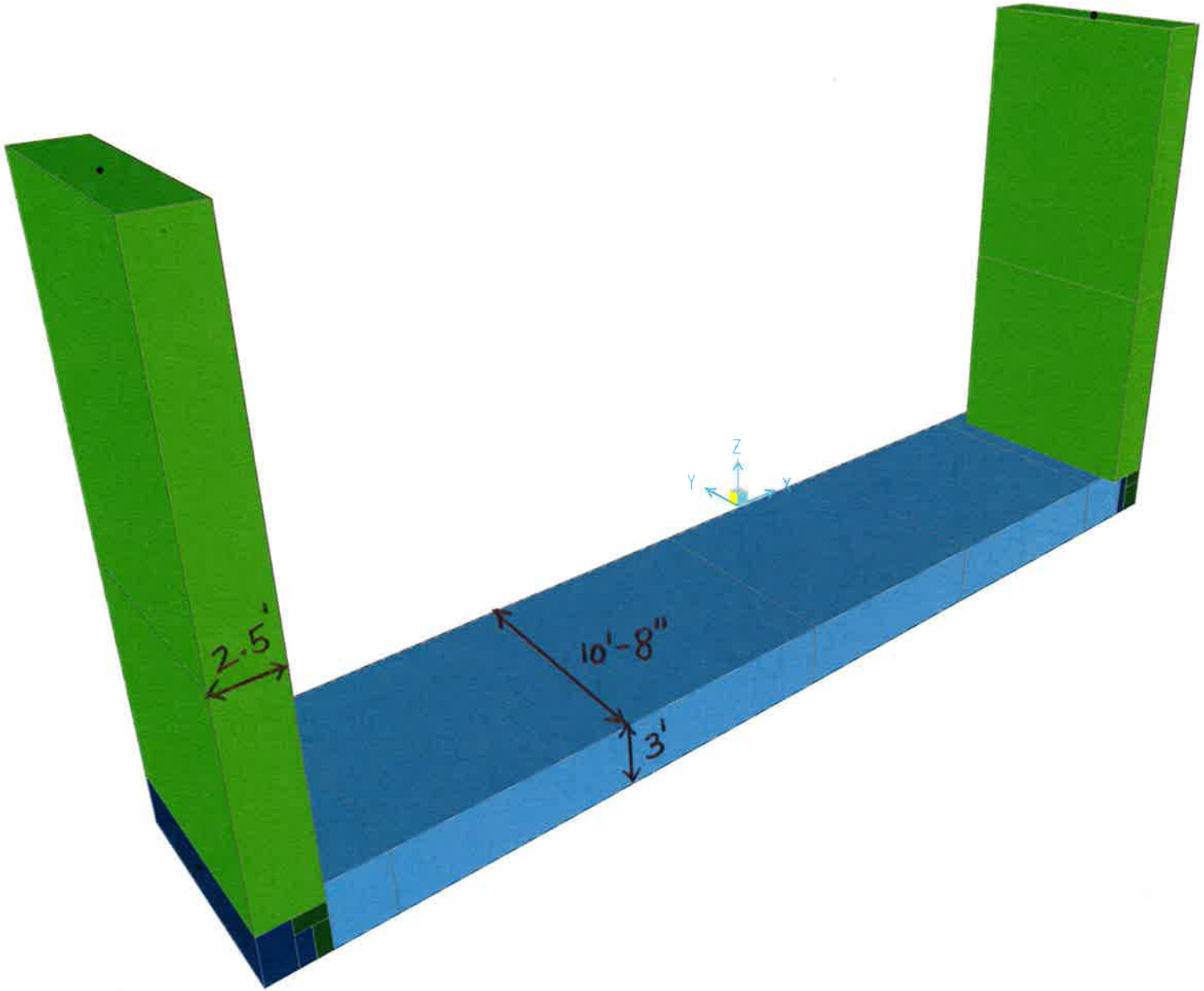
- LARGEST PILE TRIBUTARY WIDTH (10'-8") IS PAIRED W/ HIGHEST SOIL LOADS (AT DOWNSTREAM END OF MONO.) TO CREATE THIS 2-D MODEL.
- RIGID LINKS AS PER ETL 1110-2-365 ARE USED TO SIMULATE CONCRETE JOINTS, WHERE CORNER CONNECTIONS ARE MUCH STRONGER THAN THE INDIVIDUAL MEMBERS. RIGID LINK IS THE MIDDLE 1/2 OF A JOINT.



MODEL OVERVIEW:



Model Overview:



URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: MONOLITH U-1 | Computed by: LBR | Sheet ____ of ____
SAP MODEL DEAD LOAD | Checked by: ____ | Date: 7/2013
Date: ____
Reference

DEAD LOAD CALIBRATION:

↳ ACTUAL DEAD WEIGHT:

WALLS: 24' height × 2.5' thick × 10'-8" wide × 150PCF × 2 = 192,000 LB
SLAB: 51.805' long × 3' thick × 10'-8" wide × 150PCF = 248,662.5 LB

Σ = 440,662.5 LB

↳ SAP DEAD LOAD REACTION = 440,669.46 LB

↳ DIFFERENCE OF 6.96 LB → OK

*NOTE ON MODEL LOCATION:

THE PILE SPACING OF THE FIRST PILE ROW (AT THE WIDE END OF THE MONOLITH) IS SLIGHTLY LARGER THAN THAT OF THE ANALYZED STRIP. THE DIFFERENCE IN PILE SPACING IS ABOUT 4.5". BECAUSE THESE MORE WIDELY SPACED PILES CARRY LESS TRIBUTARY LOAD (TRIB. WIDTH = 4' + 10'-8"/2 = 9'-4") & THE SOIL SURROUNDING THE MONOLITH IS AT ITS LOWEST (B/W EL -4.0 & EL 0.0) IT CAN BE CONCLUDED THAT THE REDUCTION OF LOADING IN THIS REGION WILL OUTWEIGH THE SLIGHTLY LARGER PILE SPACING.

URS

Job: Maurepas Freshwater Diversion | **Project #:** 10001876

Description: Load Calculations for SAP Inflow U-Frame Monoliths | **Computed By:** LBR | **Date:** Jul-13 | **Page:** of

Checked By: | **Date:** | **Sheet:** of

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf	$\gamma_{fill, wet}$ =	115	pcf	Flood Elevation =	31.5	ft NAVD 88
γ_{water} =	62.4	pcf	$\gamma_{fill, eff}$ =	52.6	pcf	Riprap thickness =	2.25	ft
γ_{riprap} =	132	pcf	K_0 =	0.95		$q_{surcharge, construction}$ =	300	psf
$\gamma_{riprap, eff}$ =	69.6	pcf						

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure Including Riprap:

*Above water table: $P_y = \gamma_{riprap} * Z_{riprap} + \gamma_{fill, wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{riprap, eff} * Z_{riprap} + \gamma_{fill, eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap & Surcharge:

*Above water table: $P_y = K_0 * (q_{surch, const} + q_{riprap} + \gamma_{fill, wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * [q_{surch, const} + q_{riprap, eff} + \gamma_{fill, eff} * Z_{fill}]$

$q_{riprap} = \gamma_{riprap} *$ thickness = 297 psf

$q_{riprap, eff} = \gamma_{riprap, eff} *$ thickness = 156.6 psf

*** MODEL U-1:** Model is of a 10ft-8in wide strip & uses maximum grade elevations on either side of the U-frame.

T.O. Wall Elevation =	20.0	ft NAVD 88	Wall Thickness =	2.75	ft
T.O. Slab Elevation =	-4.0	ft NAVD 88	Slab Thickness =	3	ft
T.O. Bank Elevation, *East* Side =	5.0	ft NAVD 88 (approx.)			
T.O. Bank Elevation, *West* Side =	6.0	ft NAVD 88 (approx.)			

* Water Loads: Water loads cancel out on the wing walls because water is able to flow behind walls.

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
31.50	0.0
20.00	717.6
6.00	1591.2
5.00	1653.6
-4.00	2215.2
-4.75	2262.0
-5.50	2308.8
-7.00	2402.4

Vertical Force on T.O. Slab = 2215.2 psf

Uplift Force on B.O. Slab = 2402.4 psf

* Construction Surcharge Load:

Below Top of Soil = $K_0 * q_{surcharge}$ = 285 psf

* Soil Loads, Dry (Const.): Construction surcharge loads applied separately.

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
5.00	0.0
2.75	282.2
-4.75	1101.5
-5.50	1183.5
-7.00	1347.3

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
6.00	0.0
3.75	282.2
-4.75	1210.8
-5.50	1292.7
-7.00	1456.6

* Soil Loads, UNEVEN Dry (Const.): Soil load EL 3.75 on west side, only to EL -1.25 on east side. On west/high side, soil placed to top of soil (bottom of riprap). Riprap not yet installed

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
-1.25	0.0
-4.75	382.4
-5.50	464.3
-7.00	628.2

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
6.00	0.0
3.75	0.0
-4.75	928.6
-5.50	1010.6
-7.00	1174.4

* Soil Loads, Sat (Water to EL 31.5):

EAST

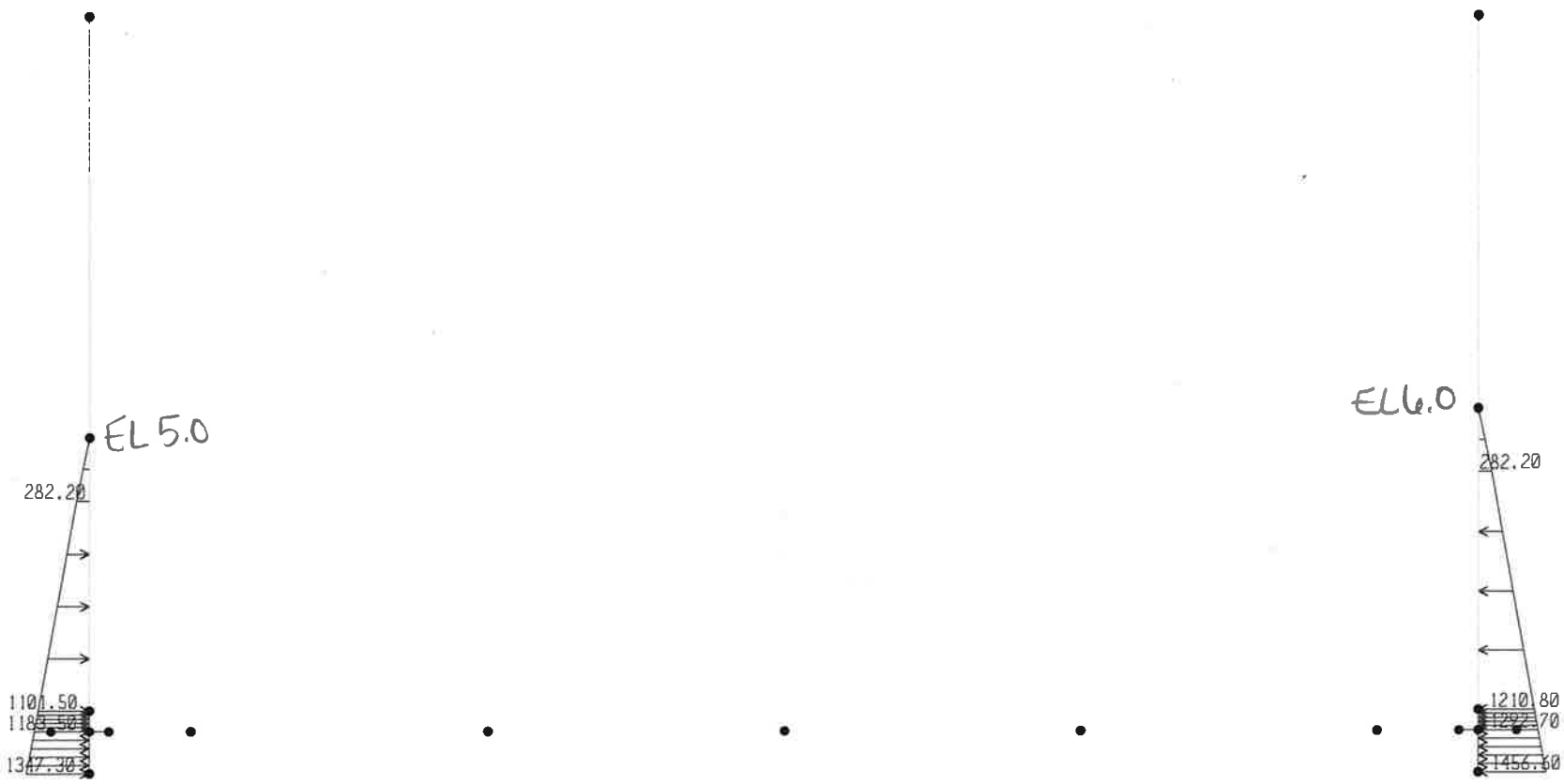
Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
5.00	0.0
2.75	148.8
-4.75	523.5
-5.50	561.0
-7.00	636.0

WEST

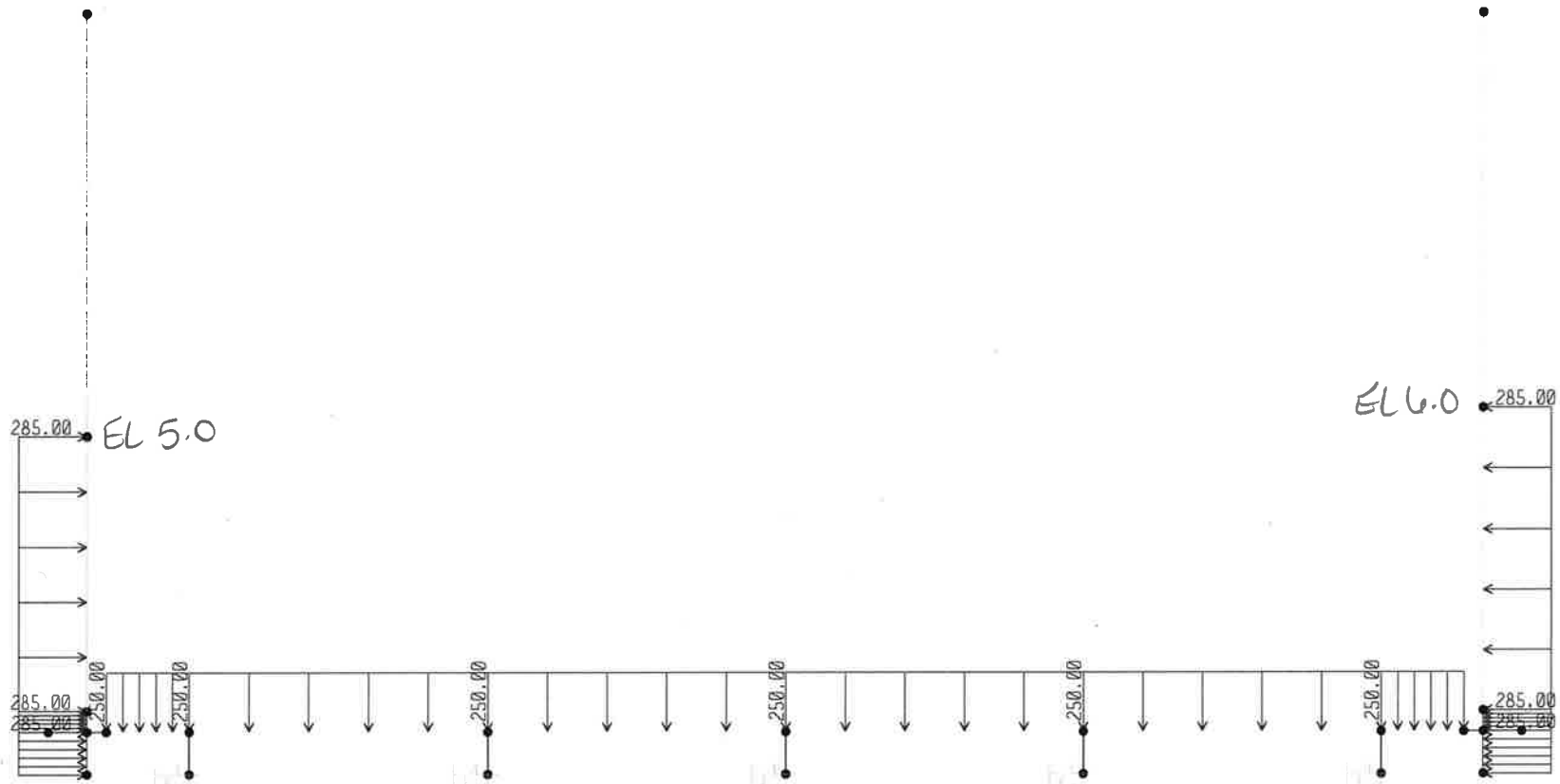
Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
6.00	0.0
3.75	148.8
-4.75	573.5
-5.50	611.0
-7.00	685.9

* NOTE: All loads are calculated on a per-foot basis. In the model, these loads are multiplied by a scale factor of 10.67 when combined into load cases. This creates a 10'-8" strip of load for soil, water, surcharge, etc.

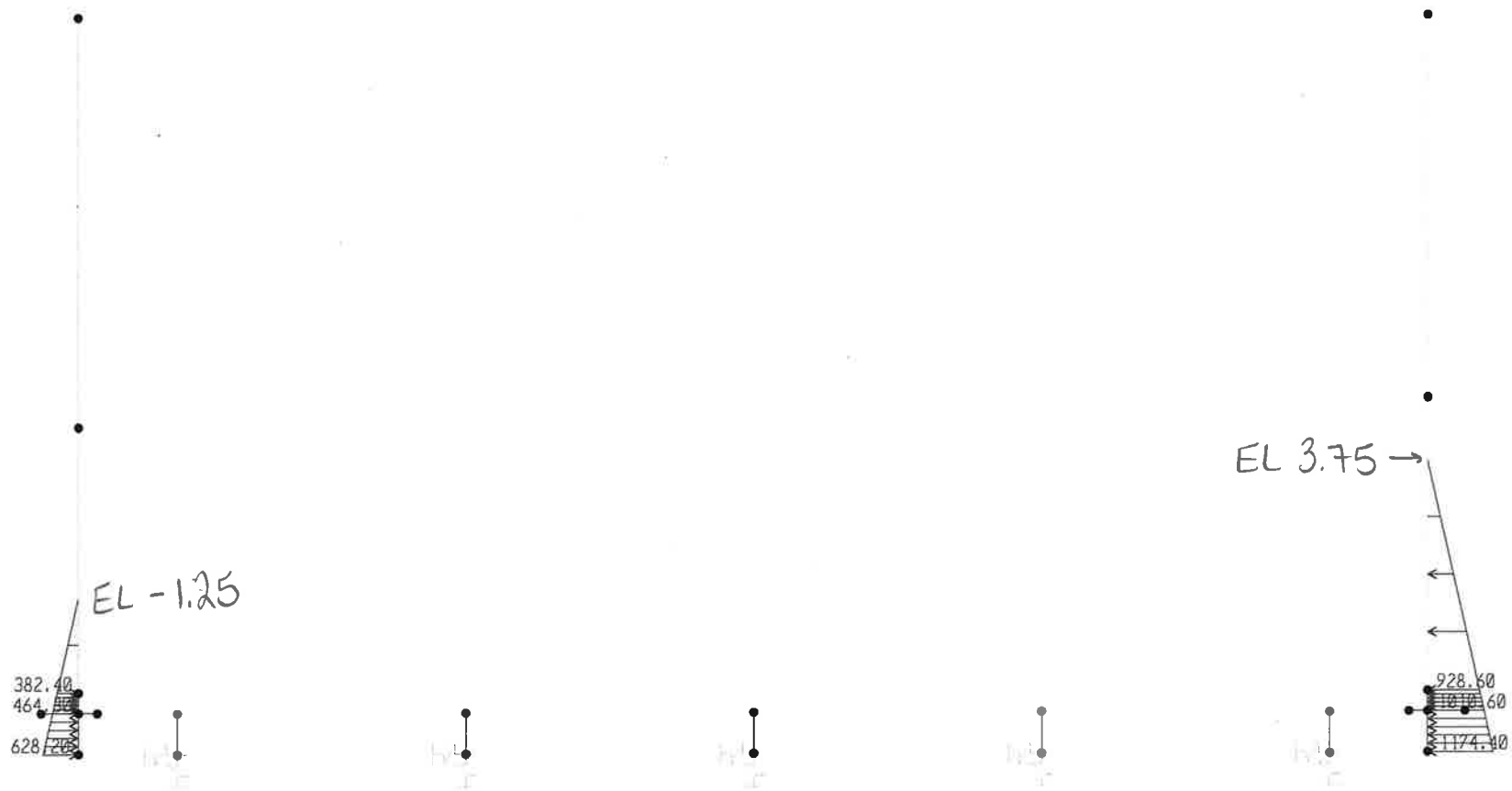
Dry Soil - Construction:



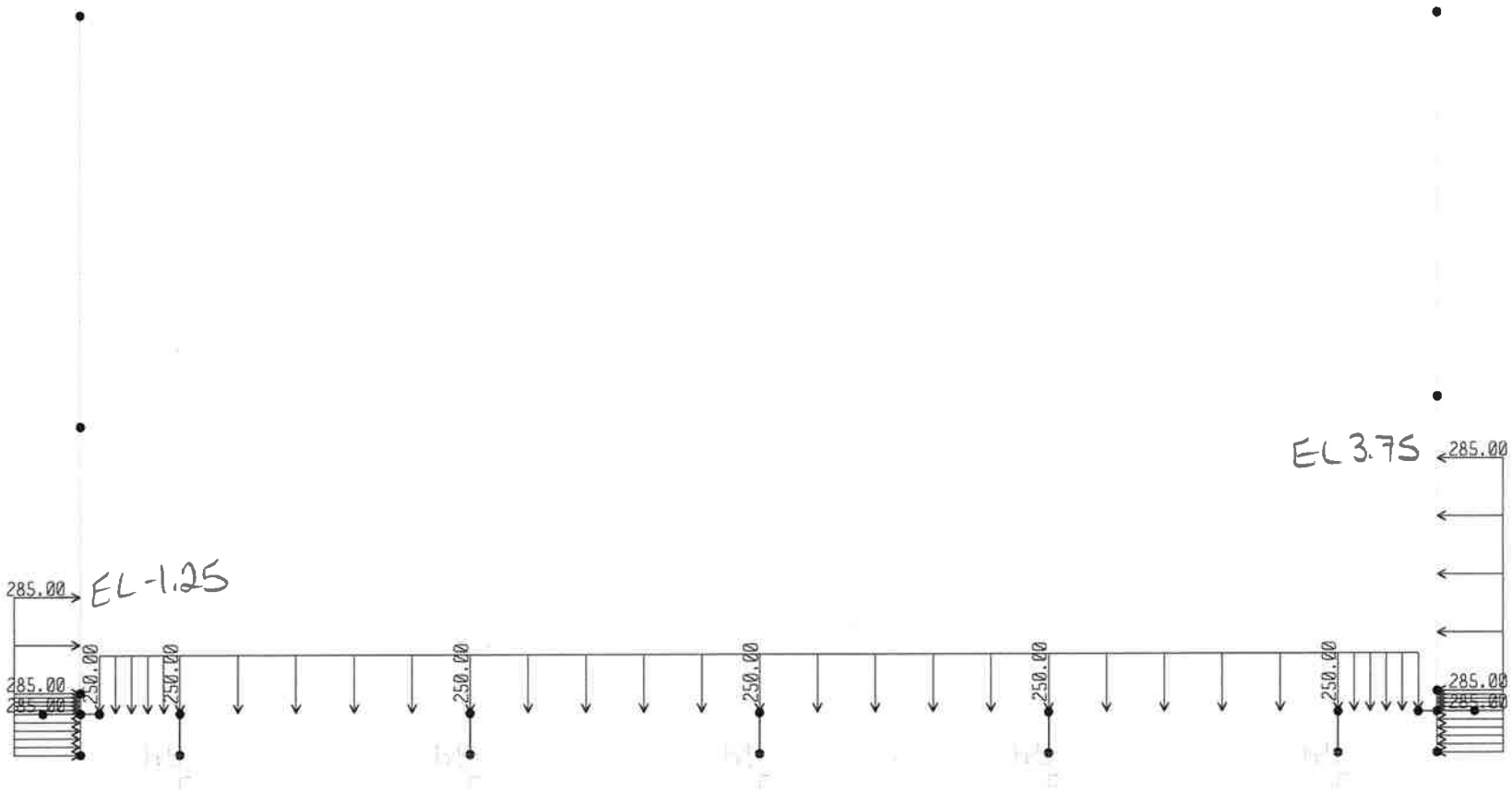
Construction Surcharge:



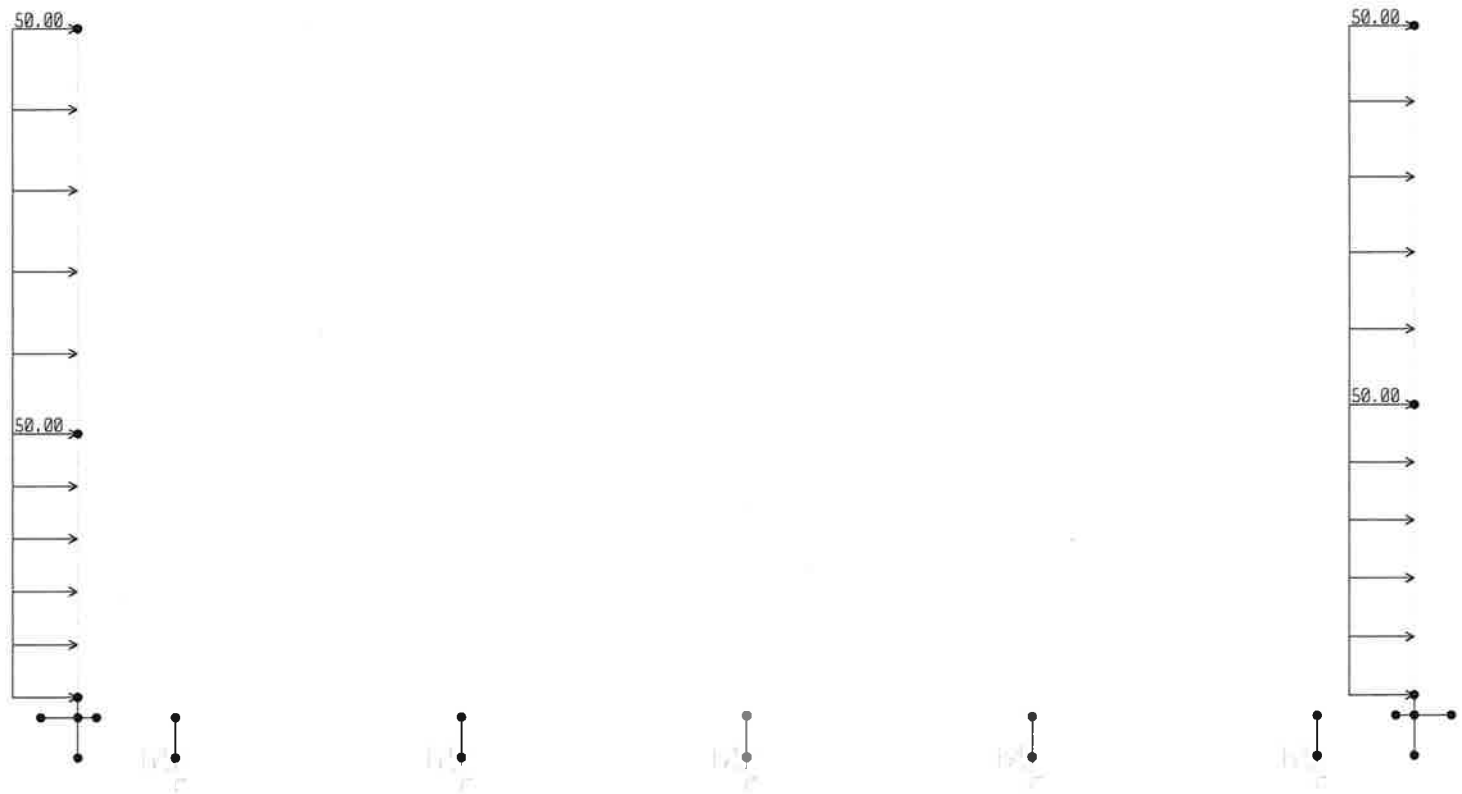
Dry Soil - Uneven Construction:



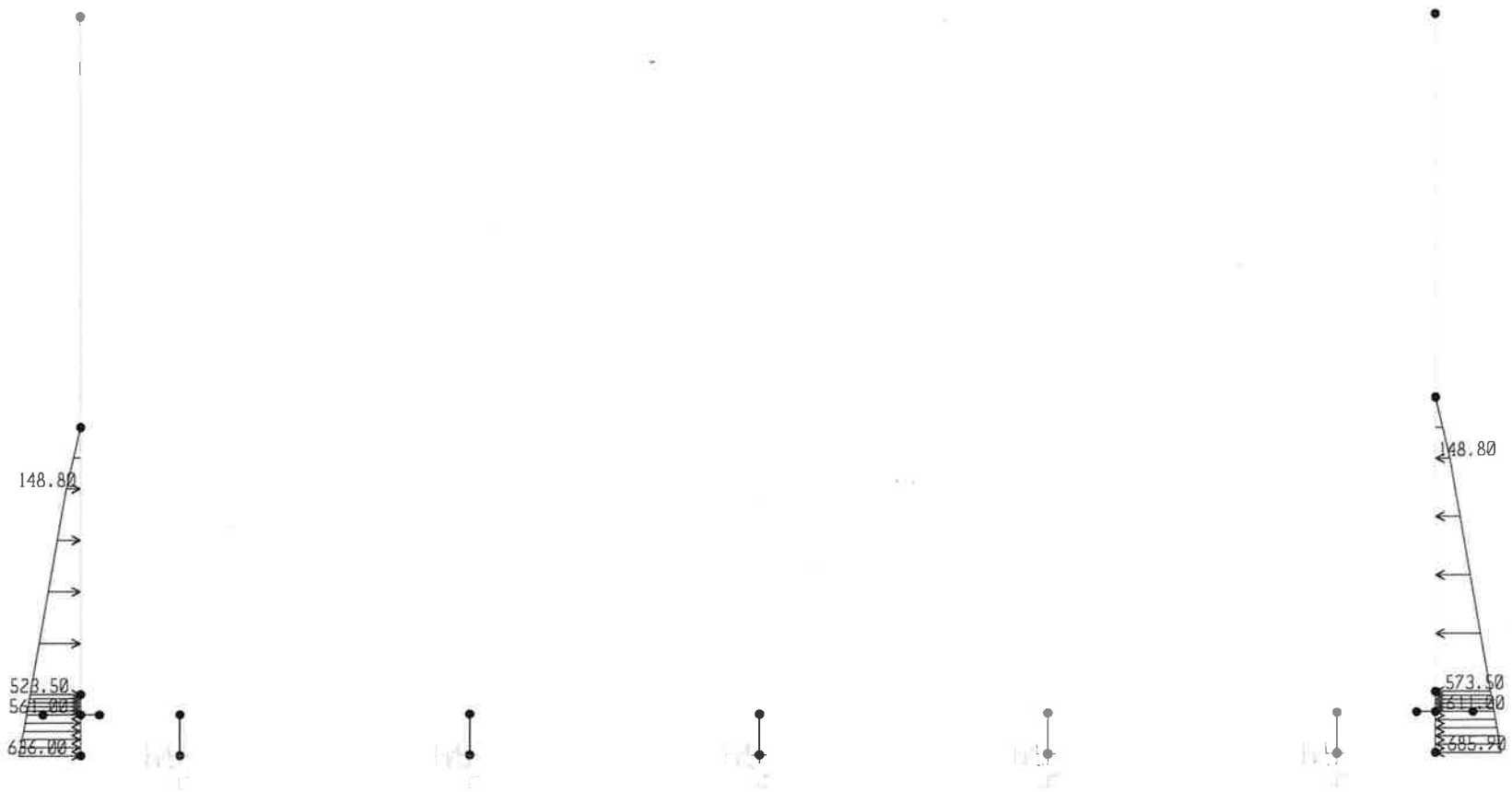
Surcharge - Uneven Construction:



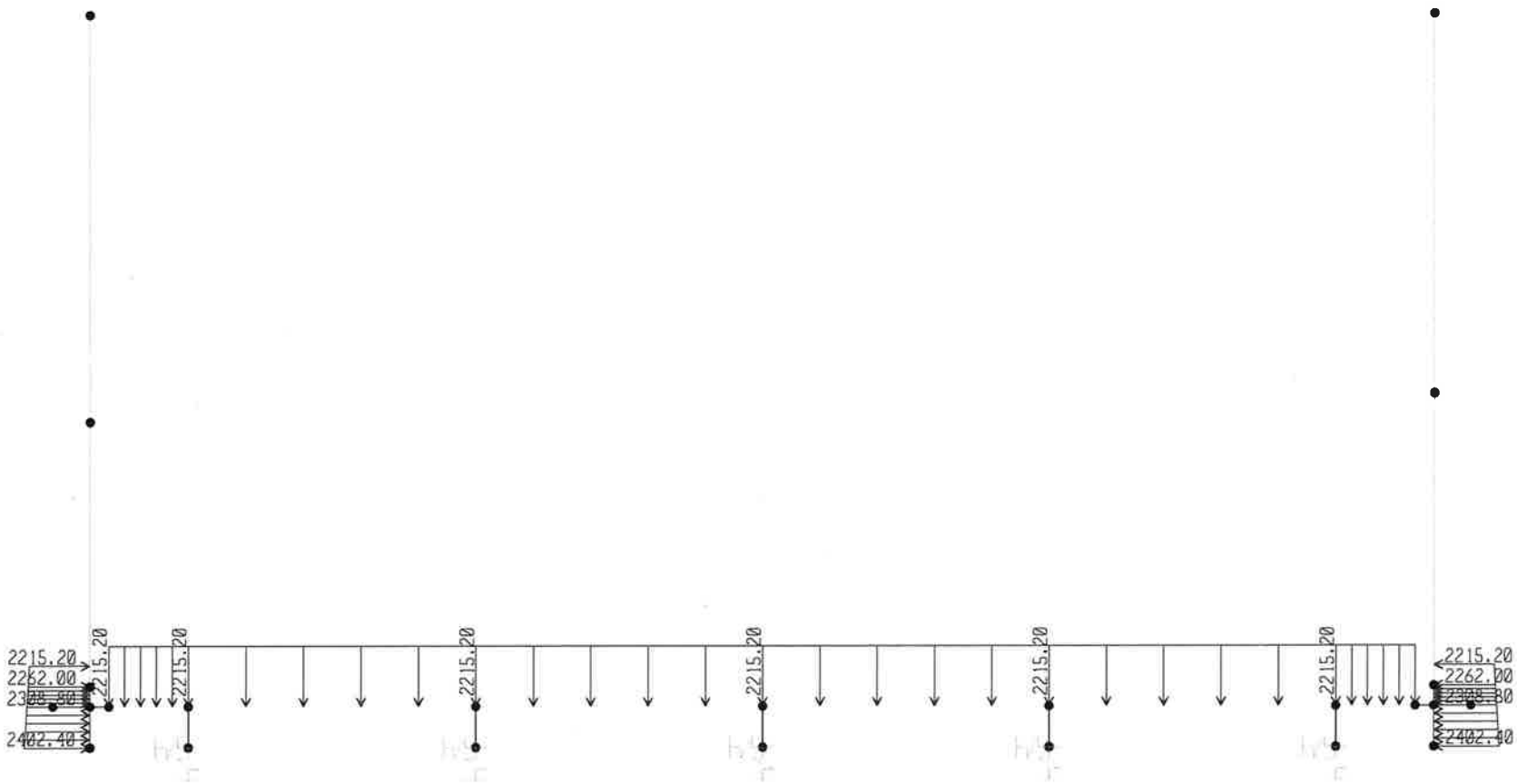
Wind During Construction:



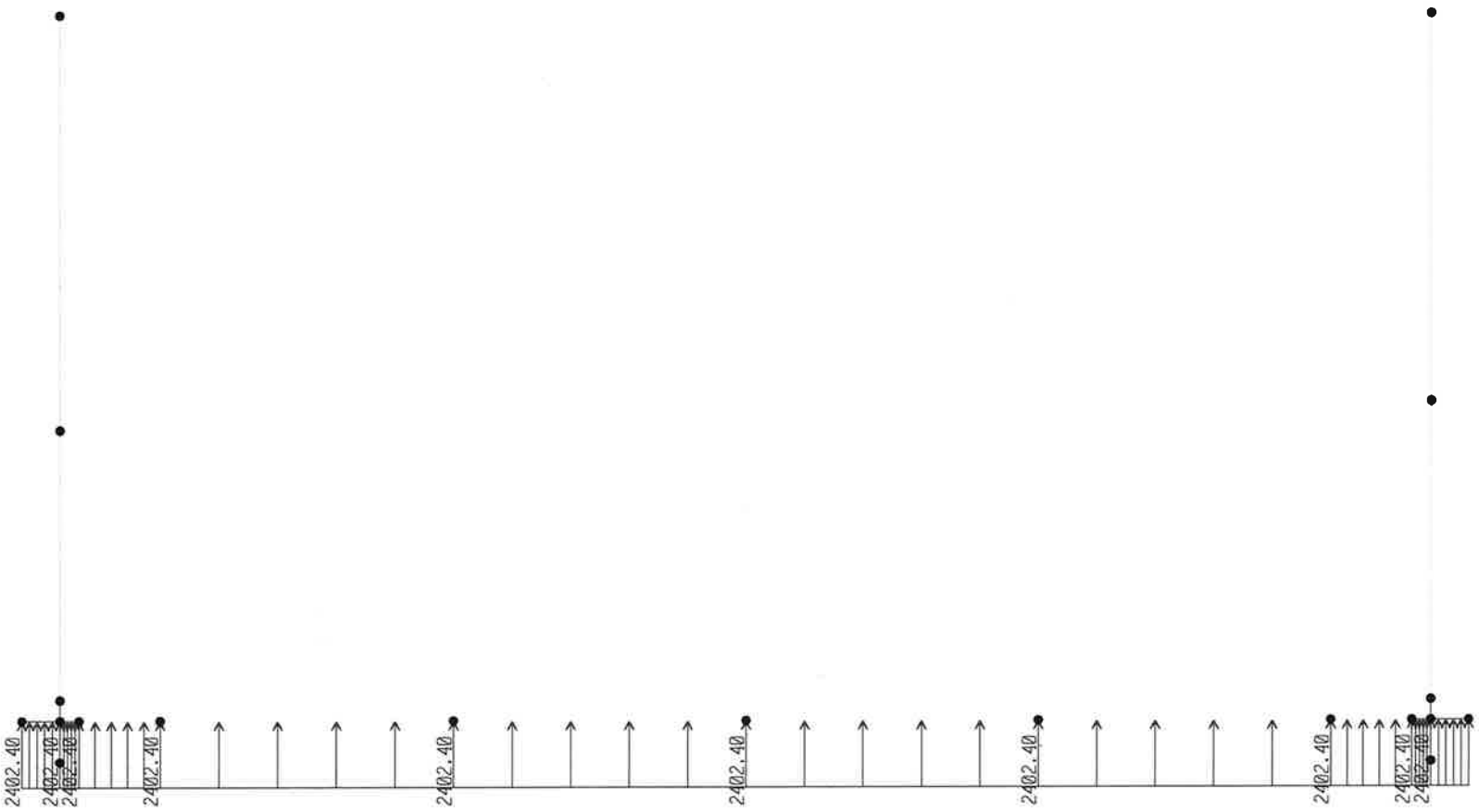
Saturated Soil:



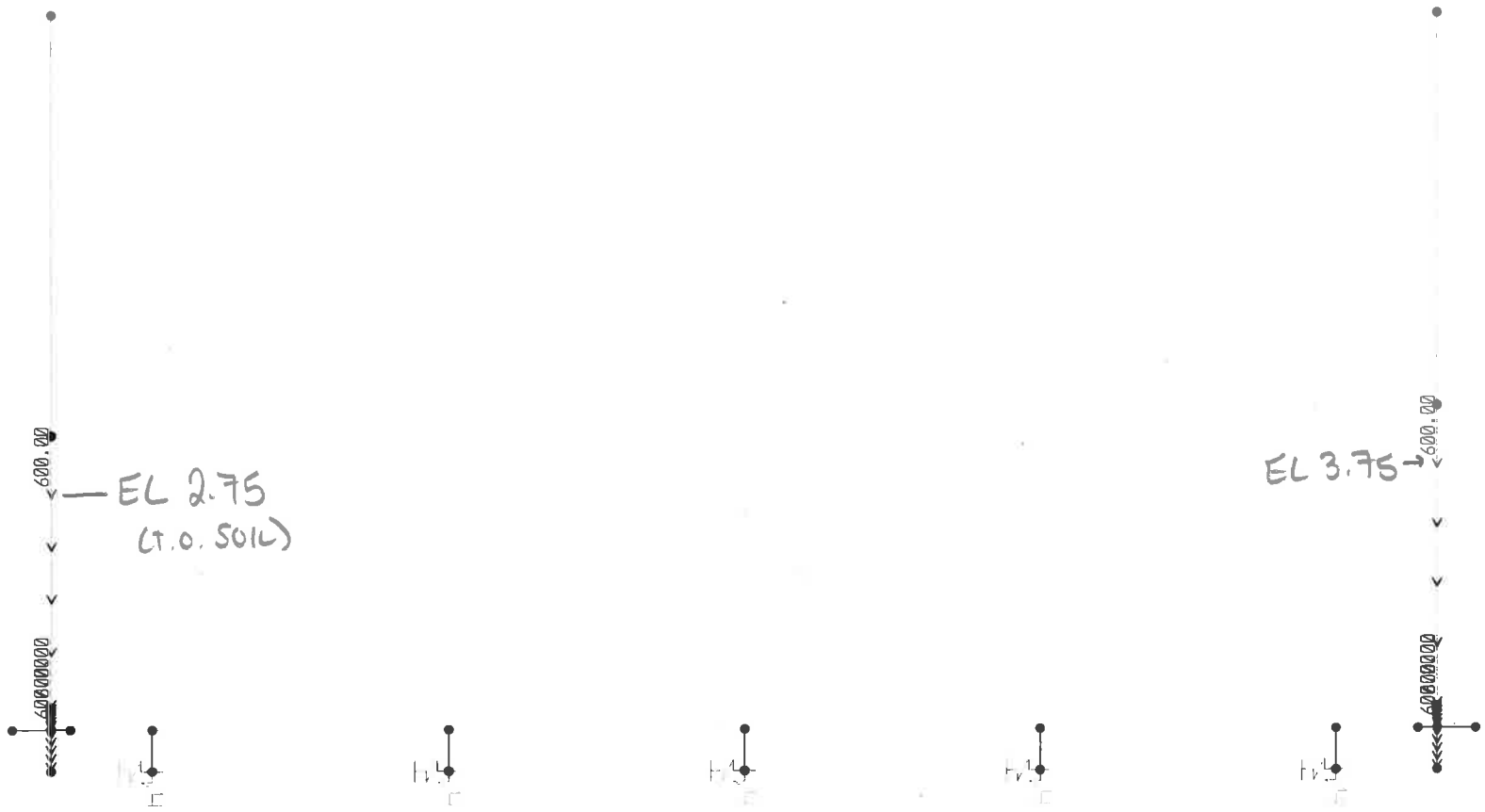
Water to EL 31.5:



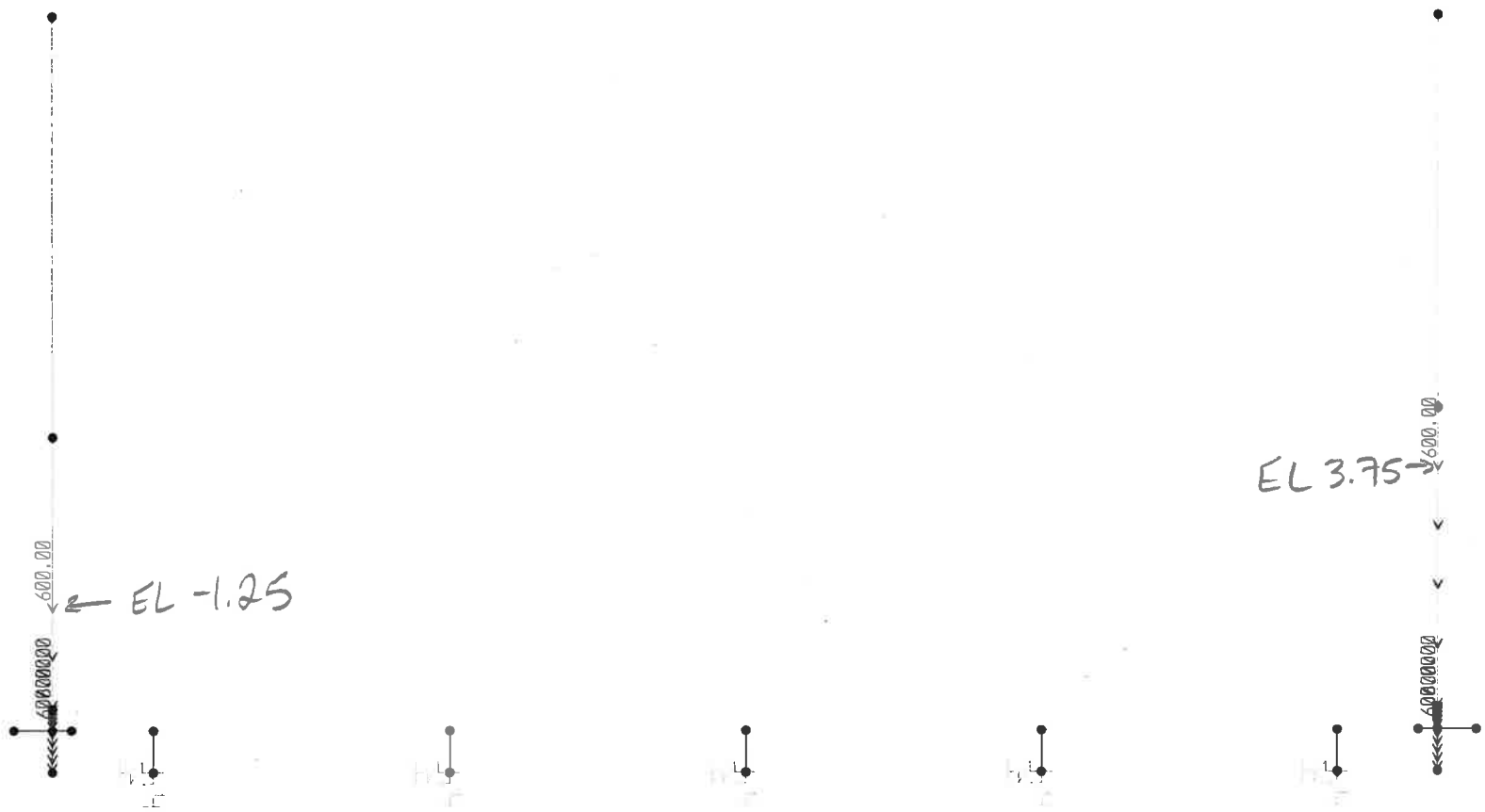
Uplift - Water to EL 31.5:



Drag Load due to Settlement:



Drag Load due to Settlement -
Uneven Construction:



PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

* A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use springs equivalent to a pile with tip EL -80.0 (1488.1 k/in) and lateral load of 10k (77.63 k/in)

TABLE: Joint Reactions

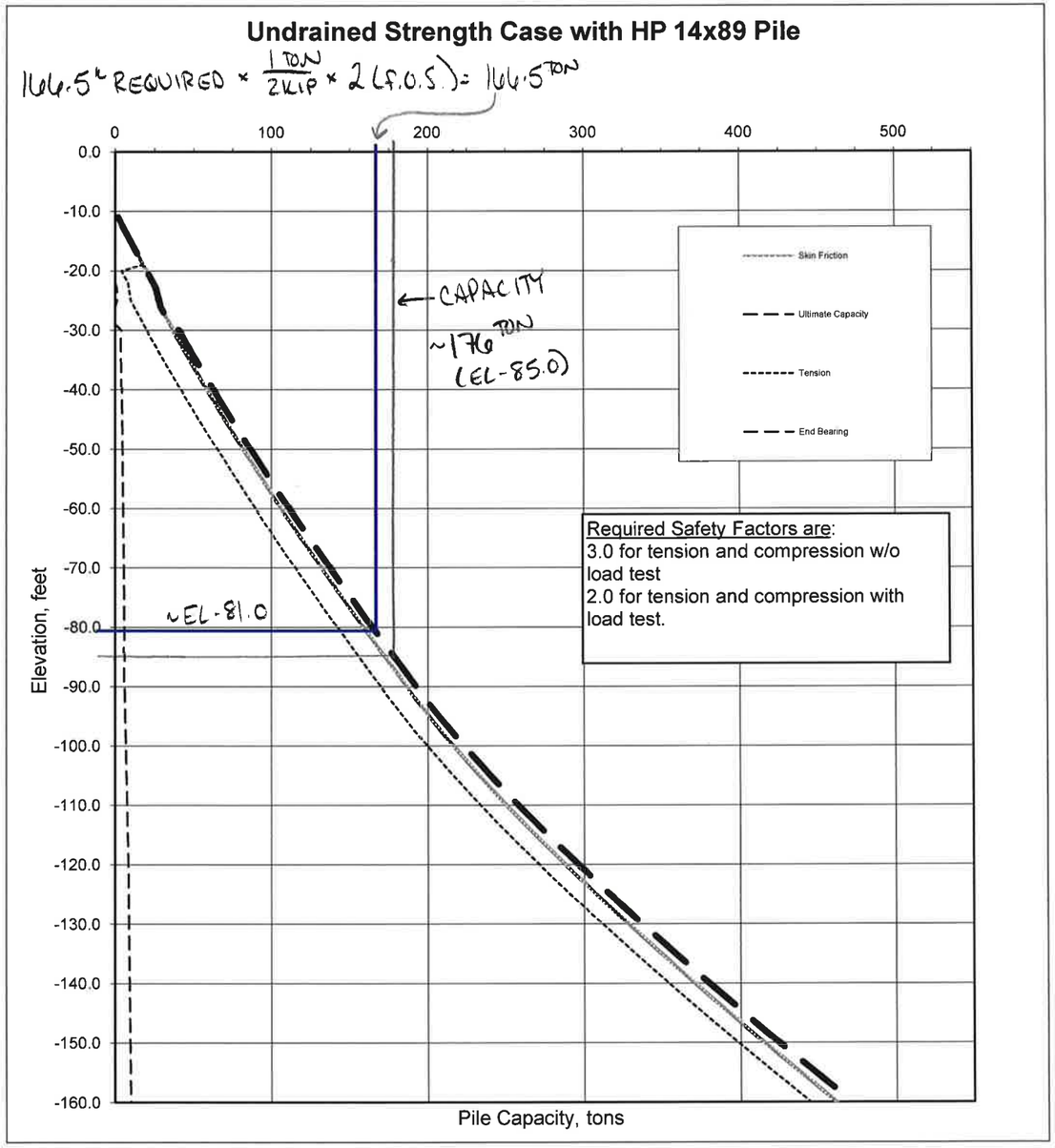
Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	DEAD	-0.85	0	143.68	0	0	0
P-2	DEAD	-0.40	0	59.65	0	0	0
P-3	DEAD	0.00	0	34.01	0	0	0
P-4	DEAD	0.40	0	59.65	0	0	0
P-5	DEAD	0.85	0	143.68	0	0	0
P-1	1a	3.11	0	144.86	0	0	0
P-2	1a	3.30	0	100.44	0	0	0
P-3	1a	3.63	0	84.26	0	0	0
P-4	1a	3.93	0	101.21	0	0	0
P-5	1a	4.03	0	138.09	0	0	0
P-1	1b	11.87	0	166.39	0	0	0
P-2	1b	12.32	0	90.75	0	0	0
P-3	1b	12.72	0	69.71	0	0	0
P-4	1b	13.07	0	92.07	0	0	0
P-5	1b	13.31	0	149.94	0	0	0
P-1	1c	-6.03	0	133.69	0	0	0
P-2	1c	-5.73	0	61.15	0	0	0
P-3	1c	-5.38	0	34.01	0	0	0
P-4	1c	-4.93	0	58.15	0	0	0
P-5	1c	-4.34	0	153.67	0	0	0
P-1	2	0.97	0	72.64	0	0	0
P-2	2	1.17	0	38.85	0	0	0
P-3	2	1.42	0	27.67	0	0	0
P-4	2	1.66	0	39.08	0	0	0
P-5	2	1.83	0	70.31	0	0	0

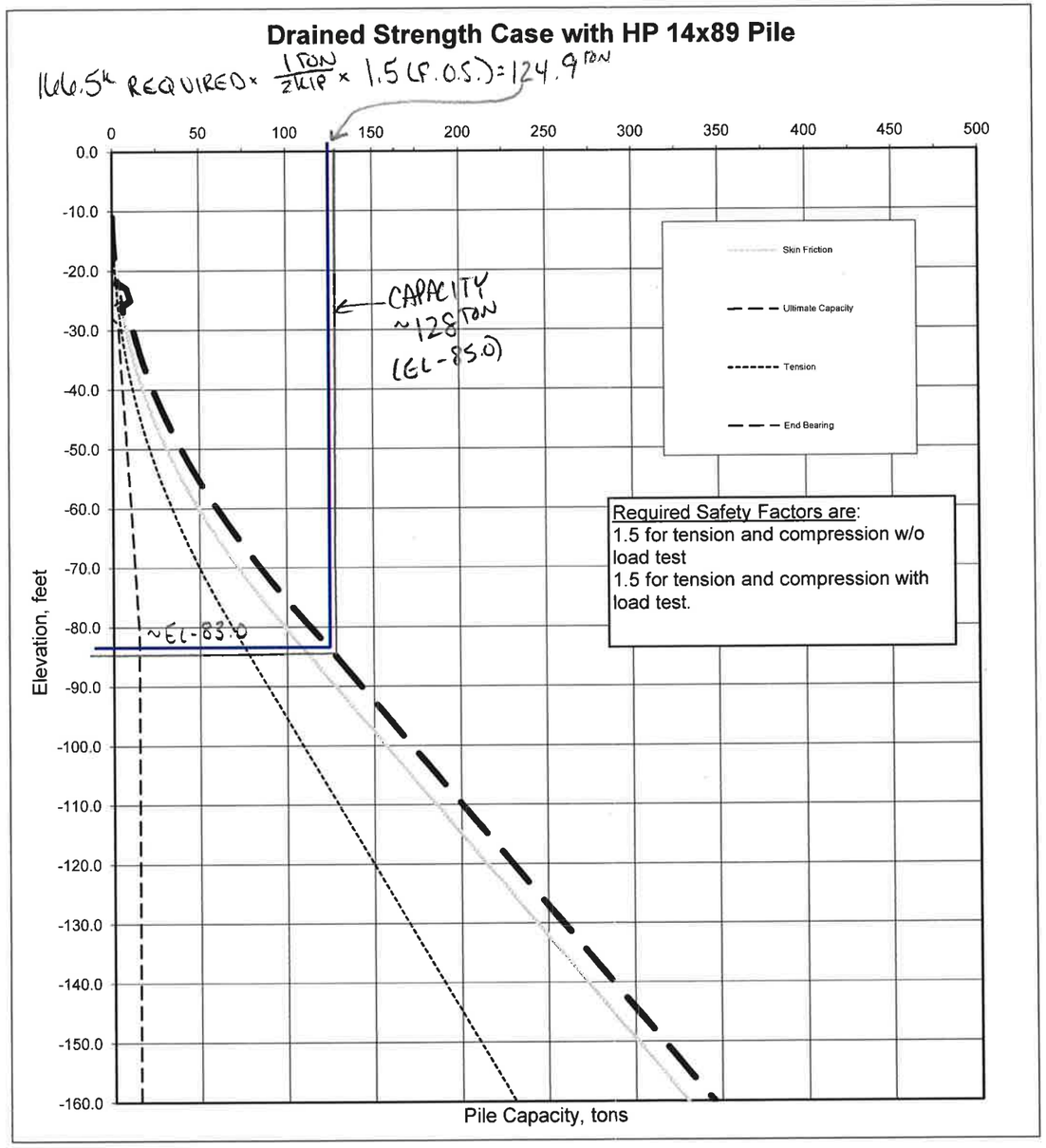
Vertical Reactions:

MAXIMUM REACTION = 166.39 kips
MINIMUM REACTION = 27.67 kips

Horizontal Reactions:

MAXIMUM REACTION = 13.31 kips
MINIMUM REACTION = -6.03 kips





Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

PUT TIPS @ EL -85.0

C_{ALLOW} = 170.67k (DRAINED CONTROLS)

Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	URS	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP **Computed By:** LBR **Date:** Jul-13 **Page:** of

Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

PILE/SPRING STIFFNESS INPUT IN SAP **HP14x73 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required from the pile capacity curves = -85.0 NAVD88

Top of pile Elevation including 9" Pile embedment = (-7.0 + 0.75) ft = -6.25 NAVD88

Therefore, required length of pile = 78.75 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

Modulus of Elasticity of the pile (E) = 29,000 ksi

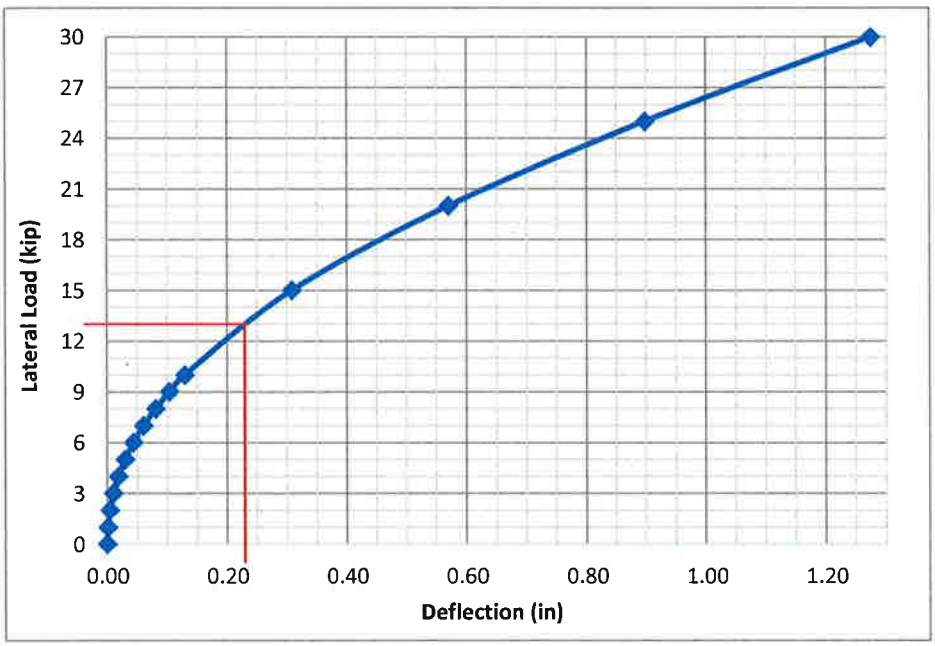
Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 1393.7 k/in

= **16724 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 13k reaction, deflection is about 0.23"

Spring = 13k/0.23" = 56.522 k/in = 678.26 k/ft

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	DEAD	-0.64	0	142.36	0	0	0
P-2	DEAD	-0.31	0	60.43	0	0	0
P-3	DEAD	0.00	0	35.08	0	0	0
P-4	DEAD	0.31	0	60.43	0	0	0
P-5	DEAD	0.64	0	142.36	0	0	0
P-1	1a	3.23	0	144.18	0	0	0
P-2	1a	3.37	0	100.83	0	0	0
P-3	1a	3.62	0	84.93	0	0	0
P-4	1a	3.85	0	101.43	0	0	0
P-5	1a	3.92	0	137.49	0	0	0
P-1	1b	12.07	0	165.24	0	0	0
P-2	1b	12.40	0	91.54	0	0	0
P-3	1b	12.71	0	70.61	0	0	0
P-4	1b	12.97	0	92.47	0	0	0
P-5	1b	13.15	0	148.99	0	0	0
P-1	1c	-5.85	0	132.51	0	0	0
P-2	1c	-5.63	0	61.66	0	0	0
P-3	1c	-5.35	0	35.08	0	0	0
P-4	1c	-5.01	0	59.20	0	0	0
P-5	1c	-4.57	0	152.21	0	0	0
P-1	2	1.08	0	72.12	0	0	0
P-2	2	1.23	0	39.15	0	0	0
P-3	2	1.42	0	28.13	0	0	0
P-4	2	1.60	0	39.33	0	0	0
P-5	2	1.73	0	69.82	0	0	0

Vertical Reactions:

MAXIMUM REACTION = 165.24 kips

MINIMUM REACTION = 28.13 kips

Horizontal Reactions:

MAXIMUM REACTION = 13.15 kips

MINIMUM REACTION = -5.85 kips

$C_{allowable}$ = 170.67k > 165.2k - OK

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Pile displacements	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	DEAD	0.0113	0	-0.1021
P-2	DEAD	0.0055	0	-0.0434
P-3	DEAD	0.0000	0	-0.0252
P-4	DEAD	-0.0055	0	-0.0434
P-5	DEAD	-0.0113	0	-0.1021
P-1	1a	-0.0572	0	-0.1034
P-2	1a	-0.0597	0	-0.0723
P-3	1a	-0.0641	0	-0.0609
P-4	1a	-0.0681	0	-0.0728
P-5	1a	-0.0694	0	-0.0987
P-1	1b	-0.2135	0	-0.1186
P-2	1b	-0.2193	0	-0.0657
P-3	1b	-0.2248	0	-0.0507
P-4	1b	-0.2294	0	-0.0663
P-5	1b	-0.2327	0	-0.1069
P-1	1c	0.1035	0	-0.0951
P-2	1c	0.0995	0	-0.0442
P-3	1c	0.0947	0	-0.0252
P-4	1c	0.0886	0	-0.0425
P-5	1c	0.0809	0	-0.1092
P-1	2	-0.0191	0	-0.0517
P-2	2	-0.0218	0	-0.0281
P-3	2	-0.0251	0	-0.0202
P-4	2	-0.0282	0	-0.0282
P-5	2	-0.0306	0	-0.0501

Vertical Displacements:

MAXIMUM = -0.020 inch
MINIMUM = -0.119 inch

Horizontal Displacements:

MAXIMUM = 0.104 inch
MINIMUM = -0.233 inch

Maximum horizontal deflection is 0.233". Maximum allowable deflection is 0.75" (for load cases with no allowable overstress). Maximum vertical deflection is 0.119", which is less than maximum allowable of 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.23". The spring has converged.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	1a-ST	2.81	0	203.93	0	0	0
P-2	1a-ST	3.16	0	107.38	0	0	0
P-3	1a-ST	3.61	0	75.12	0	0	0
P-4	1a-ST	4.06	0	109.88	0	0	0
P-5	1a-ST	4.36	0	203.84	0	0	0
P-1	1b-ST	11.76	0	199.50	0	0	0
P-2	1b-ST	12.21	0	92.82	0	0	0
P-3	1b-ST	12.67	0	62.71	0	0	0
P-4	1b-ST	13.12	0	103.27	0	0	0
P-5	1b-ST	13.53	0	216.25	0	0	0
P-1	2-ST	0.66	0	131.87	0	0	0
P-2	2-ST	1.02	0	45.70	0	0	0
P-3	2-ST	1.41	0	18.33	0	0	0
P-4	2-ST	1.80	0	47.78	0	0	0
P-5	2-ST	2.17	0	136.17	0	0	0

Vertical Reactions:

MAXIMUM REACTION = 216.25 kips

MINIMUM REACTION = 18.33 kips

Horizontal Reactions:

MAXIMUM REACTION = 13.53 kips

MINIMUM REACTION = 0.66 kips

* Note: Pile lengths are not being adjusted based on settlement forces. A structural check of the piles will be performed using the pile length required by the traditional load cases. If the structural check is OK for settlement cases, then they will be deemed adequate at EL -90.0. Also, a slab punching shear check will be performed using the reactions from these settlement cases.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	1a-ST	-0.0497	0	-0.1463
P-2	1a-ST	-0.0559	0	-0.0770
P-3	1a-ST	-0.0639	0	-0.0539
P-4	1a-ST	-0.0718	0	-0.0788
P-5	1a-ST	-0.0772	0	-0.1463
P-1	1b-ST	-0.2080	0	-0.1431
P-2	1b-ST	-0.2161	0	-0.0666
P-3	1b-ST	-0.2241	0	-0.0450
P-4	1b-ST	-0.2321	0	-0.0741
P-5	1b-ST	-0.2394	0	-0.1552
P-1	2-ST	-0.0116	0	-0.0946
P-2	2-ST	-0.0180	0	-0.0328
P-3	2-ST	-0.0250	0	-0.0132
P-4	2-ST	-0.0319	0	-0.0343
P-5	2-ST	-0.0383	0	-0.0977

Vertical Displacements:

MAXIMUM = -0.013 inch
MINIMUM = -0.155 inch

Horizontal Displacements:

MAXIMUM = -0.012 inch
MINIMUM = -0.239 inch

Maximum horizontal deflection is 0.239". Maximum allowable deflection is 0.75" (for load cases with no allowable overstress). Maximum vertical deflection is 0.155", which is less than maximum allowable of 0.5". Therefore, all deflections OK.

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: U-1 SOIL & PILE INFO FOR STRUCTURAL CHECK | Computed by: LBR | Sheet ____ of ____
Checked by: ____ | Date: 7/2013 | Date: ____
Reference

E_s: USING P-y CURVE DATA

↳ CALIBRATED SPRING IN SAP → $13^k / 0.23'' = 56.52^k/_{IN}$

↳ FROM CPGA MANUAL, WE KNOW:

PILE STIFFNESS COEFF, $K = \frac{C_o E I}{R^3}$

C_o: FIXETY CONST. = 0.707 FOR CONSTANT E_s, PINNED
E: 29,000,000 PSI
I: 904 IN^4 (STRONG AXIS)
$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 56{,}521.7^{LB}/_{IN} = \frac{(0.707)(29{,}000{,}000\,PSI)(904\,IN^4)}{\left(\sqrt[4]{\frac{29{,}000{,}000 \times 904}{E_s}}\right)^3}$$

SOLVING FOR E_s w/ EXCEL ⇒ $E_s = 1159.33\,PSI = \underline{1.1593\,KSI}$

LATERAL GROUP REDUCTION FACTOR: HSDRS GUIDELINES SECT 4.3

- PARALLEL TO LOAD, TRAILING PILES (NO "FLOOD SIDE" CONDITION)

$R_g = 0.48\left(S_b/b\right)^{0.38}$, $S_b = 10'\text{-}3'' = 124''$ ← SMALLEST OF 3 SPACINGS, $b = 14''$

$= 1.0995$ ⇒ NO REDUCTION NECESSARY

CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONSTANT E_s & UNSUPPORTED LENGTH (CONSERVATIVE)

$PCR = n\sqrt{E_s E I}$, $n = 1$ - PINNED

$$PCR = \sqrt{(1.1593\,KSI)(29{,}000\,KSI)(904\,IN^4)} = \underline{5512.9^k}$$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____ | Sheet ____ of ____

Description: PILE PROPERTIES FOR STRUCTURAL CHECK | Computed by: LBR | Date: 7/2013

Checked by: ____ | Date: ____

Reference

* ALLOWABLE STRESSES: CPGA MANUAL PG 42-43; AISC 9TH ED PG 5-42:

ACC: IF $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

$E = 29{,}000\,KSI$
$F_y = 50\,KSI$
$A = 26.1\,IN^2$
$S.F. = 5/3 \times 6/5 = 2$

THEN $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

OTHERWISE $ACC = PCR / S.F.$

↳ $\sqrt{\frac{2\pi^2 \times 29{,}000\,KSI}{50\,KSI}} = 106.999$ ↳ $\sqrt{\frac{\pi^2 \times 29{,}000\,KSI \times 26.1\,IN^2}{3763.8^k}} = 44.55$

$\therefore ACC = \left[\frac{50\,KSI \times 26.1\,IN^2}{2}\right]\left[1 - \frac{50\,KSI \times 26.1\,IN^2}{4 \times 3763.8^k}\right] = \underline{\underline{595.94^k}}$

AT: $AT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,IN^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$

* COMBINED BENDING FACTOR: CPGA MANUAL P.32

$$COMP = \left[\frac{F3}{ACC} + \cancel{MF1} \times \left(\frac{M1}{AM1}\right) + \cancel{MF2} \times \left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

-NO TENSION FORCES-, MF1 & MF2 ACCOUNT FOR $P\Delta$ - NONE PRESENT

* AXIAL LOAD FACTOR: CPGA MANUAL P.31

$ALF = \frac{F3}{AC} \times \frac{1}{OSF} \leq 1$, AC = ALLOWABLE COMPRESSION = $\underline{294^k}$

USACE SAFETY, AISC SAFETY

↳ $AM1 = S_x \cdot F_y \cdot = (131\,IN^3)(50\,KSI)(5/6)(2/3) = \underline{3638.9^{k \cdot IN}}$

↳ AM2 NOT NECESSARY FOR 2D.

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load	Slenderness Parameters		Structural Check					Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety (5/3*6/5)	ACC = Allow. Axial Comp. Stress	ATT = Allow. Axial Tension Stress	AM1 = AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)				(kips)	(kips)	(kip-in)		Kips-in	Kips-in		
P-1	Dead	-0.64	0	142.36	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	652.50	3639	1	-3.09	0.00	0.23	0.83
P-2	Dead	-0.31	0	60.43	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	-13.74	0.00	0.10	0.35
P-3	Dead	0.00	0	35.08	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	-23.48	0.00	0.06	0.21
P-4	Dead	0.31	0	60.43	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	-13.74	0.00	0.10	0.35
P-5	Dead	0.64	0	142.36	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	-3.09	0.00	0.23	0.83
P-1	1a	3.23	0	144.18	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	90.47	0.00	0.22	0.72
P-2	1a	3.37	0	100.83	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	96.03	0.00	0.16	0.51
P-3	1a	3.62	0	84.93	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	106.08	0.00	0.14	0.43
P-4	1a	3.85	0	101.43	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	115.48	0.00	0.17	0.51
P-5	1a	3.92	0	137.49	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	118.37	0.00	0.22	0.69
P-1	1b	12.07	0	165.24	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	542.86	0.00	0.36	0.83
P-2	1b	12.40	0	91.54	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	563.73	0.00	0.26	0.46
P-3	1b	12.71	0	70.61	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	583.60	0.00	0.24	0.35
P-4	1b	12.97	0	92.47	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	600.46	0.00	0.27	0.46
P-5	1b	13.15	0	148.99	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	612.24	0.00	0.35	0.75
P-1	1c	-5.85	0	132.51	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	203.08	0.00	0.23	0.67
P-2	1c	-5.63	0	61.66	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	192.93	0.00	0.13	0.31
P-3	1c	-5.35	0	35.08	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	180.20	0.00	0.09	0.18
P-4	1c	-5.01	0	59.20	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	165.01	0.00	0.12	0.30
P-5	1c	-4.57	0	152.21	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	145.81	0.00	0.25	0.76
P-1	2	1.08	0	72.12	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	11.56	0.00	0.12	0.42
P-2	2	1.23	0	39.15	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	16.67	0.00	0.07	0.23
P-3	2	1.42	0	28.13	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	23.23	0.00	0.05	0.16
P-4	2	1.60	0	39.33	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	29.53	0.00	0.07	0.23
P-5	2	1.73	0	69.82	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	34.13	0.00	0.12	0.41
P-1	1a-ST	2.81	0	203.93	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	74.10	0.00	0.30	1.02
P-2	1a-ST	3.16	0	107.38	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	87.71	0.00	0.17	0.54
P-3	1a-ST	3.61	0	75.12	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	105.68	0.00	0.13	0.38
P-4	1a-ST	4.06	0	109.88	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	124.19	0.00	0.18	0.55
P-5	1a-ST	4.36	0	203.84	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	136.82	0.00	0.32	1.02
P-1	1b-ST	11.76	0	199.50	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	523.51	0.00	0.40	1.00
P-2	1b-ST	12.21	0	92.82	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	551.68	0.00	0.26	0.47
P-3	1b-ST	12.67	0	62.71	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	581.02	0.00	0.22	0.31
P-4	1b-ST	13.12	0	103.27	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	610.27	0.00	0.29	0.52
P-5	1b-ST	13.53	0	216.25	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1.17	637.38	0.00	0.45	1.09
P-1	2-ST	0.66	0	131.87	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	-2.43	0.00	0.22	0.77
P-2	2-ST	1.02	0	45.70	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	9.53	0.00	0.08	0.27
P-3	2-ST	1.41	0	18.33	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	22.88	0.00	0.04	0.11
P-4	2-ST	1.80	0	47.78	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	36.63	0.00	0.09	0.28
P-5	2-ST	2.17	0	136.17	50	26.10	904.0	326.0	131.0	44.3	29000	1.159	1	1	170.7	0.0	5513	107	37	2	614	653	3639	1	50.04	0.00	0.24	0.80

NO COMBINED BENDING ISSUES DUE TO SETTLEMENT – OK

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	3	ft
Wall Thickness =	2	ft
Tributary Width =	10.67	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

Traditional Cases (no settlement) presented first

Based on results, wall size of 2'-6" may be reduced

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	0	0.00	0.0	0.0	0.0	0.0
1a	118.92	11.15	685.3	64.2	0.0	0.0
1b	67.48	6.33	344.6	32.3	0.0	0.0
1c	22.11	2.07	291.1	27.3	291.1	27.3
2	42.39	3.97	230.8	21.6	0.0	0.0

* Shear values taken at a distance 'd'= 19.5in from the face of the slab.

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

Max. Shear = 11.1 kip

Max. Moment = 64.2 kip-ft (controls exterior reinforcement)

Min. Moment = 27.3 kip-ft (controls interior reinforcement) ← CONTROLS OVER SETTLEMENT CASES

*** Reinforcing Limits:**

A_{gross} = 24in * 12in strip = 288 in^2

d = 24in - 4in cover - 1/2 bar diameter = 19.50 in — #8 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.078 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 0.806 in^2 — EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.740 in^2 — ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 0.780 in^2 — ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.078 in^2**	- half each face
	Min. T&S Rebar =	**0.806 in^2**	- half each face
	Min. Flexural Rebar =	**0.780 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 19.5in

= 25,159 lb

ϕVc = 25.2kip > Vu = 11.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in^2 * 60ksi * (19.5in - 1.162in / 2)
= 807.09 kip-in/ft
= 67.26 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 64.2kip-ft → Use #8 @ 12"

Interior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in^2 * 60ksi * (19.5in - 1.162in / 2)
= 807.09 kip-in/ft
= 67.26 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 27.3kip-ft → Use #8 @ 12"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	265.21	24.86	0.0	0.0	985.1	92.4
1a	243.10	22.79	686.8	64.4	572.7	53.7
1b	243.10	22.79	250.8	23.5	867.5	81.3
1c	227.31	21.31	74.7	7.0	1133.5	106.3
2	145.19	13.61	196.1	18.4	422.9	39.6

Shear & Moment values taken at faces of connections (where slab meets wall).

Max. Shear = 24.9 kip
Max. Moment = 64.4 kip-ft (controls bottom reinforcement) ← CONTROLS OVER SETTLEMENT CASES
Min. Moment = 106.3 kip-ft (controls top reinforcement)

*** Reinforcing Limits:** A_{gross} = 36in * 12in strip = 432 in^2
d = 36in - 4in cover - 1/2 bar diameter = 31.44 in #9 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 4.617 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 1.210 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 1.193 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.257 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**4.617 in^2**	- half each face
	Min. T&S Rebar =	**1.210 in^2**	- half each face
	Min. Flexural Rebar =	**1.257 in^2**	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= $0.85 * 2 * \sqrt{4000} * 12in * 31.436in$

= 40,559 lb

ϕVc = 40.6kip > Vu = 24.9kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2))$ $= \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try #9 @ 12" to start: As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = $1 * 60ksi / (0.85 * 4ksi * 12in)$ = 1.471 in

$\phi Mn = 0.9 * 1in^2 * 60ksi * (31.436in - 1.471in / 2)$

= 1657.8 kip-in/ft

= 138.15 kip-ft/ft

ϕMn = 138.2kip-ft > Mu = 64.4kip-ft → Use #9 @ 12"

Top Face:

* Will try #9 @ 12" to start: As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = $1 * 60ksi / (0.85 * 4ksi * 12in)$ = 1.471 in

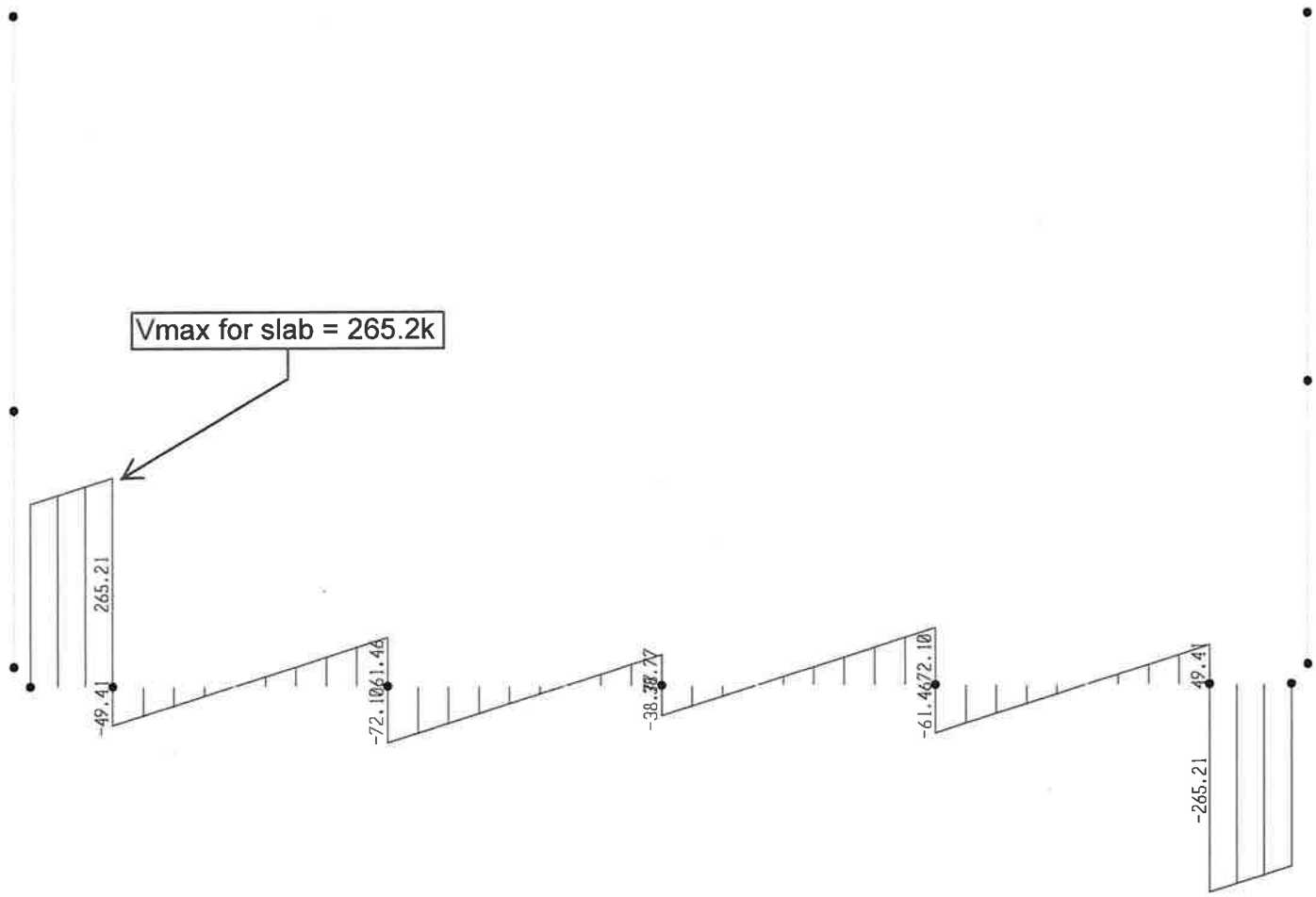
$\phi Mn = 0.9 * 1in^2 * 60ksi * (31.436in - 1.471in / 2)$

= 1657.8 kip-in/ft

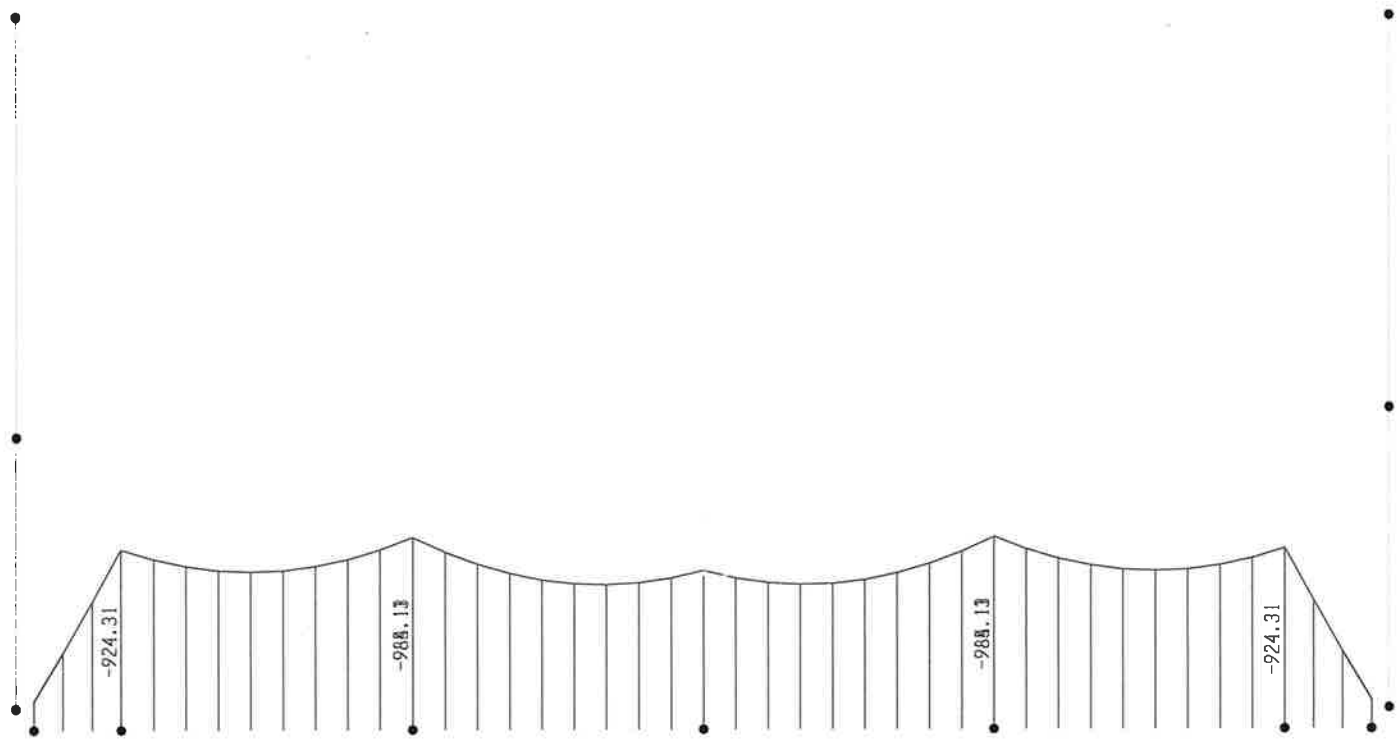
= 138.15 kip-ft/ft

ϕMn = 138.2kip-ft > Mu = 106.3kip-ft → Use #9 @ 12"

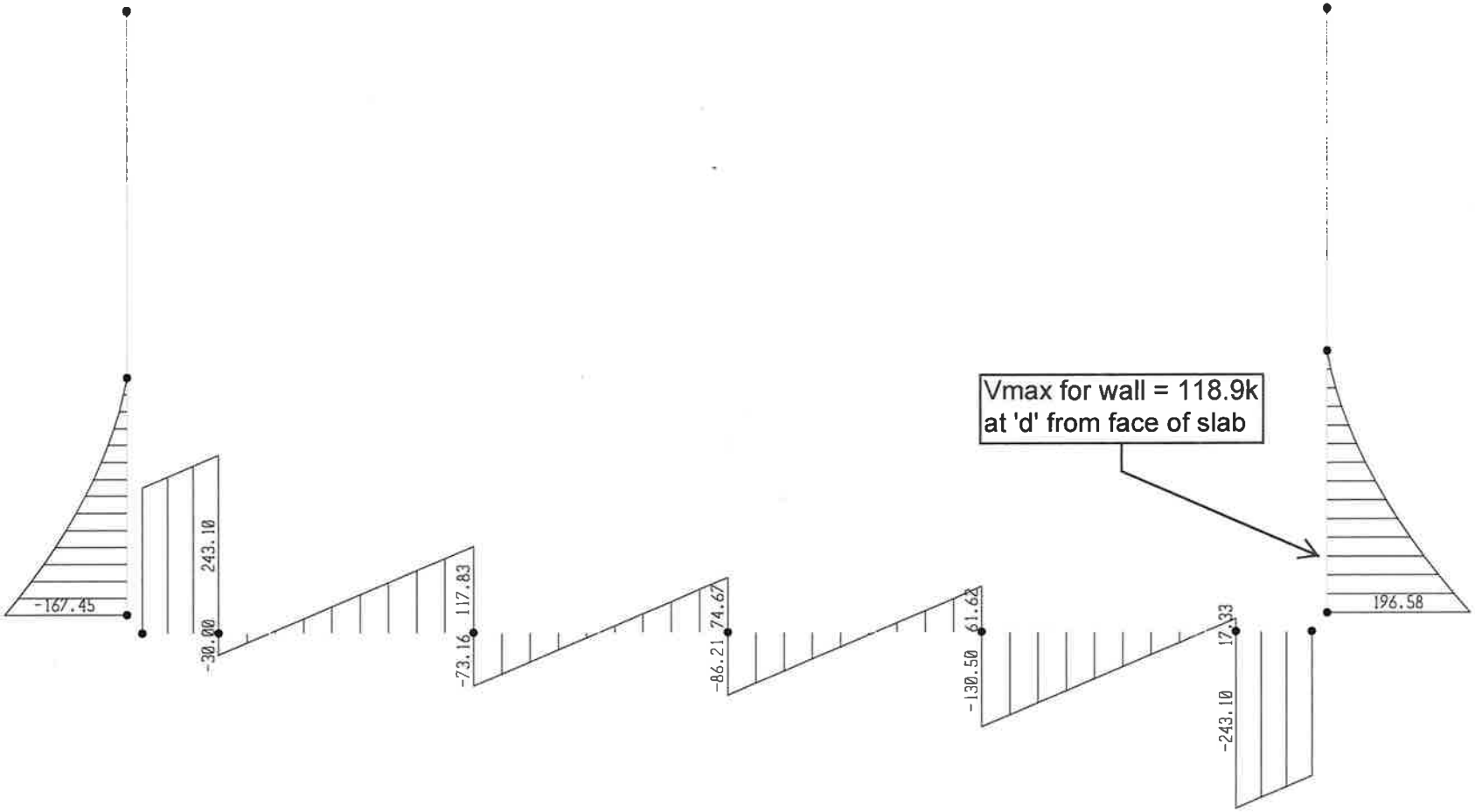
* SAP results are shown on the following 10 pages. Please note that the resulting shear/moments shown are for a 10'-8" wide tributary width.



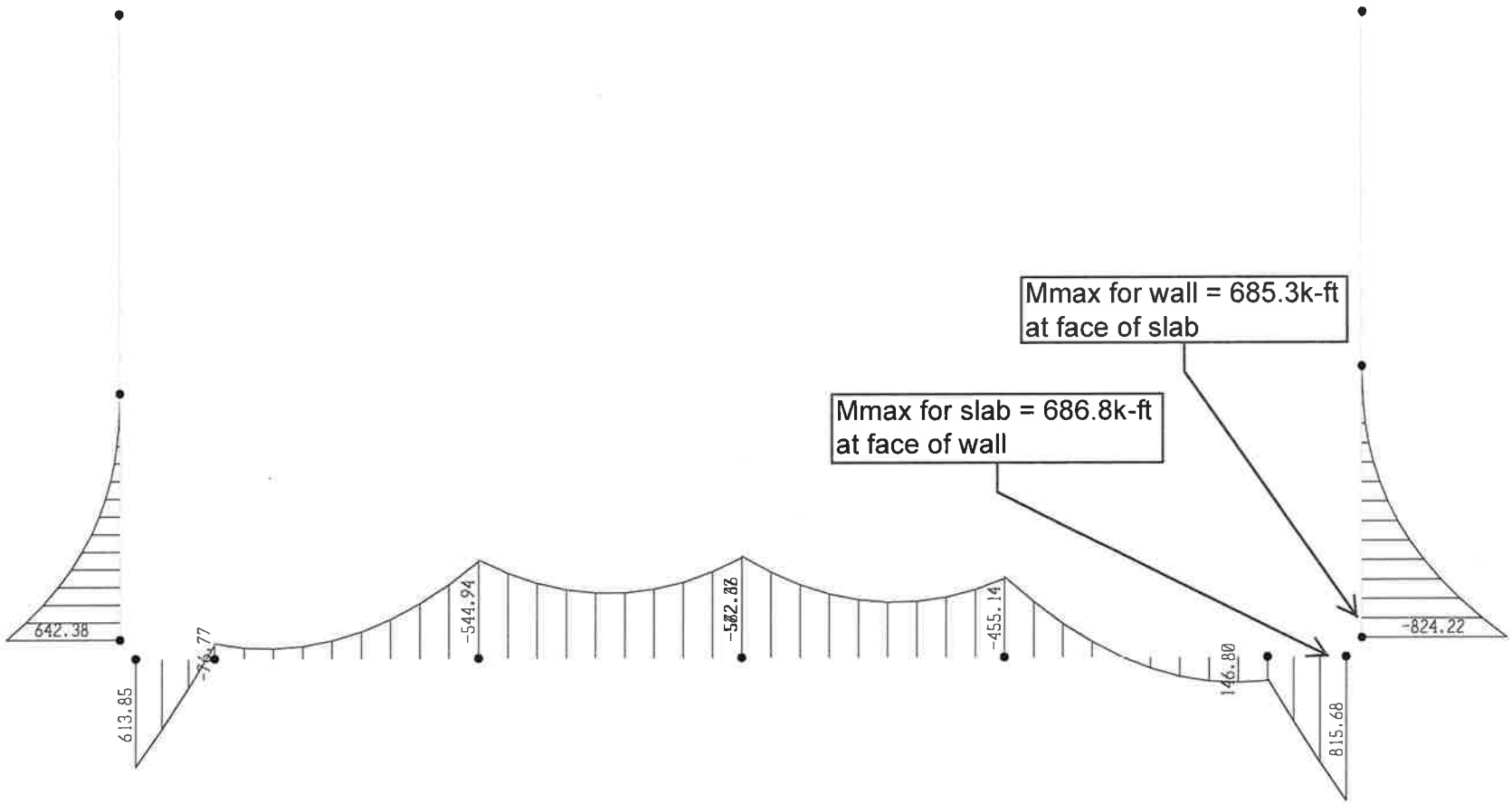
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C Dead) - Kip, ft, F Units



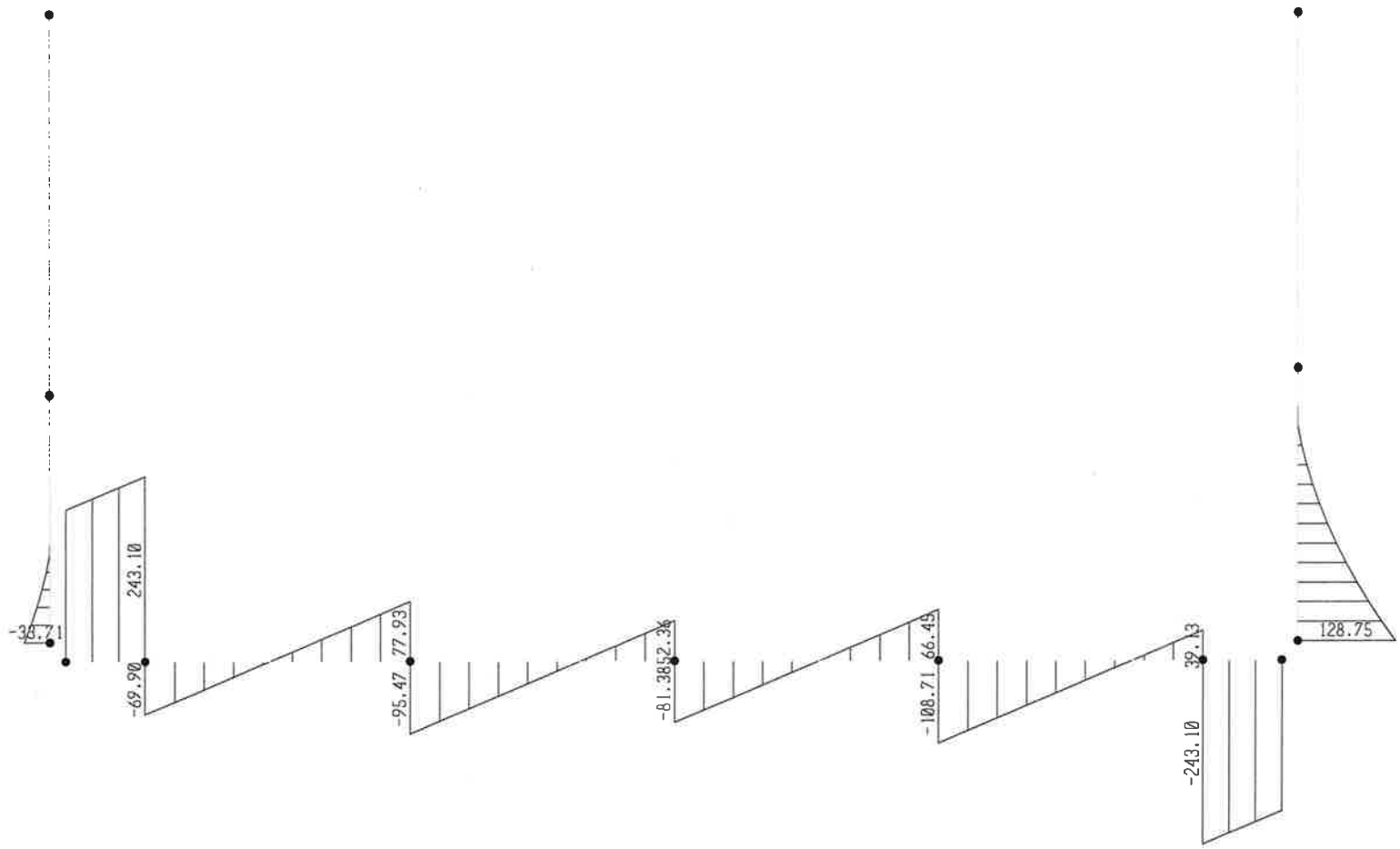
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C Dead) - Kip, ft, F Units



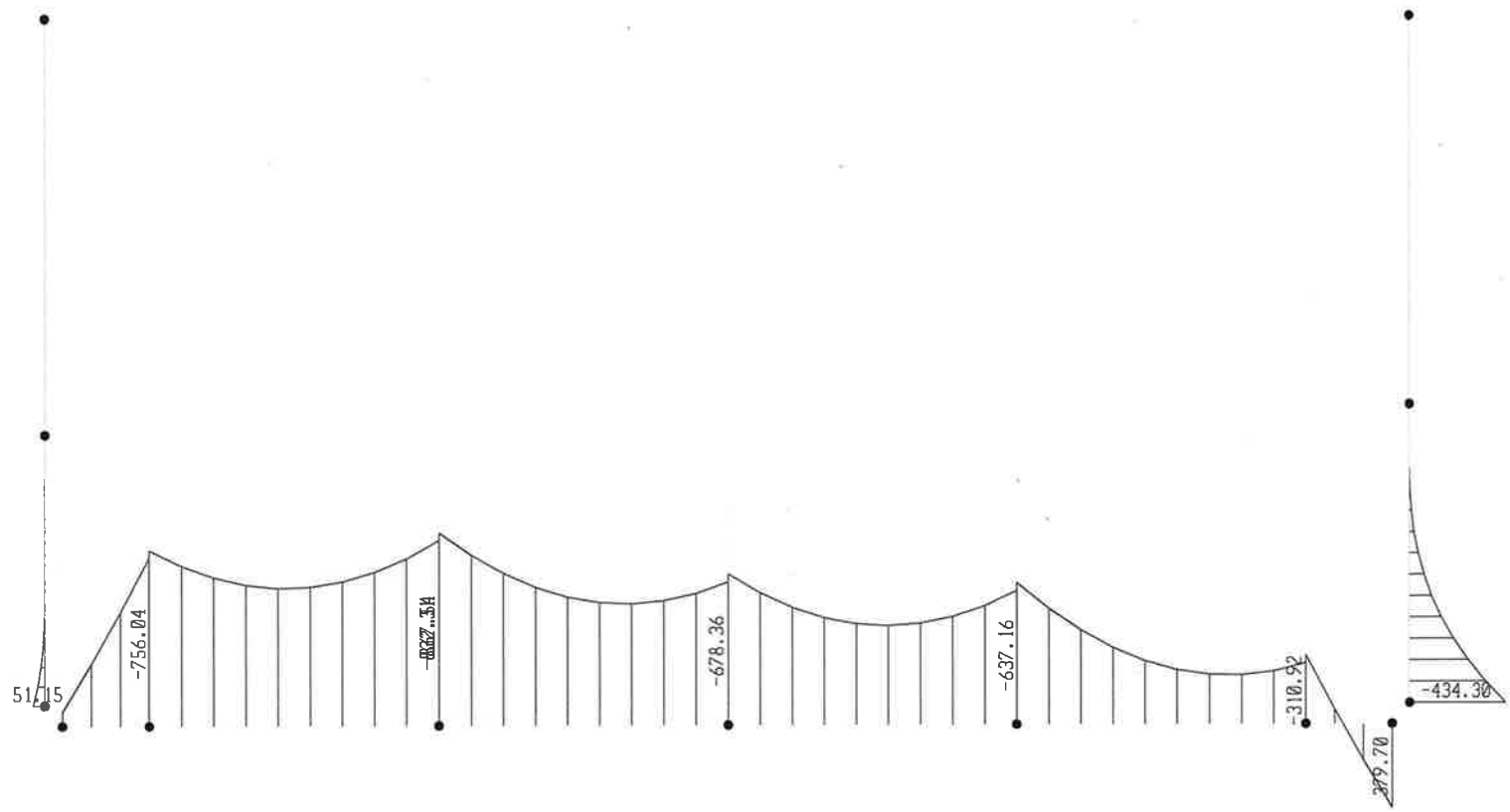
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 1a) - Kip, ft, F Units



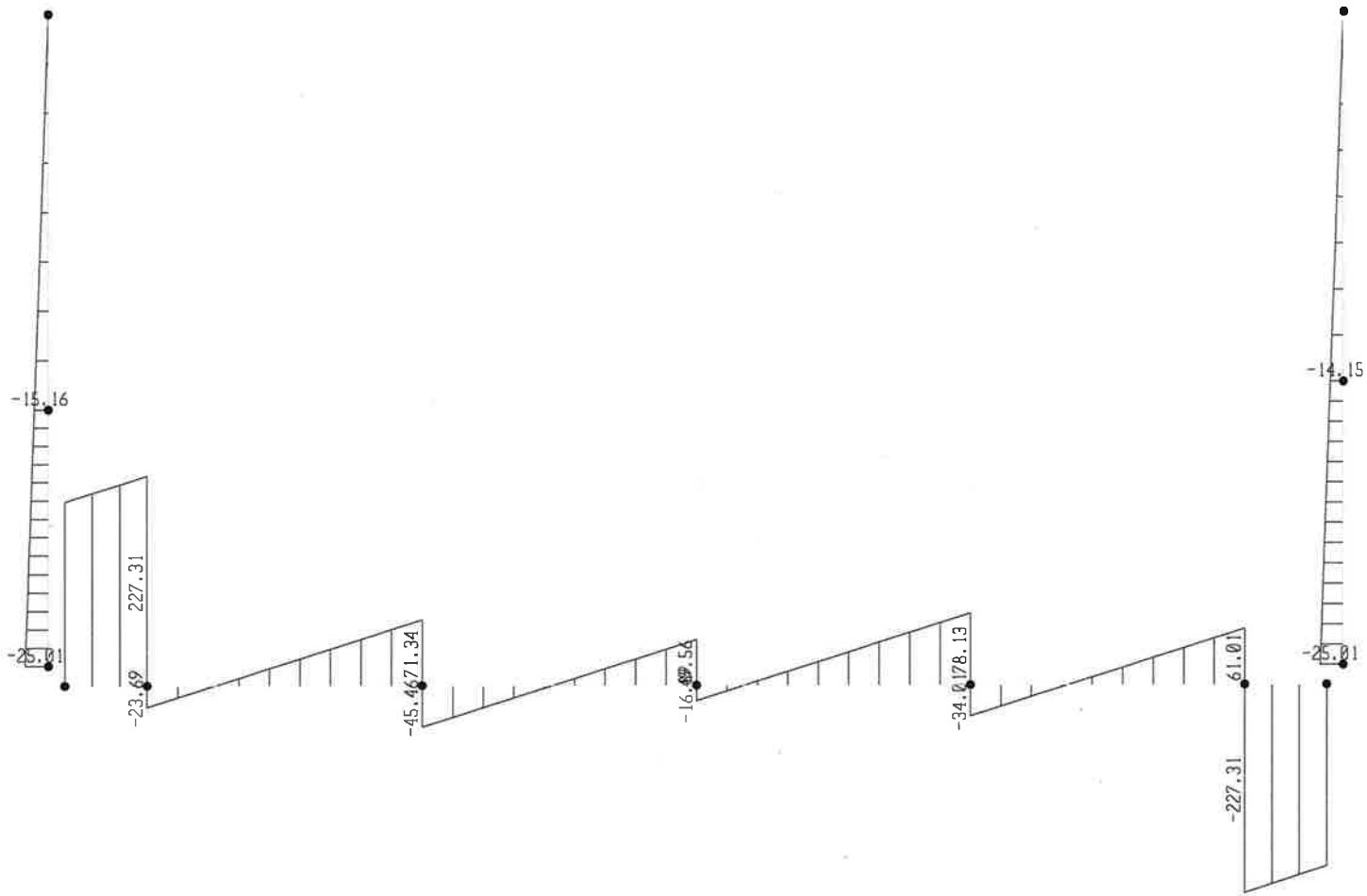
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 1a) - Kip, ft, F Units



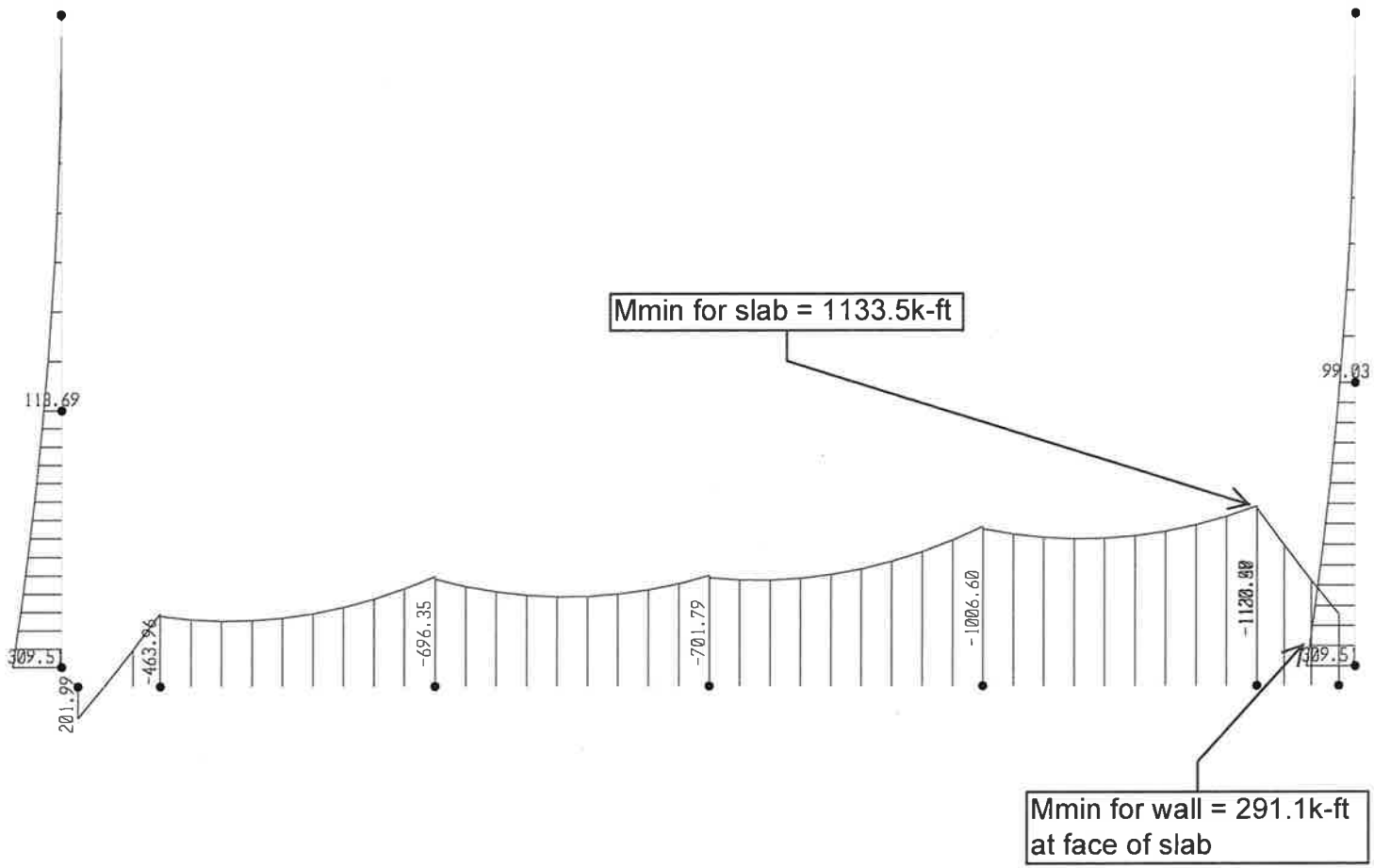
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 1b) - Kip, ft, F Units



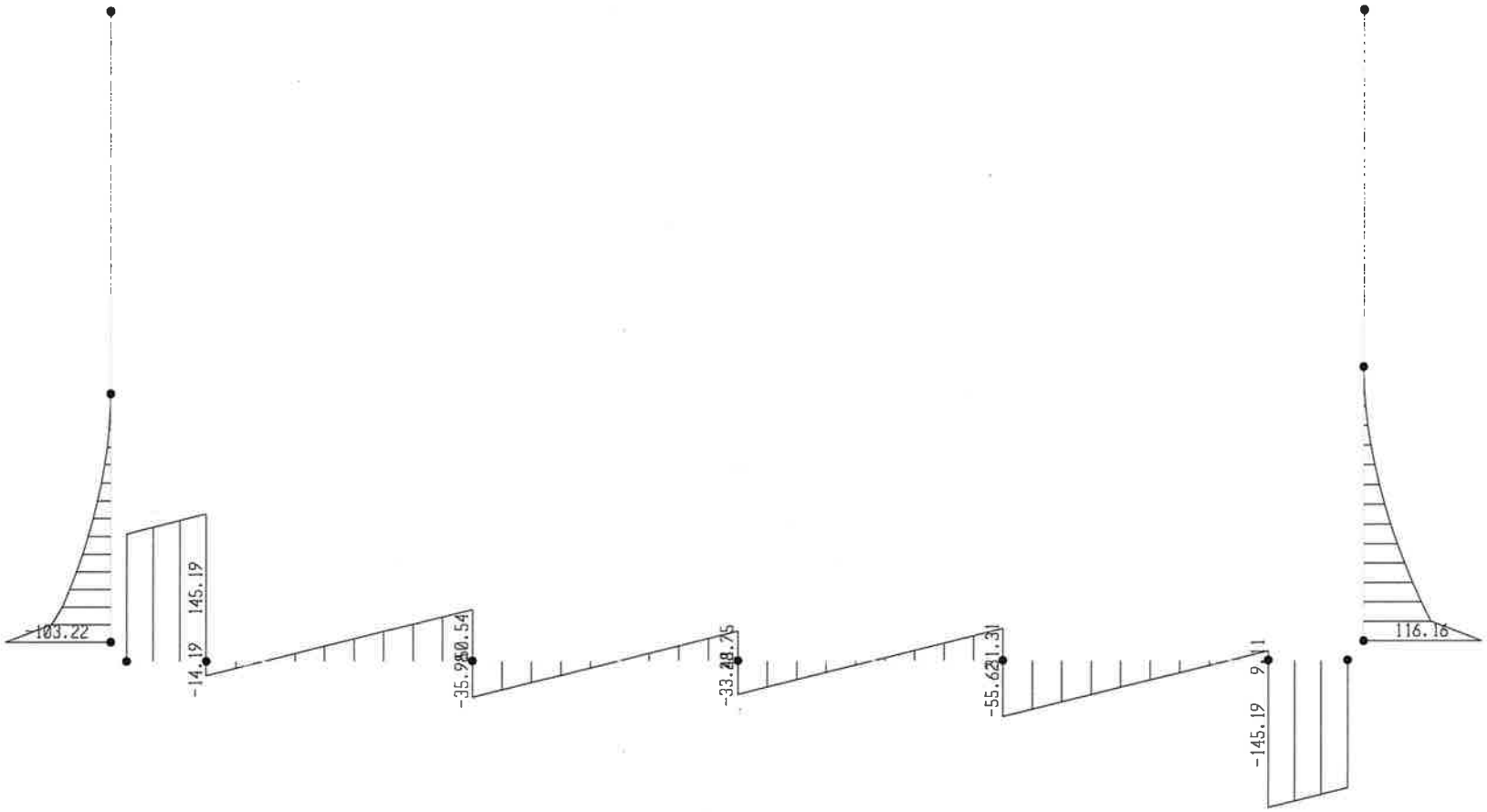
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 1b) - Kip, ft, F Units



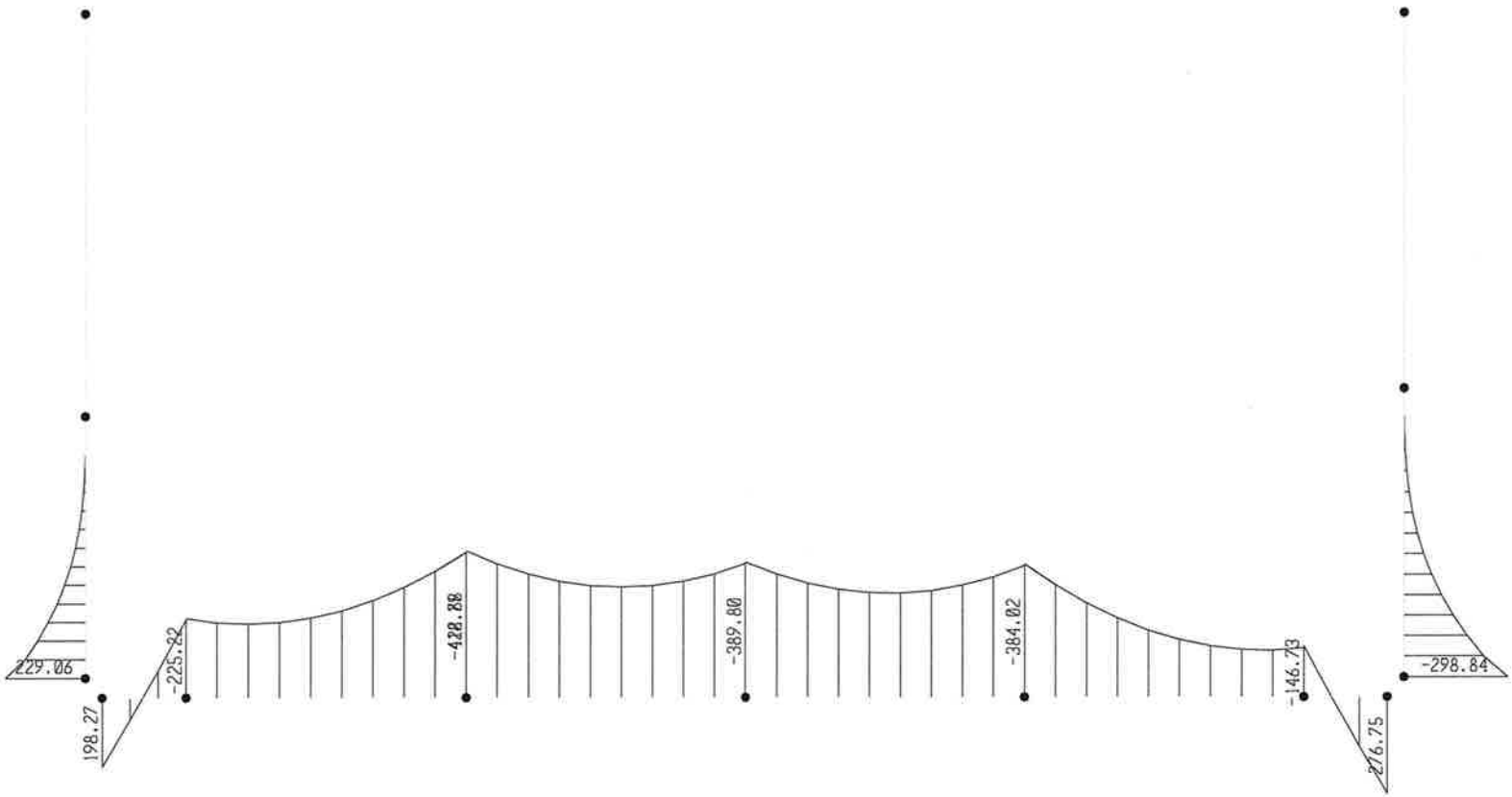
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 1c) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 1c) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 2) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 2) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-1 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	3	ft
Wall Thickness =	2	ft
Tributary Width =	10.67	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

Settlement Cases Only

Based on results, wall size of 2'-6" may be reduced

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	118.92	11.15	685.3	64.2	0.0	0.0
1b-ST	67.48	6.33	344.6	32.3	0.0	0.0
2-ST	42.39	3.97	230.8	21.6	0.0	0.0

* Shear values taken at a distance 'd'= 19.5in from the face of the slab.

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

Max. Shear = 11.1 kip

Max. Moment = 64.2 kip-ft (controls exterior reinforcement)

Min. Moment = 0.0 kip-ft (controls interior reinforcement)

*** Reinforcing Limits:**

A_{gross} = 24in * 12in strip = 288 in^2

d = 24in - 4in cover - 1/2 bar diameter = 19.50 in — #8 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.078 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 0.806 in^2 — EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.740 in^2 — ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 0.780 in^2 — ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**0.078 in^2**	- half each face
	Min. T&S Rebar =	**0.806 in^2**	- half each face
	Min. Flexural Rebar =	**0.780 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 19.5in

= 25,159 lb

ϕVc = 25.2kip > Vu = 11.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in^2 * 60ksi * (19.5in - 1.162in / 2)
= 807.09 kip-in/ft
= 67.26 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 64.2kip-ft → Use #8 @ 12"

Interior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in^2 * 60ksi * (19.5in - 1.162in / 2)
= 807.09 kip-in/ft
= 67.26 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 0kip-ft → Use #8 @ 12"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	373.52	35.02	523.7	49.1	1049.6	98.4
1b-ST	373.52	35.02	87.8	8.2	1178.9	110.5
2-ST	297.35	27.88	5.9	0.6	1010.9	94.8

Shear & Moment values taken at faces of connections (where slab meets wall).

Max. Shear = 35.0 kip
Max. Moment = 49.1 kip-ft (controls bottom reinforcement)
Min. Moment = 110.5 kip-ft (controls top reinforcement) ← CONTROLS

*** Reinforcing Limits:** A_{gross} = 36in * 12in strip = 432 in^2
d = 36in - 4in cover - 1/2 bar diameter = 31.44 in #9 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 4.617 in^2

Limits of Minimum Reinforcement:	$0.0028 \times A_{gross}$ =	1.210 in^2	EM 1110-2-2104, 2-8a, temp. & shrinkage
	$(3 * \sqrt{f'_c} * b * d) / f_y$ =	1.193 in^2	ACI 318-02, 10.5, flexural member min.
	$(200 * b * d) / f_y$ =	1.257 in^2	ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**4.617 in^2**	- half each face
	Min. T&S Rebar =	**1.210 in^2**	- half each face
	Min. Flexural Rebar =	**1.257 in^2**	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$
= $0.85 * 2 * \sqrt{4000} * 12in * 31.436in$
= 40,559 lb

ϕVc = 40.6kip > Vu = 35kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try #9 @ 12" to start: As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

ϕMn = 0.9 * 1in² * 60ksi * (31.436in - 1.471in / 2)
= 1657.8 kip-in/ft
= 138.15 kip-ft/ft

ϕMn = 138.2kip-ft > Mu = 49.1kip-ft → Use #9 @ 12"

Top Face:

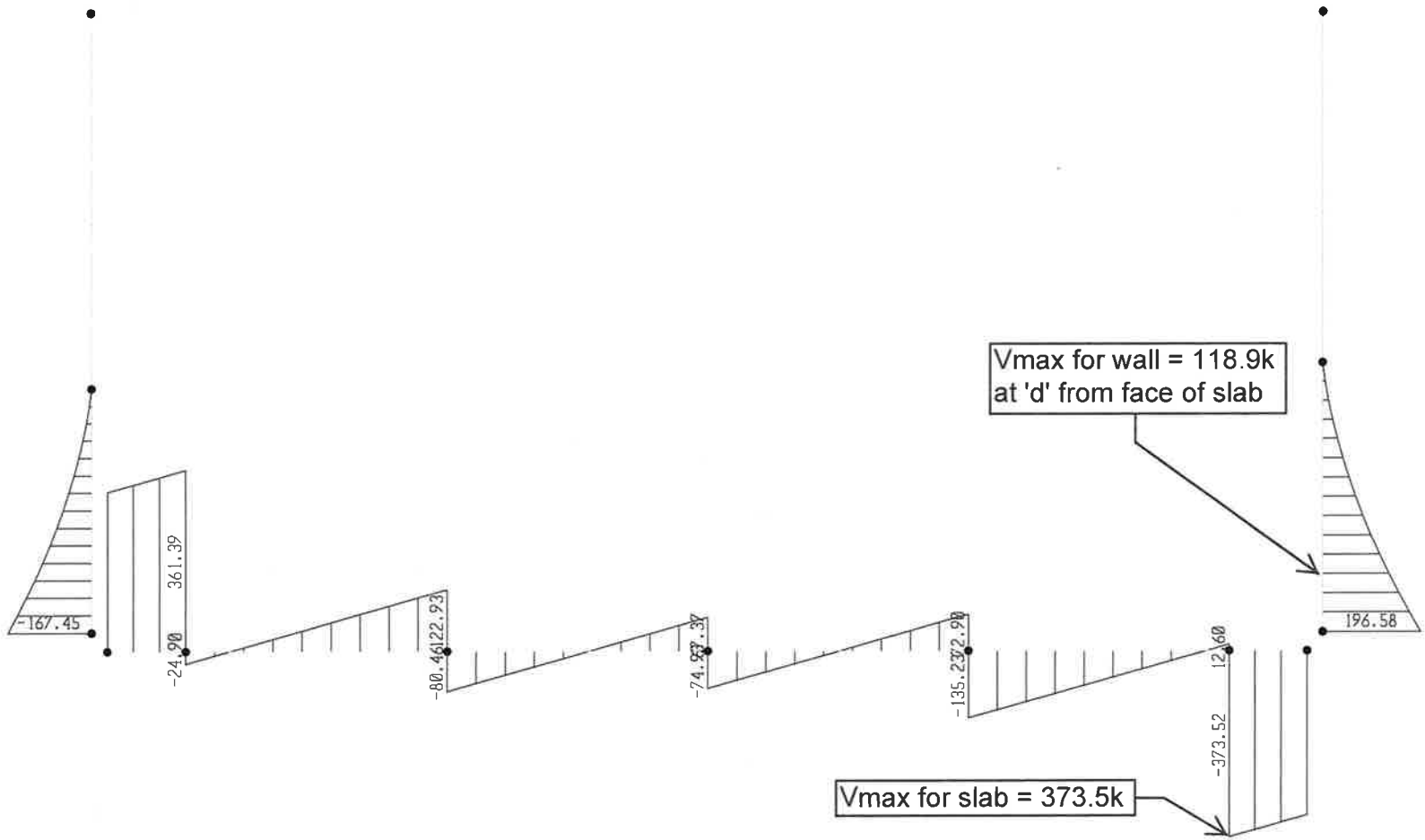
* Will try #9 @ 12" to start: As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

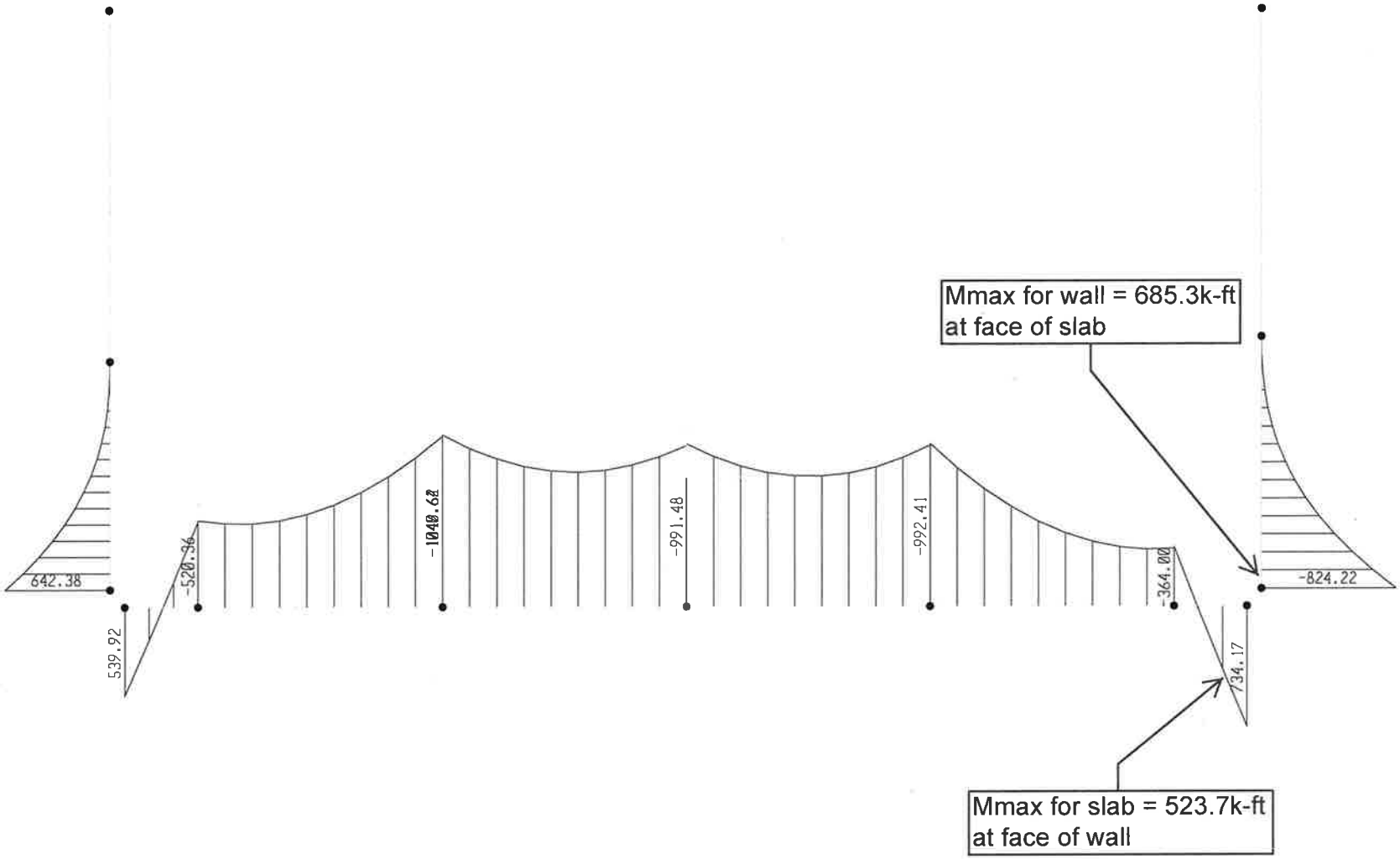
ϕMn = 0.9 * 1in² * 60ksi * (31.436in - 1.471in / 2)
= 1657.8 kip-in/ft
= 138.15 kip-ft/ft

ϕMn = 138.2kip-ft > Mu = 110.5kip-ft → Use #9 @ 12"

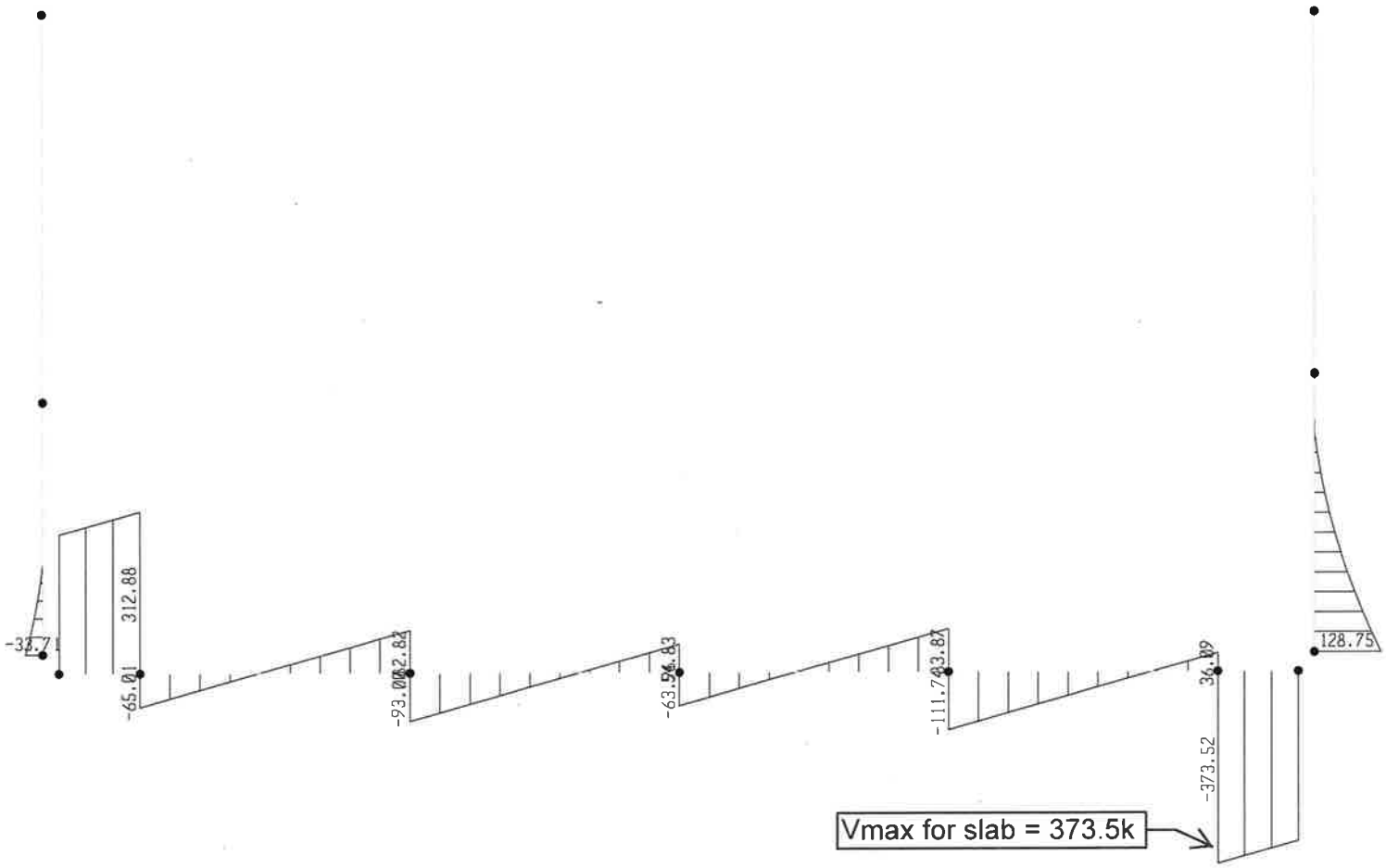
* SAP results are shown on the following pages. Please note that the resulting shear/moments shown are for a 10'-8" wide tributary width.



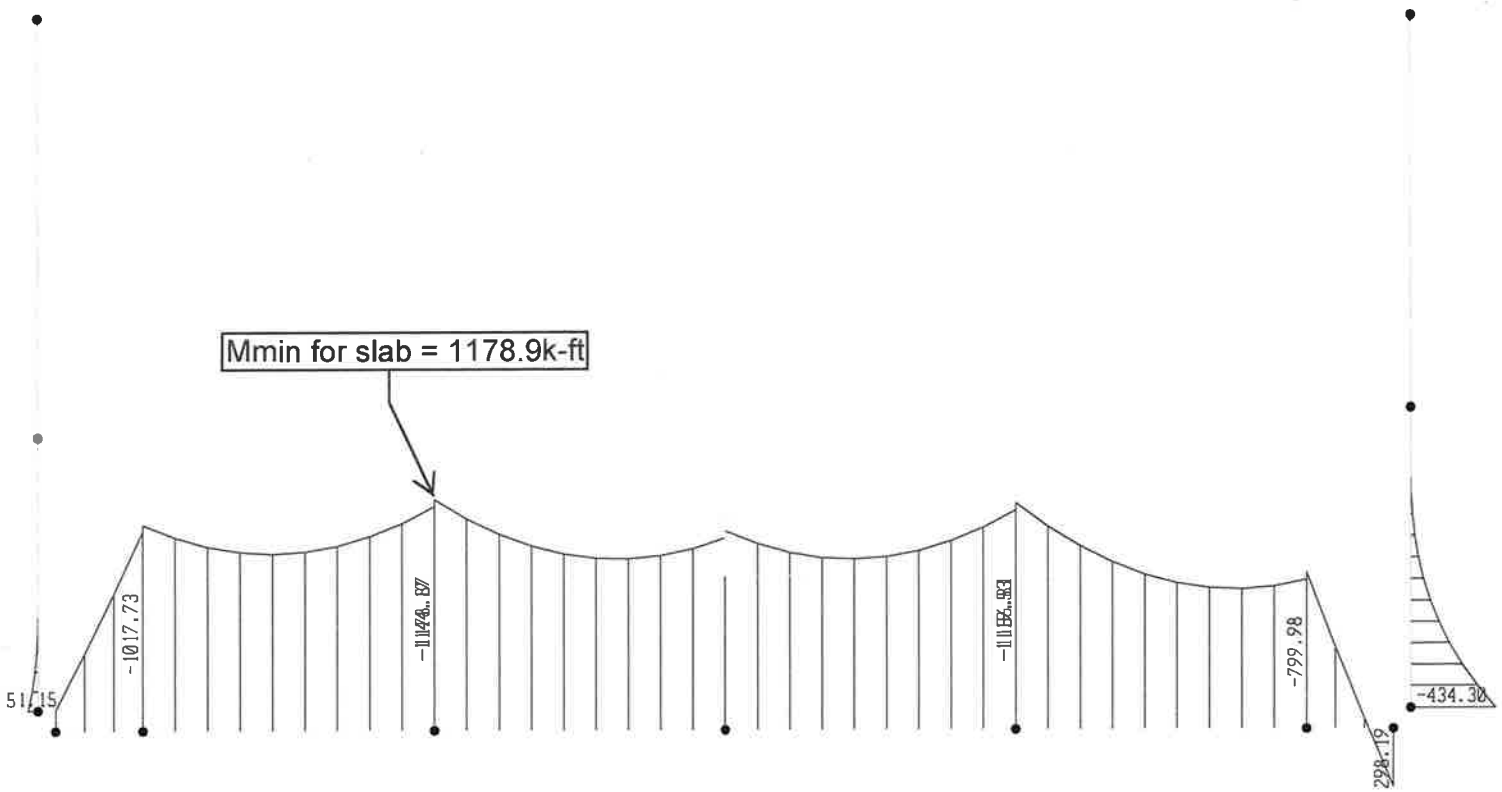
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 1a-ST) - Kip, ft, F Units



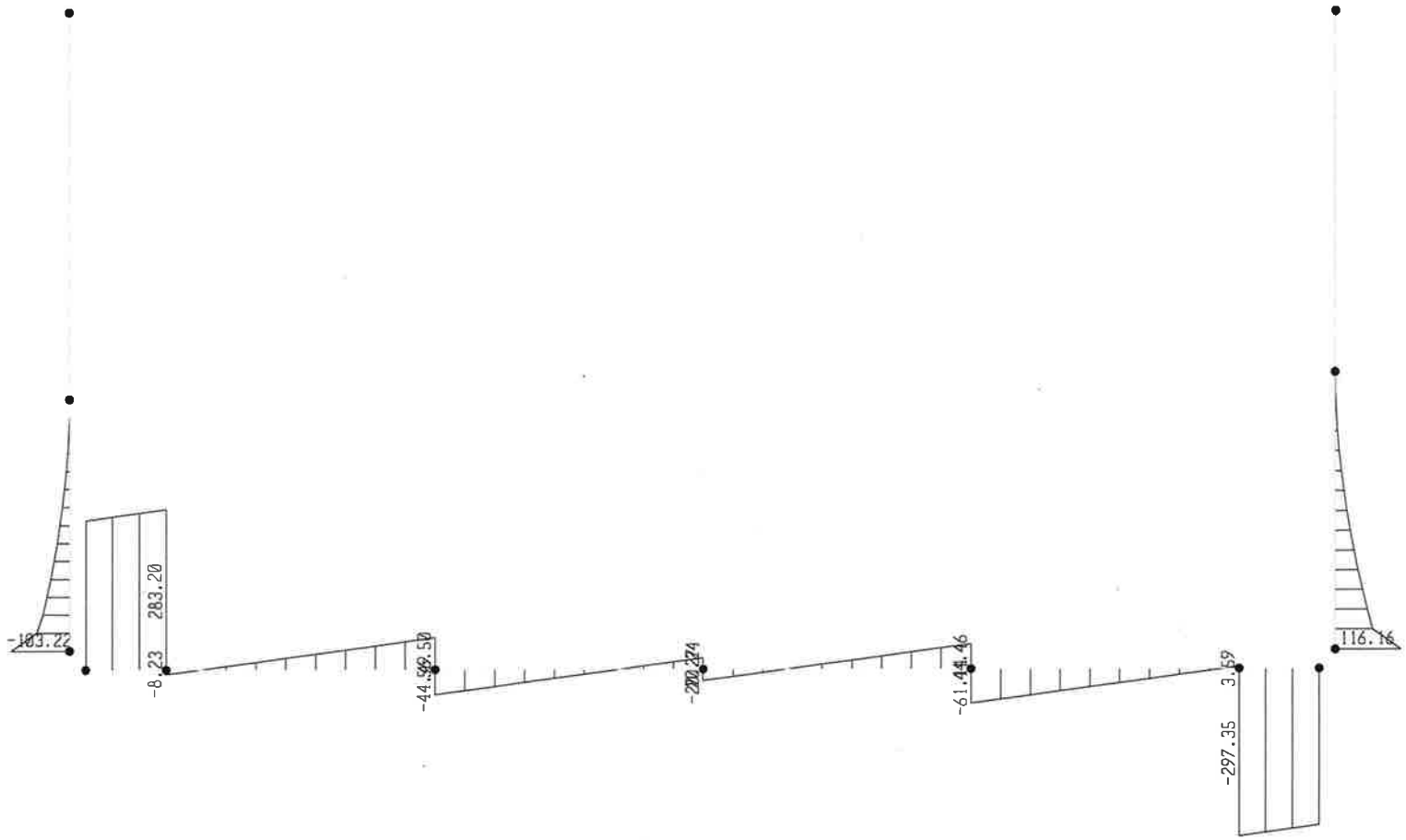
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 1a-ST) - Kip, ft, F Units



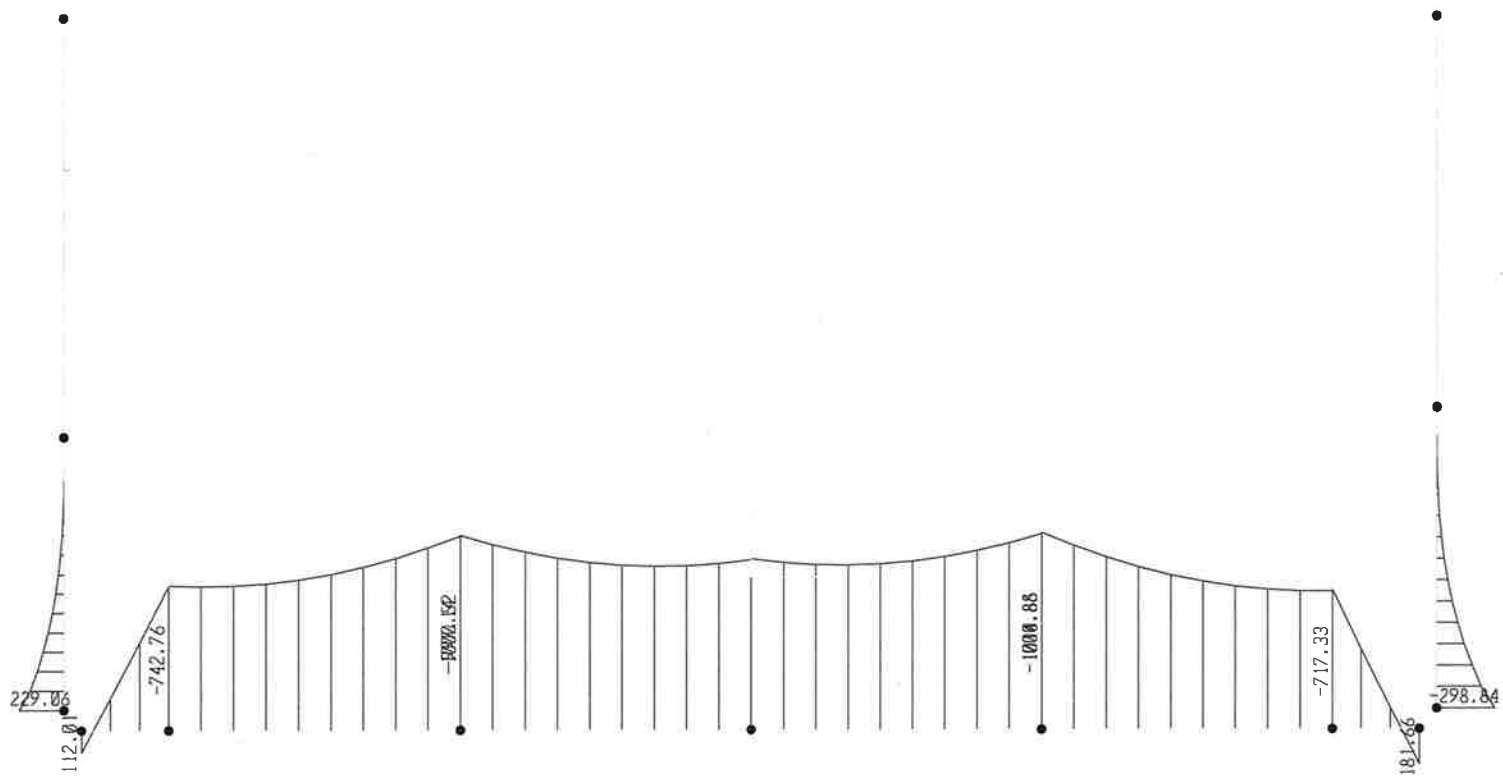
SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 1b-ST) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 1b-ST) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Shear Force 2-2 Diagram (C 2-ST) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-1 Model, HP14x89, settlement included - Moment 3-3 Diagram (C 2-ST) - Kip, ft, F Units

URS

Job MAUREPAS | Project No. 10001876 | Page ___ of ___
Description SECONDARY REINF. | Computed by LBR | Sheet ___ of ___
Checked by ___ | Date 7/2013 | Date ___
Reference

SLAB & WALLS NEED ONLY TEMP. & SHRINKAGE REINF. IN SECONDARY DIRECTION.

→ WALLS: 2'-0" MEMBER, T&S MIN = 0.806 in², HALF EACH FACE

⇒ USE #6 @ 12" (A_s = 0.44 in²)

→ SLAB: 3'-0" MEMBER, T&S MIN = 1.21 in², HALF EACH FACE

⇒ USE #8 @ 12" (A_s = 0.79 in²)

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____

Description: U-1 - WALL DEFLECTION / CRACKING CHECK. | Computed by: LBR | Sheet ____ of ____ | Date: 7/2013

Checked by: ____ | Date: ____

Reference

- CHECK THAT WALL DOES NOT CRACK DUE TO MOMENT DEFLECTIONS. IF SO, REDUCED MOMENT OF INERTIA WILL APPLY (ACI 318 SECTION 9.5.2.3)

$$M_{cr} = \frac{f_r I_g}{y_t} \quad \text{(EQ 9-9)}; \qquad f_r = 7.5\sqrt{f'_c} \quad \text{(EQ 9-10)}$$

1' STRIP

$$I_g = \frac{1}{12} bh^3 = \frac{1}{12}(12'')(24'')^3 = 13824\ \text{in}^4$$

$$y_t = 1/2\, h = 12''$$

$$\therefore\ M_{cr,WALL} = \frac{(7.5)\sqrt{4000}\,(13824\ \text{in}^4)}{12''} = 546{,}441.58\ \text{IN}\cdot\text{LB} = 45{,}536.8\ \text{FT}\cdot\text{LB}$$

$\Rightarrow$ WALL CRACKS W/SERVICE MOMENTS $> 45.537^{k\cdot ft}$

↳ MAX. MOMENT $= 64.2^{k\cdot ft}$, WHICH INCLUDES HYDRAULIC, SAFETY & O/S FACTORS.

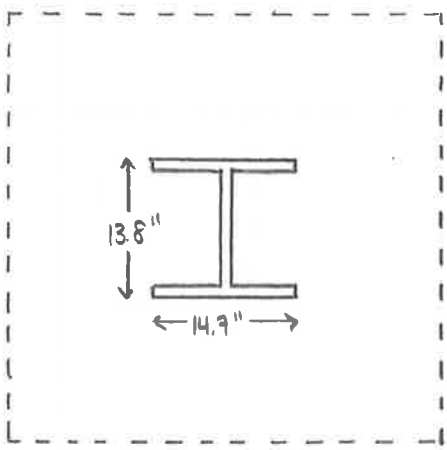
$$\rightarrow \frac{64.2^{k\cdot ft} \times 1.1667\ (O/S)}{1.3 \times 1.7\ (H_f \times H_s)} = 33.9^{k\cdot ft}\ \text{SERVICE MOMENT}$$

$\therefore$ WALL DOES NOT CRACK - $M_{cr} = 45.5^{k\cdot ft} > M_u = 33.9^{k\cdot ft}$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: 11-1 - SLAB PUNCHING SHEAR CHECK | Computed by: LBR | Sheet ___ of ___
Checked by: ___ | Date: 7/2013 | Date: ___
Reference

- d_{SLAB} = 36" - 9" PILE EMBED = 27"
- CLOSEST EDGE 5'-0" FROM ℄ PILE - DOES NOT EFFECT PERIMETER



$$b_o = 2\times(13.8''+d) + 2\times(14.7''+d)$$
$$= 2\times(13.8''+27'') + 2\times(14.7''+27'')$$
$$= 165''$$

$$\phi V_c = \min.\begin{cases} ① \ \phi\left(2+\frac{4}{\beta}\right)\sqrt{f'_c}\,b_o d & \text{ACI 318 (11-33)} \\ ② \ \phi\left(\frac{\alpha d}{b_o}+2\right)\sqrt{f'_c}\,b_o d & (11\text{-}34) \\ ③ \ \phi 4\sqrt{f'_c}\,b_o d & (11\text{-}35) \end{cases}$$

$\beta = \frac{13.8''}{14.7''} = 0.939$

$\alpha = 20$ (min., conservative)

- BY INSPECTION, ③ CONTROLS -

$$\phi V_c = (0.85)(4)\sqrt{4000}\,(165'')(27'') = \underline{957{,}980.4^{LB}}$$

- MAX. REACTION = 216.25^k

- TREATED AS ENVIRONMENTAL FORCE SUBJECT TO HYDRAULIC & SAFETY FACTORS, LOAD = $216.25^k \times 1.3 \times 1.7 = \underline{477.9^k}$

$\phi V_c = 957.98^k > 477.9^k \rightarrow$ OK

URS

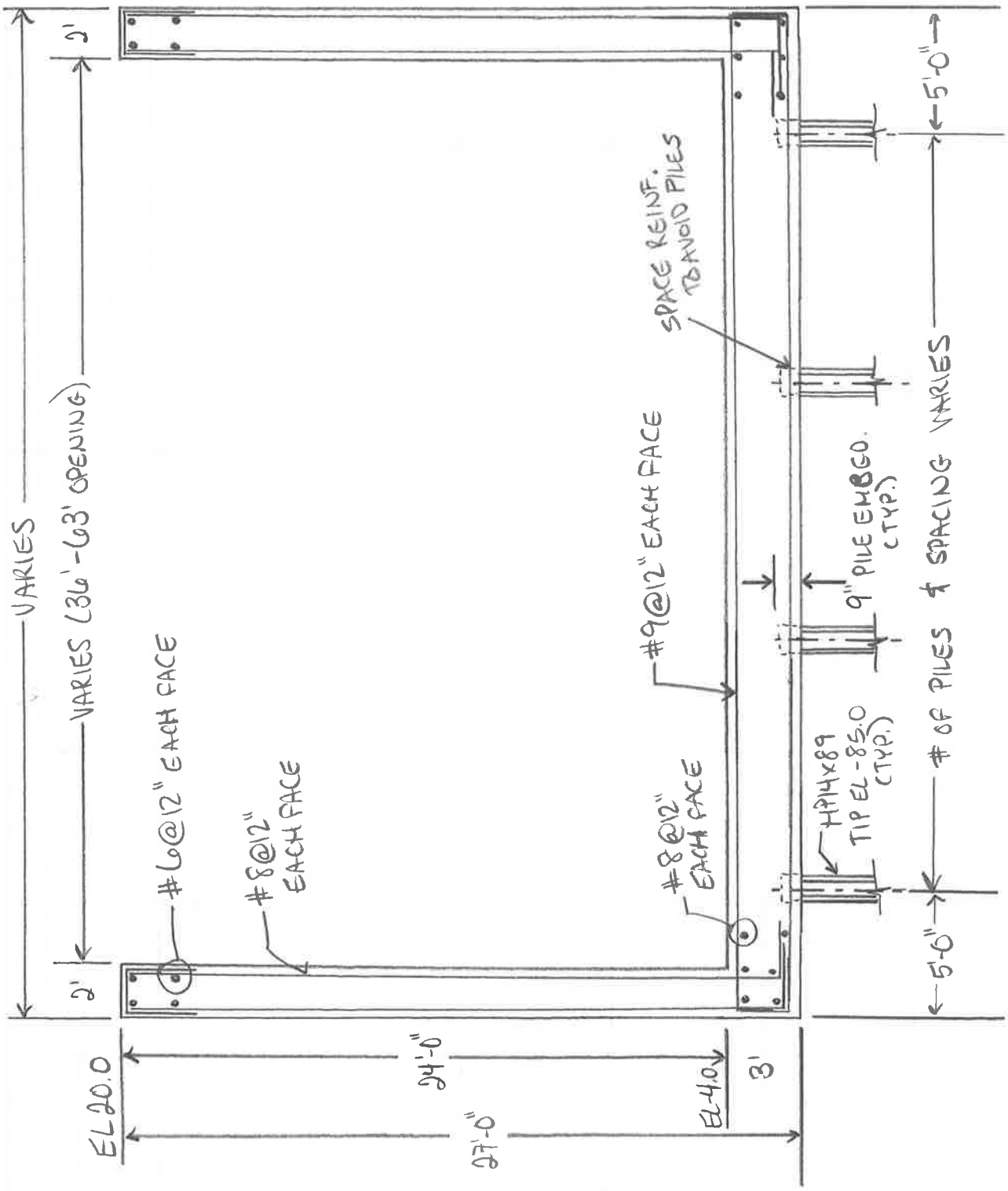
Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

Description ____ Computed by ____ Date ____

Checked by ____ Date ____

Reference



SECTION 3

U-2 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	Flood Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
2-ST	Flood Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL31.5
L_strut water	Vertical load on strut from water to EL 31.5
U_high water	Uplift load from water to EL 31.5
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_saturated	Soil pressure from saturated soil (water to EL 31.5)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	L_strut water
	U_high water
	S_saturated
2-ST	DEAD
	L_high water
	L_strut water
	U_high water
	S_saturated
	ST_cohesion

In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

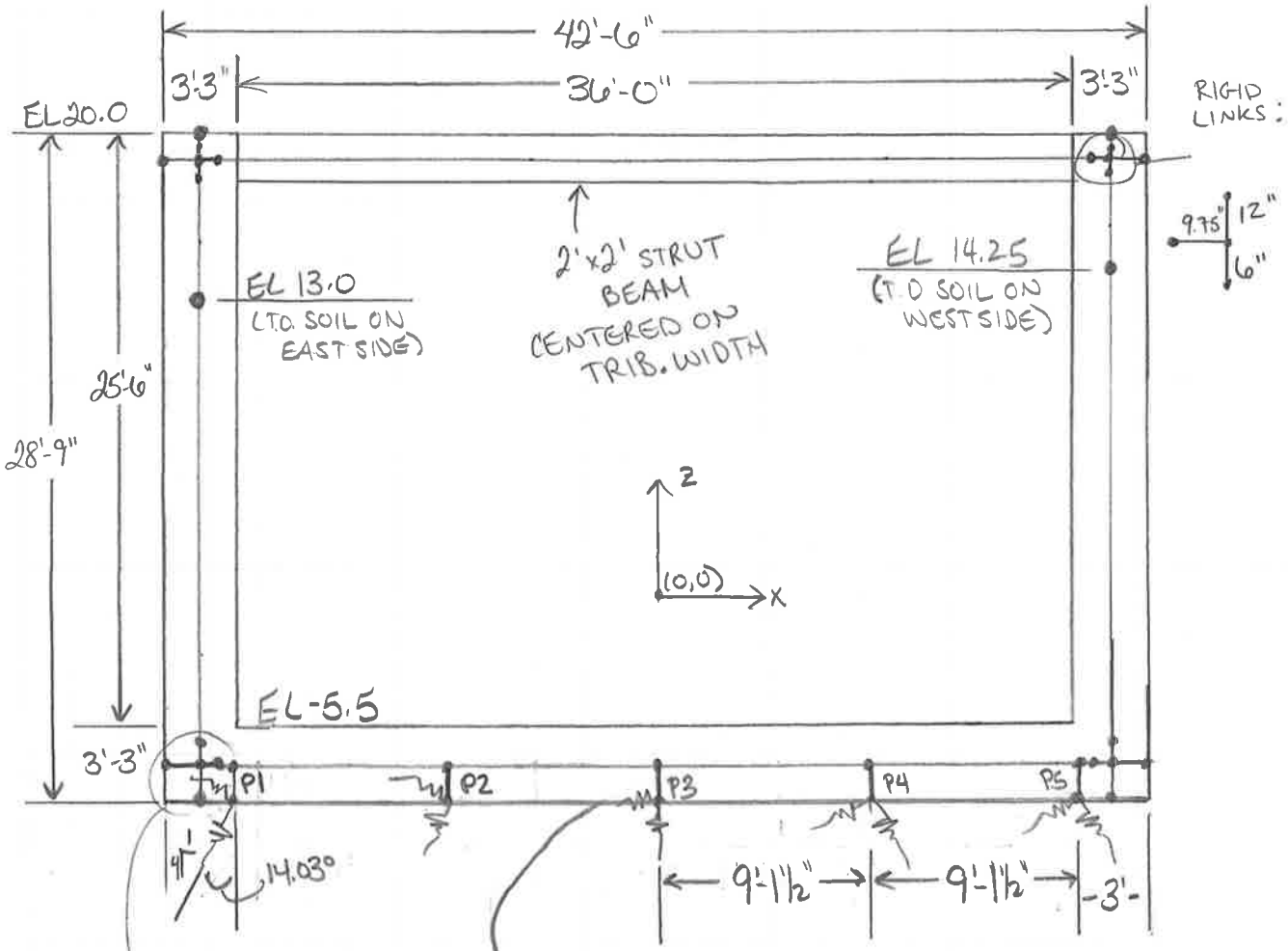
URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: MONOLITH 11-2 | Computed by: LBR | Sheet ___ of ___
SAP MODEL LAYOUT | Checked by: ___ | Date: 4/2013 | Date: ___

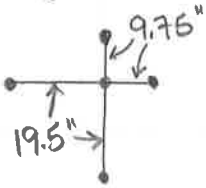
Reference

- THE LARGEST PILE TRIBUTARY WIDTH (12') IS PAIRED W/ THE HIGHEST SOIL LOADS (AT DOWNSTREAM END OF MONOLITH) TO CREATE THIS 2-D MODEL.
- RIGID LINKS ARE USED TO SIMULATE CONCRETE JOINTS, WHERE THE CORNER CONNECTIONS ARE MUCH STRONGER THAN THE INDIVIDUAL MEMBERS. LINKS ARE THE MIDDLE HALF OF EACH JOINT.

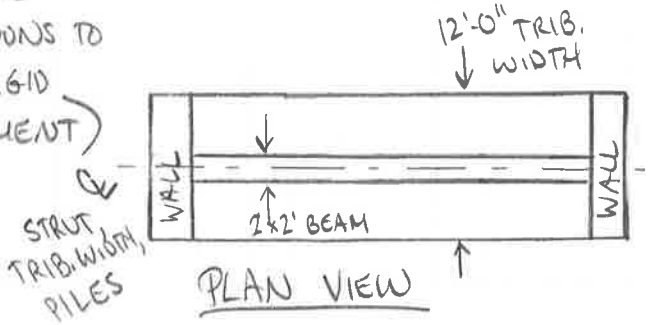
SEE ETL



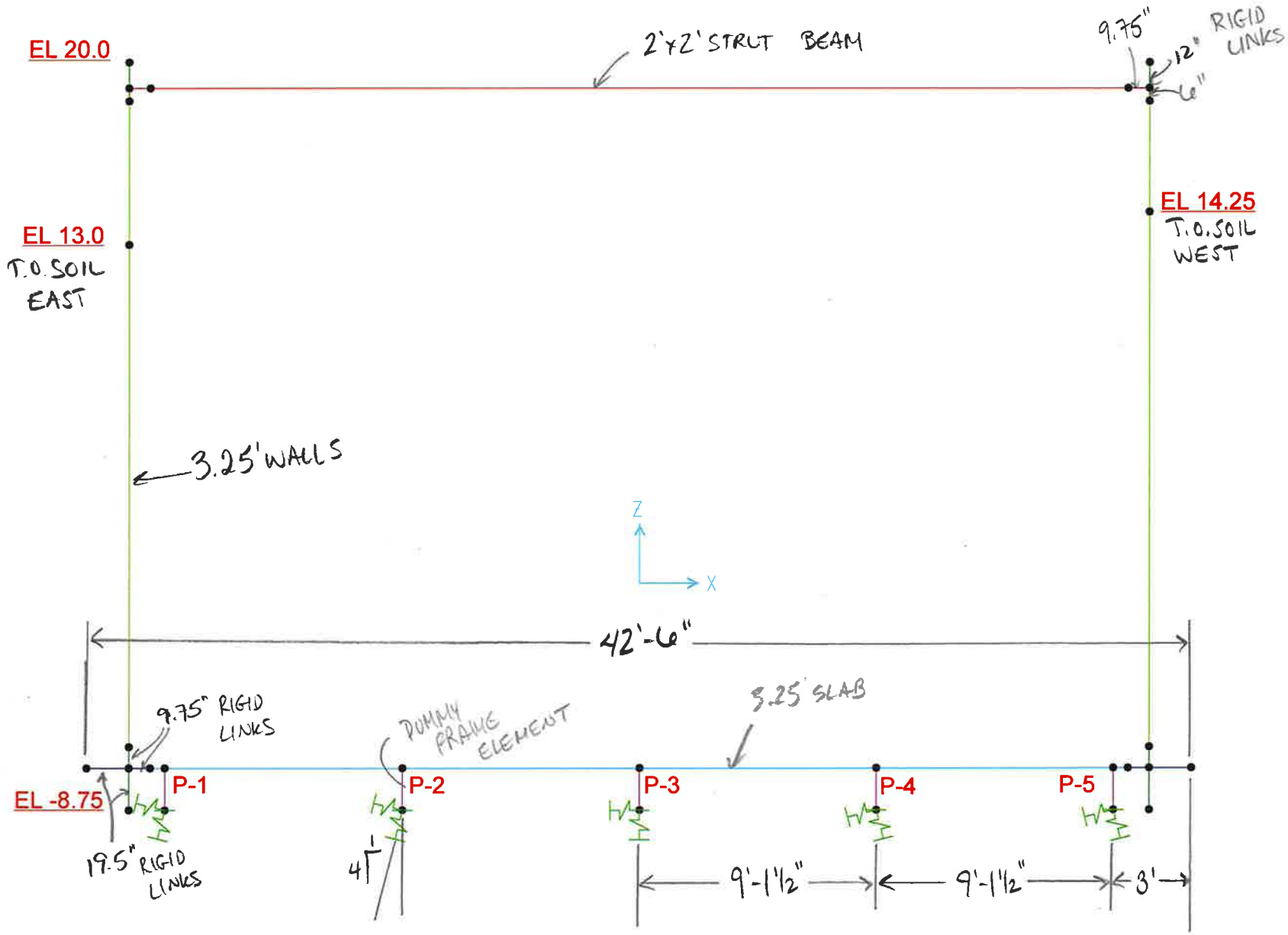
RIGID LINKS:



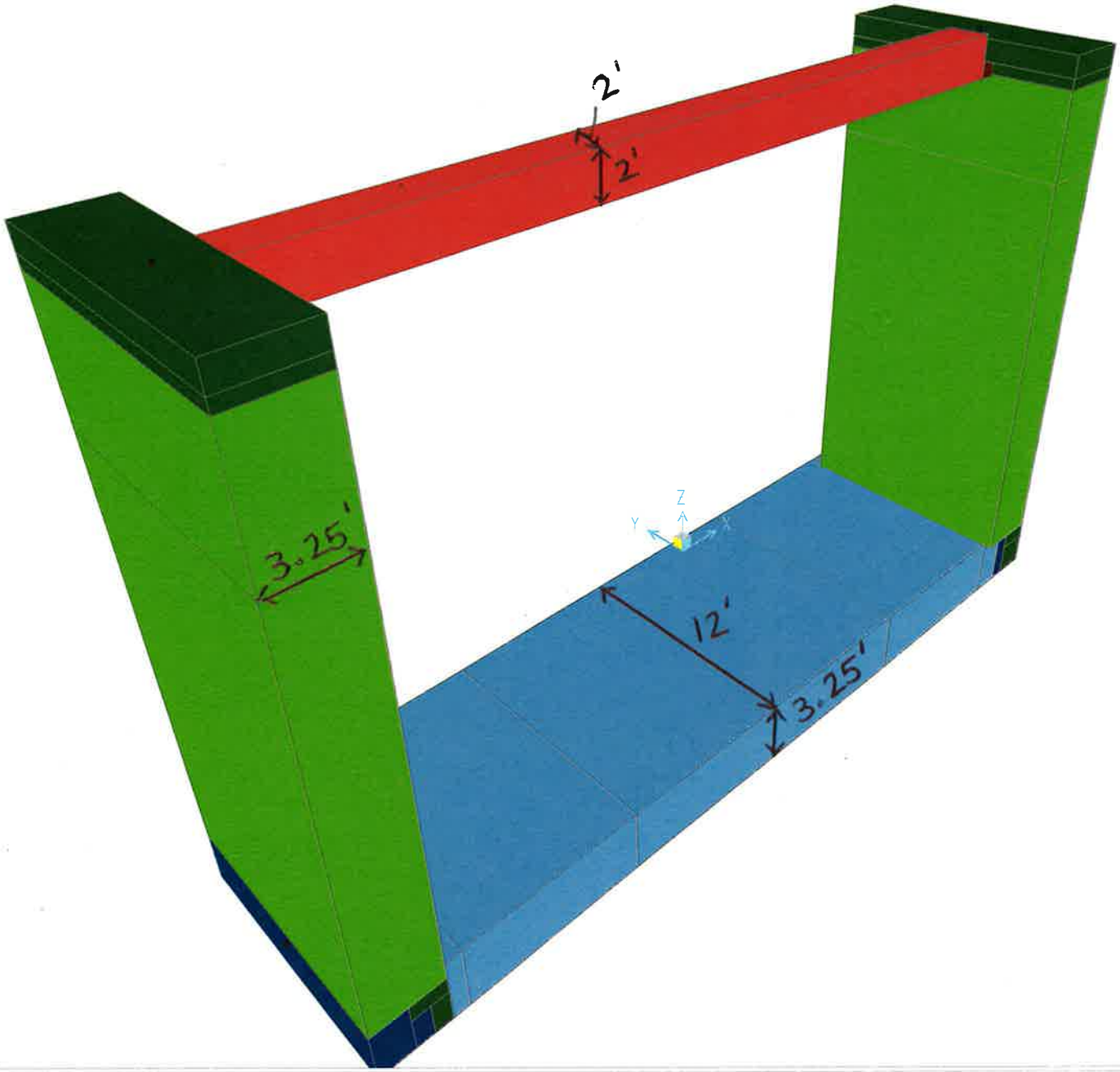
WEIGHTLESS FRAME CONNECTS PILE HEAD LOCATIONS TO ℄ SLAB (RIGID DUMMY ELEMENT)



Model Overview:



Model Overview:



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft slab and walls WITH STRUT - 3-D View - Kip, ft, F Units

URS

Page ____ of ____

Job: MAUREPAS DIVERSION | Project No. 10001876 | Sheet ____ of ____

Description: MONOLITH U-2 | Computed by: LBR | Date: 7/2013

SAP MODEL DEAD LOAD | Checked by: ____ | Date: ____

Reference

DEAD LOAD CALIBRATION:

↳ ACTUAL DEAD WEIGHT:

WALLS: 25.5' height × 3.25' thick × 12' wide × 150PCF × 2 WALLS = 298,350 LB
SLAB: 42.5' long × 3.25' thick × 12' wide × 150PCF = 248,625 LB
STRUT: 2' high × 2' wide × 36' long × 150 PCF = 21,600 LB

Σ = 568,575 LB

↳ SAP DEAD LOAD REACTION Σ = 568,501.87

↳ DIFFERENCE = 73.13 LB -OR- 0.013% → OK

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP Inflow U-Frame Monoliths **Computed By:** LBR **Date:** Jul-13 **Page:** of

Checked By: **Date:** **Sheet:** of

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf	$\gamma_{fill, wet}$ =	115	pcf	Flood Elevation =	31.5	ft NAVD 88
γ_{water} =	62.4	pcf	$\gamma_{fill, eff}$ =	52.6	pcf	Riprap thickness =	2.25	ft
γ_{riprap} =	132	pcf	K_0 =	0.95		$q_{surcharge, construction}$ =	300	psf
$\gamma_{riprap, eff}$ =	69.6	pcf						

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure Including Riprap:

*Above water table: $P_y = \gamma_{riprap} * Z_{riprap} + \gamma_{fill, wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{riprap, eff} * Z_{riprap} + \gamma_{fill, eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap:

*Above water table: $P_y = K_0 * (q_{surch, const} + q_{riprap} + \gamma_{fill, wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * [q_{surch, const} + q_{riprap, eff} + \gamma_{fill, eff} * Z_{fill}]$

$q_{riprap} = \gamma_{riprap} *$ thickness = 297 psf

$q_{riprap, eff} = \gamma_{riprap, eff} *$ thickness = 156.6 psf

*** MODEL U-2:** Model is of a 12ft wide strip & uses maximum grade elevations on either side of the U-frame.

T.O. Wall & Strut Elevation =	20.0	ft NAVD 88	Wall Thickness =	3.25	ft
T.O. Slab Elevation =	-5.5	ft NAVD 88	Slab Thickness =	3.25	ft
T.O. Bank Elevation, *East* Side =	13.0	ft NAVD 88 (approx.)	Strut Thickness =	2	ft
T.O. Bank Elevation, *West* Side =	14.25	ft NAVD 88 (approx.)			

* Water Loads: Water loads cancel out on the wing walls because water is able to flow behind walls.

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
31.50	0.0
20.00	717.6
14.25	1076.4
13.00	1154.4
-5.50	2308.8
-6.313	2359.5
-7.125	2410.2
-8.75	2511.6

Vertical Force on T.O. Slab = 2308.8 psf

Uplift Force on B.O. Slab = 2511.6 psf

Vertical Force on T.O. Strut = 717.6 psf

Uplift Force on B.O. Strut = 842.4 psf

* Construction Surcharge Load:

Above Top of Soil = $q_{surcharge}$ = 300 psf

Below Top of Soil = $K_0 * q_{surcharge}$ = 285 psf

* Soil Loads, Dry (Const.): Construction surcharge loads applied separately.

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
13.00	0.0
10.75	282.2
-6.313	2146.2
-7.125	2235.0
-8.75	2412.5

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
14.25	0.0
12.00	282.2
-6.313	2282.8
-7.125	2371.6
-8.75	2549.1

* Soil Loads, UNEVEN Dry (Const.): Soil load EL 12.0 on west side, only to EL 7.0 on east side. On west/high side, soil placed to top of soil (bottom of riprap). Riprap not yet installed.

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
7.00	0.0
-6.313	1454.4
-7.13	1543.2
-8.75	1720.7

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
14.25	0.0
12.00	0.0
-6.313	2000.6
-7.13	2089.4
-8.75	2266.9

* Soil Loads, Sat (Water to EL 31.5):

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
13.00	0.0
10.75	148.8
-6.313	1001.4
-7.13	1042.0
-8.75	1123.2

WEST

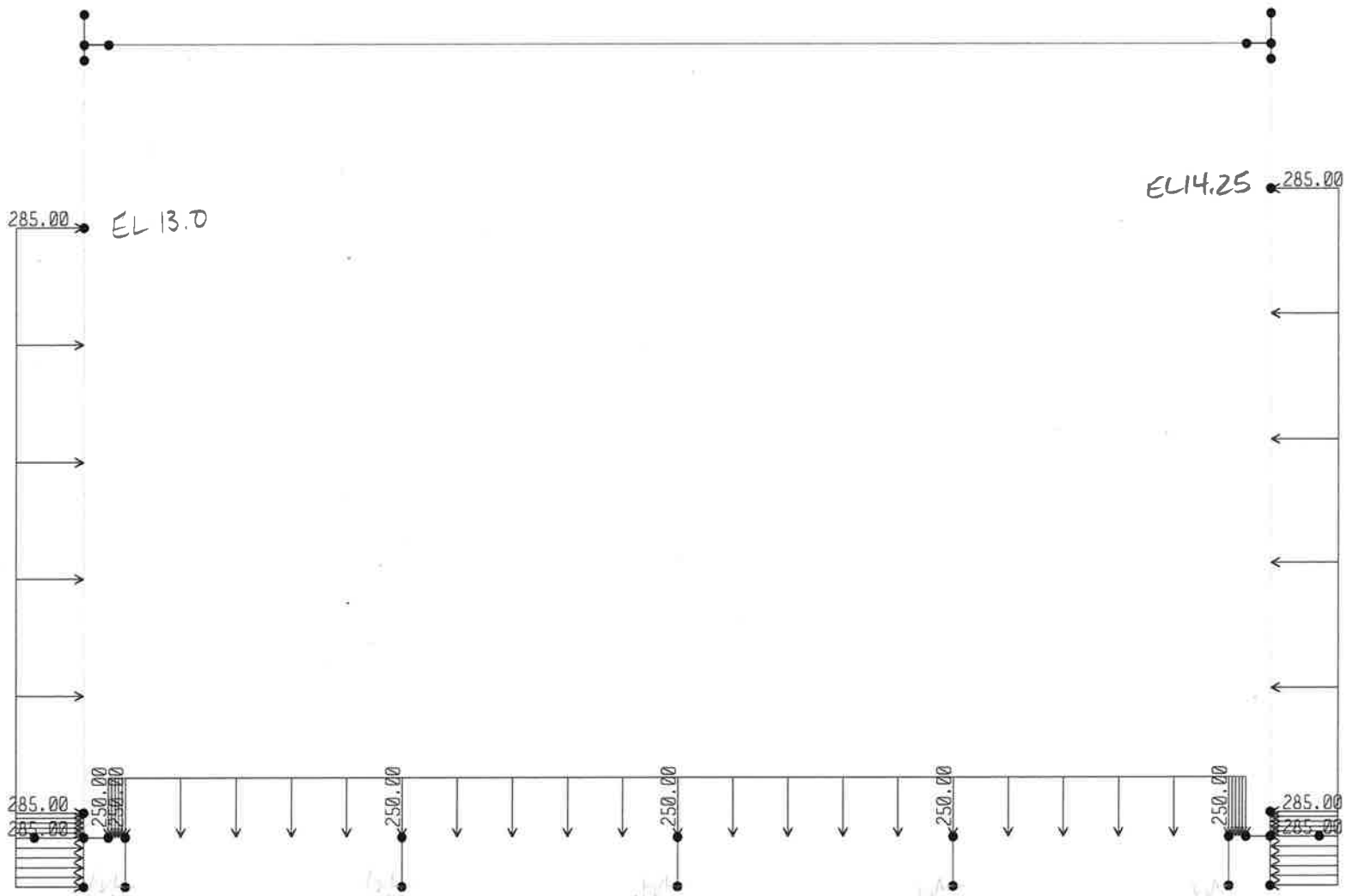
Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
20.00	0.0
14.25	0.0
12.00	148.8
-6.313	1063.8
-7.13	1104.4
-8.75	1185.6

* Note: All loads are calculated on a per-foot basis. In the model, these loads (with the exception of the water load on the strut) are multiplied by a scale factor of 12 when combined into load cases. This creates a 12'-0" strip of load for soil, water, surcharge, etc.

The strut is the only member of a differing width; for the strut water load, a total force of 2ft * P_{water} is applied, and this load is given a scale factor of 1.

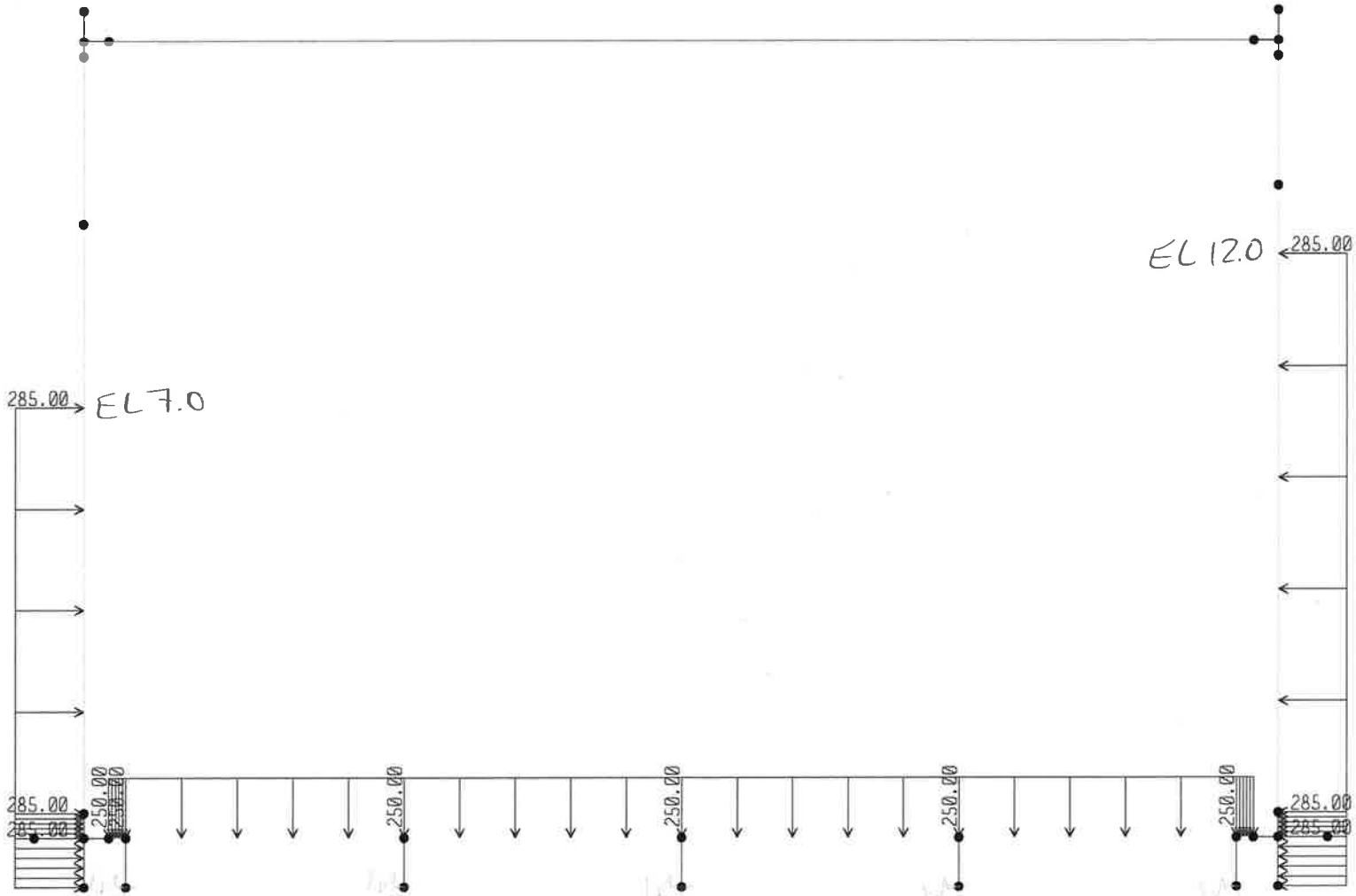
Dry Soil - Construction:

Construction Surcharge:

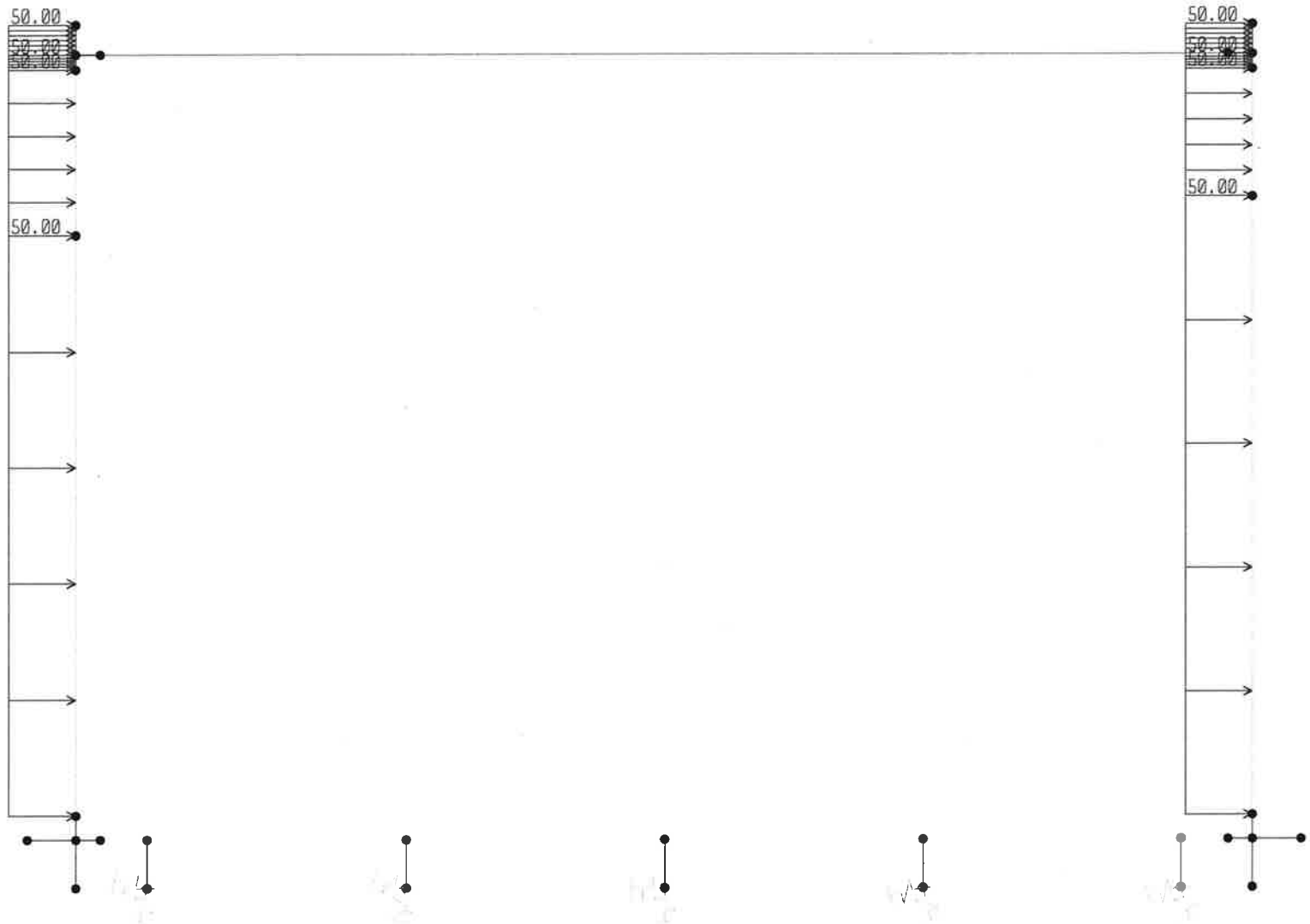


Dry Soil - Uneven Construction:

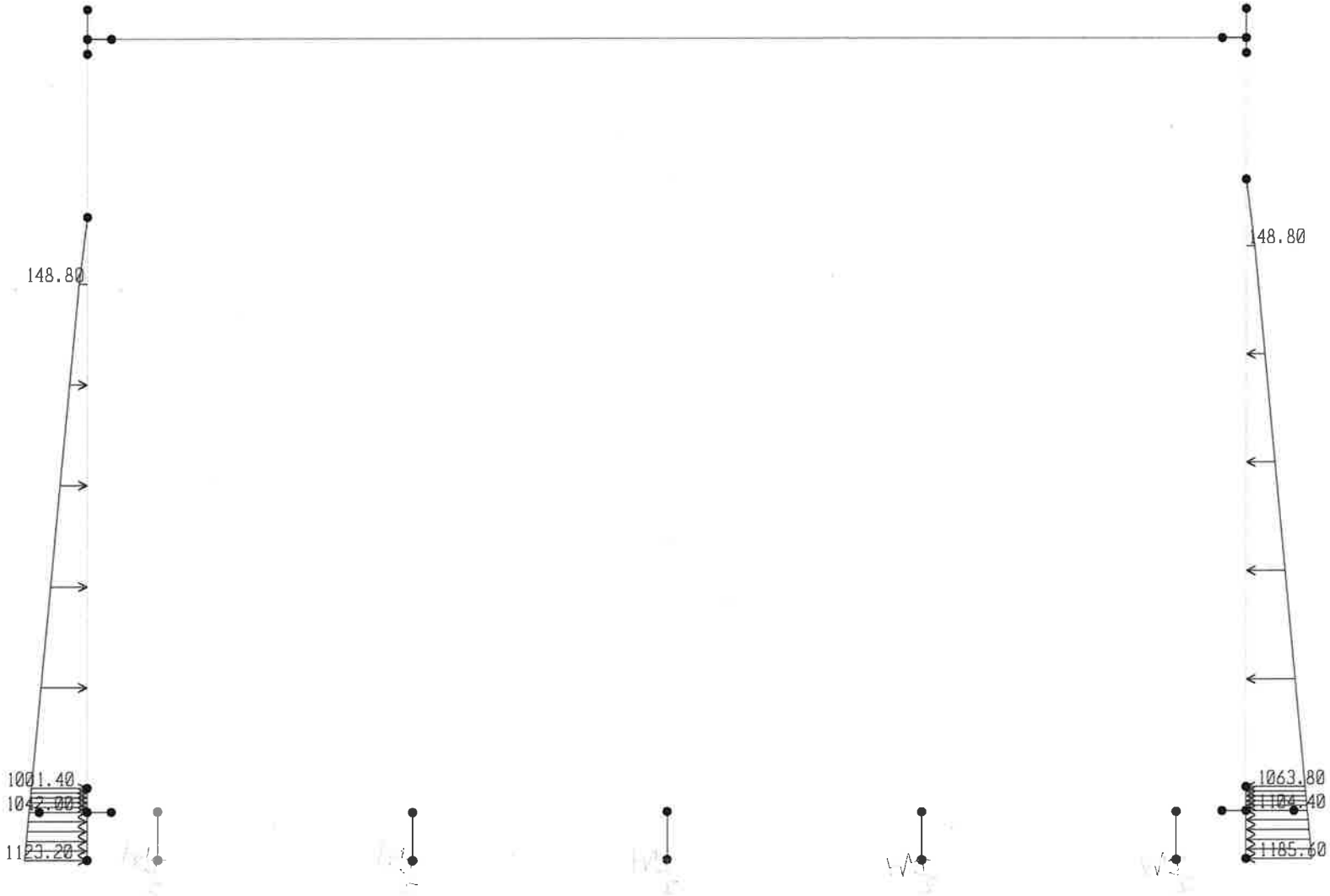
Surcharge - Uneven Construction:



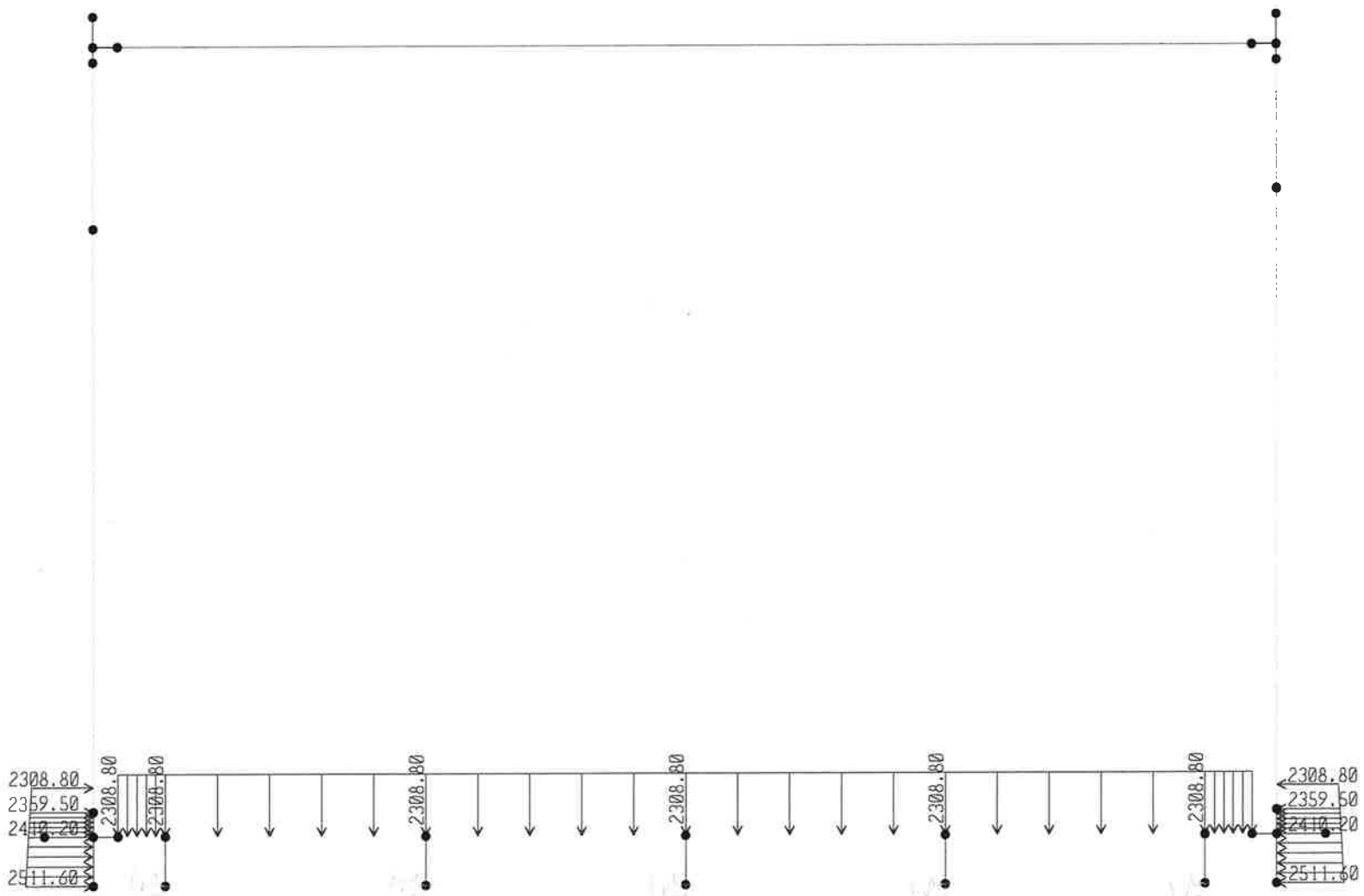
Wind During Construction:



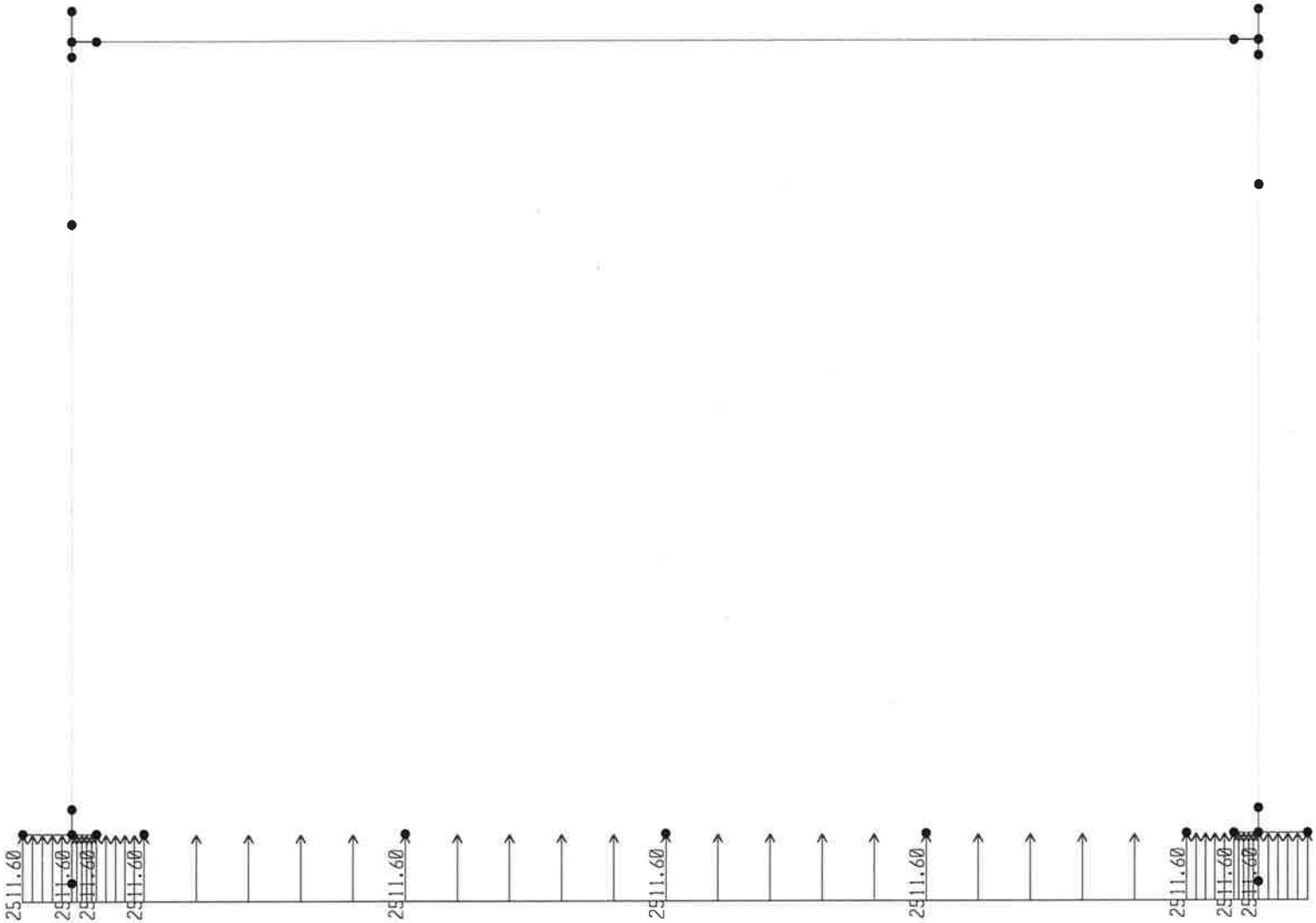
Saturated Soil:



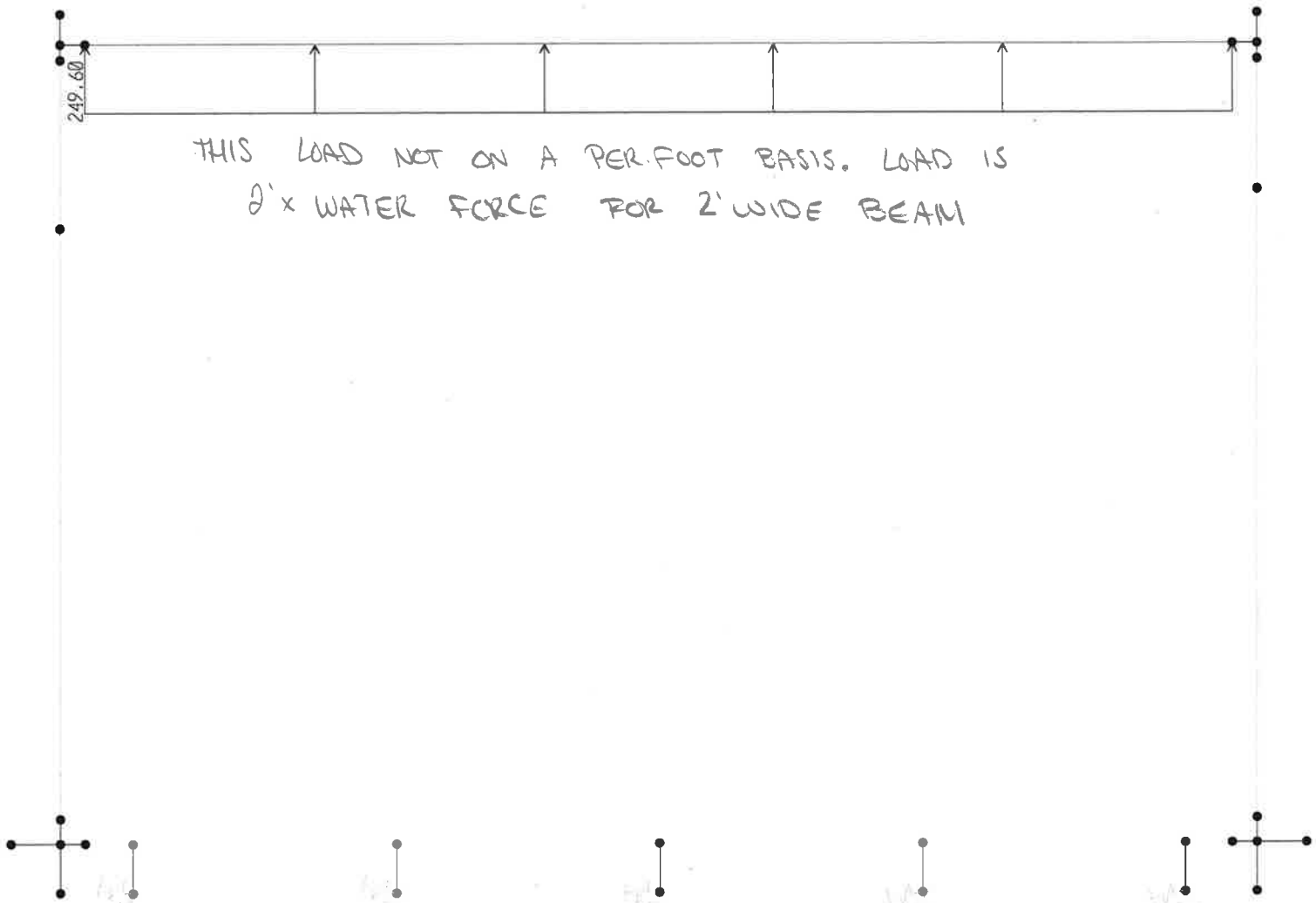
Water to EL 31.5:



Uplift - Water to EL 31.5:



Water to EL 31.5 on Strut Beam:



Downdrag Force due to Cohesion:

Downdrag Due to Cohesion - Uneven Construction:

PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model Pile Reactions Before Spring Calibration	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

* A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use a vertical spring based on a pile tip elevation of -95.0 and a lateral reaction of 20kip (0.5701" corresponding deflection).

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	Dead	-1.21	0	142.13	0	0	0
P-2	Dead	-0.91	0	103.70	0	0	0
P-3	Dead	0.00	0	90.49	0	0	0
P-4	Dead	0.91	0	103.70	0	0	0
P-5	Dead	1.21	0	142.13	0	0	0
P-1	1a	4.69	0	148.06	0	0	0
P-2	1a	4.61	0	160.28	0	0	0
P-3	1a	5.73	0	136.01	0	0	0
P-4	1a	6.82	0	116.17	0	0	0
P-5	1a	6.83	0	136.56	0	0	0
P-1	1b	18.62	0	160.56	0	0	0
P-2	1b	18.46	0	207.79	0	0	0
P-3	1b	19.58	0	128.59	0	0	0
P-4	1b	20.66	0	60.64	0	0	0
P-5	1b	20.99	0	139.67	0	0	0
P-1	1c	-5.32	0	134.92	0	0	0
P-2	1c	-5.02	0	87.22	0	0	0
P-3	1c	-4.13	0	90.49	0	0	0
P-4	1c	-3.20	0	120.18	0	0	0
P-5	1c	-2.90	0	149.34	0	0	0
P-1	2	0.64	0	215.49	0	0	0
P-2	2	0.97	0	175.83	0	0	0
P-3	2	2.43	0	149.94	0	0	0
P-4	2	3.88	0	157.33	0	0	0
P-5	2	4.26	0	211.66	0	0	0

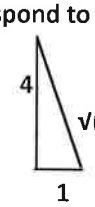
Vertical Reactions:

MAXIMUM REACTION = 215.49 kips
MINIMUM REACTION = 60.64 kips

Horizontal Reactions:

MAXIMUM REACTION = 20.99 kips
MINIMUM REACTION = -5.32 kips

* Piles are battered at 4V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves

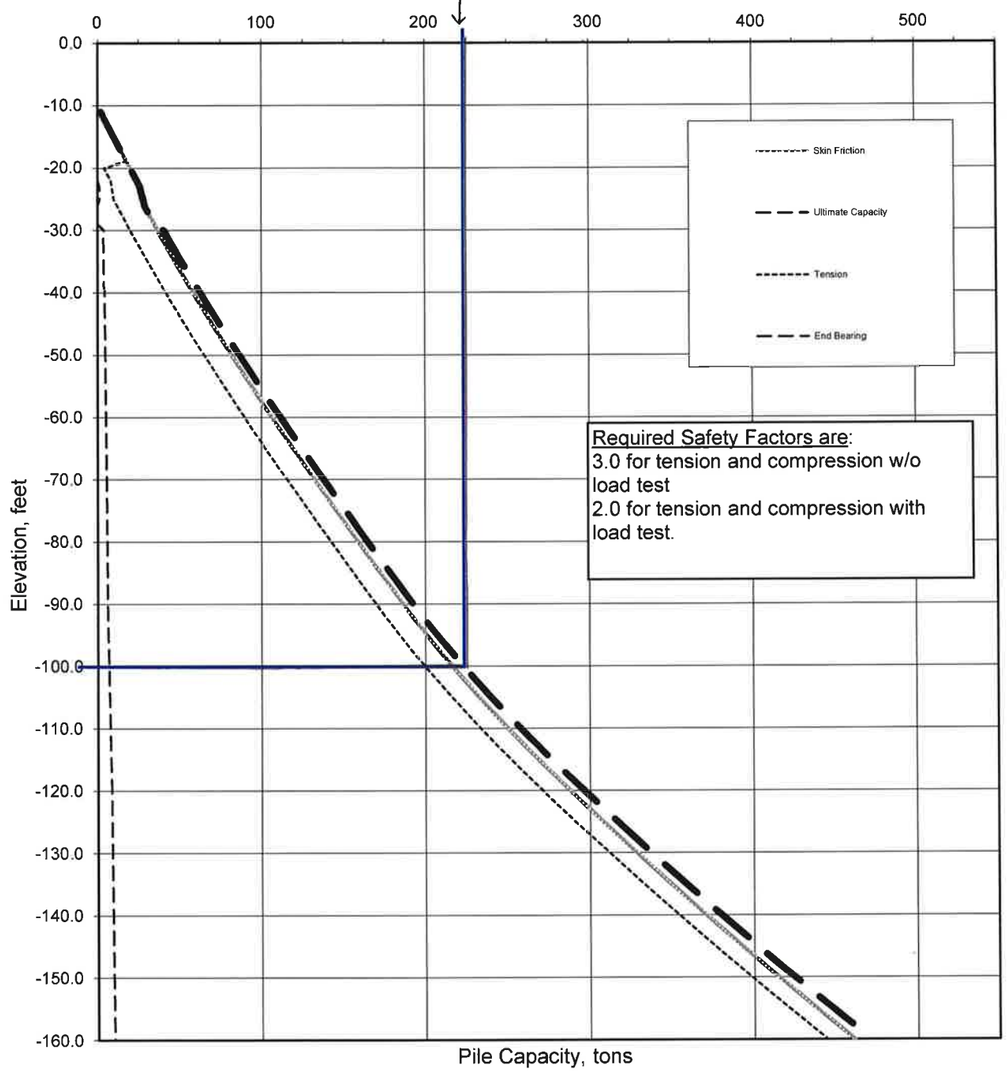


$\sqrt{(4^2+1^2)} = 4.1231$

215.49 kips * 4.1231 / 4 = 222.12 k

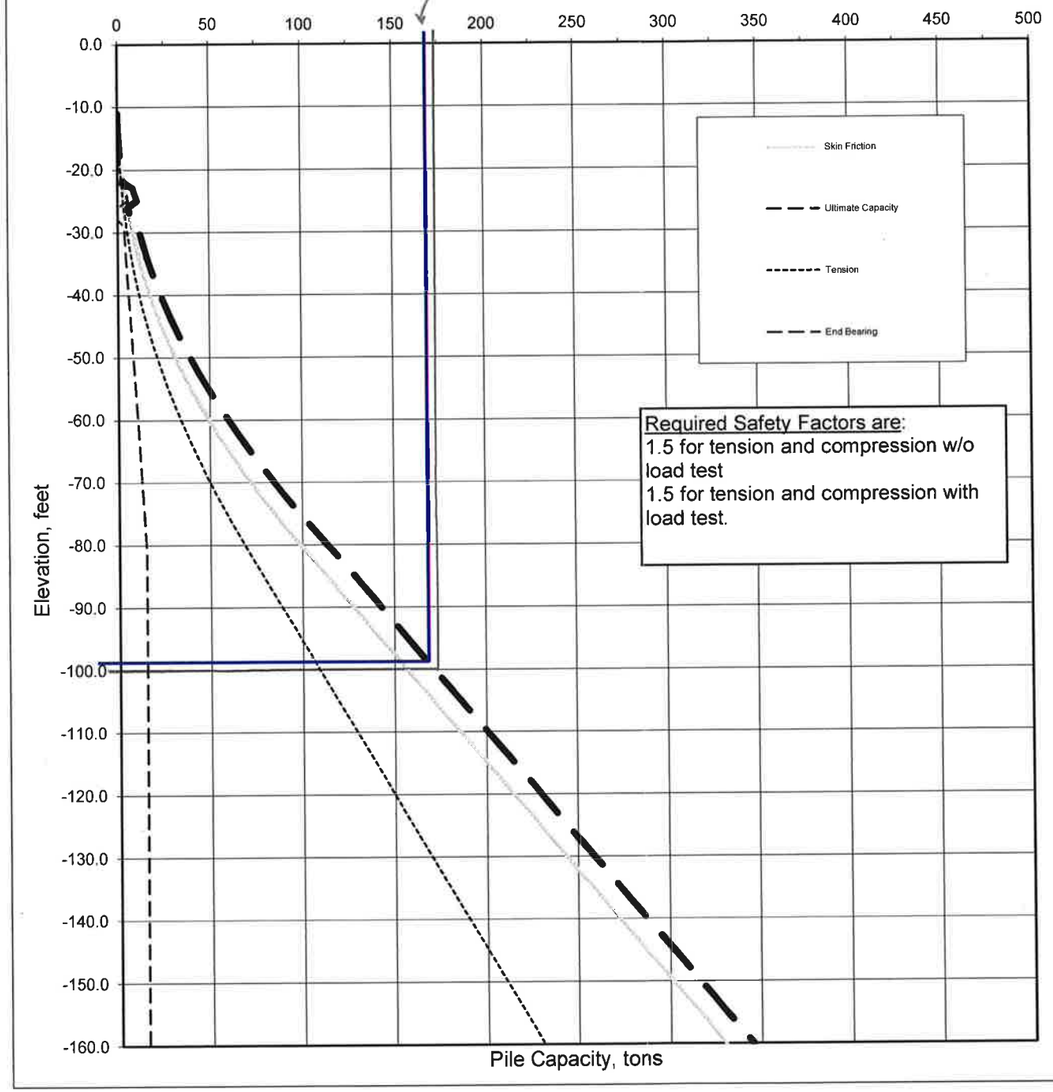
Undrained Strength Case with HP 14x89 Pile

222k REQUIRED × 1 TON / 2KIP × 2 (F.O.S.) = 222 TON



Drained Strength Case with HP 14x89 Pile

222k REQ × 1 TON / 2KIP × 1.5 (F.O.S.) = 166.5 TON



Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

PUT TIPS @ EL -100.0

C_{ALLOW} = 224k (UNDRAINED CONTROLS)

Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	**URS**	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP Inflow U-Frame Monoliths **Computed By:** LBR **Date:** Jul-13 **Page:** of

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PILE/SPRING STIFFNESS INPUT IN SAP **HP14x89 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required pile from the pile capacity curves = -100.0 NAVD88

Top of pile Elevation including 9" Pile embedment = (-8.75 + 0.75) ft = -8.00 NAVD88

Therefore, required length of pile = 92.00 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

Modulus of Elasticity of the pile (E) = 29,000 ksi

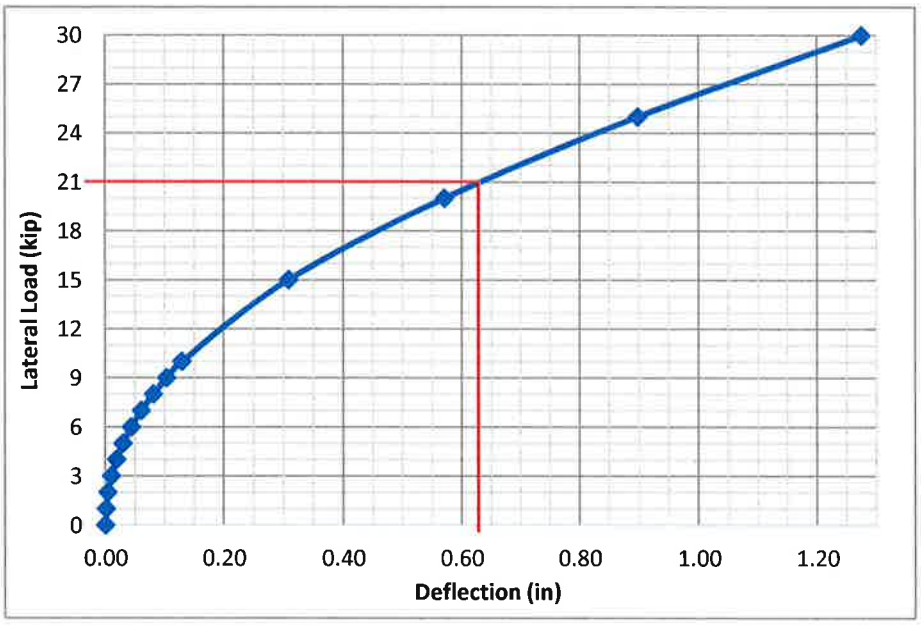
Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 1192.9 k/in

= **14315 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 21k reaction, deflection is about 0.63"

Spring = 21k/0.63in = 33.333 k/in = 400 k/ft

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

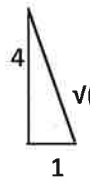
TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	Dead	-1.19	0	141.02	0	0	0
P-2	Dead	-0.91	0	104.21	0	0	0
P-3	Dead	0.00	0	91.67	0	0	0
P-4	Dead	0.91	0	104.21	0	0	0
P-5	Dead	1.19	0	141.02	0	0	0
P-1	1a	4.69	0	147.84	0	0	0
P-2	1a	4.61	0	160.39	0	0	0
P-3	1a	5.72	0	136.31	0	0	0
P-4	1a	6.81	0	116.05	0	0	0
P-5	1a	6.83	0	136.47	0	0	0
P-1	1b	18.62	0	159.92	0	0	0
P-2	1b	18.44	0	208.27	0	0	0
P-3	1b	19.56	0	129.19	0	0	0
P-4	1b	20.64	0	60.50	0	0	0
P-5	1b	20.98	0	139.35	0	0	0
P-1	1c	-5.30	0	133.87	0	0	0
P-2	1c	-5.01	0	86.61	0	0	0
P-3	1c	-4.12	0	91.67	0	0	0
P-4	1c	-3.19	0	120.80	0	0	0
P-5	1c	-2.91	0	148.17	0	0	0
P-1	2	0.66	0	214.10	0	0	0
P-2	2	0.97	0	176.47	0	0	0
P-3	2	2.43	0	151.44	0	0	0
P-4	2	3.88	0	157.88	0	0	0
P-5	2	4.24	0	210.31	0	0	0

Vertical Reactions:
MAXIMUM REACTION = 214.10 kips
MINIMUM REACTION = 60.50 kips

Horizontal Reactions:
MAXIMUM REACTION = 20.98 kips
MINIMUM REACTION = -5.30 kips

* Piles are battered at 4V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(4^2+1^2)} = 4.1231$

214.10 kips * 4.1231 / 4 = 220.69 k

$C_{ALLOW} = 224^k > C_{ULT} = 221^k \rightarrow$ OK

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	inch	inch	inch
P-1	Dead	0.0358	0	-0.1182
P-2	Dead	0.0273	0	-0.0874
P-3	Dead	0.0000	0	0.0000
P-4	Dead	-0.0273	0	-0.0874
P-5	Dead	-0.0358	0	-0.1182
P-1	1a	-0.1407	0	-0.1239
P-2	1a	-0.1382	0	-0.1345
P-3	1a	-0.1717	0	-0.1143
P-4	1a	-0.2044	0	-0.0973
P-5	1a	-0.2048	0	-0.1144
P-1	1b	-0.5586	0	-0.1341
P-2	1b	-0.5533	0	-0.1746
P-3	1b	-0.5868	0	-0.1083
P-4	1b	-0.6191	0	-0.0507
P-5	1b	-0.6294	0	-0.1168
P-1	1c	0.1590	0	-0.1122
P-2	1c	0.1504	0	-0.0734
P-3	1c	0.1237	0	-0.0768
P-4	1c	0.0958	0	-0.1013
P-5	1c	0.0874	0	-0.1242
P-1	2	-0.0197	0	-0.1795
P-2	2	-0.0291	0	-0.1479
P-3	2	-0.0728	0	-0.1269
P-4	2	-0.1163	0	-0.1324
P-5	2	-0.1272	0	-0.1763

Vertical Displacements:

MAXIMUM = 0.000 inch
MINIMUM = -0.180 inch

Horizontal Displacements:

MAXIMUM = 0.159 inch
MINIMUM = -0.629 inch

Maximum horizontal deflection is 0.629". Maximum allowable deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.180", which is less than the maximum allowable 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.63". The spring has converged.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

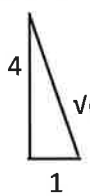
TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	1a-ST	4.45	0	225.12	0	0	0
P-2	1a-ST	4.59	0	208.78	0	0	0
P-3	1a-ST	6.19	0	172.09	0	0	0
P-4	1a-ST	7.79	0	164.85	0	0	0
P-5	1a-ST	8.09	0	223.15	0	0	0
P-1	1b-ST	19.98	0	215.46	0	0	0
P-2	1b-ST	19.90	0	251.52	0	0	0
P-3	1b-ST	21.40	0	161.63	0	0	0
P-4	1b-ST	23.00	0	105.38	0	0	0
P-5	1b-ST	23.71	0	232.48	0	0	0
P-1	2-ST	0.41	0	291.37	0	0	0
P-2	2-ST	0.95	0	224.86	0	0	0
P-3	2-ST	2.89	0	187.22	0	0	0
P-4	2-ST	4.85	0	206.68	0	0	0
P-5	2-ST	5.51	0	296.98	0	0	0

Vertical Reactions:
MAXIMUM REACTION = 296.98 kips
MINIMUM REACTION = 105.38 kips

Horizontal Reactions:
MAXIMUM REACTION = 23.71 kips
MINIMUM REACTION = 0.41 kips

* Piles are battered at 4V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(4^2+1^2)} = 4.1231$

296.98 kips * 4.1231 / 4 = 306.12 k

NOTE: Pile lengths are not being adjusted based on settlement forces. A structural check of the piles will be performed using the pile length required by traditional load cases. If structural check is ok for "ST" cases, then they will be deemed adequate @ EL -100.0. Also, punching shear in the slab will be performed using the max. "ST" reaction.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	inch	inch	inch
P-1	1a-ST	-0.1335	0	-0.1887
P-2	1a-ST	-0.1376	0	-0.1750
P-3	1a-ST	-0.1856	0	-0.1443
P-4	1a-ST	-0.2337	0	-0.1382
P-5	1a-ST	-0.2427	0	-0.1871
P-1	1b-ST	-0.5995	0	-0.1806
P-2	1b-ST	-0.5970	0	-0.2108
P-3	1b-ST	-0.6421	0	-0.1355
P-4	1b-ST	-0.6900	0	-0.0883
P-5	1b-ST	-0.7112	0	-0.1949
P-1	2-ST	-0.0124	0	-0.2443
P-2	2-ST	-0.0284	0	-0.1885
P-3	2-ST	-0.0866	0	-0.1569
P-4	2-ST	-0.1456	0	-0.1733
P-5	2-ST	-0.1652	0	-0.2490

Vertical Displacements:

MAXIMUM = -0.088 inch

MINIMUM = -0.249 inch

Horizontal Displacements:

MAXIMUM = -0.012 inch

MINIMUM = -0.711 inch

Maximum horizontal displacement is 0.711". Maximum allowable deflection is 0.75" (for load cases with no allowable overstress). Maximum vertical deflection is 0.249", which is less than the maximum allowable 0.5". Therefore, all deflections OK.

URS

Job: MAUREPAS | Project No. 10001876 | Page ___ of ___
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Checked by: | Date: 7/2013 | Date:

Reference

Es: USING P-y CURVE DATA

↳ CALIBRATED SPRING IN SAP = $21^{K}/0.63'' = 33.33\ ^{K}/_{IN}$

↳ FROM CPGA MANUAL, WE KNOW:

PILE STIFFNESS COEFF, $K = \frac{C_o E I}{R^3}$

C_o = FIXETY CONST = 0.707 FOR CONSTANT E_s, PINNED
$E = 29{,}000{,}000$ PSI
$I = 904\ IN^4$ (STRONG AXIS)
$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 33{,}333\ ^{LB}/_{IN} = \frac{(0.707)(29{,}000{,}000\ PSI)(904\ IN^4)}{\left(\sqrt[4]{\frac{(29{,}000{,}000)(904)}{E_s}}\right)^3}$$

SOLVING FOR E_s W/ EXCEL $\Rightarrow$ $E_s = 573.36$ PSI = 0.573 KSI

LATERAL GROUP REDUCTION: HSDRS GUIDELINES SECT 4.3

- PARALLEL TO LOADING, $R_g = 0.48\left(^{Sb}/_{b}\right)^{0.38}$, $Sb = 9'-1\frac{1}{2}'' = 109.5''$, $b = 14''$

$= 1.049 \Rightarrow$ NO REDUCTION NECESSARY

CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONSTANT E_s, UNSUPPORTED LENGTH (CONSERVATIVE)

$PCR = n\sqrt{E_s E I}$, WHERE $n = 1$ - PINNED

$= \sqrt{(0.573)(29{,}000\ KSI)(904\ IN^4)} = 3876.99^{KIPS}$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
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Reference

*ALLOWABLE STRESSES: CPGA MANUAL PG 42-43; AISC 9TH ED PG 5-42:

ACC: IF $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

$E = 29{,}000\,KSI$
$F_y = 50\,KSI$
$A = 26.1\,IN^2$
$S.F. = 5/3 \times 6/5 = 2$

THEN $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

OTHERWISE $ACC = PCR / S.F.$

↳ $\sqrt{\frac{2\pi^2 \times 29{,}000\,KSI}{50\,KSI}} = 106.999$ ↳ $\sqrt{\frac{\pi^2 \times 29{,}000\,KSI \times 26.1\,IN^2}{3763.8^k}} = 44.55$

$\therefore ACC = \left[\frac{50\,KSI \times 26.1\,IN^2}{2}\right]\left[1 - \frac{50\,KSI \times 26.1\,IN^2}{4 \times 3763.8^k}\right] = \underline{\underline{595.94^k}}$

AT: $AT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,IN^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$

*COMBINED BENDING FACTOR: CPGA MANUAL P.32

$$COMP = \left[\frac{F3}{ACC} + \cancel{MF1} \times \left(\frac{M1}{AM1}\right) + \cancel{MF2} \times \left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

-NO TENSION FORCES-, MF1 & MF2 ACCOUNT FOR PΔ - NONE PRESENT

*AXIAL LOAD FACTOR: CPGA MANUAL P.31

$ALF = \frac{F3}{AC} \times \frac{1}{OSF} \leq 1$, AC = ALLOWABLE COMPRESSION = $\underline{294^k}$

USACE SAFETY
AISC SAFETY

↳ $AM1 = S_x \cdot F_y \cdot = (131\,IN^3)(50\,KSI)(5/6)(2/3) = \underline{3638.9^{k \cdot IN}}$

↳ AM2 NOT NECESSARY FOR 2D.

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load	Slenderness Parameters		Structural Check					Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety (5/3*6/5)	ACC = Allow. Axial Comp. Stress	ATT = Allow. Axial Tension Stress	AM1 = AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)				(kips)	(kips)	(kip-in)		Kips-in	Kips-in		
P-1	Dead	-1.19	0	141.02	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	652.50	3639	1	15.30	0.00	0.24	0.65
P-2	Dead	-0.91	0	104.21	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	5.84	0.00	0.18	0.48
P-3	Dead	0.00	0	91.67	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	-23.48	0.00	0.16	0.42
P-4	Dead	0.91	0	104.21	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	5.84	0.00	0.18	0.48
P-5	Dead	1.19	0	141.02	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	15.30	0.00	0.24	0.65
P-1	1a	4.69	0	147.84	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	150.99	0.00	0.25	0.58
P-2	1a	4.61	0	160.39	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	147.53	0.00	0.26	0.63
P-3	1a	5.72	0	136.31	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	197.07	0.00	0.24	0.54
P-4	1a	6.81	0	116.05	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	248.87	0.00	0.23	0.46
P-5	1a	6.83	0	136.47	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	249.85	0.00	0.25	0.54
P-1	1b	18.62	0	159.92	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1010.83	0.00	0.47	0.63
P-2	1b	18.44	0	208.27	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	996.46	0.00	0.53	0.82
P-3	1b	19.56	0	129.19	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1087.26	0.00	0.44	0.51
P-4	1b	20.64	0	60.50	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1177.95	0.00	0.36	0.24
P-5	1b	20.98	0	139.35	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1207.14	0.00	0.48	0.55
P-1	1c	-5.30	0	133.87	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	177.94	0.00	0.23	0.53
P-2	1c	-5.01	0	86.61	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	165.01	0.00	0.16	0.34
P-3	1c	-4.12	0	91.67	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	126.69	0.00	0.16	0.36
P-4	1c	-3.19	0	120.80	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	88.89	0.00	0.19	0.48
P-5	1c	-2.91	0	148.17	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	77.95	0.00	0.23	0.58
P-1	2	0.66	0	214.10	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	-2.43	0.00	0.36	0.99
P-2	2	0.97	0	176.47	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	7.85	0.00	0.30	0.81
P-3	2	2.43	0	151.44	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	59.68	0.00	0.27	0.70
P-4	2	3.88	0	157.88	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	116.72	0.00	0.30	0.73
P-5	2	4.24	0	210.31	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	131.74	0.00	0.39	0.97
P-1	1a-ST	4.45	0	225.12	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	140.66	0.00	0.36	0.89
P-2	1a-ST	4.59	0	208.78	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	146.67	0.00	0.33	0.82
P-3	1a-ST	6.19	0	172.09	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	219.02	0.00	0.30	0.68
P-4	1a-ST	7.79	0	164.85	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	298.12	0.00	0.31	0.65
P-5	1a-ST	8.09	0	223.15	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	313.70	0.00	0.39	0.88
P-1	1b-ST	19.98	0	215.46	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1122.16	0.00	0.57	0.85
P-2	1b-ST	19.90	0	251.52	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1115.48	0.00	0.62	0.99
P-3	1b-ST	21.40	0	161.63	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1243.61	0.00	0.52	0.64
P-4	1b-ST	23.00	0	105.38	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1386.82	0.00	0.48	0.42
P-5	1b-ST	23.71	0	232.48	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1.17	1452.52	0.00	0.68	0.92
P-1	2-ST	0.41	0	291.37	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	-10.54	0.00	0.49	1.34
P-2	2-ST	0.95	0	224.86	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	7.18	0.00	0.38	1.03
P-3	2-ST	2.89	0	187.22	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	77.18	0.00	0.33	0.86
P-4	2-ST	4.85	0	206.68	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	157.97	0.00	0.39	0.95
P-5	2-ST	5.51	0	296.98	50	26.10	904.0	326.0	131.0	44.3	29000	0.573	1	1	217.3	0.0	3877	107	44	2	598	653	3639	1	187.45	0.00	0.55	1.37

$C_{ALLOW} = 224^k$ FOR VERTICAL PILE

FOR 4V:1H, $224^k \times \frac{4}{\sqrt{4^2+1^2}} = 217.3^k$

NO COMBINED BENDING ISSUES DUE TO SETTLEMENT

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:** Notes / References

Bottom Slab Thickness =	3.25	ft	
Wall Thickness =	3.25	ft	Traditional Cases
Tributary Width =	12	ft	(no cohesion settlement)
Design Width =	12	in	presented first
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

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	37.41	3.12	1081.3	90.1	0.0	0.0
1a	344.63	28.72	1495.4	124.6	1210.9	100.9
1b	303.78	25.32	1877.9	156.5	602.2	50.2
1c	57.79	4.82	1259.3	104.9	0.0	0.0
2	194.81	16.23	1905.6	158.8	0.0	0.0

* Shear values taken at a distance 'd'= 34.37in from the face of the slab.
^ Moment values taken at faces of connections (where slab meets wall).

Max. Shear = 28.7 kip
Max. Moment = 158.8 kip-ft (controls exterior reinforcement)
Min. Moment = 100.9 kip-ft (controls interior reinforcement) ← CONTROLS OVER SETTLEMENT CASES

*** Reinforcing Limits:**

A_{gross} = 39in * 12in strip = 468 in^2
d = 39in - 4in cover - 1/2 bar diameter = 34.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 5.002 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 1.310 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * √(f'_c) * b * d) / f_y = 1.304 in^2 ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 1.375 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.002 in^2**	- half each face
	Min. T&S Rebar =	**1.310 in^2**	- half each face
	Min. Flexural Rebar =	**1.375 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = ϕ * 2 * √(f'_c) * b * d
= 0.85 * 2 * √4000 * 12in * 34.365in
= 44,338 lb

ϕVc = 44.3kip > Vu = 28.7kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#9 @ 6"** to start: As, #9 @ 6" = 2.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 2 * 60ksi / (0.85 * 4ksi * 12in) = 2.941 in

$\phi Mn =$ 0.9 * 2in² * 60ksi * (34.365in - 2.941in / 2)
= 3552.6 kip-in/ft
= 296.05 kip-ft/ft

ϕMn = 296kip-ft > Mu = 158.8kip-ft → Use #9 @ 6"

Interior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in² * 60ksi * (in - 1.162in / 2)
= 1441.2 kip-in/ft
= 120.10 kip-ft/ft

ϕMn = 120.1kip-ft > Mu = 100.9kip-ft → Use #8 @ 12"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	207.23	17.27	462.1	38.5	1340.4	111.7
1a	236.61	19.72	1714.3	142.9	672.6	56.1
1b	254.42	21.20	2049.8	170.8	1593.3	132.8
1c	186.97	15.58	794.4	66.2	1158.0	96.5
2	341.64	28.47	1335.4	111.3	1874.4	156.2

* Shear values taken at a distance 'd'= 34.37in from the face of the slab.

Max. Shear = 28.5 kip
Max. Moment = 170.8 kip-ft (controls bottom reinforcement)
Min. Moment = 156.2 kip-ft (controls top reinforcement)

*** Reinforcing Limits:** A_{gross} = 39in * 12in strip = 468 in^2
d = 39in - 4in cover - 1/2 bar diameter = 34.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 5.002 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross} =$ 1.310 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y =$ 1.304 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y =$ 1.375 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**5.002 in^2**	- half each face
	Min. T&S Rebar =	**1.310 in^2**	- half each face
	Min. Flexural Rebar =	**1.375 in^2**	- per face

* Section Design:

Shear:

Shear Capacity $(\phi V_c) = \phi * 2 * \sqrt{f'_c} * b * d$

$= 0.85 * 2 * \sqrt{4000} * 12in * 34.365in$

$= 44{,}338$ lb

$\phi Vc = 44.3kip > Vu = 28.5kip \rightarrow$ Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try **#8 @ 6"** to start: As, #8 @ 6" = 1.58 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $1.58 * 60ksi / (0.85 * 4ksi * 12in) =$ 2.324 in

$\phi Mn = 0.9 * 1.58in^2 * 60ksi * (34.365in - 2.324in / 2)$

$= 2832.9$ kip-in/ft

$= 236.08$ kip-ft/ft

$\phi Mn = 236.1kip\text{-}ft > Mu = 170.8kip\text{-}ft \rightarrow$ Use #8 @ 6"

Top Face:

* Will try **#9 @ 6"** to start: As, #9 @ 6" = 2.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $2 * 60ksi / (0.85 * 4ksi * 12in) =$ 2.941 in

$\phi Mn = 0.9 * 2in^2 * 60ksi * (in - 2.941in / 2)$

$= 3552.6$ kip-in/ft

$= 296.05$ kip-ft/ft

$\phi Mn = 296kip\text{-}ft > Mu = 156.2kip\text{-}ft \rightarrow$ Use #9 @ 6"

* SECONDARY REINF. CAN BE TEMP & SHRINKAGE MINIMUM.

↳ FOR 3'-3" SECTIONS, T&S Min = $0.6551 in^2$ PER FACE

⇒ USE #8@12" ($A_s = 0.79 in^2$)

In the exterior faces of the walls, the controlling moments occur at the bottoms of the walls (where slab meets wall). It is possible to reduce the amount of exterior reinforcing in the top of the walls because of the reduction in moment in this region.

* Determine the capacity of #8 @ 12" (transition from #8 @ 6" to #8 @ 12" in exterior face):

#9 @ 12" As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (34.365in - 1.471in / 2)
= 1816 kip-in/ft
$\phi Mn =$ 151.33 kip-ft/ft

$\phi Mn =$ 1816.00 kip-ft per 12ft strip

* See the moment diagrams in the attached SAP results for a breakdown of moments along the length of the walls & the areas in which the moment is less than the capacity of #9 @ 12" bars.

* The controlling distance is found in LC 2: the #9 @ 6" reinforcing must be continued approximately 1'-2" from the top of the slab before it may be reduced to #9 @ 12".

* The required embedment length of #9 bars spaced 6" o.c. is 32". This means that the terminating #9 bars must extend a minimum of 3'-10" from the top of the slab.

*** Strut Beam:**

Load Case	Max. Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
Dead	21.73	90.4	125.4
1a	20.45	52.2	166.4
1b	23.16	69.8	204.9
1c	20.52	78.5	141.7
2	35.21	131.4	224.7

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

Max. Shear = 35.21 kip
Max. Moment = 131.4 kip-ft (controls bottom reinforcement)
Min. Moment = 224.7 kip-ft (controls top reinforcement) ← CONTROLS OVER SETTLEMENT CASES

b = 24 in h = 24 in

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in #10 bar assumed

Shear:

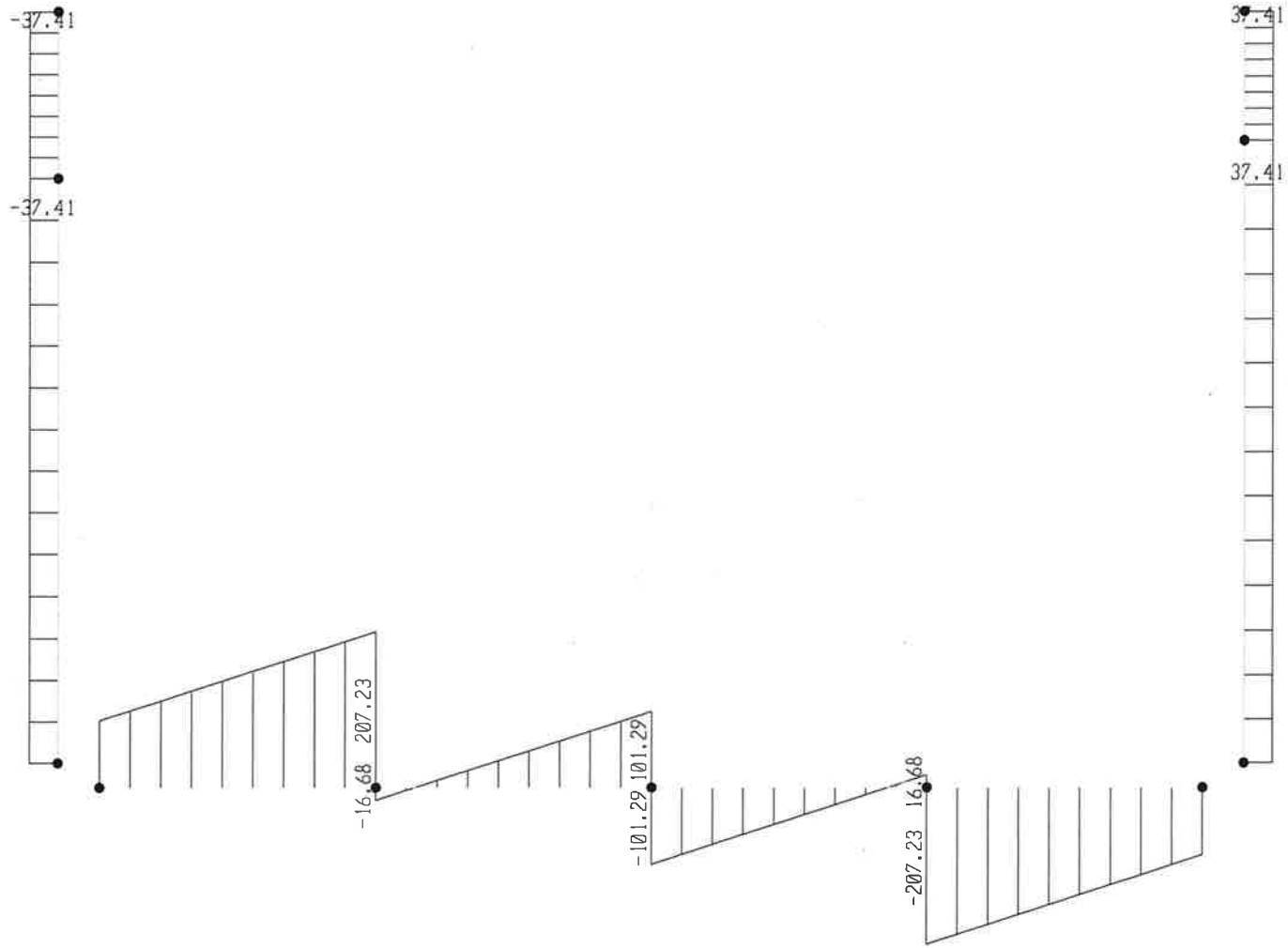
Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$
= $0.85 * 2 * \sqrt{4000} * 24in * 19.365in$
= 49,970 lb

ϕVc = 50kip > Vu = 35.2kip → Section OK

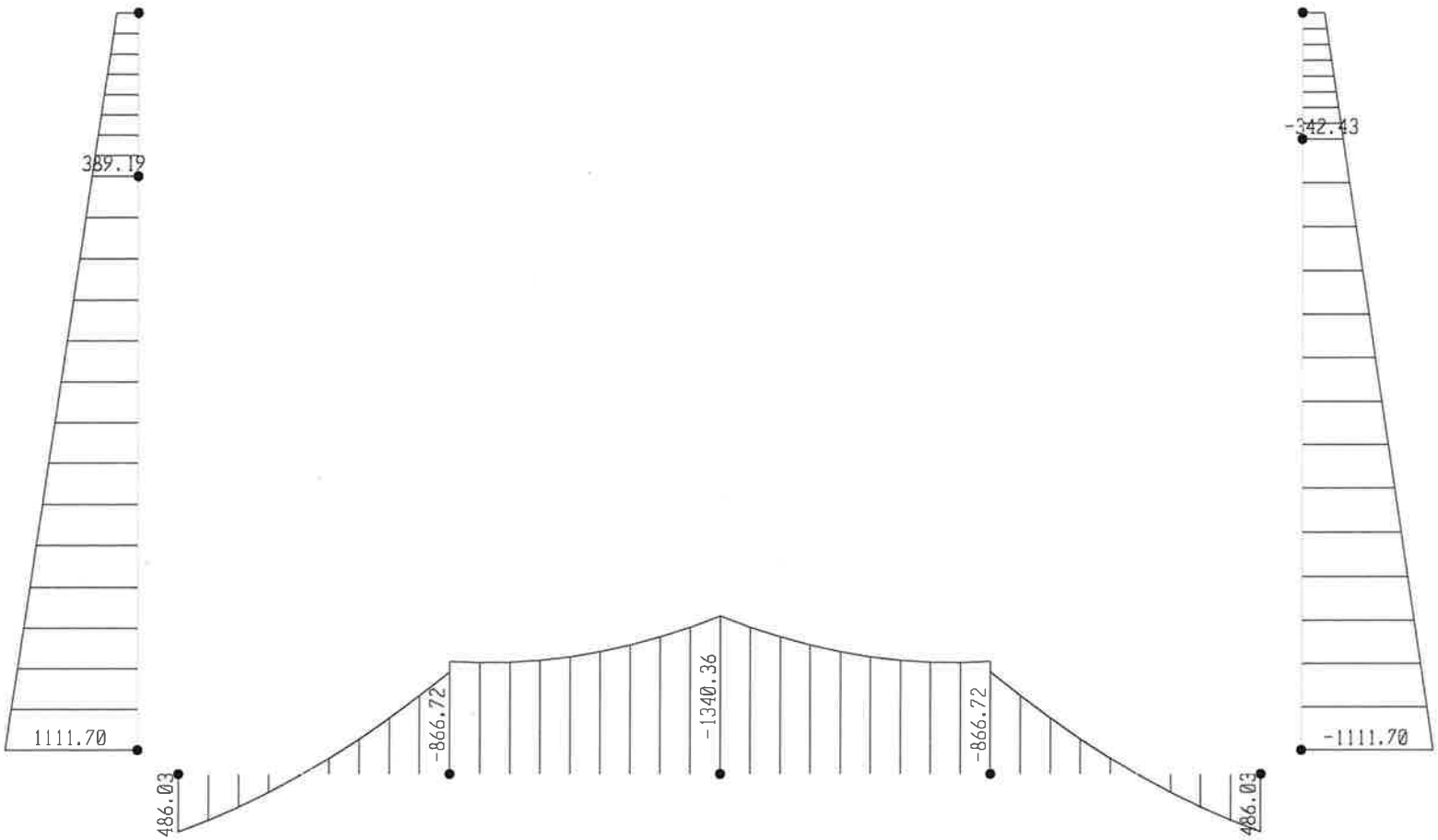
Moment:

Moment reinforcing & other beam calculations follow the SAP result images.

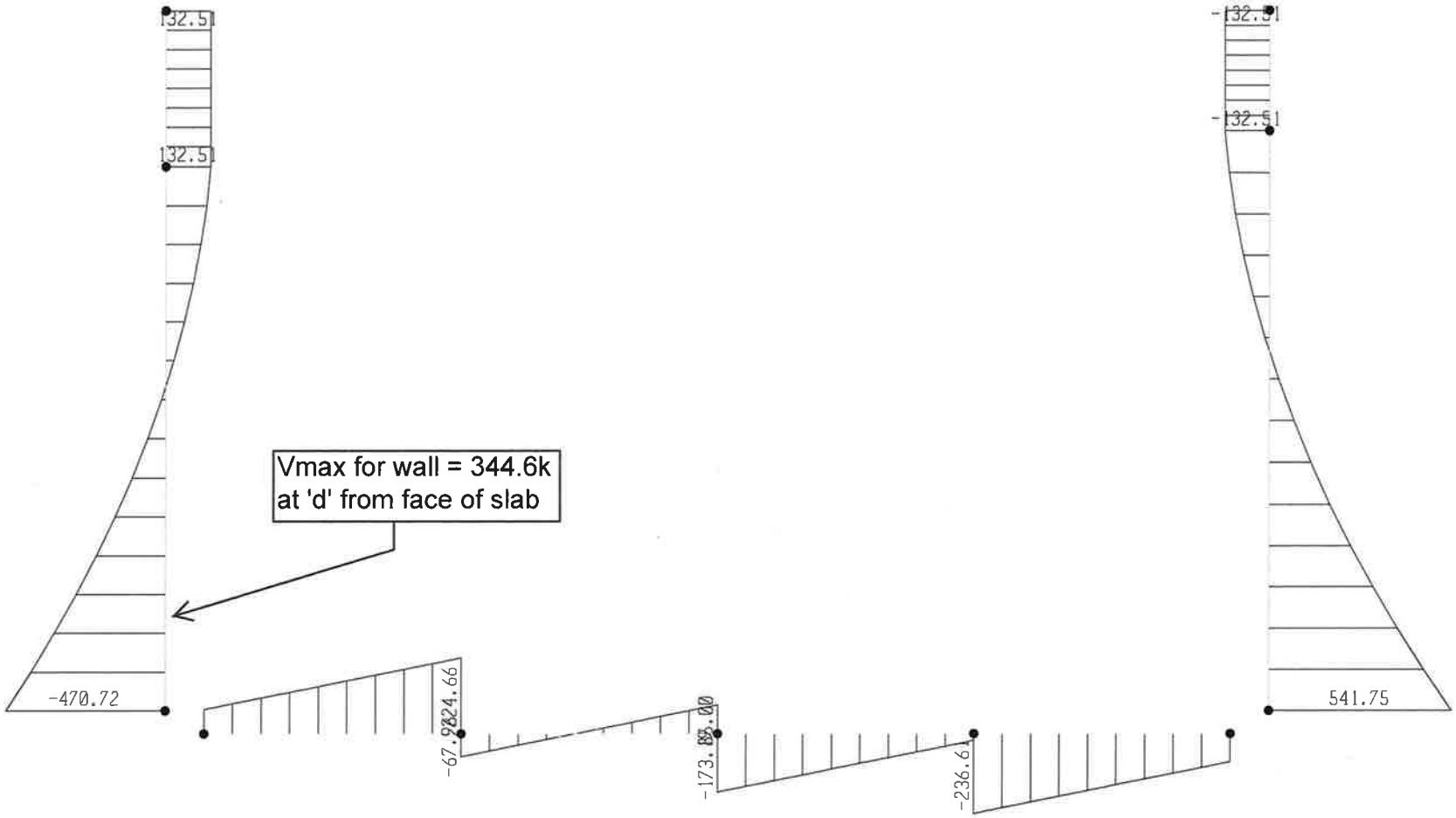
* SAP results are shown on the following 15 pages. The wall & slab moments & shears are presented first, followed by the strut beam shear & moments. Please note that the wall shear & moments shown are for a 12' wide tributary width.



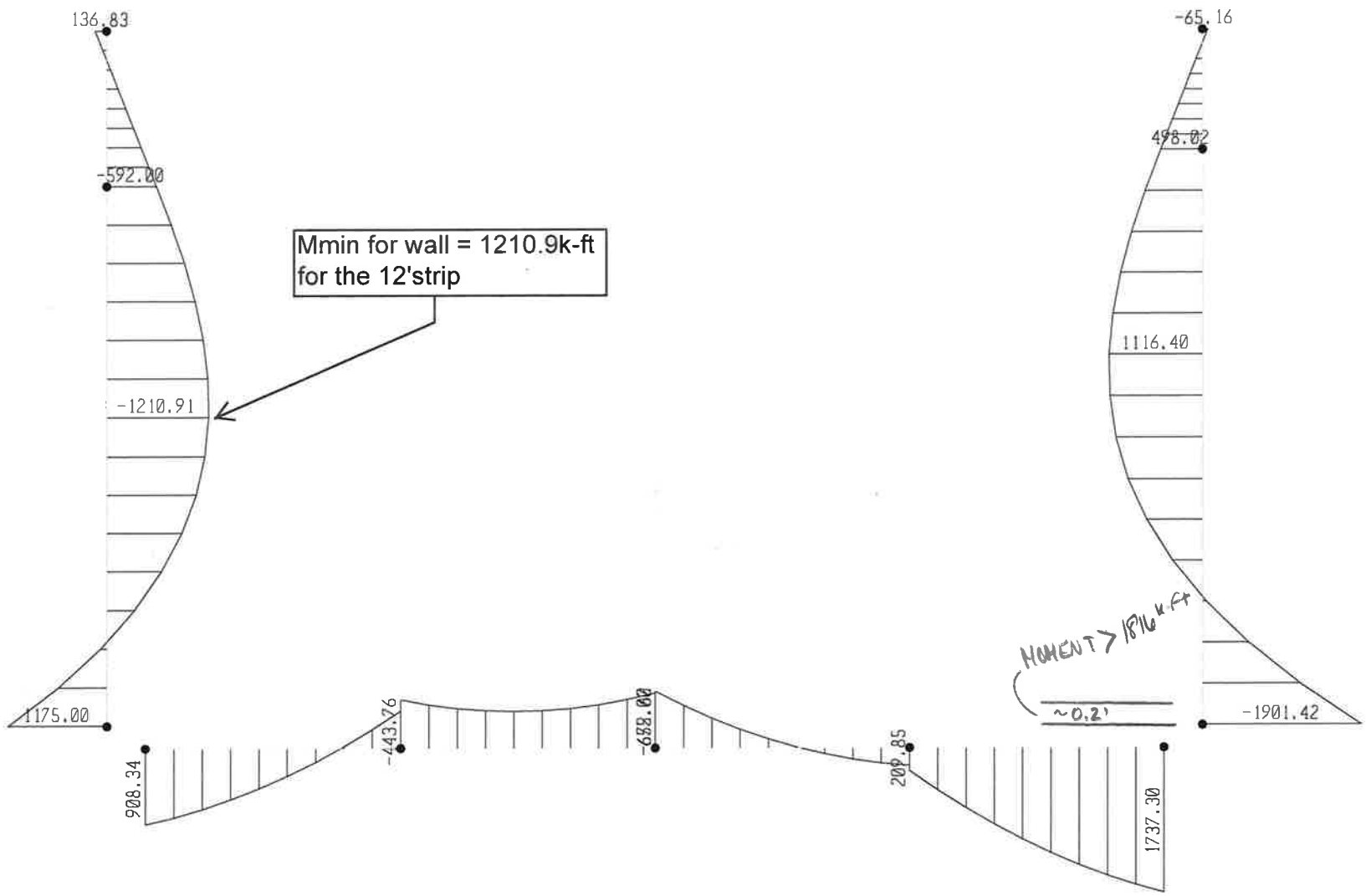
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C Dead) - Kip, ft, F Units



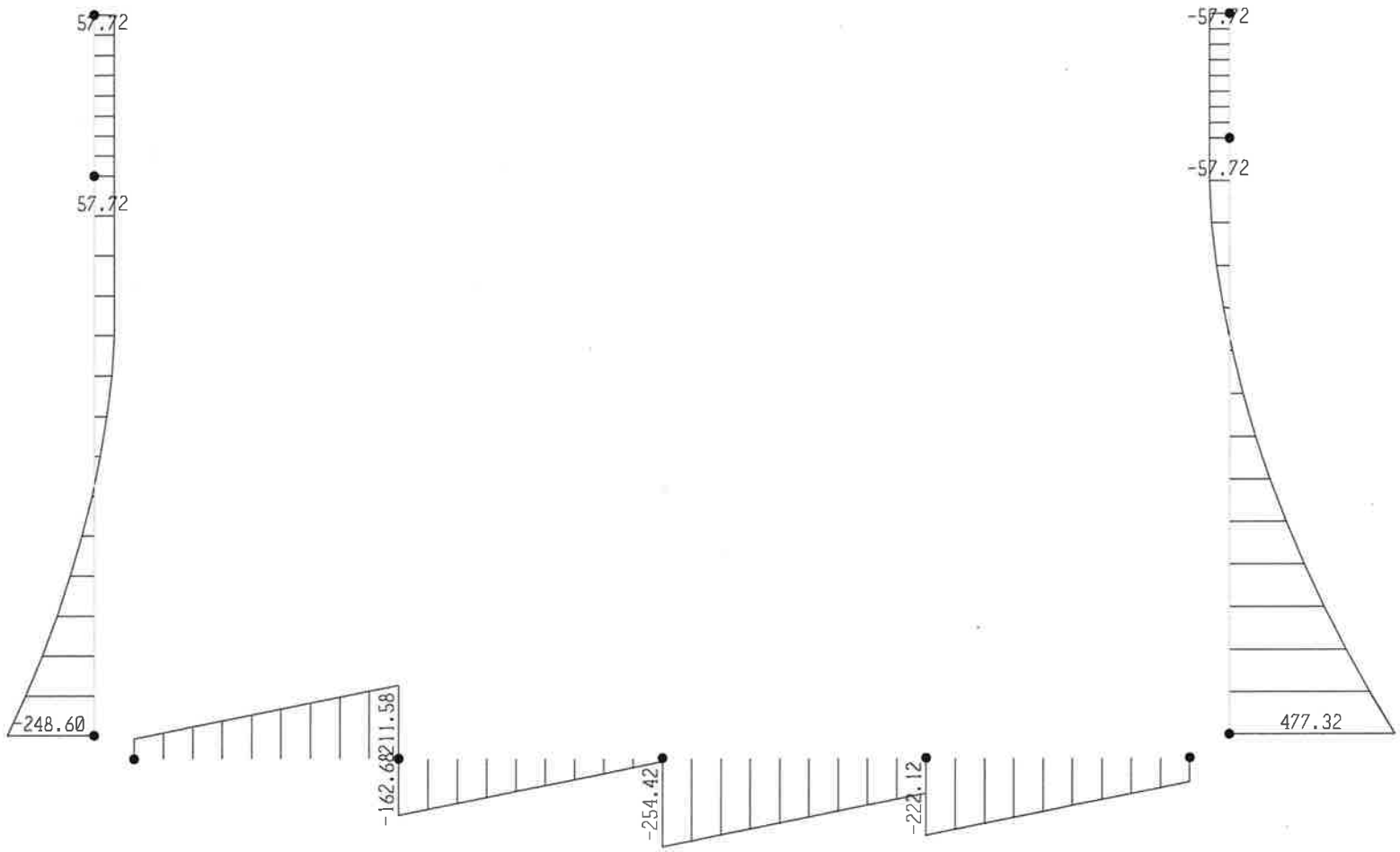
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C Dead) - Kip, ft, F Units



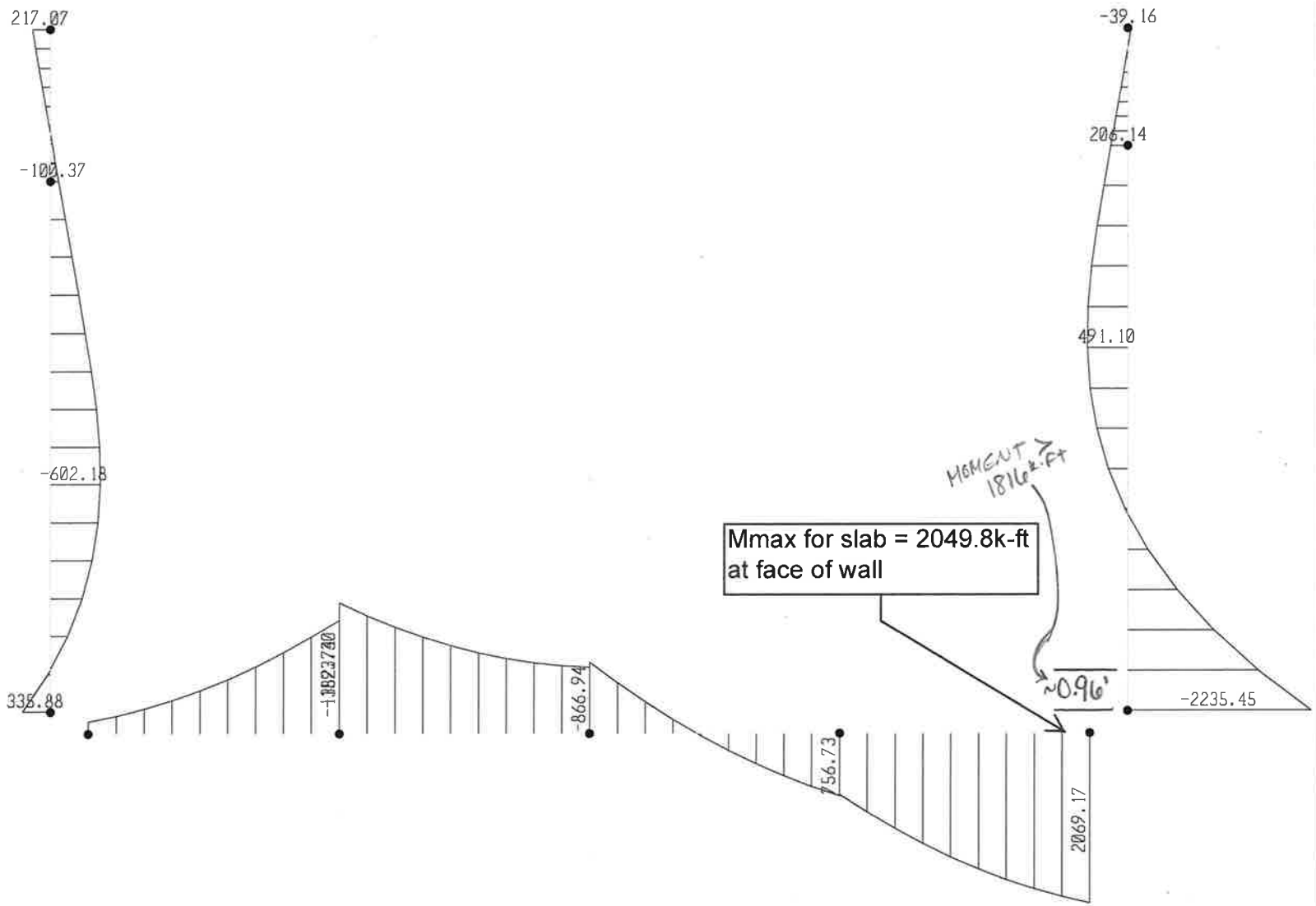
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1a) - Kip, ft, F Units



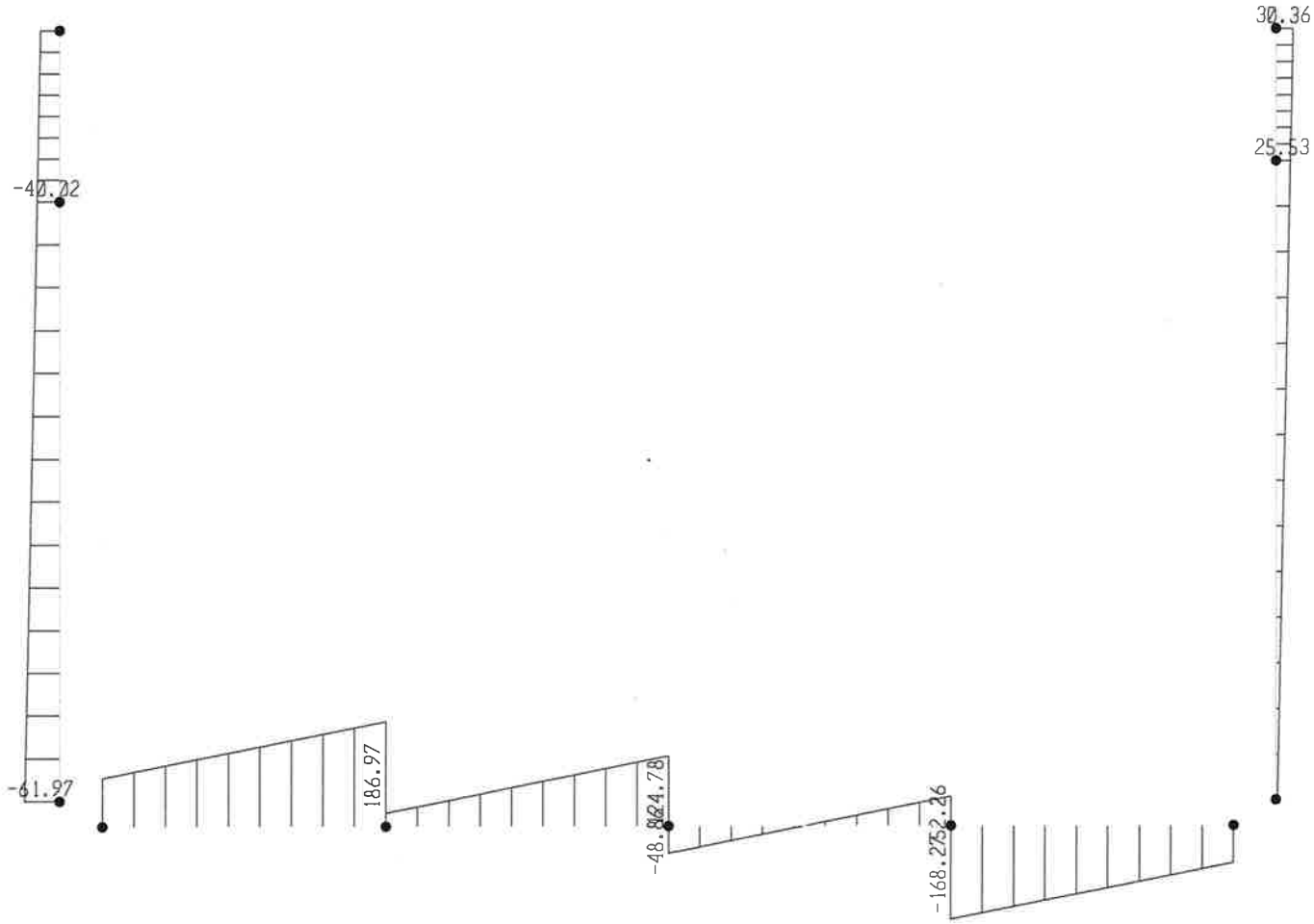
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1a) - Kip, ft, F Units



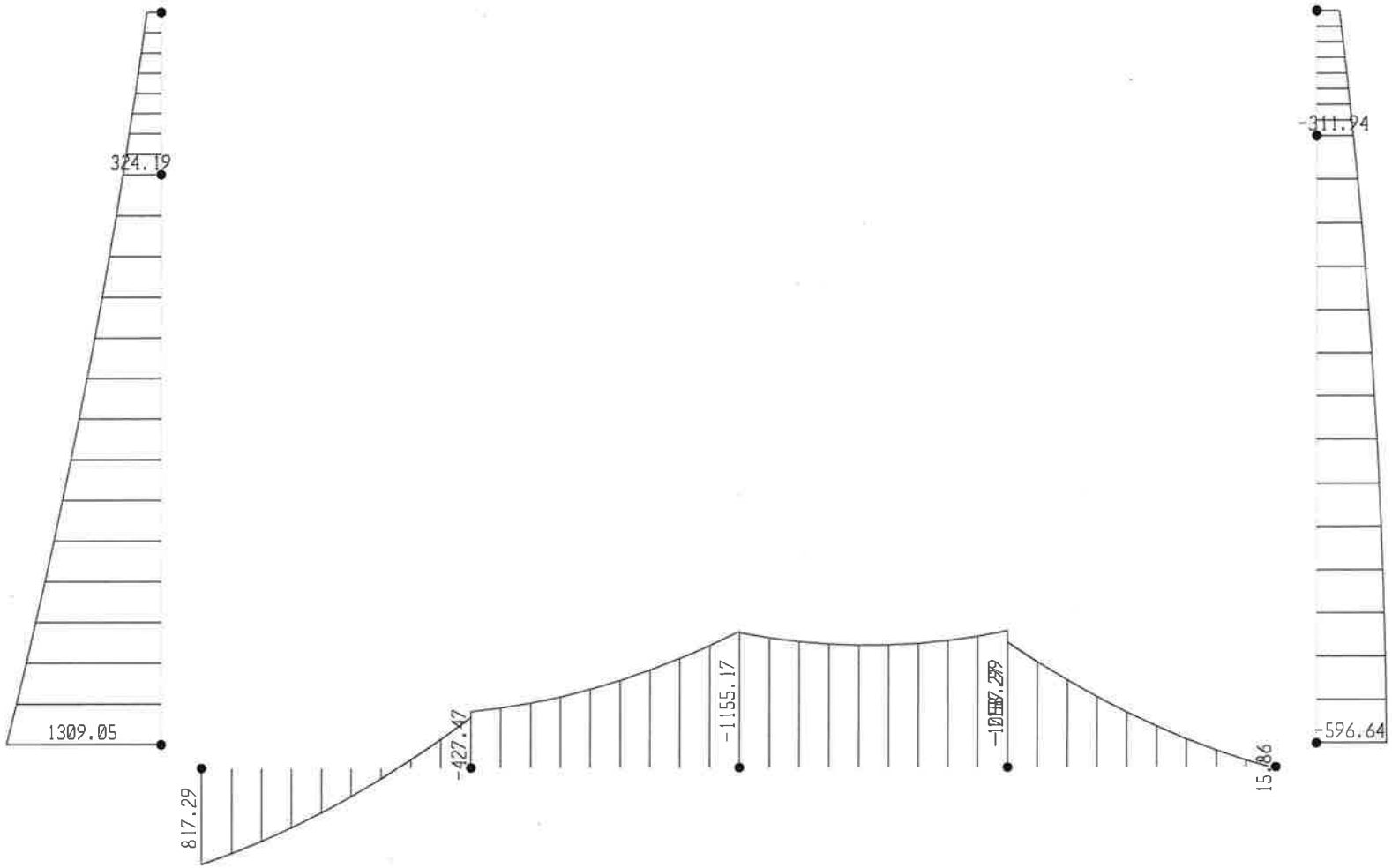
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1b) - Kip, ft, F Units



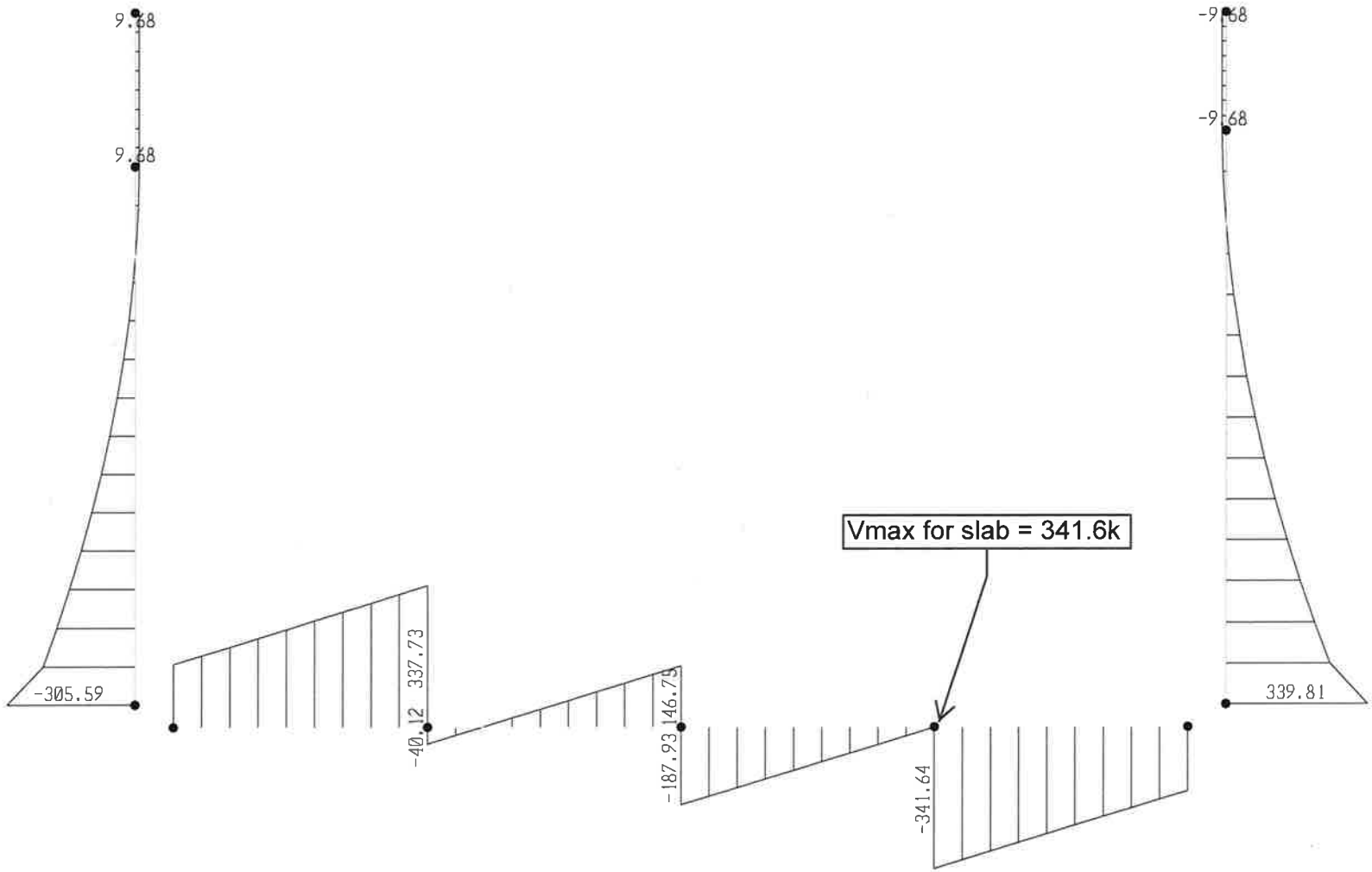
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1b) - Kip, ft, F Units



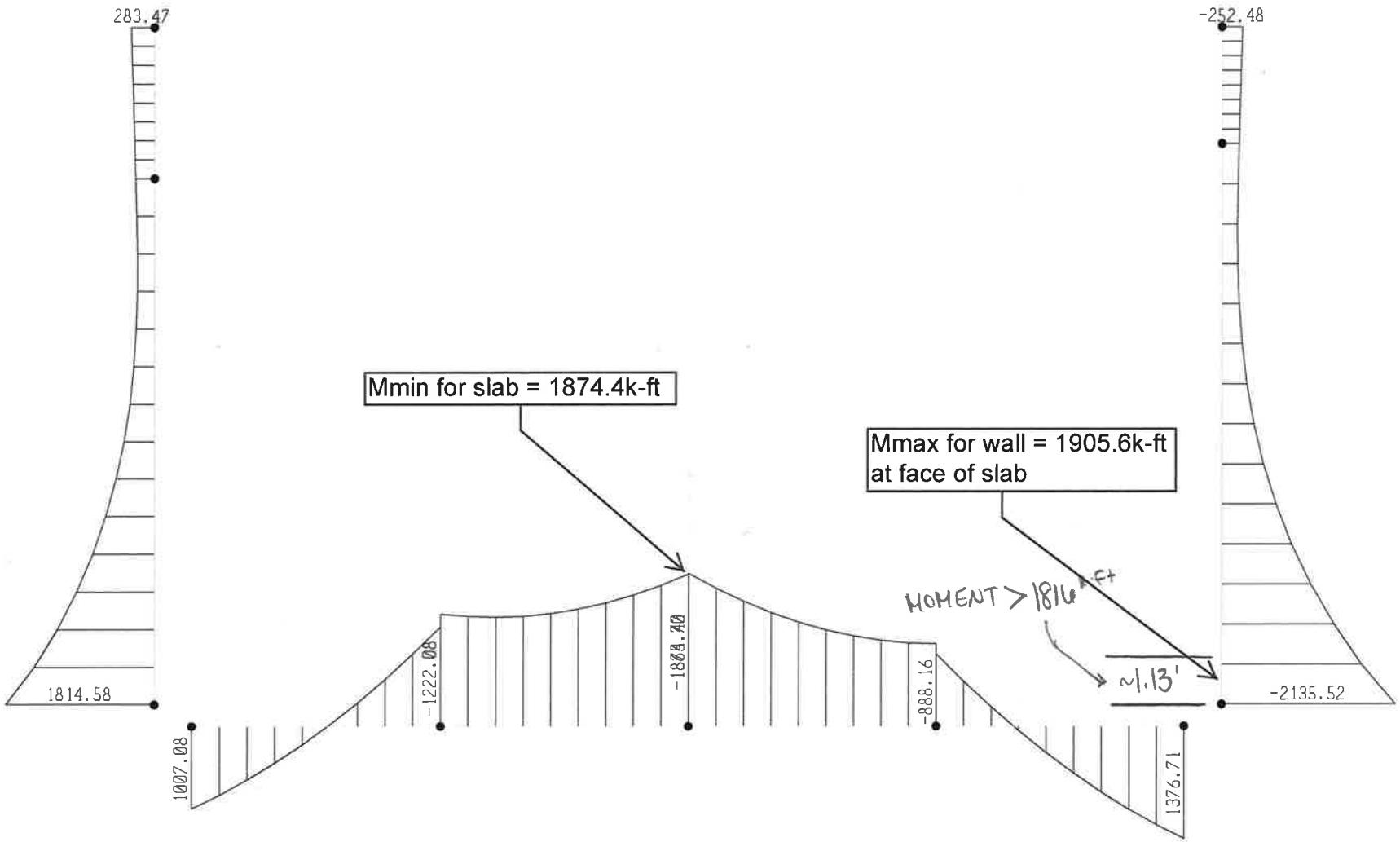
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1c) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1c) - Kip, ft, F Units

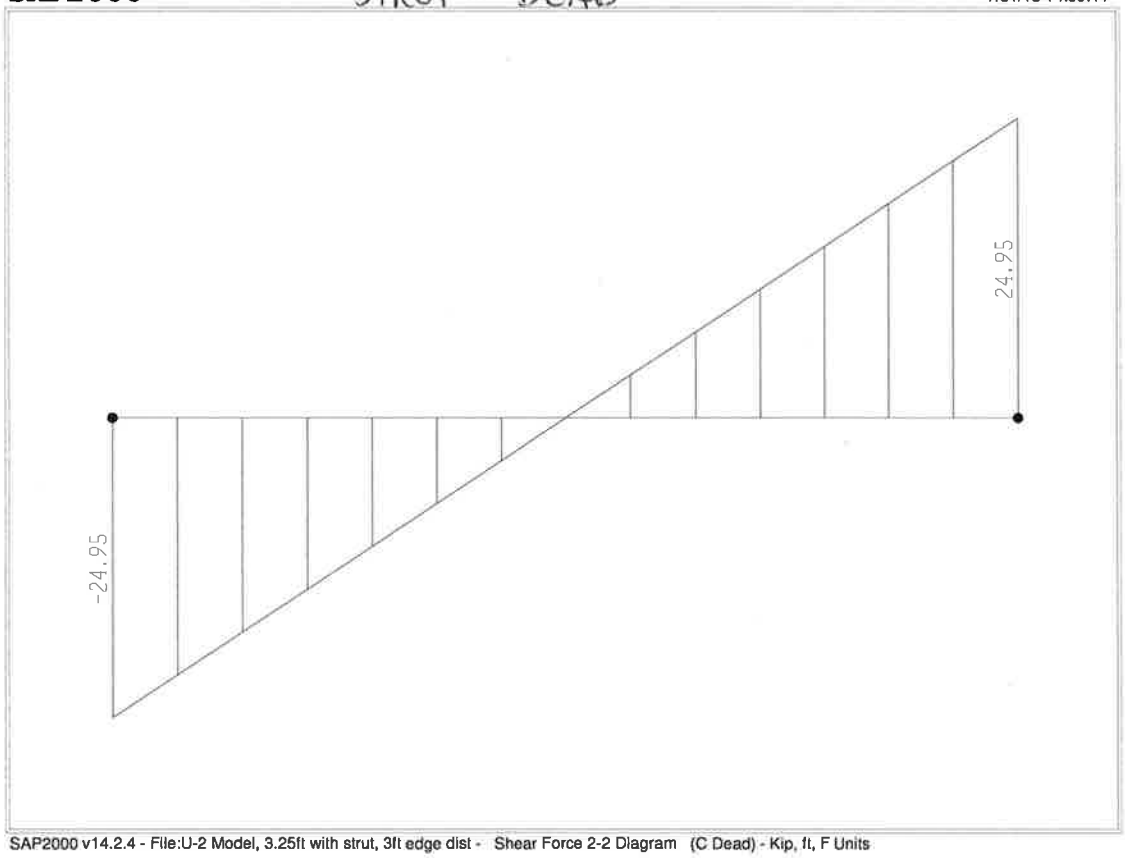


SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 2) - Kip, ft, F Units



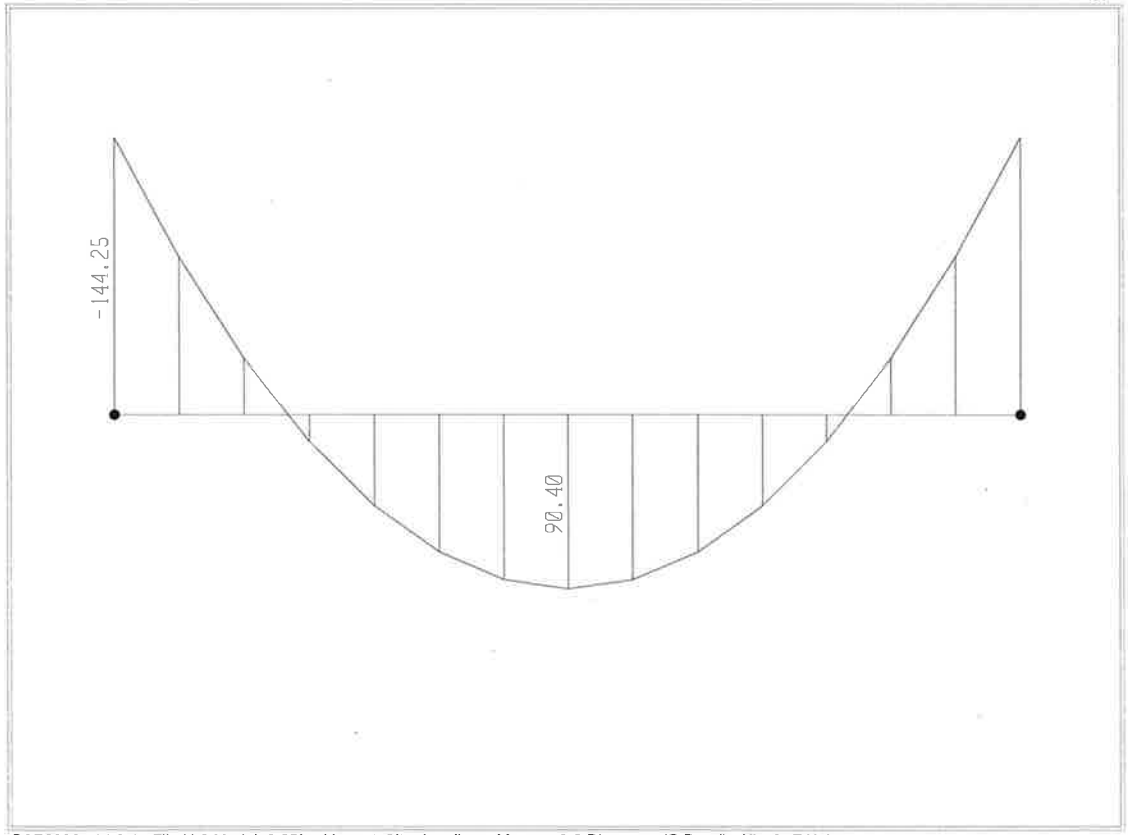
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 2) - Kip, ft, F Units

SAP2000 STRUT - DEAD 7/31/13 14:09:44



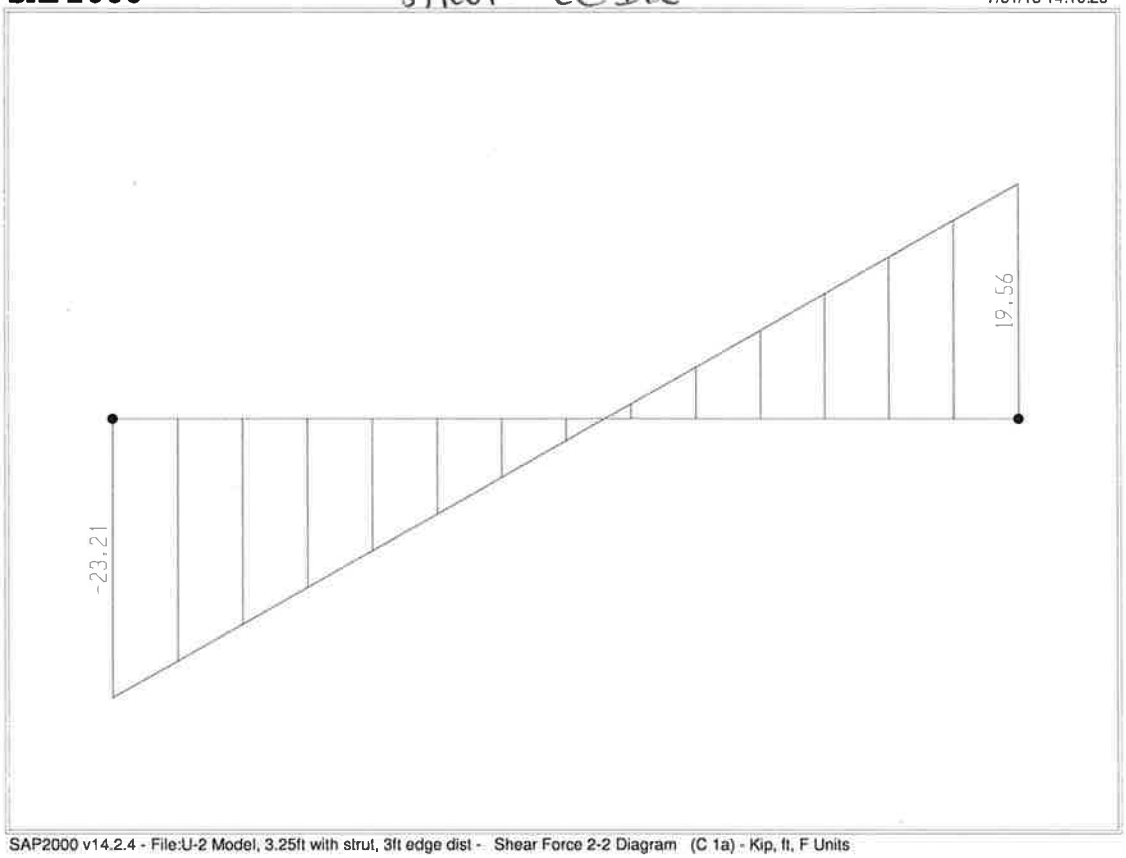
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C Dead) - Kip, ft, F Units

SAP2000 7/31/13 14:12:57



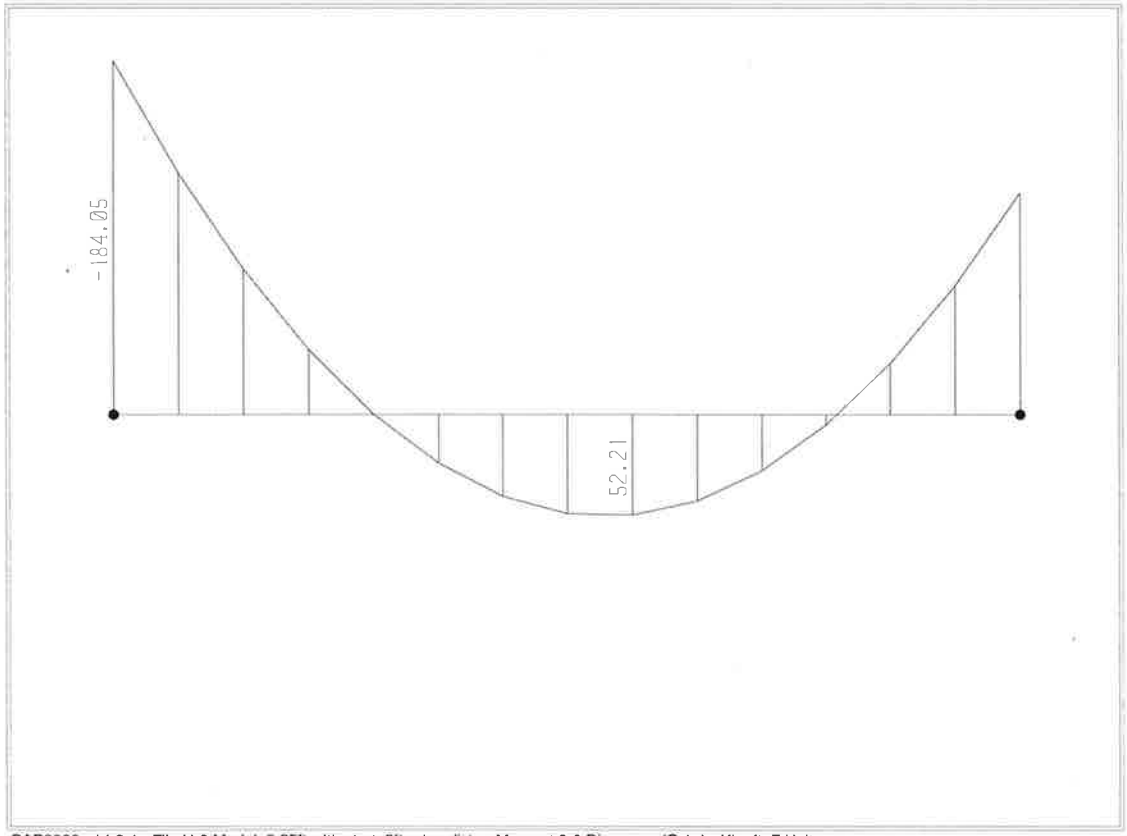
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C Dead) - Kip, ft, F Units

SAP2000 STRUT- LC 1a 7/31/13 14:10:26



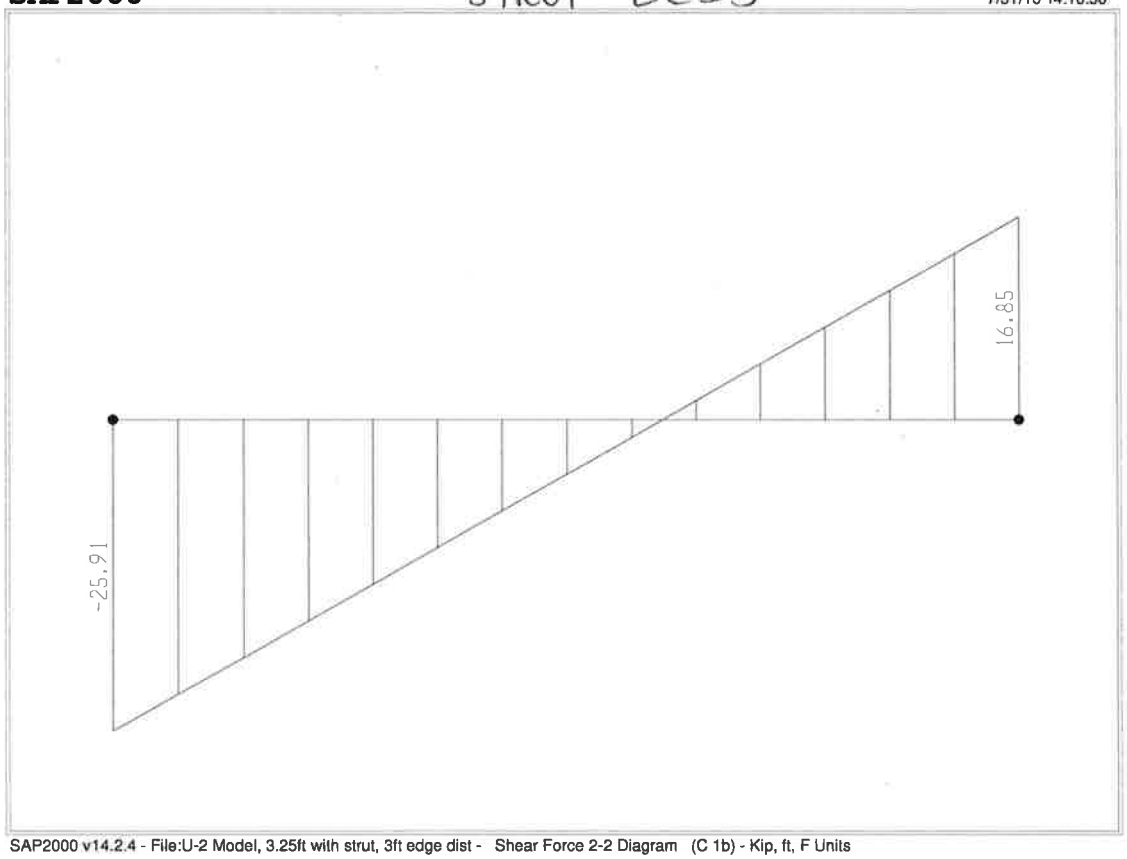
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1a) - Kip, ft, F Units

SAP2000 7/31/13 14:13:35



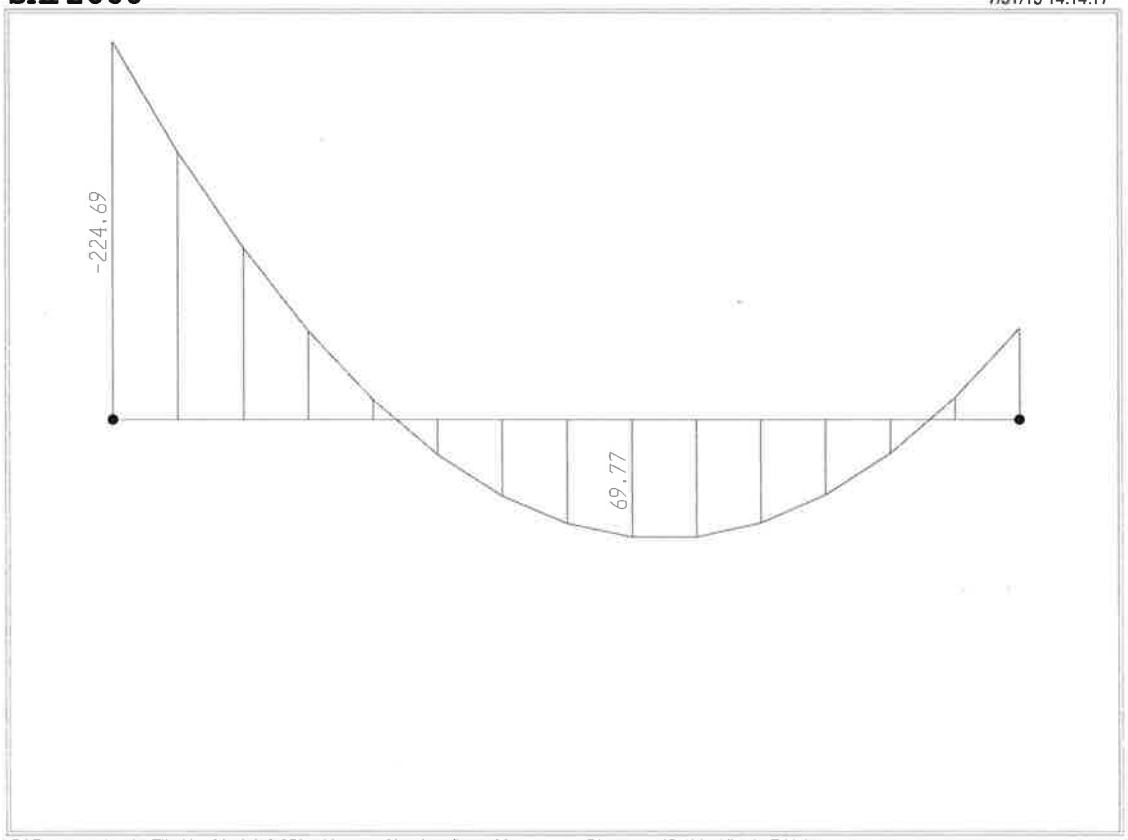
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1a) - Kip, ft, F Units

SAP2000 STRUT - LC 1b 7/31/13 14:10:50



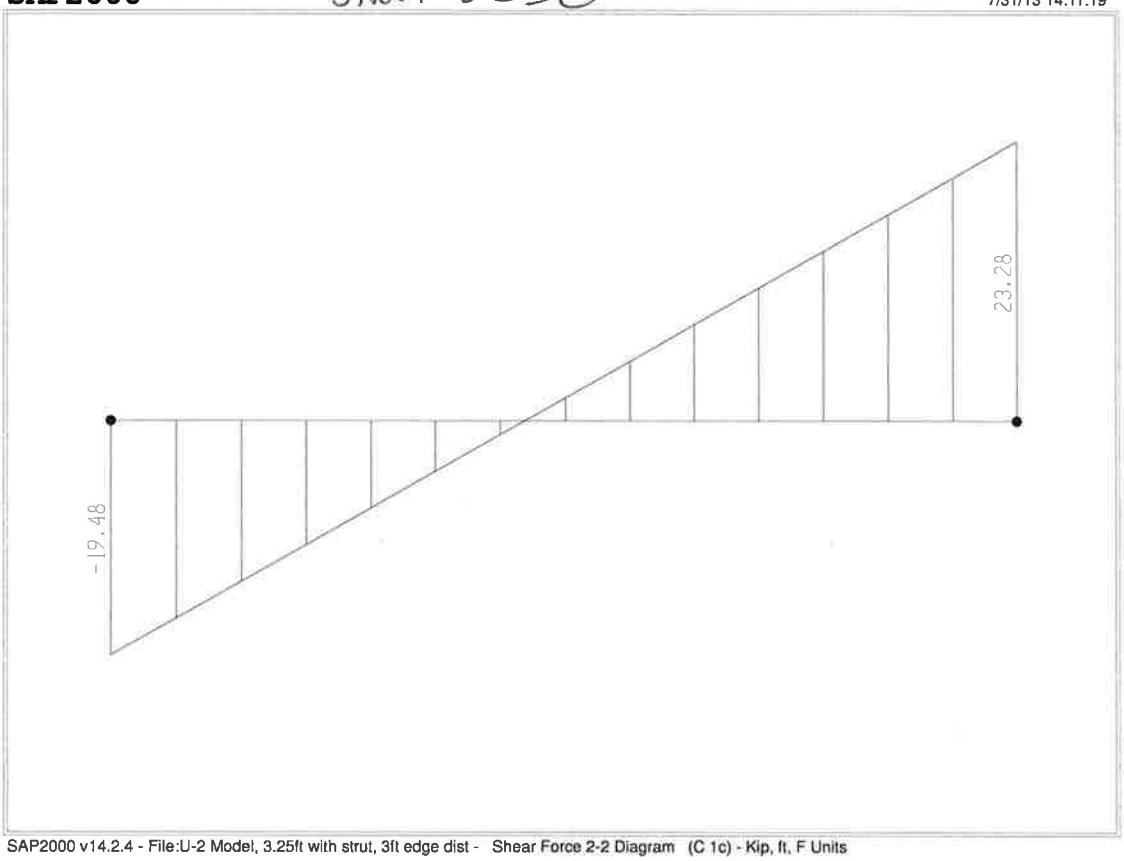
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1b) - Kip, ft, F Units

SAP2000 7/31/13 14:14:17



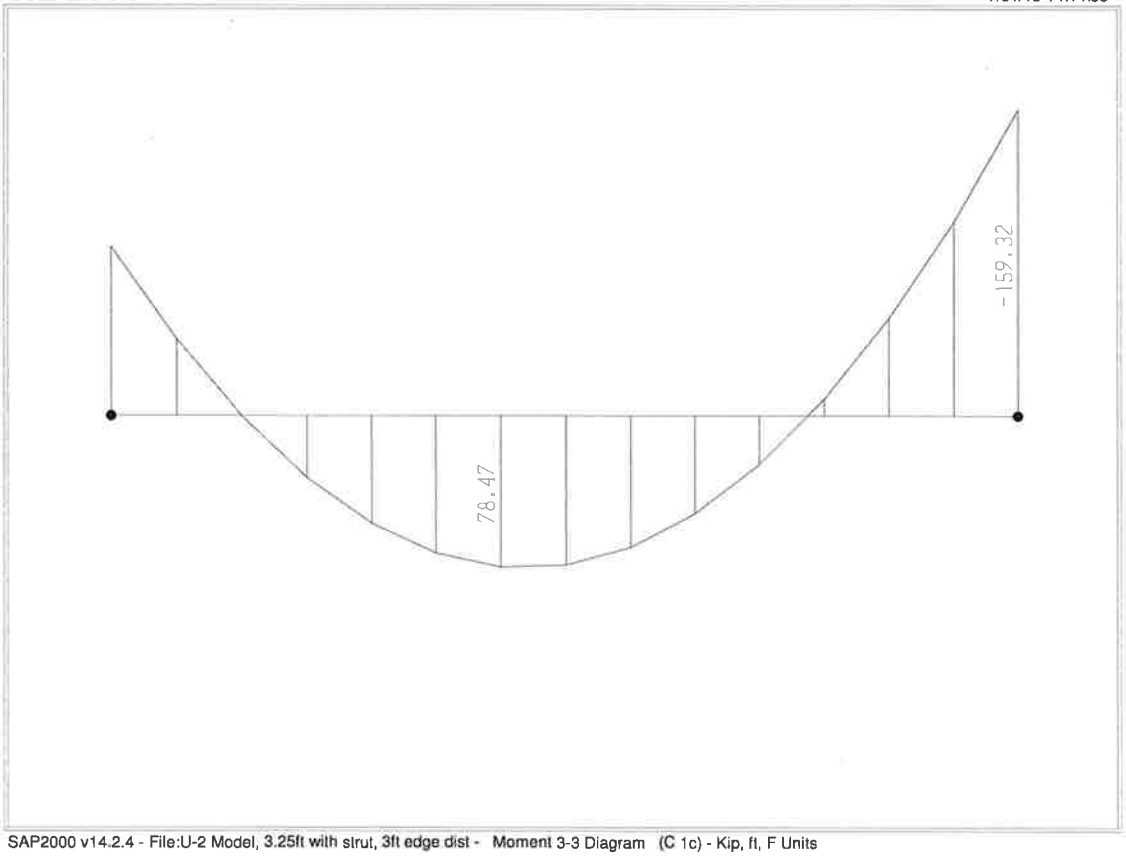
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1b) - Kip, ft, F Units

SAP2000 STRUT-LC1c 7/31/13 14:11:19



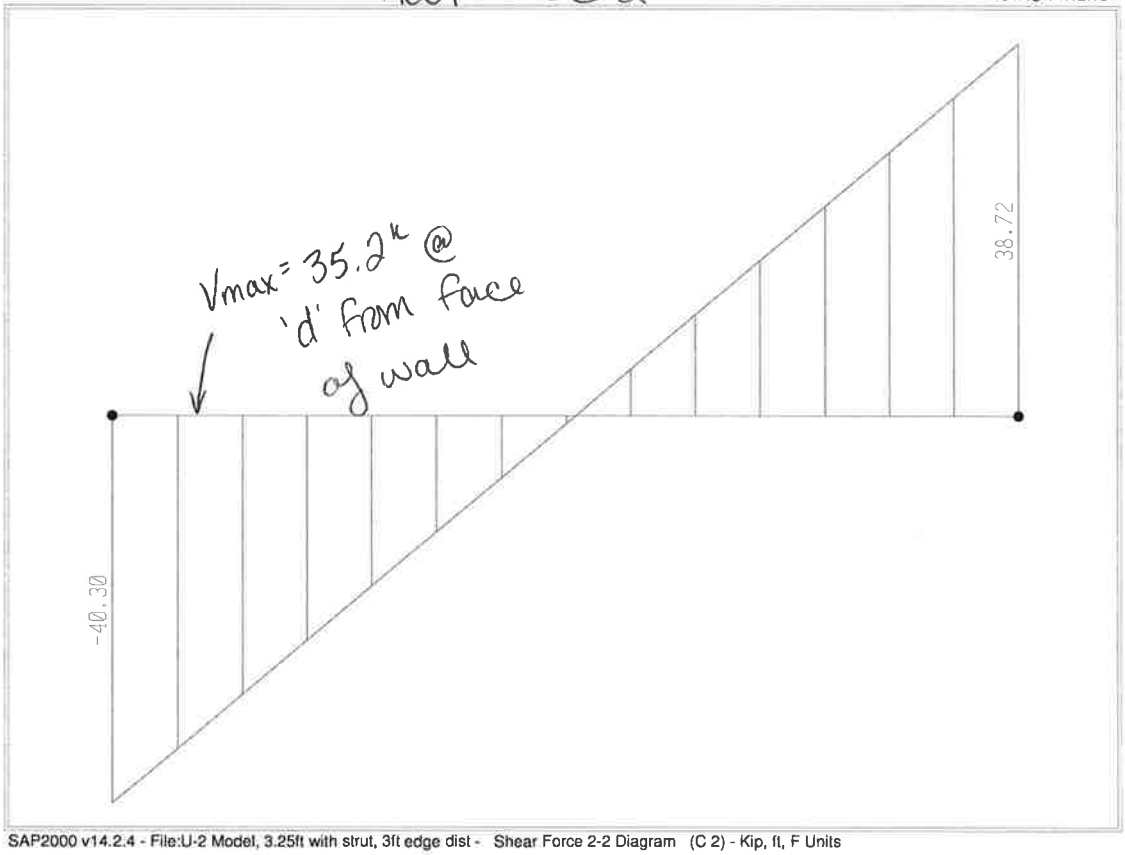
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1c) - Kip, ft, F Units

SAP2000 7/31/13 14:14:55



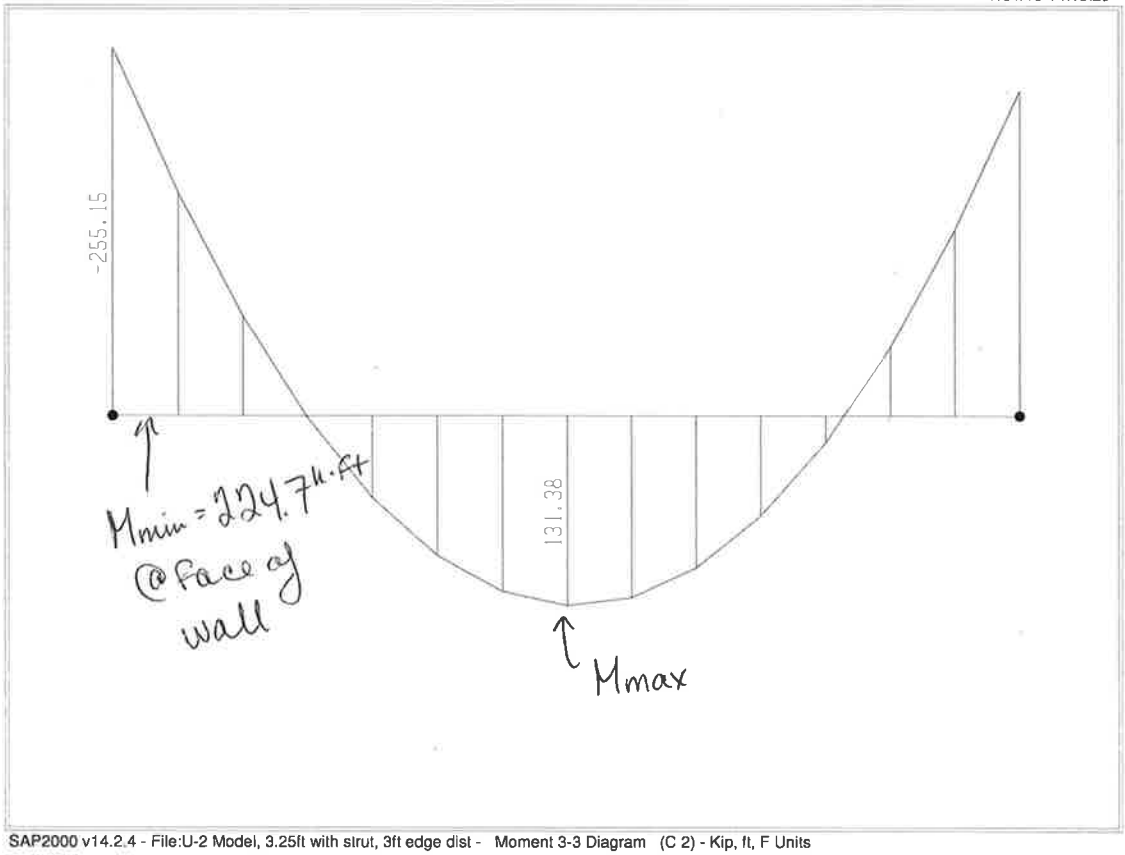
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1c) - Kip, ft, F Units

SAP2000 STRUT- LC 2 7/31/13 14:12:18



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 2) - Kip, ft, F Units

SAP2000 7/31/13 14:15:29



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 2) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-2 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:** Notes / References

Bottom Slab Thickness =	3.25	ft	
Wall Thickness =	3.25	ft	Settlement Cases Only
Tributary Width =	12	ft	
Design Width =	12	in	
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

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	380.63	31.72	2370.4	197.5	745.8	62.2
1b-ST	336.43	28.04	2673.0	222.8	147.0	12.3
2-ST	236.81	19.73	2926.6	243.9	0.0	0.0

* Shear values taken at a distance 'd'= 34.37in from the face of the slab.
^ Moment values taken at faces of connections (where slab meets wall).

Max. Shear = 31.7 kip
Max. Moment = 243.9 kip-ft (controls exterior reinforcement) ← CONTROLS
Min. Moment = 62.2 kip-ft (controls interior reinforcement)

*** Reinforcing Limits:**

A_{gross} = 39in * 12in strip = 468 in^2
d = 39in - 4in cover - 1/2 bar diameter = 34.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 5.002 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 1.310 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * √(f'_c) * b * d) / f_y = 1.304 in^2 ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 1.375 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.002 in^2**	- half each face
	Min. T&S Rebar =	**1.310 in^2**	- half each face
	Min. Flexural Rebar =	**1.375 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = ϕ * 2 * √(f'_c) * b * d
= 0.85 * 2 * √4000 * 12in * 34.365in
= 44,338 lb

ϕVc = 44.3kip > Vu = 31.7kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#9 @ 6"** to start: As, #9 @ 6" = 2 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 2 * 60ksi / (0.85 * 4ksi * 12in) = 2.941 in

$\phi Mn =$ 0.9 * 2in² * 60ksi * (34.365in - 2.941in / 2)
= 3552.6 kip-in/ft
= 296.05 kip-ft/ft

ϕMn = 296kip-ft > Mu = 243.9kip-ft → Use #9 @ 6"

Interior Face:

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * 0.79in² * 60ksi * (in - 1.162in / 2)
= 1441.2 kip-in/ft
= 120.10 kip-ft/ft

ϕMn = 120.1kip-ft > Mu = 62.2kip-ft → Use #8 @ 12"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	359.70	29.98	2167.1	180.6	1646.7	137.2
1b-ST	332.75	27.73	2419.7	201.6	2159.3	179.9
2-ST	485.25	40.44	1863.7	155.3	3010.8	250.9

* Shear values taken at a distance 'd'= 34.37in from the face of the slab.

Max. Shear = 40.4 kip
Max. Moment = 201.6 kip-ft (controls bottom reinforcement) ← CONTROLS
Min. Moment = 250.9 kip-ft (controls top reinforcement)

*** Reinforcing Limits:** A_{gross} = 39in * 12in strip = 468 in^2
d = 39in - 4in cover - 1/2 bar diameter = 34.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross} =$ 5.002 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross} =$ 1.310 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{(f'_c)} * b * d) / f_y =$ 1.304 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y =$ 1.375 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**5.002 in^2**	- half each face
	Min. T&S Rebar =	**1.310 in^2**	- half each face
	Min. Flexural Rebar =	**1.375 in^2**	- per face

* Section Design:

Shear:

Shear Capacity $(\phi V_c) = \phi * 2 * \sqrt{(f'_c)} * b * d$

$= 0.85 * 2 * \sqrt{4000} * 12in * 34.365in$

$= 44{,}338$ lb

$\phi Vc = 44.3kip > Vu = 40.4kip \rightarrow$ Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try #8 @ 6" to start: As, #8 @ 6" = 1.58 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $1.58 * 60ksi / (0.85 * 4ksi * 12in) =$ 2.324 in

$\phi Mn = 0.9 * 1.58in^2 * 60ksi * (34.365in - 2.324in / 2)$

$= 2832.9$ kip-in/ft

$= 236.08$ kip-ft/ft

$\phi Mn = 236.1kip\text{-}ft > Mu = 201.6kip\text{-}ft \rightarrow$ Use #8 @ 6"

Top Face:

* Will try #9 @ 6" to start: As, #9 @ 6" = 2 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ $2 * 60ksi / (0.85 * 4ksi * 12in) =$ 2.941 in

$\phi Mn = 0.9 * 2in^2 * 60ksi * (in - 2.941in / 2)$

$= 3552.6$ kip-in/ft

$= 296.05$ kip-ft/ft

$\phi Mn = 296kip\text{-}ft > Mu = 250.9kip\text{-}ft \rightarrow$ Use #9 @ 6"

In the exterior faces of the walls, the controlling moments occur at the bottoms of the walls (where slab meets wall). It is possible to reduce the amount of exterior reinforcing in the top of the walls because of the reduction in moment in this region.

* Determine the capacity of #8 @ 12" (transition from #8 @ 6" to #8 @ 12" in exterior face):

#9 @ 12" As, #9 @ 12" = 1 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (34.365in - 1.471in / 2)
= 1816 kip-in/ft
$\phi Mn =$ 151.33 kip-ft/ft

$\phi Mn =$ 1816.00 kip-ft per 12ft strip

* See the moment diagrams in the attached SAP results for a breakdown of moments along the length of the walls & the areas in which the moment is less than the capacity of #9 @ 12" bars.

* The controlling distance is found in LC 2: the #9 @ 6" reinforcing must be continued approximately 5'-2" from the top of the slab before it may be reduced to #9 @ 12".

* The required embedment length of #9 bars spaced 6" o.c. is 32". This means that the terminating #9 bars must extend a minimum of 7'-10" from the top of the slab.

CONTROLS

*** Strut Beam:**

Load Case	Max. Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
1a-ST	20.42	59.6	158.5
1b-ST	23.05	76.3	196.2
2-ST	35.18	140.1	215.4

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

Max. Shear = 35.18 kip
Max. Moment = 140.1 kip-ft (controls bottom reinforcement) ← CONTROLS
Min. Moment = 215.4 kip-ft (controls top reinforcement)

b = 24 in h = 24 in

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in #10 bar assumed

Shear:

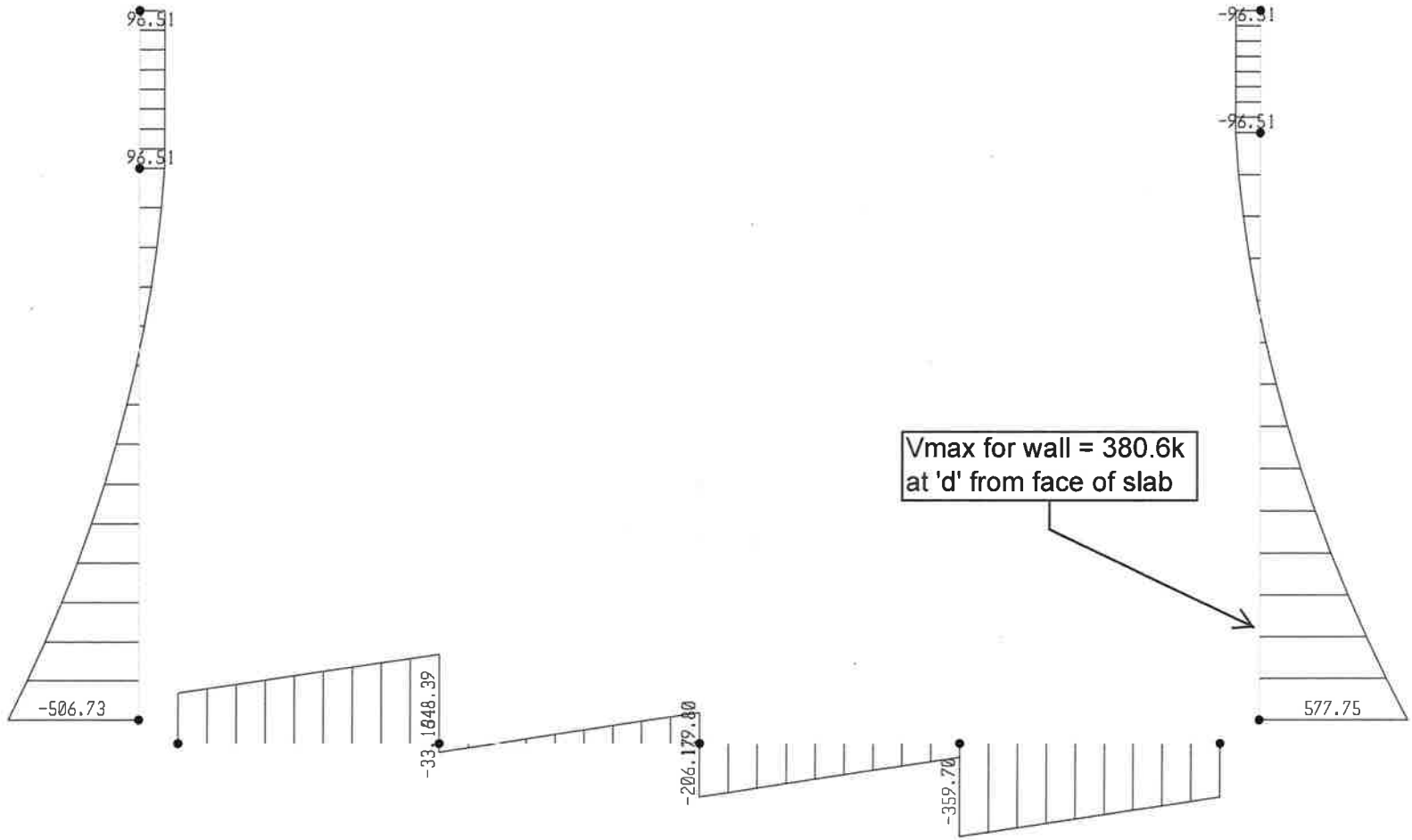
Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$
= 0.85 * 2 * √4000 * 24in * 19.365in
= 49,970 lb

ϕVc = 50kip > Vu = 35.2kip → Section OK

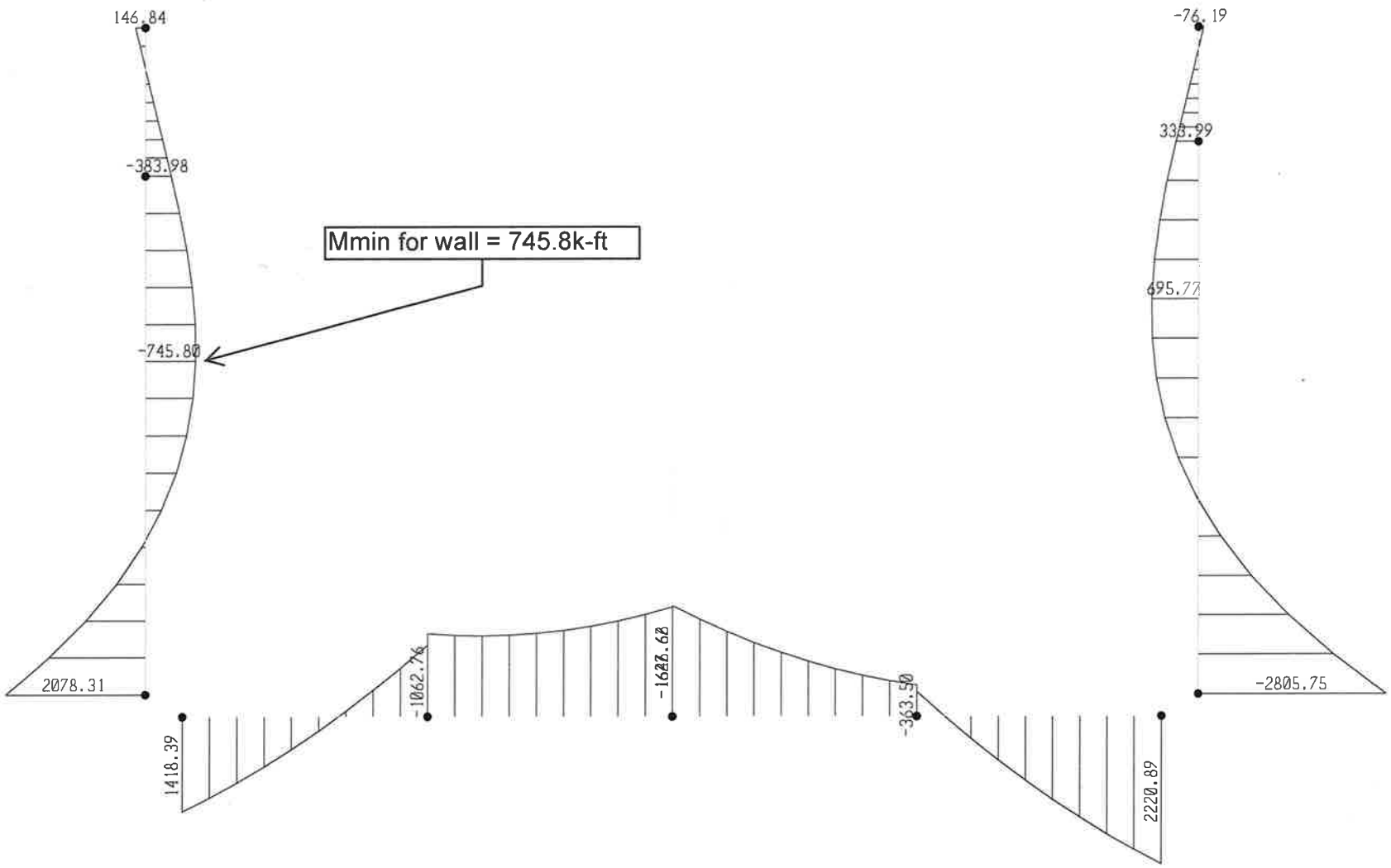
Moment:

Moment reinforcing & other beam calculations follow the SAP result images.

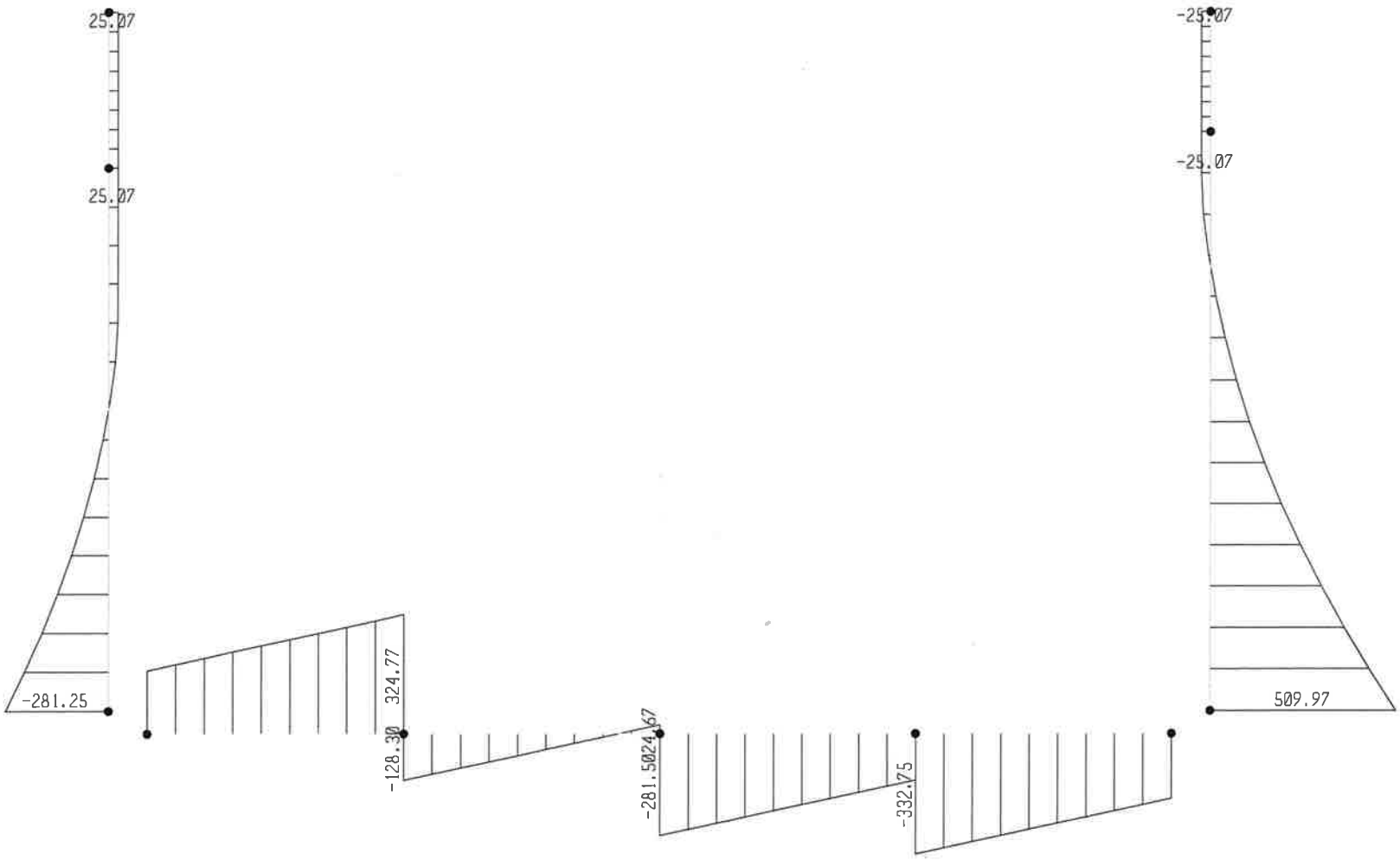
* SAP results are shown on the following 9 pages. The wall & slab moments & shears are presented first, followed by the strut beam shear & moments. Please note that the wall shear & moments shown are for a 12' wide tributary width.



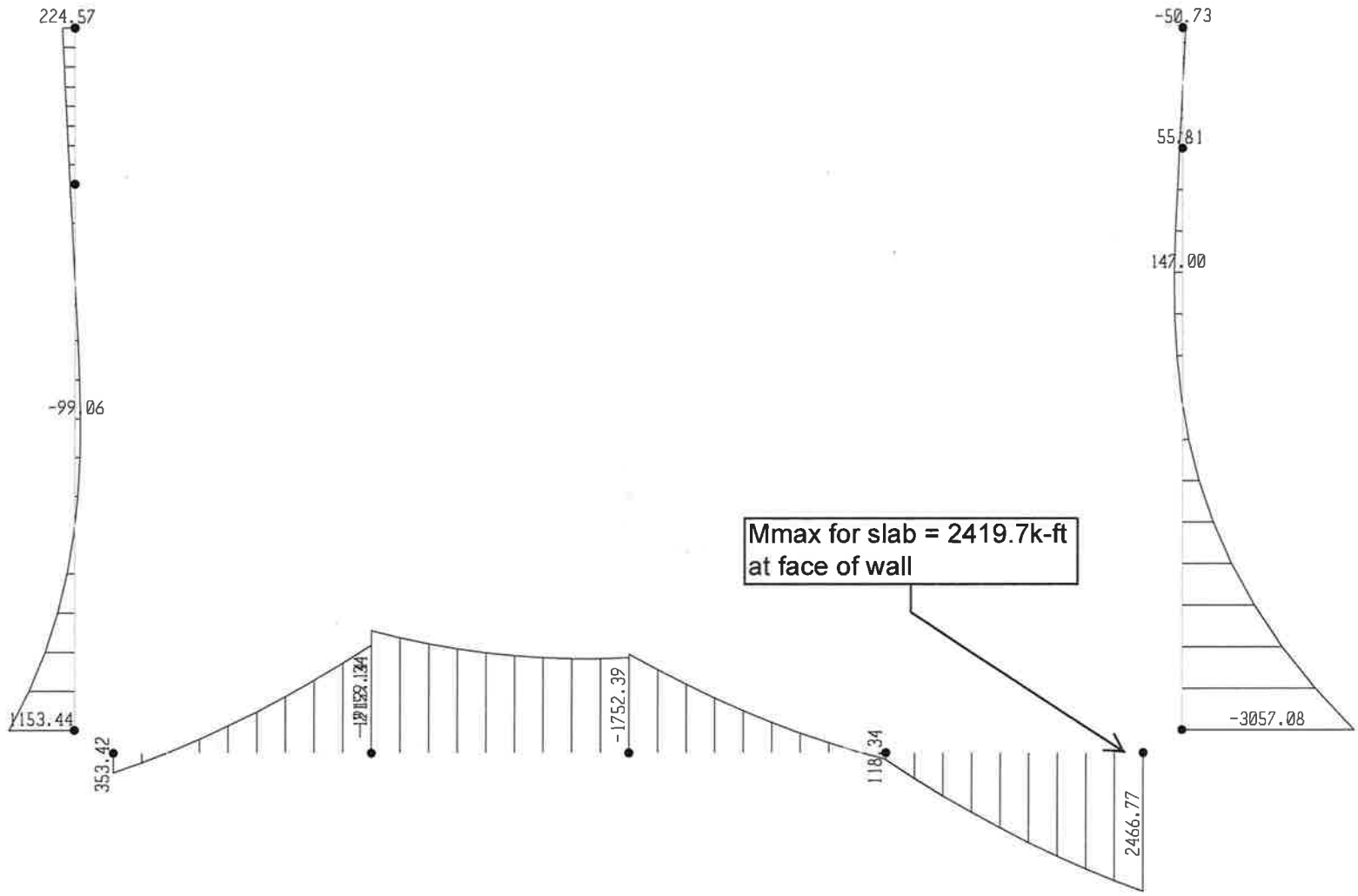
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1a-ST) - Kip, ft, F Units



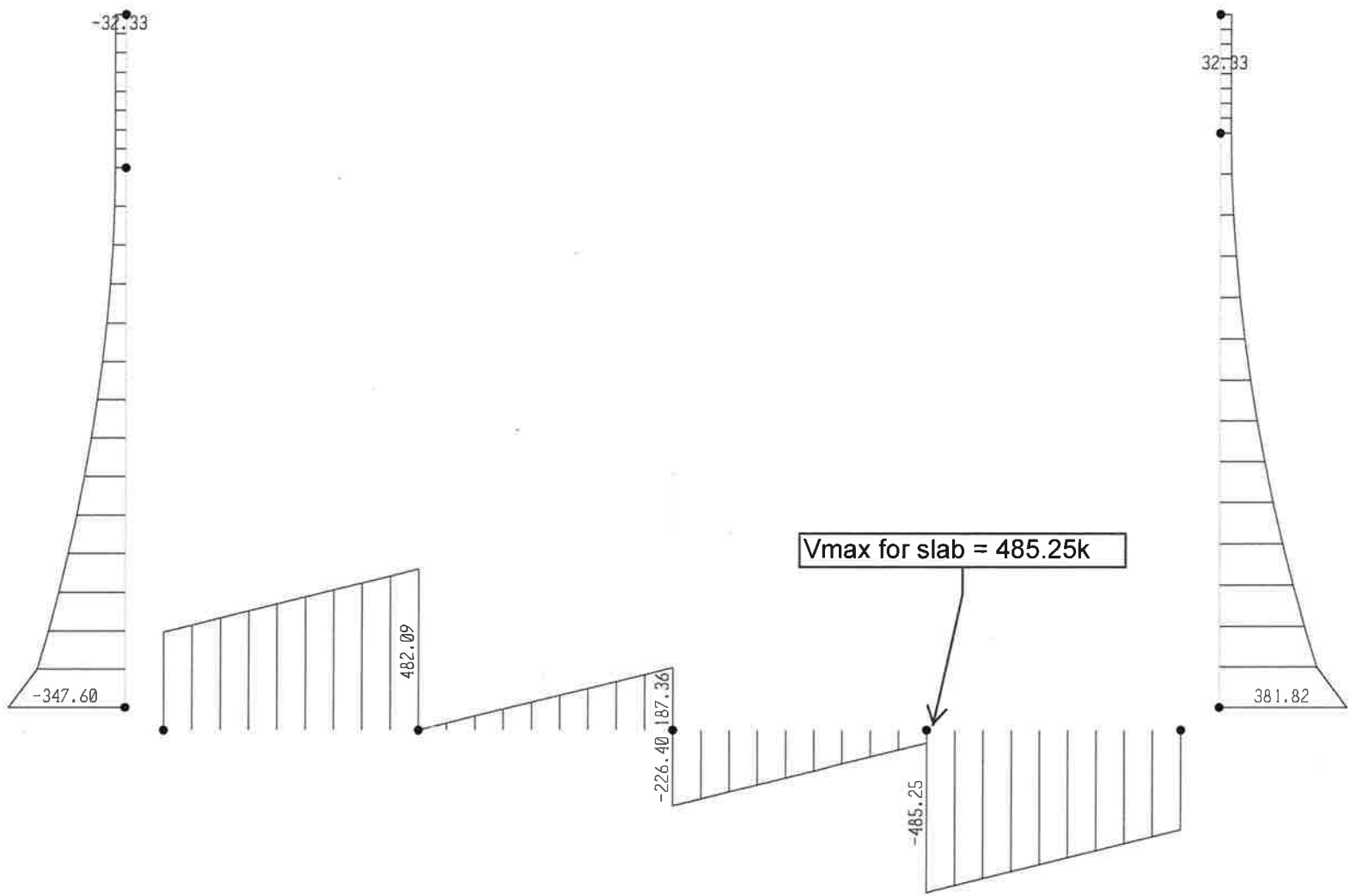
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1a-ST) - Kip, ft, F Units



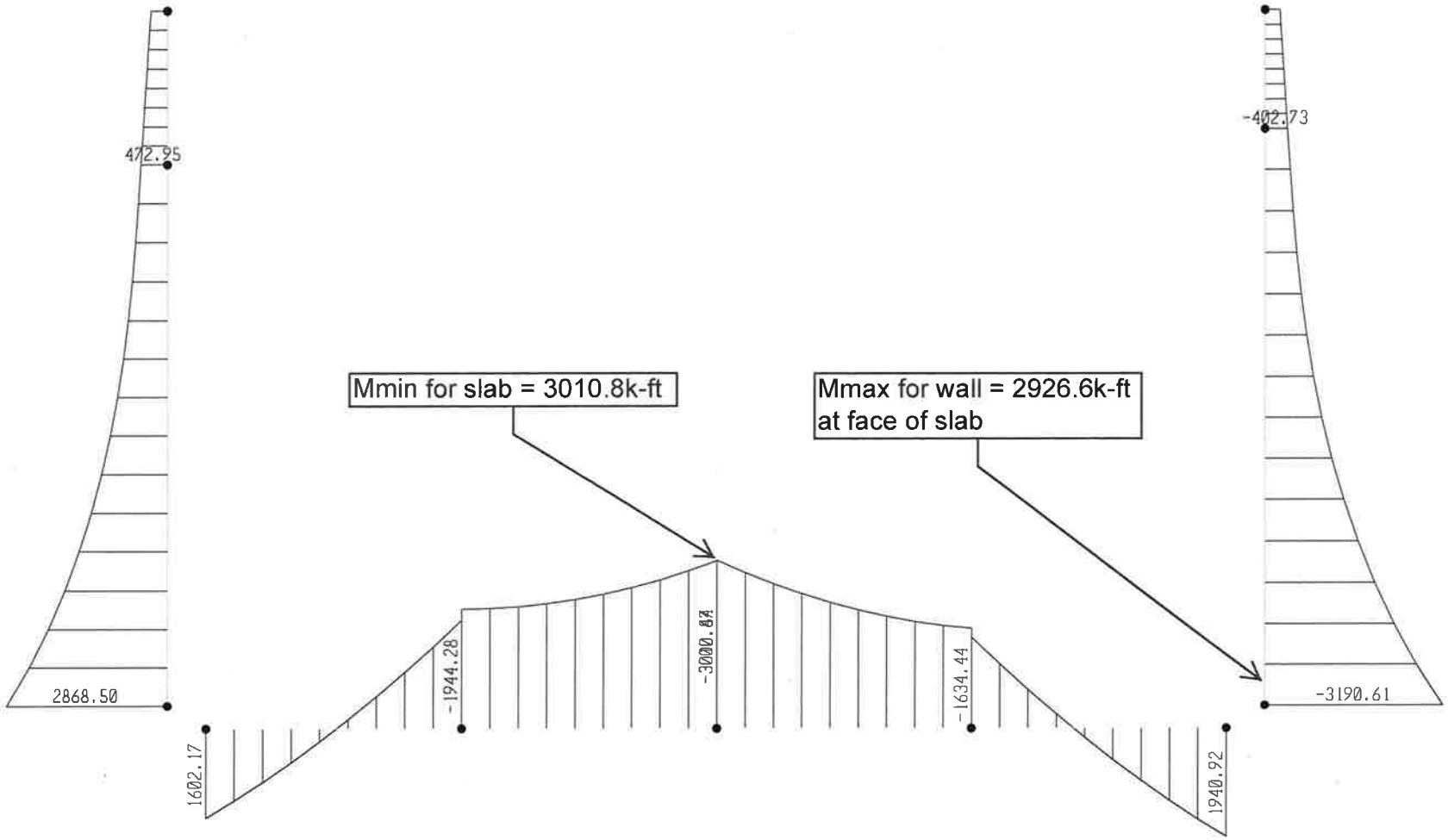
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1b-ST) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1b-ST) - Kip, ft, F Units

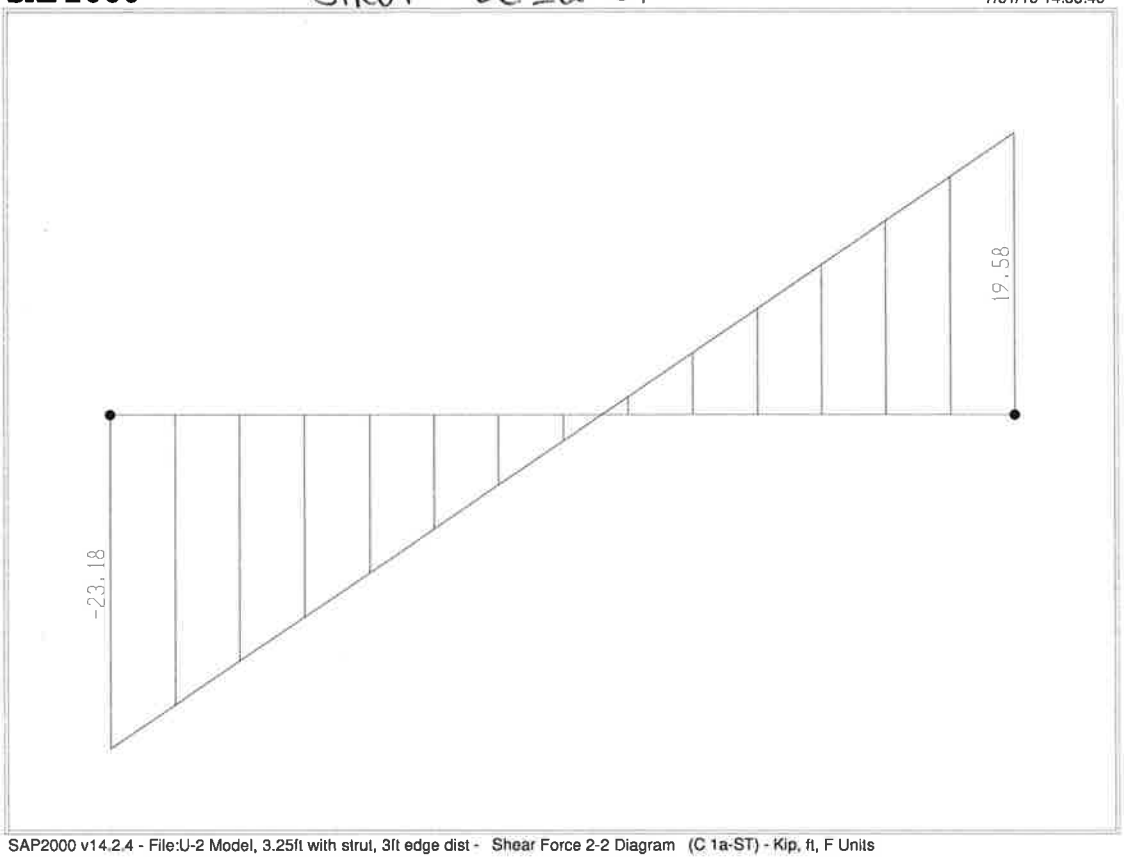


SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 2_ST) - Kip, ft, F Units



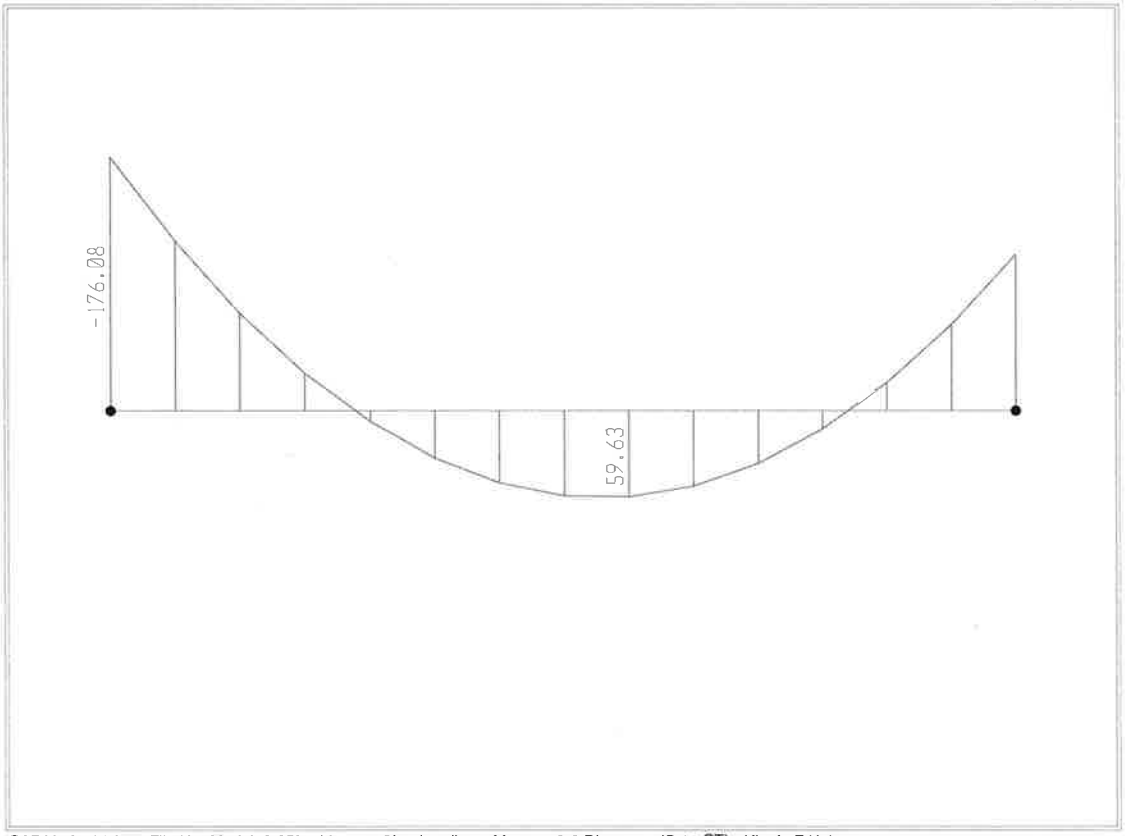
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 2_ST) - Kip, ft, F Units

SAP2000 STRUT - LC 1a-ST 7/31/13 14:58:46



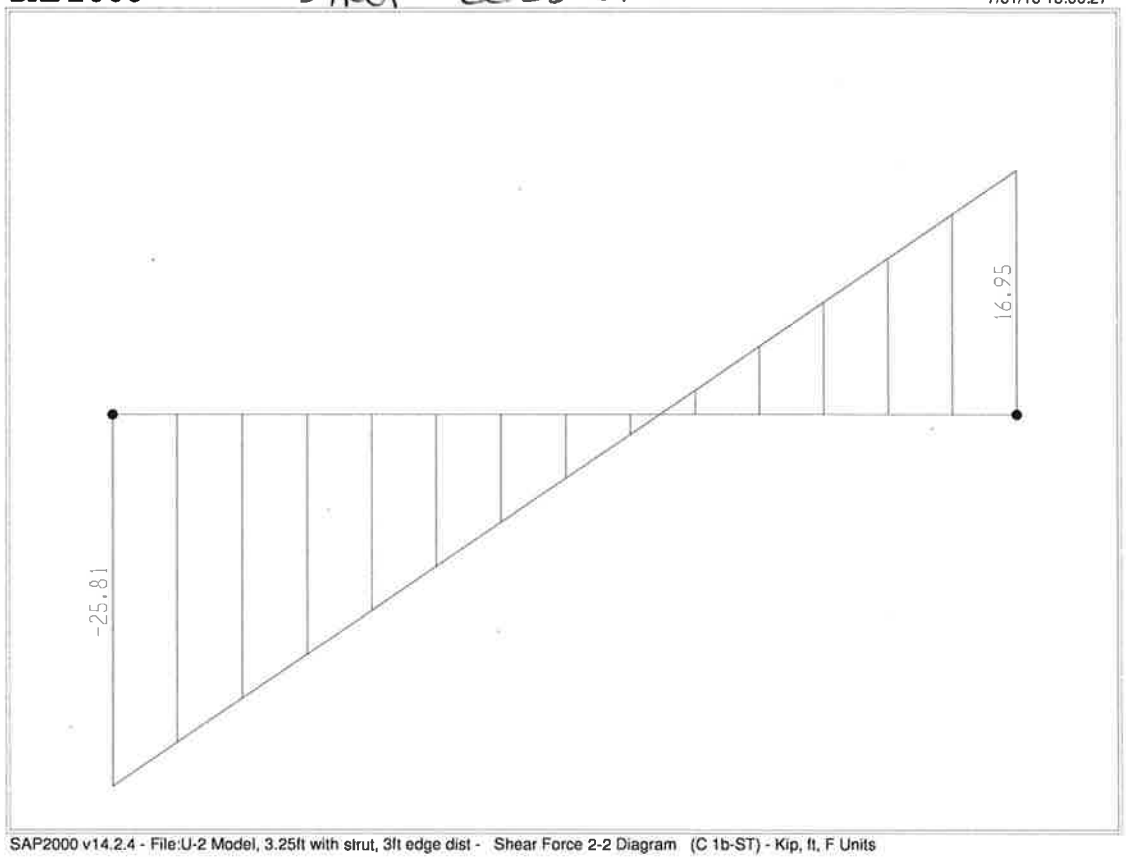
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 7/31/13 15:01:47



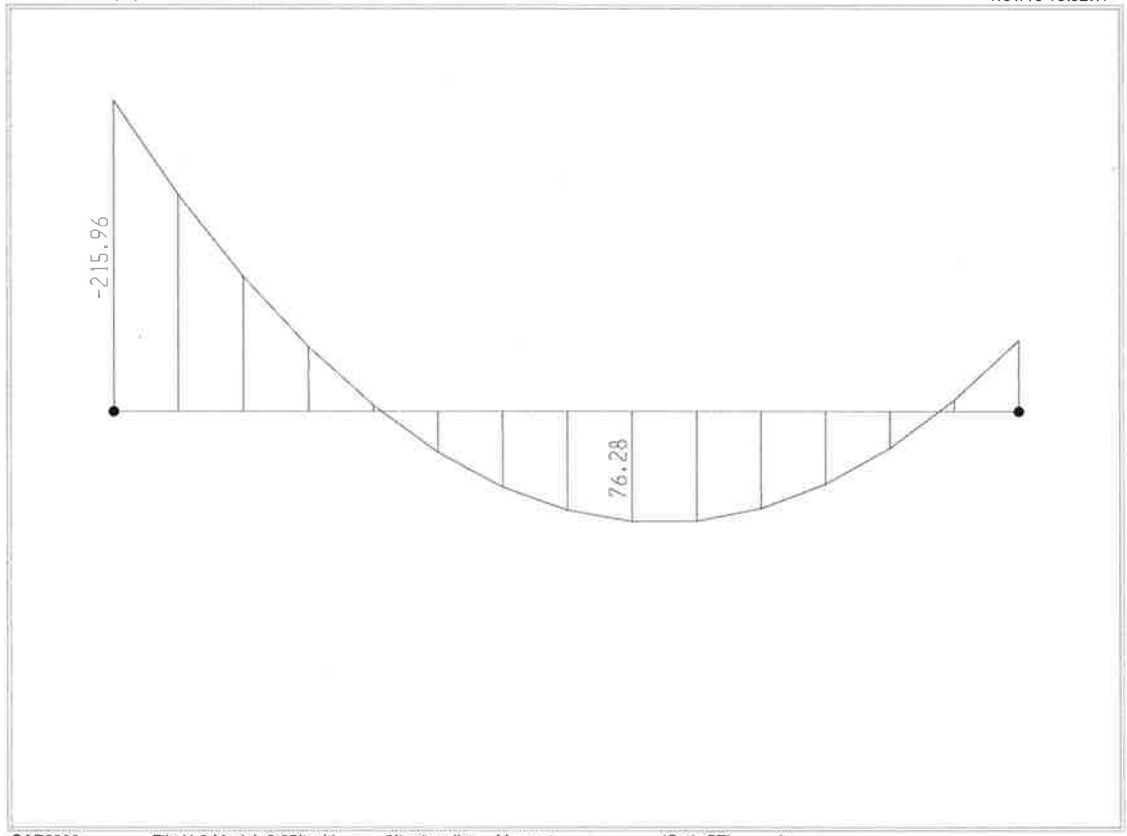
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 STRUT - LC 1b-ST 7/31/13 15:00:27



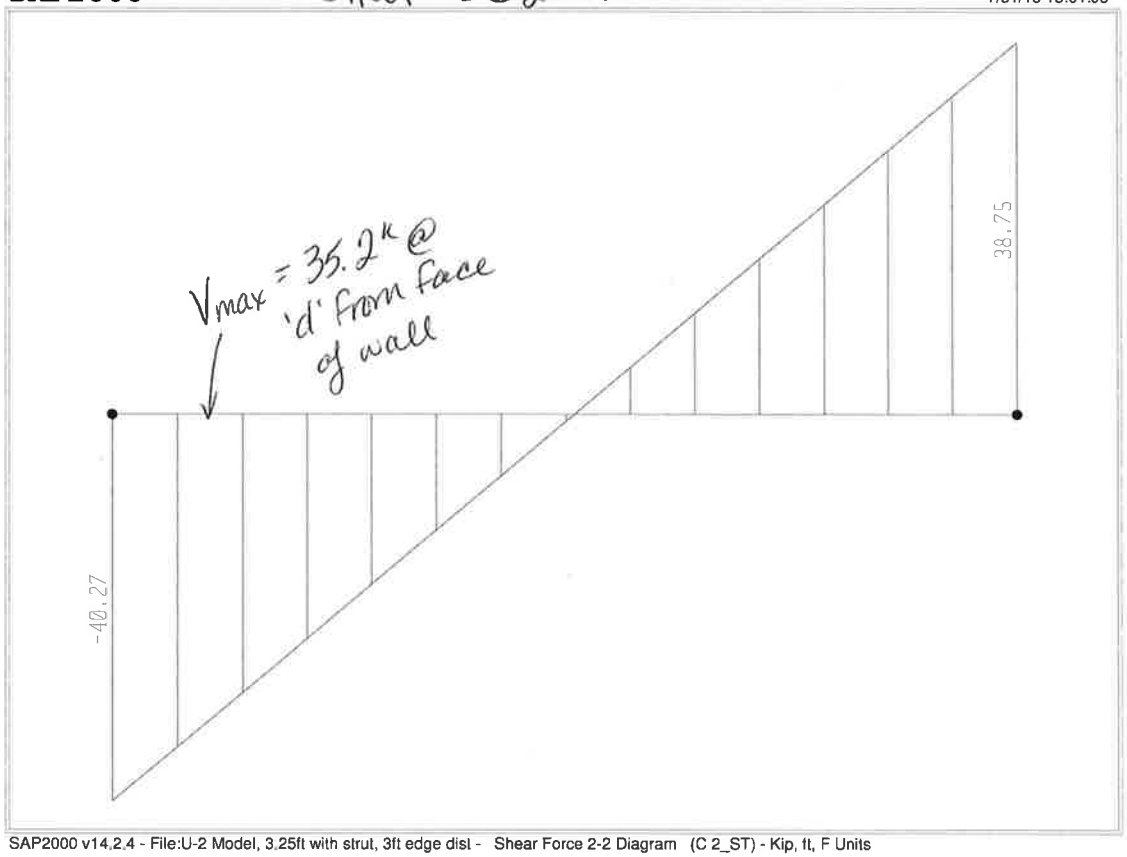
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 7/31/13 15:02:17



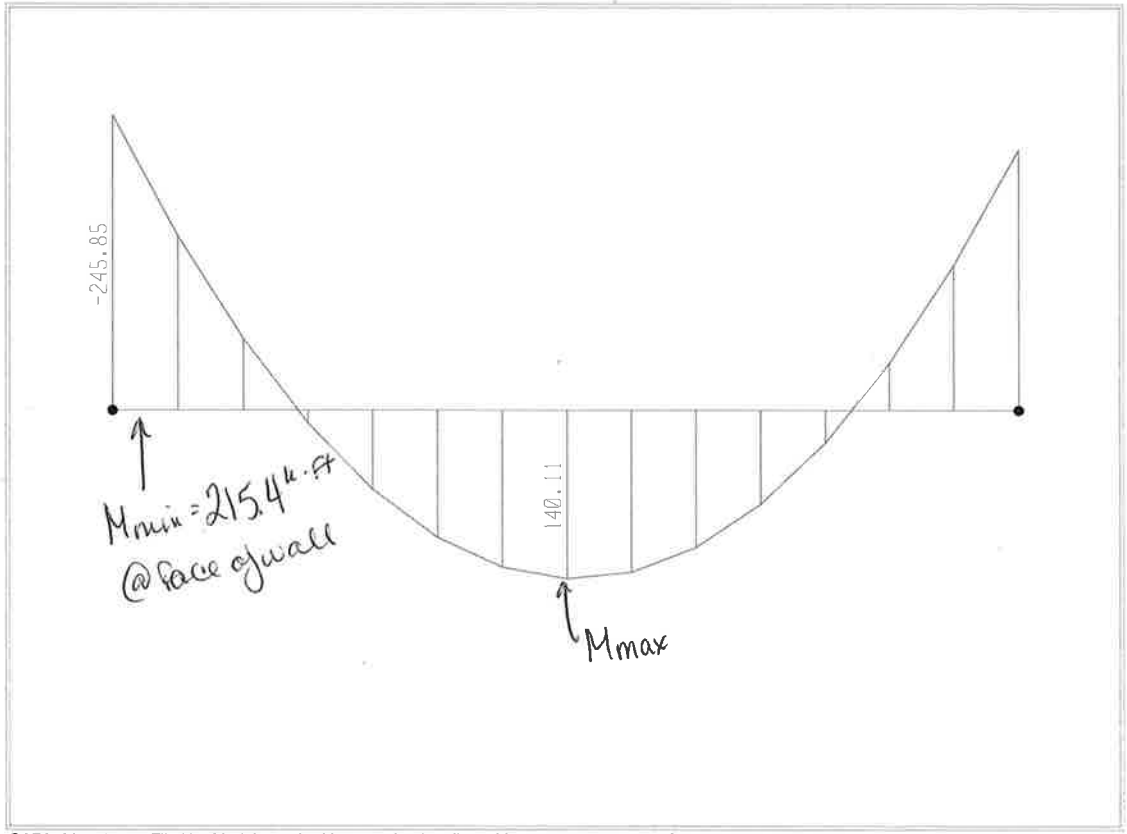
SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 STRUT · LC 2-ST 7/31/13 15:01:06



SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Shear Force 2-2 Diagram (C 2_ST) - Kip, ft, F Units

SAP2000 7/31/13 15:02:46

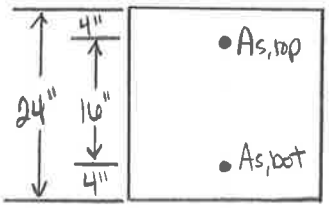


SAP2000 v14.2.4 - File:U-2 Model, 3.25ft with strut, 3ft edge dist - Moment 3-3 Diagram (C 2_ST) - Kip, ft, F Units

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: STRUT BEAM - U2 | Computed by: LBR | Sheet ___ of ___ | Date: 7/2013
REINF. DESIGN | Checked by: ___ | Date: ___

Reference



$M_{bottom} = 140.1^{k\cdot ft}$

$M_{top} = 224.7^{k\cdot ft}$

#10 bar

$d = 24" - 4" - \frac{1}{2} \times 1.27" = 19.365"$

TOP:

$$\rho_{req} = \frac{0.85 f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2 \cdot R_m}{0.85 f'_c}}\right)$$

$$R_m = \frac{M_u}{\phi b d^2} = \frac{224.7^{k\cdot ft} \times 12\frac{in}{ft} \times 1000\frac{lb}{k}}{(0.9)(24")(19.365")^2} = 332.9$$

$$\rho_{req} = \frac{(0.85)(4\,ksi)}{60\,ksi}\left(1 - \sqrt{1 - \frac{2 \times 332.9}{(0.85)(4000\,psi)}}\right) = 0.00585$$

$$\therefore A_{s,req} = \rho b d = (0.00585)(24")(19.365") = \underline{2.719\,in^2}$$

$\Rightarrow$ USE 3-#9 BARS ($A_s = 3.0\,in^2$) IN TOP

BOTTOM:

$$R_m = \frac{(140.1^{k\cdot ft})(12)(1000)}{(0.9)(24")(19.365")^2} = 207.55$$

$$\rho_{req} = \frac{(0.85)(4)}{60}\left(1 - \sqrt{1 - \frac{2 \times 207.55}{0.85 \times 4000}}\right) = 0.00357$$

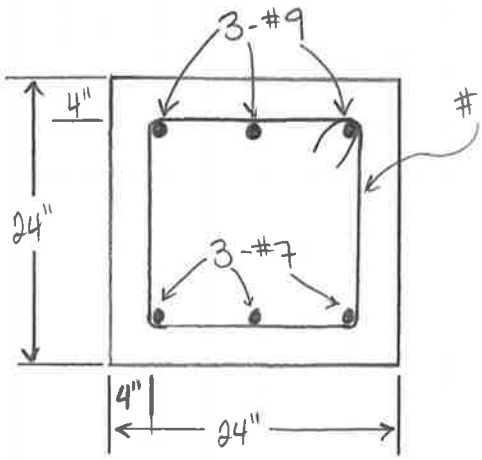
$$\therefore A_{s,req} = \rho b d = (0.00357)(24")(19.365") = \underline{1.66\,in^2}$$

$\Rightarrow$ USE 3-#7 BARS ($A_s = 1.8\,in^2$) IN BOTTOM

TIES: USE #3 TIES (BARS < #11). SPACING CAN BE MAX. ALLOWED B/C NOT NECESSARY FOR SHEAR. MAX SPACING = $d/2 = 19.5"/2 = \underline{9.75"}$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: STRUT BEAM-U2 | Computed by: LBR | Sheet ___ of ___ | Date: 7/2013
REINF. DESIGN & OTHER CHECKS | Checked by: ___ | Date: ___
Reference



#3 TIES @ 9½" o.c.

- CHECK MINIMUM THICKNESS: ACI 318 TABLE 9.5(a)

↳ FOR BEAMS, BOTH ENDS CONTINUOUS:

$h_{min} = \ell/21 = (36' \times 12)/21 = 20.6''$

$h = 24'' > h_{min} = 20.6'' \rightarrow$ OK

- CHECK AXIAL FORCE DOES NOT GO OVER MAX. ALLOWABLE:
ACI 318 - 14.5.2 (WALL DESIGN)

$$\phi P_n = 0.55\,\phi\, f'_c A_g \left[1 - \left(\frac{k\ell_c}{32h}\right)^2\right] \qquad \text{(EQ 14-1)}$$

$\phi = 0.65$ (TENSION CONTROLLED, NORMAL REINF.) - ACI 9.3.2.2
$K = 0.8$ (BOTH ENDS RESTRAINED) - ACI 14.5.2(a)

$$\phi P_n = (0.55)(0.65)(4000\,PSI)(24'' \times 24'')\left[1 - \left(\frac{0.8 \times 432''}{32 \times 24}\right)^2\right] = 656{,}884.8^{LB} = 656.9^{k}$$

↳ AXIAL LOADS FROM SAP:

DEAD = -37.41^k
LC1a = 132.5^k ← MAX << 657^k → OK
LC1b = 57.72^k
LC1c = -32.07^k
LC2 = -9.68^k

*SETTLEMENT CASE AXIAL FORCES ALL SMALLER THAN THESE

(-) SHOW TENSION, MAX = 37.4^k

- CHECK TENSION CAPACITY: f_r = MOD. OF RUPTURE = $7.5\sqrt{f'_c} = 7.5\sqrt{4000} = 474.3\,PSI$ (ACI 318 EQ 9-10)

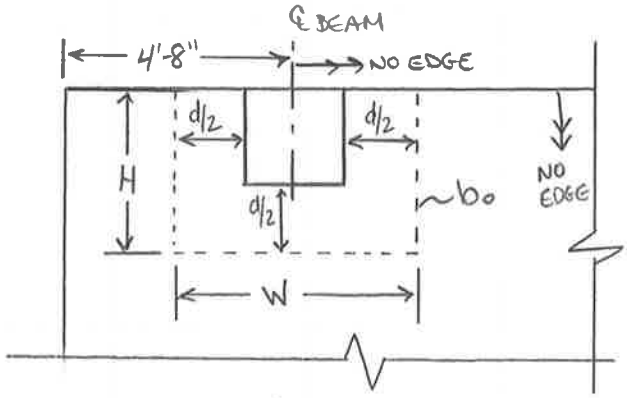
↳ HIGHEST TENSION LOAD = 37.4^k. SINCE MEMBER IS IN PURE TENSION, SAFETY FACTOR SHOULD BE 1.65, NOT THE 1.3 VALUE INPUT IN SAP.

$$T = \frac{37.4^k \times \frac{1.65}{1.3}}{24'' \times 24''} = 0.0824^{KSI} = 82.4^{PSI} << 474.3^{PSI} \rightarrow \text{OK}$$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Sheet ___ of ___
Description: STRUT BEAM - U2 | Computed by: LBR | Date: 7/2013
CHECKS, SLAB PUNCHING CHECK | Checked by: ___ | Date: ___
Reference

→ PUNCHING SHEAR IN WALL:



$d_{wall} = 39" - 4" - 1\frac{1}{2}" = 34.5" = 2.875'$ (#8)

$b_o = H \times 2 + W \times 2$ = PERIMETER SHEARED AREA
$= (2' + \frac{2.875'}{2}) \times 2 + (2' + 2.875') \times 2$
$= 16.625'$
$= 199.5"$

$$\phi V_{c,P.S.} = \min \begin{cases} ① \ \phi\left(2 + \frac{4}{\beta}\right)\sqrt{f'_c}\, b_o d & (11\text{-}33) \quad \beta = \frac{24"}{24"} = 1 \\ ② \ \phi\left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}\, b_o d & (11\text{-}34) \quad \alpha_s = 20 \text{ (min - conservative)} \\ ③ \ \phi 4\sqrt{f'_c}\, b_o d & (11\text{-}35) \end{cases}$$

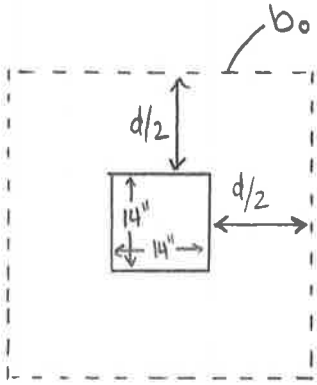
BY INSPECTION, ③ CONTROLS, $\phi V_c = (0.85)(4)\sqrt{4000}\,(199.5")(34.5")$
$= \underline{\underline{1480^k}}$

$\underline{P_{max} = 132.5^k << 1480^k} \rightarrow \underline{\underline{OK}}$

URS

Job	MAUREPAS DIVERSION	Project No.	10001876
Description	SLAB - U2	Computed by	LBR
	PUNCHING SHEAR CHECK.	Checked by	

Page ____ of ____
Sheet ____ of ____
Date 7/2013
Date ____
Reference



$d_{SLAB} = 39" - 4" - \frac{1}{2}(1.27") = 34.365"$

$b_o = 2 \times (14" + 34.365") + 2 \times (14" + 34.365")$
$= 193.46"$

$$\phi V_c = \min \begin{cases} ① \ \phi\left(2 + \frac{4}{\beta}\right)\sqrt{f'_c}\, b_o d \\ ② \ \phi\left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}\, b_o d \\ ③ \ \phi 4\sqrt{f'_c}\, b_o d \end{cases}$$

$\beta = \frac{14"}{14"} = 1$

$\alpha_s = 20$ (min. - conservative)

BY INSPECTION, ③ CONTROLS, $\phi V_c = (0.85)(4)\sqrt{4000}\,(193.46")(34.365")$
$= \underline{1429.6^k}$

- MAX. REACTION = 306.12^k

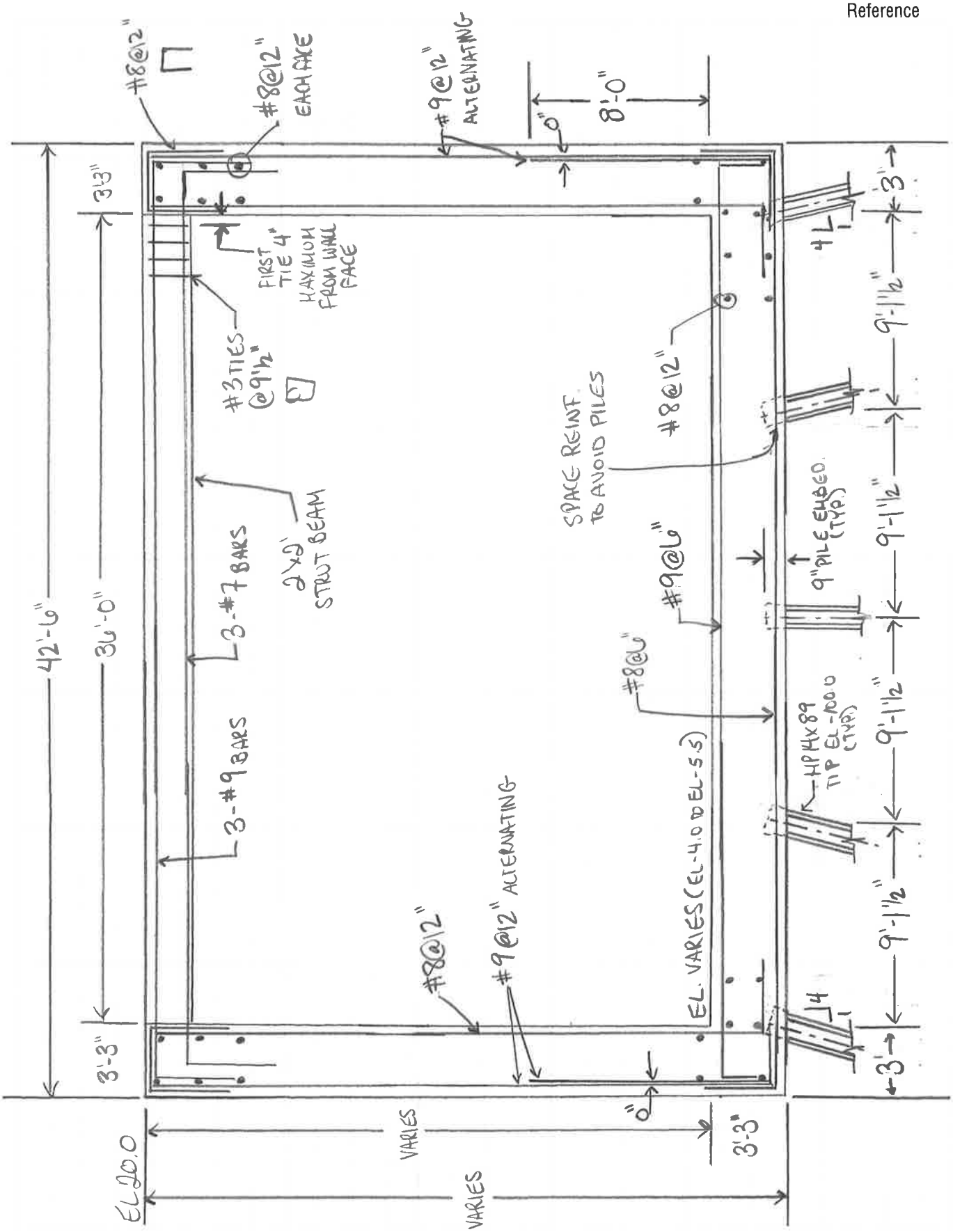
- IF TREATED AS ENVIRONMENTAL FORCE SUBJECT TO HYDRAULIC & SAFETY FACTORS, LOAD = $306.1^k \times 1.3 \times 1.7 = 676.5^k$

$\underline{676.5^k << \phi V_c = 1429.6^k} \rightarrow$ OK

URS

Job	MAUREPAS DIVERSION	Project No.	16001876	Page ____ of ____	
Description	U-2	Computed by	LBR	Sheet ____ of ____	
	REINFORCEMENT	Checked by		Date	7/2013
				Date	

Reference



SECTION 4

U-3 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	Flood Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
2-ST	Flood Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 31.5 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Inflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL 31.5
L_strut water	Vertical load on strut from water to EL 31.5
U_high water	Uplift load from water to EL 31.5
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_saturated	Soil pressure from saturated soil (water to EL 31.5)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	L_strut water
	U_high water
	S_saturated
2-ST	DEAD
	L_high water
	L_strut water
	U_high water
	S_saturated
	ST_cohesion

In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

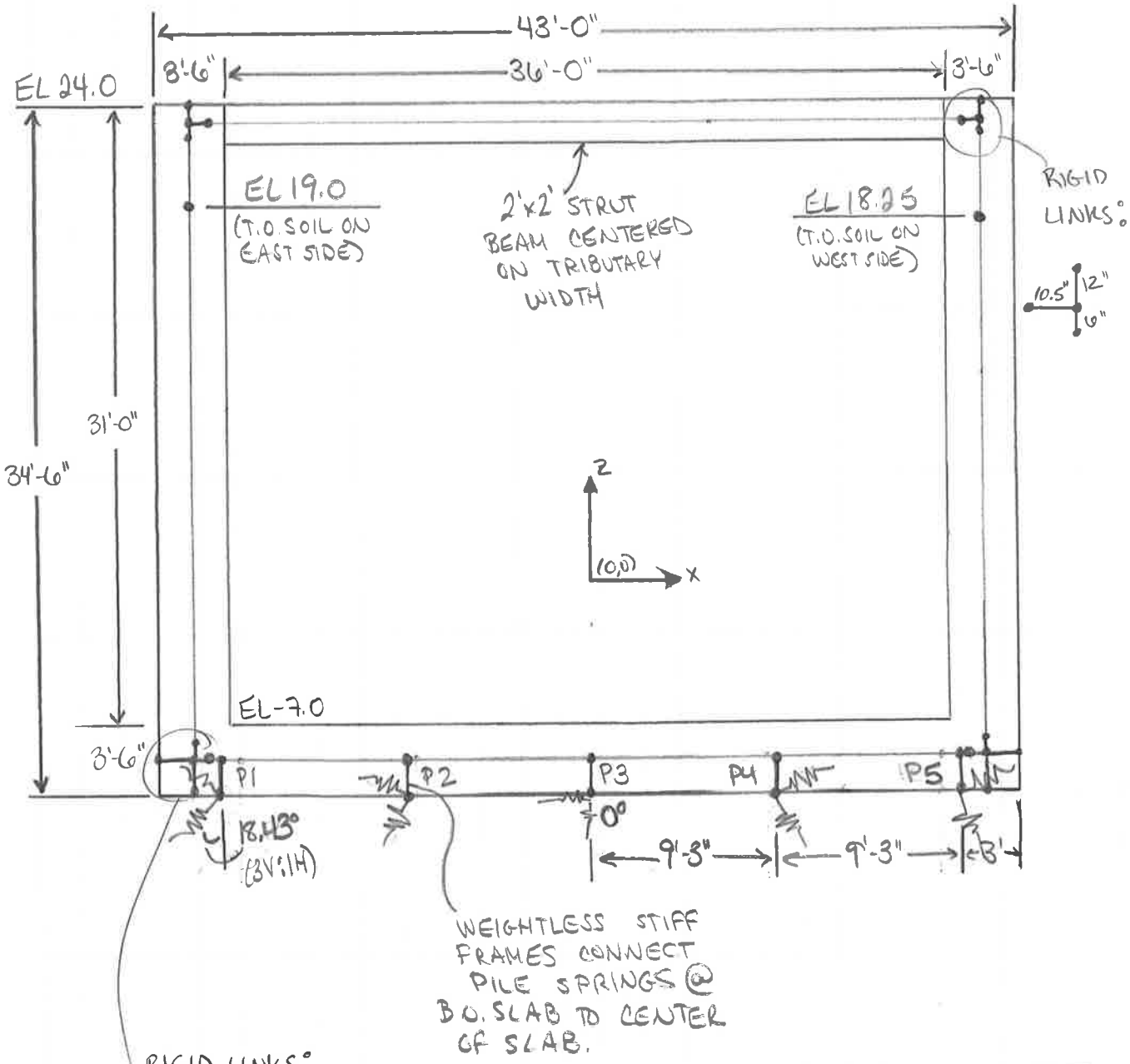
The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

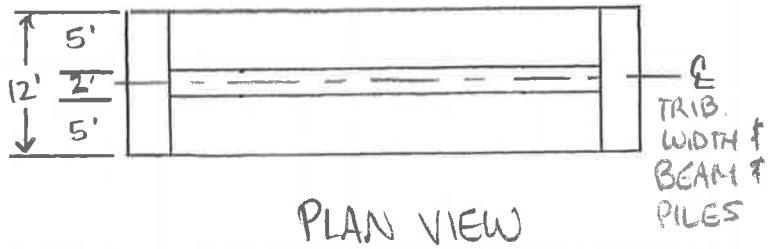
URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: MONOLITH U-3 | Computed by: LBR | Sheet ___ of ___ | Date: 7/2013
SAP MODEL LAYOUT | Checked by: ___ | Date: ___

Reference

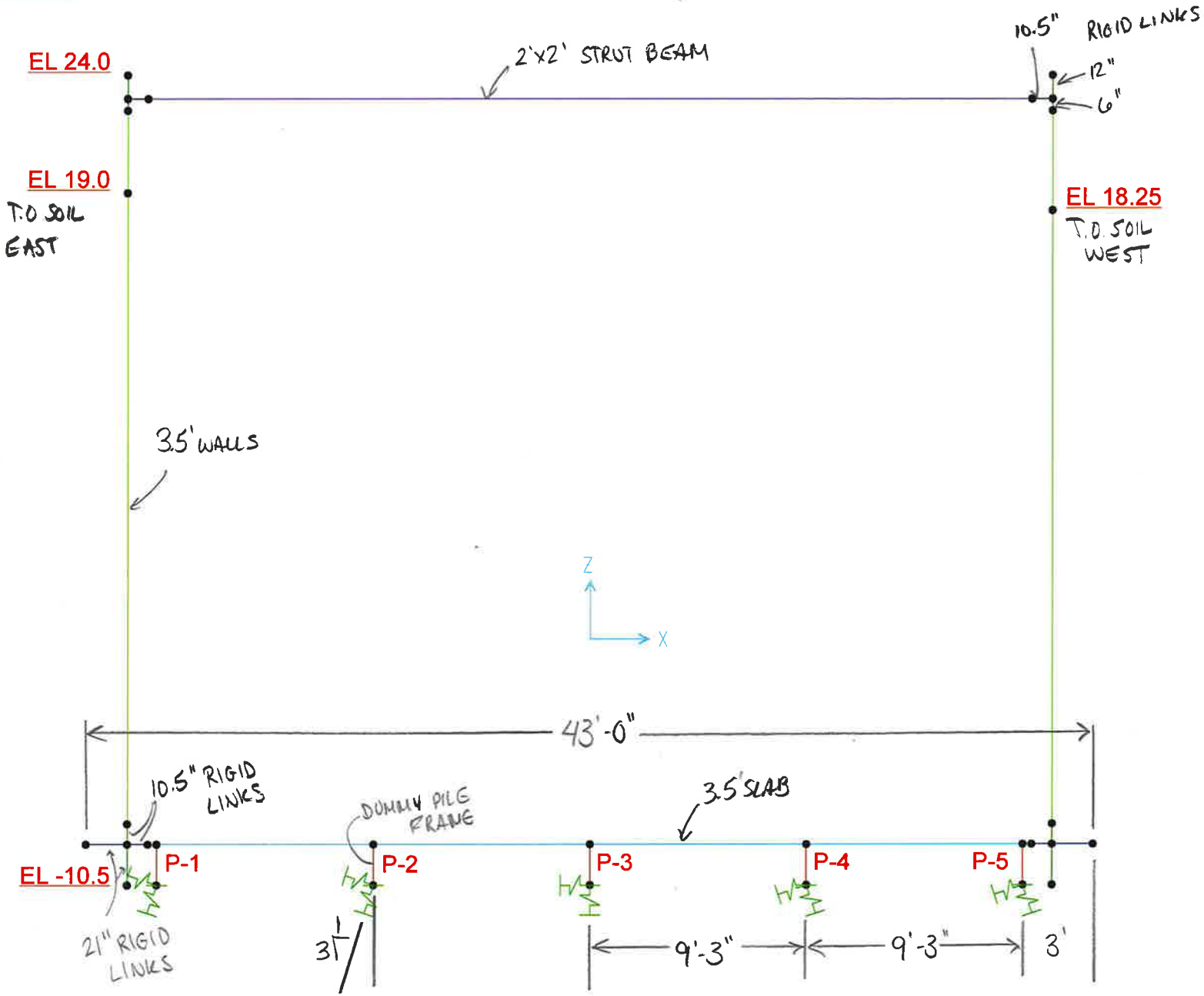
- LARGEST PILE TRIBUTARY WIDTH (12') IS PAIRED W/THE HIGHEST SOIL LOADS (@ DOWNSTREAM END) TO CREATE THIS 2-D MODEL.
- RIGID LINKS AS PER ETL 1110-2-355 ARE USED TO SIMULATE JOINTS. SEE GENERAL INFO SECTION FOR MORE DETAILS.



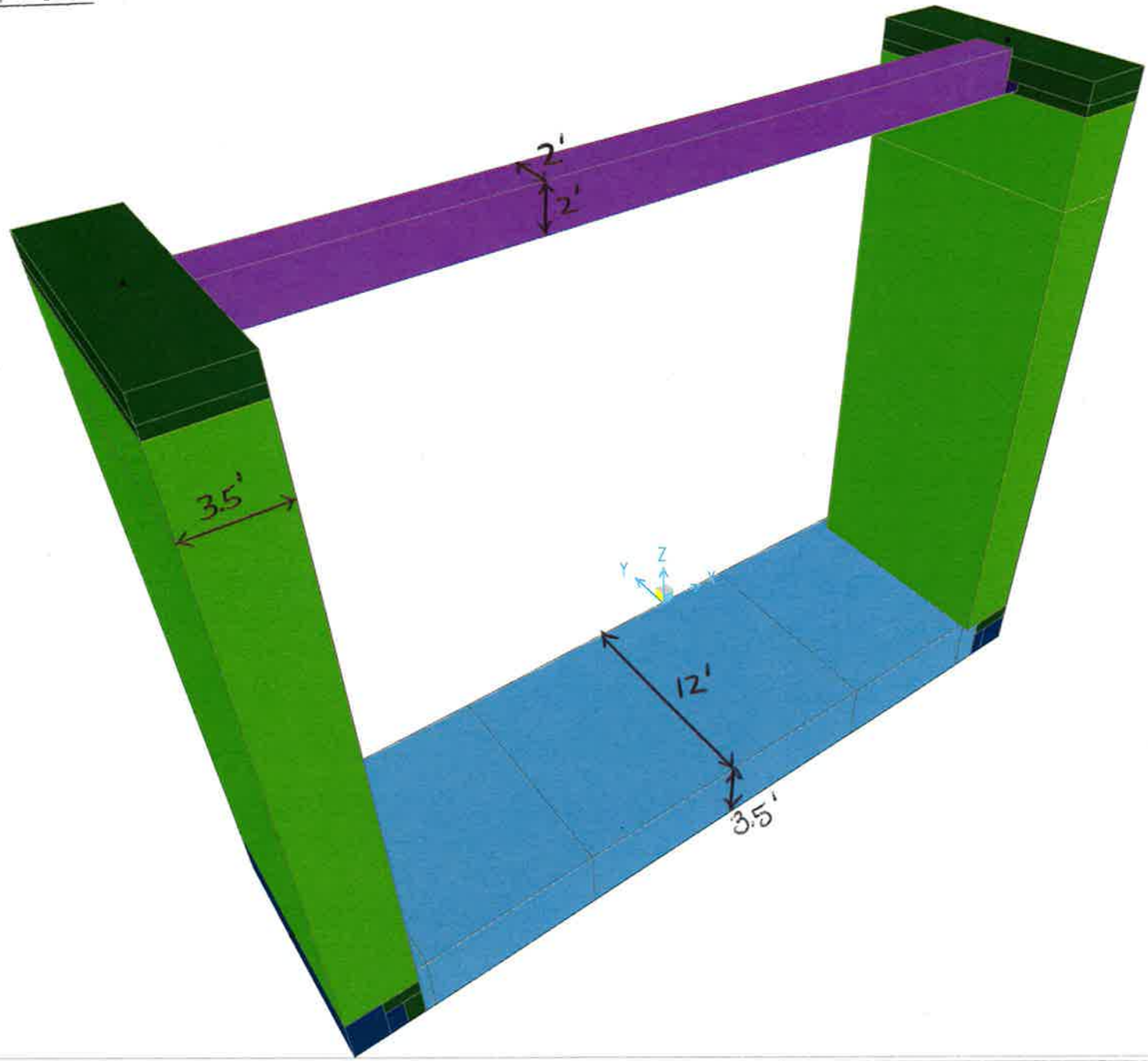


PLAN VIEW

Model Overview:



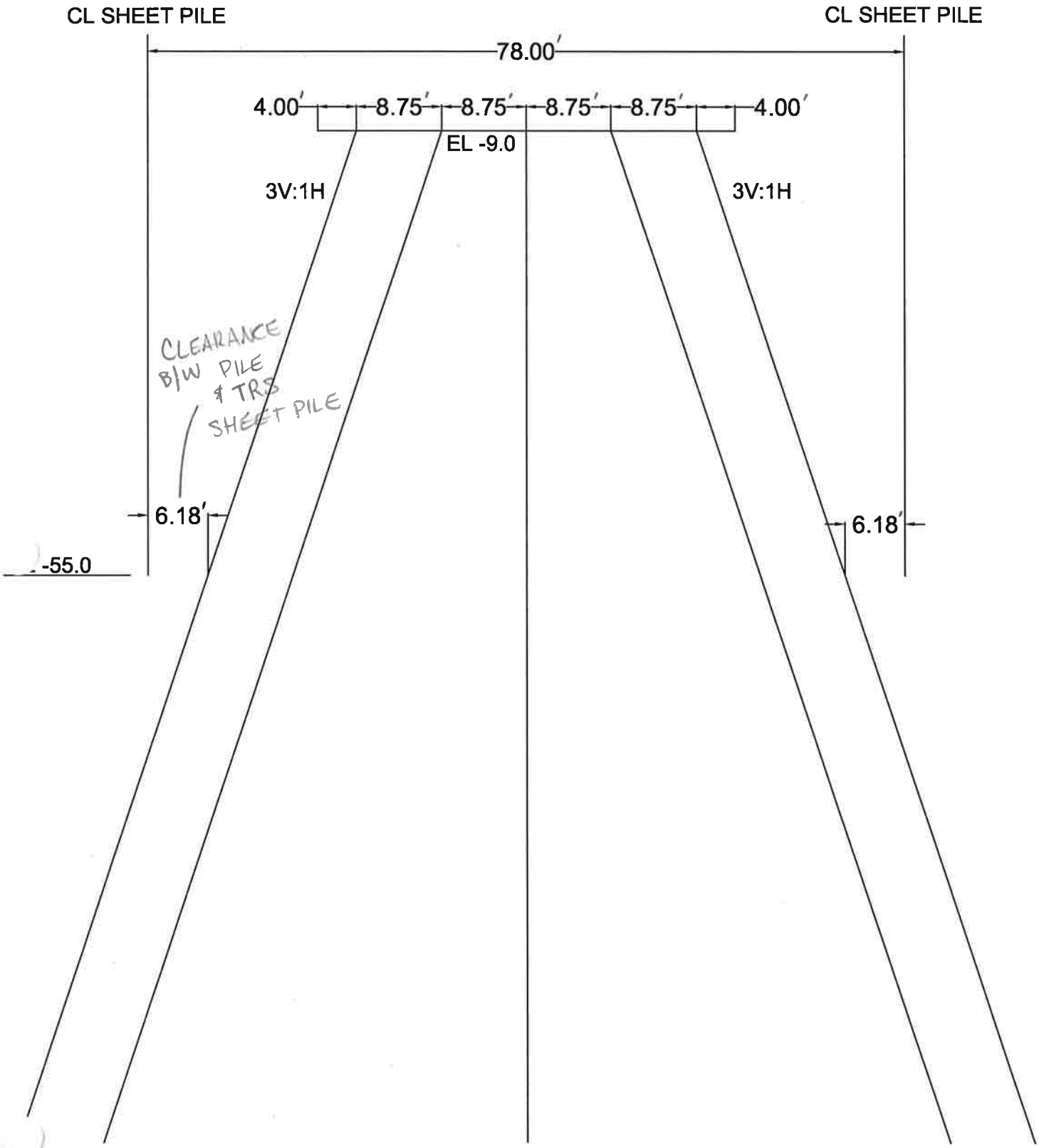
MODEL OVERVIEW:



HAUREPAS DIVERSION

LBR 7/2013

U-3



URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: MONOLITH U-3 | Computed by: LBR | Sheet ____ of ____
SAP MODEL DEAD LOAD | Checked by: ____ | Date: 7/2013
Date: ____
Reference

DEAD LOAD CALIBRATION:

↳ ACTUAL DEAD WEIGHT:

WALLS: 31' height × 3.5' thick × 12' wide × 150PCF × 2 walls = 390,600 LB
SLAB: 43' long × 3.5' thick × 12' wide × 150PCF = 270,900 LB
STRUT: 36' long × 2' high × 2' wide × 150PCF = 21,600 LB

$\Sigma = 683,100$ LB

↳ SAP REACTION $\Sigma = 682,806$ LB

↳ DIFFERENCE OF 294 LB, OR 0.04% → OK

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP Inflow U-Frame Monoliths **Computed By:** LBR **Date:** Jul-13 **Page:** of

Checked By: **Date:** **Sheet:** of

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf	$\gamma_{fill, wet}$ =	115	pcf	Flood Elevation =	31.5	ft NAVD 88
γ_{water} =	62.4	pcf	$\gamma_{fill, eff}$ =	52.6	pcf	Riprap thickness =	2.25	ft
γ_{riprap} =	132	pcf	K_0 =	0.95		$q_{surcharge, construction}$ =	300	psf
$\gamma_{riprap, eff}$ =	69.6	pcf						

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure Including Riprap:

*Above water table: $P_y = \gamma_{riprap} * Z_{riprap} + \gamma_{fill, wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{riprap, eff} * Z_{riprap} + \gamma_{fill, eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap:

*Above water table: $P_y = K_0 * (q_{surch, const} * q_{riprap} + \gamma_{fill, wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * [q_{surch, const} * q_{riprap, eff} + \gamma_{fill, eff} * Z_{fill}]$

$q_{riprap} = \gamma_{riprap} *$ thickness = 297 psf

$q_{riprap, eff} = \gamma_{riprap, eff} *$ thickness = 156.6 psf

*** MODEL U-3:** Model is of a 12ft wide strip & uses maximum grade elevations on either side of the U-frame.

T.O. Wall & Strut Elevation =	24.0	ft NAVD 88	Wall Thickness =	3.5	ft
T.O. Slab Elevation =	-7.0	ft NAVD 88	Slab Thickness =	3.5	ft
T.O. Bank Elevation, *East* Side =	19.0	ft NAVD 88 (approx.)	Strut Thickness =	2	ft
T.O. Bank Elevation, *West* Side =	18.25	ft NAVD 88 (approx.)			

* Water Loads: Water loads cancel out on the wing walls because water is able to flow behind walls.

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
31.50	0.0
24.00	468.0
18.25	826.8
19.00	780.0
-7.00	2402.4
-7.875	2457.0
-8.750	2511.6
-10.50	2620.8

Vertical Force on T.O. Slab = 2402.4 psf

Uplift Force on B.O. Slab = 2620.8 psf

Vertical Force on T.O. Strut = 468.0 psf

Uplift Force on B.O. Strut = 592.8 psf

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP Inflow U-Frame Monoliths **Computed By:** LBR **Date:** Jul-13 **Page:** of

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* Construction Surcharge Loads:

Below Top of Soil = $K_0 * q_{surcharge}$ = 285 psf

* Soil Loads, Dry (Const.): Construction surcharge loads applied separately.

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
19.00	0.0
16.75	282.2
-7.875	2972.4
-8.750	3068.0
-10.50	3259.2

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
18.25	0.0
16.00	282.2
-7.875	2890.5
-8.750	2986.1
-10.50	3177.3

* Soil Loads, UNEVEN Dry (Const.): Soil load to EL 16.75 on east side, only to EL 11.75 on west side. On east/high side, soil placed to top of soil (bottom of riprap). Riprap not yet installed.

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
19.00	0.0
16.75	0.0
-7.875	2690.3
-8.75	2785.9
-10.50	2977.1

WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
11.75	0.0
-7.875	2144.0
-8.75	2239.6
-10.50	2430.8

* Soil Loads, Sat (Water to EL 31.5):

EAST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
19.00	0.0
16.75	148.8
-7.875	1379.3
-8.75	1423.0
-10.50	1510.5

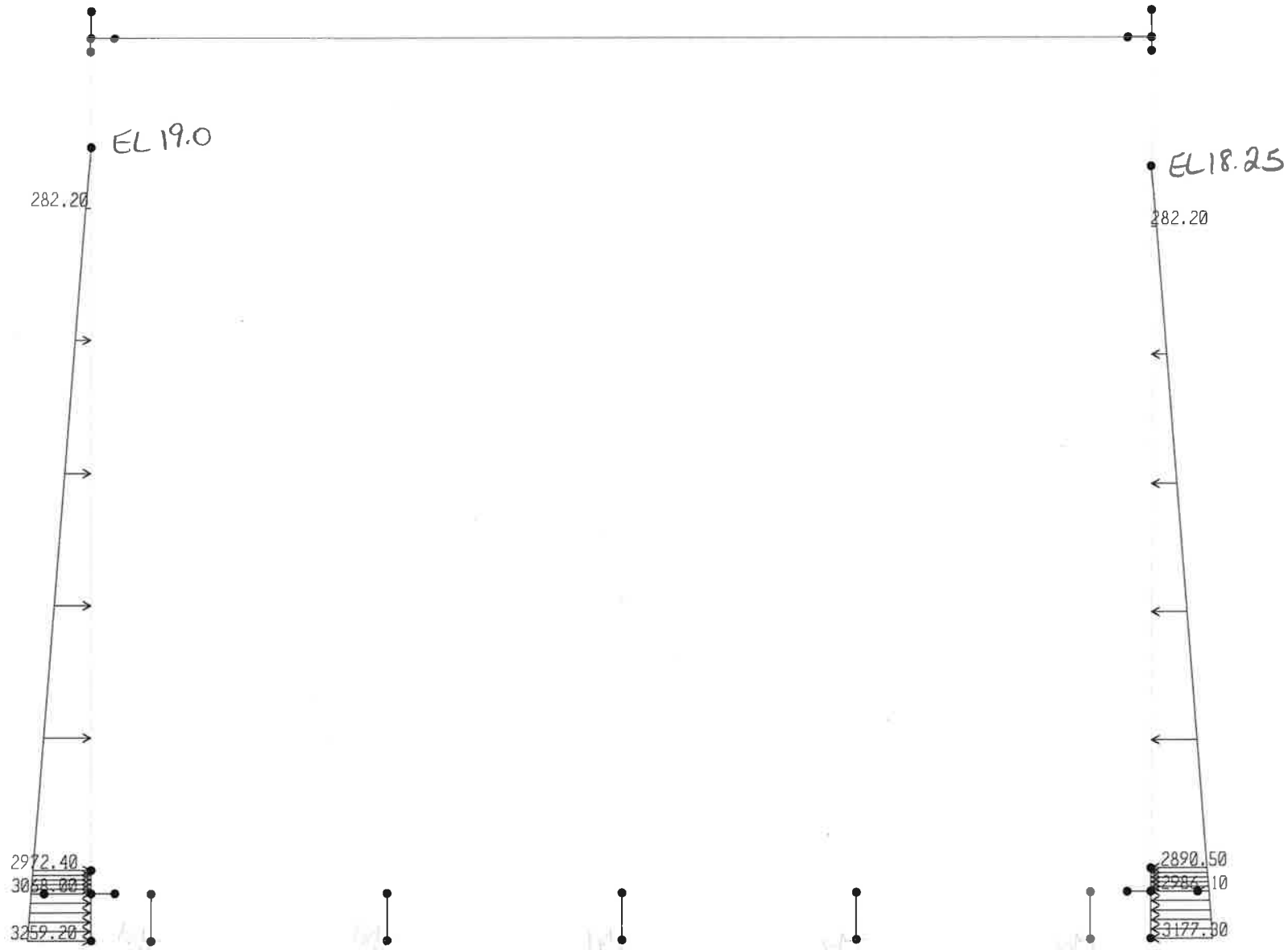
WEST

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
24.00	0.0
18.25	0.0
16.00	148.8
-7.875	1341.8
-8.75	1385.5
-10.50	1473.0

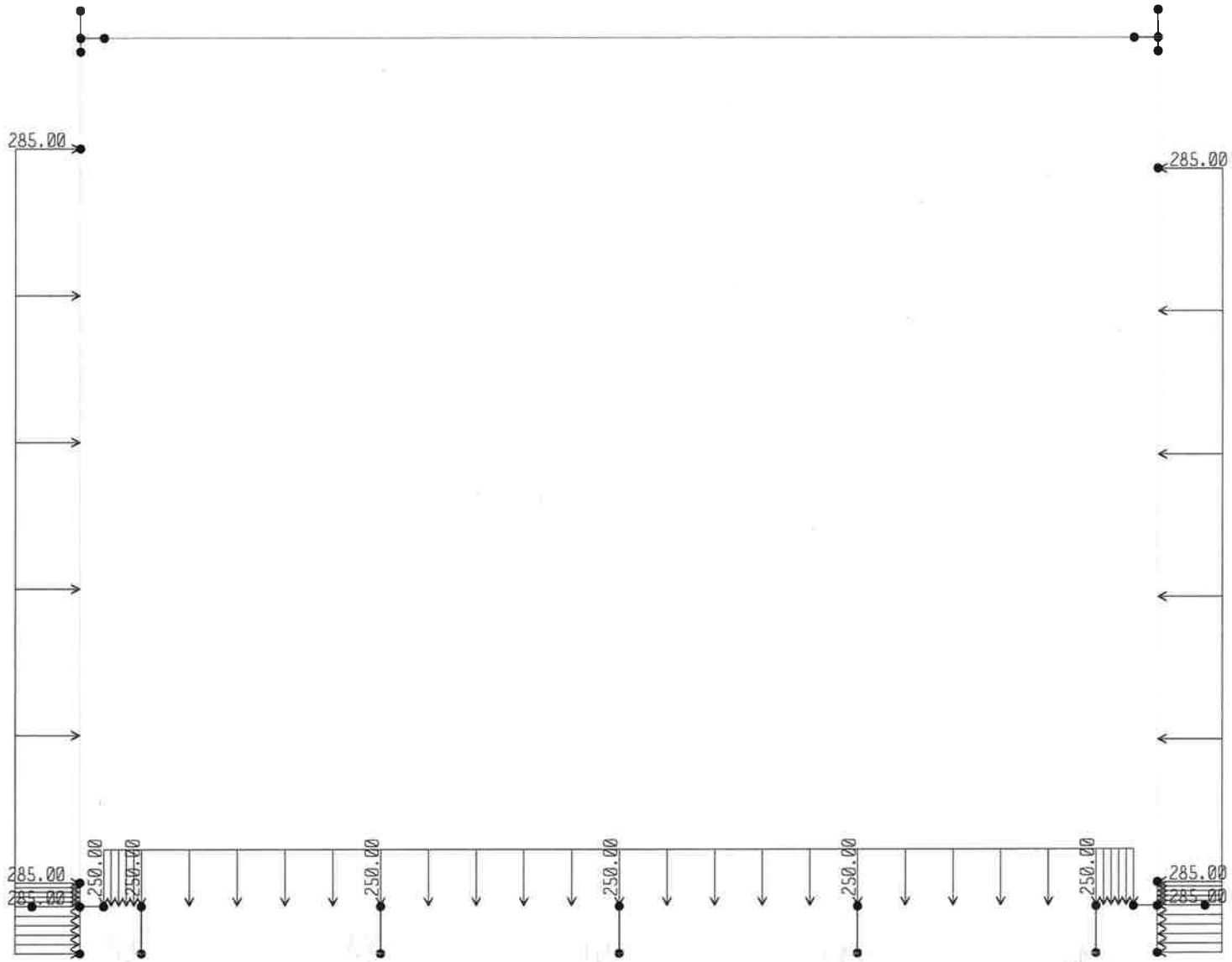
* NOTE: All loads are calculated on a per-foot basis. In the model, these loads (with the exception of the water load on the strut) are multiplied by a scale factor of 12 when combined into load cases. This creates a 12' strip of load for soil, water, surcharge, etc.

The strut is the only member of a differing width; for the strut water load, a total force of 2ft width*P_{water} is applied, and this load is given a scale factor of 1.

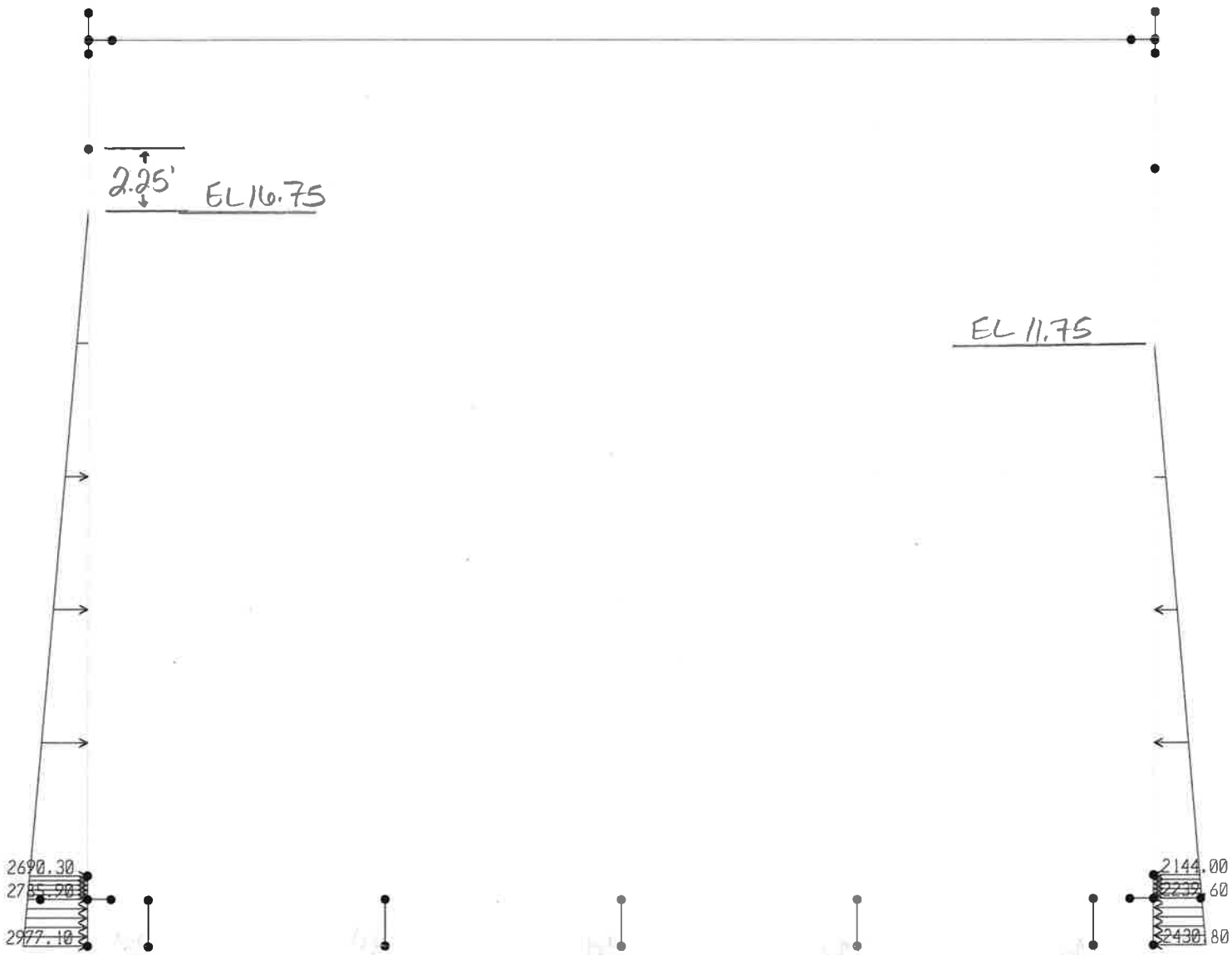
Dry Soil - Construction:



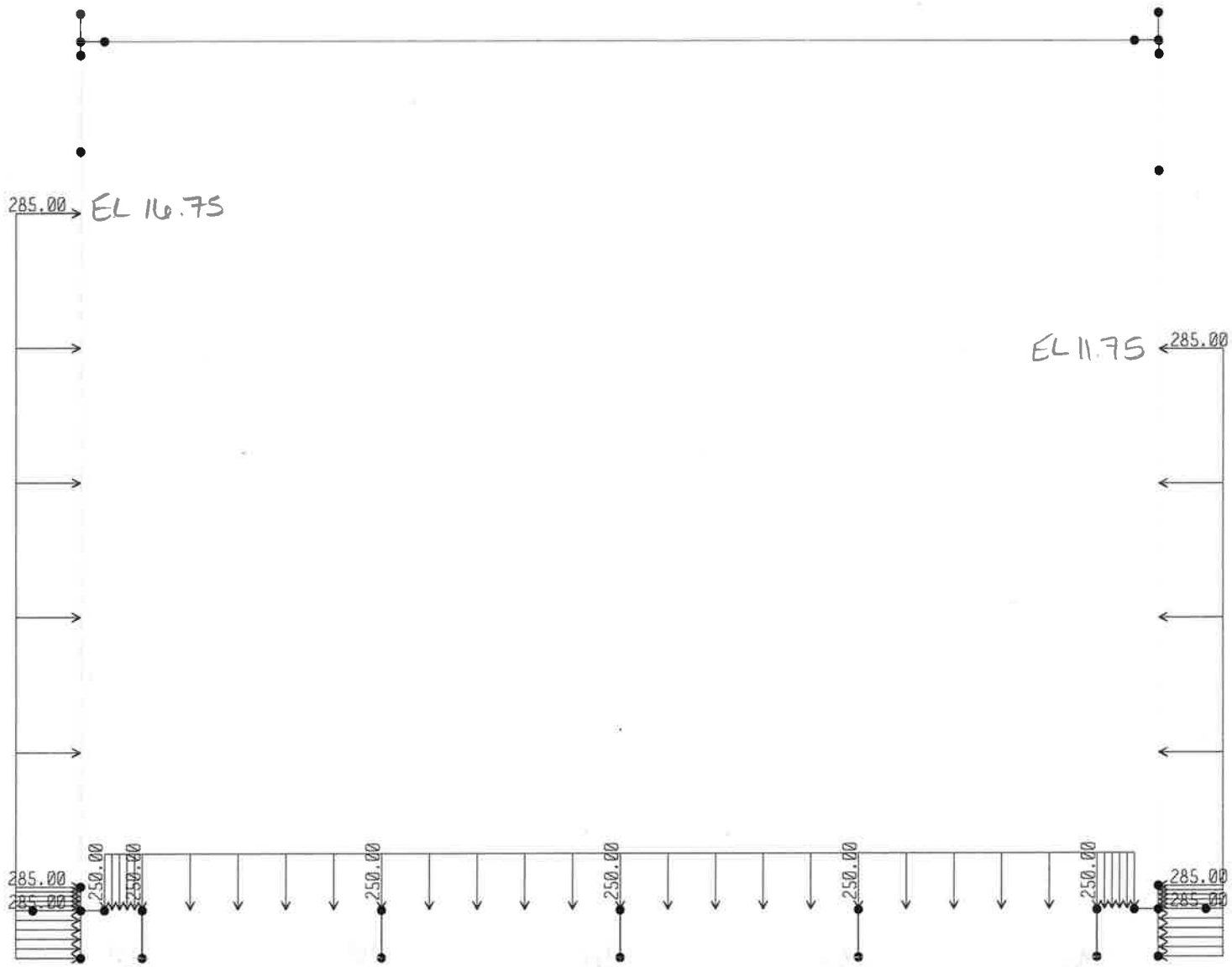
Construction Surcharge:



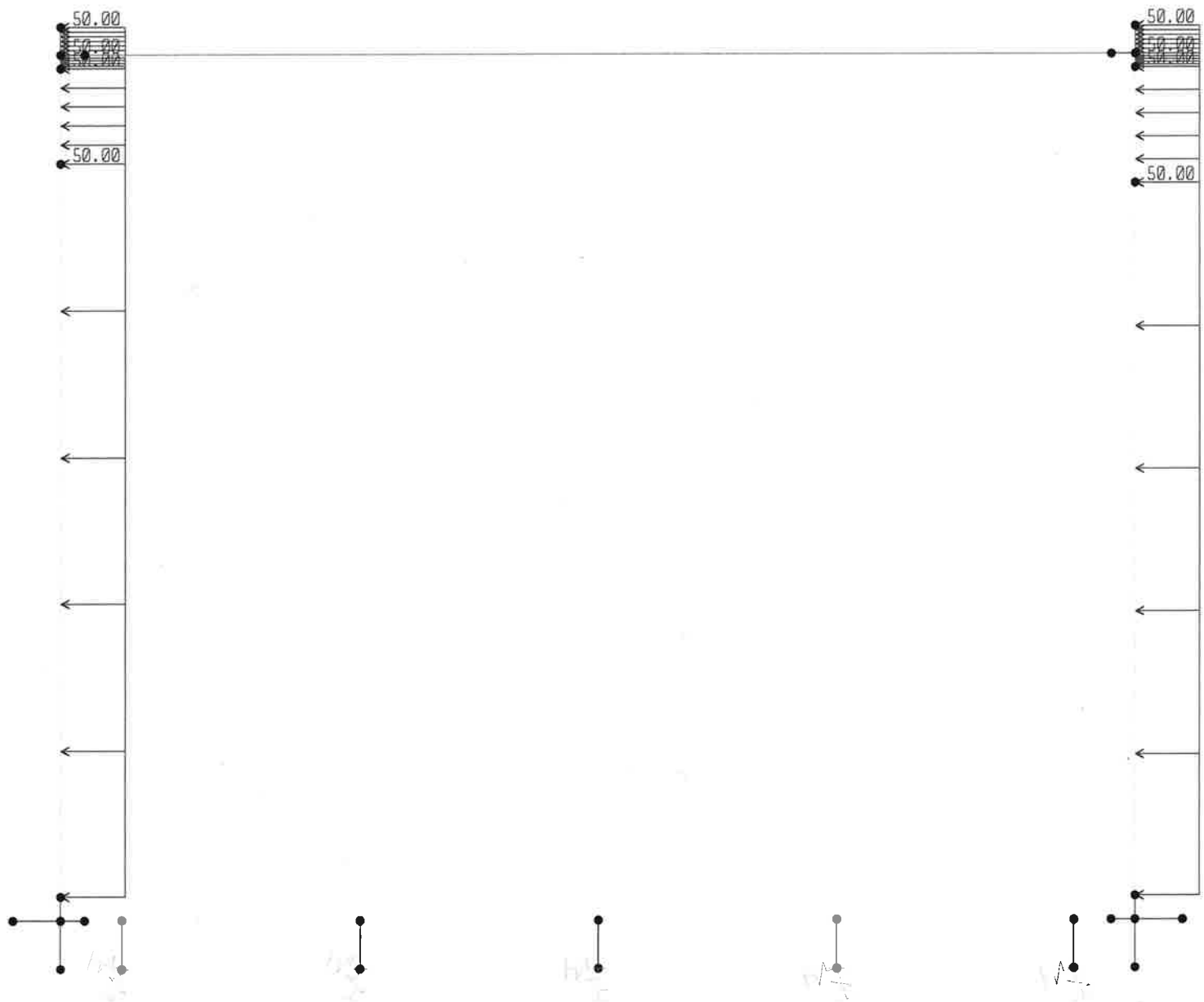
Dry Soil - Uneven Construction:



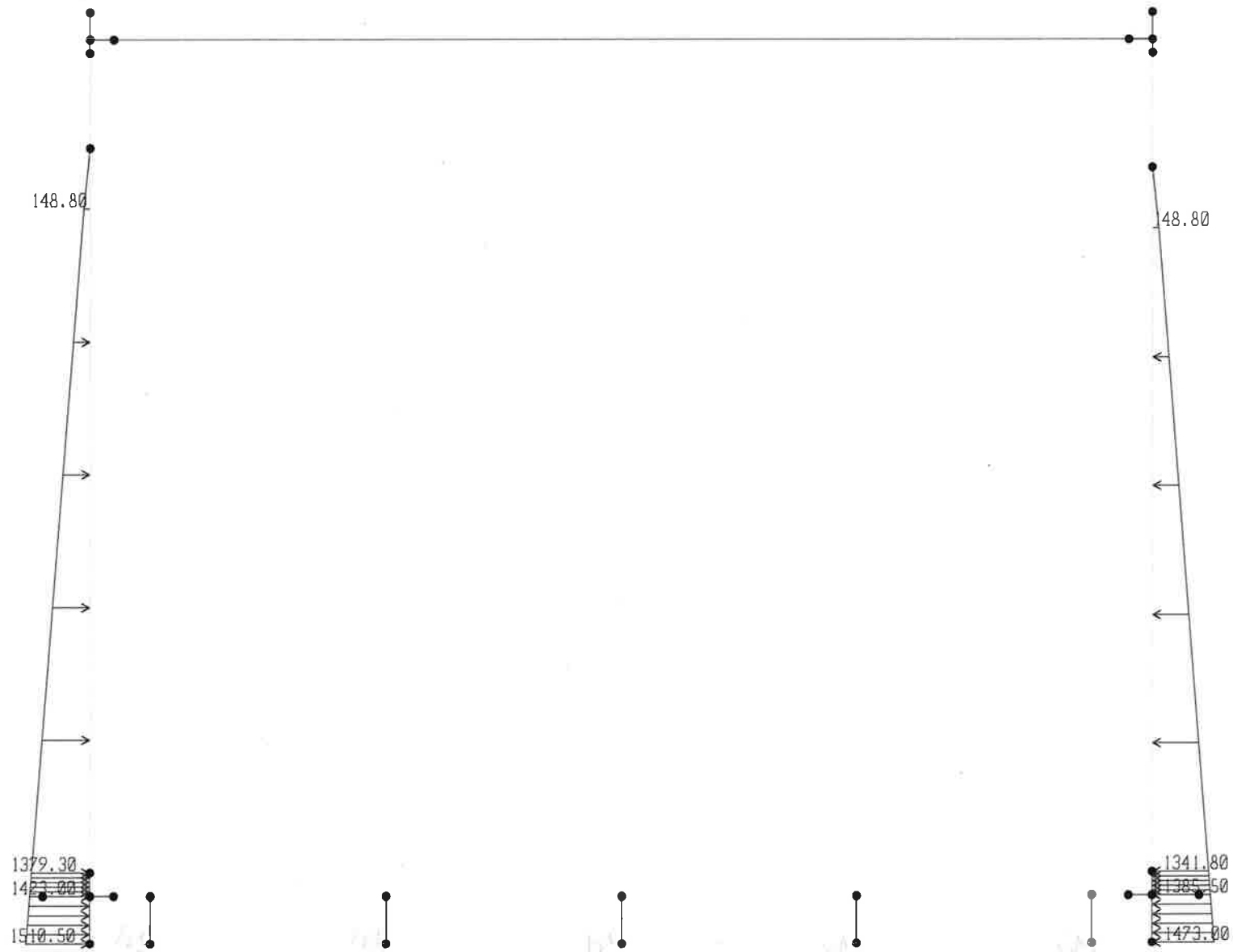
Construction Surcharge - Uneven Backfill:



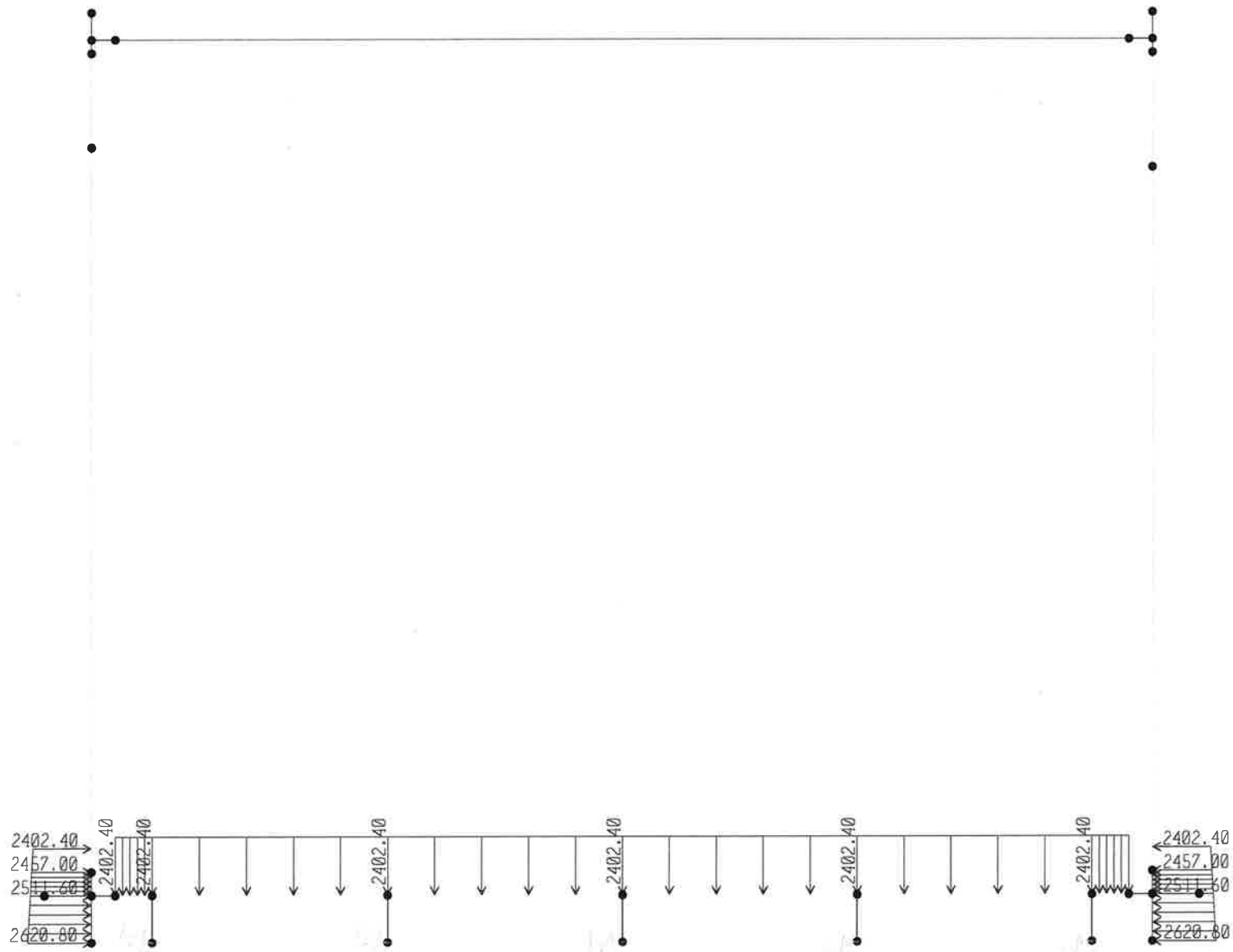
Wind During Construction:



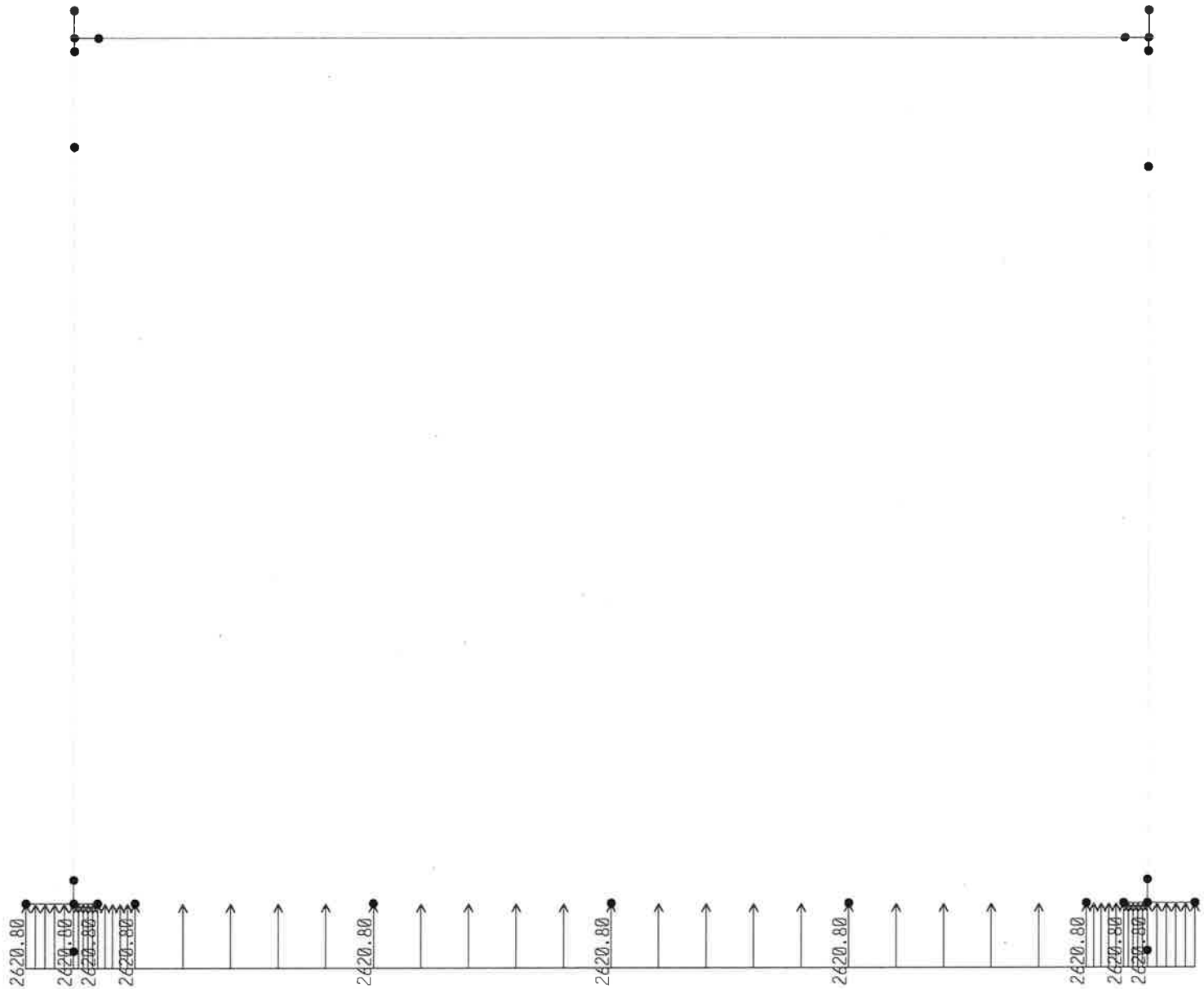
Saturated Soil:



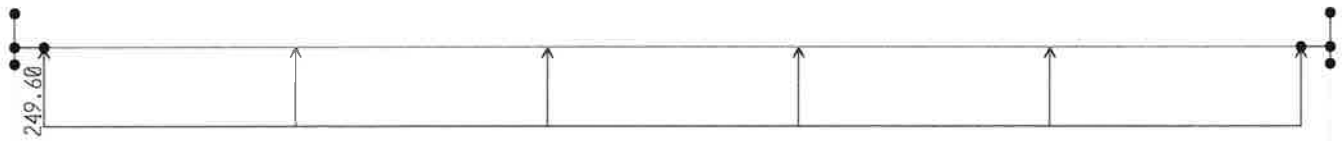
Water to EL 31.5:



Uplift - Water to EL 31.5:



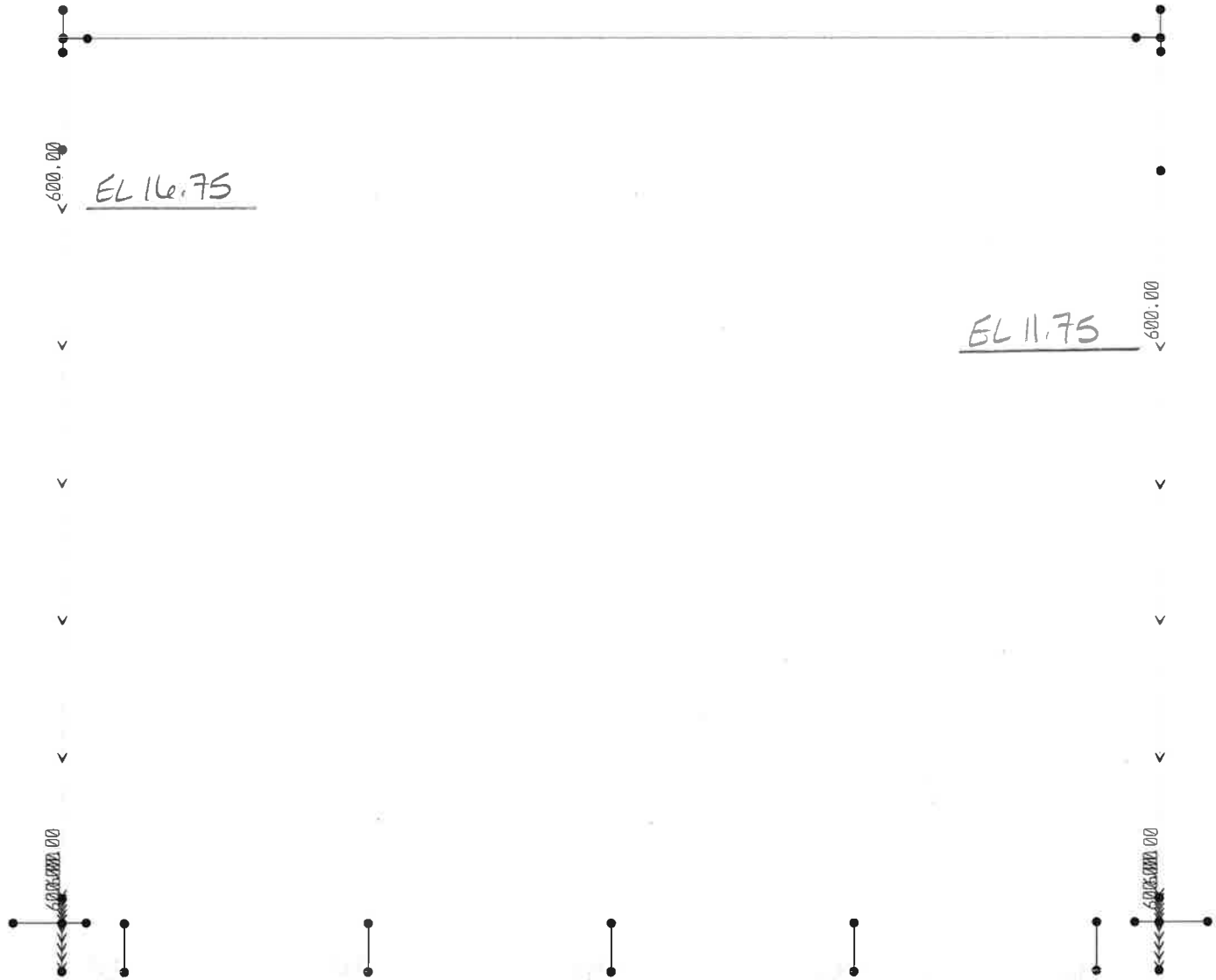
Water to EL 31.5 on Strut Beam:



NOTE: THIS IS THE ONLY LOAD NOT ON A PER-FOOT BASIS. LOAD IS OF 2' OF WATER ON BEAM

Downdrag Force Due to Clay Cohesion:

Downdrag Force Due to Clay Cohesion -
Uneven Construction:



PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

* A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use a vertical spring based on a pile tip elevation of -110.0 and a lateral reaction of 25kip (0.8973" corresponding deflection).

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	Dead	-1.67	0	168.82	0	0	0
P-2	Dead	-1.29	0	128.01	0	0	0
P-3	Dead	0.00	0	117.74	0	0	0
P-4	Dead	1.29	0	128.01	0	0	0
P-5	Dead	1.67	0	168.82	0	0	0
P-1	1a	-4.52	0	148.90	0	0	0
P-2	1a	-4.72	0	150.40	0	0	0
P-3	1a	-3.20	0	178.05	0	0	0
P-4	1a	-1.65	0	188.80	0	0	0
P-5	1a	-1.97	0	161.46	0	0	0
P-1	1b	-21.31	0	142.67	0	0	0
P-2	1b	-20.87	0	52.11	0	0	0
P-3	1b	-19.37	0	167.75	0	0	0
P-4	1b	-17.81	0	276.43	0	0	0
P-5	1b	-18.39	0	189.10	0	0	0
P-1	1c	1.92	0	179.55	0	0	0
P-2	1c	2.27	0	150.59	0	0	0
P-3	1c	3.60	0	117.74	0	0	0
P-4	1c	4.86	0	105.44	0	0	0
P-5	1c	5.27	0	158.08	0	0	0
P-1	2	-2.23	0	84.73	0	0	0
P-2	2	-2.21	0	75.48	0	0	0
P-3	2	-1.40	0	84.33	0	0	0
P-4	2	-0.59	0	92.03	0	0	0
P-5	2	-0.62	0	89.26	0	0	0

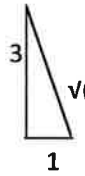
Vertical Reactions:

MAXIMUM REACTION = 276.43 kips
MINIMUM REACTION = 52.11 kips

Horizontal Reactions:

MAXIMUM REACTION = 5.27 kips
MINIMUM REACTION = -21.31 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves

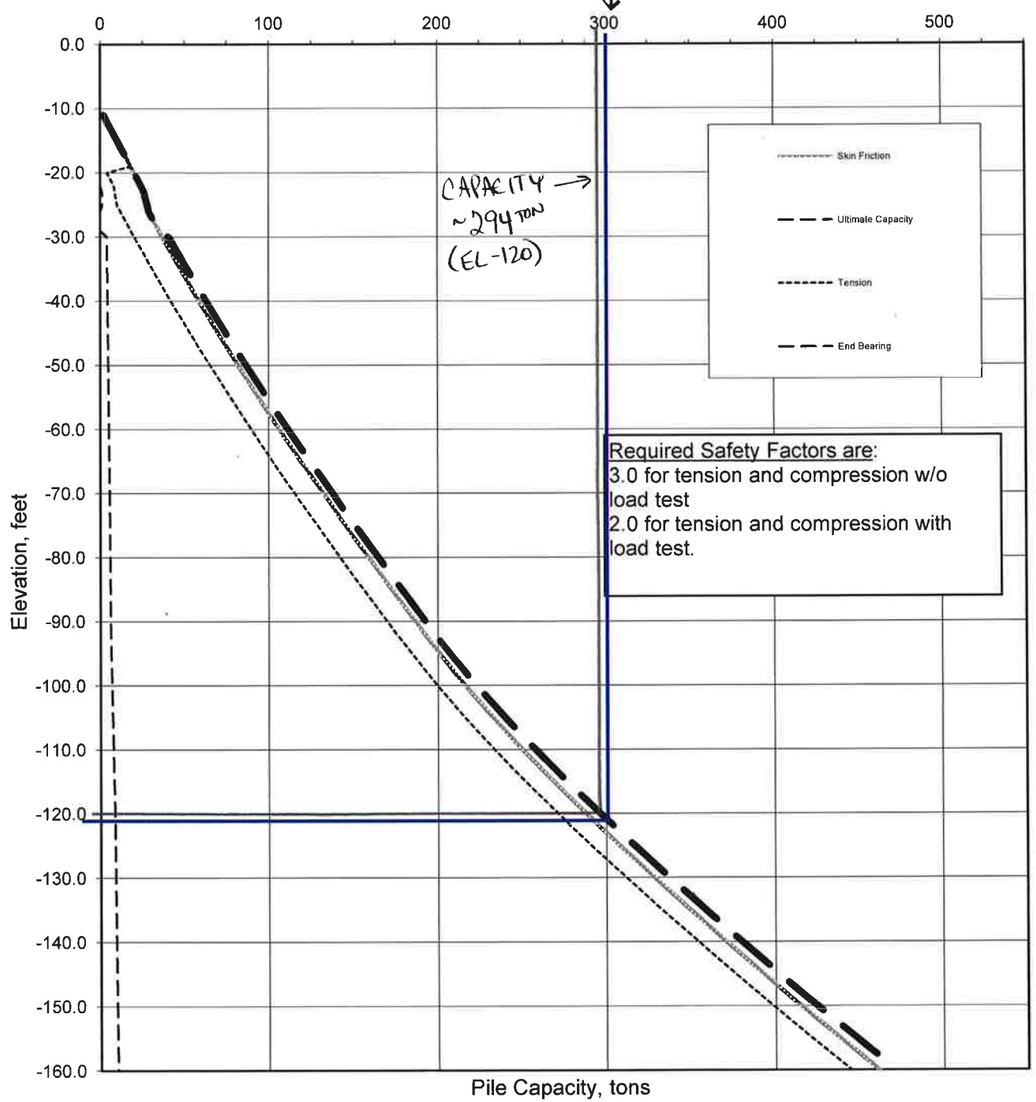


$\sqrt{(3^2+1^2)} = 3.1623$

276.43 kips * 3.1623 / 3 = 291.38 k

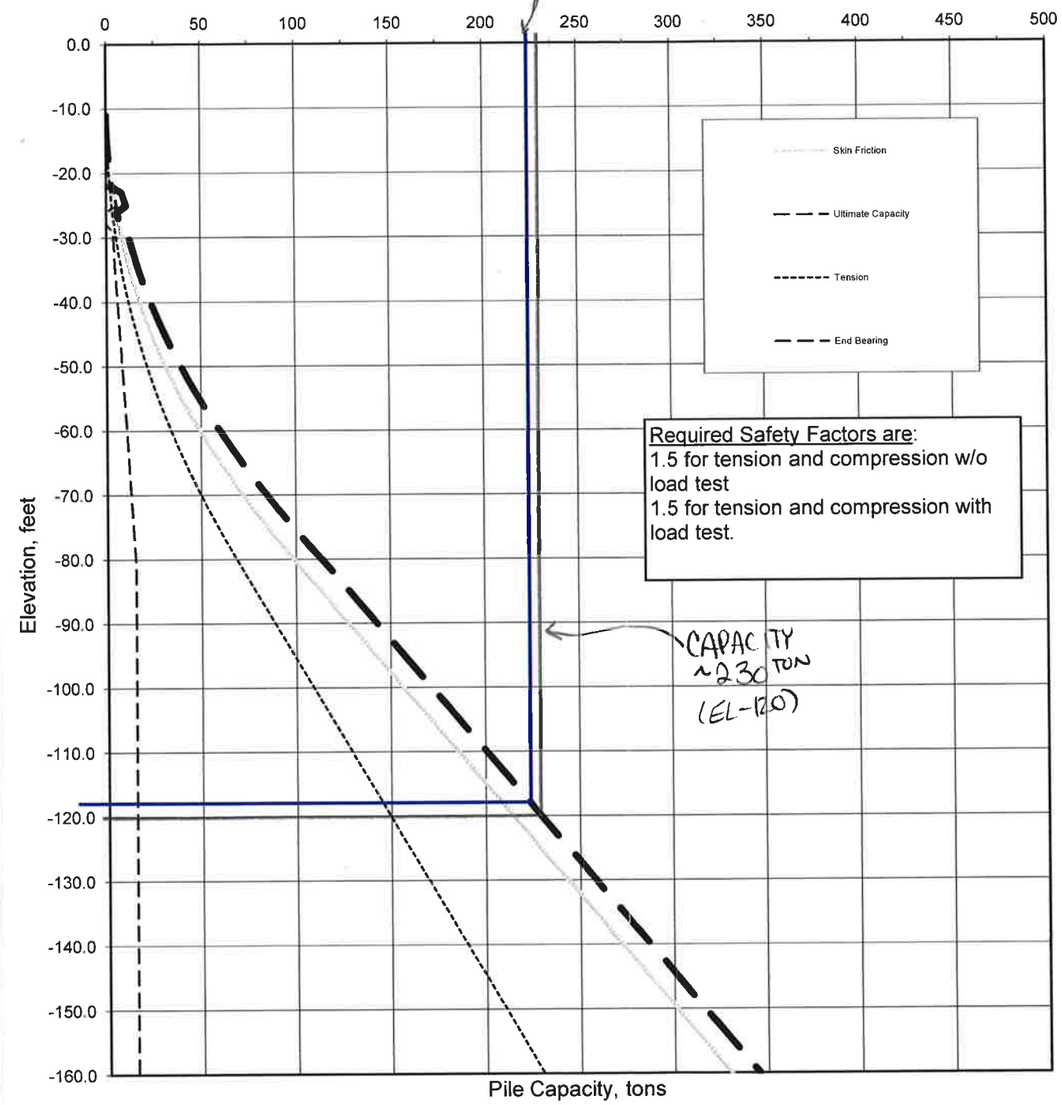
Undrained Strength Case with HP 14x89 Pile

293k REQUIRED × 1 TON / 2 KIP × 2 (F.O.S.) = 293 TON



Drained Strength Case with HP 14x89 Pile

293k × 1 TON / 2 KIP × 1.5 (F.O.S.) = 219.75 TON



Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

SET TIPS @ EL-120.0

CALLOW = 294 KIP (UNDRAINED CONTROLS)

Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	URS	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Load Calculations for SAP Inflow U-Frame Monoliths
Computed By: LBR **Date:** Jul-13 **Page:** of
Checked By: **Date:** **Sheet:** of

PILE/SPRING STIFFNESS INPUT IN SAP **HP14x89 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required pile from the pile capacity curves = -120.0 NAVD88
Top of pile Elevation including 9" Pile embedment = (-10.5 + 0.75) ft = -9.75 NAVD88
Therefore, required length of pile = 110.25 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

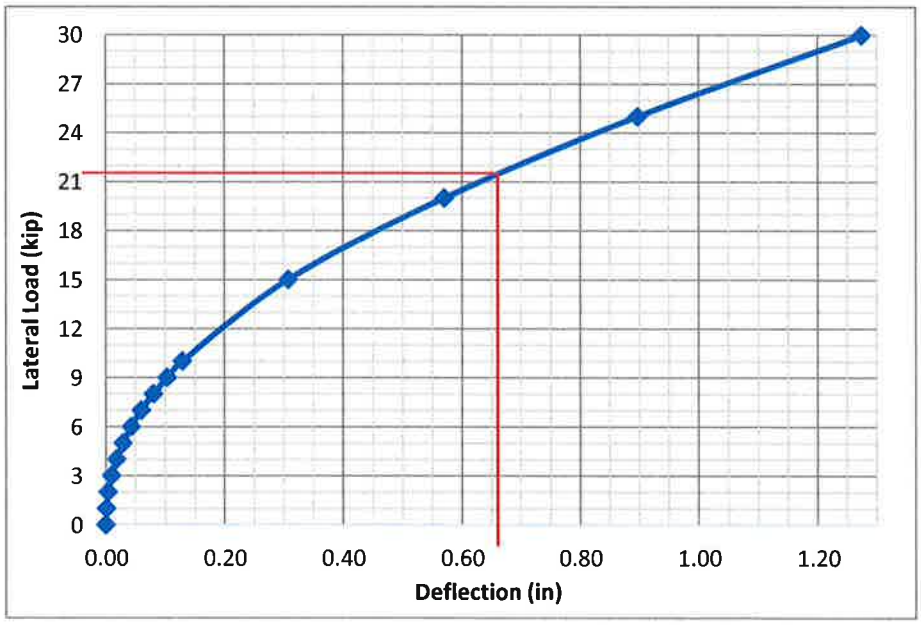
Modulus of Elasticity of the pile (E) = 29,000 ksi

Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 995.5 k/in
= **11946 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 21.5k reaction, deflection is about 0.66"
Spring = 21.5k/0.66in = 32.58 k/in = 390.9 k/ft

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	Dead	-2.10	0	166.56	0	0	0
P-2	Dead	-1.65	0	128.86	0	0	0
P-3	Dead	0.00	0	119.90	0	0	0
P-4	Dead	1.65	0	128.86	0	0	0
P-5	Dead	2.10	0	166.56	0	0	0
P-1	1a	-5.03	0	148.13	0	0	0
P-2	1a	-5.30	0	152.27	0	0	0
P-3	1a	-3.37	0	177.62	0	0	0
P-4	1a	-1.38	0	185.79	0	0	0
P-5	1a	-1.74	0	163.28	0	0	0
P-1	1b	-22.60	0	134.41	0	0	0
P-2	1b	-22.23	0	67.00	0	0	0
P-3	1b	-20.38	0	168.06	0	0	0
P-4	1b	-18.33	0	261.23	0	0	0
P-5	1b	-18.86	0	196.78	0	0	0
P-1	1c	1.64	0	178.71	0	0	0
P-2	1c	2.09	0	148.76	0	0	0
P-3	1c	3.79	0	119.90	0	0	0
P-4	1c	5.39	0	108.97	0	0	0
P-5	1c	5.85	0	154.41	0	0	0
P-1	2	-2.51	0	83.88	0	0	0
P-2	2	-2.50	0	76.53	0	0	0
P-3	2	-1.48	0	84.63	0	0	0
P-4	2	-0.43	0	90.93	0	0	0
P-5	2	-0.47	0	89.56	0	0	0

Vertical Reactions:

MAXIMUM REACTION = 261.23 kips
MINIMUM REACTION = 67.00 kips

Horizontal Reactions:

MAXIMUM REACTION = 5.85 kips
MINIMUM REACTION = -22.60 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves

$\sqrt{(3^2+1^2)} = 3.1623$

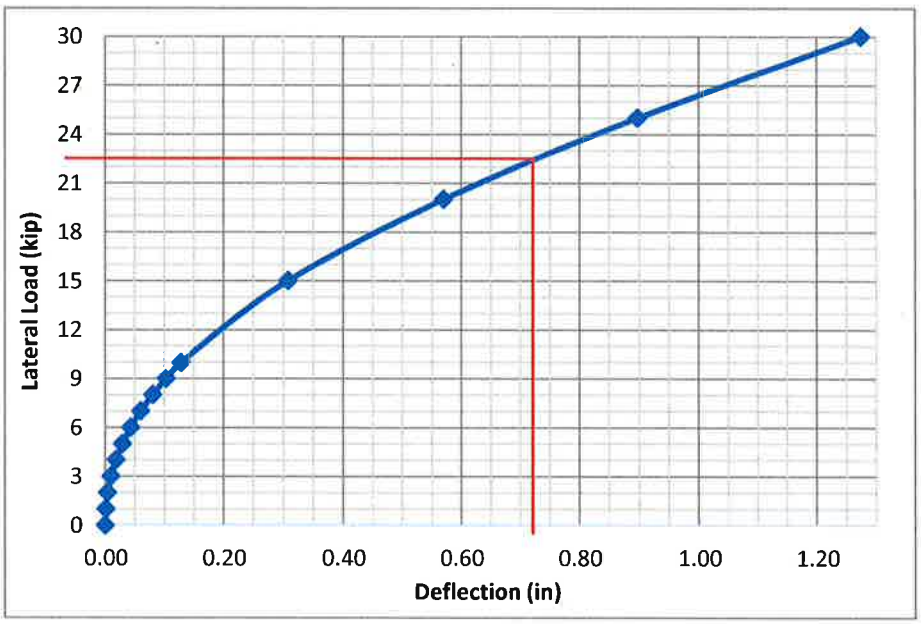
261.23 kips * 3.1623 / 3 = 275.36 k

In the previous model run using a lateral spring of 32.58k/in, SAP shows a maximum lateral displacement of 0.694". Will try one more iteration of the lateral spring to converge on the proper load/deflection combination. Will try a spring based on a 22.5k lateral load.

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 22.5k reaction, deflection is about 0.73"
Spring = 22.5k/0.73in = 30.822 k/in = 369.86 k/ft

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

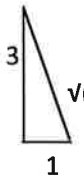
TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	Dead	-1.99	0	166.60	0	0	0
P-2	Dead	-1.56	0	128.89	0	0	0
P-3	Dead	0.00	0	119.90	0	0	0
P-4	Dead	1.56	0	128.89	0	0	0
P-5	Dead	1.99	0	166.60	0	0	0
P-1	1a	-4.91	0	148.45	0	0	0
P-2	1a	-5.16	0	151.75	0	0	0
P-3	1a	-3.33	0	177.64	0	0	0
P-4	1a	-1.45	0	186.36	0	0	0
P-5	1a	-1.80	0	163.03	0	0	0
P-1	1b	-22.31	0	136.20	0	0	0
P-2	1b	-21.91	0	63.70	0	0	0
P-3	1b	-20.15	0	168.08	0	0	0
P-4	1b	-18.22	0	264.58	0	0	0
P-5	1b	-18.78	0	195.06	0	0	0
P-1	1c	1.72	0	178.42	0	0	0
P-2	1c	2.13	0	149.39	0	0	0
P-3	1c	3.74	0	119.92	0	0	0
P-4	1c	5.26	0	108.38	0	0	0
P-5	1c	5.70	0	154.77	0	0	0
P-1	2	-2.45	0	84.03	0	0	0
P-2	2	-2.42	0	76.31	0	0	0
P-3	2	-1.46	0	84.64	0	0	0
P-4	2	-0.47	0	91.18	0	0	0
P-5	2	-0.51	0	89.45	0	0	0

Vertical Reactions:
MAXIMUM REACTION = 264.58 kips
MINIMUM REACTION = 63.70 kips

Horizontal Reactions:
MAXIMUM REACTION = 5.70 kips
MINIMUM REACTION = -22.31 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(3^2+1^2)} = 3.1623$

264.58 kips * 3.1623 / 3 = 278.89 k

$C_{ALLOW} = 294^k > C_{ULT} = 279^k \rightarrow$ OK

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	inch	inch	inch
P-1	Dead	0.06452	0	-0.16735
P-2	Dead	0.05072	0	-0.12947
P-3	Dead	0.00000	0	-0.12046
P-4	Dead	-0.05072	0	-0.12947
P-5	Dead	-0.06452	0	-0.16735
P-1	1a	0.15945	0	-0.14913
P-2	1a	0.16733	0	-0.15244
P-3	1a	0.10805	0	-0.17844
P-4	1a	0.04715	0	-0.18721
P-5	1a	0.05833	0	-0.16376
P-1	1b	0.72387	0	-0.13682
P-2	1b	0.71096	0	-0.06399
P-3	1b	0.65390	0	-0.16884
P-4	1b	0.59128	0	-0.26577
P-5	1b	0.60919	0	-0.19594
P-1	1c	-0.05593	0	-0.17923
P-2	1c	-0.06923	0	-0.15007
P-3	1c	-0.12140	0	-0.12046
P-4	1c	-0.17067	0	-0.10887
P-5	1c	-0.18497	0	-0.15547
P-1	2	0.07937	0	-0.08441
P-2	2	0.07867	0	-0.07665
P-3	2	0.04731	0	-0.08503
P-4	2	0.01538	0	-0.09159
P-5	2	0.01648	0	-0.08985

Vertical Displacements:

MAXIMUM = -0.064 inch
MINIMUM = -0.266 inch

Horizontal Displacements:

MAXIMUM = 0.724 inch
MINIMUM = -0.185 inch

Maximum horizontal displacement is 0.724". Maximum allowable deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.266", which is less than the maximum allowable 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.73". The spring has converged.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

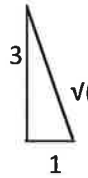
TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	M1	M2	M3
Text	Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
P-1	1a-ST	-6.61	0	255.32	0	0	0
P-2	1a-ST	-6.43	0	220.35	0	0	0
P-3	1a-ST	-3.66	0	235.40	0	0	0
P-4	1a-ST	-0.88	0	255.46	0	0	0
P-5	1a-ST	-0.87	0	263.94	0	0	0
P-1	1b-ST	-26.08	0	251.73	0	0	0
P-2	1b-ST	-25.09	0	125.44	0	0	0
P-3	1b-ST	-22.38	0	221.27	0	0	0
P-4	1b-ST	-19.71	0	329.65	0	0	0
P-5	1b-ST	-20.13	0	270.88	0	0	0
P-1	2-ST	-4.14	0	190.90	0	0	0
P-2	2-ST	-3.69	0	144.91	0	0	0
P-3	2-ST	-1.79	0	142.41	0	0	0
P-4	2-ST	-0.09	0	160.28	0	0	0
P-5	2-ST	-0.42	0	190.36	0	0	0

Vertical Reactions:
MAXIMUM REACTION = 329.65 kips
MINIMUM REACTION = 125.44 kips

Horizontal Reactions:
MAXIMUM REACTION = -0.09 kips
MINIMUM REACTION = -26.08 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(3^2+1^2)} = 3.1623$

329.65 kips * 3.1623 / 3 = 347.48 k

NOTE: PILE LENGTHS ARE NOT BEING ADJUSTED BASED ON SETTLEMENT FORCE. A STRUCTURAL CHECK OF THE PILES WILL BE PERFORMED USING THE PILE LENGTH REQ. BY TRADITIONAL LOAD CASES. IF STRUCTURAL CHECK OK FOR "ST" CASES, THEN THEY WILL BE DEEMED ADEQUATE @ EL-17.0.0

TABLE: Joint Displacements				
Joint	OutputCase	u1	u2	u3
Text	Text	inch	inch	inch
P-1	1a-ST	0.2144	0	-0.2565
P-2	1a-ST	0.2085	0	-0.2213
P-3	1a-ST	0.1189	0	-0.2365
P-4	1a-ST	0.0287	0	-0.2566
P-5	1a-ST	0.0283	0	-0.2651
P-1	1b-ST	0.8460	0	-0.2529
P-2	1b-ST	0.8140	0	-0.1260
P-3	1b-ST	0.7261	0	-0.2223
P-4	1b-ST	0.6394	0	-0.3311
P-5	1b-ST	0.6531	0	-0.2721
P-1	2-ST	0.1343	0	-0.1918
P-2	2-ST	0.1198	0	-0.1456
P-3	2-ST	0.0581	0	-0.1431
P-4	2-ST	-0.0031	0	-0.1610
P-5	2-ST	-0.0136	0	-0.1912

Vertical Displacements:

MAXIMUM = -0.126 inch

MINIMUM = -0.331 inch

Horizontal Displacements:

MAXIMUM = 0.846 inch

MINIMUM = -0.014 inch

Maximum horizontal displacement is 0.846". Maximum allowable deflection is 0.875" (for load cases with 16.67% allowable overstress). Maximum vertical deflection is 0.331", which is less than the maximum allowable 0.5" (load cases with no allowable overstress). Therefore, all deflections OK.

URS

Job: MAUREDAS | Project No.: 10001876 | Page ___ of ___ | Sheet ___ of ___

Description: U-3. SOIL & PILE INFO FOR PILE STRUCTURAL CHECK | Computed by: LBR | Date: 7/2013

Checked by: | Date:

Reference

E_s: USING P-Y CURVE DATA

↳ CALIBRATED SPRING IN SAP MODEL IS $22^k / 0.69" = 31.884^k/_{IN}$

↳ FROM CPGA MANUAL, WE KNOW:

PILE STIFFNESS COEFF., $K = \frac{C_o E I}{R^3}$

C_o = FIXETY CONSTANT = 0.707 FOR CONSTANT E_s, PINNED

$E = 29{,}000{,}000$ PSI

$I = 904\ IN^4$ (STRONG AXIS)

$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 31.884^k/_{IN} = \frac{(0.707)(29{,}000{,}000\ PSI)(904\ IN^4)}{\left[\sqrt[4]{\frac{(29{,}000{,}000)(904)}{E_s}}\right]^3}$$

$= 31{,}884.06^{LB}/_{IN}$

SOLVING FOR E_s, W/EXCEL $\Rightarrow$ $E_s = 540.36\ PSI = \underline{0.5404\ KSI}$

LATERAL GROUP REDUCTION: HSDRS GUIDELINES SECTION 4.3

- PARALLEL TO LOADING, TRAILING PILES (NO "FLOOD SIDE" CONDITION HERE)

$R_g = 0.48(s_b/b)^{0.38}$, $s_b = 9'\text{-}3" = 111"$, $b = 14"$

$= 1.054 \Rightarrow$ NO REDUCTION NECESSARY

CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONSTANT E_s, UNSUPPORTED LENGTH (CONSERVATIVE)

$PCR = n\sqrt{E_s E I}$ WHERE $n = 1$ - PINNED

$= 1\sqrt{(0.5404\ KSI)(29{,}000\ KSI)(904\ IN^4)} = \underline{3763.8\ KIPS}$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: PILE PROPERTIES FOR STRUCTURAL CHECK | Computed by: LBR | Sheet ____ of ____
Checked by: ____ | Date: 7/2013 | Date: ____

Reference

*ALLOWABLE STRESSES: CPGA MANUAL PG 42-43; AISC 9TH ED PG 5-42:

ACC: IF $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

$E = 29{,}000\,KSI$
$F_y = 50\,KSI$
$A = 26.1\,IN^2$
$S.F. = 5/3 \times 6/5 = 2$

THEN $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

OTHERWISE $ACC = PCR / S.F.$

↳ $\sqrt{\frac{2\pi^2 \times 29{,}000\,KSI}{50\,KSI}} = 106.999$ ↳ $\sqrt{\frac{\pi^2 \times 29{,}000\,KSI \times 26.1\,IN^2}{3763.8^k}} = 44.55$

$\therefore ACC = \left[\frac{50\,KSI \times 26.1\,IN^2}{2}\right]\left[1 - \frac{50\,KSI \times 26.1\,IN^2}{4 \times 3763.8^k}\right] = \underline{\underline{595.94^k}}$

AT: $AT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,IN^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$

*COMBINED BENDING FACTOR: CPGA MANUAL P.32

$$COMP = \left[\frac{F3}{ACC} + \cancel{MF1} \times \left(\frac{M1}{AM1}\right) + \cancel{MF2} \times \left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

"NO TENSION FORCES", MF1 & MF2 ACCOUNT FOR PΔ - NONE PRESENT

*AXIAL LOAD FACTOR: CPGA MANUAL P.31

$ALF = \frac{F3}{AC} \times \frac{1}{OSF} \leq 1$, AC = ALLOWABLE COMPRESSION = $\underline{294^k}$

USACE SAFETY
AISC SAFETY

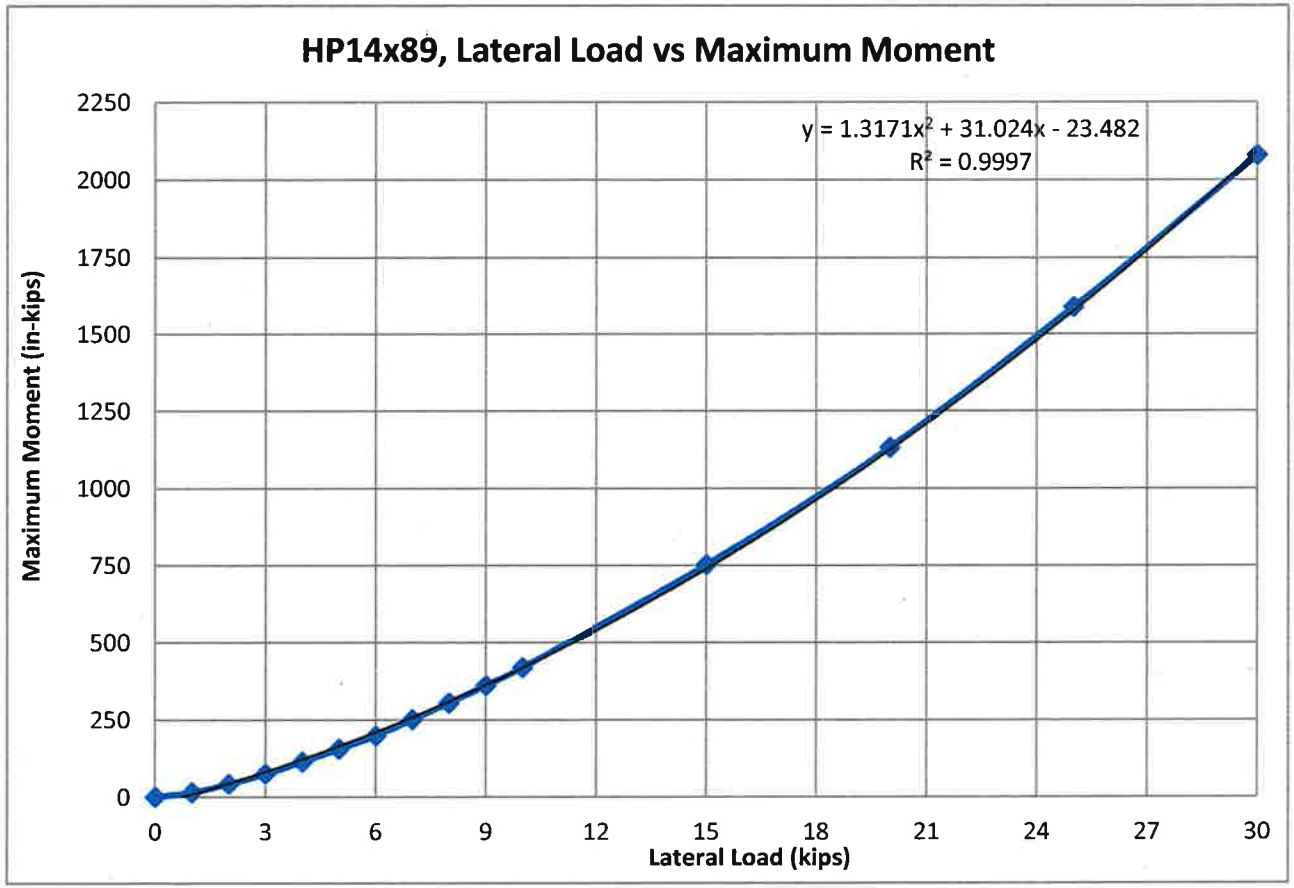
↳ $AM1 = S_x \cdot F_y \cdot = (131\,IN^3)(50\,KSI)(5/6)(2/3) = \underline{3638.9^{k \cdot IN}}$

↳ AM2 NOT NECESSARY FOR 2D.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	HP14x89 - Lateral Load vs. Maximum Moment	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	For Pile Structural Check	**Checked By:**		**Date:**		**Sheet:**	of

Applied Lateral Load (kips)	Maximum Moment (in-kips)
0	0
1	14.702
2	41.727
3	74.687
4	113.767
5	155.378
6	198.52
7	251.398
8	304.99
9	361.114
10	419.316
15	751.755
20	1131.07
25	1587.535
30	2079.189



Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load	Slenderness Parameters		Structural Check					Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety (5/3*6/5)	ACC = Allow. Axial Comp. Stress	ATT = Allow. Axial Tension Stress	AM1 = AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)				(kips)	(kips)	(kip-in)		Kips-in	Kips-in		
P-1	Dead	-1.99	0	166.60	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	652.50	3639	1	43.47	0.00	0.29	0.60
P-2	Dead	-1.56	0	128.89	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	28.12	0.00	0.22	0.46
P-3	Dead	0.00	0	119.90	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	-23.48	0.00	0.21	0.43
P-4	Dead	1.56	0	128.89	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	28.12	0.00	0.22	0.46
P-5	Dead	1.99	0	166.60	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	43.47	0.00	0.29	0.60
P-1	1a	-4.91	0	148.45	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	160.60	0.00	0.25	0.46
P-2	1a	-5.16	0	151.75	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	171.67	0.00	0.26	0.47
P-3	1a	-3.33	0	177.64	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	94.43	0.00	0.28	0.55
P-4	1a	-1.45	0	186.36	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	24.27	0.00	0.27	0.57
P-5	1a	-1.80	0	163.03	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	36.63	0.00	0.24	0.50
P-1	1b	-22.31	0	136.20	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1324.23	0.00	0.51	0.42
P-2	1b	-21.91	0	63.70	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1288.53	0.00	0.40	0.20
P-3	1b	-20.15	0	168.08	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1136.42	0.00	0.51	0.52
P-4	1b	-18.22	0	264.58	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	979.01	0.00	0.61	0.81
P-5	1b	-18.78	0	195.06	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1023.67	0.00	0.52	0.60
P-1	1c	1.72	0	178.42	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	33.78	0.00	0.26	0.55
P-2	1c	2.13	0	149.39	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	48.57	0.00	0.23	0.46
P-3	1c	3.74	0	119.92	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	110.97	0.00	0.20	0.37
P-4	1c	5.26	0	108.38	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	176.15	0.00	0.20	0.33
P-5	1c	5.70	0	154.77	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	196.15	0.00	0.27	0.48
P-1	2	-2.45	0	84.03	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	60.43	0.00	0.16	0.30
P-2	2	-2.42	0	76.31	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	59.31	0.00	0.14	0.27
P-3	2	-1.46	0	84.64	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	24.62	0.00	0.15	0.30
P-4	2	-0.47	0	91.18	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	-8.61	0.00	0.16	0.33
P-5	2	-0.51	0	89.45	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	-7.32	0.00	0.15	0.32
P-1	1a-ST	-6.61	0	255.32	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	239.13	0.00	0.42	0.78
P-2	1a-ST	-6.43	0	220.35	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	230.46	0.00	0.37	0.68
P-3	1a-ST	-3.66	0	235.40	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	107.71	0.00	0.36	0.72
P-4	1a-ST	-0.88	0	255.46	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	4.84	0.00	0.37	0.79
P-5	1a-ST	-0.87	0	263.94	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	4.51	0.00	0.38	0.81
P-1	1b-ST	-26.08	0	251.73	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1681.47	0.00	0.76	0.77
P-2	1b-ST	-25.09	0	125.44	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1584.04	0.00	0.55	0.39
P-3	1b-ST	-22.38	0	221.27	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1330.52	0.00	0.63	0.68
P-4	1b-ST	-19.71	0	329.65	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1099.67	0.00	0.73	1.01
P-5	1b-ST	-20.13	0	270.88	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1.17	1134.74	0.00	0.66	0.83
P-1	2-ST	-4.14	0	190.90	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	127.53	0.00	0.36	0.68
P-2	2-ST	-3.69	0	144.91	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	108.93	0.00	0.27	0.52
P-3	2-ST	-1.79	0	142.41	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	36.27	0.00	0.25	0.51
P-4	2-ST	-0.09	0	160.28	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	-20.68	0.00	0.27	0.57
P-5	2-ST	-0.42	0	190.36	50	26.10	904.0	326.0	131.0	44.3	29000	0.540	1	1	278.9	0.0	3764	107	45	2	596	653	3639	1	-10.22	0.00	0.32	0.68

$C_{ALLOW} = 294^k$ FOR VERTICAL PILE,
FOR 3V:1H BATTER, $294^k \times \frac{3}{\sqrt{3^2+1^2}} = \underline{278.9^k}$

NO COMBINED BENDING ISSUES DUE TO SETTLEMENT. OK

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	3.5	ft
Wall Thickness =	3.5	ft
Tributary Width =	12	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

TRADITIONAL (NO COHESION) CASES PRESENTED FIRST.

EM 1110-2-2104
EM 1110-2-2104
For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	42.71	3.56	1445.7	120.5	0.0	0.0
1a	565.79	47.15	2379.5	198.3	2750.9	229.2
1b	526.28	43.86	3339.9	278.3	1890.3	157.5
1c	68.30	5.69	1737.4	144.8	0.0	0.0
2	270.53	22.54	1384.7	115.4	1064.8	88.7

* Shear values taken at a distance 'd'= 37.37in from the face of the slab.
^ Moment values taken at faces of connections (where slab meets wall).

Max. Shear = 47.1 kip
Max. Moment = 278.3 kip-ft (controls exterior reinforcement)
Min. Moment = 229.2 kip-ft (controls interior reinforcement) ← CONTROLS OVER ST CASES

*** Reinforcing Limits:**

A_{gross} = 42in * 12in strip = 504 in^2
d = 42in - 4in cover - 1/2 bar diameter = 37.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 5.387 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 1.411 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * √(f'_c) * b * d) / f_y = 1.418 in^2 ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y = 1.495 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.387 in^2**	- half each face
	Min. T&S Rebar =	**1.411 in^2**	- half each face
	Min. Flexural Rebar =	**1.495 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = ϕ * 2 * √(f'_c) * b * d
= 0.85 * 2 * √4000 * 12in * 37.365in
= 48,209 lb

ϕVc = 48.2kip > Vu = 47.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#10 @ 6"** to start: As, #10 @ 6" = 2.5 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 2.54 * 60ksi / (0.85 * 4ksi * 12in) = 3.735 in

$\phi Mn =$ 0.9 * 2.54in² * 60ksi * (37.365in - 3.735in / 2)
= 4868.8 kip-in/ft
= 405.73 kip-ft/ft

ϕMn = 405.7kip-ft > Mu = 278.3kip-ft → Use #10 @ 6"

Interior Face:

* Will try **#8 @ 6"** to start: As, #8 @ 6" = 1.58 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.58 * 60ksi / (0.85 * 4ksi * 12in) = 2.324 in

$\phi Mn =$ 0.9 * 1.58in² * 60ksi * (37.365in - 2.324in / 2)
= 3088.9 kip-in/ft
= 257.41 kip-ft/ft

ϕMn = 257.4kip-ft > Mu = 229.2kip-ft → Use #8 @ 6"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
Dead	275.04	22.92	624.4	52.0	2029.4	169.1
1a	319.65	26.64	2942.6	245.2	468.9	39.1
1b	361.01	30.08	3873.4	322.8	1964.2	163.7
1c	252.32	21.03	1114.7	92.9	1745.6	145.5
2	190.65	15.89	1541.5	128.5	655.9	54.7

* Shear values taken at a distance 'd'= 37.37in from the face of the slab.

Max. Shear = 30.1 kip
Max. Moment = 322.8 kip-ft (controls bottom reinforcement)
Min. Moment = 169.1 kip-ft (controls top reinforcement)

*** Reinforcing Limits:** A_{gross} = 42in * 12in strip = 504 in^2
d = 42in - 4in cover - 1/2 bar diameter = 37.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross} =$ 5.387 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 1.411 in^2 — EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 1.418 in^2 — ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.495 in^2 — ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.387 in^2**	- half each face
	Min. T&S Rebar =	**1.411 in^2**	- half each face
	Min. Flexural Rebar =	**1.495 in^2**	- per face

* Section Design:

Shear:

Shear Capacity $(\phi V_c) = \phi * 2 * \sqrt{f'_c} * b * d$

$= 0.85 * 2 * \sqrt{4000} * 12in * 37.365in$

$= 48{,}209$ lb

ϕVc = 48.2kip > Vu = 30.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try **#10 @ 6"** to start: As, #10 @ 6" = 2.54 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 2.54 * 60ksi / (0.85 * 4ksi * 12in) = 3.735 in

$\phi Mn = 0.9 * 2.54in^2 * 60ksi * (37.365in - 3.735in / 2)$

= 4868.8 kip-in/ft

= 405.73 kip-ft/ft

ϕMn = 405.7kip-ft > Mu = 322.8kip-ft → Use #10 @ 6"

Top Face:

* Will try **#8 @ 6"** to start: As, #8 @ 6" = 1.58 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1.58 * 60ksi / (0.85 * 4ksi * 12in) = 2.324 in

$\phi Mn = 0.9 * 1.58in^2 * 60ksi * (37.365in - 2.324in / 2)$

= 3088.9 kip-in/ft

= 257.41 kip-ft/ft

ϕMn = 257.4kip-ft > Mu = 169.1kip-ft → Use #8 @ 6"

* SECONDARY REINF. MAY BE TEMP & SHRINKAGE MINIMUM.

↳ FOR 3'-6" SECTIONS, T&S MIN = 0.706 in^2 PER FACE

⇒ USE #8 @ 12" (A_s = 0.79 in^2)

In the exterior faces of the walls, the controlling moments occur at the bottoms of the walls (where slab meets wall). It is possible to reduce the amount of exterior reinforcing in the top of the walls because of the significant reduction in moment in this region.

* Determine the capacity of #10 @ 12" (transition from #10 @ 6" to #10 @ 12" in exterior face):

* Will try #10 @ 12" to start: As, #10 @ 12" = 1.27 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.27 * 60ksi / (0.85 * 4ksi * 12in) = 1.868 in

$\phi Mn =$ 0.9 * 1.27in^2 * 60ksi * (37.365in - 1.868in / 2)
= 2498.45 kip-in/ft
$\phi Mn =$ 208.20 kip-ft/ft

$\phi Mn =$ 2498.45 kip-ft per 12ft strip

* See the moment diagrams in the attached SAP results for a breakdown of moments along the length of the walls & the areas in which the moment is less than the capacity of #10 @ 12" bars.

* The controlling distance is found in LC 1b: the #10 @ 6" reinforcing must be continued approximately 2'-2" from the top face of the slab before it may be reduced to #10 @ 12".

* The required embedment length of a #10 bar spaced 6" o.c. is 59". This means that the terminating #10 bars must extend a minimum of 7'-1" from the top face of the slab.

*** Strut Beam:**

Load Case	Max. Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
Dead	21.71	93.85	122.02
1a	20.24	29.45	185.11
1b	25.83	68.61	268.64
1c	21.06	82.90	148.63
2	13.41	31.76	107.45

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

Max. Shear = 25.8 kip
Max. Moment = 93.9 kip-ft (controls bottom reinforcement)
Min. Moment = 268.6 kip-ft (controls top reinforcement)

CONTROLS OVER ST CASES

b = 24 in h = 24 in

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in #10 bar assumed

Shear:

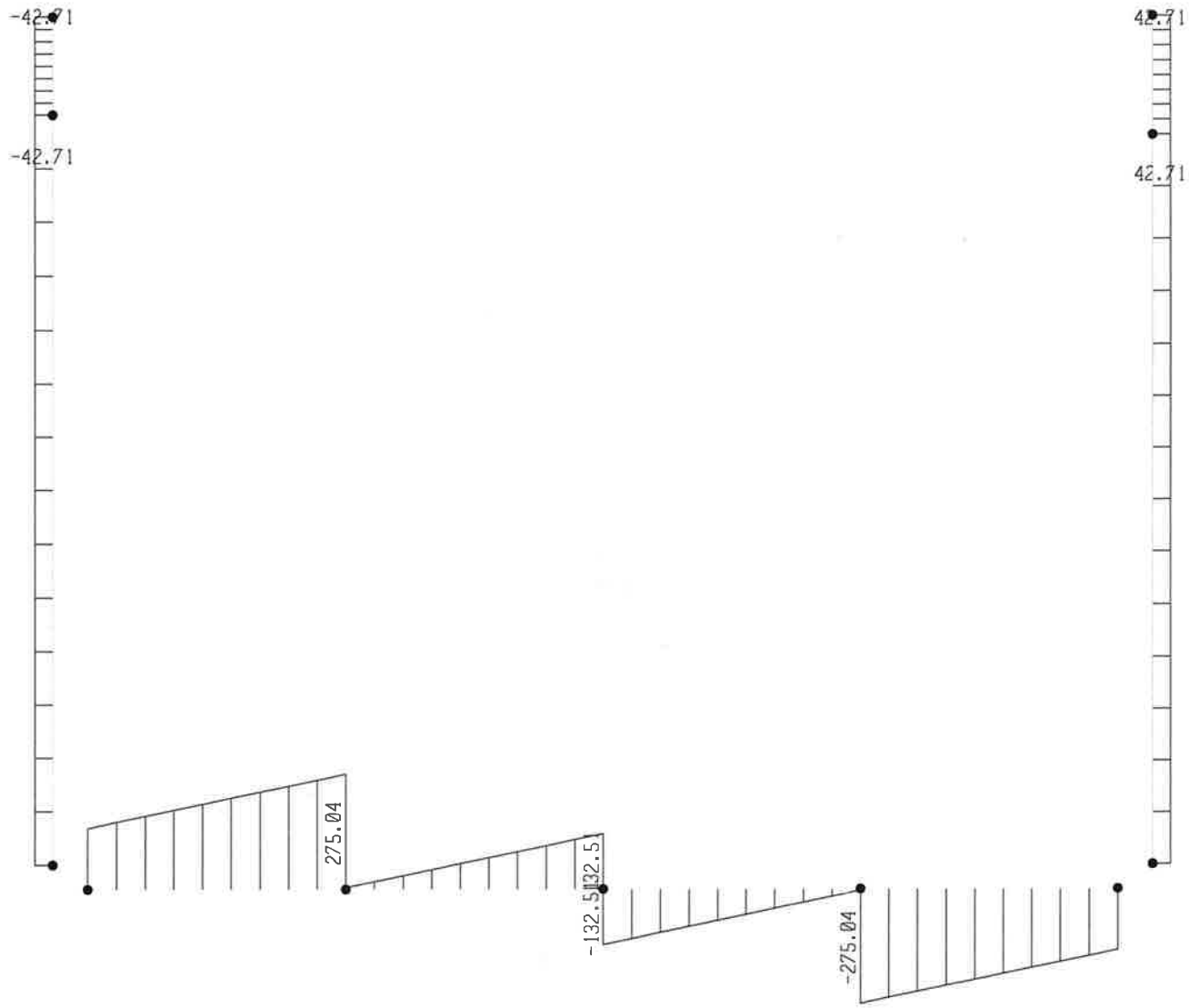
Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$
= 0.85 * 2 * √4000 * 24in * 19.365in
= 49,970 lb

ϕVc = 50kip > Vu = 25.8kip → Section OK

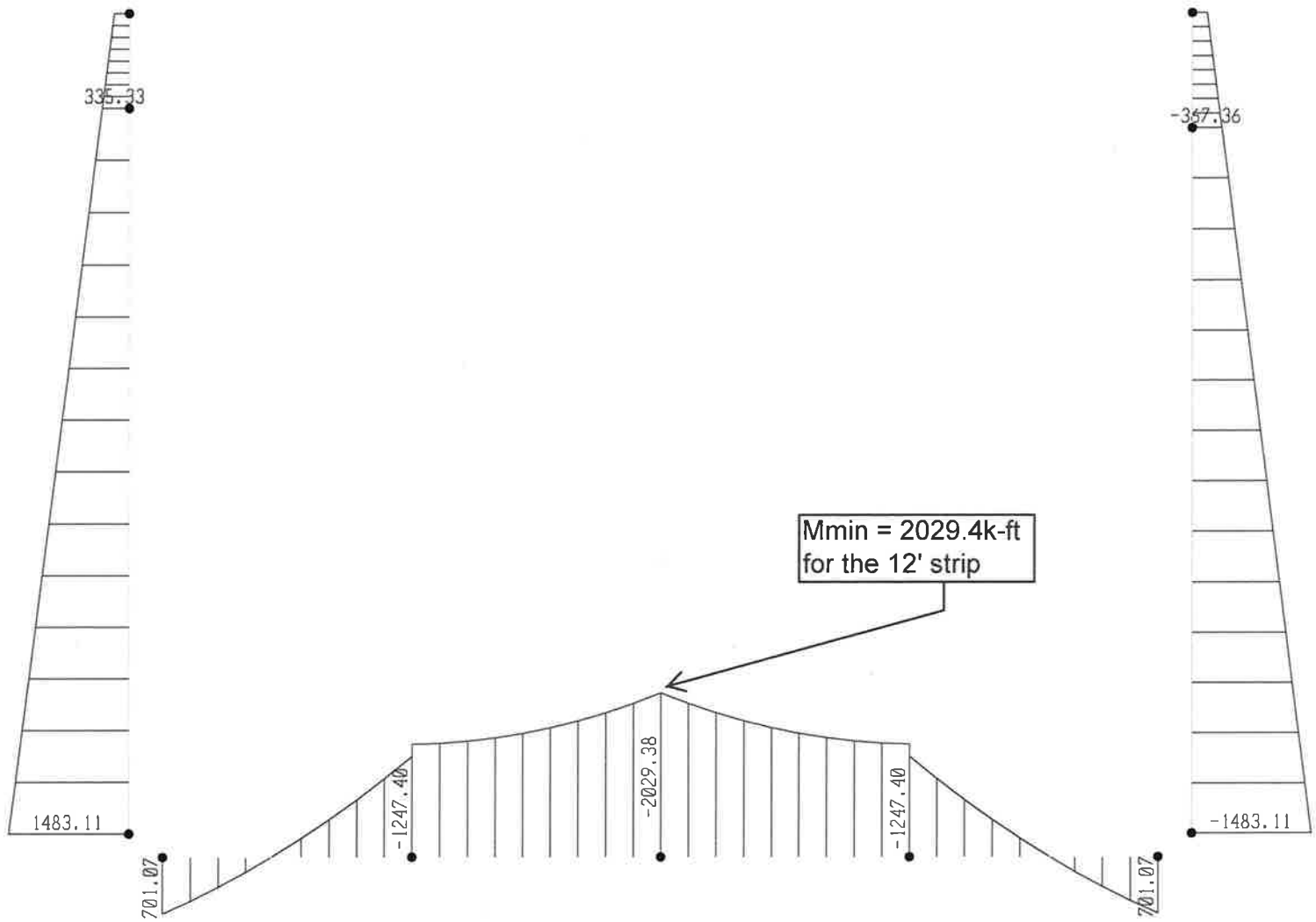
Moment:

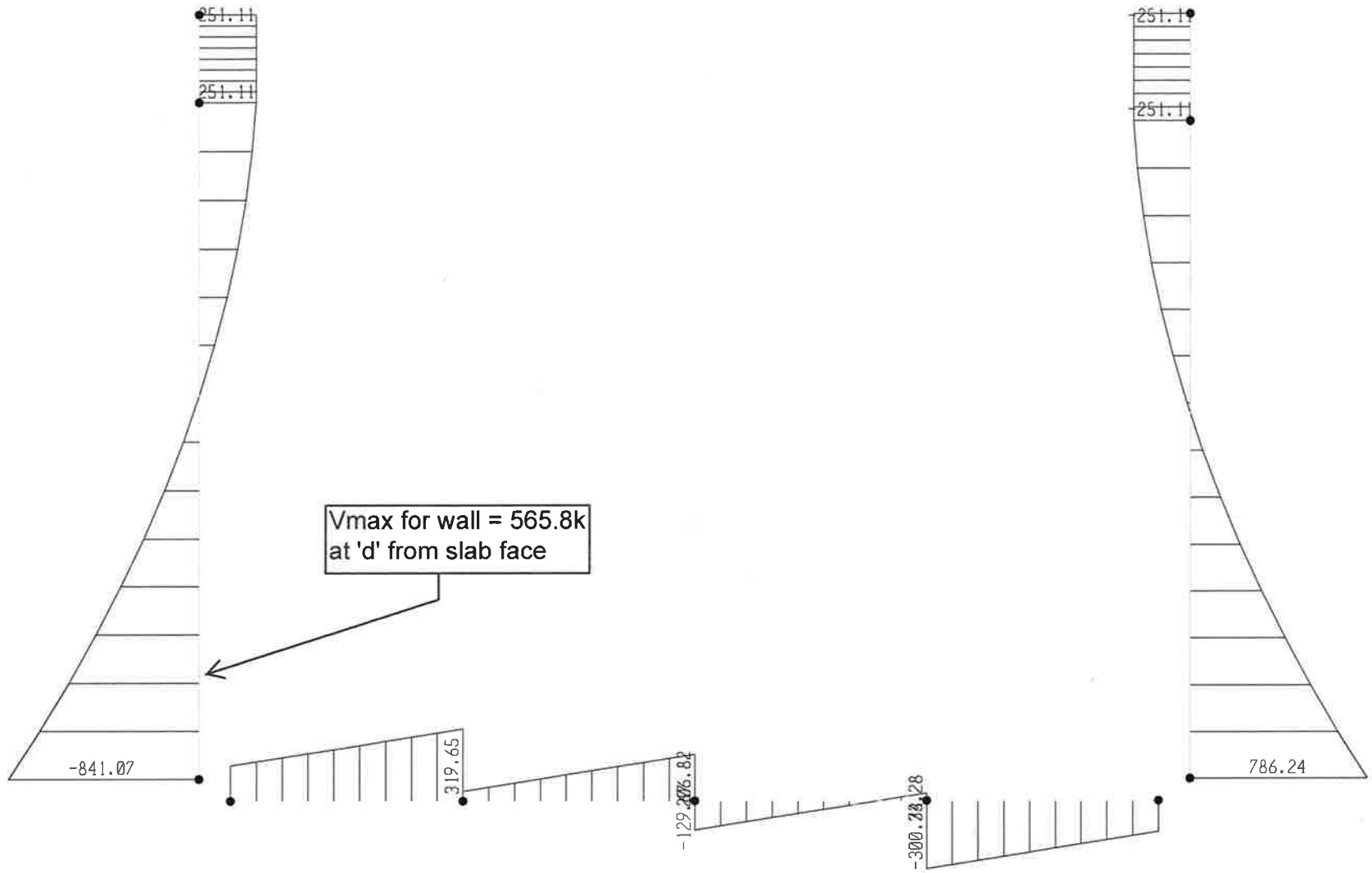
Moment reinforcing & other beam calculations follow the SAP result images.

* SAP results are shown on the following 15 pages. The wall & slab moments & shears are presented first, followed by the strut beam shear & moments. Please note that the wall shear & moments shown are for a 12' wide tributary width.

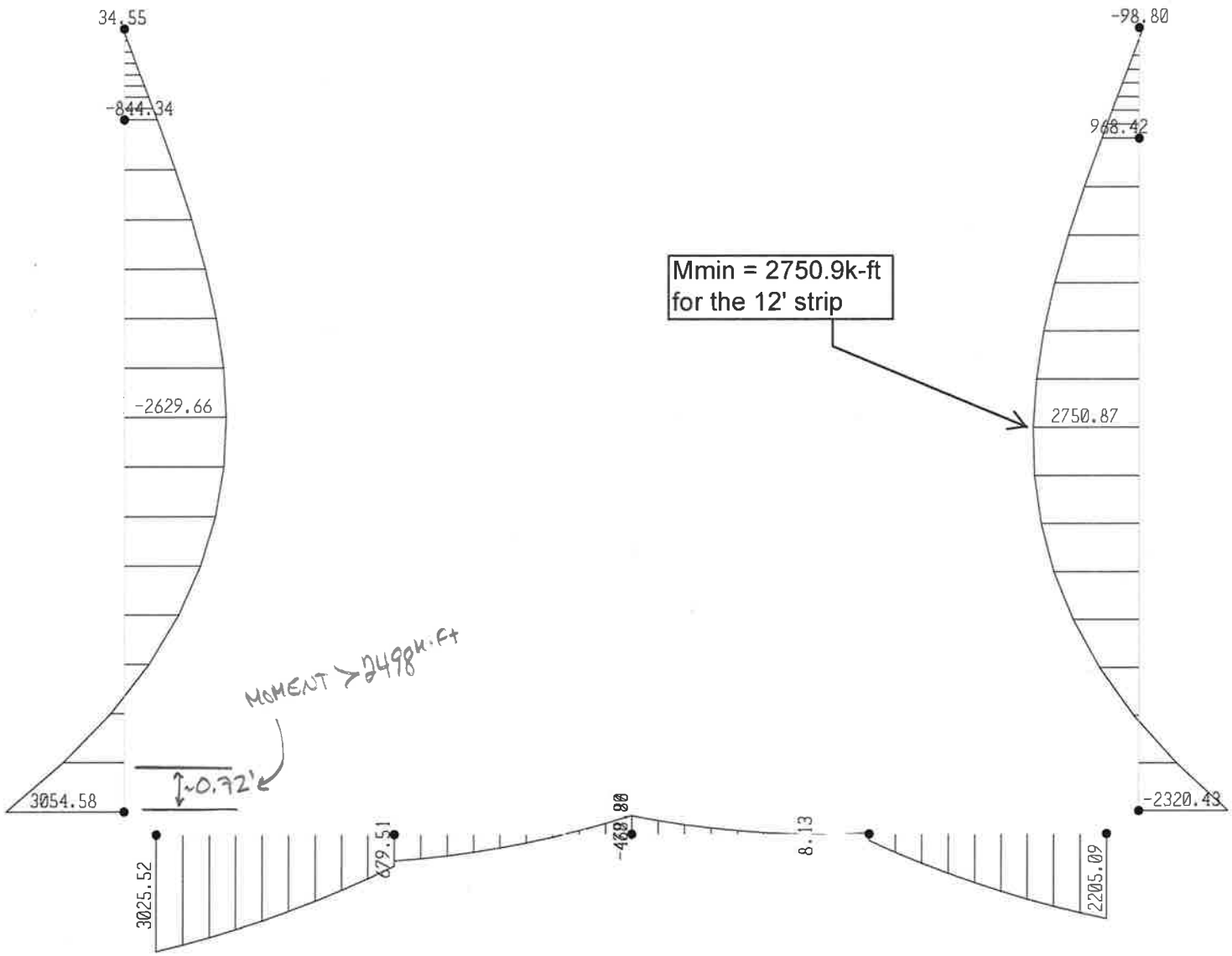


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C dead) - Kip, ft, F Units

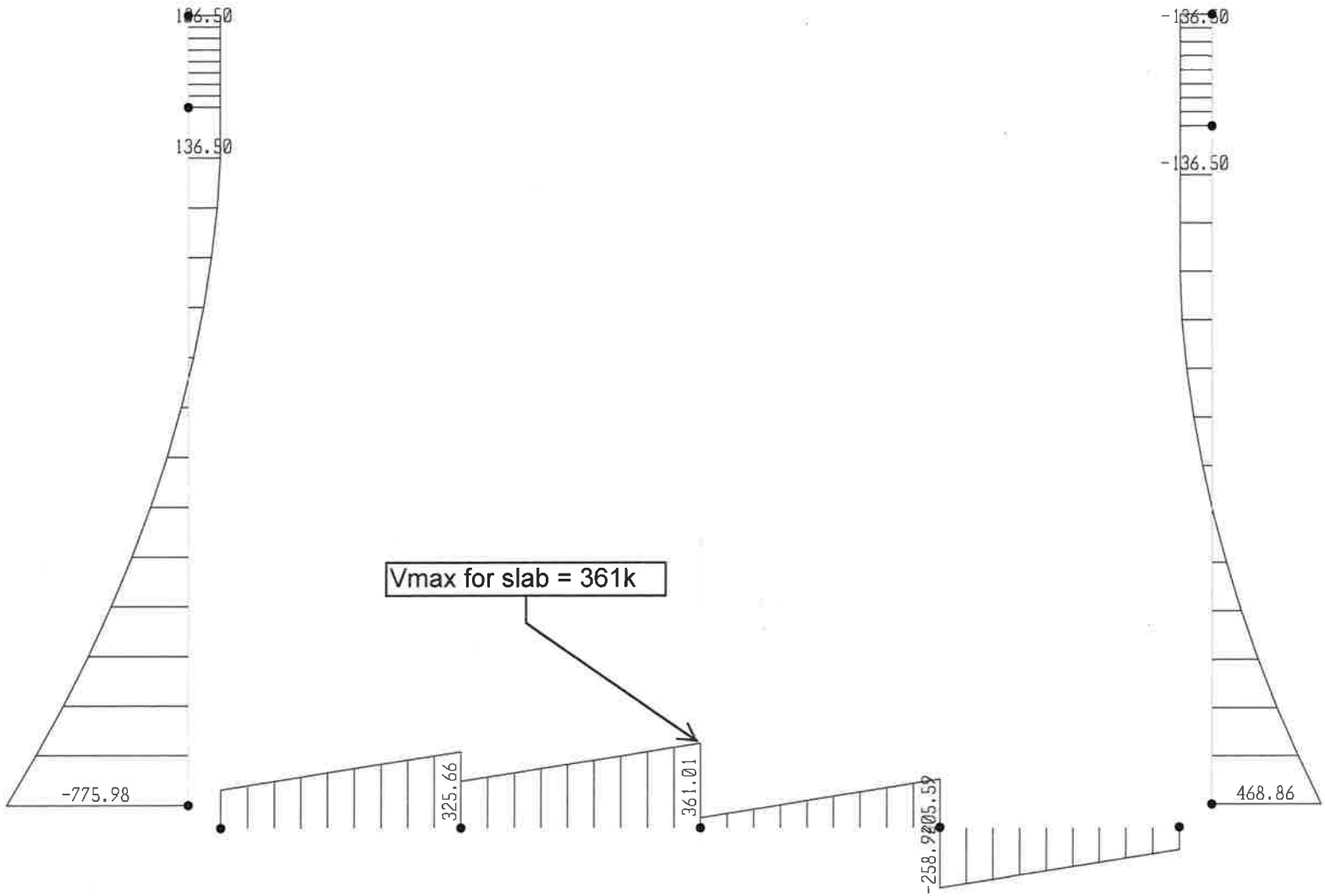

335.33
1483.11
-367.36
-1483.11
Mmin = 2029.4k-ft
for the 12' strip
-1247.40
-2029.38
-1247.40
701.07
701.07



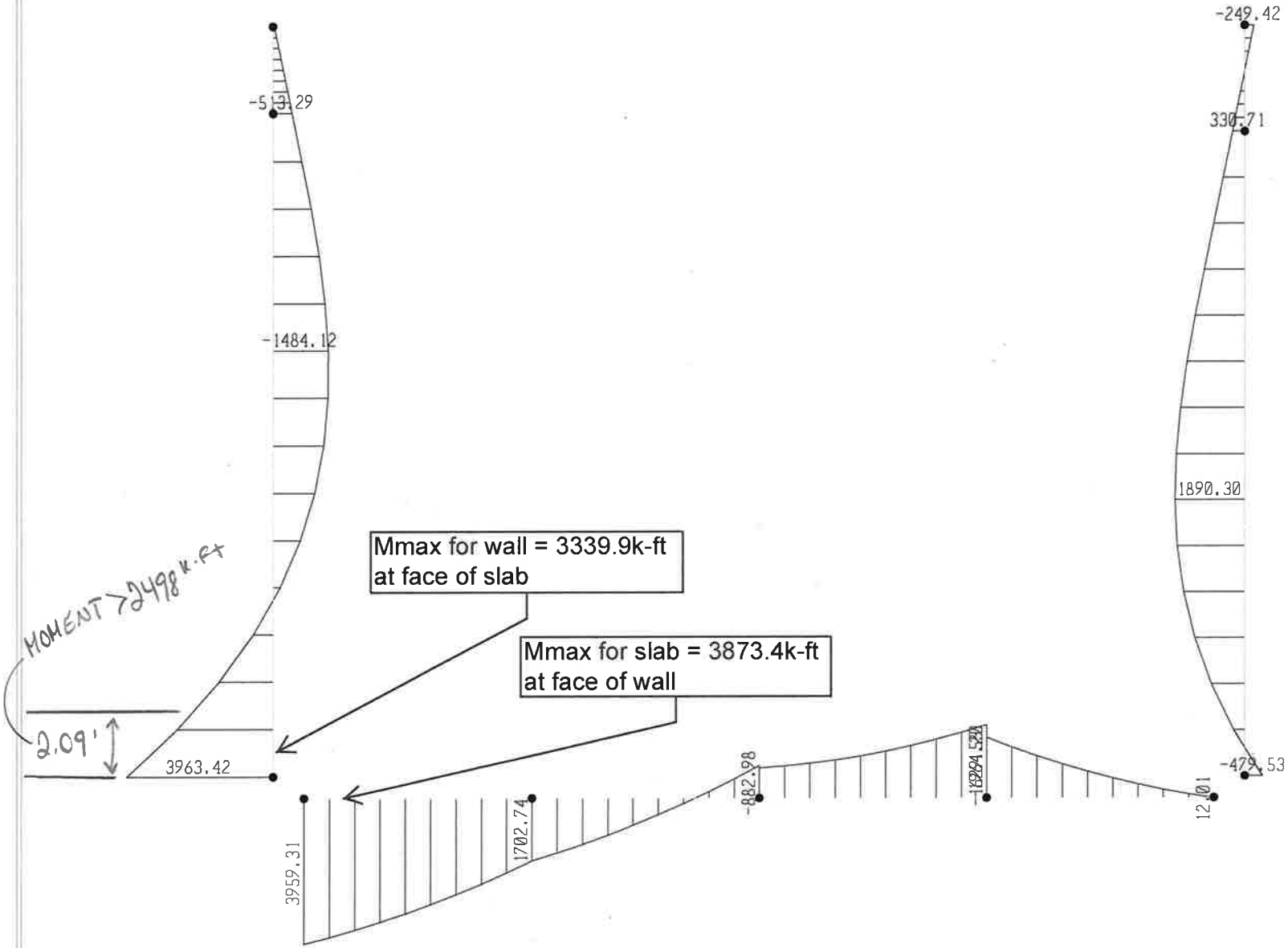
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1a) - Kip, ft, F Units



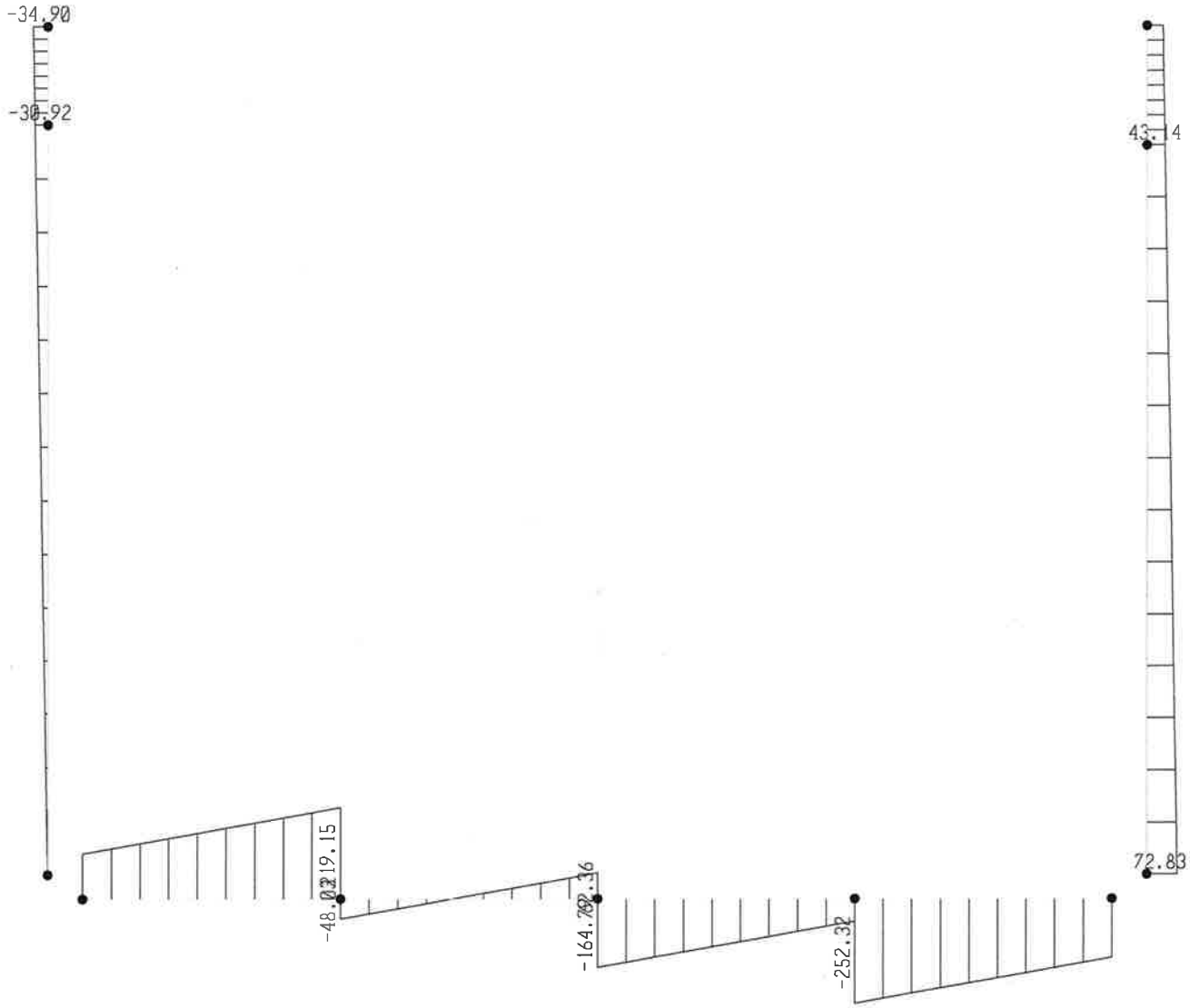
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1a) - Kip, ft, F Units



SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1b) - Kip, ft, F Units

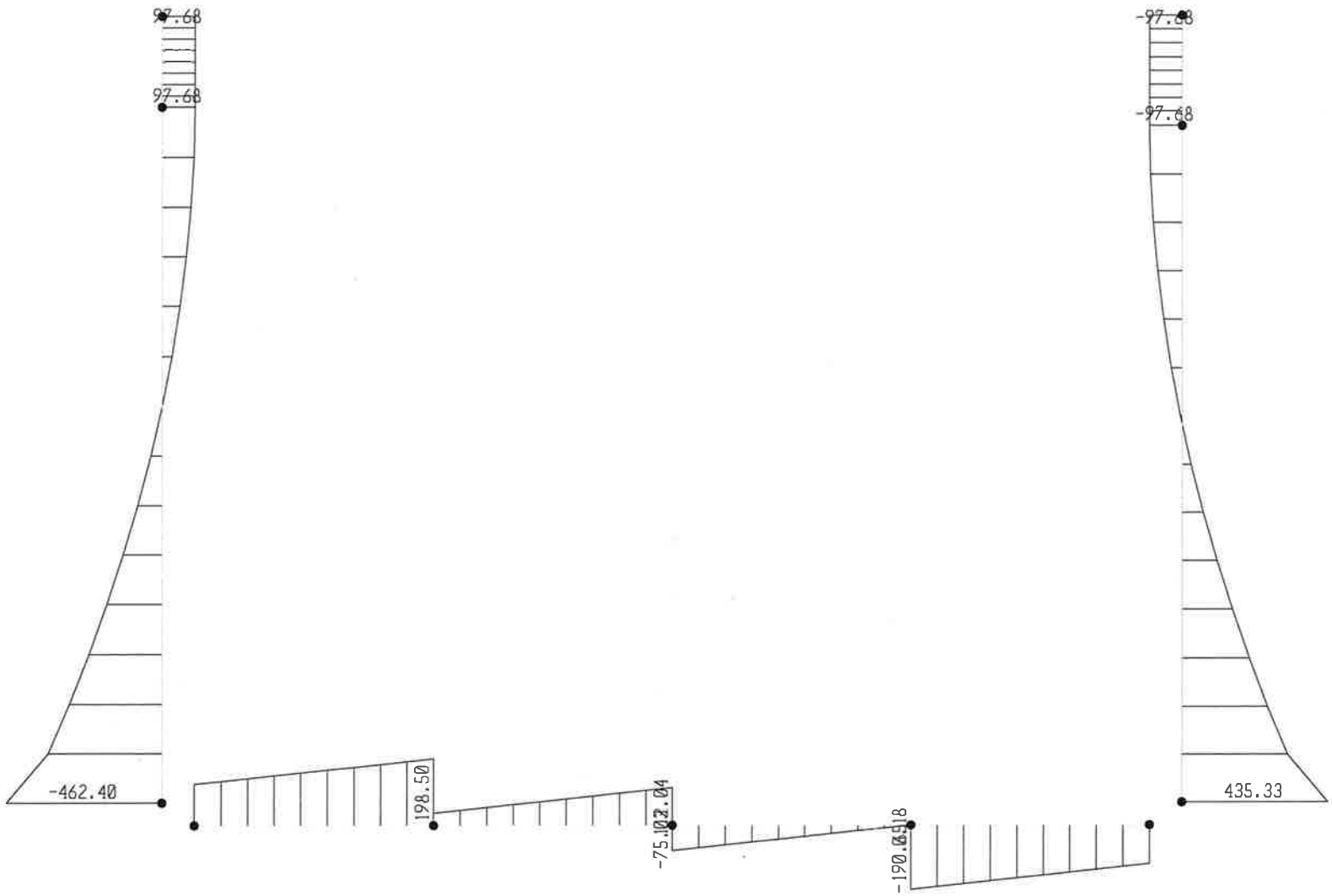


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1b) - Kip, ft, F Units

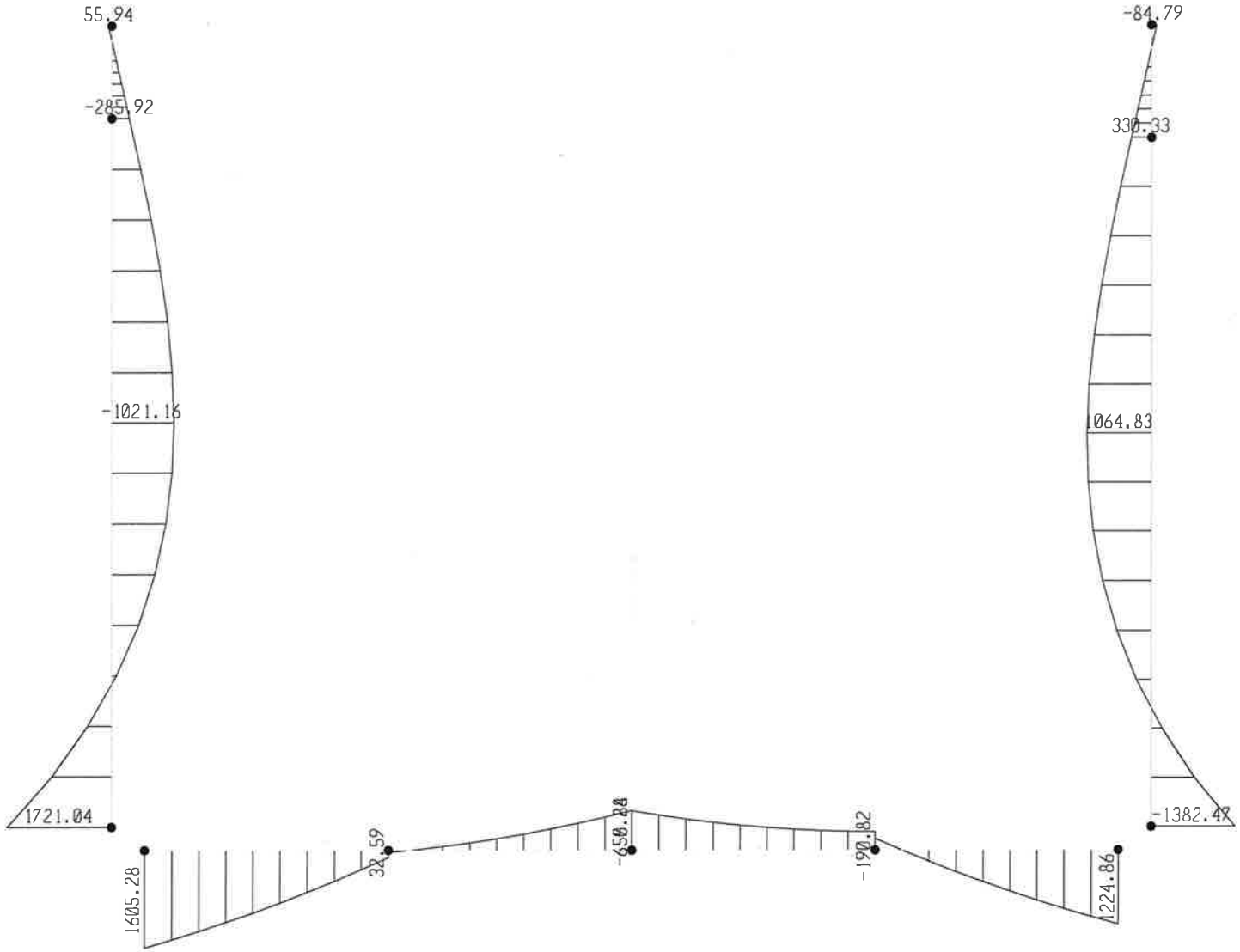


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1c) - Kip, ft, F Units

SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1c) - Kip, ft, F Units

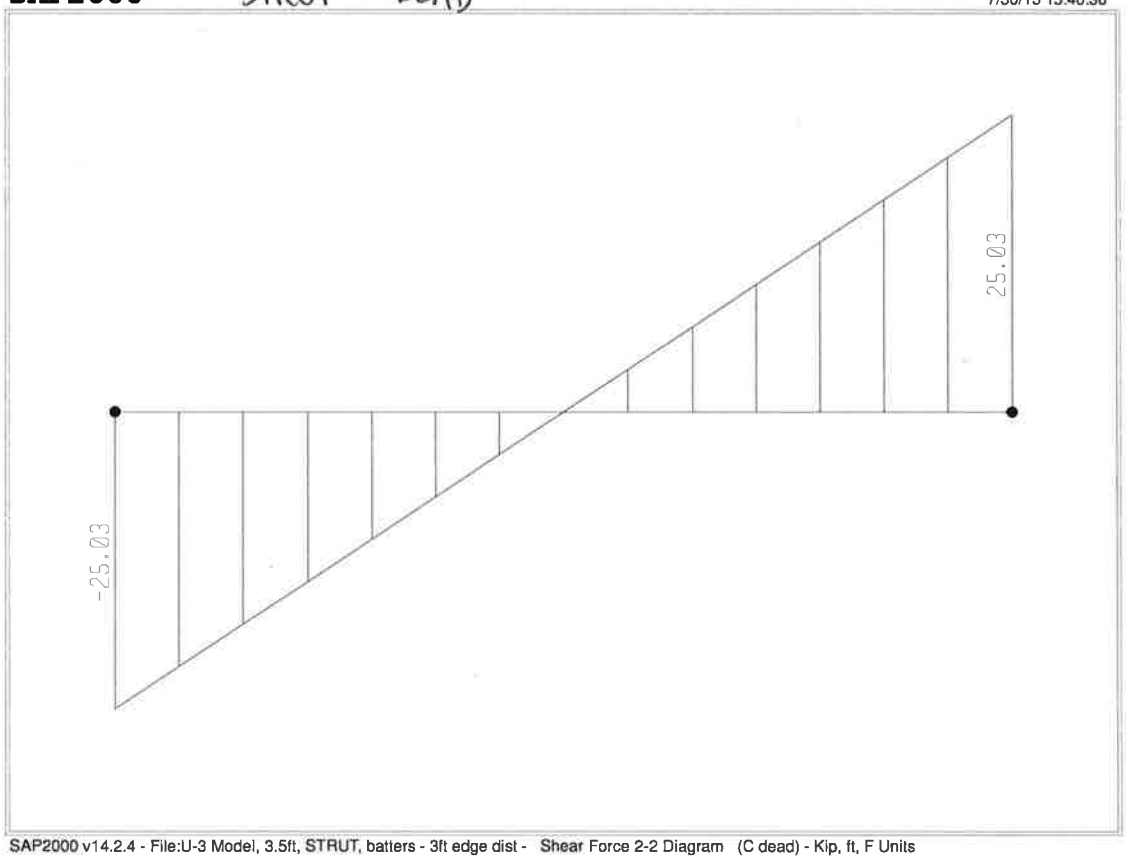


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 2) - Kip, ft, F Units



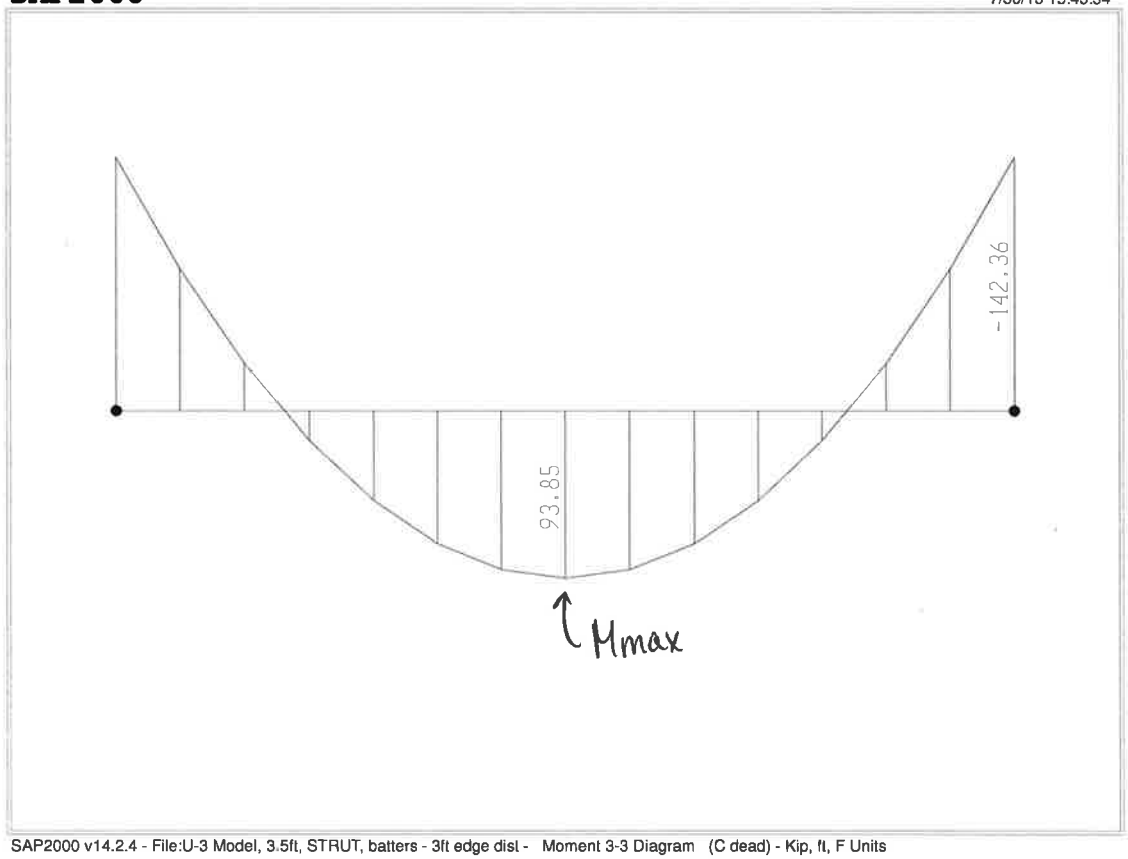
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 2) - Kip, ft, F Units

SAP2000 STRUT – DEAD 7/30/13 15:40:36



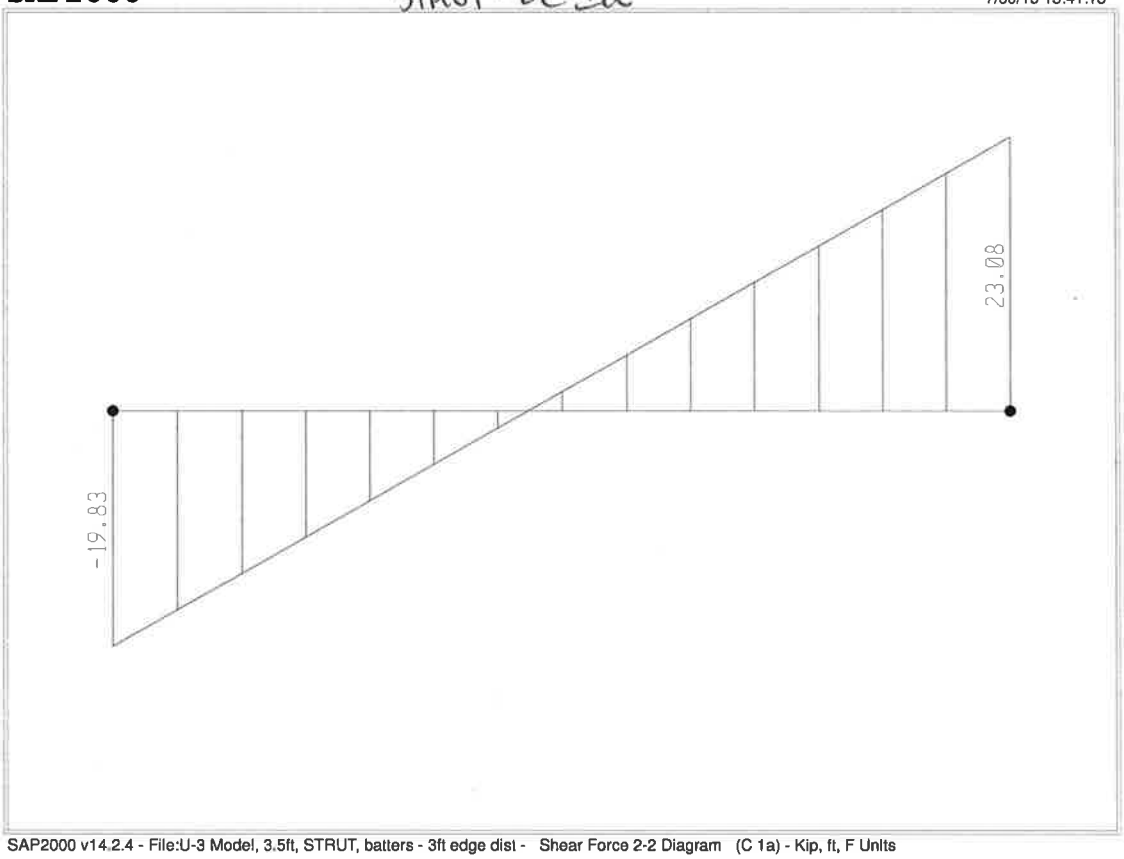
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C dead) - Kip, ft, F Units

SAP2000 7/30/13 15:43:34



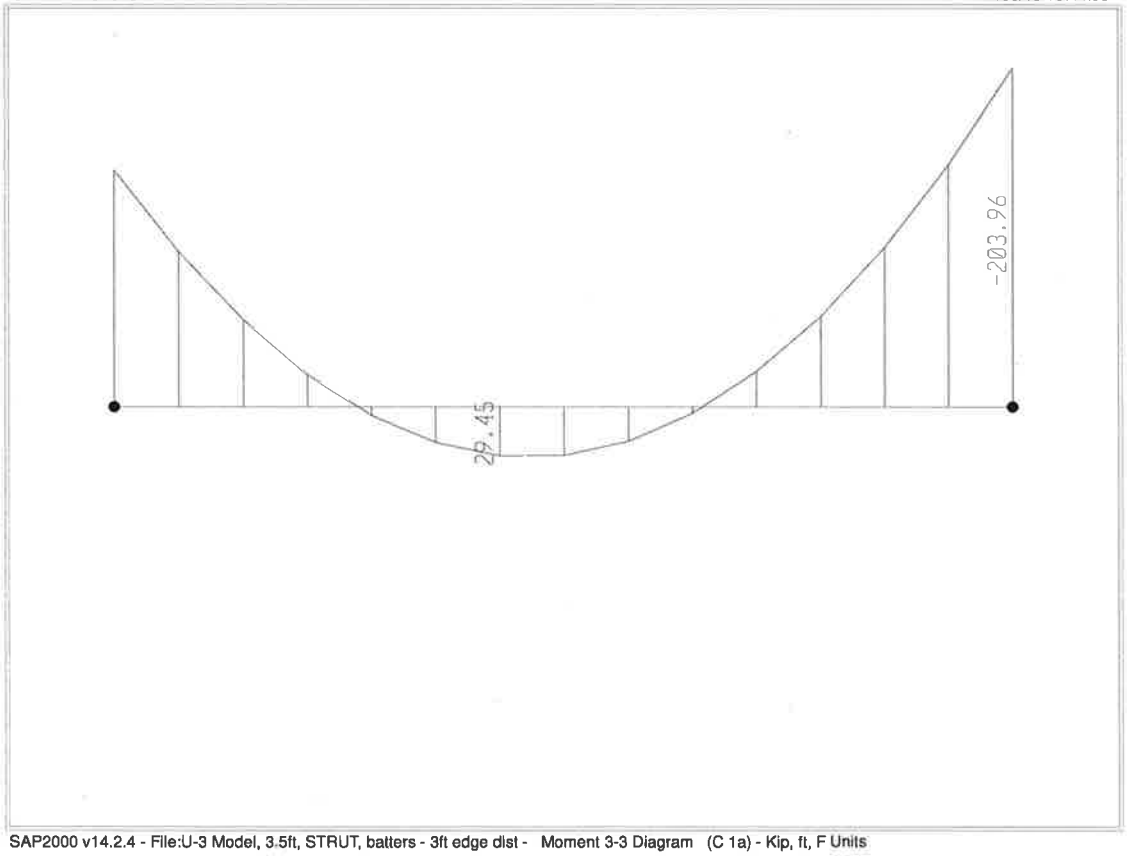
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C dead) - Kip, ft, F Units

SAP2000 STRUT - LC 1a 7/30/13 15:41:18



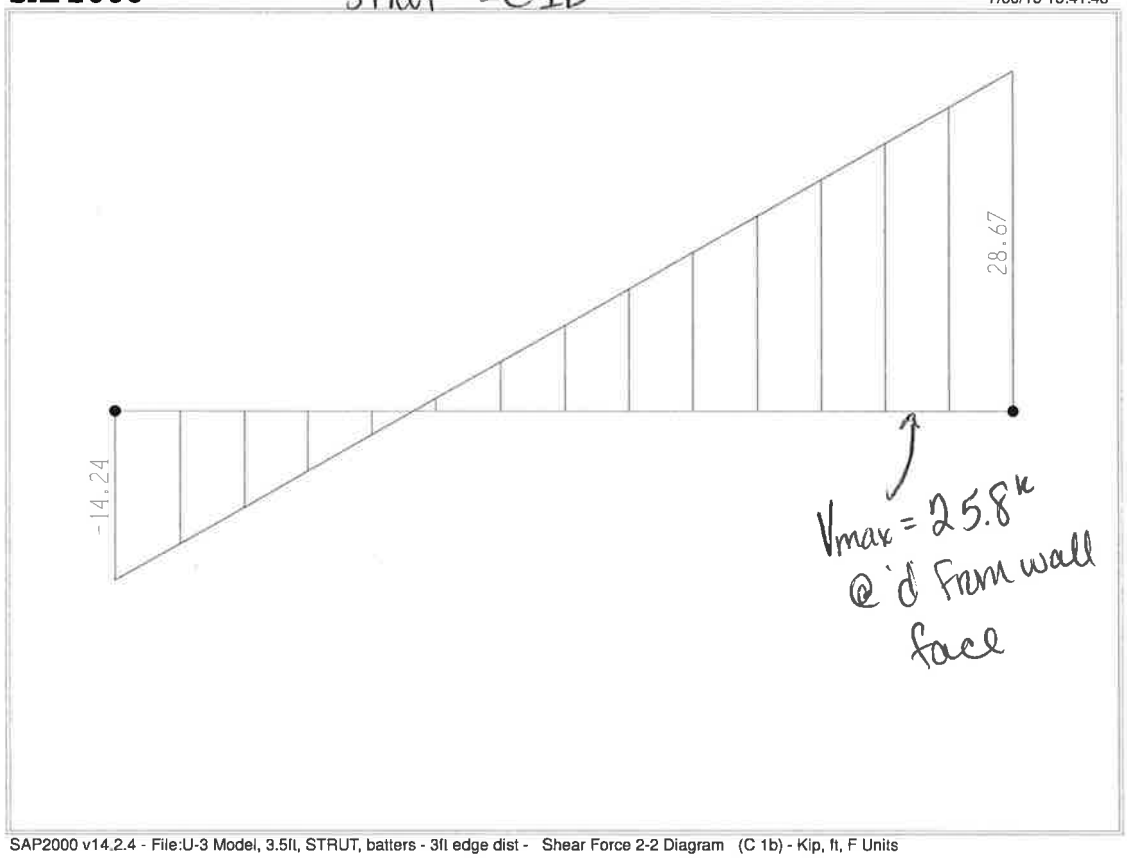
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1a) - Kip, ft, F Units

SAP2000 7/30/13 15:44:08



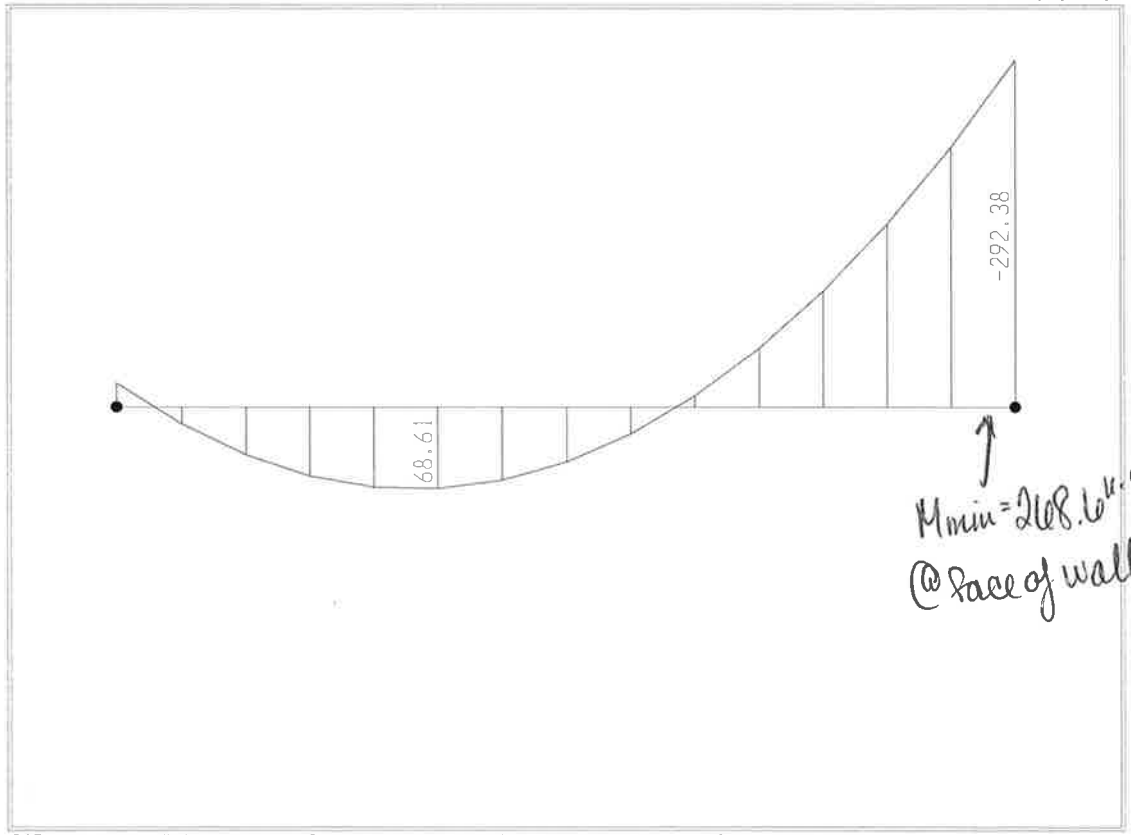
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1a) - Kip, ft, F Units

SAP2000 STRUT - LC 1b 7/30/13 15:41:43



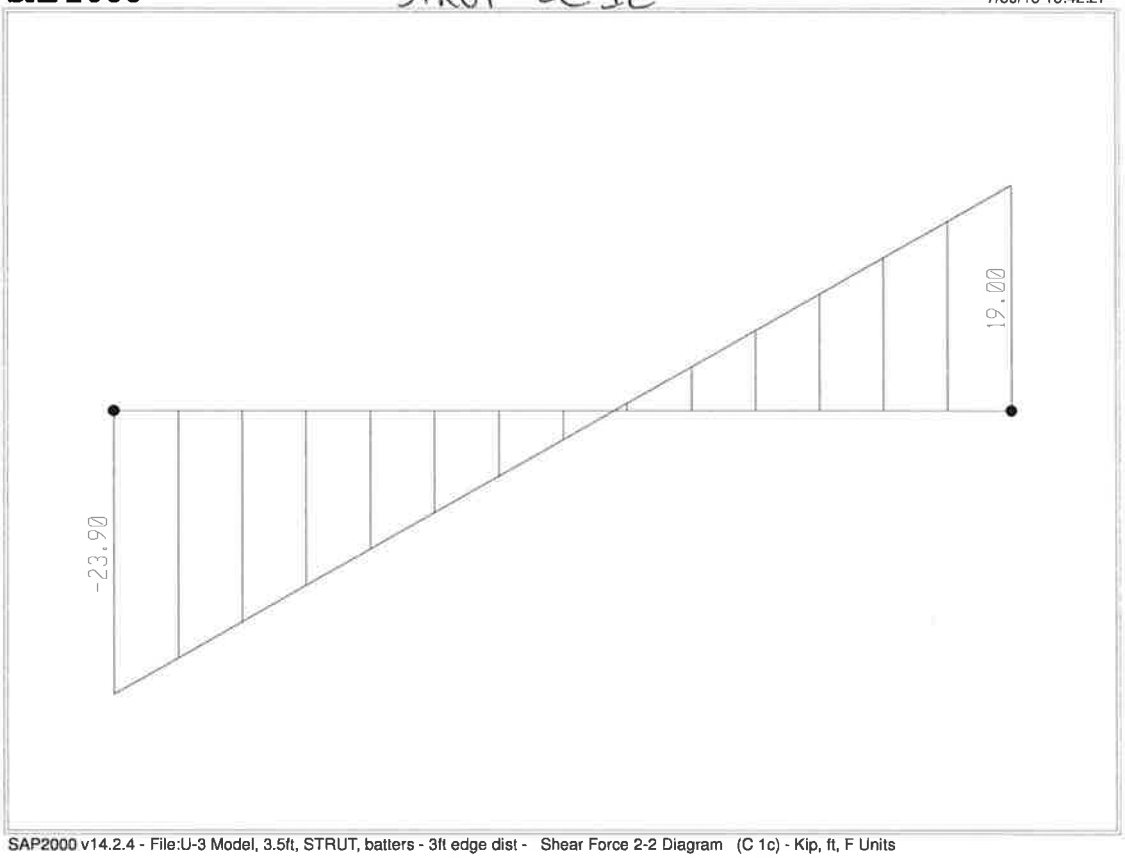
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1b) - Kip, ft, F Units

SAP2000 7/30/13 15:44:45



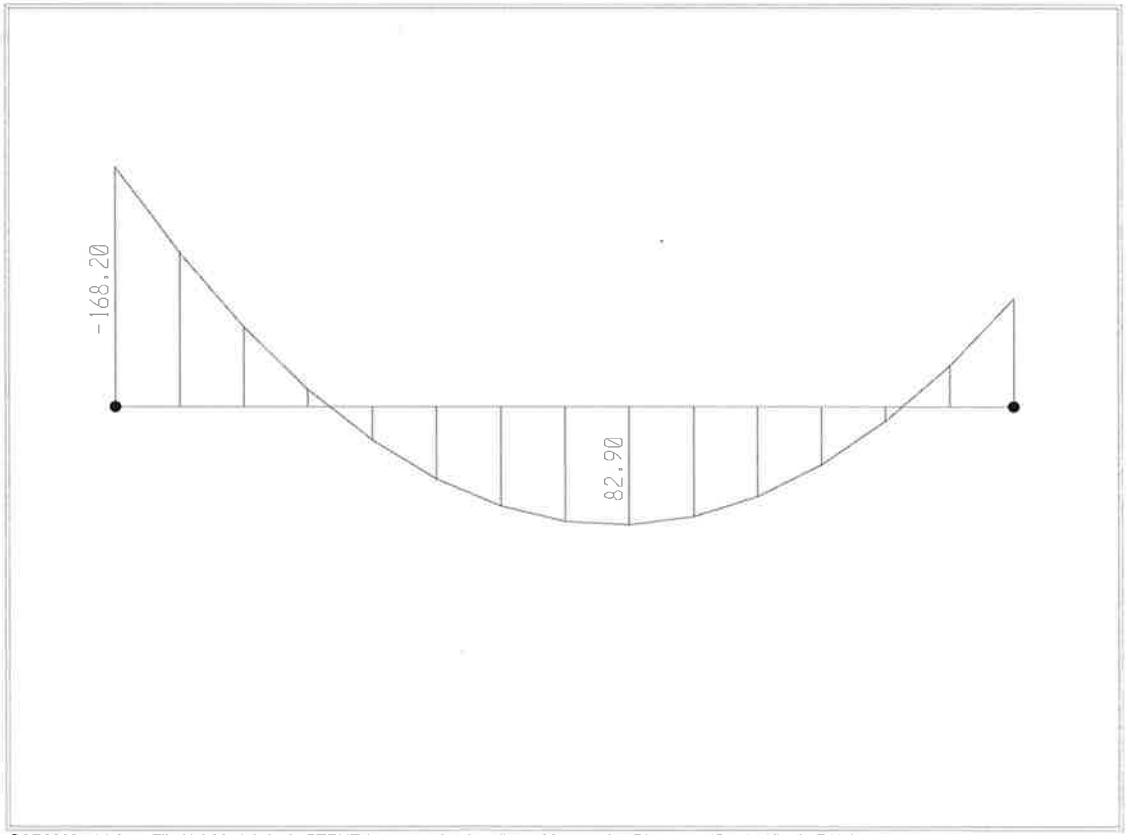
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1b) - Kip, ft, F Units

SAP2000 STRUT LC 1c 7/30/13 15:42:27



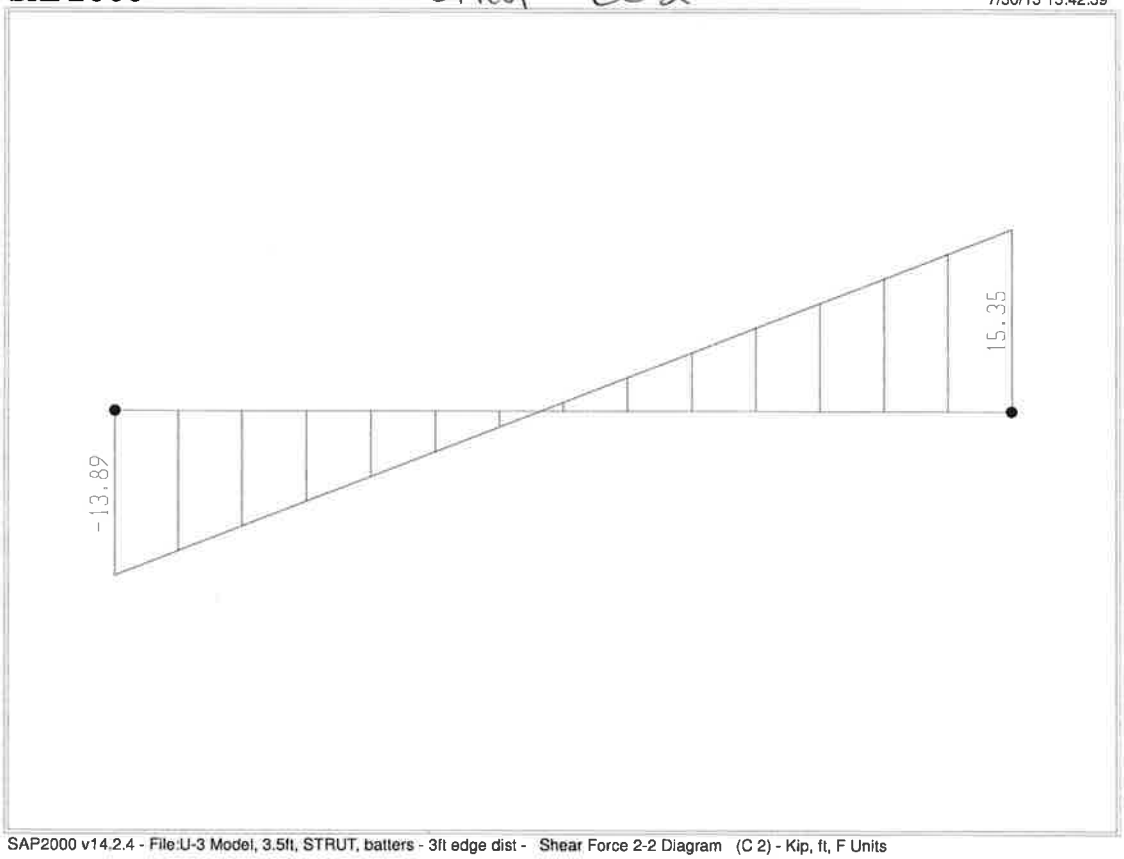
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1c) - Kip, ft, F Units

SAP2000 7/30/13 15:45:55



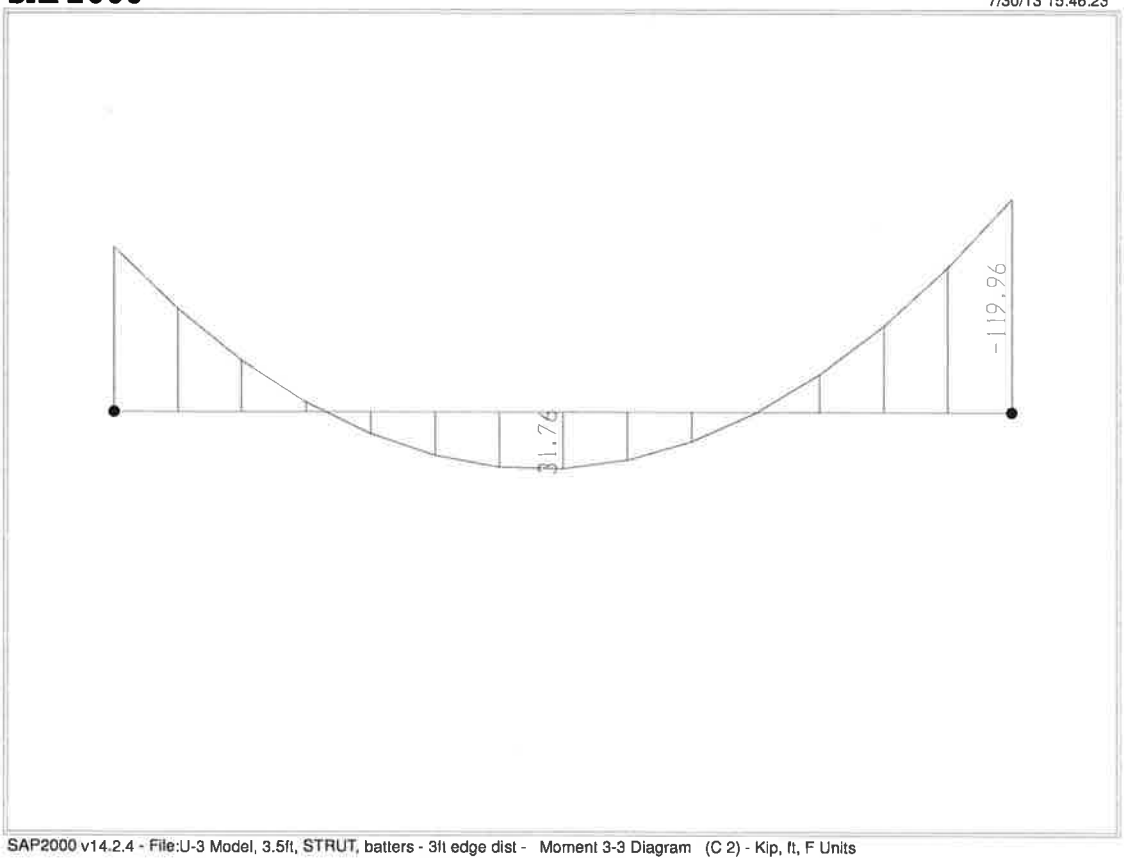
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1c) - Kip, ft, F Units

SAP2000 STRUT LC 2 7/30/13 15:42:39



SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 2) - Kip, ft, F Units

SAP2000 7/30/13 15:46:23



SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 2) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-3 Model	**Computed By:**	LBR	**Date:**	Jul-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	3.5	ft
Wall Thickness =	3.5	ft
Tributary Width =	12	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

SETTLEMENT CASES ONLY

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment^ (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment^ (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	605.87	50.49	3572.3	297.7	2121.9	176.8
1b-ST	563.20	46.93	4439.5	370.0	1210.0	100.8
2-ST	317.30	26.44	2776.4	231.4	388.7	32.4

** SEE NOTE BELOW

* Shear values taken at a distance 'd'= 37.37in from the face of the slab.

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

Max. Shear = 50.5 kip

Max. Moment = 370.0 kip-ft (controls exterior reinforcement) ← CONTROLS

Min. Moment = 176.8 kip-ft (controls interior reinforcement)

*** Reinforcing Limits:**

A_{gross} = 42in * 12in strip = 504 in^2

d = 42in - 4in cover - 1/2 bar diameter = 37.37 in — #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 5.387 in^2

Limits of Minimum Reinforcement:

$0.0028 \times A_{gross}$ =	1.411 in^2	EM 1110-2-2104, 2-8a, temp. & shrinkage
$(3 * \sqrt{f'_c} * b * d) / f_y$ =	1.418 in^2	ACI 318-02, 10.5, flexural member min.
$(200 * b * d) / f_y$ =	1.495 in^2	ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.387 in^2**	- half each face
	Min. T&S Rebar =	**1.411 in^2**	- half each face
	Min. Flexural Rebar =	**1.495 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 37.365in

= 48,209 lb

ϕVc = 48.2kip < Vu = 50.5kip → Section NOT OK

NOTE: The shear force from LC 1a-ST is 4.75% higher than the allowable shear capacity of the section. Considering the conservative nature of the model, the large surchage & settlement forces included, and the application of hydraulic & safety factors, we believe this slight overstress is allowable.

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Exterior Face:

* Will try **#10 @ 6"** to start: As, #10 @ 6" = 2.54 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 2.54 * 60ksi / (0.85 * 4ksi * 12in) = 3.735 in

$\phi Mn =$ 0.9 * 2.54in^2 * 60ksi * (37.365in - 3.735in / 2)
= 4868.8 kip-in/ft
= 405.73 kip-ft/ft

ϕMn = 405.7kip-ft > Mu = 370kip-ft → Use #10 @ 6"

Interior Face:

* Will try **#8 @ 6"** to start: As, #8 @ 6" = 1.6 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.58 * 60ksi / (0.85 * 4ksi * 12in) = 2.324 in

$\phi Mn =$ 0.9 * 1.58in^2 * 60ksi * (37.365in - 2.324in / 2)
= 3088.9 kip-in/ft
= 257.41 kip-ft/ft

ϕMn = 257.4kip-ft > Mu = 176.8kip-ft → Use #8 @ 6"

*** Slab:**

Load Case	Max. Shear* (kip)	Shear / Trib. Width (kip/ft)	Maximum Moment (kip-ft)	Max. Moment / Trib. Width (kip-ft/ft)	Minimum Moment (kip-ft)	Min. Moment / Trib. Width (kip-ft/ft)
1a-ST	498.18	41.52	3545.2	295.4	2011.4	167.6
1b-ST	487.44	40.62	4382.9	365.2	2891.1	240.9
2-ST	406.79	33.90	2244.5	187.0	2442.8	203.6

* Shear values taken at a distance 'd'= 37.37in from the face of the slab.

Max. Shear = 41.5 kip
Max. Moment = 365.2 kip-ft (controls bottom reinforcement) ← CONTROLS
Min. Moment = 240.9 kip-ft (controls top reinforcement) ←

*** Reinforcing Limits:** A_{gross} = 42in * 12in strip = 504 in^2
d = 42in - 4in cover - 1/2 bar diameter = 37.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 5.387 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 1.411 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 1.418 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.495 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**5.387 in^2**	- half each face
	Min. T&S Rebar =	**1.411 in^2**	- half each face
	Min. Flexural Rebar =	**1.495 in^2**	- per face

* Section Design:

Shear:

Shear Capacity $(\phi V_c) = \phi * 2 * \sqrt{f'_c} * b * d$

$= 0.85 * 2 * \sqrt{4000} * 12in * 37.365in$

$= 48{,}209$ lb

ϕVc = 48.2kip > Vu = 41.5kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Bottom Face:

* Will try **#10 @ 6"** to start: As, #10 @ 6" = 2.54 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 2.54 * 60ksi / (0.85 * 4ksi * 12in) = 3.735 in

$\phi Mn = 0.9 * 2.54in^2 * 60ksi * (37.365in - 3.735in / 2)$

= 4868.8 kip-in/ft

= 405.73 kip-ft/ft

ϕMn = 405.7kip-ft > Mu = 365.2kip-ft → Use #10 @ 6"

Top Face:

* Will try **#8 @ 6"** to start: As, #8 @ 6" = 1.6 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1.58 * 60ksi / (0.85 * 4ksi * 12in) = 2.324 in

$\phi Mn = 0.9 * 1.58in^2 * 60ksi * (37.365in - 2.324in / 2)$

= 3088.9 kip-in/ft

= 257.41 kip-ft/ft

ϕMn = 257.4kip-ft > Mu = 240.9kip-ft → Use #8 @ 6"

In the exterior faces of the walls, the controlling moments occur at the bottoms of the walls (where slab meets wall). It is possible to reduce the amount of exterior reinforcing in the top of the walls because of the significant reduction in moment in this region.

* Determine the capacity of #10 @ 12" (transition from #10 @ 6" to #10 @ 12" in exterior face):

* Will try #10 @ 12" to start: As, #10 @ 12" = 1.27 in^2

$a = A_s * f_y / (0.85 * f'_c * b) = 1.27 * 60ksi / (0.85 * 4ksi * 12in) =$ 1.868 in

$\phi Mn = 0.9 * 1.27in^2 * 60ksi * (37.365in - 1.868in / 2)$
$= 2498.45$ kip-in/ft
ϕMn = 208.20 kip-ft/ft

<u>ϕMn = 2498.45 kip-ft per 12ft strip</u>

* See the moment diagrams in the attached SAP results for a breakdown of moments along the length of the walls & the areas in which the moment is less than the capacity of #10 @ 12" bars.

* The controlling distance is found in LC 1b: the #10 @ 6" reinforcing must be continued approximately 3'-10" from the top face of the slab before it may be reduced to #10 @ 12".

* The required embedment length of a #10 bar spaced 6" o.c. is 59". This means that the terminating #10 bars must extend a minimum of 8'-9" from the top face of the slab.

CONTROLS

*** Strut Beam:**

Load Case	Max. Shear* (kip)	Maximum Moment (kip-ft)	Minimum Moment (kip-ft)
1a-ST	20.23	39.51	174.85
1b-ST	25.76	77.55	258.20
2-ST	13.40	43.53	95.48

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

Max. Shear = 25.8 kip
Max. Moment = 77.6 kip-ft (controls bottom reinforcement)
Min. Moment = 258.2 kip-ft (controls top reinforcement)

b = 24 in h = 24 in

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in #10 bar assumed

Shear:

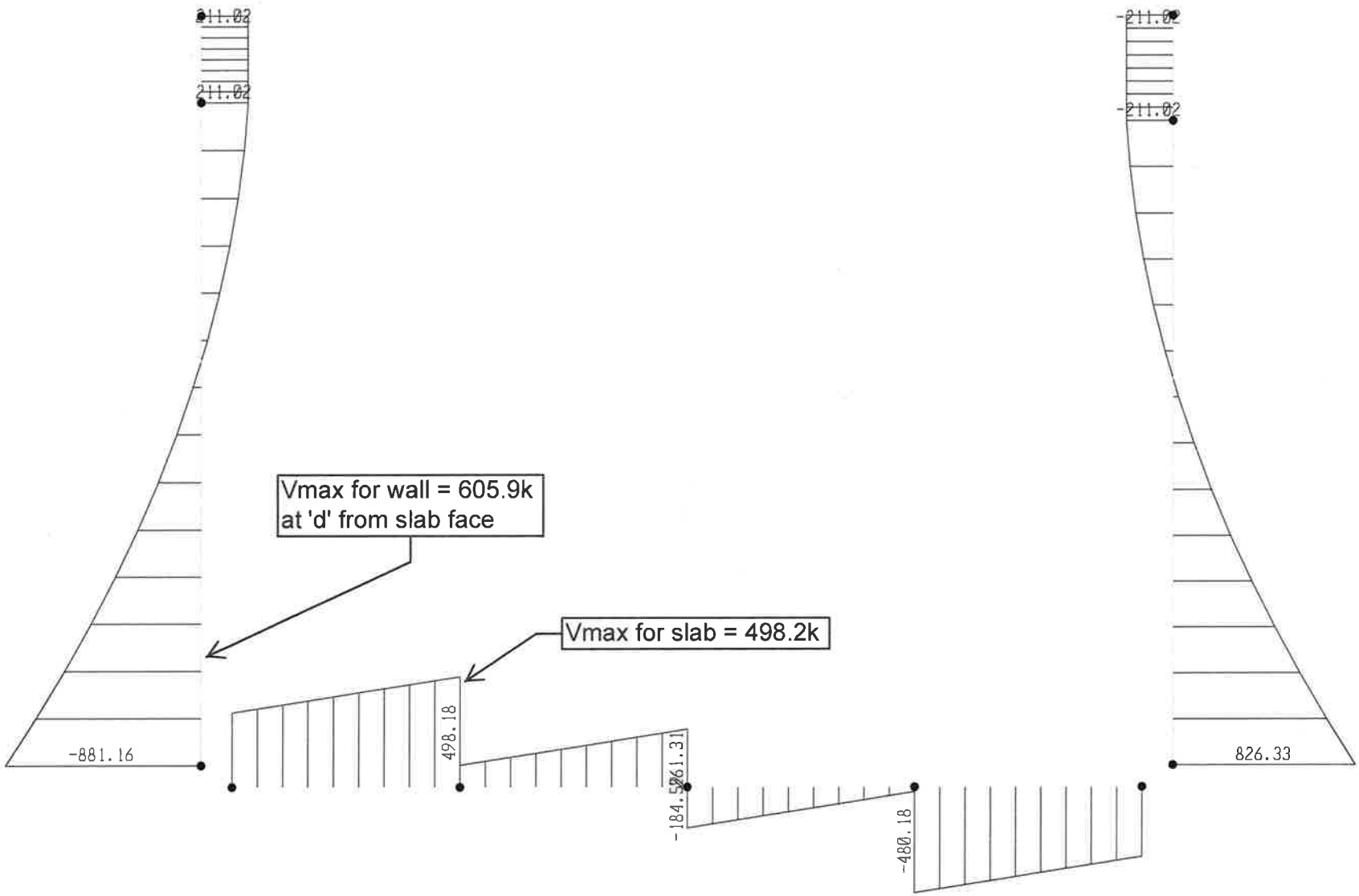
Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$
= $0.85 * 2 * \sqrt{4000} * 24in * 19.365in$
= 49,970 lb

ϕVc = 50kip > Vu = 25.8kip → Section OK

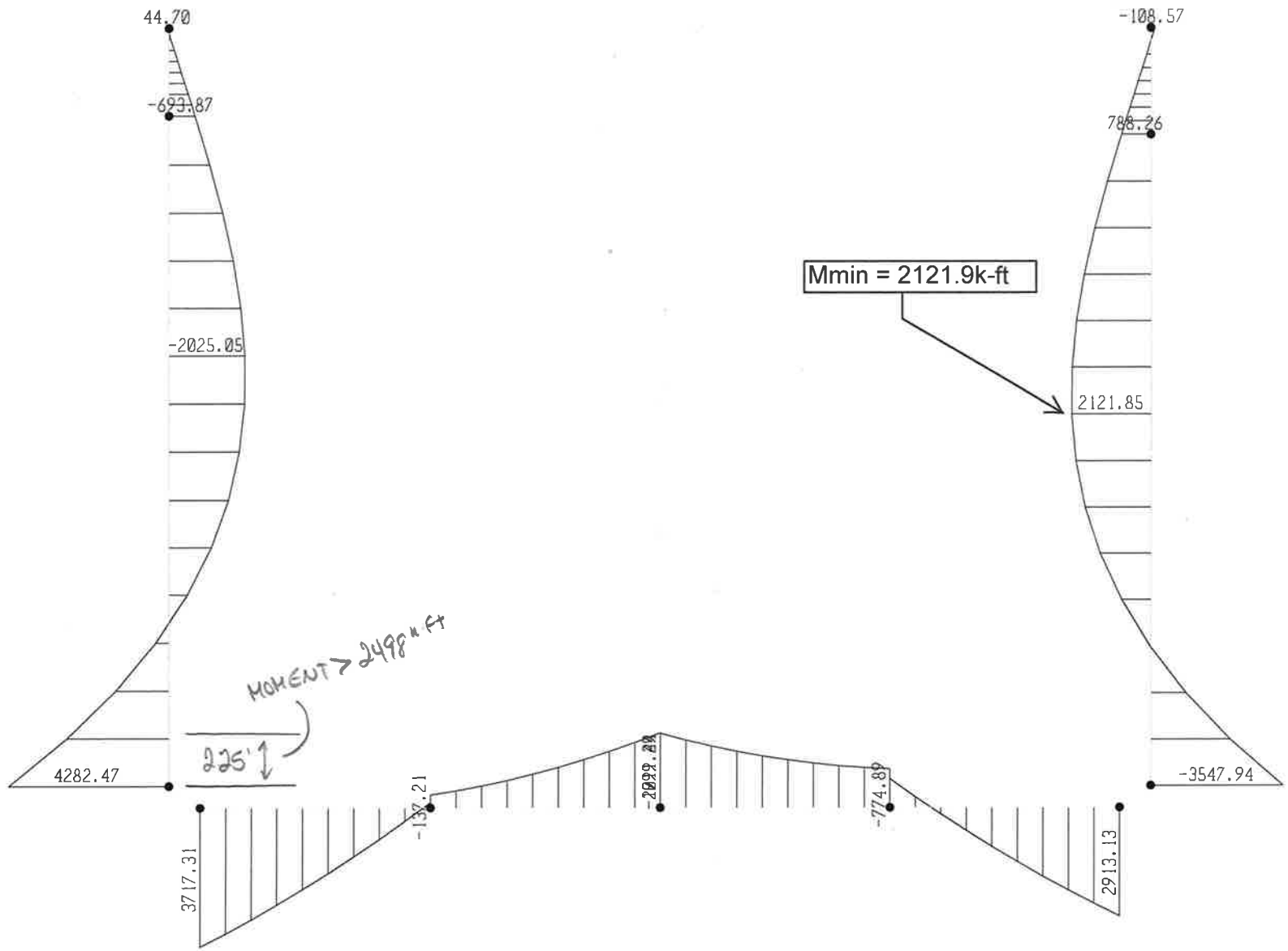
Moment:

Moment reinforcing & other beam calculations follow the SAP result images.

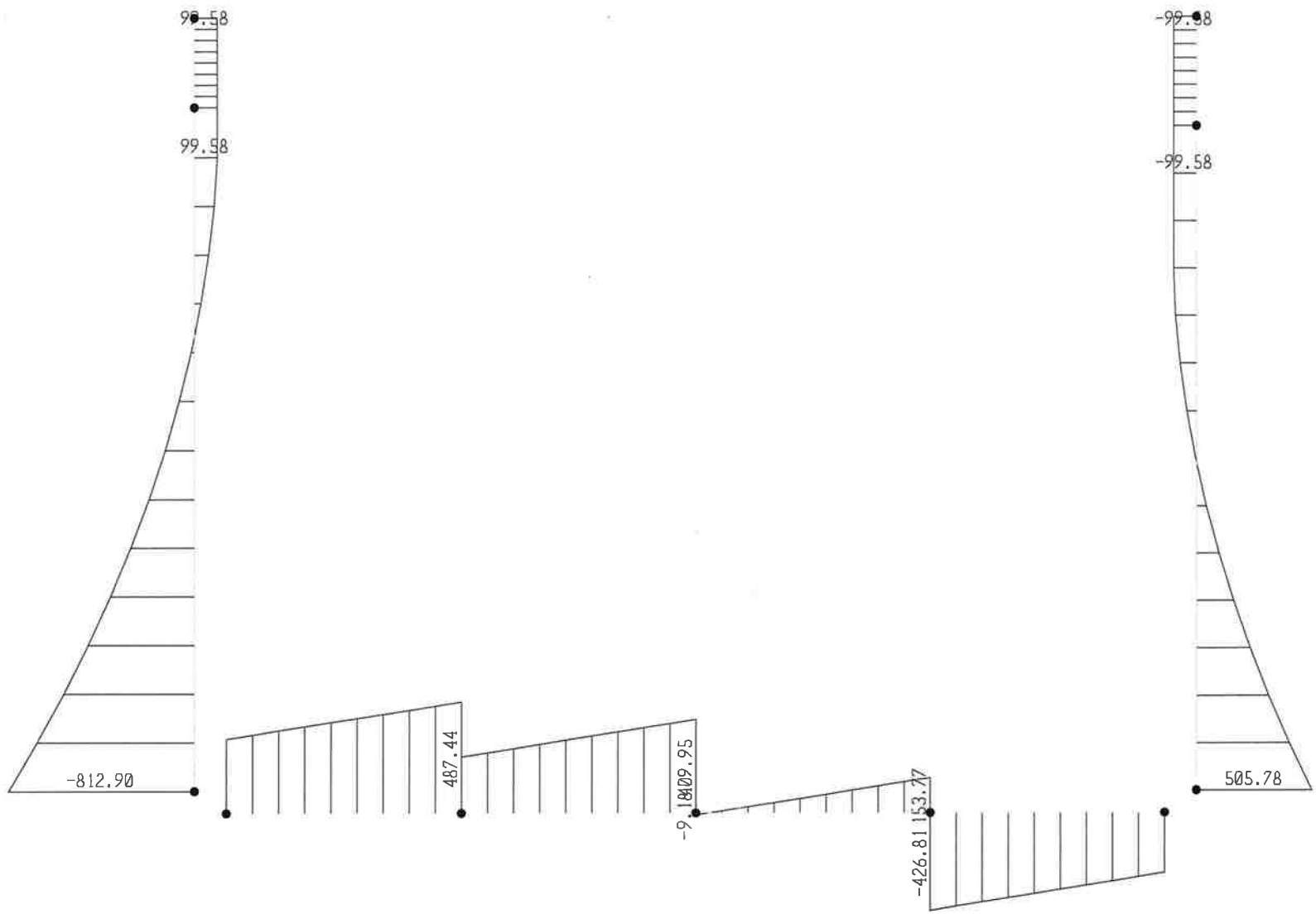
SAP results shown on following 9 pages. Wall & slab moments & shears first, strut beam after. Please note that wall/slab results for a 12' strip.



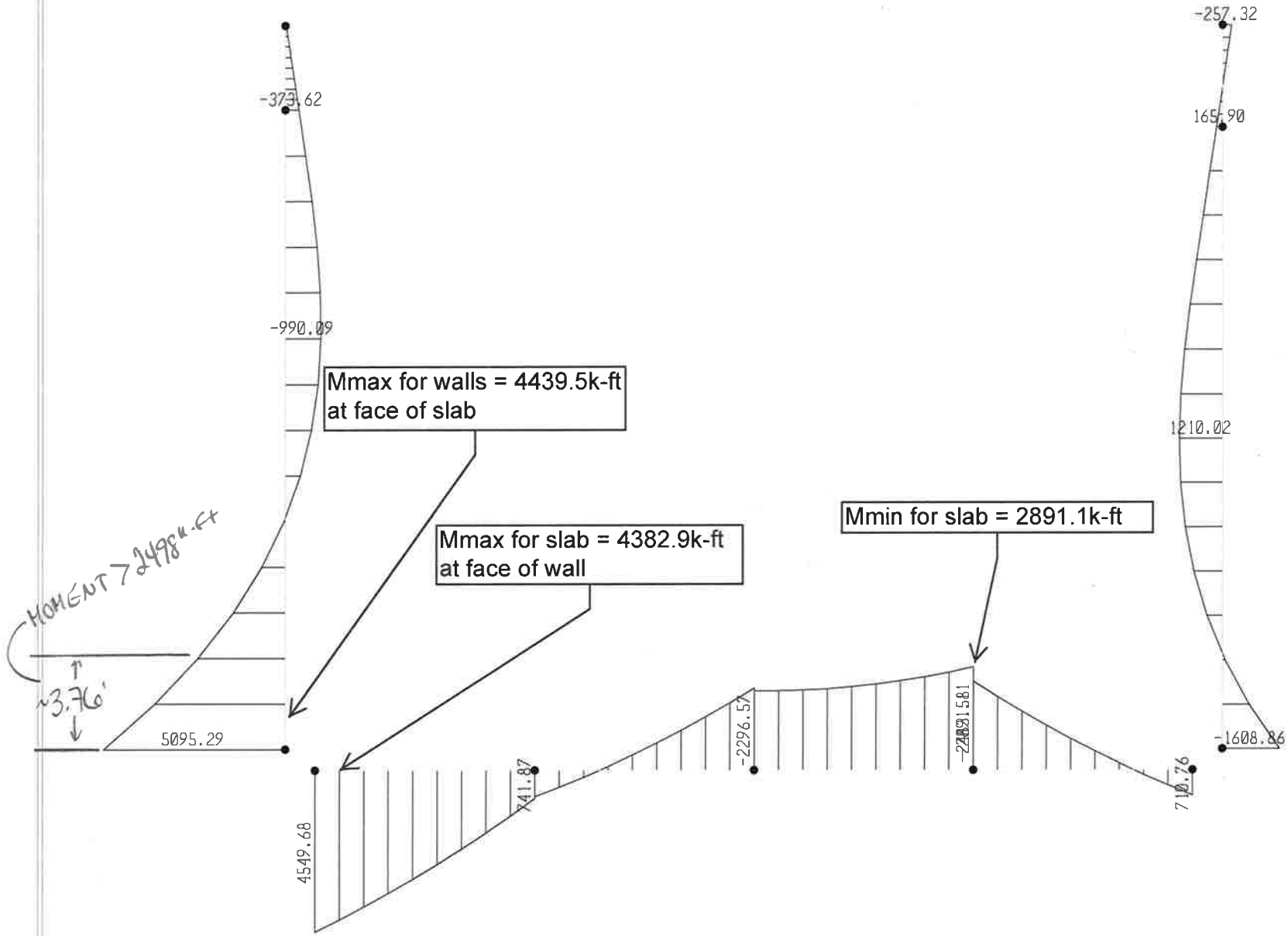
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1a-ST) - Kip, ft, F Units

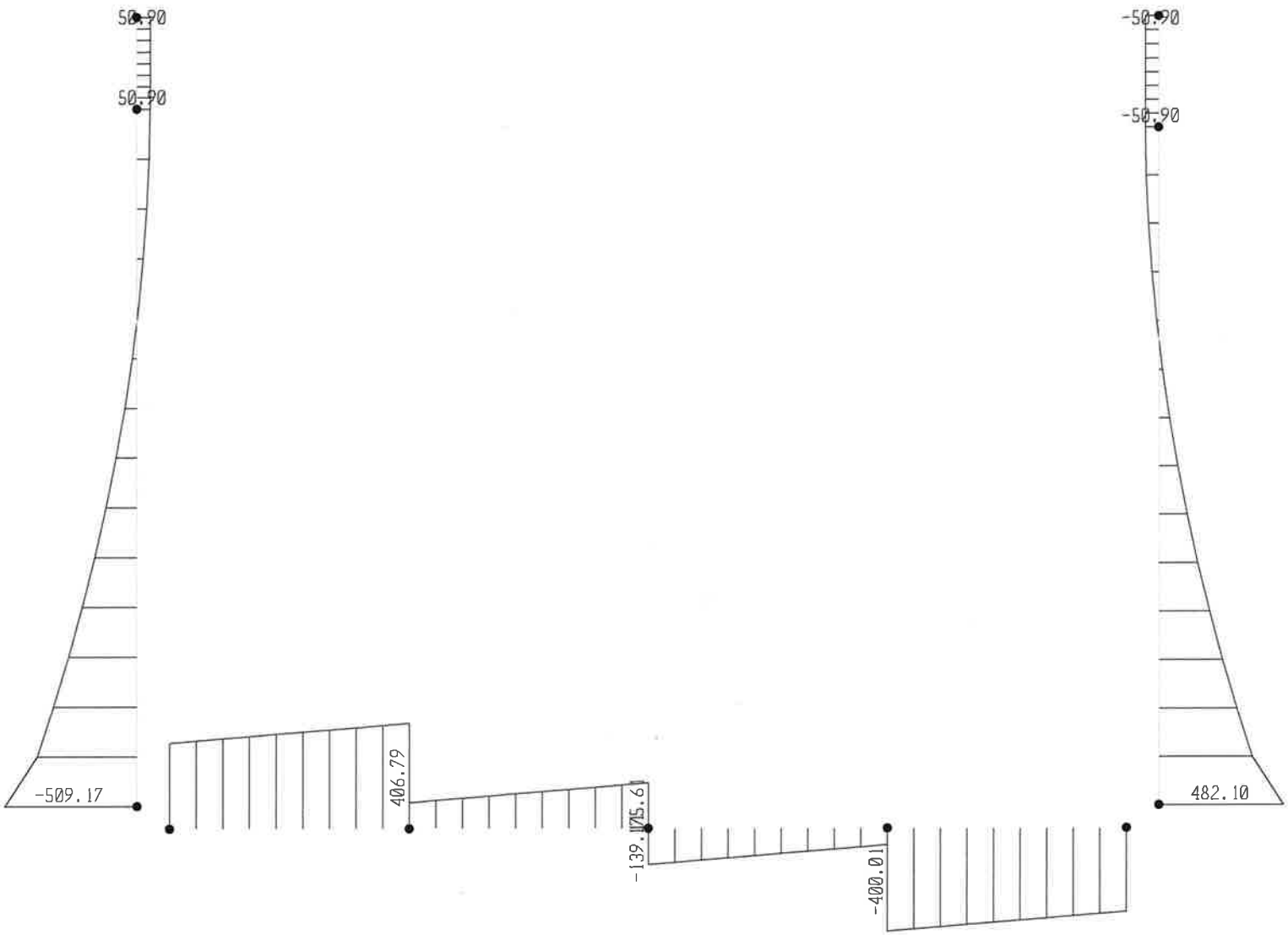


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1a-ST) - Kip, ft, F Units

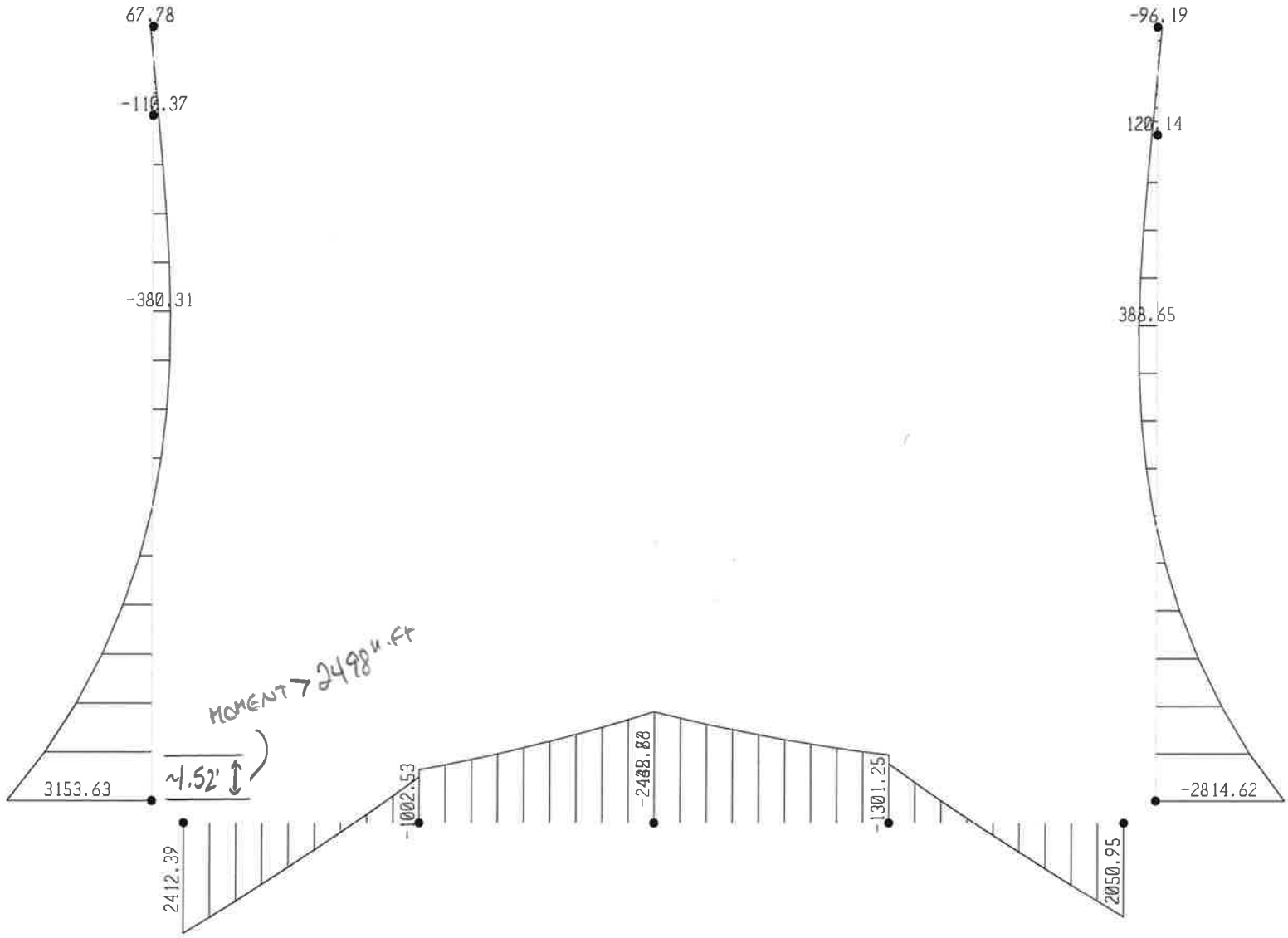


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1b-ST) - Kip, ft, F Units


-373.62
-990.09
Mmax for walls = 4439.5k-ft
at face of slab
Mmax for slab = 4382.9k-ft
at face of wall
Mmin for slab = 2891.1k-ft
MOMENT > 2498k-ft
~3.76'
5095.29
4549.68
741.87
-2296.57
-2891.581
710.76
-257.32
165.90
1210.02
-1608.86

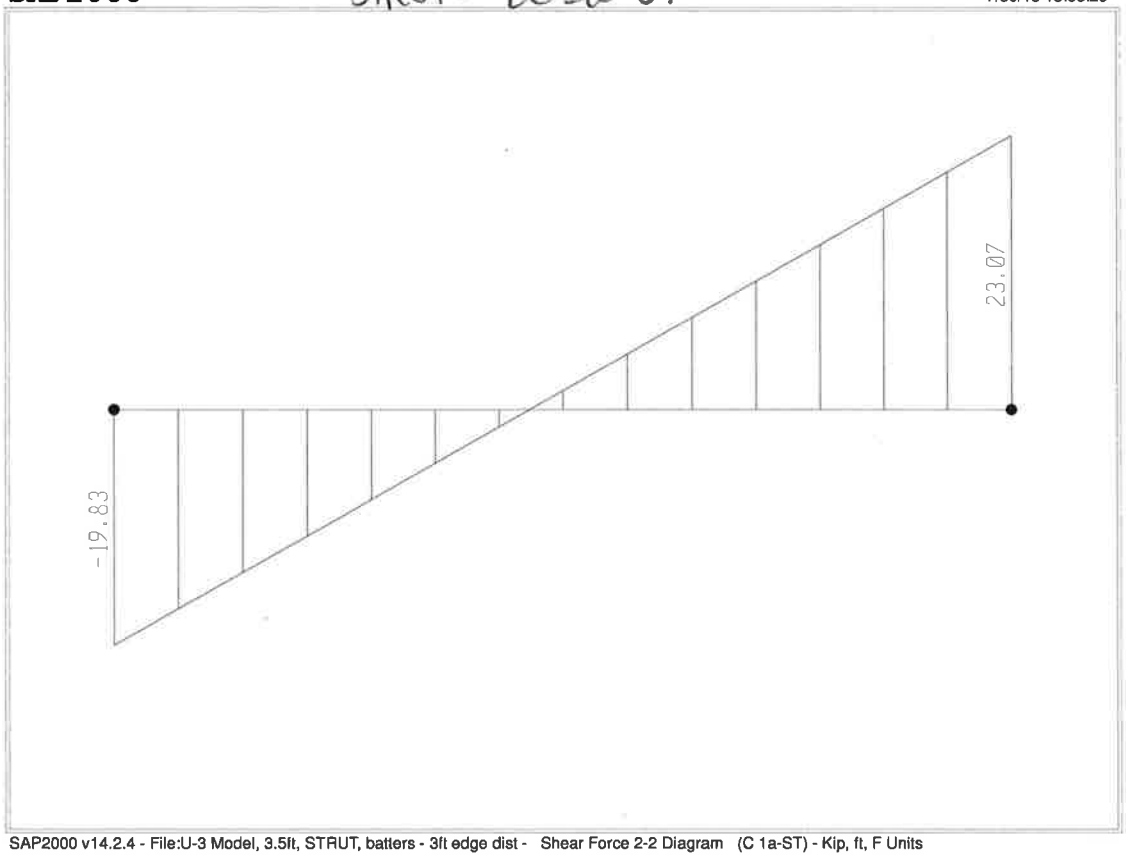


SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 2-ST) - Kip, ft, F Units



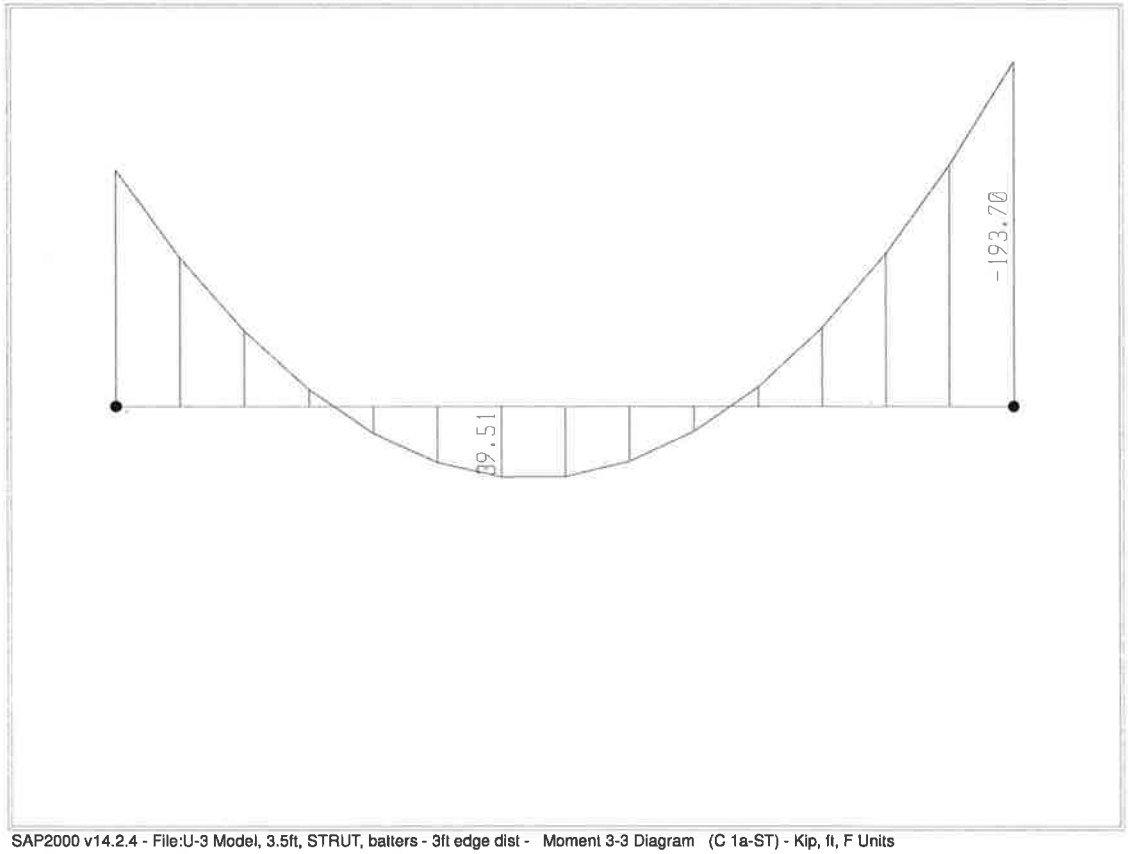
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 STRUT- LC 1a-ST 7/30/13 15:56:20



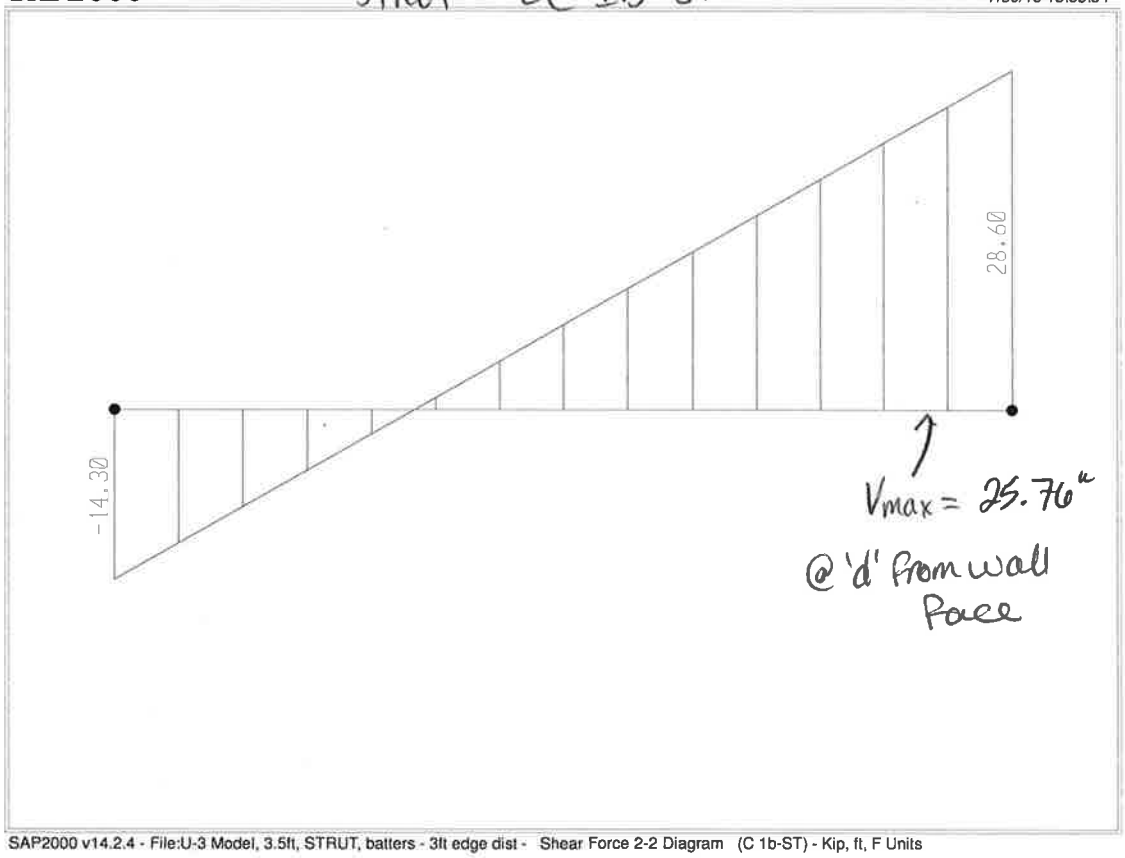
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 7/30/13 15:53:50



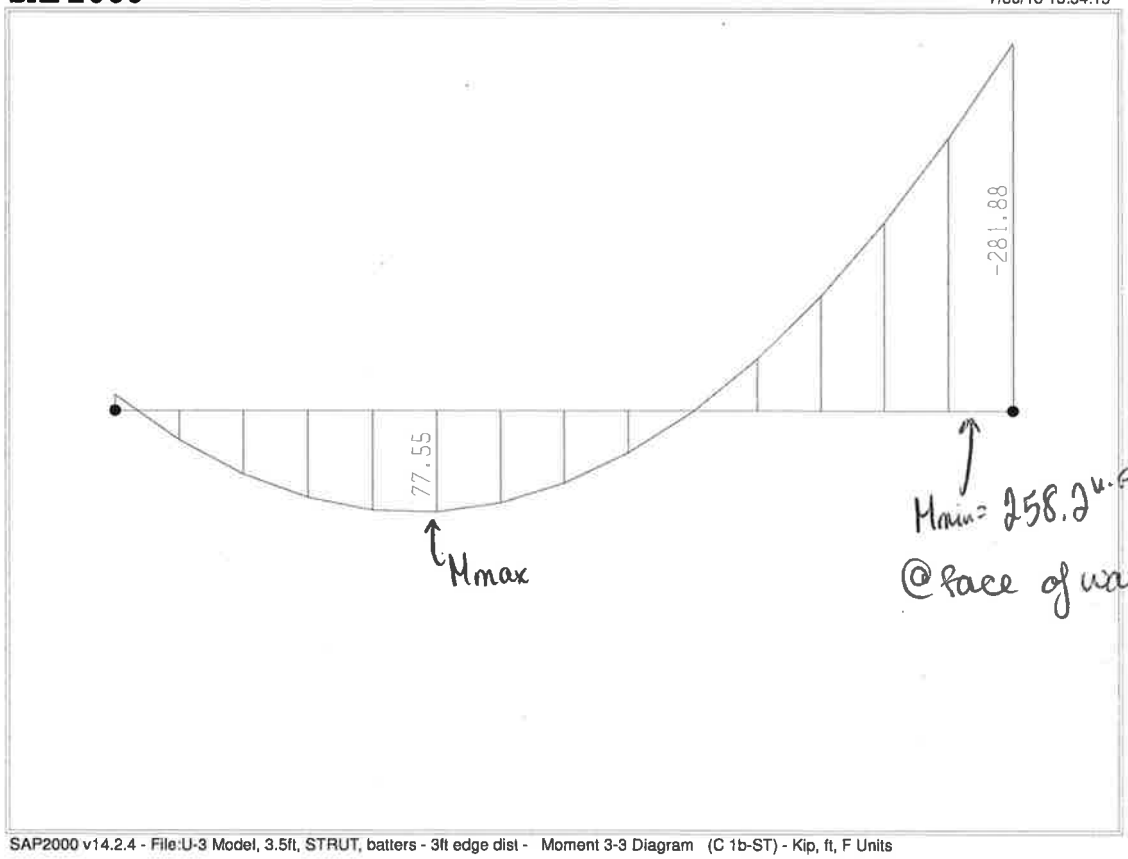
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 STRUT - LC 1b-ST 7/30/13 15:55:54



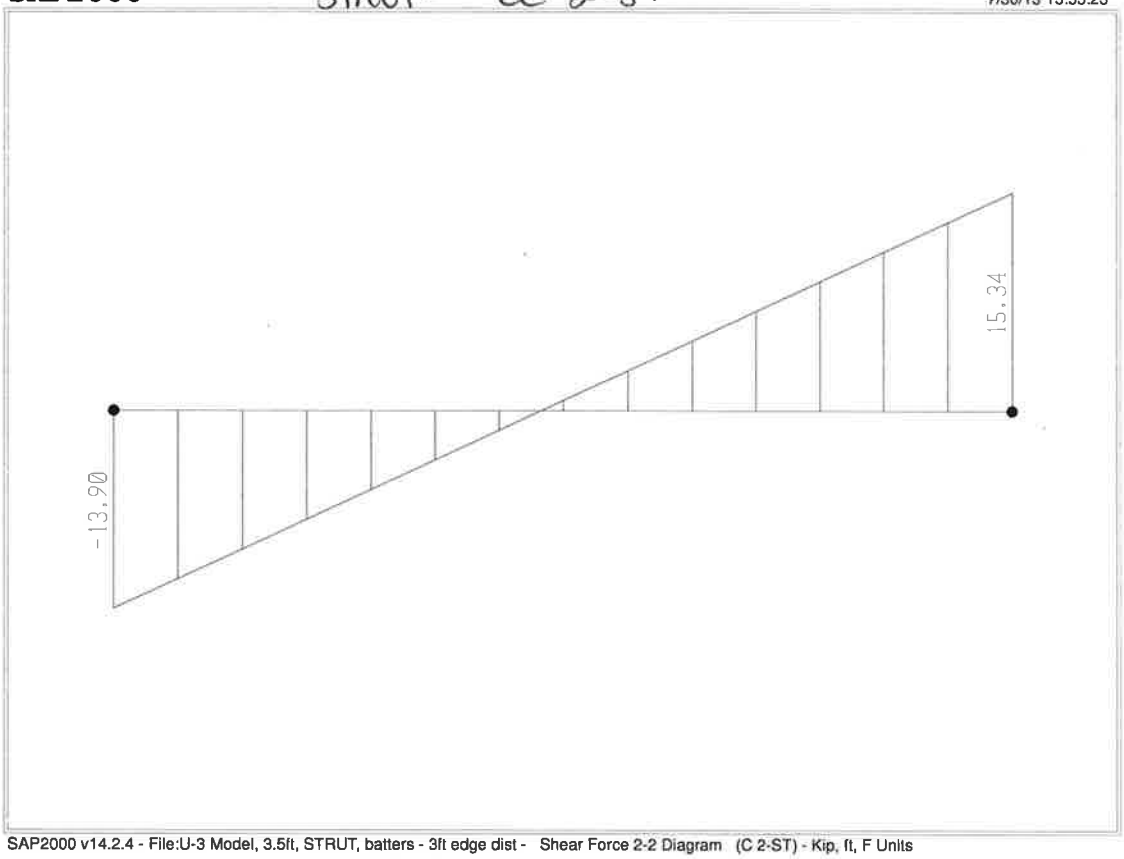
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 7/30/13 15:54:15



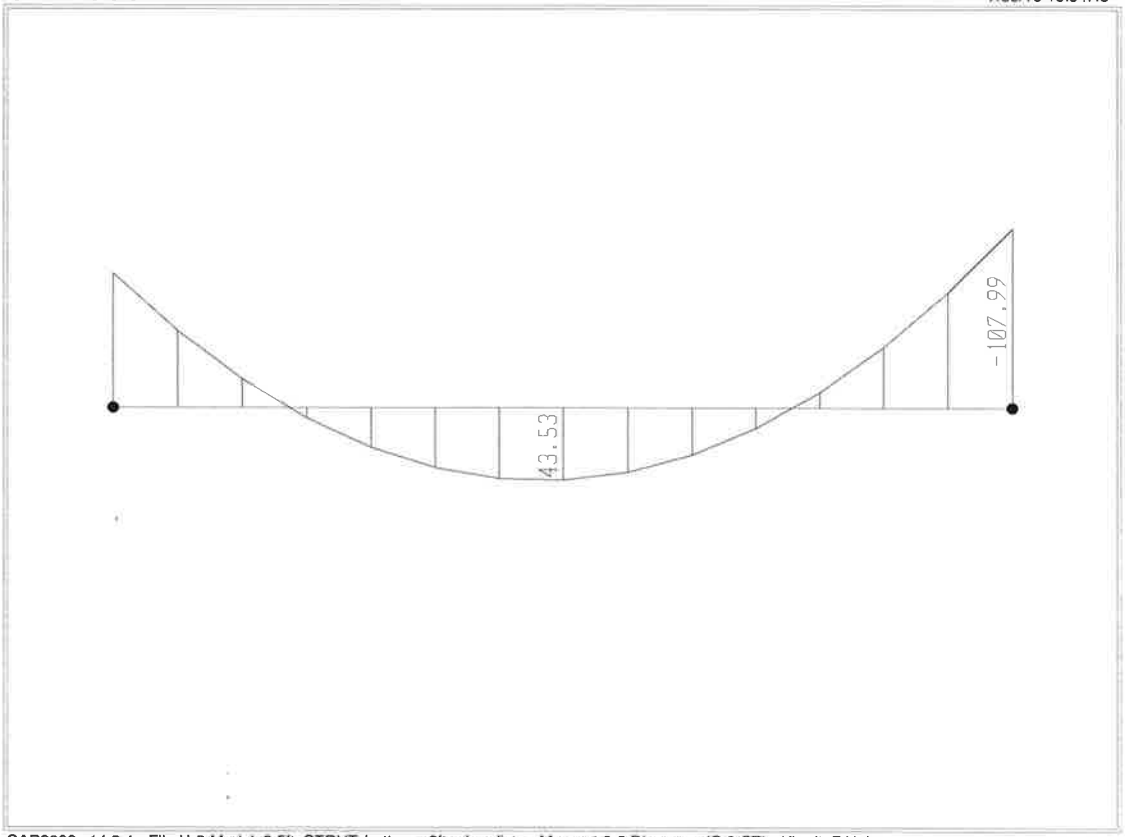
SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 STRUT- LC 2-ST 7/30/13 15:55:23



SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Shear Force 2-2 Diagram (C 2-ST) - Kip, ft, F Units

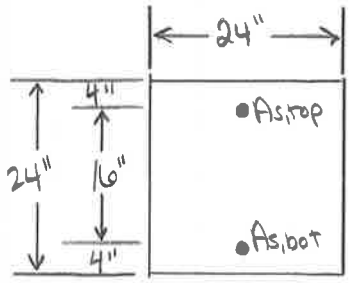
SAP2000 7/30/13 15:54:45



SAP2000 v14.2.4 - File:U-3 Model, 3.5ft, STRUT, batters - 3ft edge dist - Moment 3-3 Diagram (C 2-ST) - Kip, ft, F Units

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: STRUT BEAM - U3 | Computed by: LBR | Sheet ____ of ____ | Date: 7/2013
REINF. DESIGN | Checked by: ____ | Date: ____
Reference



$M_{bottom} = 95.8^{k\cdot ft}$

$M_{top} = 267.3^{k\cdot ft}$

$d = 24" - 4"_{COVER} - 1/2 \times 1.27" = 19.365"$

TOP:

$$\rho_{req} = \frac{0.85 f'_c}{f_y}\left(1 - \sqrt{1 - \frac{2 \cdot R_m}{0.85 f'_c}}\right)$$

$$R_m = \frac{M_u}{\phi b d^2} = \frac{267.3^{k\cdot ft} \times 12\frac{in}{ft} \times 1000\frac{lb}{k}}{(0.9)(24")(19.37)^2} = 395.8$$

$$\rho_{req} = \frac{(0.85)(4\,ksi)}{60\,ksi}\left(1 - \sqrt{1 - \frac{2 \times 395.8}{0.85(4000\,psi)}}\right) = 0.00703$$

$$\therefore A_{s,req} = \rho b d = (0.00703)(24")(19.365") = \underline{3.27\,in^2}$$

$\Rightarrow$ USE 3-#10 BARS ($A_s = 3.81\,in^2$)

BOTTOM:

$$R_m = \frac{95.8^{k\cdot ft} \times 12\frac{in}{ft} \times 1000\frac{lb}{k}}{(0.9)(24")(19.365")^2} = 141.92$$

$$\rho_{req} = \frac{(0.85)(4)}{(60)}\left(1 - \sqrt{1 - \frac{2 \times 141.9}{0.85 \times 4000}}\right) = 0.0024$$

-BUT- $A_{s,min}$ FOR A FLEXURAL MEMBER = 0.0033

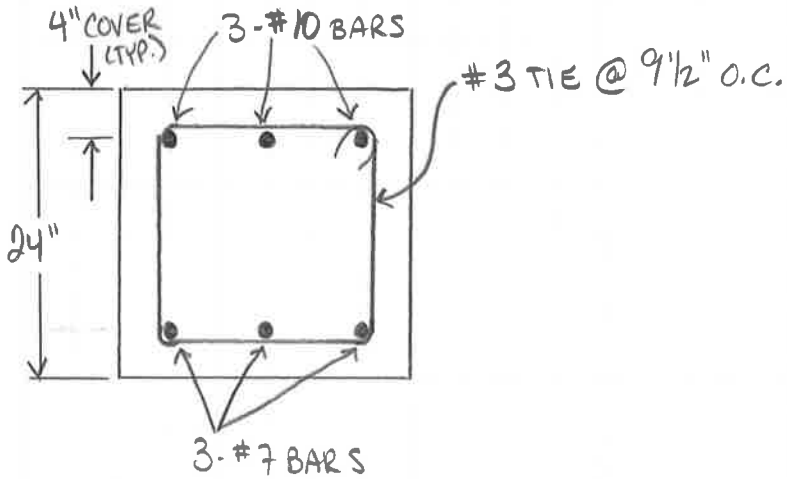
$$\therefore A_{s,req} = \rho b d = (0.0033)(24")(19.365") = \underline{1.534\,in^2}$$

$\Rightarrow$ USE 3-#7 BARS ($A_s = 1.8\,in^2$) IN BOTTOM

TIES: USE #3 TIES B/C BARS < #11. SPACING CAN BE MAX. B/C THEY ARE NOT NECESSARY FOR SHEAR. MAX $S = d/2 = 19.5"/2 = \underline{9.75"}$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: STRUT BEAM - U3 | Computed by: LBR | Sheet ____ of ____ | Date: 7/2013
REINF. DESIGN | Checked by: ____ | Date: ____
Reference



- CHECK MIN. THICKNESS: ACI 318 TABLE 9.5(a)

  - FOR BEAMS, BOTH ENDS CONTINUOUS: $h_{min} = \ell/21 = \frac{36' \times 12''}{21} = 20.6''$
    $20.6'' < 24'' \rightarrow$ OK

- CHECK AXIAL FORCE DOES NOT GO OVER MAX. ALLOWABLE:
  ACI318 - 14.5.2 (WALL DESIGN)

$$\phi P_n = 0.55 \phi f'_c A_g \left[1 - \left(\frac{K \ell_c}{32h}\right)^2\right] \quad \text{(EQ 14-1)}$$

$\phi = 0.65$ (TENSION CONTROLLED, NORMAL REINF.) - ACI 9.3.2.2
$K = 0.8$ (RESTRAINED BOTH ENDS) - ACI 14.5.2(a)

$$\phi P_n = (0.55)(0.65)(4000\text{psi})(24'' \times 24'')\left[1 - \left(\frac{(0.8)(36' \times 12')}{32 \times 24''}\right)^2\right] = 656{,}884.8^{LB} = 656.9^{k}$$

↳ AXIAL FORCES FROM SAP:

LC 1a = 245.5^k ← MAX - OK
LC 1b = 130.4^k
LC 1c = -43.13^k
LC 2 = 93.9^k
DEAD = -50.3^k (-) SHOWS TENSION - MAX 50.3^k

(LC 1a-ST, 1b-ST, 2-ST ALL HAVE SMALLER AXIAL FORCES THAN THEIR TRADITIONAL COUNTERPARTS)

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: STRUT BEAM - U3 | Computed by: LBR | Sheet ___ of ___ | Date: 7/2013
Checked by: | Date:

Reference

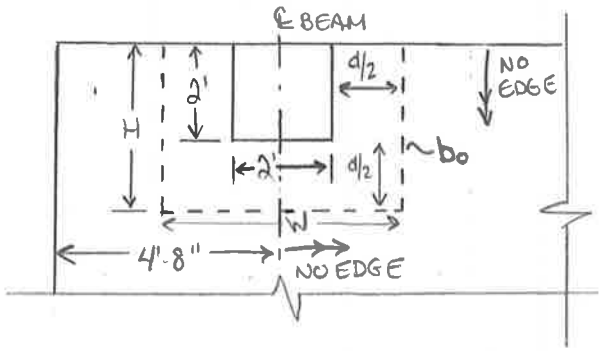
→ TENSION CAPACITY OF STRUT: ACI 318 - 9.5.2.3 (EQ. 9-10)

↳ f_r = MODULUS OF RUPTURE = $7.5\sqrt{f'_c} = 7.5\sqrt{4000} = \underline{\underline{474.3^{PSI}}}$

↳ HIGHEST TENSION LOAD = 50.3^k. SINCE MEMBER IS IN PURE TENSION, THE SAFETY FACTOR SHOULD BE 1.65 INSTEAD OF THE 1.3 NUMBER INPUT IN SAP COMBINATIONS.

$$T = \frac{50.3^k \times \frac{1.65}{1.3}}{24'' \times 24''} = 0.1108^{KSI} = 110.8^{PSI} << 474.3^{PSI} - \underline{\underline{OK}}$$

→ CHECK PUNCHING SHEAR IN WALL:



$d_{wall} = 39'' - 4'' - \frac{1}{2} \times 1'' = 34.5'' = 2.875'$

b_o = PERIMETER OF SHEARED AREA

$$\underline{b_o} = \underbrace{2 \times (2' + 2.875)}_{2 \times W} + \underbrace{2 \times (2' + 1.4375)}_{2 \times H}$$

$$= 16.6 \text{ FT} = \underline{\underline{199.5 \text{ IN}}}$$

$$\phi V_c = \min \begin{cases} ① \left(2 + \frac{4}{\beta}\right)\sqrt{f'_c}\, b_o d & (11\text{-}33) \\ ② \left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}\, b_o d & (11\text{-}34) \\ ③ \; 4\sqrt{f'_c}\, b_o d & (11\text{-}35) \end{cases}$$

$\beta = \frac{24''}{24''} = 1$

$\alpha_s = 20$ (min. - conservative)

① $\left(2 + \frac{4}{1}\right)\sqrt{4000}(199.5'')(34.5'') = 2611.8^k$

② $\left(\frac{20 \times 34.5''}{119.5''} + 2\right)\sqrt{4000}(199.5)(34.5) = 3384.1^k$

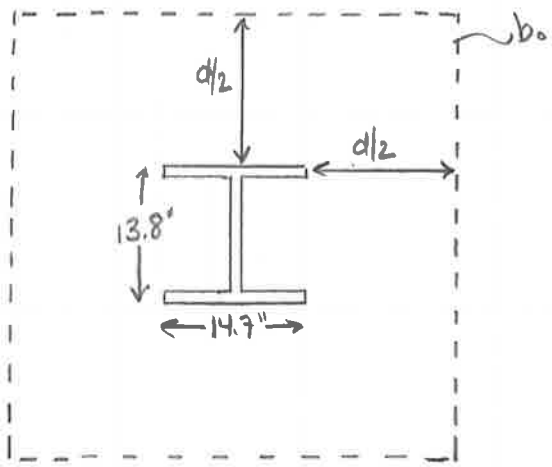
③ $4\sqrt{4000}(199.5'')(34.5'') = 1741.2^k \leftarrow \times \phi = \times .85 = \underline{\underline{1480^k}}$

$$\underline{P_{max} = 245.5^k << \phi V_c = 1480^k \leftarrow \underline{\underline{OK}}}$$

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: U-3 - SLAB PUNCHING SHEAR CHECK | Computed by: LBR | Sheet ___ of ___ | Date: 7/2013
Checked by: ___ | Date: ___
Reference

- d_{SLAB}: 42" − 9" PILE EMBED ≈ 3" ADD'L HEIGHT FROM BATTER = 30"



$$b_o = 2\times(13.8''+d) + 2\times(14.7''+d)$$
$$= 2\times(13.8''+30'') + 2\times(14.7''+30'')$$
$$= 177''$$

$$\phi V_c = \min.\begin{cases} ① \ \phi\left(2+\frac{4}{\beta}\right)\sqrt{f'_c}\, b_o d & \text{ACI 318 (11-33)} \\ ② \ \phi\left(\frac{\alpha d}{b_o}+2\right)\sqrt{f'_c}\, b_o d & (11\text{-}34) \\ ③ \ \phi 4\sqrt{f'_c}\, b_o d & (11\text{-}35) \end{cases}$$

$\beta = \frac{13.8''}{14.7''} = 0.939$

$\alpha = 20$ (min, conservative)

- BY INSPECTION, ③ CONTROLS, $\phi V_c = (0.85)(4)\sqrt{4000}\,(177'')(30'')$
$= \underline{1141.84^k}$

- MAX. REACTION: 344^k

- IF TREATED AS ENVIRONMENTAL FORCE SUBJECT TO HYDRAULIC & SAFETY FACTORS, LOAD = $344^k \times 1.3 \times 1.7 = 760.25^k$

$760^k < 1141.8^k \rightarrow$ ok

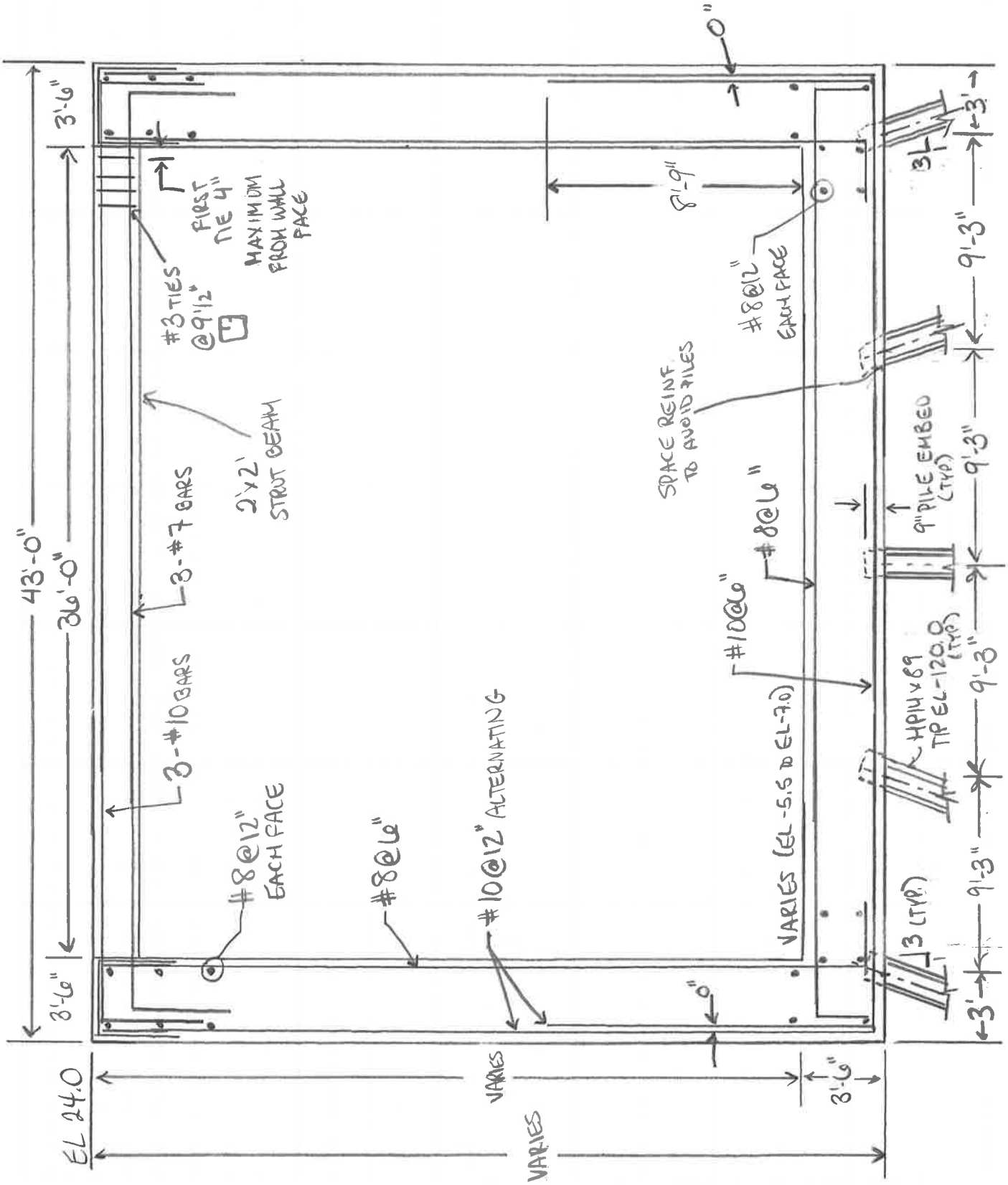
URS

Job: MAUREPAS DIVERSION
Description: MONOLITH U-3 REINFORCEMENT

Project No. 10001876
Computed by: LBR
Checked by:

Page ____ of ____
Sheet ____ of ____
Date: 7/2013
Date:

Reference



SECTION 5

U-4 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of

Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	High Water Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
2-ST	High Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)
3	Low Water Condition	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2.0 NAVD88)
			Lateral Load from Soil Saturated below EL 2.0
3-ST	Low Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2.0 NAVD88)
			Lateral Load from Soil Saturated below EL 2.0
			Vertical Downdrag (600psf on walls/slab edges)

Notes: High Water is at EL 9.0 because this is the T.O. Levees adjacent to the outflow channel
Low Water is at EL 2.0 because the T.O. Weir separating the headworks from the sedimentation basin is EL 2.5. 6 inches of water is removed to conservatively account for evaporation.

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of

Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL 9.0
L_low water	Lateral & vertical loads from water to EL 2.0
U_high water	Uplift load from water to EL 9.0
U_low water	Uplift load from water to EL 2.0
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_high water	Soil pressure from saturated soil (water to EL 9.0)
S_low water	Soil pressure from saturated & dry soil (water to EL 2.0)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	U_high water
	S_high water
2-ST	DEAD
	L_high water
	U_high water
	S_high water
	ST_cohesion
3	DEAD
	L_low water
	U_low water
	S_low water

In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

LC #	Patterns Included
3-ST	DEAD
	L_low water
	U_low water
	S_low water
	ST_cohesion

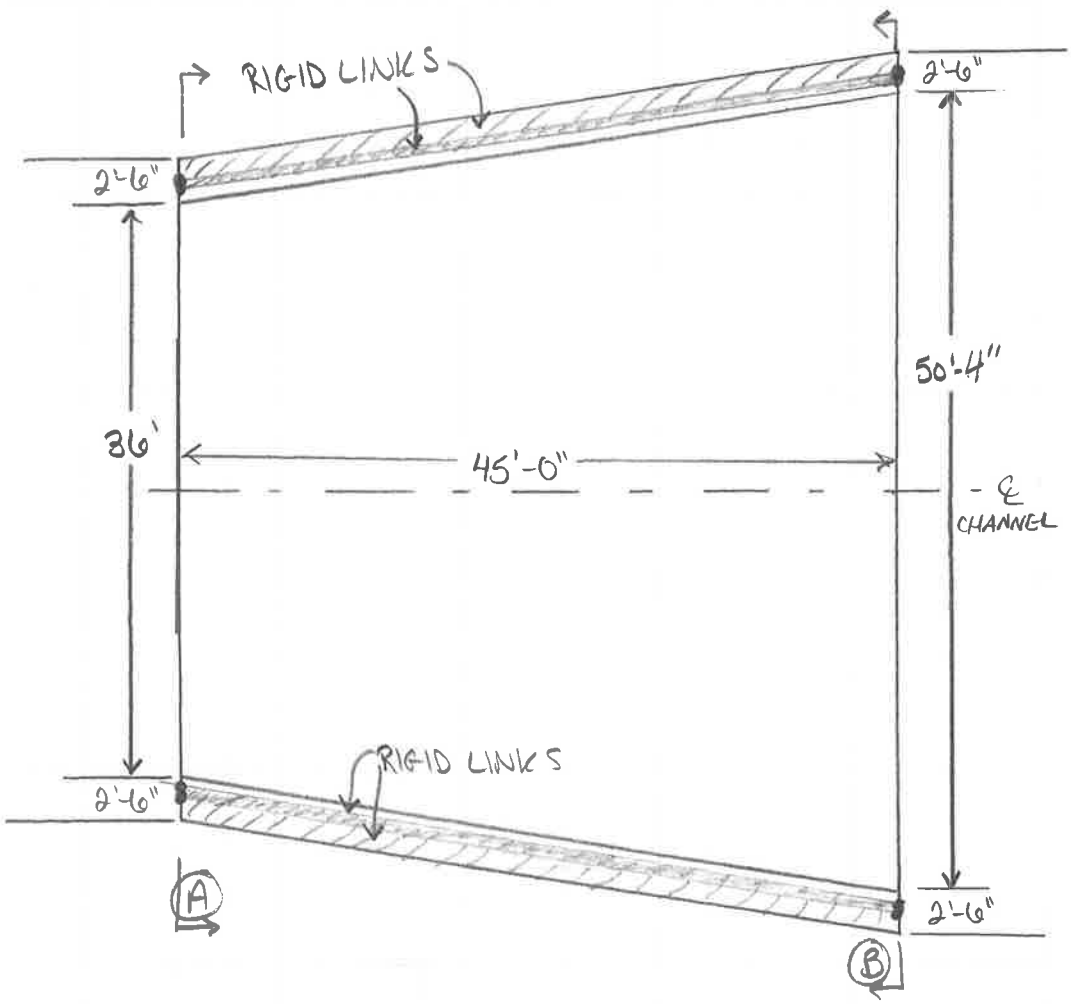
URS

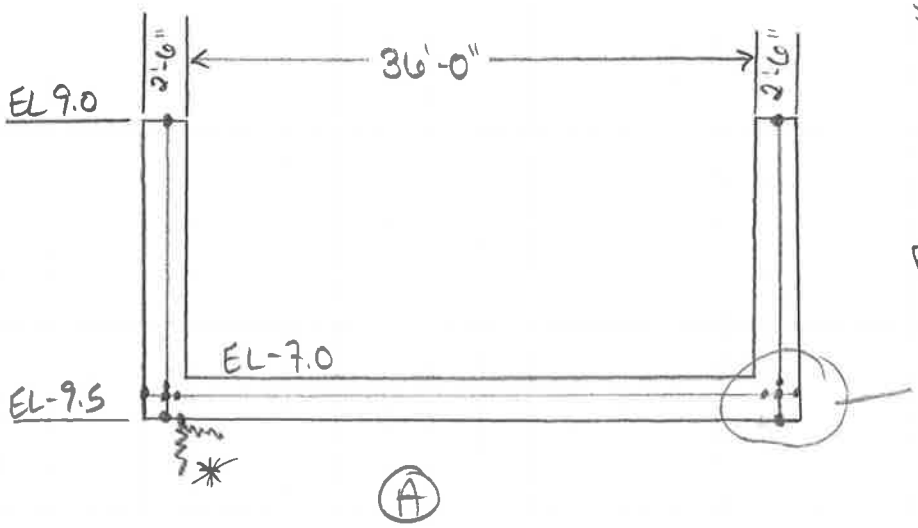
Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____

Description: MONOLITH U-4 | Computed by: LBR | Sheet ____ of ____

SAP MODEL LAYOUT | Checked by ____ | Date: 8/2013

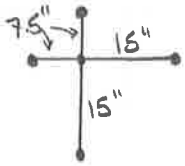
Reference





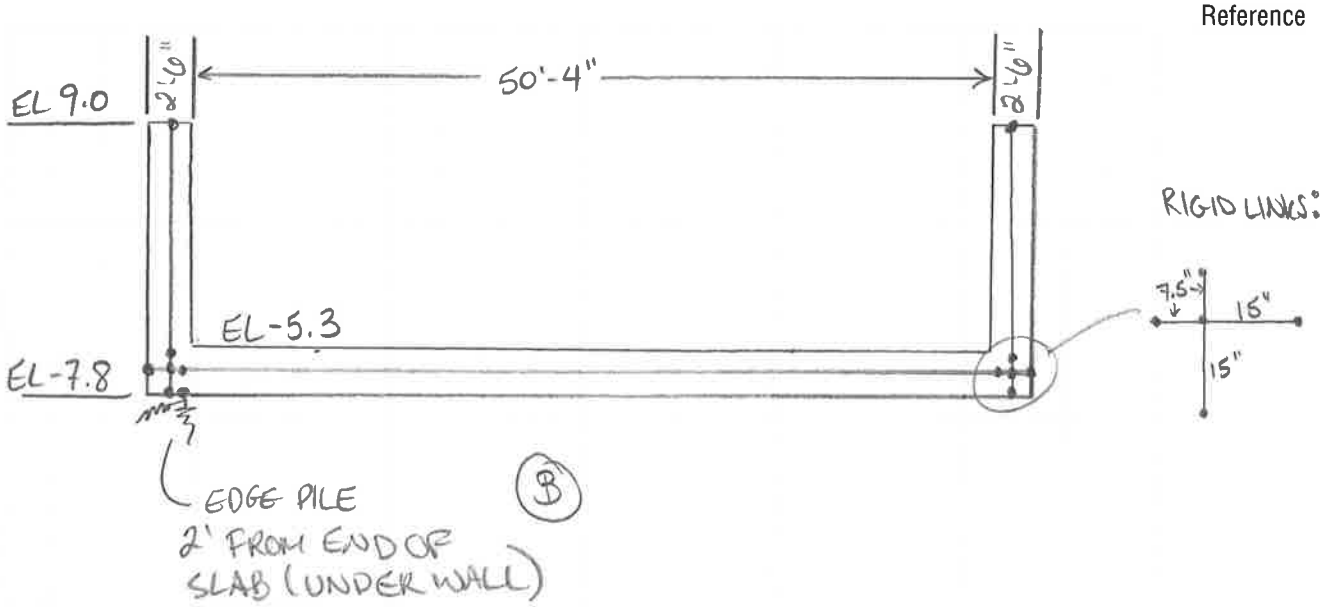
* EDGE PILES ARE 2' FROM END OF SLAB ON ALL ROWS. (UNDER WALL)

RIGID LINKS:



URS

Job: MAURGPAS DIVERSION
Description: U-4 SAP LAYOUT & DEAD LOAD CALIBRATION
Project No.: 10001876
Computed by: LBR
Checked by:
Page ___ of ___
Sheet ___ of ___
Date: 8/2013
Date:
Reference



DEAD LOAD CALIBRATION:

↳ ACTUAL WEIGHT:

length along wall ℄ from CAD

WALLS: $\frac{(14.3'+16')}{2}$ height × 2.5' thick × 45.6' long × 2 × 150 pcf = 518,130 LB

SLAB: $\frac{(41'+55.33')}{2}$ wide × 2.5' thick × 45' long × 150 pcf = 812,784.4 LB

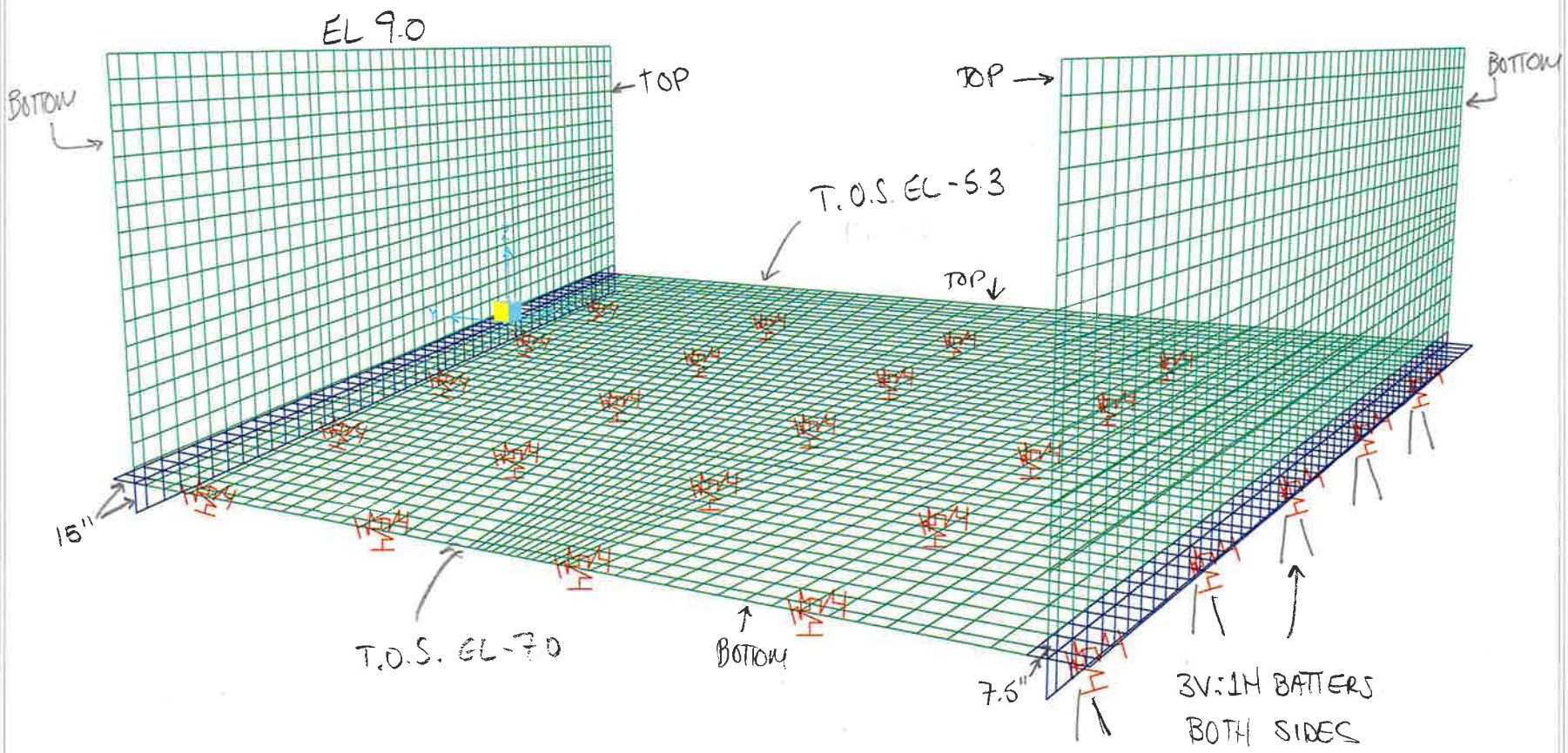
Σ = 1,330,914.4 LB

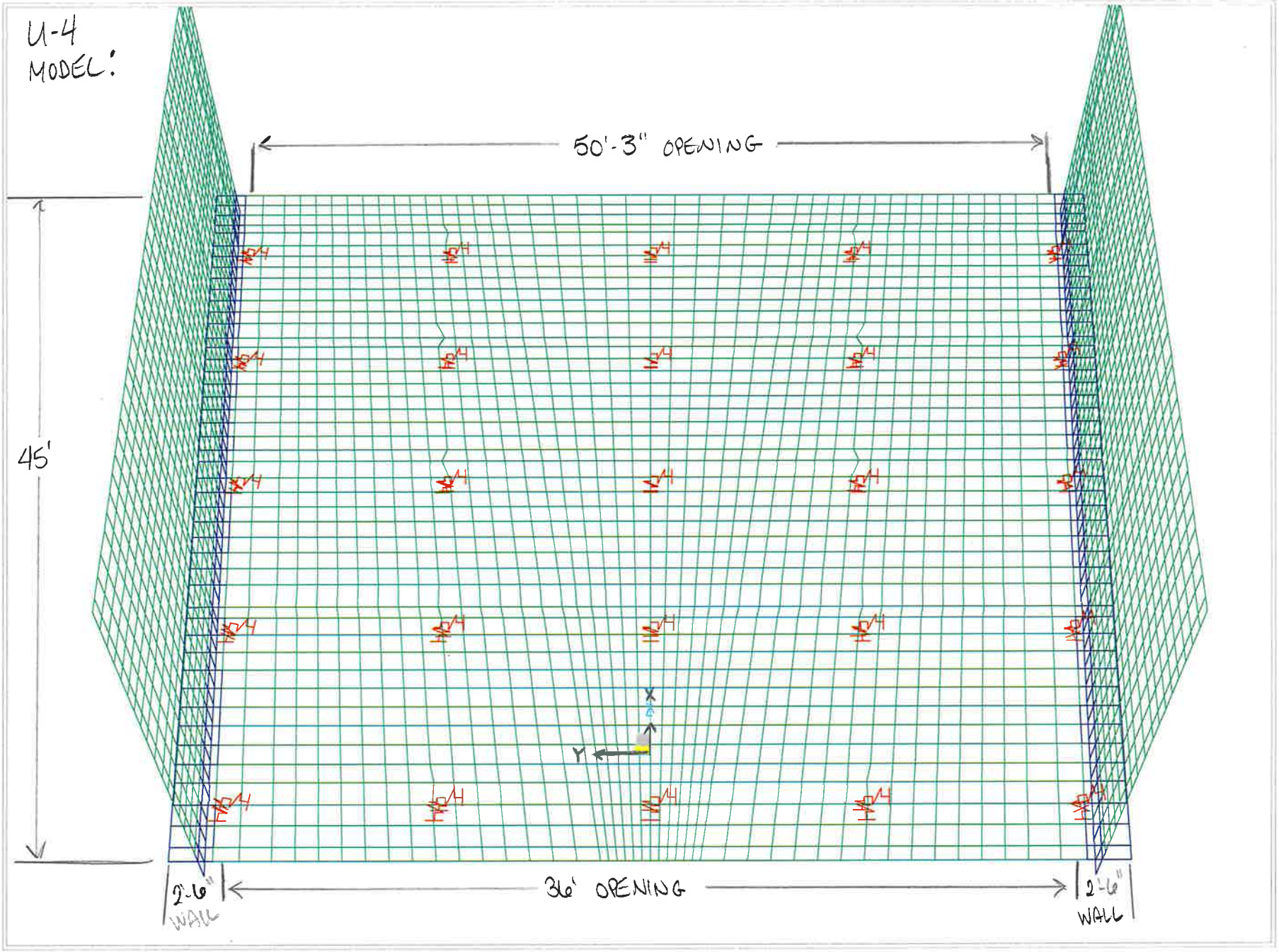
↳ SAP DEAD LOAD = 1,335,061.74 LB

↳ DIFFERENCE OF 4147.3 LB, OR 0.31% → OK

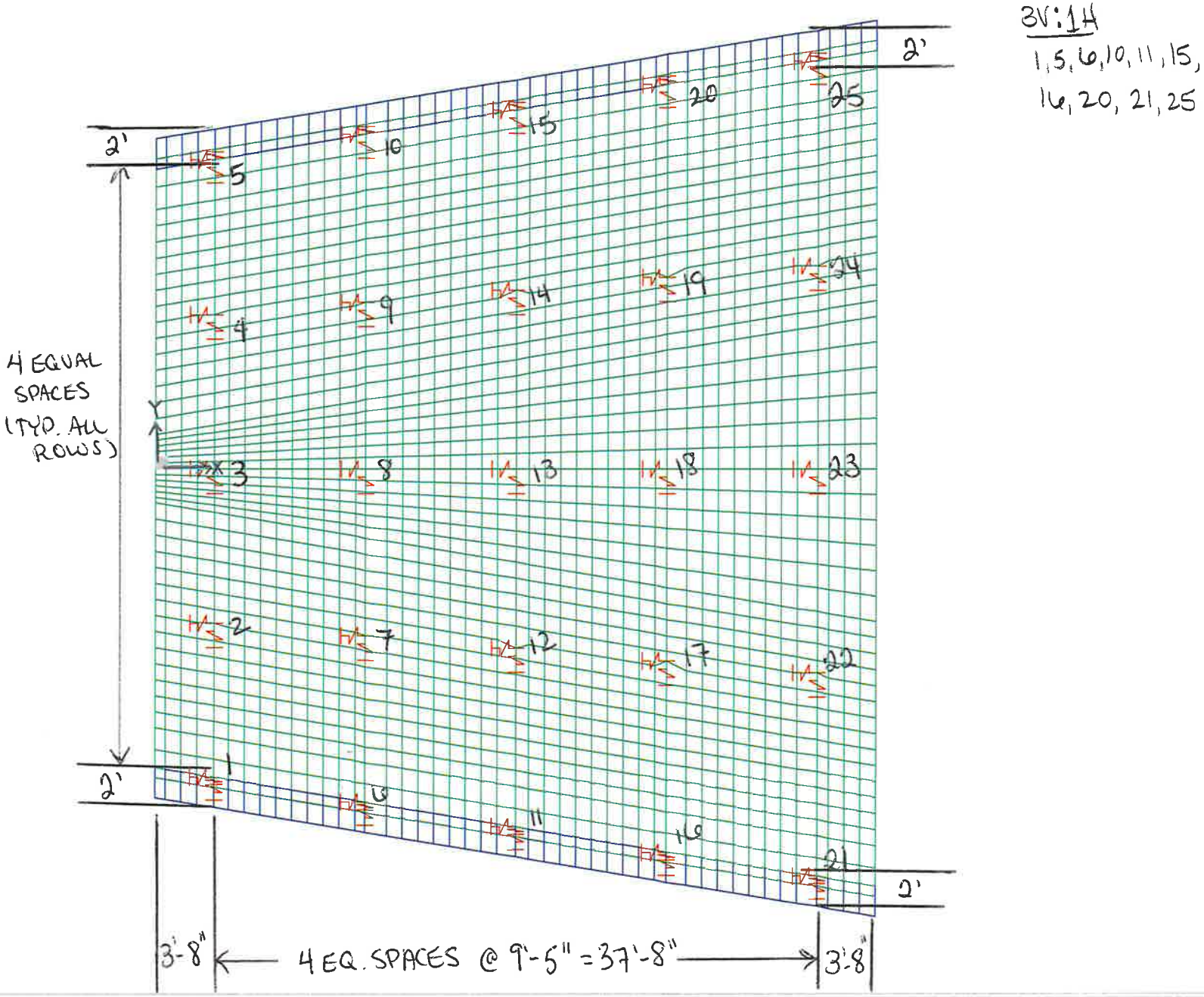
U-4 MODEL:

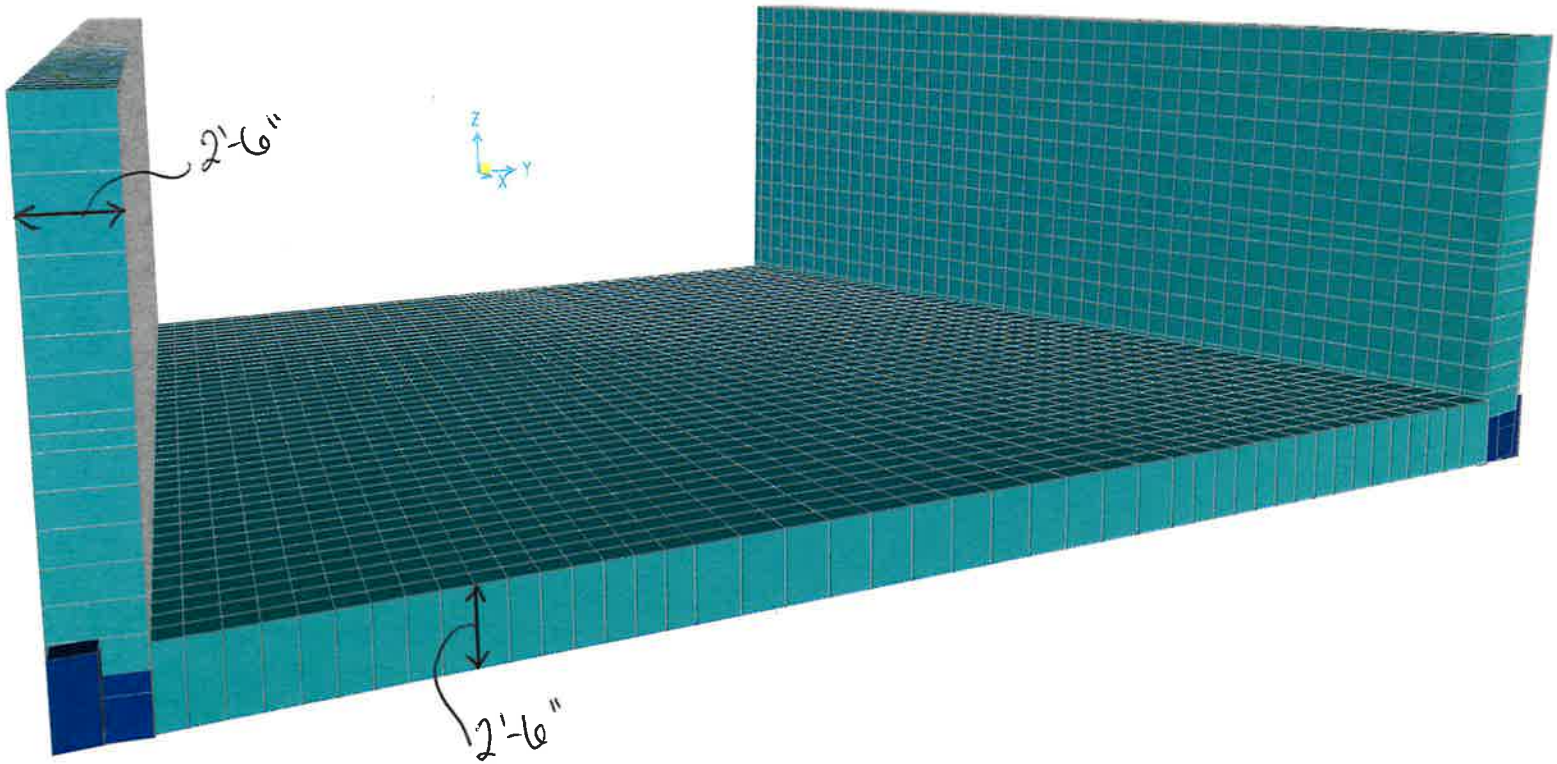
RED = PILE SPRINGS
LIGHT BLUE = NORMAL 4000 PSI 2'-6" MEMBERS
DARK BLUE = "RIGID LINK" 2'-6" MEMBERS




U-4
MODEL:
50'-3" OPENING
45'
X
Y
2'-6"
WALL
36' OPENING
2'-6"
WALL

PILE LAYOUT


3V:1H
1, 5, 6, 10, 11, 15, 16, 20, 21, 25
2'
2'
2'
2'
4 EQUAL SPACES (TYP. ALL ROWS)
Y
X
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
3'-8"
4 EQ. SPACES @ 9'-5" = 37'-8"
3'-8"


2'-6"
Z
Y
X
2'-6"

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page:	of
Description:	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

References

OUTFLOW MONOLITH - U-4 LOADS

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf
γ_{water} =	62.4	pcf
γ_{soil} =	115	pcf
γ' =	52.6	pcf
K_0 =	0.95	
Vert. Surcharge =	250	psf
Horiz. Surcharge =	300	psf

Top of Bank=	9.0	ft NAVD88
Top of Walls=	9.0	ft NAVD88
Top of Base Slab=	-7.0	ft NAVD88 @ start of Monolith
	-5.3	ft NAVD88 @ end of Monolith with 3.78% slope
Bottom of Slab=	-9.5	ft NAVD88 @ start of Monolith
	-7.8	ft NAVD88 @ end of Monolith with 3.78% slope
Minimum water level =	2.0	ft NAVD88
Maximum water level =	9.0	ft NAVD88
Wall thickness=	2.5	ft
Slab thickness=	2.5	ft

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure:

*Above water table: $P_y = \gamma_{fill,\ wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{fill,\ eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap:

*Above water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ eff} * Z_{fill})$

*** LOADS FOR SAP MODEL:**

* Construction Surcharge Loads: Below Top of Soil = $K_0 * q_{surcharge}$ = 285 ksf

* Soil Loads, Dry (Const.): Construction surcharge load applied separately

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
9.0	0.0
-5.925	1630.6
-6.55	1698.8
-7.625	1816.3
-7.8	1835.4
-8.25	1884.6
-9.5	2021.1

URS

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* Soil Loads, UNEVEN Dry (Const.): Soil to EL 9.0 on one side (use pressures above), only to EL 4.0 on other side (use pressures calculated below)

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
9.0	0.0
4.0	0.0
-5.925	1084.3
-6.55	1152.6
-7.625	1270.0
-7.8	1289.2
-8.25	1338.3
-9.5	1474.9

* Soil Loads, Maximum & Minimum Water Levels:

Soil with Min Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
9.0	0.0
2.0	764.8
-5.925	1160.8
-6.55	1192.0
-7.625	1245.7
-7.8	1254.5
-8.25	1276.9
-9.5	1339.4

Soil with Max Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
9.0	0.0
-5.925	745.8
-6.55	777.0
-7.625	830.8
-7.8	839.5
-8.25	862.0
-9.5	924.4

* Water Loads:

- Water press. on **top** of base slab:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-7.0	561.60	998.40	(Pressure at upstream end)
-5.3	455.52	892.32	(Pressure at downstream end)

- Uplift at **bottom** of base slab/uplift:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-9.5	717.60	1154.40	(Pressure at upstream end)
-7.8	611.52	1048.32	(Pressure at downstream end)

- Lateral Water Loads:

Min Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
9.0	0.0
2.0	0.0
-5.925	494.5
-6.55	533.5
-7.625	600.6
-7.80	611.5
-8.25	639.6
-9.5	717.6

Max Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
9.0	0.0
-5.925	931.3
-6.55	970.3
-7.625	1037.4
-7.8	1048.3
-8.25	1076.4
-9.5	1154.4

Note: Water Pressure is equal on either side of the wall (as per hydraulics engineers). Most water pressure cancels out along walls.

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
Description	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
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Monolith U-4 SAP Data:

Outflow Monolith outer wall Joint Pattern for lateral force due to Construction Soil (dry): **"Lat Soil"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
9	0.00
-9.5	2021.13

Equations:

0 = C*9 + D
2021.13 = C*-9.5 + D

C =	-109.250
D =	983.250

Outflow Monolith outer wall Joint Pattern for lateral force due to Uneven Construction Soil: **"Lat Soil - Uneven"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
4	0.00
-9.5	1474.88

Equations:

0 = C*4 + D
1474.88 = C*-9.5 + D

C =	-109.250
D =	437.000

Outflow Monolith wall Joint Pattern for lateral **Soil** load due to **Min Water Level**: **"Lat Soil - Min Water"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
9.0	0.00
2.0	764.75

Equations:

0 = C*9 + D
764.75 = C*2 + D

C =	-109.250	Above Water Level
D =	983.250	

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
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Z	P
2.0	764.75
-9.5	1339.41

Equations:

764.75 = C*2 + D
1339.41 = C*-9.5 + D

C =	-49.970	Below Water Level
D =	864.690	

Outflow Monolith wall Joint Pattern for lateral **Water** load due to **Min Water Level**: **"Lat Water - MIN"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
2.0	0.00
-9.5	717.60

Equations:

0 = C*2 + D
717.6 = C*-9.5 + D

C =	-62.400
D =	124.800

Outflow Monolith outer wall Joint Pattern for lateral **Soil** load due to **Max Water Level**:

The Joint Pattern created for the Lateral Construction Soil Load may be used for this load pattern with a scaling factor.

Soil Pressure @ EL -9.5, Construction Soil = 2021.125 psf
Soil Pressure @ EL -9.5, Saturated Soil = 924.445 psf

Scale factor = 924.45 / 2021.13
= **0.45739** * "Lat Soil" pattern

Outflow Monolith outer wall Joint Pattern for lateral **Water** load due to **Max Water Level**: **"Lat Water - MAX"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
9.0	0.00
-9.5	1154.40

Equations:

0 = C*9 + D
1154.4 = C*-9.5 + D

C =	-62.400
D =	561.600

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
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Outflow Monolith Joint Pattern due to **Downward Water Pressure on Base Slab**:

Min Water: "Vert Water - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	561.60
45.0	455.52

Equations:

561.6 = A*0 + D
455.52 = A*45 + D

A =	-2.357
D =	561.600

Max Water: "Vert Water - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	998.40
45.0	892.32

Equations:

998.4 = A*0 + D
892.32 = A*45 + D

A =	-2.357
D =	998.400

Outflow MonolithJoint Pattern due to **Uplift Pressure on Base Slab**:

Min Water Uplift: "Uplift - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	717.60
45.0	611.52

Equations:

717.6 = A*0 + D
611.52 = A*45 + D

A =	-2.357
D =	717.600

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
Description	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
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Max Water Uplift: "Uplift - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

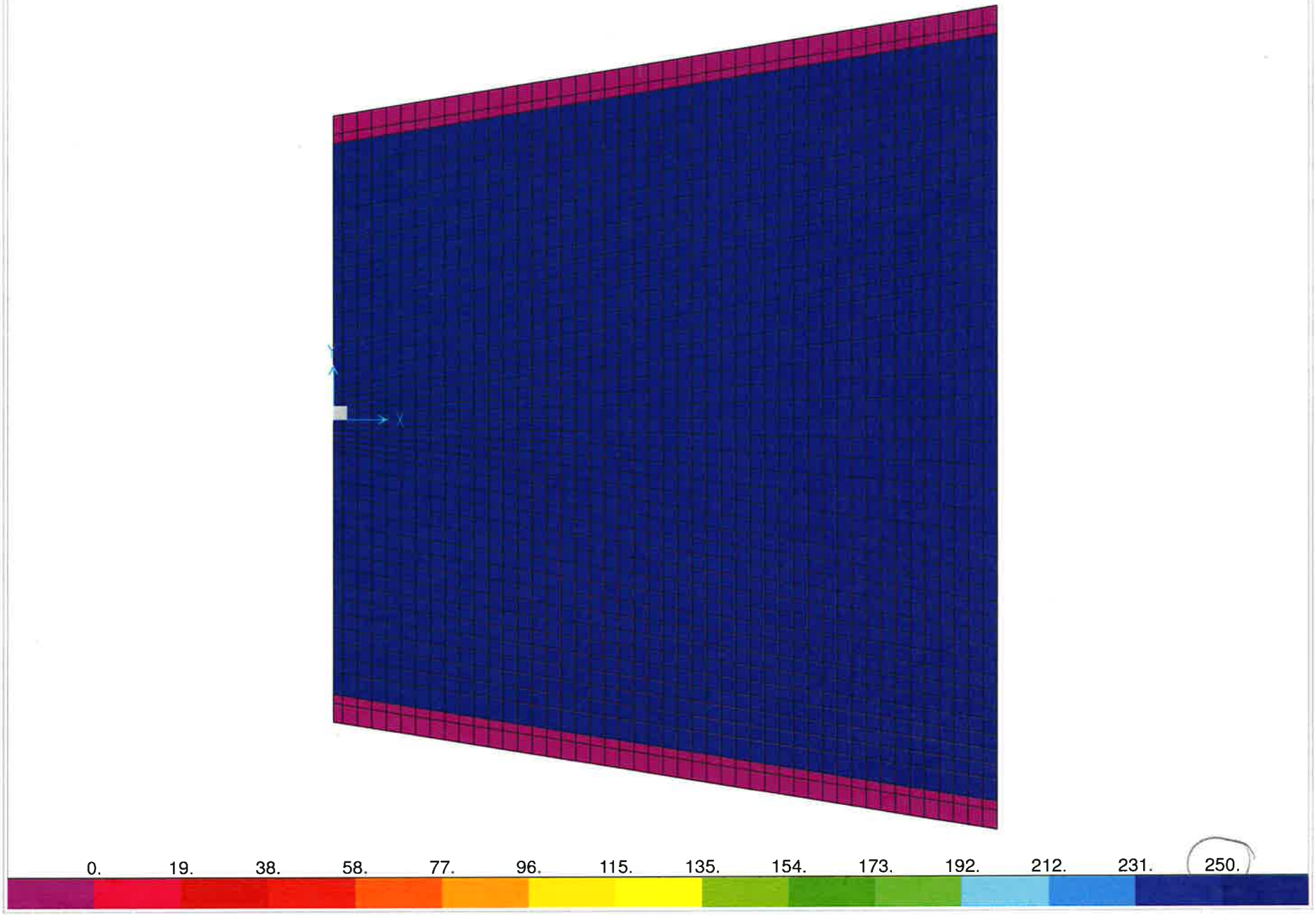
X	P
0	1154.40
45.0	1048.32

Equations:

1154.4 = A*0 + D
1048.32 = A*45 + D

A =	-2.357
D =	1154.400

CONSTRUCTION SURCHARGE:

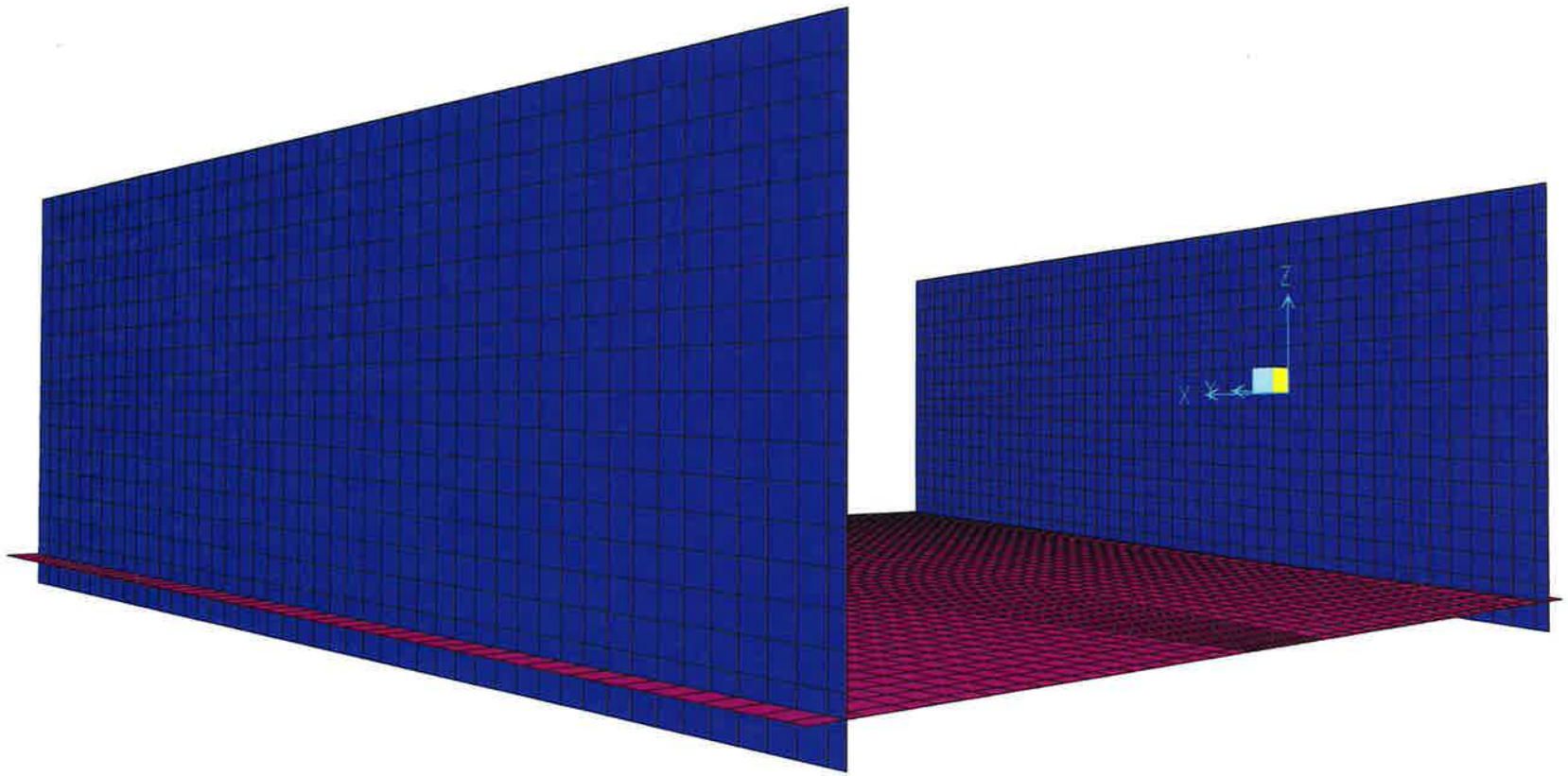


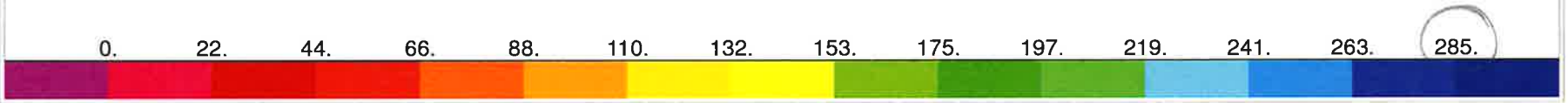
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Top (LS_const) - lb, ft, F Units

SAP2000

8/5/13 9:57:56

CONSTRUCTION SURCHARGE:





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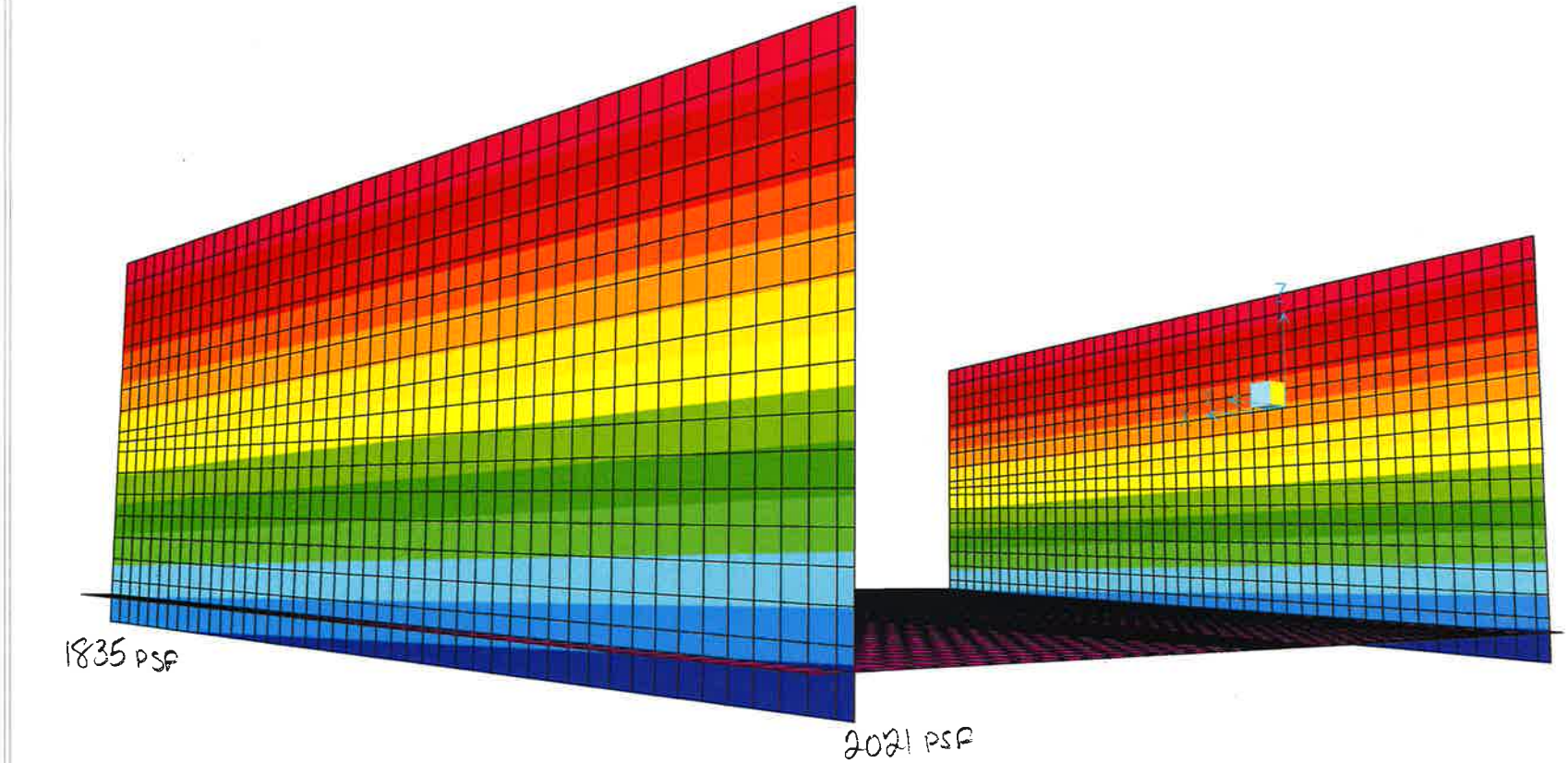
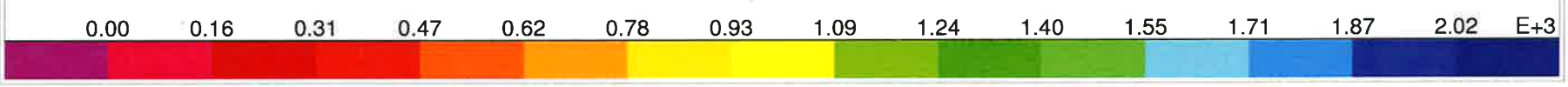
SAP2000 8/5/13 9:46:50

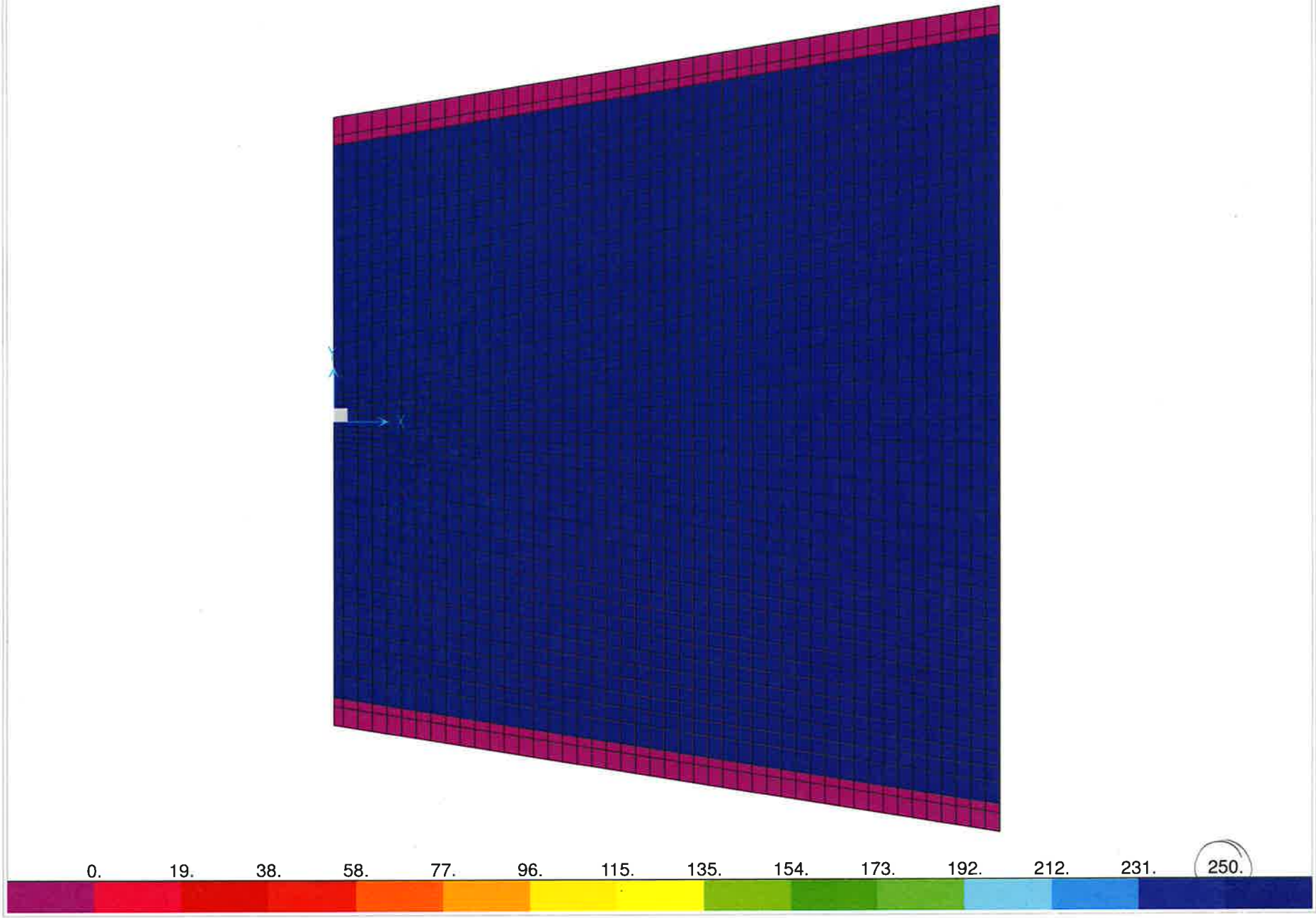
CONSTRUCTION SOIL:





SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (S_const) - lb, ft, F Units

UNEVEN CONSTRUCTION SURCHARGE:

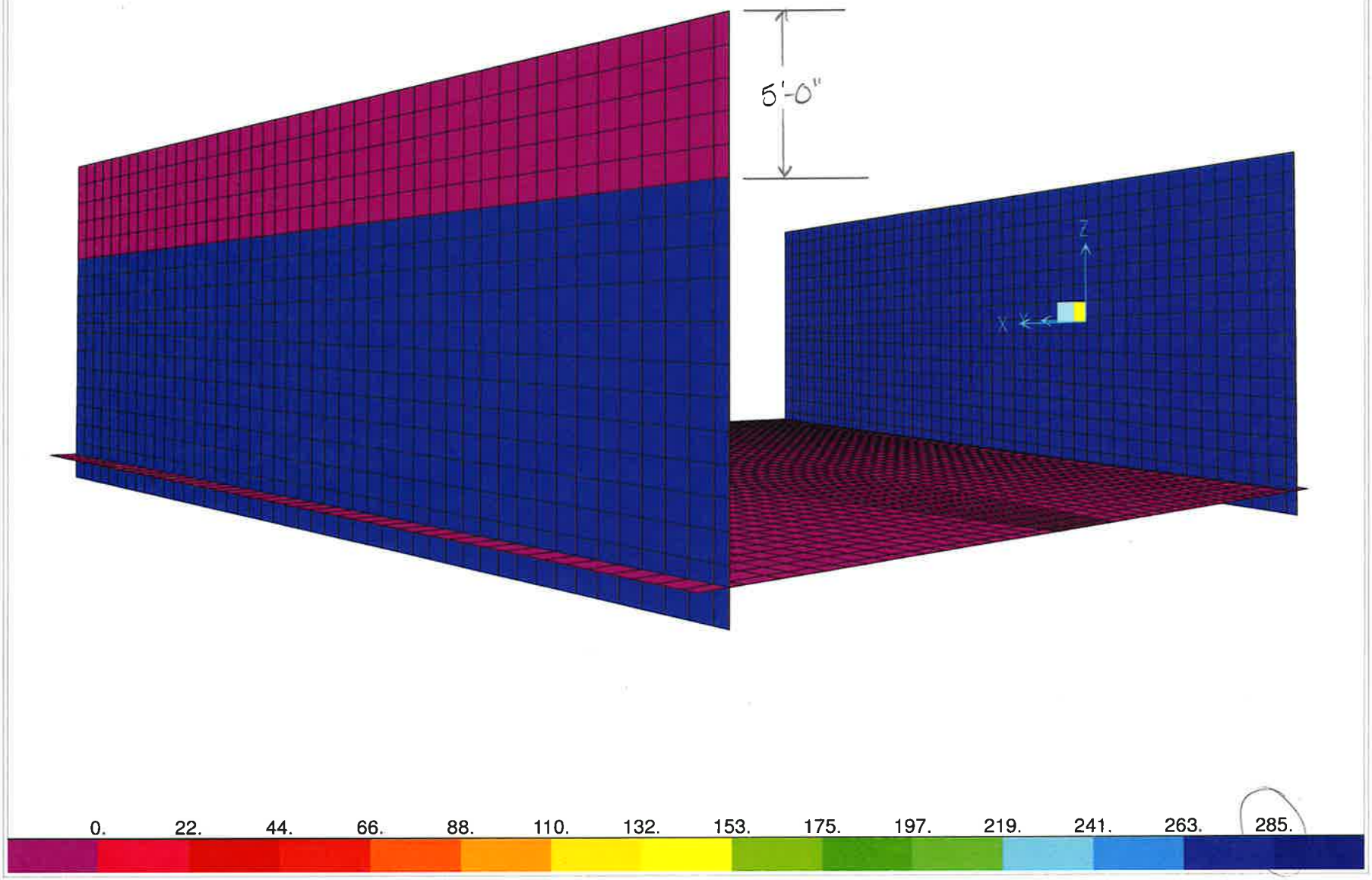


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Top (LS_const_uneven) - lb, ft, F Units

SAP2000

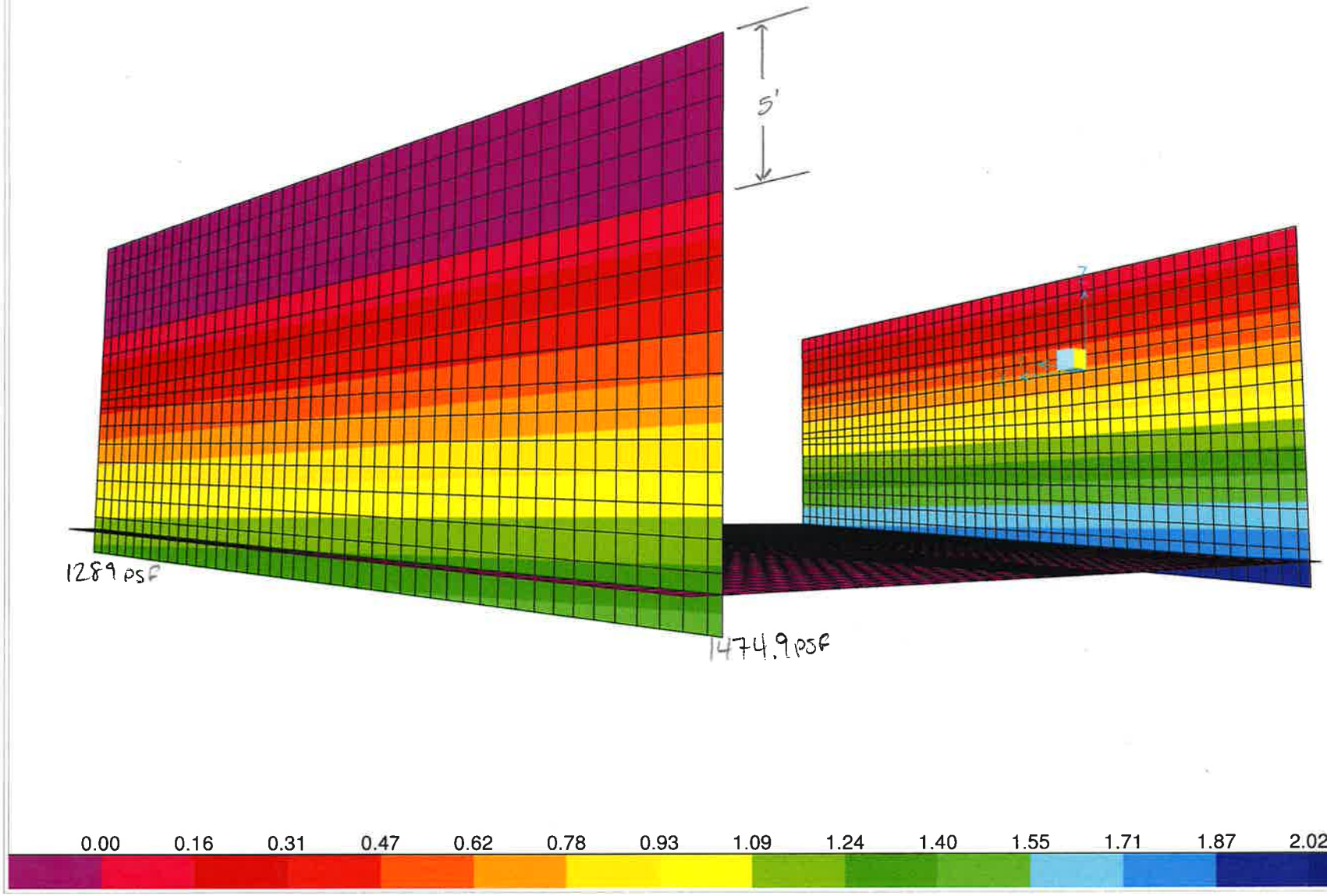
8/5/13 10:01:03

UNEVEN CONSTRUCTION SURCHARGE



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (LS_const_uneven) - lb, ft, F Units

UNEVEN CONSTRUCTION SOIL:

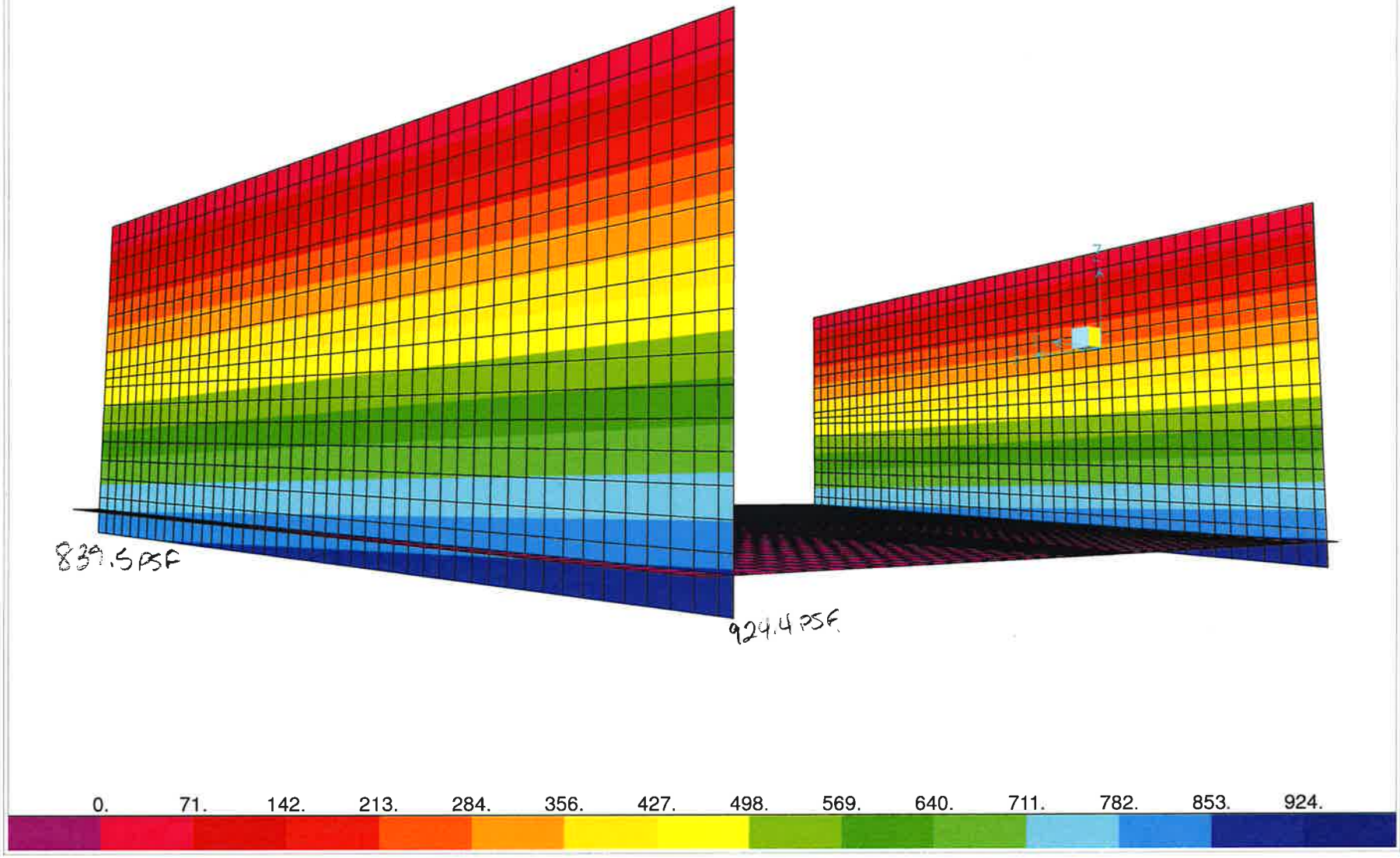


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (S_const_uneven) - lb, ft, F Units

SAP 2000

8/5/13 9:54:16

SATURATED SOIL - MAX WATER LEVEL:

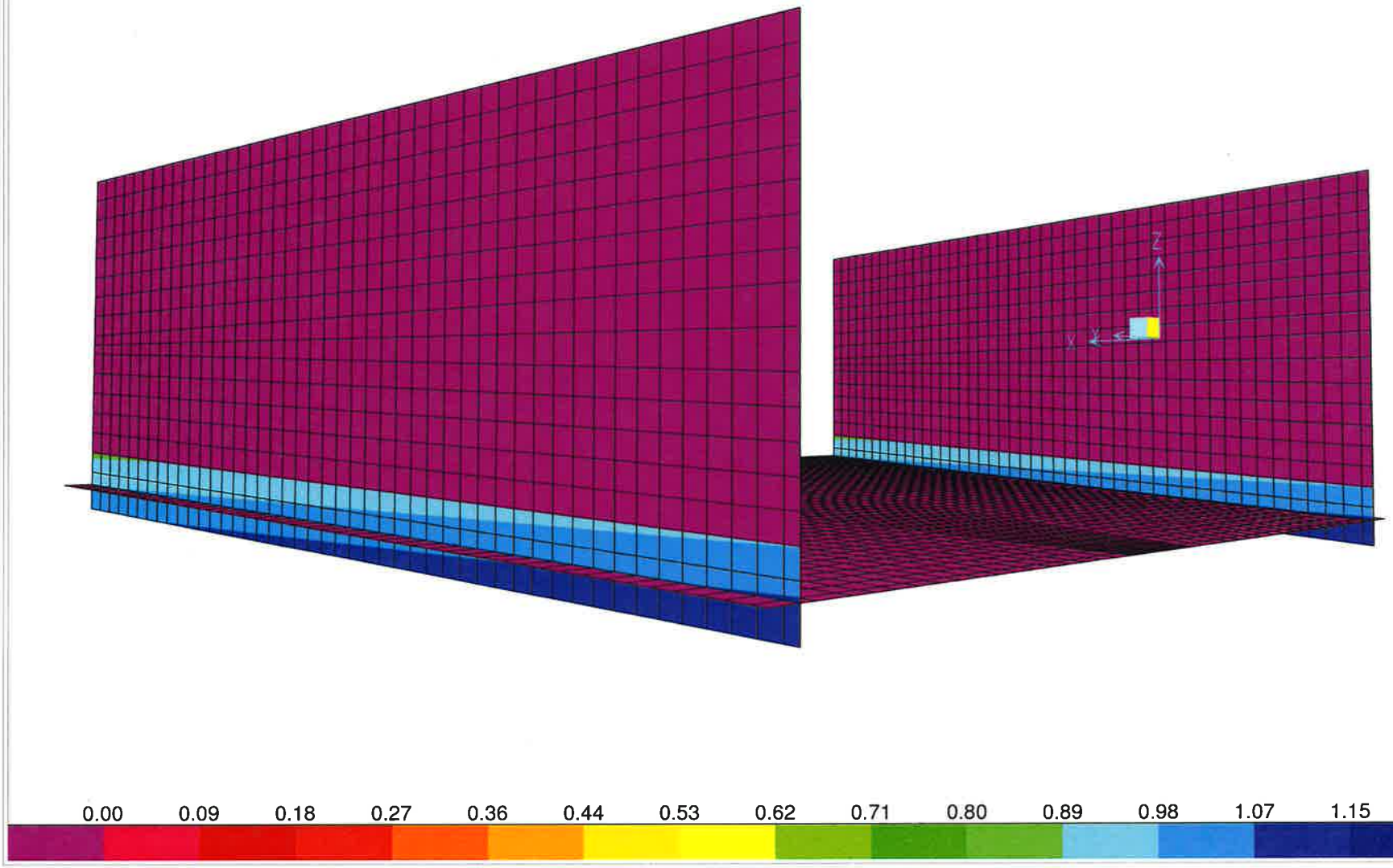


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (S_high water) - lb, ft, F Units

SAP 2000

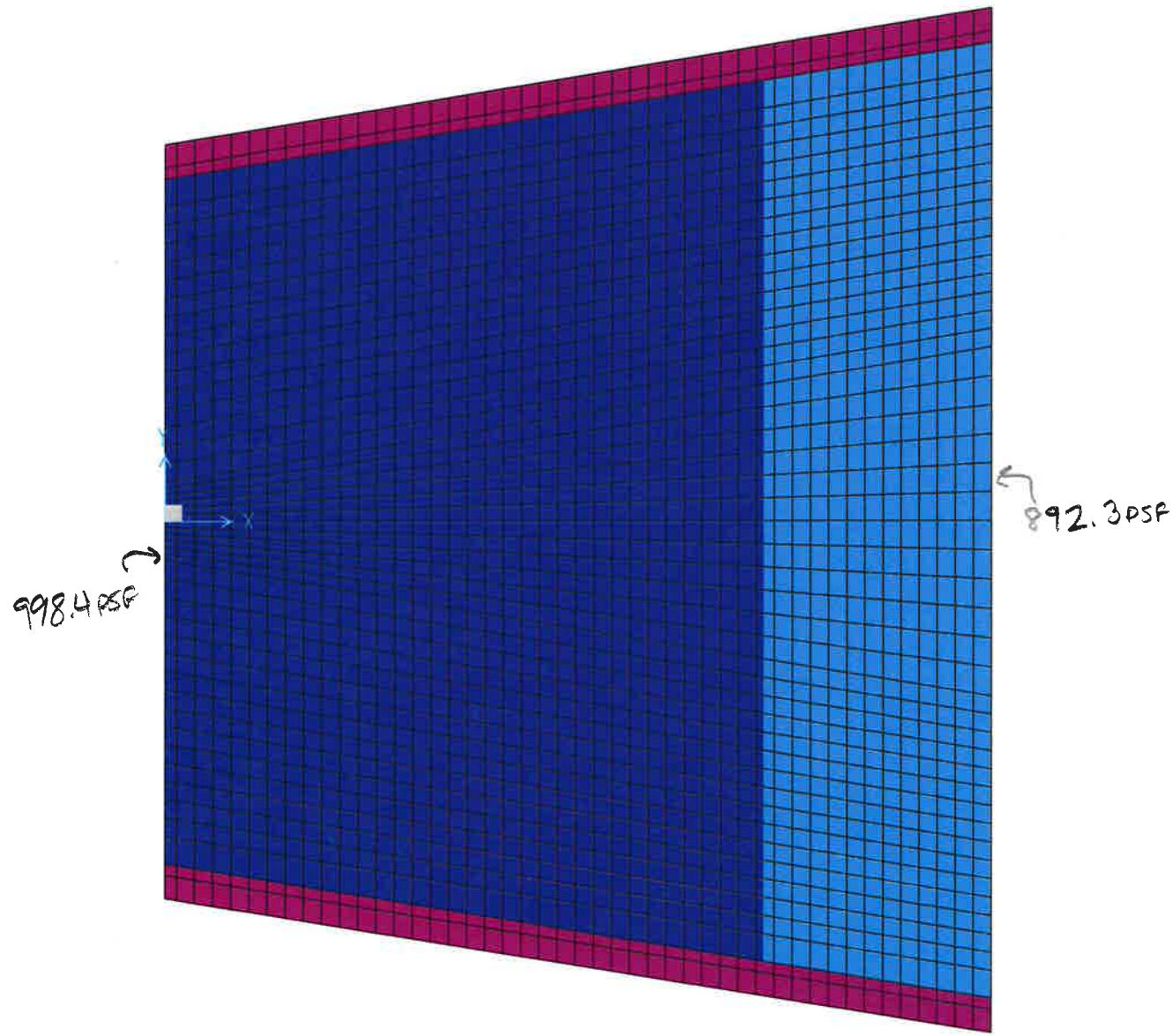
8/5/13 10:57:47

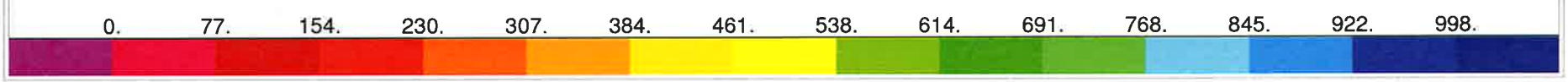
WATER TO EL 9.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (L_high water) - lb, ft, F Units

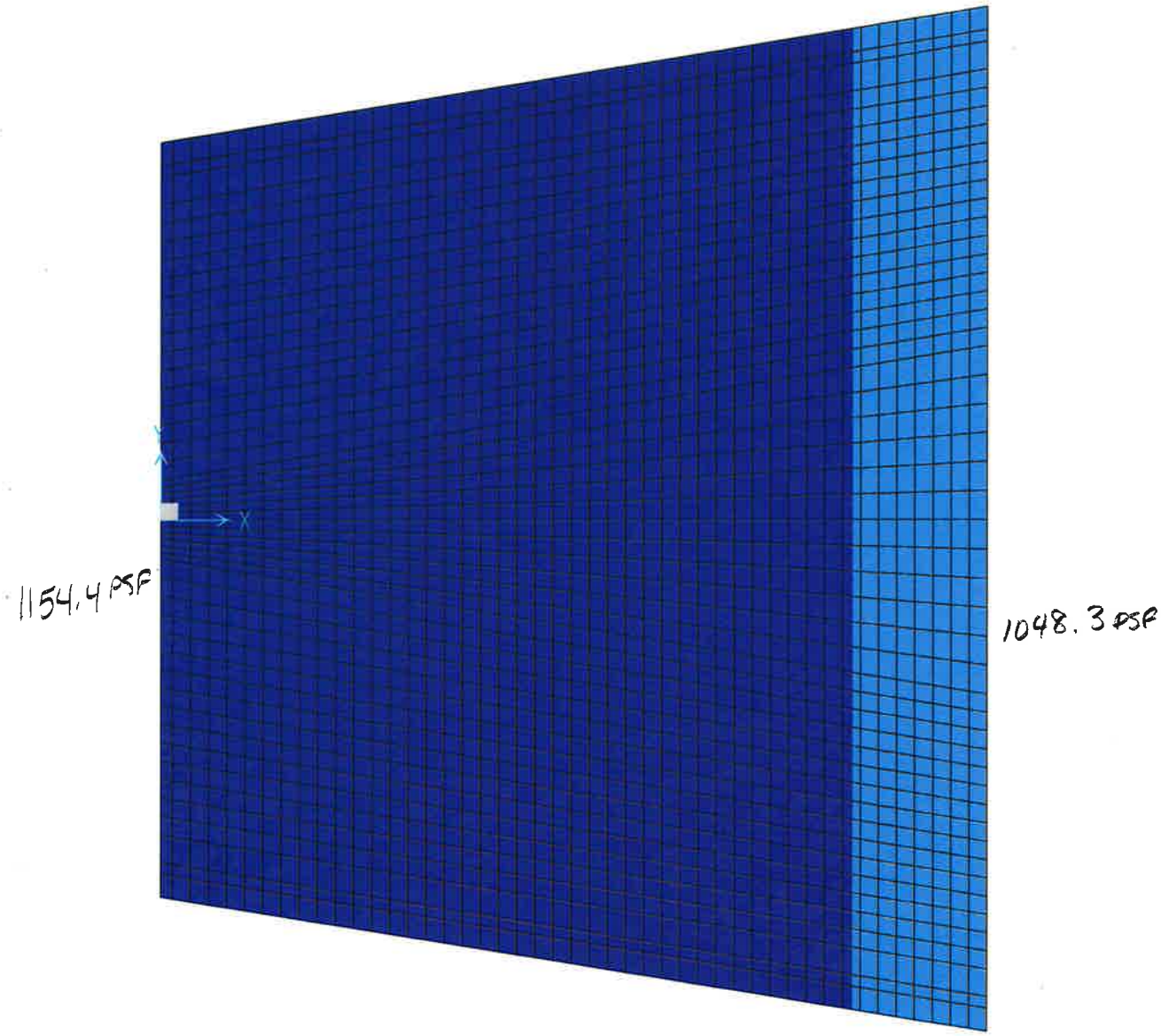
WATER TO EL 9.0, DOWNWARD FORCE:

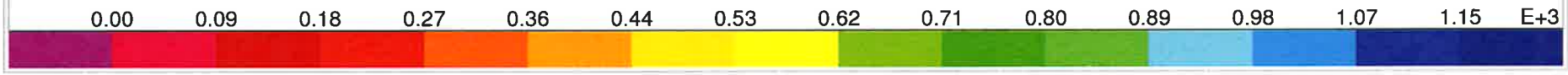




SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Top (L_high water) - lb, ft, F Units

UPLIFT - MAX WATER LEVEL:

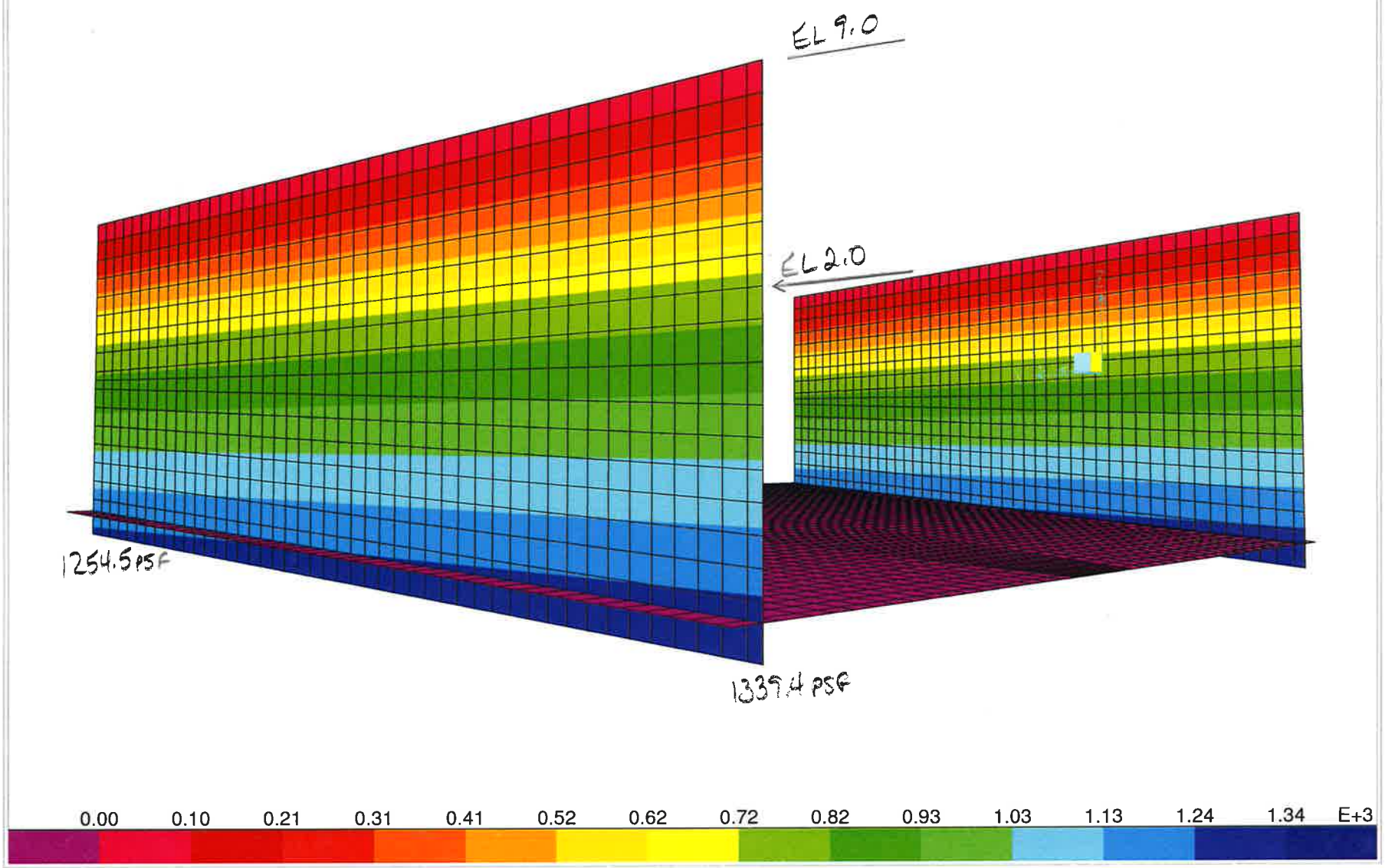




SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (U_high water) - lb, ft, F Units

SAP2000 8/5/13 10:29:37

PARTIALLY SUBMERGED SOIL - WATER EL 2.0:

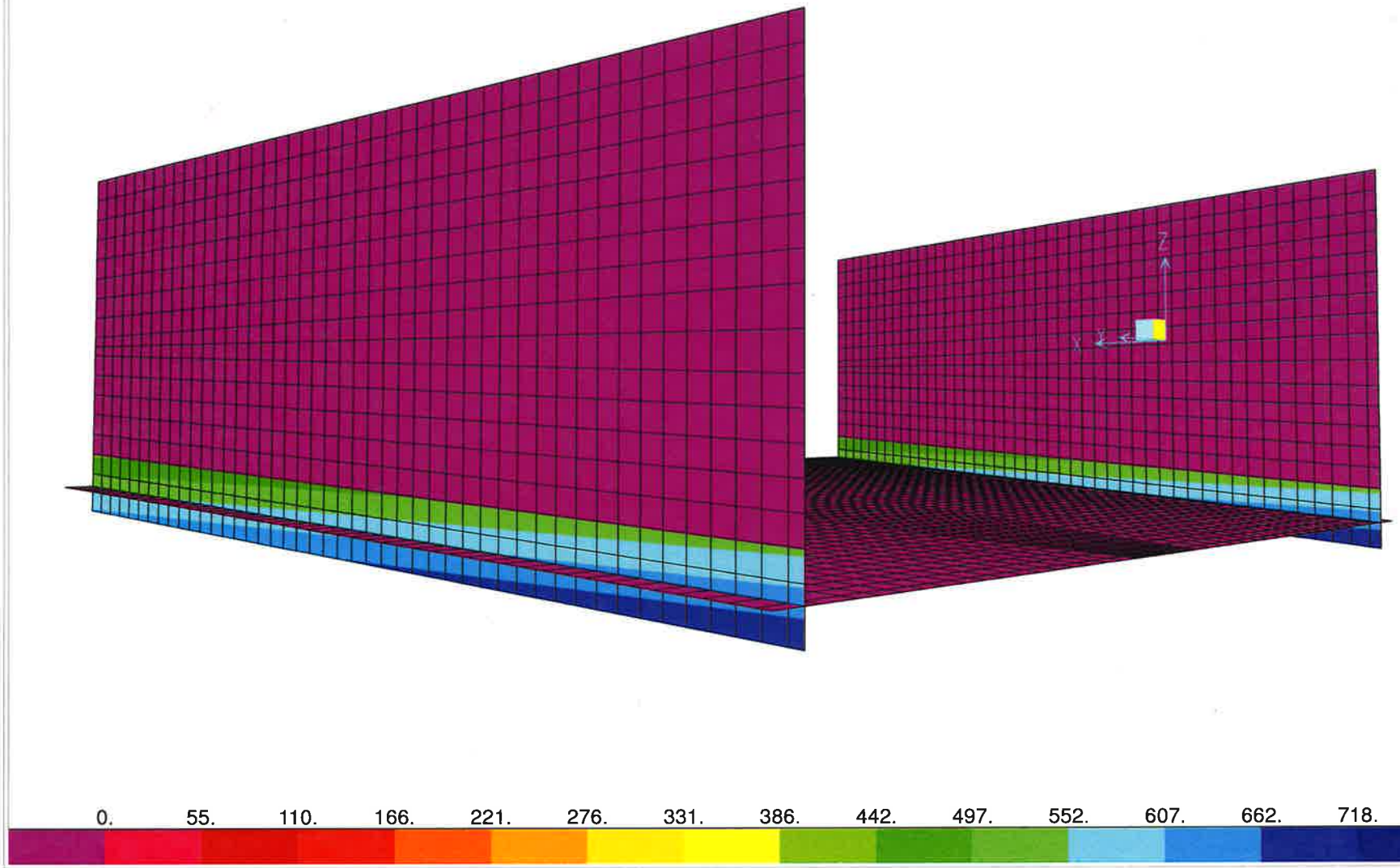


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (S_low water) - lb, ft, F Units

SAP 2000

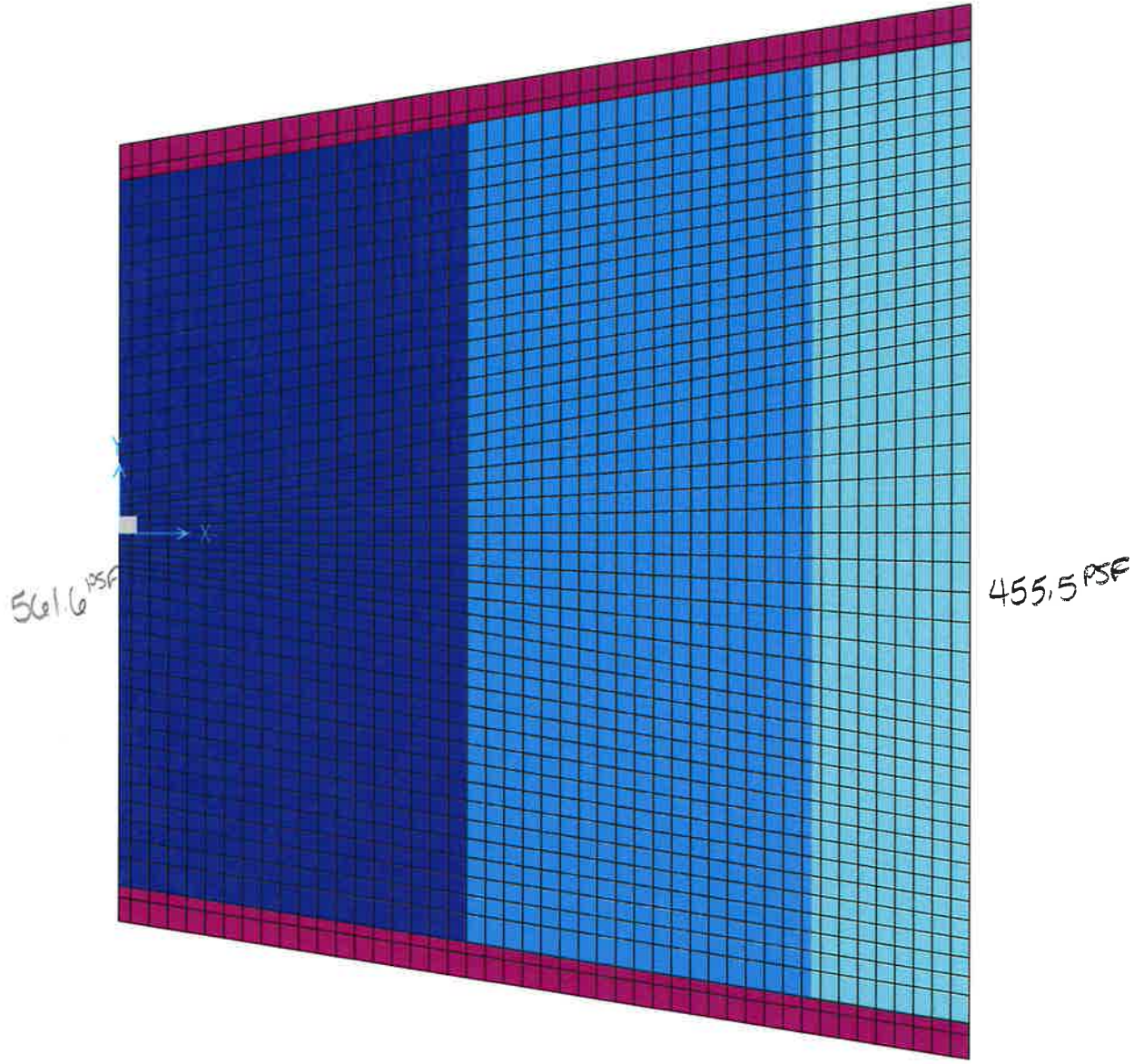
8/5/13 10:57:13

WATER TO EL 2.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (L_low water) - lb, ft, F Units

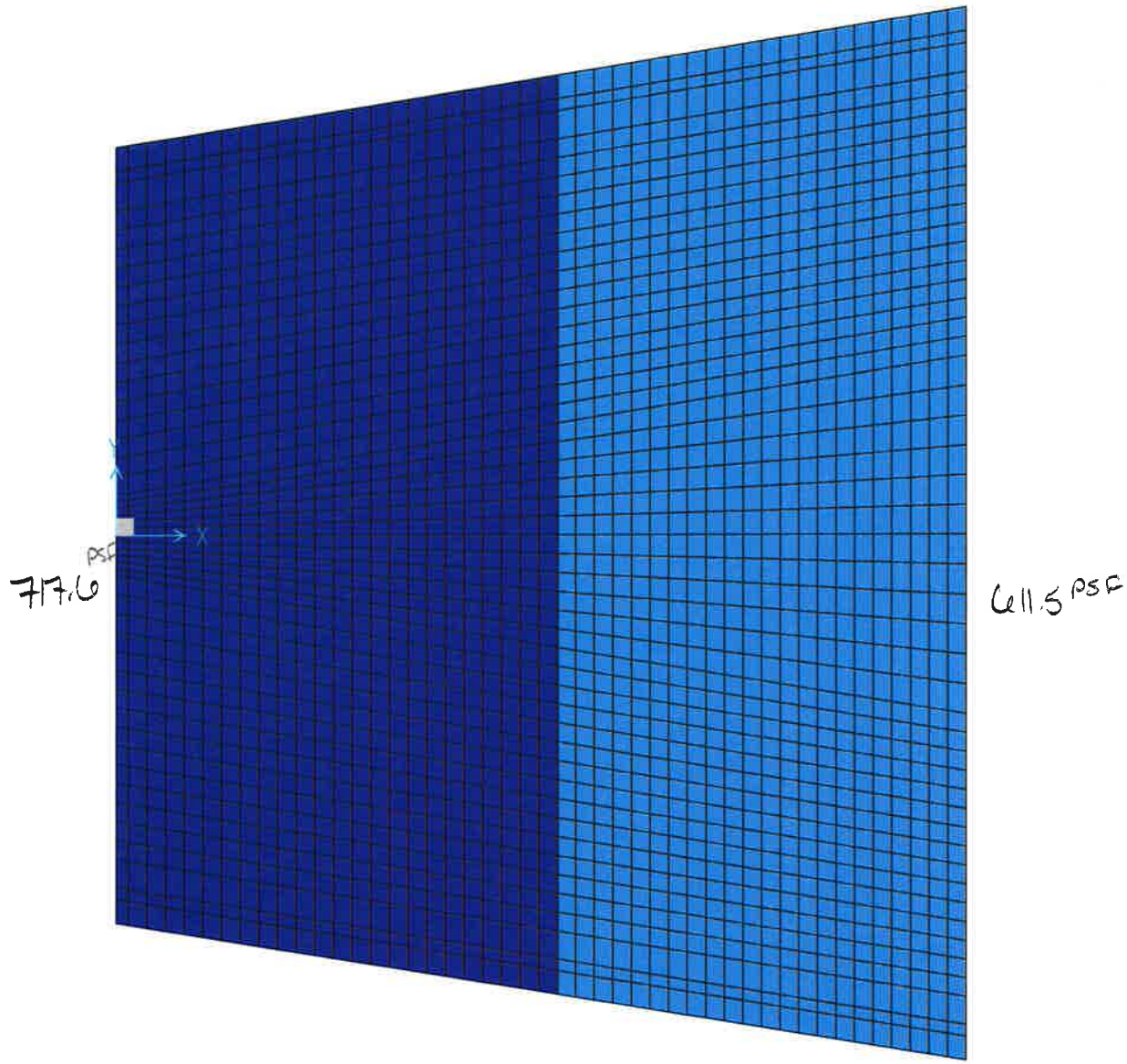
WATER TO EL 2.0, DOWNWARD FORCE:

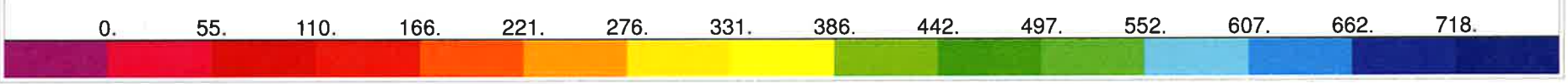


0. 43. 86. 130. 173. 216. 259. 302. 346. 389. 432. 475. 518. 562.

SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Top (L_low water) - lb, ft, F Units

UPLIFT-MIN. WATER LEVEL:

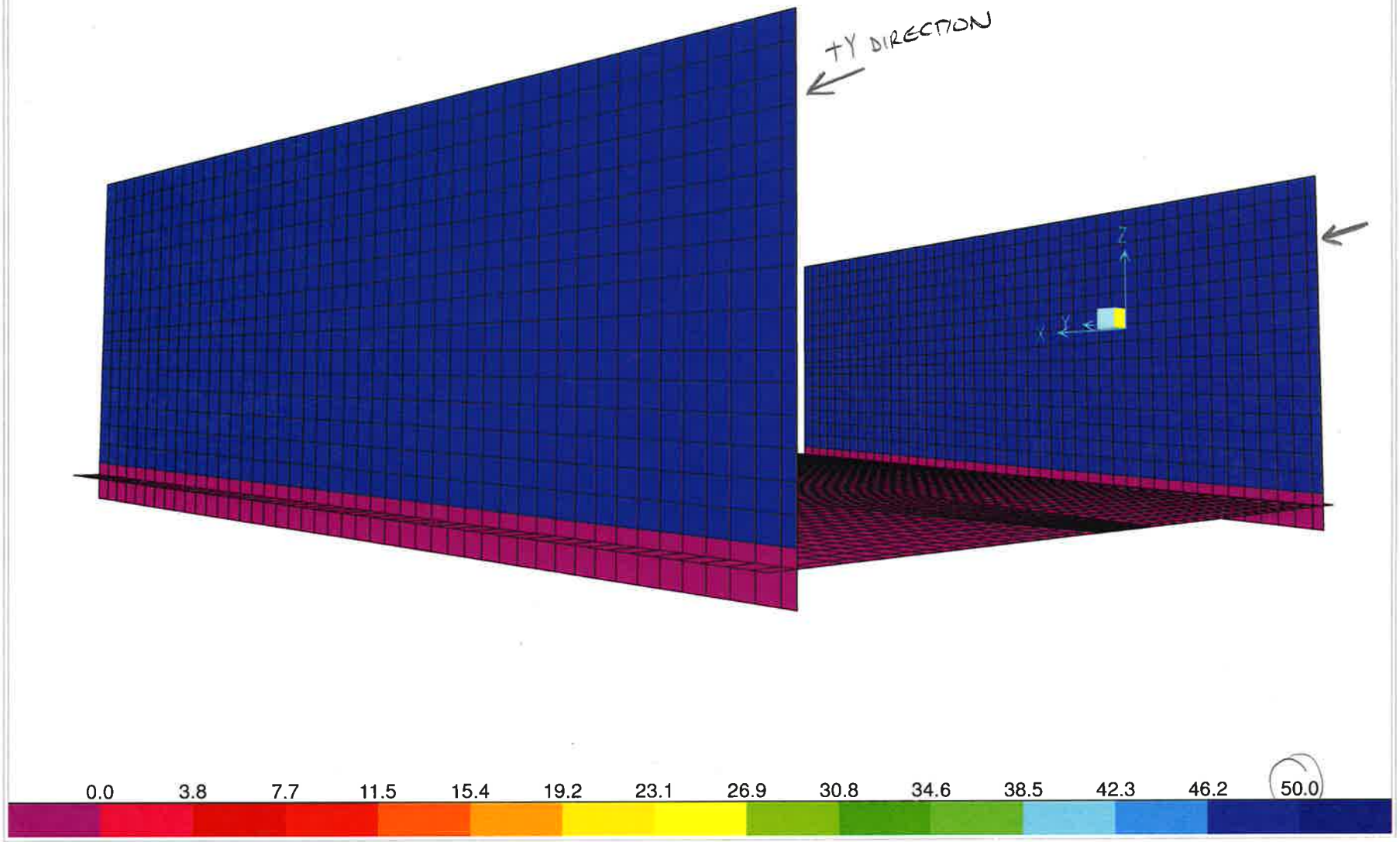




SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Surface Pressure - Face Bottom (U_low water) - lb, ft, F Units

SAP2000 8/5/13 10:11:59

WIND DURING CONSTRUCTION:

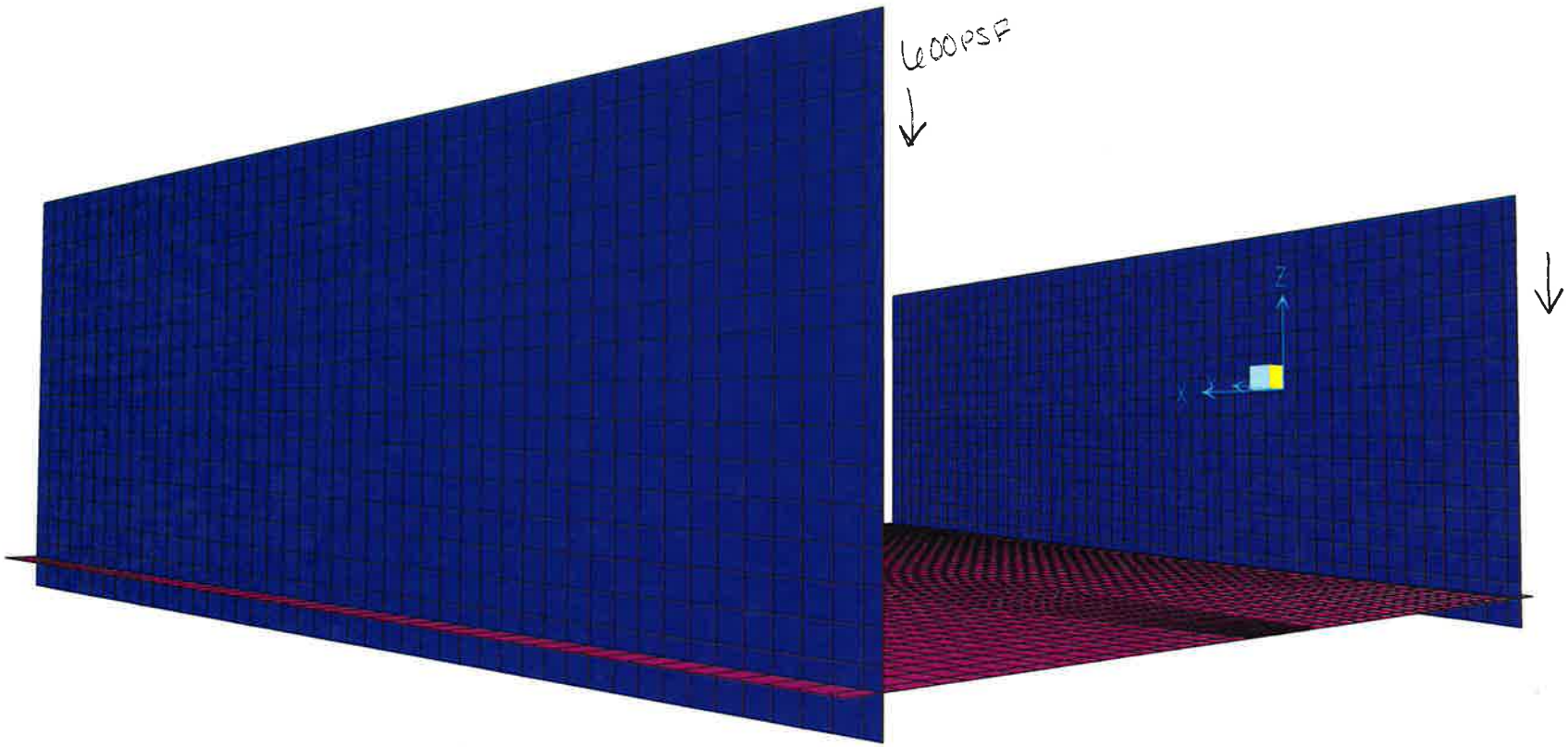


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Uniform (W_construction) (GLOBAL - Y) - lb, ft, F Units

SAP2000

8/5/13 10:06:18

SETTLEMENT FORCE -



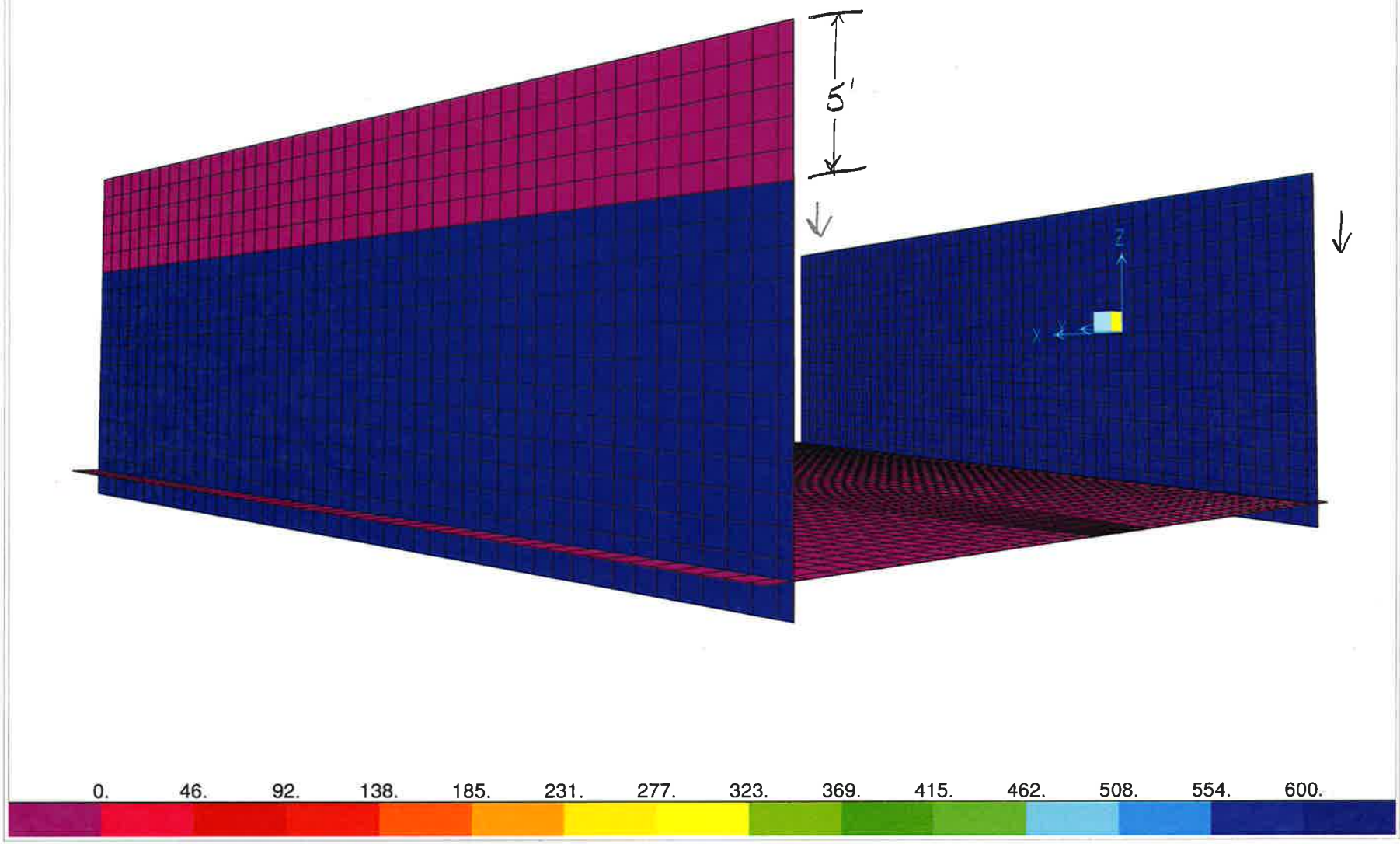
0. 46. 92. 138. 185. 231. 277. 323. 369. 415. 462. 508. 554. 600.

SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Uniform (ST_cohesion) (GLOBAL - Gravity) - lb, ft, F Units

SAP 2000

8/5/13 10:08:36

SETTLEMENT FORCE - UNEVEN FILL:



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Area Uniform (ST_cohesion_uneven) (GLOBAL - Gravity) - lb, ft, F Units

PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use springs equivalent to a pile with tip EL -80.0 (1522.2 k/in) and lateral load of 10k (77.6 k/in)

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	1a	-13.51	1.24	-0.67	*
P-2	1a	-13.77	0.09	92.64	
P-3	1a	-13.78	0.00	101.50	
P-4	1a	-13.77	-0.09	92.65	
P-5	1a	-13.51	-1.24	-0.67	*
P-6	1a	-13.53	1.08	6.00	*
P-7	1a	-13.85	0.03	106.70	
P-8	1a	-13.88	0.00	113.74	
P-9	1a	-13.85	-0.03	106.69	
P-10	1a	-13.53	-1.08	6.00	*
P-11	1a	-13.55	0.92	13.65	*
P-12	1a	-13.93	-0.03	115.68	
P-13	1a	-13.96	0.00	119.00	
P-14	1a	-13.93	0.03	115.68	
P-15	1a	-13.55	-0.92	13.65	*
P-16	1a	-13.57	0.78	19.08	*
P-17	1a	-13.97	-0.10	121.97	
P-18	1a	-14.00	0.00	120.25	
P-19	1a	-13.97	0.10	121.97	
P-20	1a	-13.57	-0.78	19.08	*
P-21	1a	-13.59	0.59	28.00	*
P-22	1a	-13.96	-0.18	131.53	
P-23	1a	-14.01	0.00	123.11	
P-24	1a	-13.96	0.18	131.54	
P-25	1a	-13.59	-0.59	28.00	*
P-1	1b	-13.31	-9.69	-12.68	*
P-2	1b	-12.20	-10.39	105.05	
P-3	1b	-10.88	-10.42	86.13	
P-4	1b	-9.57	-10.40	60.81	
P-5	1b	-8.17	-10.34	62.55	*
P-6	1b	-13.55	-11.15	-7.38	*
P-7	1b	-12.39	-11.72	121.14	
P-8	1b	-10.96	-11.71	96.44	
P-9	1b	-9.51	-11.66	67.22	
P-10	1b	-7.96	-11.54	68.75	*
P-11	1b	-13.79	-12.63	-1.31	*
P-12	1b	-12.56	-13.06	132.22	
P-13	1b	-11.03	-12.98	101.36	
P-14	1b	-9.45	-12.91	70.70	
P-15	1b	-7.76	-12.74	75.46	*
P-16	1b	-14.03	-14.07	3.02	*
P-17	1b	-12.72	-14.39	140.66	
P-18	1b	-11.06	-14.25	102.90	
P-19	1b	-9.37	-14.14	72.43	
P-20	1b	-7.54	-13.95	81.01	*
P-21	1b	-14.26	-15.56	10.08	*
P-22	1b	-12.82	-15.74	151.09	
P-23	1b	-11.08	-15.53	104.69	
P-24	1b	-9.28	-15.38	75.40	
P-25	1b	-7.35	-15.14	88.38	*

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	1c	-0.02	-3.55	63.24	*
P-2	1c	0.06	-2.30	46.65	
P-3	1c	0.09	-2.13	30.26	
P-4	1c	0.05	-1.95	36.82	
P-5	1c	-0.08	-0.56	77.58	*
P-6	1c	-0.02	-3.58	66.05	*
P-7	1c	0.04	-2.27	49.29	
P-8	1c	0.07	-2.11	33.13	
P-9	1c	0.03	-1.95	39.00	
P-10	1c	-0.08	-0.50	79.97	*
P-11	1c	-0.02	-3.61	68.71	*
P-12	1c	0.04	-2.25	50.77	
P-13	1c	0.06	-2.10	34.93	
P-14	1c	0.02	-1.94	40.40	
P-15	1c	-0.09	-0.44	82.17	*
P-16	1c	-0.03	-3.65	71.70	*
P-17	1c	0.03	-2.23	51.59	
P-18	1c	0.05	-2.08	35.53	
P-19	1c	0.01	-1.92	41.23	
P-20	1c	-0.10	-0.37	84.81	*
P-21	1c	-0.03	-3.68	74.18	*
P-22	1c	0.01	-2.22	50.53	
P-23	1c	0.02	-2.06	33.57	
P-24	1c	-0.01	-1.90	39.99	
P-25	1c	-0.11	-0.32	86.74	*
P-1	2	-5.50	-0.14	19.69	*
P-2	2	-5.53	-0.07	35.14	
P-3	2	-5.51	0.00	32.61	
P-4	2	-5.53	0.07	35.14	
P-5	2	-5.50	0.14	19.70	*
P-6	2	-5.51	-0.21	22.42	*
P-7	2	-5.56	-0.09	39.55	
P-8	2	-5.55	0.00	36.39	
P-9	2	-5.56	0.09	39.55	
P-10	2	-5.51	0.21	22.43	*
P-11	2	-5.52	-0.28	25.39	*
P-12	2	-5.59	-0.11	42.11	
P-13	2	-5.58	0.00	37.72	
P-14	2	-5.59	0.11	42.11	
P-15	2	-5.52	0.28	25.39	*
P-16	2	-5.53	-0.34	27.85	*
P-17	2	-5.61	-0.14	43.82	
P-18	2	-5.60	0.00	37.70	
P-19	2	-5.61	0.14	43.82	
P-20	2	-5.53	0.34	27.85	*
P-21	2	-5.54	-0.41	31.10	*
P-22	2	-5.61	-0.17	46.01	
P-23	2	-5.61	0.00	37.55	
P-24	2	-5.61	0.16	46.01	
P-25	2	-5.54	0.41	31.10	*

* Denotes battered piles

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	3	-8.26	0.57	1.75	*
P-2	3	-8.38	-0.02	45.69	
P-3	3	-8.37	0.00	46.71	
P-4	3	-8.38	0.02	45.70	
P-5	3	-8.26	-0.57	1.76	*
P-6	3	-8.27	0.47	5.65	*
P-7	3	-8.43	-0.06	52.73	
P-8	3	-8.43	0.00	52.21	
P-9	3	-8.43	0.06	52.73	
P-10	3	-8.27	-0.47	5.65	*
P-11	3	-8.28	0.37	10.07	*
P-12	3	-8.47	-0.10	56.81	
P-13	3	-8.48	0.00	53.72	
P-14	3	-8.47	0.10	56.81	
P-15	3	-8.28	-0.37	10.07	*
P-16	3	-8.30	0.29	13.32	*
P-17	3	-8.50	-0.14	59.57	
P-18	3	-8.50	0.00	53.24	
P-19	3	-8.50	0.14	59.57	
P-20	3	-8.30	-0.29	13.32	*
P-21	3	-8.31	0.17	18.40	*
P-22	3	-8.50	-0.19	64.19	
P-23	3	-8.51	0.00	53.72	
P-24	3	-8.50	0.19	64.19	
P-25	3	-8.31	-0.17	18.40	*

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	Dead	-0.05	-1.49	70.41	*
P-2	Dead	0.05	-0.18	41.73	
P-3	Dead	0.09	0.00	30.26	
P-4	Dead	0.05	0.17	41.74	
P-5	Dead	-0.05	1.49	70.41	*
P-6	Dead	-0.05	-1.54	73.01	*
P-7	Dead	0.04	-0.16	44.14	
P-8	Dead	0.07	0.00	33.13	
P-9	Dead	0.04	0.16	44.14	
P-10	Dead	-0.05	1.54	73.01	*
P-11	Dead	-0.06	-1.59	75.44	*
P-12	Dead	0.03	-0.15	45.59	
P-13	Dead	0.06	0.00	34.93	
P-14	Dead	0.03	0.15	45.59	
P-15	Dead	-0.06	1.59	75.44	*
P-16	Dead	-0.06	-1.64	78.25	*
P-17	Dead	0.02	-0.15	46.41	
P-18	Dead	0.05	0.00	35.53	
P-19	Dead	0.02	0.15	46.41	
P-20	Dead	-0.06	1.64	78.25	*
P-21	Dead	-0.07	-1.68	80.46	*
P-22	Dead	0.00	-0.16	45.26	
P-23	Dead	0.02	0.00	33.57	
P-24	Dead	0.00	0.16	45.26	
P-25	Dead	-0.07	1.68	80.46	*

* Denotes battered piles

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.1 kips
MINIMUM REACTION = -14.3 kips

Horizontal Reactions, Y-Direction:

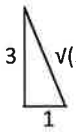
MAXIMUM REACTION = 1.7 kips
MINIMUM REACTION = -15.7 kips

Vertical Reactions:

MAXIMUM REACTION = 151.1 kips
MINIMUM REACTION = -12.7 kips

Max. Battered Reaction = 88.4 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



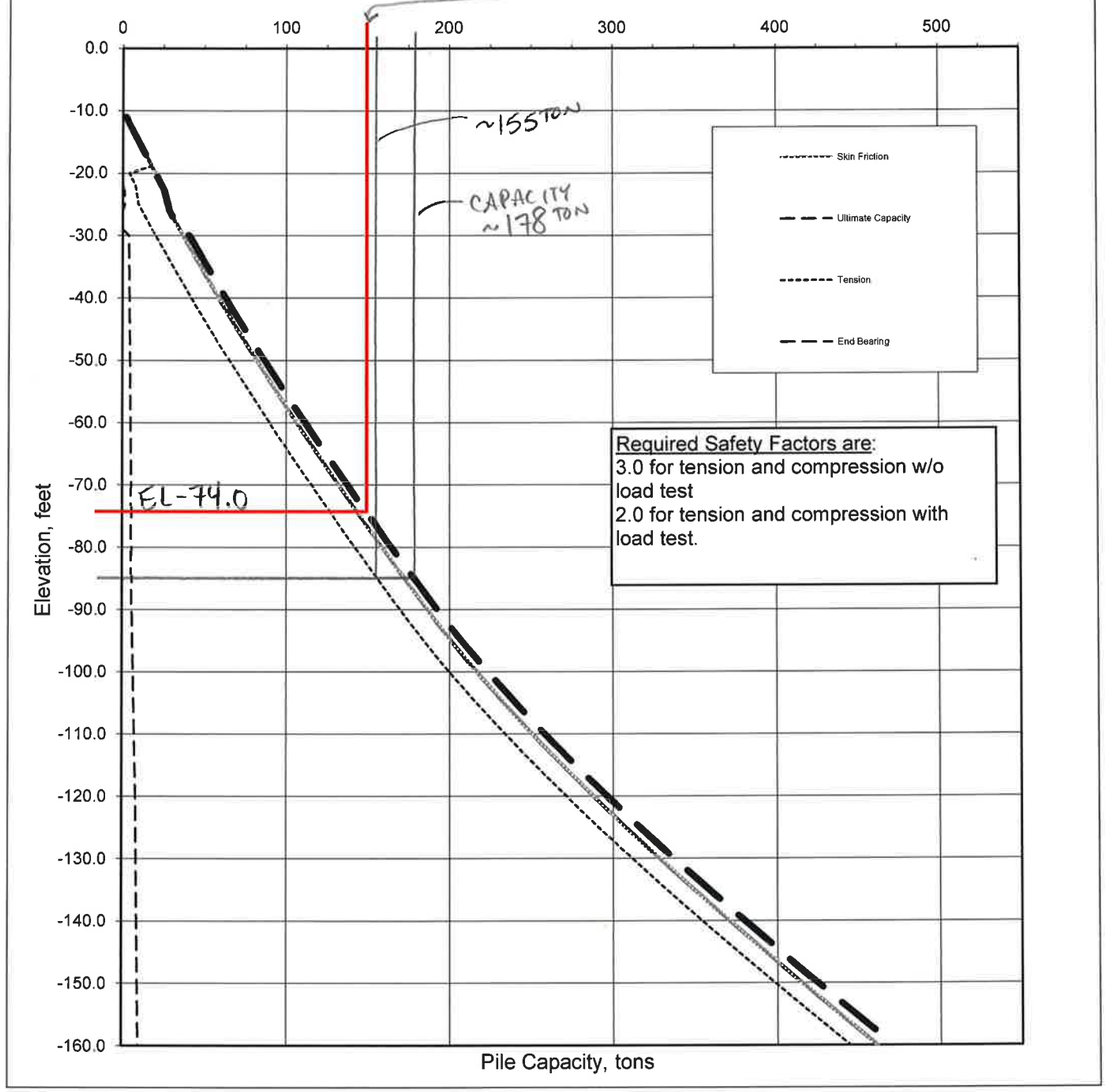
$\sqrt{(3^2+1^2)} = 3.1623$

88.4 kips * 3.1623 / 3 = 93.2 kips

Therefore, Absolute Maximum Vertical Reaction = 151.1 kips

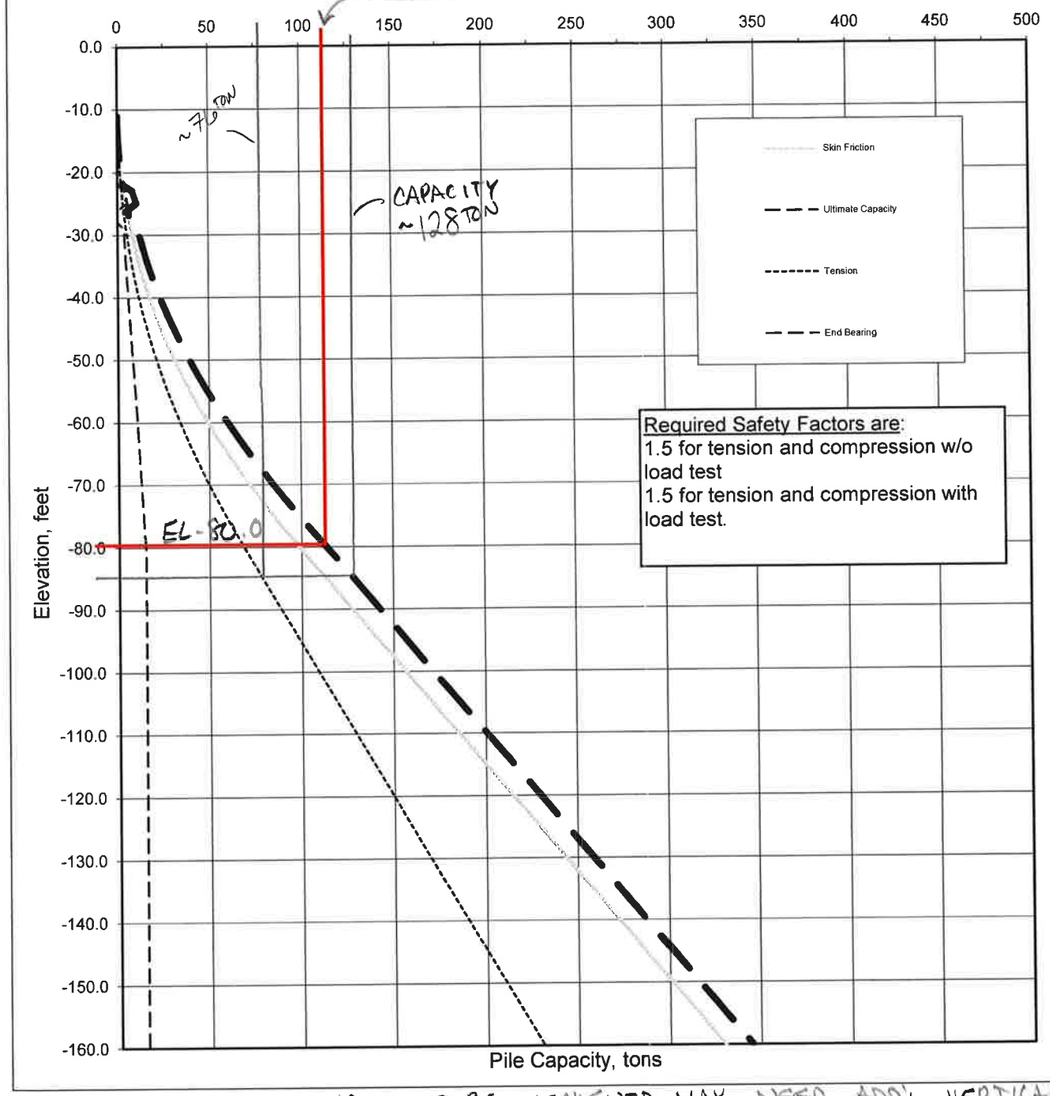
Undrained Strength Case with HP 14x89 Pile

151^k REQUIRED × 1 TON / 2 KIP × 2 (FOS.) = 151 TON



Drained Strength Case with HP 14x89 Pile

151^k REQ × 1 TON / 2 KIP × 1.5 (F.O.S.) = 113.2 TON



B/C LATERAL SPRINGS ABOUT TO BE WEAKENED, MAY NEED ADD'L VERTICAL CAPACITY. SET TIPS @ EL-85.0 ⇒ C_{ALLOW} = 170.7^k (DRAINED CONTROLS)

T_{ALLOW} = 101.3^k (DRAINED CONTROLS)

Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Lake Maurepas Diversion Canal	Project No. 10001863	Pile Capacities: Intake Structure HP - 14X89	URS	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Load Calculations for SAP **Computed By:** LBR **Date:** Aug-13 **Page:** of
Monolith U-4 Pile Springs **Checked By:** **Date:** **Sheet:** of

PILE/SPRING STIFFNESS INPUT IN SAP **HP14x89 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required from the pile capacity curves = -85.0 NAVD88
Top of pile Elevation including 9" Pile embedment = (-8.65 + 0.75) ft = -7.90 NAVD88 (-8.65 is avg. value)
Therefore, required length of pile = 77.10 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

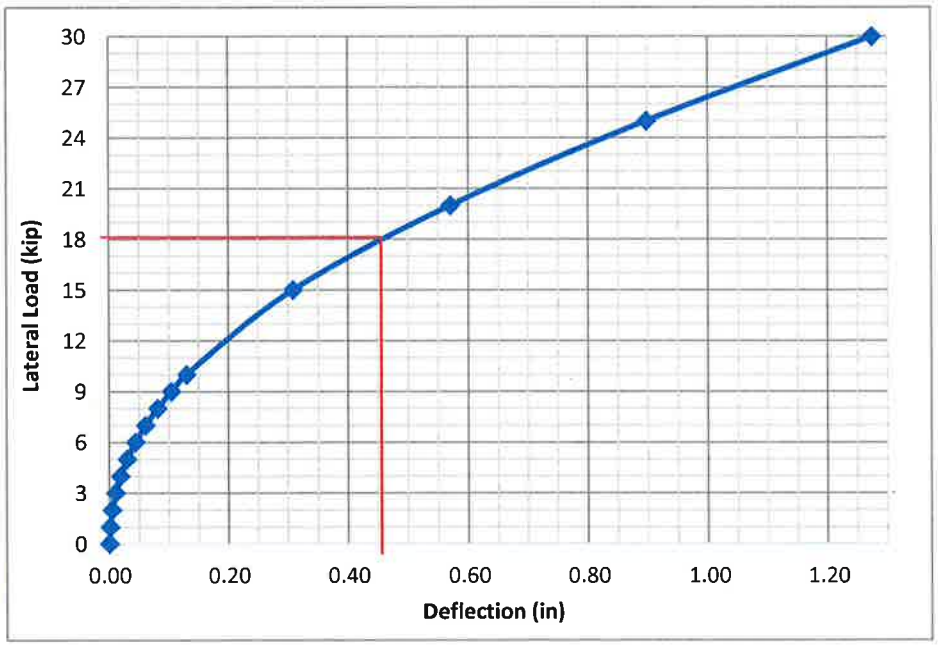
Modulus of Elasticity of the pile (E) = 29,000 ksi

Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 1423.5 k/in
= **17082 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



Try the spring that corresponds to a 15k lateral reaction

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
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The results below use springs equivalent to a pile with tip EL -85.0 (1423.5 k/in) and lateral load of 15k (48.7 k/in)

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	1a	-13.60	0.79	0.56	*
P-2	1a	-13.77	0.07	91.66	
P-3	1a	-13.78	0.00	101.40	
P-4	1a	-13.77	-0.07	91.66	
P-5	1a	-13.60	-0.79	0.56	*
P-6	1a	-13.61	0.68	7.09	*
P-7	1a	-13.82	0.03	105.41	
P-8	1a	-13.84	0.00	113.54	
P-9	1a	-13.82	-0.03	105.41	
P-10	1a	-13.61	-0.68	7.09	*
P-11	1a	-13.62	0.57	14.56	*
P-12	1a	-13.87	-0.01	114.42	
P-13	1a	-13.89	0.00	119.09	
P-14	1a	-13.87	0.01	114.42	
P-15	1a	-13.62	-0.58	14.56	*
P-16	1a	-13.64	0.49	19.91	*
P-17	1a	-13.90	-0.05	120.86	
P-18	1a	-13.92	0.00	120.82	
P-19	1a	-13.90	0.05	120.86	
P-20	1a	-13.64	-0.49	19.91	*
P-21	1a	-13.65	0.37	28.59	*
P-22	1a	-13.89	-0.10	130.50	
P-23	1a	-13.92	0.00	124.21	
P-24	1a	-13.89	0.10	130.50	
P-25	1a	-13.65	-0.37	28.59	*
P-1	1b	-13.31	-9.54	-14.83	* T
P-2	1b	-12.16	-9.81	111.79	
P-3	1b	-10.89	-9.81	86.15	
P-4	1b	-9.62	-9.83	52.86	
P-5	1b	-8.28	-9.92	66.32	*
P-6	1b	-13.54	-10.91	-10.34	* T
P-7	1b	-12.32	-11.07	128.55	
P-8	1b	-10.94	-11.04	96.35	
P-9	1b	-9.55	-11.05	58.12	
P-10	1b	-8.07	-11.11	73.16	*
P-11	1b	-13.76	-12.27	-5.20	* T
P-12	1b	-12.47	-12.34	140.37	
P-13	1b	-10.98	-12.27	101.44	
P-14	1b	-9.47	-12.26	60.88	
P-15	1b	-7.87	-12.30	80.60	*
P-16	1b	-14.00	-13.63	-1.51	* T
P-17	1b	-12.61	-13.61	149.63	
P-18	1b	-11.01	-13.49	103.30	
P-19	1b	-9.38	-13.46	62.00	
P-20	1b	-7.66	-13.50	86.70	*
P-21	1b	-14.21	-15.00	4.44	* T
P-22	1b	-12.71	-14.88	160.40	
P-23	1b	-11.02	-14.72	105.46	
P-24	1b	-9.29	-14.67	64.79	
P-25	1b	-7.47	-14.68	94.88	*

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	1c	-0.02	-2.98	62.03	*
P-2	1c	0.04	-2.12	48.43	
P-3	1c	0.06	-2.00	30.58	
P-4	1c	0.03	-1.89	35.54	
P-5	1c	-0.04	-0.98	78.33	*
P-6	1c	-0.02	-3.00	65.01	*
P-7	1c	0.03	-2.10	51.00	
P-8	1c	0.05	-1.99	33.36	
P-9	1c	0.02	-1.88	37.72	
P-10	1c	-0.05	-0.94	80.64	*
P-11	1c	-0.02	-3.02	67.83	*
P-12	1c	0.02	-2.08	52.40	
P-13	1c	0.04	-1.98	35.07	
P-14	1c	0.02	-1.88	39.18	
P-15	1c	-0.05	-0.90	82.76	*
P-16	1c	-0.03	-3.05	71.00	*
P-17	1c	0.02	-2.07	53.15	
P-18	1c	0.03	-1.96	35.61	
P-19	1c	0.01	-1.87	40.07	
P-20	1c	-0.06	-0.86	85.30	*
P-21	1c	-0.03	-3.07	73.61	*
P-22	1c	0.01	-2.06	52.00	
P-23	1c	0.02	-1.95	33.64	
P-24	1c	0.00	-1.85	39.00	
P-25	1c	-0.06	-0.82	87.19	*
P-1	2	-5.52	-0.10	19.95	*
P-2	2	-5.54	-0.05	34.93	
P-3	2	-5.53	0.00	32.71	
P-4	2	-5.54	0.04	34.93	
P-5	2	-5.52	0.10	19.96	*
P-6	2	-5.53	-0.15	22.66	*
P-7	2	-5.56	-0.06	39.25	
P-8	2	-5.55	0.00	36.44	
P-9	2	-5.56	0.06	39.25	
P-10	2	-5.53	0.15	22.67	*
P-11	2	-5.53	-0.19	25.58	*
P-12	2	-5.58	-0.07	41.82	
P-13	2	-5.57	0.00	37.85	
P-14	2	-5.58	0.07	41.82	
P-15	2	-5.53	0.19	25.59	*
P-16	2	-5.54	-0.23	28.03	*
P-17	2	-5.59	-0.09	43.57	
P-18	2	-5.58	0.00	37.94	
P-19	2	-5.59	0.08	43.57	
P-20	2	-5.54	0.23	28.03	*
P-21	2	-5.54	-0.28	31.22	*
P-22	2	-5.59	-0.10	45.79	
P-23	2	-5.59	0.00	37.93	
P-24	2	-5.59	0.10	45.79	
P-25	2	-5.54	0.28	31.22	*

* Denotes battered piles

T = MAY REQUIRE TENSION CONNECTOR

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
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TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	3	-8.30	0.36	2.37	*
P-2	3	-8.38	-0.01	45.17	
P-3	3	-8.38	0.00	46.74	
P-4	3	-8.38	0.01	45.17	
P-5	3	-8.30	-0.36	2.37	*
P-6	3	-8.31	0.29	6.19	*
P-7	3	-8.41	-0.03	52.05	
P-8	3	-8.42	0.00	52.21	
P-9	3	-8.41	0.03	52.04	
P-10	3	-8.31	-0.29	6.19	*
P-11	3	-8.32	0.23	10.50	*
P-12	3	-8.44	-0.06	56.15	
P-13	3	-8.45	0.00	53.89	
P-14	3	-8.44	0.06	56.15	
P-15	3	-8.32	-0.23	10.51	*
P-16	3	-8.33	0.17	13.70	*
P-17	3	-8.46	-0.09	58.99	
P-18	3	-8.46	0.00	53.67	
P-19	3	-8.46	0.08	58.99	
P-20	3	-8.33	-0.18	13.70	*
P-21	3	-8.34	0.10	18.65	*
P-22	3	-8.46	-0.11	63.64	
P-23	3	-8.46	0.00	54.42	
P-24	3	-8.46	0.11	63.64	
P-25	3	-8.34	-0.10	18.65	*

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	Dead	-0.03	-1.00	70.18	*
P-2	Dead	0.04	-0.12	41.98	
P-3	Dead	0.06	0.00	30.58	
P-4	Dead	0.04	0.12	41.98	
P-5	Dead	-0.03	1.00	70.18	*
P-6	Dead	-0.03	-1.03	72.82	*
P-7	Dead	0.03	-0.11	44.36	
P-8	Dead	0.05	0.00	33.36	
P-9	Dead	0.03	0.11	44.36	
P-10	Dead	-0.03	1.03	72.82	*
P-11	Dead	-0.04	-1.06	75.29	*
P-12	Dead	0.02	-0.10	45.79	
P-13	Dead	0.04	0.00	35.07	
P-14	Dead	0.02	0.10	45.79	
P-15	Dead	-0.04	1.06	75.29	*
P-16	Dead	-0.04	-1.10	78.15	*
P-17	Dead	0.01	-0.10	46.61	
P-18	Dead	0.03	0.00	35.61	
P-19	Dead	0.01	0.10	46.61	
P-20	Dead	-0.04	1.10	78.15	*
P-21	Dead	-0.05	-1.12	80.40	*
P-22	Dead	0.00	-0.11	45.50	
P-23	Dead	0.02	0.00	33.64	
P-24	Dead	0.00	0.11	45.50	
P-25	Dead	-0.05	1.12	80.40	*

* Denotes battered piles

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.1 kips
MINIMUM REACTION = -14.2 kips

Horizontal Reactions, Y-Direction:

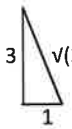
MAXIMUM REACTION = 1.1 kips
MINIMUM REACTION = -15.0 kips

Vertical Reactions:

MAXIMUM REACTION = 160.4 kips
MINIMUM REACTION = -14.8 kips

Max. Battered Reaction = 94.9 kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(3^2+1^2)} = 3.1623$

94.88 kips * 3.1623 / 3 = 100.02 kips

Therefore, Absolute Maximum Vertical Reaction = 160.40 kips

$C_{allowable,\ EL\ -85.0}$ = **170.7 kips > Max Reaction = 160.4 kips** **OK**

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-4 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

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TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	1a	0.27921	-0.01613	-0.00039
P-2	1a	0.28274	-0.00144	-0.06439
P-3	1a	0.28297	0.00000	-0.07124
P-4	1a	0.28274	0.00145	-0.06439
P-5	1a	0.27920	0.01613	-0.00039
P-6	1a	0.27949	-0.01403	-0.00498
P-7	1a	0.28380	-0.00071	-0.07405
P-8	1a	0.28417	0.00000	-0.07976
P-9	1a	0.28379	0.00072	-0.07405
P-10	1a	0.27948	0.01404	-0.00498
P-11	1a	0.27977	-0.01180	-0.01023
P-12	1a	0.28478	0.00014	-0.08038
P-13	1a	0.28530	0.00000	-0.08366
P-14	1a	0.28478	-0.00013	-0.08038
P-15	1a	0.27977	0.01181	-0.01023
P-16	1a	0.28001	-0.01003	-0.01399
P-17	1a	0.28535	0.00108	-0.08490
P-18	1a	0.28583	0.00000	-0.08487
P-19	1a	0.28535	-0.00108	-0.08490
P-20	1a	0.28001	0.01004	-0.01399
P-21	1a	0.28033	-0.00751	-0.02008
P-22	1a	0.28526	0.00204	-0.09167
P-23	1a	0.28590	0.00000	-0.08726
P-24	1a	0.28526	-0.00203	-0.09168
P-25	1a	0.28033	0.00752	-0.02008
P-1	1b	0.27340	0.19596	0.01042
P-2	1b	0.24976	0.20138	-0.07853
P-3	1b	0.22363	0.20134	-0.06052
P-4	1b	0.19755	0.20180	-0.03713
P-5	1b	0.16998	0.20368	-0.04659
P-6	1b	0.27808	0.22395	0.00726
P-7	1b	0.25299	0.22734	-0.09031
P-8	1b	0.22462	0.22674	-0.06768
P-9	1b	0.19604	0.22685	-0.04083
P-10	1b	0.16577	0.22815	-0.05140
P-11	1b	0.28263	0.25203	0.00366
P-12	1b	0.25603	0.25335	-0.09861
P-13	1b	0.22553	0.25195	-0.07126
P-14	1b	0.19455	0.25174	-0.04277
P-15	1b	0.16169	0.25254	-0.05662
P-16	1b	0.28744	0.27981	0.00106
P-17	1b	0.25886	0.27943	-0.10511
P-18	1b	0.22602	0.27705	-0.07257
P-19	1b	0.19270	0.27649	-0.04356
P-20	1b	0.15730	0.27721	-0.06091
P-21	1b	0.29186	0.30809	-0.00312
P-22	1b	0.26089	0.30561	-0.11268
P-23	1b	0.22619	0.30217	-0.07409
P-24	1b	0.19076	0.30124	-0.04551
P-25	1b	0.15339	0.30142	-0.06666

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	1c	0.00037	0.06112	-0.04358
P-2	1c	-0.00078	0.04352	-0.03402
P-3	1c	-0.00126	0.04112	-0.02148
P-4	1c	-0.00069	0.03876	-0.02496
P-5	1c	0.00089	0.02019	-0.05502
P-6	1c	0.00042	0.06163	-0.04567
P-7	1c	-0.00055	0.04309	-0.03583
P-8	1c	-0.00101	0.04086	-0.02344
P-9	1c	-0.00048	0.03869	-0.02650
P-10	1c	0.00100	0.01936	-0.05665
P-11	1c	0.00047	0.06211	-0.04765
P-12	1c	-0.00045	0.04274	-0.03681
P-13	1c	-0.00084	0.04059	-0.02464
P-14	1c	-0.00036	0.03854	-0.02752
P-15	1c	0.00111	0.01856	-0.05814
P-16	1c	0.00052	0.06267	-0.04988
P-17	1c	-0.00031	0.04248	-0.03734
P-18	1c	-0.00062	0.04030	-0.02501
P-19	1c	-0.00018	0.03831	-0.02815
P-20	1c	0.00123	0.01767	-0.05992
P-21	1c	0.00057	0.06311	-0.05171
P-22	1c	-0.00011	0.04234	-0.03653
P-23	1c	-0.00035	0.04003	-0.02363
P-24	1c	0.00009	0.03798	-0.02740
P-25	1c	0.00133	0.01692	-0.06125
P-1	2	0.11336	0.00215	-0.01402
P-2	2	0.11368	0.00094	-0.02454
P-3	2	0.11347	0.00002	-0.02298
P-4	2	0.11368	-0.00090	-0.02454
P-5	2	0.11337	-0.00211	-0.01402
P-6	2	0.11348	0.00305	-0.01592
P-7	2	0.11414	0.00118	-0.02757
P-8	2	0.11399	0.00002	-0.02560
P-9	2	0.11414	-0.00114	-0.02757
P-10	2	0.11349	-0.00301	-0.01593
P-11	2	0.11360	0.00397	-0.01797
P-12	2	0.11449	0.00145	-0.02938
P-13	2	0.11441	0.00001	-0.02659
P-14	2	0.11450	-0.00142	-0.02938
P-15	2	0.11361	-0.00394	-0.01798
P-16	2	0.11371	0.00479	-0.01969
P-17	2	0.11474	0.00177	-0.03061
P-18	2	0.11466	0.00001	-0.02666
P-19	2	0.11474	-0.00175	-0.03061
P-20	2	0.11372	-0.00477	-0.01969
P-21	2	0.11384	0.00579	-0.02193
P-22	2	0.11483	0.00212	-0.03217
P-23	2	0.11482	0.00001	-0.02665
P-24	2	0.11484	-0.00210	-0.03217
P-25	2	0.11385	-0.00576	-0.02193

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	3	0.17050	-0.00731	-0.00166
P-2	3	0.17211	0.00014	-0.03173
P-3	3	0.17207	0.00001	-0.03284
P-4	3	0.17211	-0.00012	-0.03173
P-5	3	0.17051	0.00734	-0.00167
P-6	3	0.17068	-0.00603	-0.00435
P-7	3	0.17277	0.00063	-0.03656
P-8	3	0.17281	0.00001	-0.03668
P-9	3	0.17277	-0.00061	-0.03656
P-10	3	0.17068	0.00606	-0.00435
P-11	3	0.17085	-0.00469	-0.00738
P-12	3	0.17333	0.00117	-0.03945
P-13	3	0.17343	0.00001	-0.03786
P-14	3	0.17333	-0.00115	-0.03945
P-15	3	0.17085	0.00471	-0.00738
P-16	3	0.17100	-0.00358	-0.00963
P-17	3	0.17365	0.00175	-0.04144
P-18	3	0.17372	0.00001	-0.03771
P-19	3	0.17365	-0.00173	-0.04144
P-20	3	0.17100	0.00360	-0.00963
P-21	3	0.17119	-0.00208	-0.01310
P-22	3	0.17364	0.00234	-0.04471
P-23	3	0.17381	0.00001	-0.03823
P-24	3	0.17364	-0.00232	-0.04471
P-25	3	0.17120	0.00210	-0.01310

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	Dead	0.00063	0.02047	-0.04930
P-2	Dead	-0.00074	0.00238	-0.02949
P-3	Dead	-0.00126	0.00000	-0.02148
P-4	Dead	-0.00074	-0.00238	-0.02949
P-5	Dead	0.00063	-0.02046	-0.04930
P-6	Dead	0.00071	0.02113	-0.05116
P-7	Dead	-0.00051	0.00220	-0.03116
P-8	Dead	-0.00101	0.00000	-0.02343
P-9	Dead	-0.00051	-0.00220	-0.03116
P-10	Dead	0.00071	-0.02113	-0.05116
P-11	Dead	0.00079	0.02178	-0.05289
P-12	Dead	-0.00040	0.00210	-0.03217
P-13	Dead	-0.00084	0.00000	-0.02464
P-14	Dead	-0.00040	-0.00209	-0.03217
P-15	Dead	0.00079	-0.02177	-0.05289
P-16	Dead	0.00088	0.02250	-0.05490
P-17	Dead	-0.00025	0.00208	-0.03274
P-18	Dead	-0.00062	0.00000	-0.02501
P-19	Dead	-0.00025	-0.00208	-0.03274
P-20	Dead	0.00088	-0.02250	-0.05490
P-21	Dead	0.00095	0.02309	-0.05648
P-22	Dead	-0.00001	0.00218	-0.03196
P-23	Dead	-0.00035	0.00000	-0.02363
P-24	Dead	-0.00001	-0.00218	-0.03196
P-25	Dead	0.00095	-0.02309	-0.05648

Horizontal Displacement, X-Direction:

MAXIMUM = 0.2919 inch
MINIMUM = -0.0013 inch

Horizontal Displacement, Y-Direction:

MAXIMUM = 0.3081 inch
MINIMUM = -0.0231 inch

Vertical Displacement:

MAXIMUM = 0.0104 inch
MINIMUM = -0.1127 inch

Maximum horizontal displacement is 0.3081". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.1127". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.3079". The spring has converged.

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	1a-ST	-13.68	-0.65	86.61	*
P-2	1a-ST	-13.72	-0.17	111.11	
P-3	1a-ST	-13.68	0.00	96.29	
P-4	1a-ST	-13.72	0.17	111.12	
P-5	1a-ST	-13.68	0.65	86.61	*
P-6	1a-ST	-13.70	-0.78	95.59	*
P-7	1a-ST	-13.78	-0.20	123.47	
P-8	1a-ST	-13.75	0.00	106.42	
P-9	1a-ST	-13.78	0.20	123.46	
P-10	1a-ST	-13.70	0.78	95.58	*
P-11	1a-ST	-13.71	-0.91	105.10	*
P-12	1a-ST	-13.82	-0.24	130.33	
P-13	1a-ST	-13.80	0.00	109.40	
P-14	1a-ST	-13.82	0.24	130.33	
P-15	1a-ST	-13.71	0.91	105.09	*
P-16	1a-ST	-13.73	-1.04	113.40	*
P-17	1a-ST	-13.85	-0.28	134.75	
P-18	1a-ST	-13.83	0.00	108.38	
P-19	1a-ST	-13.85	0.28	134.76	
P-20	1a-ST	-13.73	1.04	113.40	*
P-21	1a-ST	-13.75	-1.18	123.59	*
P-22	1a-ST	-13.86	-0.33	139.77	
P-23	1a-ST	-13.85	0.00	106.03	
P-24	1a-ST	-13.86	0.33	139.77	
P-25	1a-ST	-13.75	1.18	123.59	*
P-1	1b-ST	-13.46	-12.26	69.01	*
P-2	1b-ST	-12.15	-11.29	135.98	
P-3	1b-ST	-10.80	-11.05	81.88	
P-4	1b-ST	-9.54	-10.89	62.45	
P-5	1b-ST	-8.27	-10.17	130.81	*
P-6	1b-ST	-13.69	-13.67	75.99	*
P-7	1b-ST	-12.32	-12.56	151.32	
P-8	1b-ST	-10.86	-12.30	90.29	
P-9	1b-ST	-9.48	-12.13	66.54	
P-10	1b-ST	-8.07	-11.36	139.05	*
P-11	1b-ST	-13.92	-15.08	83.17	*
P-12	1b-ST	-12.46	-13.84	160.87	
P-13	1b-ST	-10.90	-13.54	93.13	
P-14	1b-ST	-9.40	-13.36	67.70	
P-15	1b-ST	-7.87	-12.55	147.61	*
P-16	1b-ST	-14.16	-16.49	89.90	*
P-17	1b-ST	-12.60	-15.12	168.00	
P-18	1b-ST	-10.93	-14.78	92.60	
P-19	1b-ST	-9.31	-14.59	67.33	
P-20	1b-ST	-7.65	-13.75	155.44	*
P-21	1b-ST	-14.38	-17.91	97.35	*
P-22	1b-ST	-12.72	-16.41	174.03	
P-23	1b-ST	-10.95	-16.01	89.79	
P-24	1b-ST	-9.23	-15.81	66.73	
P-25	1b-ST	-7.46	-14.94	164.41	*

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3	
Text	Text	Kip	Kip	Kip	
P-1	2-ST	-5.60	-1.54	106.01	*
P-2	2-ST	-5.48	-0.29	54.38	
P-3	2-ST	-5.42	0.00	27.60	
P-4	2-ST	-5.48	0.29	54.38	
P-5	2-ST	-5.60	1.53	106.01	*
P-6	2-ST	-5.61	-1.61	111.16	*
P-7	2-ST	-5.51	-0.29	57.30	
P-8	2-ST	-5.46	0.00	29.32	
P-9	2-ST	-5.51	0.29	57.30	
P-10	2-ST	-5.61	1.61	111.17	*
P-11	2-ST	-5.62	-1.68	116.12	*
P-12	2-ST	-5.53	-0.30	57.73	
P-13	2-ST	-5.48	0.00	28.17	
P-14	2-ST	-5.53	0.30	57.73	
P-15	2-ST	-5.62	1.68	116.12	*
P-16	2-ST	-5.63	-1.76	121.52	*
P-17	2-ST	-5.54	-0.31	57.47	
P-18	2-ST	-5.49	0.00	25.51	
P-19	2-ST	-5.54	0.31	57.47	
P-20	2-ST	-5.63	1.76	121.52	*
P-21	2-ST	-5.64	-1.83	126.23	*
P-22	2-ST	-5.56	-0.33	55.06	
P-23	2-ST	-5.52	0.00	19.75	
P-24	2-ST	-5.56	0.33	55.06	
P-25	2-ST	-5.64	1.83	126.22	*
P-1	3-ST	-8.38	-1.08	88.42	*
P-2	3-ST	-8.33	-0.25	64.62	
P-3	3-ST	-8.28	0.00	41.62	
P-4	3-ST	-8.33	0.25	64.62	
P-5	3-ST	-8.39	1.07	88.42	*
P-6	3-ST	-8.40	-1.17	94.69	*
P-7	3-ST	-8.37	-0.27	70.10	
P-8	3-ST	-8.32	0.00	45.09	
P-9	3-ST	-8.37	0.26	70.10	
P-10	3-ST	-8.40	1.17	94.69	*
P-11	3-ST	-8.41	-1.26	101.04	*
P-12	3-ST	-8.39	-0.29	72.06	
P-13	3-ST	-8.35	0.00	44.21	
P-14	3-ST	-8.39	0.29	72.06	
P-15	3-ST	-8.41	1.26	101.04	*
P-16	3-ST	-8.42	-1.35	107.20	*
P-17	3-ST	-8.41	-0.31	72.89	
P-18	3-ST	-8.37	0.00	41.24	
P-19	3-ST	-8.41	0.31	72.89	
P-20	3-ST	-8.42	1.35	107.19	*
P-21	3-ST	-8.43	-1.45	113.65	*
P-22	3-ST	-8.43	-0.34	72.91	
P-23	3-ST	-8.39	0.00	36.24	
P-24	3-ST	-8.43	0.34	72.91	
P-25	3-ST	-8.43	1.44	113.65	*

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	1a-ST	0.28088	0.01329	-0.06084
P-2	1a-ST	0.28162	0.00358	-0.07805
P-3	1a-ST	0.28085	0.00001	-0.06764
P-4	1a-ST	0.28162	-0.00357	-0.07806
P-5	1a-ST	0.28088	-0.01327	-0.06084
P-6	1a-ST	0.28123	0.01600	-0.06715
P-7	1a-ST	0.28289	0.00413	-0.08674
P-8	1a-ST	0.28227	0.00001	-0.07476
P-9	1a-ST	0.28289	-0.00412	-0.08673
P-10	1a-ST	0.28123	-0.01598	-0.06715
P-11	1a-ST	0.28159	0.01878	-0.07383
P-12	1a-ST	0.28383	0.00486	-0.09156
P-13	1a-ST	0.28335	0.00001	-0.07686
P-14	1a-ST	0.28383	-0.00484	-0.09155
P-15	1a-ST	0.28158	-0.01876	-0.07383
P-16	1a-ST	0.28192	0.02130	-0.07966
P-17	1a-ST	0.28445	0.00574	-0.09466
P-18	1a-ST	0.28397	0.00001	-0.07614
P-19	1a-ST	0.28445	-0.00572	-0.09467
P-20	1a-ST	0.28192	-0.02128	-0.07966
P-21	1a-ST	0.28229	0.02424	-0.08682
P-22	1a-ST	0.28468	0.00674	-0.09818
P-23	1a-ST	0.28441	0.00001	-0.07448
P-24	1a-ST	0.28468	-0.00673	-0.09819
P-25	1a-ST	0.28229	-0.02422	-0.08682
P-1	1b-ST	0.27637	0.25173	-0.04848
P-2	1b-ST	0.24943	0.23179	-0.09552
P-3	1b-ST	0.22181	0.22692	-0.05752
P-4	1b-ST	0.19597	0.22357	-0.04387
P-5	1b-ST	0.16991	0.20883	-0.09189
P-6	1b-ST	0.28119	0.28071	-0.05338
P-7	1b-ST	0.25291	0.25789	-0.10630
P-8	1b-ST	0.22299	0.25261	-0.06343
P-9	1b-ST	0.19459	0.24908	-0.04674
P-10	1b-ST	0.16568	0.23331	-0.09768
P-11	1b-ST	0.28587	0.30972	-0.05843
P-12	1b-ST	0.25592	0.28410	-0.11301
P-13	1b-ST	0.22385	0.27809	-0.06542
P-14	1b-ST	0.19303	0.27440	-0.04756
P-15	1b-ST	0.16158	0.25775	-0.10369
P-16	1b-ST	0.29083	0.33863	-0.06315
P-17	1b-ST	0.25882	0.31044	-0.11802
P-18	1b-ST	0.22442	0.30346	-0.06505
P-19	1b-ST	0.19119	0.29953	-0.04730
P-20	1b-ST	0.15718	0.28234	-0.10920
P-21	1b-ST	0.29536	0.36769	-0.06838
P-22	1b-ST	0.26118	0.33698	-0.12226
P-23	1b-ST	0.22491	0.32884	-0.06308
P-24	1b-ST	0.18945	0.32458	-0.04688
P-25	1b-ST	0.15324	0.30668	-0.11549

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	2-ST	0.11503	0.03157	-0.07447
P-2	2-ST	0.11256	0.00596	-0.03820
P-3	2-ST	0.11135	0.00002	-0.01939
P-4	2-ST	0.11256	-0.00591	-0.03820
P-5	2-ST	0.11504	-0.03152	-0.07447
P-6	2-ST	0.11523	0.03307	-0.07809
P-7	2-ST	0.11323	0.00602	-0.04026
P-8	2-ST	0.11209	0.00002	-0.02060
P-9	2-ST	0.11324	-0.00598	-0.04025
P-10	2-ST	0.11523	-0.03303	-0.07809
P-11	2-ST	0.11542	0.03455	-0.08157
P-12	2-ST	0.11355	0.00617	-0.04056
P-13	2-ST	0.11246	0.00002	-0.01979
P-14	2-ST	0.11355	-0.00614	-0.04056
P-15	2-ST	0.11542	-0.03451	-0.08157
P-16	2-ST	0.11562	0.03613	-0.08537
P-17	2-ST	0.11384	0.00642	-0.04037
P-18	2-ST	0.11280	0.00002	-0.01792
P-19	2-ST	0.11385	-0.00639	-0.04037
P-20	2-ST	0.11563	-0.03609	-0.08537
P-21	2-ST	0.11580	0.03754	-0.08867
P-22	2-ST	0.11425	0.00682	-0.03868
P-23	2-ST	0.11333	0.00002	-0.01387
P-24	2-ST	0.11426	-0.00679	-0.03868
P-25	2-ST	0.11581	-0.03751	-0.08867
P-1	3-ST	0.17217	0.02210	-0.06211
P-2	3-ST	0.17099	0.00516	-0.04539
P-3	3-ST	0.16994	0.00002	-0.02924
P-4	3-ST	0.17099	-0.00513	-0.04539
P-5	3-ST	0.17218	-0.02207	-0.06212
P-6	3-ST	0.17242	0.02399	-0.06652
P-7	3-ST	0.17186	0.00547	-0.04925
P-8	3-ST	0.17091	0.00001	-0.03168
P-9	3-ST	0.17187	-0.00544	-0.04925
P-10	3-ST	0.17242	-0.02396	-0.06652
P-11	3-ST	0.17267	0.02589	-0.07098
P-12	3-ST	0.17238	0.00589	-0.05062
P-13	3-ST	0.17148	0.00001	-0.03106
P-14	3-ST	0.17238	-0.00586	-0.05062
P-15	3-ST	0.17267	-0.02586	-0.07098
P-16	3-ST	0.17291	0.02775	-0.07530
P-17	3-ST	0.17275	0.00640	-0.05121
P-18	3-ST	0.17186	0.00001	-0.02897
P-19	3-ST	0.17276	-0.00638	-0.05121
P-20	3-ST	0.17291	-0.02772	-0.07530
P-21	3-ST	0.17316	0.02967	-0.07984
P-22	3-ST	0.17306	0.00704	-0.05122
P-23	3-ST	0.17233	0.00001	-0.02546
P-24	3-ST	0.17306	-0.00701	-0.05122
P-25	3-ST	0.17316	-0.02964	-0.07984

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

Horizontal Reactions, X-Direction:

MAXIMUM REACTION =	-5.42	kips
MINIMUM REACTION =	-14.38	kips

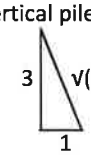
Horizontal Reactions, Y-Direction:

MAXIMUM REACTION =	1.83	kips
MINIMUM REACTION =	-17.91	kips

Vertical Reactions:

MAXIMUM REACTION =	174.03	kips
MINIMUM REACTION =	19.75	kips
Max. Battered Reaction =	164.41	kips

* Piles are battered at 3V:1H. Vertical reaction must be increased by a factor (hypotenuse/vertical length) to correspond to vertical pile capacity curves



$\sqrt{(3^2+1^2)} = 3.1623$

164.4 kips * 3.1623 / 3 = 173.30 kips

Therefore, Absolute Maximum Vertical Reaction = 174.03 kips

Horizontal Displacement, X-Direction:

MAXIMUM =	0.2954	inch
MINIMUM =	0.1114	inch

Horizontal Displacement, Y-Direction:

MAXIMUM =	0.3677	inch
MINIMUM =	-0.0375	inch

Vertical Displacement:

MAXIMUM =	-0.0139	inch
MINIMUM =	-0.1223	inch

Maximum horizontal displacement is 0.368". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.122". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: U-4 SOIL & PILE INFO FOR STRUCTURAL CHECK | Computed by: LBR | Sheet ___ of ___
Checked by: | Date: 8/2013
Date: | Reference

E_s: USING P-y CURVE DATA

↳ CALIBRATED SPRING IN SAP → $15.2^k / 0.315'' = 48.254^k/IN$

↳ FROM CPGA MANUAL, WE KNOW

PILE STIFFNESS $K = \frac{C_0 EI}{R^3}$

C_0: 0.707 FIXETY CONST. FOR PINNED, CONSTANT E_s
E: 29,000,000 PSI
I: $904 IN^4$ (STRONG AXIS)
$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\rightarrow K = 48{,}253.97^{LB}/IN = \frac{(0.707)(29{,}000{,}000 PSI)(904 IN^4)}{\left(\sqrt[4]{\frac{29{,}000{,}000 \times 904}{E_s}}\right)^3}$$

SOLVING FOR E_s W/EXCEL ⇒ $E_s = 938.92 PSI = \underline{0.9389 KSI}$

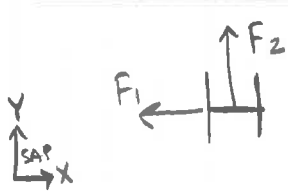
CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONST. E_s & UNSUPPORTED LENGTH (CONSERVATIVE)

$PCR = n\sqrt{E_s EI}$, $n = 1$ - PINNED

$PCR_{,STRONG\ AXIS} = \sqrt{(0.9389)(29{,}000 KSI)(904 IN^4)} = \underline{4961.3^k}$

$PCR_{,WEAK\ AXIS} = \sqrt{(0.9389)(29{,}000 KSI)(326 IN^4)} = \underline{2979.3^k}$

ORIENTATION OF PILES:



F_1 (F_x) FORCES ARE COUPLED W/ STRONG AXIS & M1 MOMENTS

F_2 (F_y) FORCES ARE COUPLED W/ WEAK AXIS & M2 MOMENTS

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___ | Sheet ___ of ___

Description: PILE PROPERTIES FOR STRUCTURAL CHECK. | Computed by: LBK | Date: 8/2013

Checked by: | Date:

Reference

*ACC: CPGA MANUAL PG 42-43

- IF - $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

- THEN - $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

↳ $\sqrt{\frac{2\pi^2 \cdot 29{,}000\,KSI}{50\,KSI}} = 106.99$ > ↳ $\sqrt{\frac{\pi^2 \cdot 29{,}000 \cdot 26.1\,IN^2}{2979.3^k}} = 50.07$ ← SMALLER PCR = LARGER RESULT

→ $\therefore ACC_S = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 4961}\right] = \underline{\underline{609.6^k}}$ STRONG AXIS

→ $\therefore ACC_W = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 2979}\right] = \underline{\underline{581.0^k}}$ WEAK AXIS

$ATT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,IN^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$ BOTH AXIS

*CBF - COMBINED BENDING: CPGA PG 32

$$COMP = \left[\frac{F3}{ACC} + MF1\left(\frac{M1}{AM1}\right) + MF2\left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

$$TENSION = \left[\frac{-F3}{ATT} + \text{"} + \text{"}\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

↳ $\underline{AM1} = S_x F_y = 131\,IN^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{3638.9^{K \cdot IN}}$ (USAGE FACTOR; AISC FACTOR)

↳ $\underline{AM2} = S_y F_y = 44.3\,IN^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{1230.56^{K \cdot IN}}$

*AXIAL LOAD FACTOR:

$ALF = \frac{F3}{AC} \times \frac{1}{OSF}$ (COMP) -OR- $\frac{-F3}{AT} \times \frac{1}{OSF}$ (TENS.)

Maurepas Diversion
Monolith U-4: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1a	-13.6	0.8	0.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	641.88	1.70	0.15	0.00
P-2	1a	-13.8	0.1	91.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	653.43	-21.30	0.30	0.46
P-3	1a	-13.8	0.0	101.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	654.17	-23.48	0.31	0.51
P-4	1a	-13.8	-0.1	91.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	653.42	-21.29	0.30	0.46
P-5	1a	-13.6	-0.8	0.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	641.87	1.71	0.15	0.00
P-6	1a	-13.6	0.7	7.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	642.79	-1.67	0.16	0.04
P-7	1a	-13.8	0.0	105.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	656.88	-22.41	0.32	0.53
P-8	1a	-13.8	0.0	113.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	658.13	-23.48	0.33	0.57
P-9	1a	-13.8	0.0	105.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	656.88	-22.40	0.32	0.53
P-10	1a	-13.6	-0.7	7.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	642.78	-1.66	0.16	0.04
P-11	1a	-13.6	0.6	14.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	643.72	-5.21	0.18	0.08
P-12	1a	-13.9	0.0	114.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	660.13	-23.28	0.33	0.57
P-13	1a	-13.9	0.0	119.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	661.83	-23.48	0.34	0.60
P-14	1a	-13.9	0.0	114.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	660.12	-23.28	0.33	0.57
P-15	1a	-13.6	-0.6	14.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	643.71	-5.20	0.18	0.08
P-16	1a	-13.6	0.5	19.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	644.50	-8.01	0.19	0.11
P-17	1a	-13.9	-0.1	120.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	661.99	-21.84	0.34	0.61
P-18	1a	-13.9	0.0	120.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	663.56	-23.48	0.34	0.61
P-19	1a	-13.9	0.1	120.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	661.98	-21.85	0.34	0.61
P-20	1a	-13.6	-0.5	19.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	644.49	-7.99	0.19	0.11
P-21	1a	-13.7	0.4	28.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	645.54	-11.96	0.20	0.15
P-22	1a	-13.9	-0.1	130.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	661.70	-20.38	0.35	0.66
P-23	1a	-13.9	0.0	124.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	663.79	-23.47	0.35	0.62
P-24	1a	-13.9	0.1	130.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	661.69	-20.40	0.35	0.66
P-25	1a	-13.7	-0.4	28.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	645.53	-11.94	0.20	0.15
P-1	1b	-13.3	-9.5	-14.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	623.10	392.53	0.44	0.13
P-2	1b	-12.2	-9.8	111.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	548.74	407.45	0.57	0.56
P-3	1b	-10.9	-9.8	86.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	470.61	407.34	0.52	0.43
P-4	1b	-9.6	-9.8	52.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	396.88	408.61	0.45	0.27
P-5	1b	-8.3	-9.9	66.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	323.59	413.85	0.46	0.35
P-6	1b	-13.5	-10.9	-10.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	638.21	471.55	0.49	0.09
P-7	1b	-12.3	-11.1	128.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	558.69	481.44	0.65	0.65
P-8	1b	-10.9	-11.0	96.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	473.50	479.67	0.58	0.48
P-9	1b	-9.5	-11.0	58.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	392.77	480.01	0.51	0.29
P-10	1b	-8.1	-11.1	73.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	312.82	483.82	0.51	0.39
P-11	1b	-13.8	-12.3	-5.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	653.07	555.73	0.55	0.05
P-12	1b	-12.5	-12.3	140.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	568.10	559.81	0.72	0.70
P-13	1b	-11.0	-12.3	101.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	476.15	555.47	0.64	0.51
P-14	1b	-9.5	-12.3	60.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	388.70	554.84	0.56	0.31
P-15	1b	-7.9	-12.3	80.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	302.47	557.30	0.57	0.43
P-16	1b	-14.0	-13.6	-1.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	668.88	643.84	0.61	0.01
P-17	1b	-12.6	-13.6	149.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	576.93	642.61	0.79	0.75
P-18	1b	-11.0	-13.5	103.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	477.59	634.86	0.70	0.52
P-19	1b	-9.4	-13.5	62.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	383.66	633.05	0.62	0.31
P-20	1b	-7.7	-13.5	86.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	291.47	635.40	0.63	0.46
P-21	1b	-14.2	-15.0	4.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	683.56	738.49	0.68	0.02
P-22	1b	-12.7	-14.9	160.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	583.30	730.00	0.87	0.81
P-23	1b	-11.0	-14.7	105.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	478.09	718.29	0.76	0.53
P-24	1b	-9.3	-14.7	64.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	378.40	715.13	0.68	0.33
P-25	1b	-7.5	-14.7	94.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	281.77	715.73	0.70	0.50

ADJUSTED FOR BATTERED PILES

Maurepas Diversion
Monolith U-4: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1c	0.0	-3.0	62.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.93	80.53	0.15	0.33
P-2	1c	0.0	-2.1	48.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.30	48.19	0.11	0.24
P-3	1c	0.1	-2.0	30.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.57	43.94	0.08	0.15
P-4	1c	0.0	-1.9	35.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.43	39.78	0.08	0.18
P-5	1c	0.0	-1.0	78.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.14	8.30	0.12	0.41
P-6	1c	0.0	-3.0	65.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.85	81.49	0.15	0.34
P-7	1c	0.0	-2.1	51.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.65	47.42	0.11	0.26
P-8	1c	0.0	-2.0	33.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.95	43.47	0.08	0.17
P-9	1c	0.0	-1.9	37.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.76	39.65	0.09	0.19
P-10	1c	0.0	-0.9	80.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.97	6.94	0.12	0.43
P-11	1c	0.0	-3.0	67.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.78	82.41	0.16	0.36
P-12	1c	0.0	-2.1	52.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.81	46.79	0.11	0.26
P-13	1c	0.0	-2.0	35.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.20	42.99	0.08	0.18
P-14	1c	0.0	-1.9	39.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.94	39.39	0.09	0.20
P-15	1c	-0.1	-0.9	82.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.80	5.63	0.13	0.44
P-16	1c	0.0	-3.1	71.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.69	83.48	0.16	0.38
P-17	1c	0.0	-2.1	53.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-23.01	46.33	0.11	0.27
P-18	1c	0.0	-2.0	35.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.54	42.49	0.08	0.18
P-19	1c	0.0	-1.9	40.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-23.21	38.99	0.09	0.20
P-20	1c	-0.1	-0.9	85.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.62	4.19	0.13	0.45
P-21	1c	0.0	-3.1	73.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.62	84.30	0.17	0.39
P-22	1c	0.0	-2.1	52.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-23.32	46.09	0.11	0.26
P-23	1c	0.0	-1.9	33.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-22.96	42.00	0.08	0.17
P-24	1c	0.0	-1.8	39.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-23.34	38.41	0.09	0.20
P-25	1c	-0.1	-0.8	87.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	-21.46	2.98	0.13	0.46
P-1	2	-5.5	-0.1	20.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	187.93	-20.22	0.10	0.12
P-2	2	-5.5	0.0	34.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	188.64	-22.07	0.13	0.20
P-3	2	-5.5	0.0	32.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	188.18	-23.46	0.12	0.19
P-4	2	-5.5	0.0	34.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	188.65	-22.12	0.13	0.20
P-5	2	-5.5	0.1	20.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	187.94	-20.28	0.10	0.12
P-6	2	-5.5	-0.1	22.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.20	-18.85	0.10	0.14
P-7	2	-5.6	-0.1	39.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.66	-21.70	0.13	0.23
P-8	2	-5.6	0.0	36.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.33	-23.46	0.13	0.21
P-9	2	-5.6	0.1	39.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.66	-21.75	0.13	0.23
P-10	2	-5.5	0.1	22.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.21	-18.90	0.10	0.14
P-11	2	-5.5	-0.2	25.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.47	-17.43	0.11	0.16
P-12	2	-5.6	-0.1	41.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	190.45	-21.28	0.14	0.25
P-13	2	-5.6	0.0	37.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	190.27	-23.46	0.13	0.22
P-14	2	-5.6	0.1	41.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	190.46	-21.33	0.14	0.25
P-15	2	-5.5	0.2	25.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.48	-17.48	0.11	0.16
P-16	2	-5.5	-0.2	28.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.72	-16.17	0.11	0.17
P-17	2	-5.6	-0.1	43.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	191.00	-20.79	0.14	0.26
P-18	2	-5.6	0.0	37.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	190.82	-23.46	0.13	0.22
P-19	2	-5.6	0.1	43.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	191.00	-20.84	0.14	0.26
P-20	2	-5.5	0.2	28.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	188.73	-16.21	0.11	0.17
P-21	2	-5.5	-0.3	31.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	189.00	-14.64	0.12	0.19
P-22	2	-5.6	-0.1	45.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	191.21	-20.26	0.14	0.27
P-23	2	-5.6	0.0	37.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	191.18	-23.46	0.13	0.22
P-24	2	-5.6	0.1	45.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	191.22	-20.30	0.14	0.27
P-25	2	-5.5	0.3	31.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	189.02	-14.68	0.12	0.19

Maurepas Diversion
Monolith U-4: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	3	-8.3	0.4	2.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	324.94	-12.26	0.10	0.01
P-2	3	-8.4	0.0	45.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	329.08	-23.28	0.18	0.26
P-3	3	-8.4	0.0	46.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	328.97	-23.47	0.19	0.27
P-4	3	-8.4	0.0	45.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	329.08	-23.31	0.18	0.26
P-5	3	-8.3	-0.4	2.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	324.94	-12.23	0.10	0.01
P-6	3	-8.3	0.3	6.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	325.38	-14.25	0.11	0.04
P-7	3	-8.4	0.0	52.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	330.78	-22.53	0.19	0.30
P-8	3	-8.4	0.0	52.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	330.89	-23.47	0.20	0.31
P-9	3	-8.4	0.0	52.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	330.79	-22.56	0.19	0.30
P-10	3	-8.3	-0.3	6.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	325.39	-14.22	0.11	0.04
P-11	3	-8.3	0.2	10.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	325.83	-16.33	0.12	0.06
P-12	3	-8.4	-0.1	56.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	332.24	-21.71	0.20	0.33
P-13	3	-8.4	0.0	53.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	332.52	-23.47	0.20	0.32
P-14	3	-8.4	0.1	56.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	332.24	-21.74	0.20	0.33
P-15	3	-8.3	-0.2	10.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	325.84	-16.30	0.12	0.06
P-16	3	-8.3	0.2	13.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	326.22	-18.03	0.13	0.08
P-17	3	-8.5	-0.1	59.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.07	-20.83	0.21	0.35
P-18	3	-8.5	0.0	53.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.26	-23.47	0.20	0.31
P-19	3	-8.5	0.1	59.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.08	-20.86	0.21	0.35
P-20	3	-8.3	-0.2	13.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	326.23	-18.00	0.13	0.08
P-21	3	-8.3	0.1	18.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	326.72	-20.32	0.14	0.12
P-22	3	-8.5	-0.1	63.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.05	-19.93	0.21	0.37
P-23	3	-8.5	0.0	54.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.50	-23.47	0.20	0.32
P-24	3	-8.5	0.1	63.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	333.05	-19.96	0.21	0.37
P-25	3	-8.3	-0.1	18.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	326.72	-20.29	0.14	0.12
P-1	1a-ST	-13.7	-0.6	86.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	647.33	-2.85	0.28	0.46
P-2	1a-ST	-13.7	-0.2	111.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	649.77	-18.03	0.32	0.56
P-3	1a-ST	-13.7	0.0	96.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	647.23	-23.47	0.30	0.48
P-4	1a-ST	-13.7	0.2	111.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	649.76	-18.05	0.32	0.56
P-5	1a-ST	-13.7	0.6	86.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	647.32	-2.88	0.28	0.46
P-6	1a-ST	-13.7	-0.8	95.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	648.49	1.49	0.29	0.51
P-7	1a-ST	-13.8	-0.2	123.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	653.93	-17.19	0.34	0.62
P-8	1a-ST	-13.7	0.0	106.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	651.89	-23.47	0.32	0.53
P-9	1a-ST	-13.8	0.2	123.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	653.92	-17.21	0.34	0.62
P-10	1a-ST	-13.7	0.8	95.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	648.48	1.46	0.29	0.51
P-11	1a-ST	-13.7	-0.9	105.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	649.65	5.99	0.30	0.56
P-12	1a-ST	-13.8	-0.2	130.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	657.01	-16.07	0.35	0.65
P-13	1a-ST	-13.8	0.0	109.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	655.42	-23.47	0.32	0.55
P-14	1a-ST	-13.8	0.2	130.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	657.00	-16.09	0.35	0.65
P-15	1a-ST	-13.7	0.9	105.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	649.64	5.96	0.30	0.56
P-16	1a-ST	-13.7	-1.0	113.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	650.74	10.12	0.32	0.60
P-17	1a-ST	-13.9	-0.3	134.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	659.04	-14.71	0.35	0.68
P-18	1a-ST	-13.8	0.0	108.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	657.44	-23.47	0.32	0.54
P-19	1a-ST	-13.9	0.3	134.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	659.04	-14.74	0.35	0.68
P-20	1a-ST	-13.7	1.0	113.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	650.72	10.08	0.32	0.60
P-21	1a-ST	-13.7	-1.2	123.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	651.95	14.99	0.34	0.65
P-22	1a-ST	-13.9	-0.3	139.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	659.78	-13.15	0.36	0.70
P-23	1a-ST	-13.9	0.0	106.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	658.89	-23.47	0.32	0.53
P-24	1a-ST	-13.9	0.3	139.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	659.78	-13.18	0.36	0.70
P-25	1a-ST	-13.7	1.2	123.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	651.94	14.95	0.34	0.65

Maurepas Diversion
Monolith U-4: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1b-ST	-13.5	-12.3	69.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	632.68	554.81	0.63	0.37
P-2	1b-ST	-12.1	-11.3	136.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	547.73	494.55	0.66	0.68
P-3	1b-ST	-10.8	-11.1	81.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	465.33	480.23	0.56	0.41
P-4	1b-ST	-9.5	-10.9	62.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	392.56	470.44	0.51	0.31
P-5	1b-ST	-8.3	-10.2	130.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	323.40	428.25	0.56	0.69
P-6	1b-ST	-13.7	-13.7	76.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	648.33	646.79	0.71	0.40
P-7	1b-ST	-12.3	-12.6	151.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	558.43	573.90	0.74	0.76
P-8	1b-ST	-10.9	-12.3	90.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	468.74	557.50	0.63	0.45
P-9	1b-ST	-9.5	-12.1	66.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	388.79	546.65	0.57	0.33
P-10	1b-ST	-8.1	-11.4	139.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	312.59	499.05	0.62	0.74
P-11	1b-ST	-13.9	-15.1	83.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	663.71	744.11	0.79	0.44
P-12	1b-ST	-12.5	-13.8	160.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	567.76	657.89	0.82	0.81
P-13	1b-ST	-10.9	-13.5	93.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	471.25	638.25	0.69	0.47
P-14	1b-ST	-9.4	-13.4	67.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	384.56	626.29	0.62	0.34
P-15	1b-ST	-7.9	-12.6	147.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	302.19	573.46	0.68	0.78
P-16	1b-ST	-14.2	-16.5	89.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	680.14	846.33	0.88	0.48
P-17	1b-ST	-12.6	-15.1	168.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	576.81	746.58	0.89	0.84
P-18	1b-ST	-10.9	-14.8	92.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	472.91	722.67	0.74	0.47
P-19	1b-ST	-9.3	-14.6	67.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	379.57	709.33	0.68	0.34
P-20	1b-ST	-7.7	-13.7	155.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	291.17	652.11	0.74	0.82
P-21	1b-ST	-14.4	-17.9	97.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	695.28	954.38	0.97	0.52
P-22	1b-ST	-12.7	-16.4	174.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	584.22	840.37	0.97	0.87
P-23	1b-ST	-11.0	-16.0	89.8	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	474.33	811.13	0.80	0.45
P-24	1b-ST	-9.2	-15.8	66.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1.17	374.87	796.00	0.74	0.34
P-25	1b-ST	-7.5	-14.9	164.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1.17	281.41	733.67	0.81	0.87
P-1	2-ST	-5.6	-1.5	106.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	191.65	27.32	0.25	0.65
P-2	2-ST	-5.5	-0.3	54.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	186.16	-14.37	0.15	0.32
P-3	2-ST	-5.4	0.0	27.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	183.48	-23.45	0.11	0.16
P-4	2-ST	-5.5	0.3	54.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	186.17	-14.44	0.15	0.32
P-5	2-ST	-5.6	1.5	106.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	191.66	27.24	0.25	0.65
P-6	2-ST	-5.6	-1.6	111.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.09	29.90	0.26	0.69
P-7	2-ST	-5.5	-0.3	57.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	187.65	-14.28	0.16	0.34
P-8	2-ST	-5.5	0.0	29.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	185.11	-23.45	0.12	0.17
P-9	2-ST	-5.5	0.3	57.3	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	187.66	-14.34	0.16	0.34
P-10	2-ST	-5.6	1.6	111.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.10	29.82	0.26	0.69
P-11	2-ST	-5.6	-1.7	116.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.51	32.45	0.27	0.72
P-12	2-ST	-5.5	-0.3	57.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	188.34	-14.03	0.16	0.34
P-13	2-ST	-5.5	0.0	28.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	185.94	-23.45	0.12	0.17
P-14	2-ST	-5.5	0.3	57.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	188.35	-14.09	0.16	0.34
P-15	2-ST	-5.6	1.7	116.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.53	32.38	0.27	0.72
P-16	2-ST	-5.6	-1.8	121.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.97	35.18	0.28	0.75
P-17	2-ST	-5.5	-0.3	57.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.00	-13.65	0.16	0.34
P-18	2-ST	-5.5	0.0	25.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	186.69	-23.46	0.11	0.15
P-19	2-ST	-5.5	0.3	57.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.01	-13.70	0.16	0.34
P-20	2-ST	-5.6	1.8	121.5	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	192.98	35.11	0.28	0.75
P-21	2-ST	-5.6	-1.8	126.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	193.37	37.64	0.29	0.78
P-22	2-ST	-5.6	-0.3	55.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.91	-13.03	0.15	0.32
P-23	2-ST	-5.5	0.0	19.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	187.88	-23.46	0.10	0.12
P-24	2-ST	-5.6	0.3	55.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	189.92	-13.08	0.15	0.32
P-25	2-ST	-5.6	1.8	126.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	193.39	37.58	0.29	0.78

Maurepas Diversion
Monolith U-4: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ X-axis PCR	Y-axis PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	3-ST	-8.4	-1.1	88.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	329.25	11.44	0.24	0.55
P-2	3-ST	-8.3	-0.3	64.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	326.19	-15.61	0.21	0.38
P-3	3-ST	-8.3	0.0	41.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	323.50	-23.46	0.18	0.24
P-4	3-ST	-8.3	0.2	64.6	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	326.19	-15.65	0.21	0.38
P-5	3-ST	-8.4	1.1	88.4	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	329.26	11.38	0.24	0.55
P-6	3-ST	-8.4	-1.2	94.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	329.89	14.57	0.26	0.58
P-7	3-ST	-8.4	-0.3	70.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	328.45	-15.13	0.22	0.41
P-8	3-ST	-8.3	0.0	45.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	325.98	-23.46	0.18	0.26
P-9	3-ST	-8.4	0.3	70.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	328.45	-15.17	0.22	0.41
P-10	3-ST	-8.4	1.2	94.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	329.90	14.51	0.26	0.58
P-11	3-ST	-8.4	-1.3	101.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	330.52	17.73	0.27	0.62
P-12	3-ST	-8.4	-0.3	72.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	329.78	-14.47	0.22	0.42
P-13	3-ST	-8.4	0.0	44.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	327.47	-23.46	0.18	0.26
P-14	3-ST	-8.4	0.3	72.1	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	329.78	-14.52	0.22	0.42
P-15	3-ST	-8.4	1.3	101.0	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	330.53	17.68	0.27	0.62
P-16	3-ST	-8.4	-1.4	107.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	331.16	20.85	0.28	0.66
P-17	3-ST	-8.4	-0.3	72.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	330.75	-13.68	0.22	0.43
P-18	3-ST	-8.4	0.0	41.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	328.44	-23.46	0.18	0.24
P-19	3-ST	-8.4	0.3	72.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	330.76	-13.72	0.22	0.43
P-20	3-ST	-8.4	1.3	107.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	331.16	20.80	0.28	0.66
P-21	3-ST	-8.4	-1.4	113.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	331.79	24.10	0.30	0.70
P-22	3-ST	-8.4	-0.3	72.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	331.54	-12.69	0.22	0.43
P-23	3-ST	-8.4	0.0	36.2	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	329.65	-23.46	0.17	0.21
P-24	3-ST	-8.4	0.3	72.9	50	26.1	904	326	131	44.3	29000	0.939	1	1	170.7	-101.3	4961	2979	107	39	2	610	581	653	3639	1231	1	331.54	-12.73	0.22	0.43
P-25	3-ST	-8.4	1.4	113.7	50	26.1	904	326	131	44.3	29000	0.939	1	1	161.9	-96.1	4961	2979	107	39	2	610	581	653	3639	1231	1	331.80	24.05	0.30	0.70

NO ALF OR CBF FAILURES IN ANY LOAD CASE

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	3	ft *
Wall Thickness =	2.5	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

Results indicate a slab thicker than 2'-6" is necessary

TRADITIONAL CASES

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
Dead	0.00	0.0	0.0	0.0	0.0
1a	27.10	202.0	0.7	40.5	4.3
1b	27.10	202.0	0.7	40.5	4.3
1c	1.24	12.1	12.1	2.3	2.3
2	11.00	79.0	0.5	14.8	1.4
3	20.50	140.4	1.0	28.2	2.8

* Shear values taken at a distance 'd'= 25.37in from the face of the slab.

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

Max. Shear =	**27.1 kip**	
Max. Moment, Primary =	**202.0 kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**12.1 kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**40.5 kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**4.3 kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

* Reinforcing Limits:

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 3.848 in^2

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

(3 * √(f'_c) * b * d) / f_y = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

* CHECK OF PILES FOR ADDITIONAL LOAD DUE TO THICKER SLAB IS INCLUDED AFTER SAP RESULT IMAGES.

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 27.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Exterior Face:

* Will try **#10 @ 8"** to start: As, #10 @ 8" = 1.91 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1.905 * 60ksi / (0.85 * 4ksi * 12in) = 2.801 in

ϕMn = 0.9 * 1.905in^2 * 60ksi * (25.365in - 2.801in / 2)

= 2465.2 kip-in/ft

= 205.43 kip-ft/ft

ϕMn = 205.4kip-ft > Mu = 202kip-ft → Use #10 @ 8"

Primary Interior Face:

* Will try **#6 @ 8"** to start: As, #6 @ 8" = 0.66 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.66 * 60ksi / (0.85 * 4ksi * 12in) = 0.971 in

ϕMn = 0.9 * 0.66in^2 * 60ksi * (25.365in - 0.971in / 2)

= 886.71 kip-in/ft

= 73.89 kip-ft/ft

ϕMn = 73.9kip-ft > Mu = 12.1kip-ft → Use #6 @ 8"

FLEXURAL MINIMUMS NEGLECTED B/C OF ACI 318 ALLOWANCE - $40.5^{k \cdot ft} \times 1.33 = 54^{k \cdot ft}$, WHICH IS LESS THAN CAPACITY OF REINFORCEMENT (ACI 318 - 10.5.3)

Secondary Interior & Exterior Faces: * $M_{max,\ secondary}$ = 40.5 k-ft

* Will try **#6 @ 8"** to start: As, #6 @ 8" = 0.66 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.66 * 60ksi / (0.85 * 4ksi * 12in) = 0.971 in

ϕMn = 0.9 * 0.66in^2 * 60ksi * (25.365in - 0.971in / 2)

= 886.71 kip-in/ft

= 73.89 kip-ft/ft

ϕMn = 73.9kip-ft > Mu = 40.5kip-ft → Use #6 @ 8"

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
Dead	21.3	4.5	3.0	46.5	4.3	29.0
1a	26.4	12.7	239.4	81.6	59.2	65.0
1b	31.1	15.3	234.1	69.0	59.2	82.4
1c	6.9	4.9	18.8	42.8	4.1	27.8
2	11.9	5.2	85.8	35.2	20.4	27.0
3	17.5	7.4	166.7	50.4	41.6	37.5

* Shear taken at a distance 'd' = 31.37 inch from piles.

CONTROLS OVER SETTLEMENT CASES

Max. Shear = 31.1 kip
Max. Moment, Primary = 239.4 kip-ft (SAP M11, controls *bottom transverse* reinforcement)
Min. Moment, Primary = 81.6 kip-ft (SAP M11, controls *top transverse* reinforcement)
Max. Moment, Secondary = 59.2 kip-ft (SAP M22, controls *bottom longitudinal* reinforcement)
Min. Moment, Secondary = 82.4 kip-ft (SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

A_{gross} = 36in * 12in strip = 432 in^2

d = 36in - 4in cover - 1/2 bar diameter = 31.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 4.617 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 1.210 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 1.190 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.255 in^2 ACI 318-02, 10.5, flexural member min.

Slab Section Summary:			
	Max. Rebar =	**4.617 in^2**	- half each face
	Min. T&S Rebar =	**1.210 in^2**	- half each face
	Min. Flexural Rebar =	**1.255 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 31.365in

= 40,467 lb

ϕVc = 40.5kip > Vu = 31.1kip → Section OK

*239k·ft MOMENT IS THE REASON FOR A 3' SLAB. AMOUNT OF REINF REQUIRED WOULD HAVE EXCEEDED MAX. ALLOWABLE FOR A 2'-6" SECTION.

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try **#10 @ 8"** to start: As, #10 @ 8" = 1.905 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.905 * 60ksi / (0.85 * 4ksi * 12in) = 2.801 in

$\phi Mn =$ 0.9 * 1.905in^2 * 60ksi * (31.365in - 2.801in / 2)
= 3082.4 kip-in/ft
= 256.87 kip-ft/ft

ϕMn = 256.9kip-ft > Mu = 239.4kip-ft → Use #10 @ 8"

Primary Top Face:

* Will try **#8 @ 8"** to start: As, #8 @ 8" = 1.185 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.185 * 60ksi / (0.85 * 4ksi * 12in) = 1.743 in

$\phi Mn =$ 0.9 * 1.185in^2 * 60ksi * (31.365in - 1.743in / 2)
= 1951.3 kip-in/ft
= 162.61 kip-ft/ft

ϕMn = 162.6kip-ft > Mu = 81.6kip-ft → Use #8 @ 8"

FLEXURAL MINIMUMS NEGLECTED B/C OF ACI 318 ALLOWANCE - 82.4 k-ft × 1.33 = 109.9 k-ft, WHICH IS LESS THAN REINF. CAPACITY (ACI 318-10.5.3)

Secondary Bottom Face: * $M_{max, secondary}$ = 82.4 k-ft

* Will try **#8 @ 8"** to start: As, #8 @ 8" = 1.185 in^2

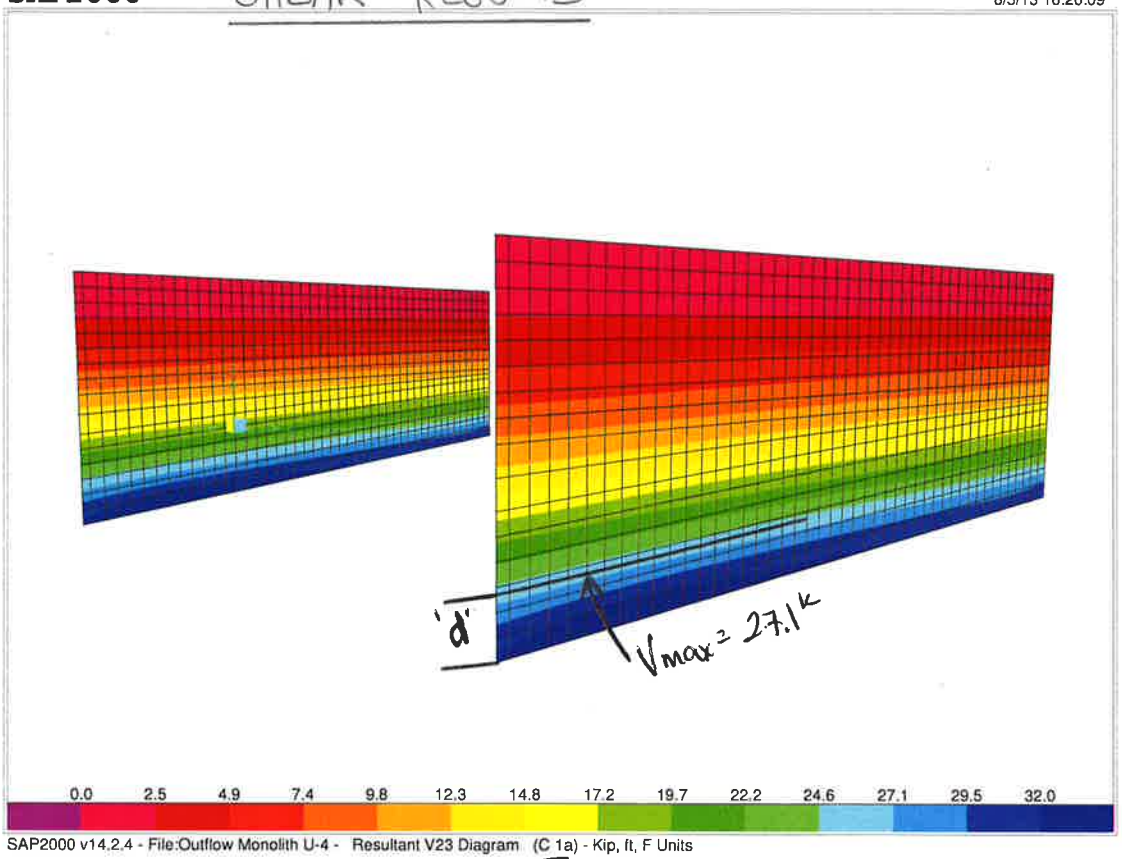
$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.185 * 60ksi / (0.85 * 4ksi * 12in) = 1.743 in

$\phi Mn =$ 0.9 * 1.185in^2 * 60ksi * (31.365in - 1.743in / 2)
= 1951.3 kip-in/ft
= 162.61 kip-ft/ft

ϕMn = 162.6kip-ft > Mu = 82.4kip-ft → Use #8 @ 8"

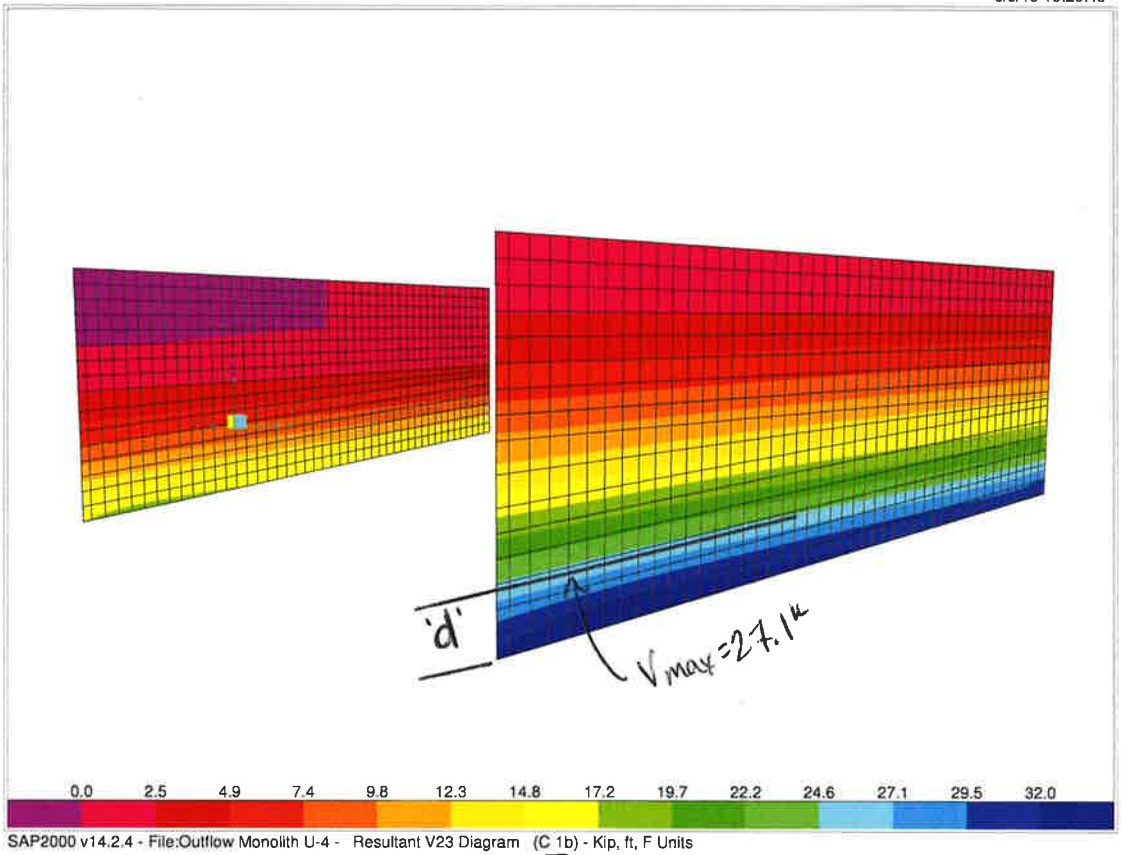
MOMENT & SHEAR RESULT IMAGES FOLLOW THIS SPREADSHEET.

SAP2000 SHEAR RESULTS 8/5/13 16:20:09



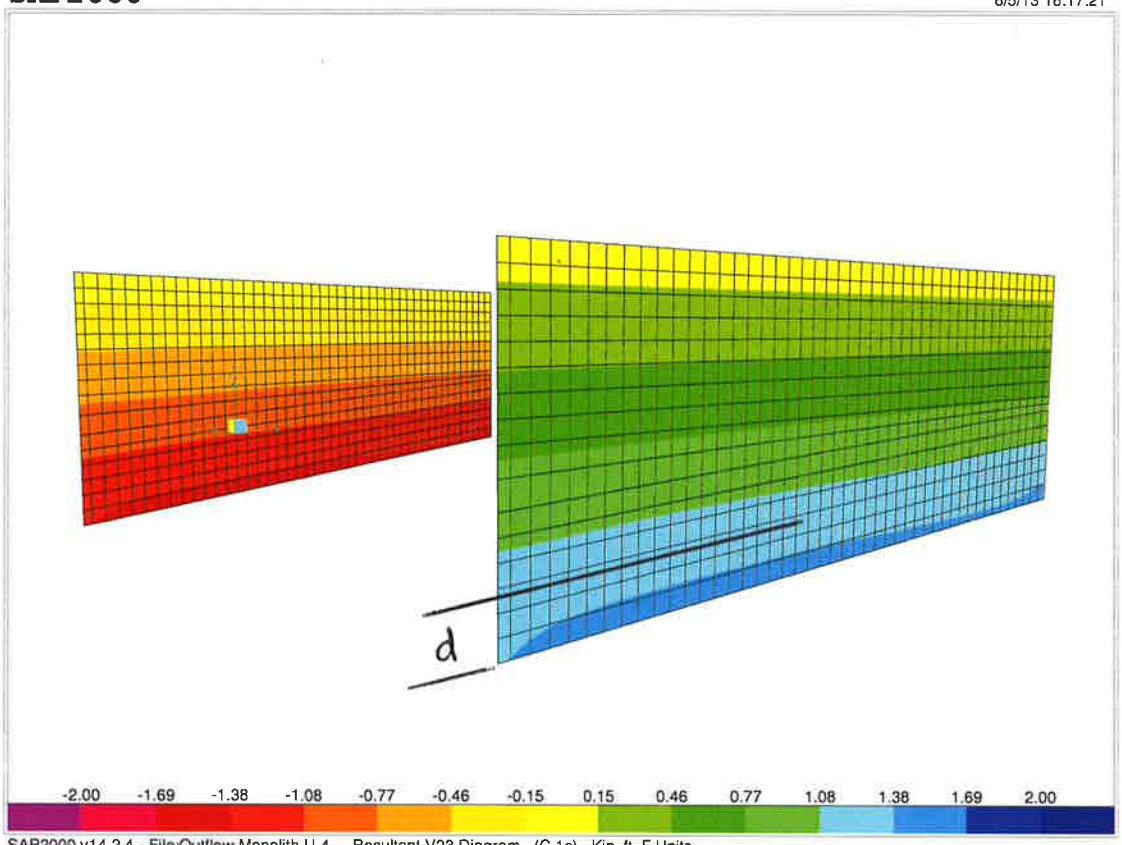
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/5/13 16:20:43



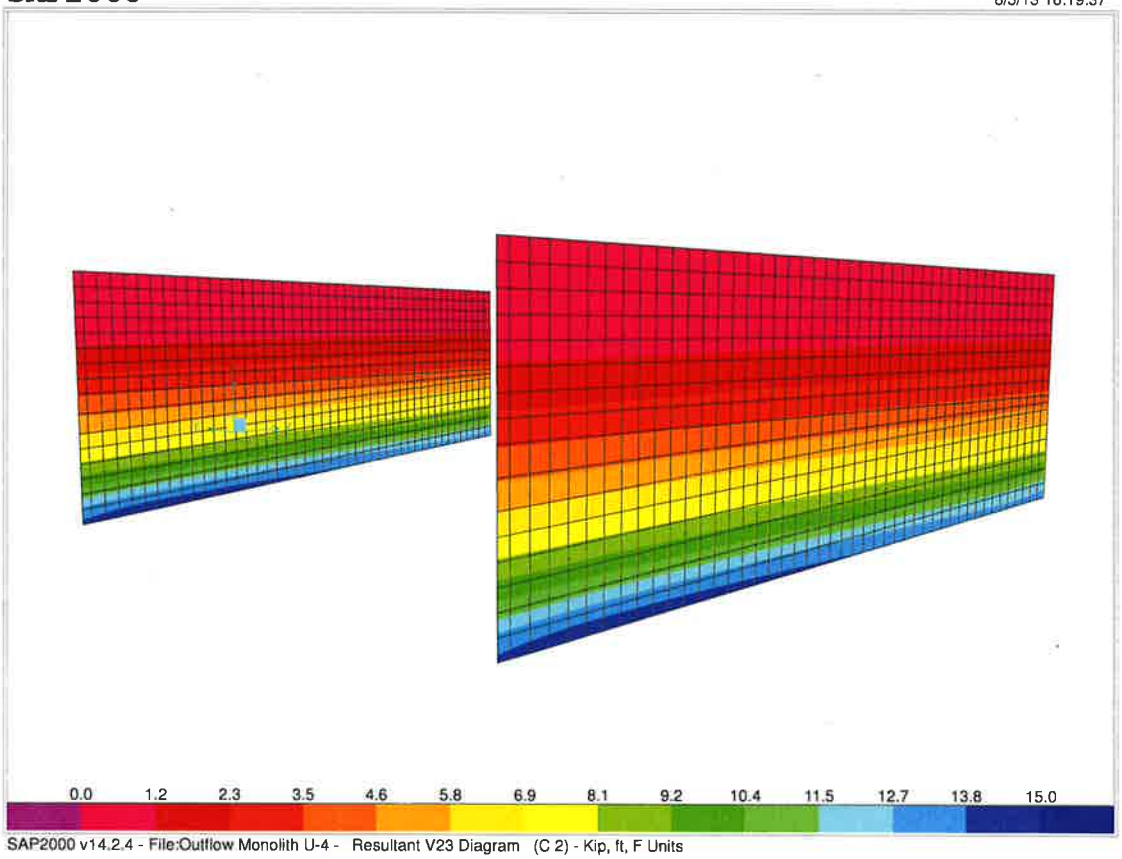
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/5/13 16:17:21

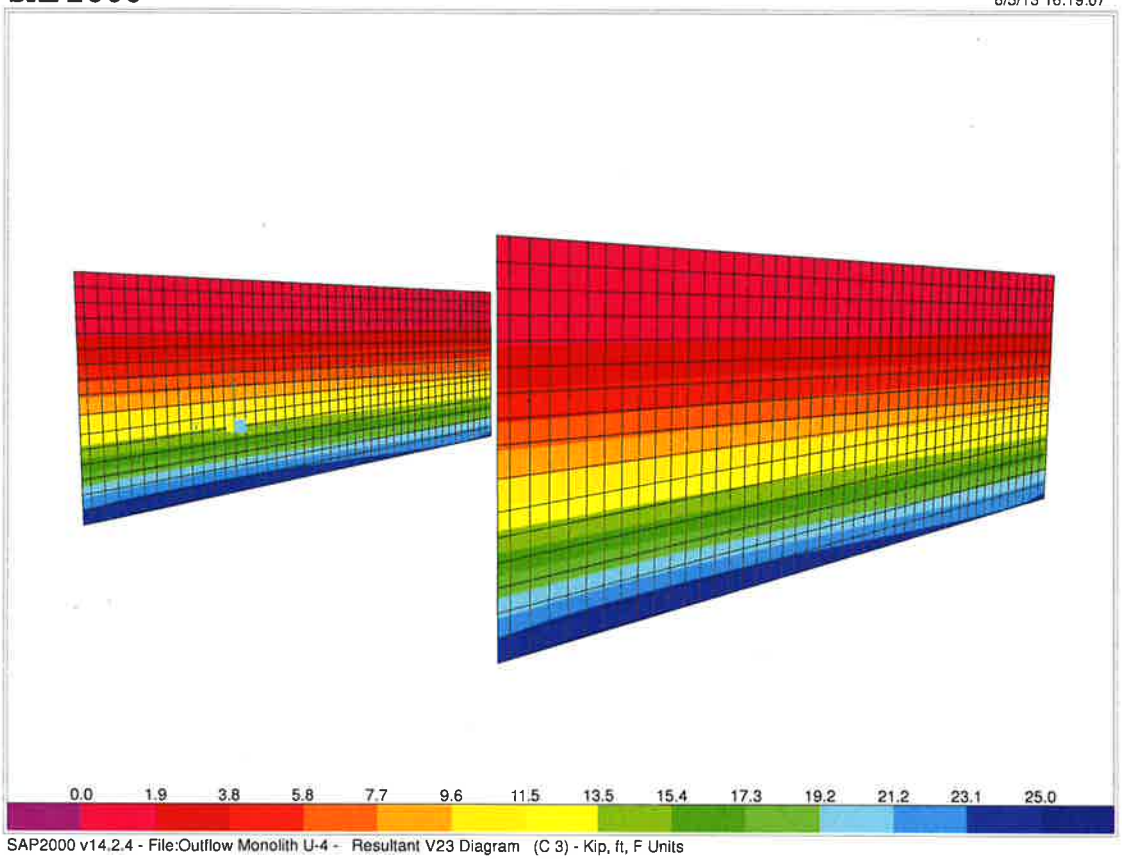


SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/5/13 16:19:37



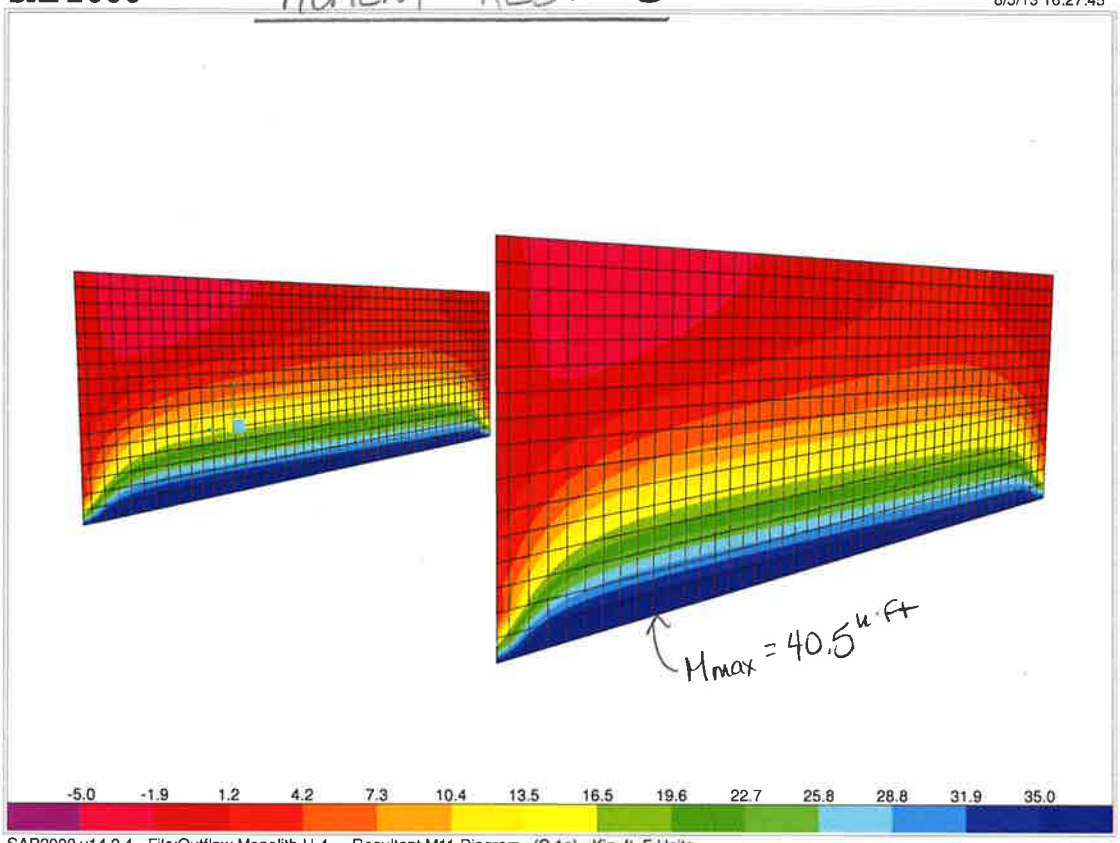
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 2) - Kip, ft, F Units



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

7

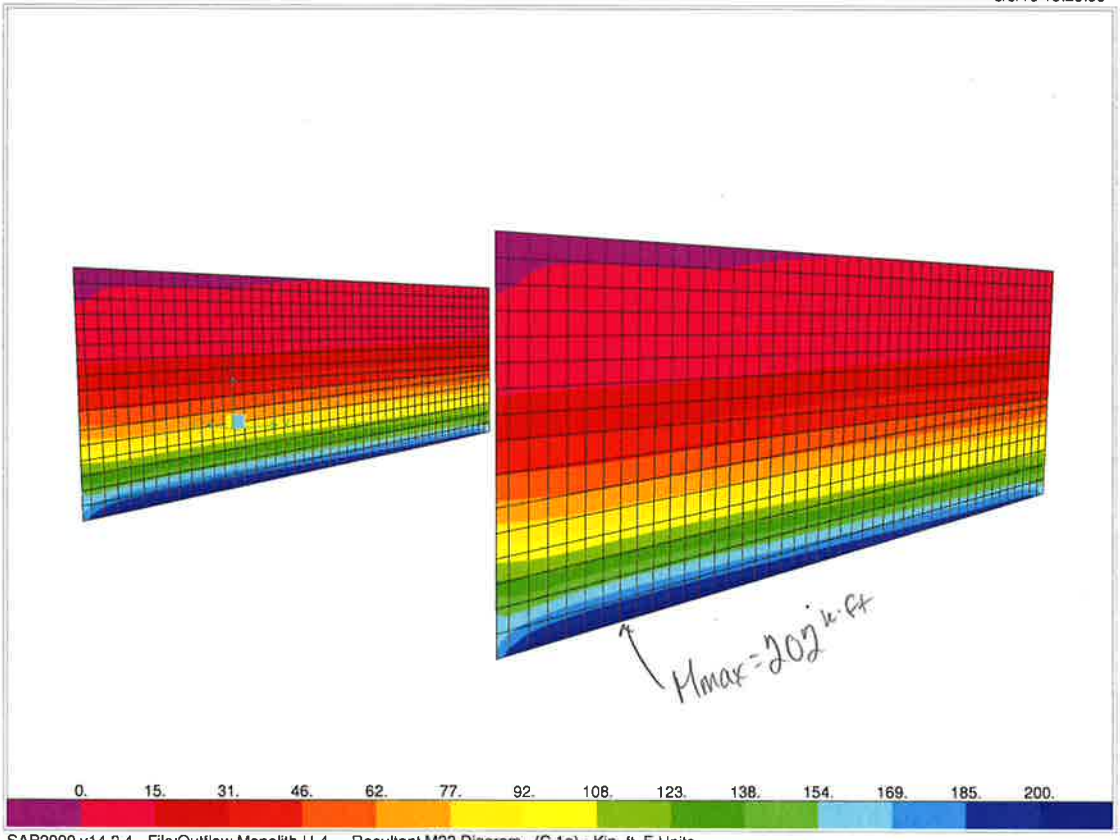
SAP2000 MOMENT RESULTS 8/5/13 16:27:45



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

Secondary (horizontal)

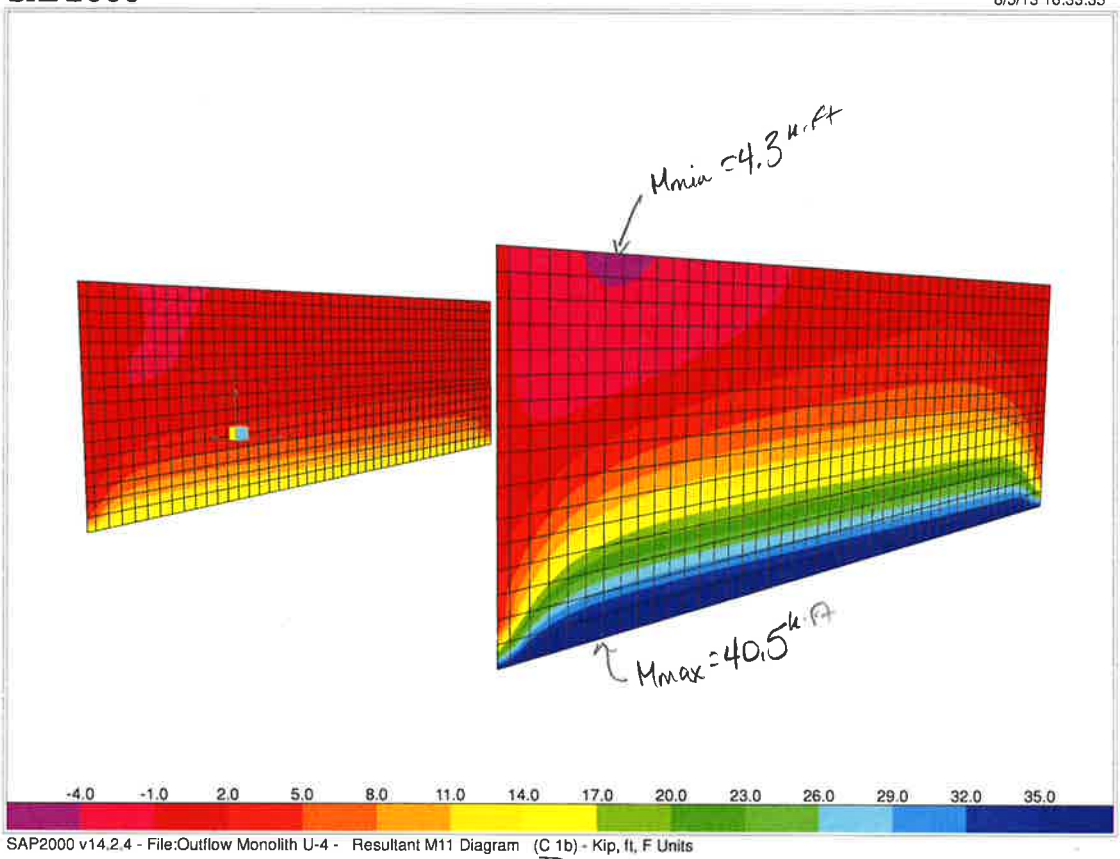
SAP2000 8/5/13 16:29:53



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

Primary (vertical)

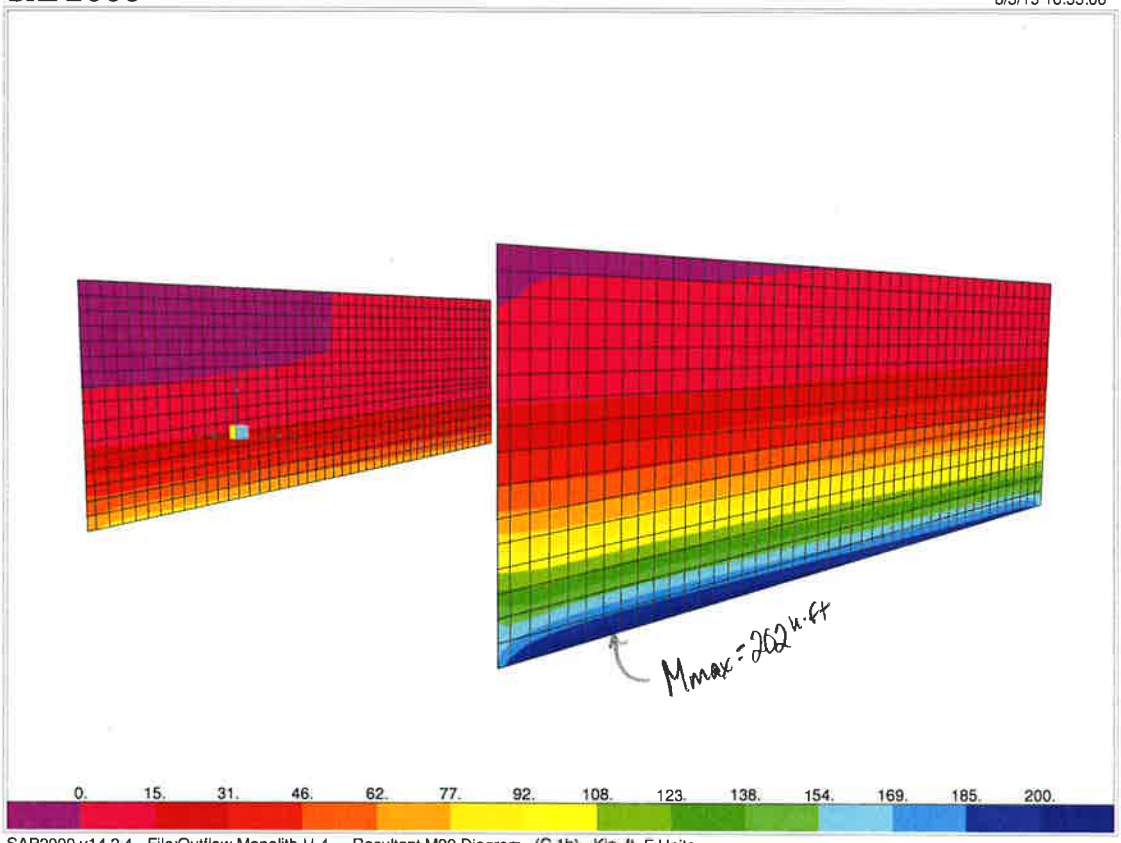
SAP2000 8/5/13 16:33:35



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

Secondary

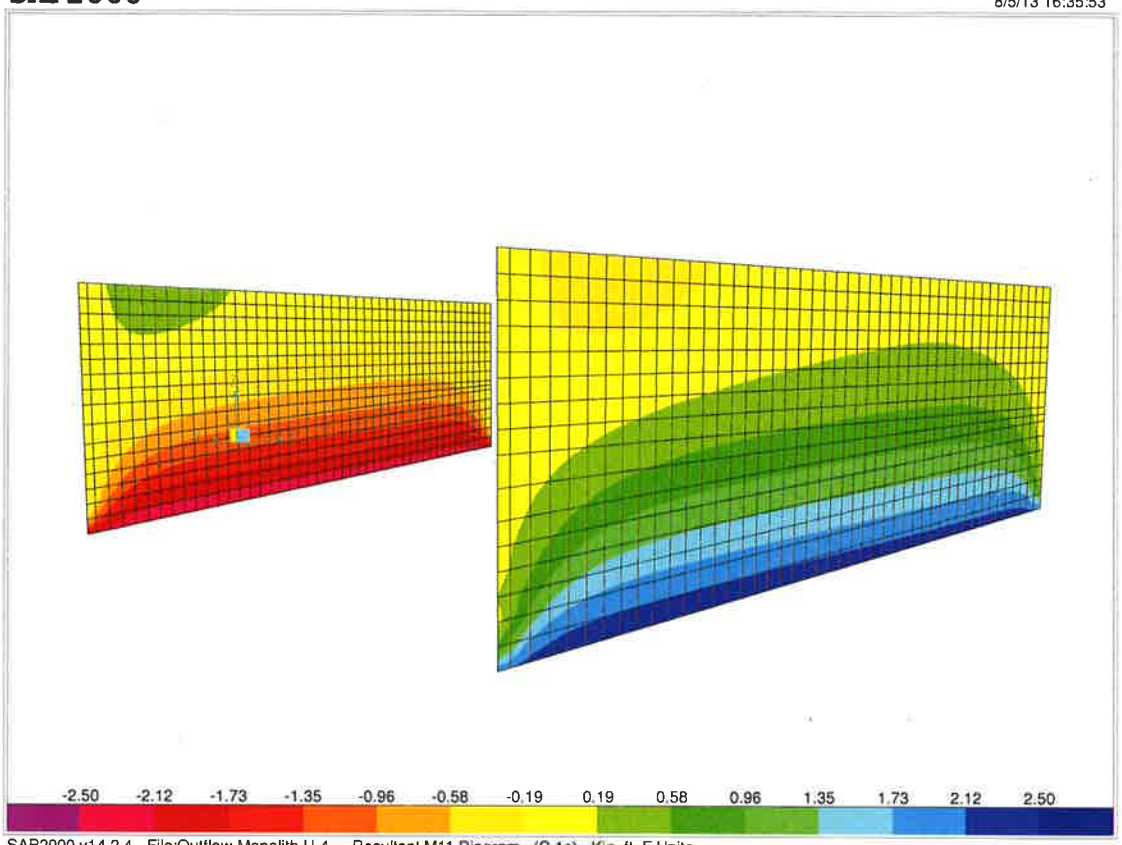
SAP2000 8/5/13 16:35:06



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

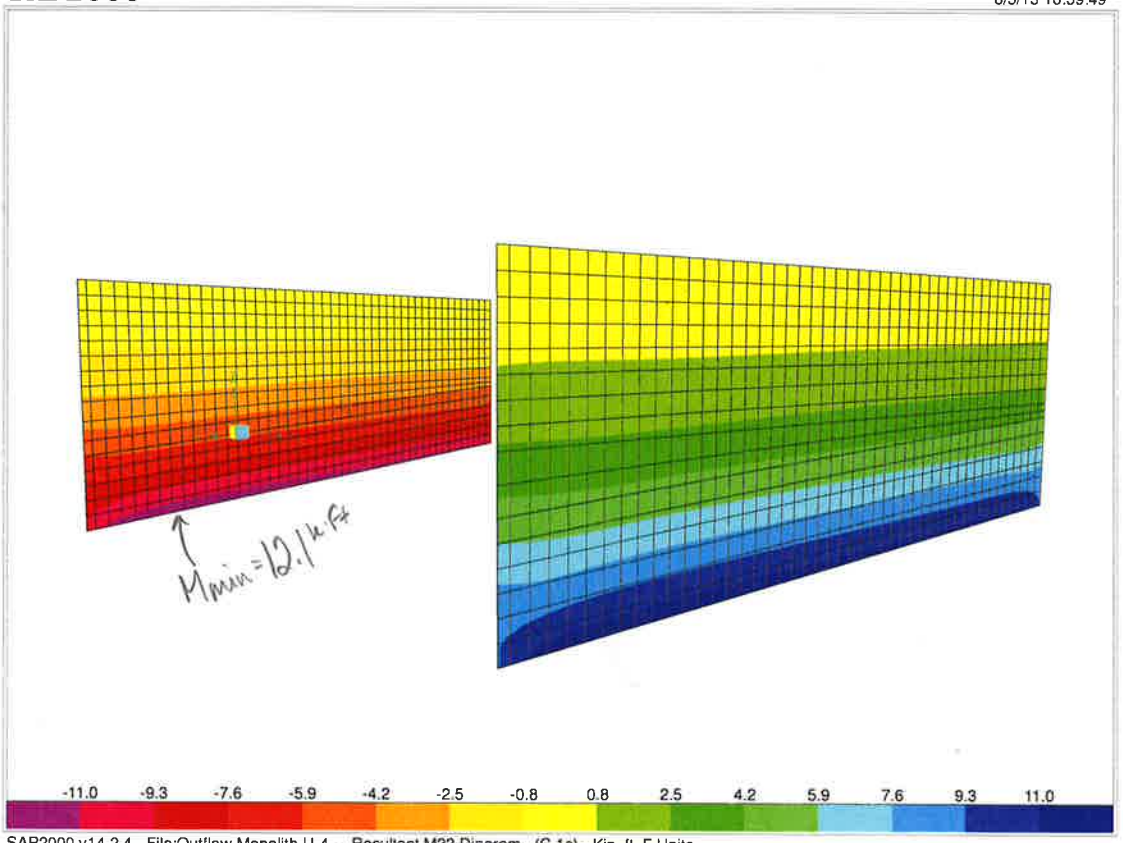
Primary

SAP2000 8/5/13 16:35:53



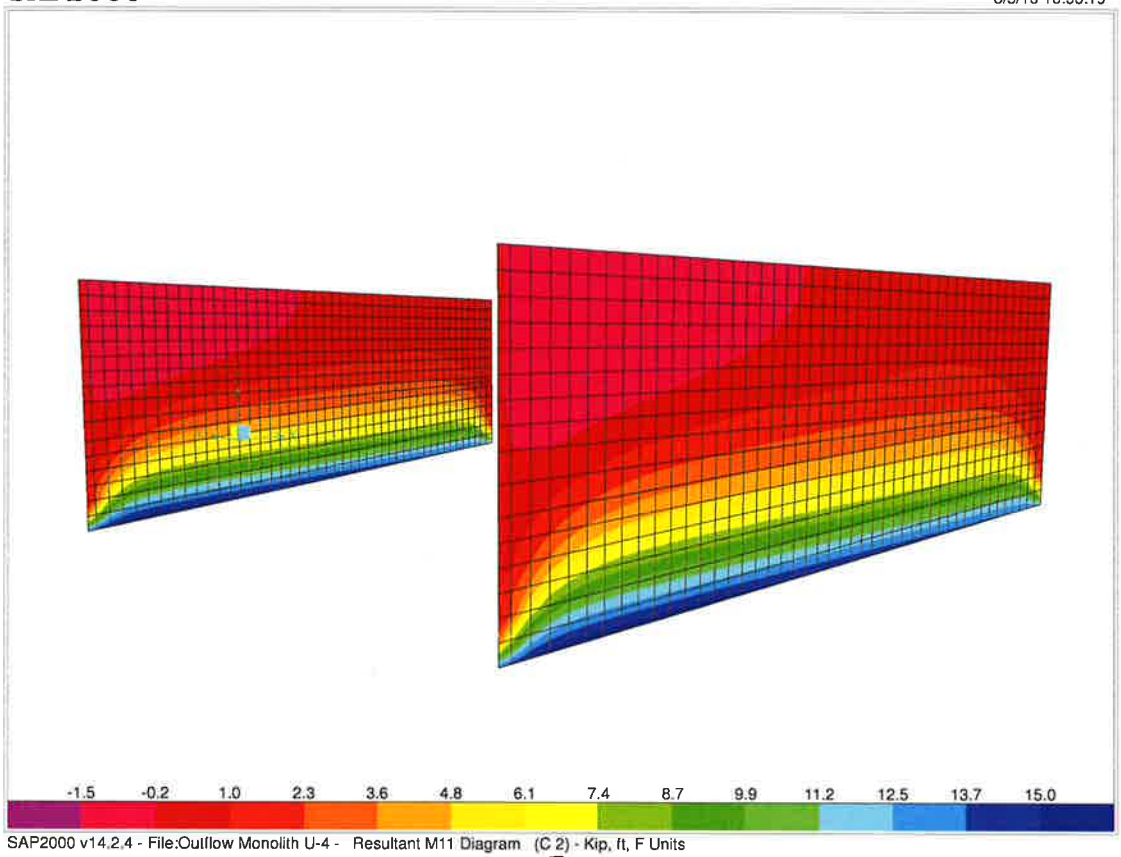
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/5/13 16:39:49



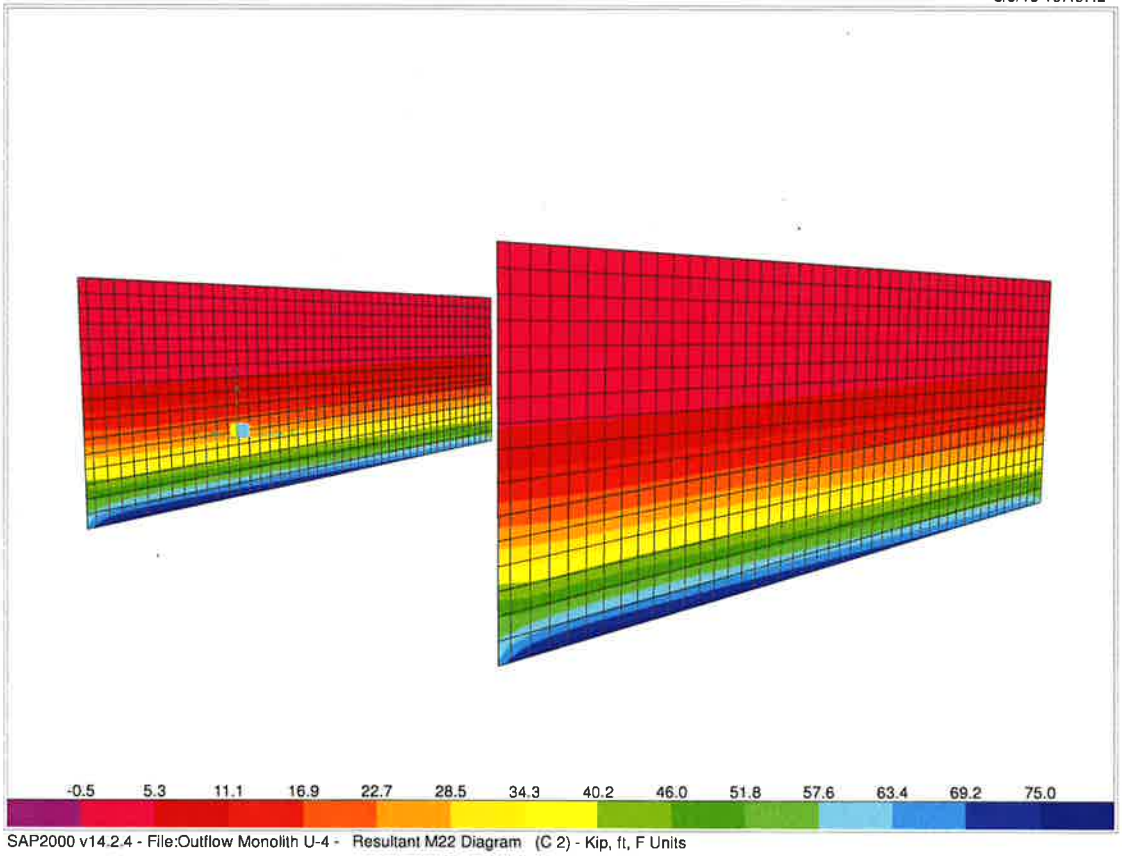
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/5/13 16:38:19



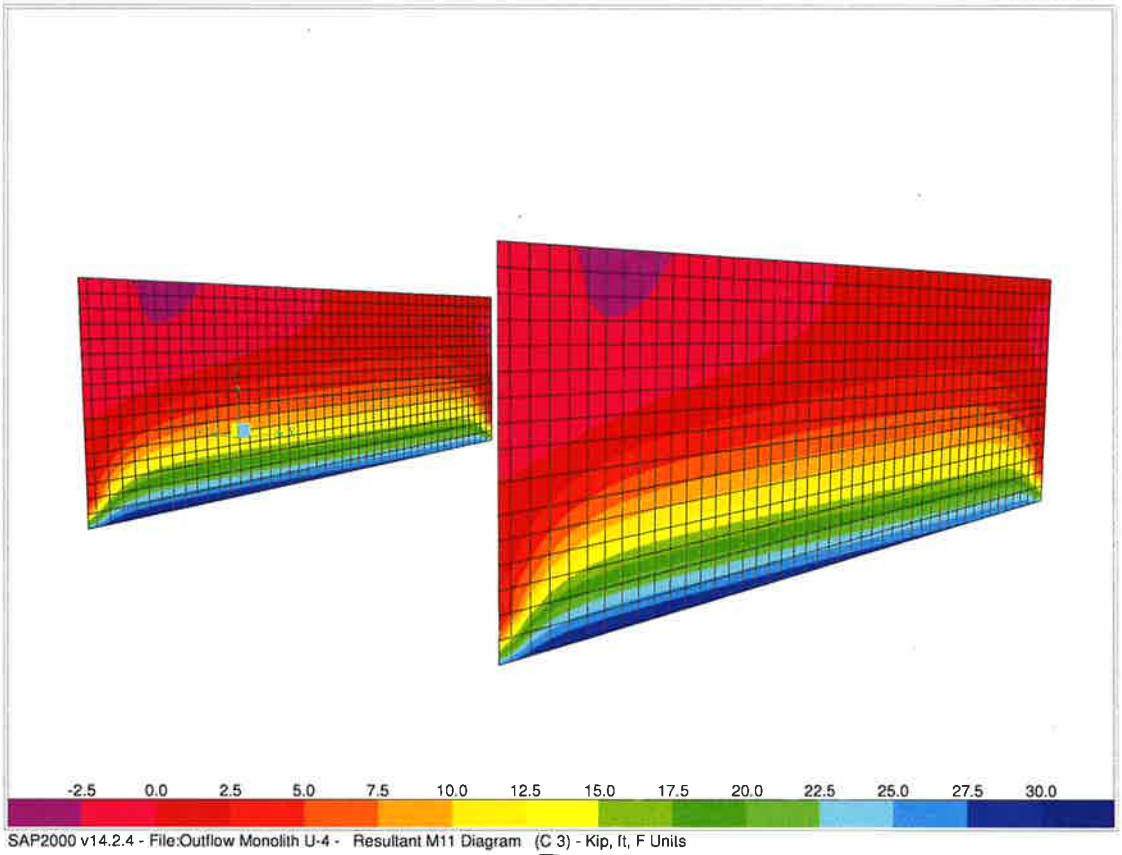
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/5/13 16:46:42



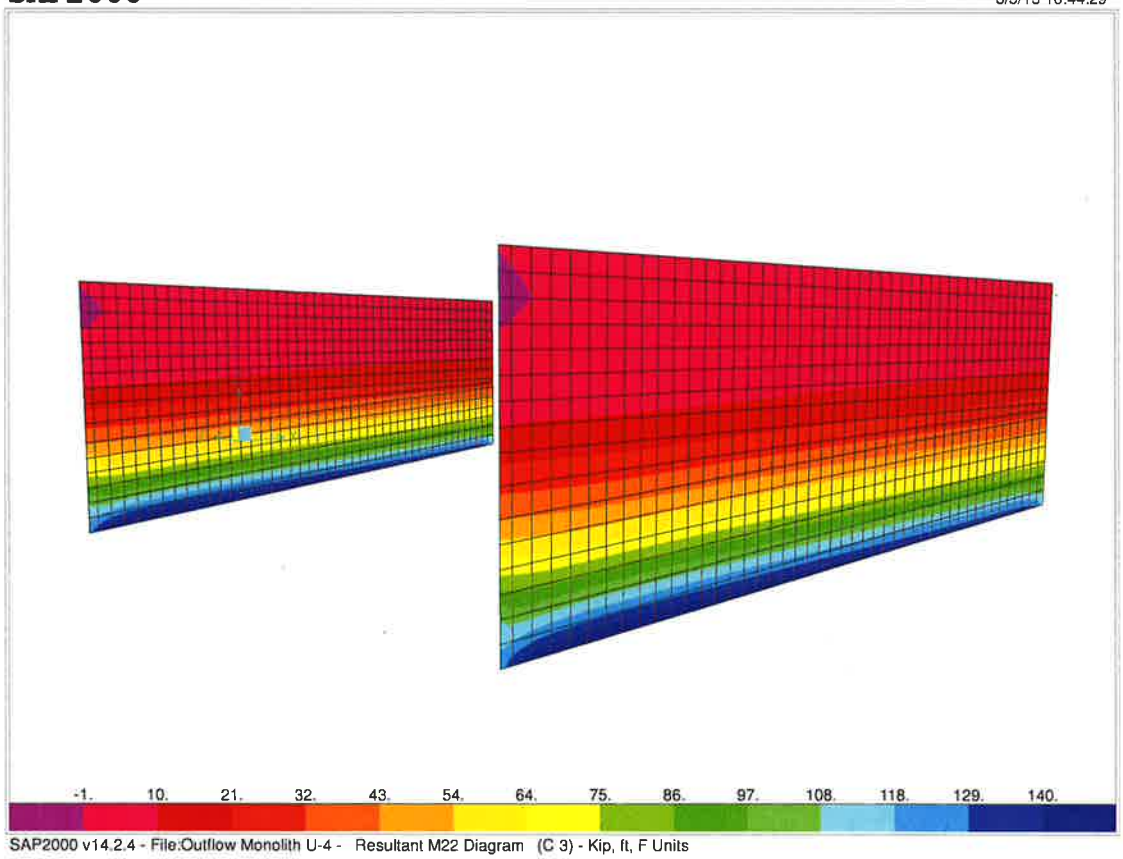
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/5/13 16:45:34



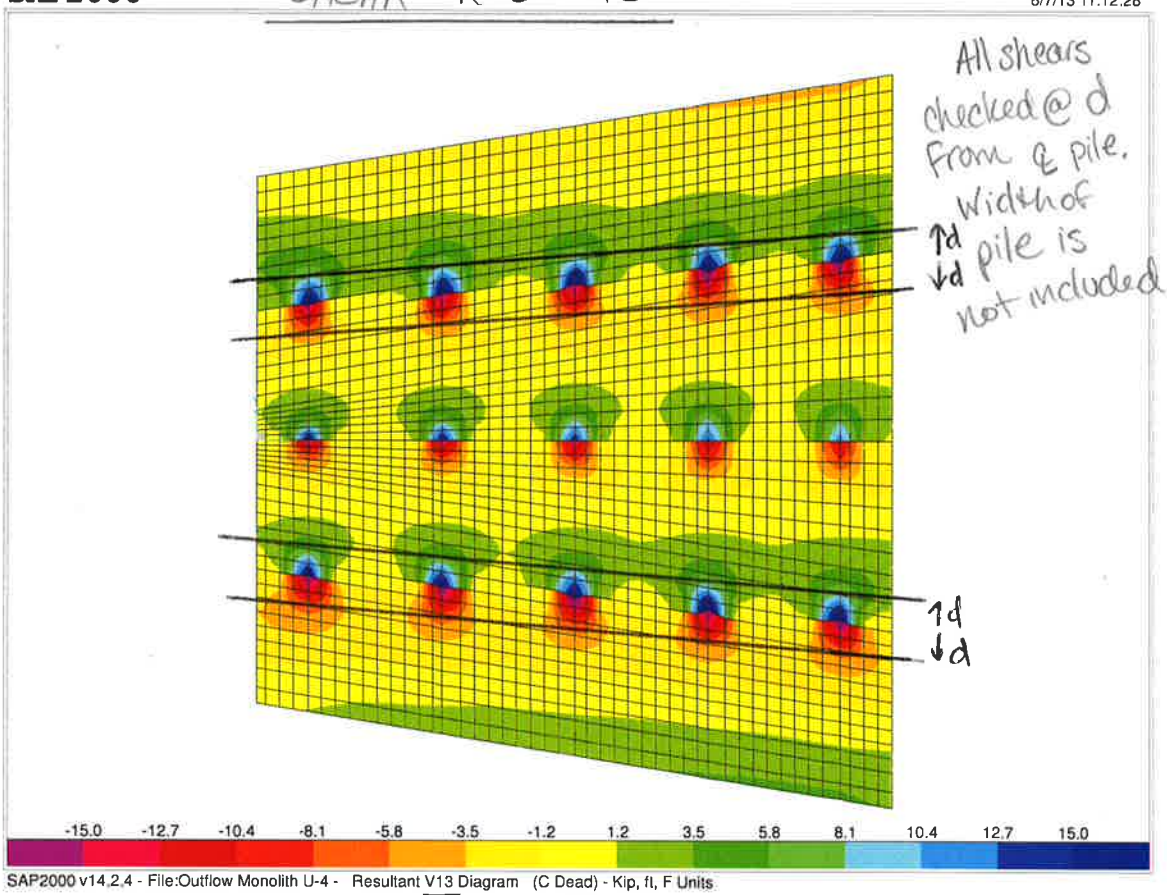
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/5/13 16:44:29



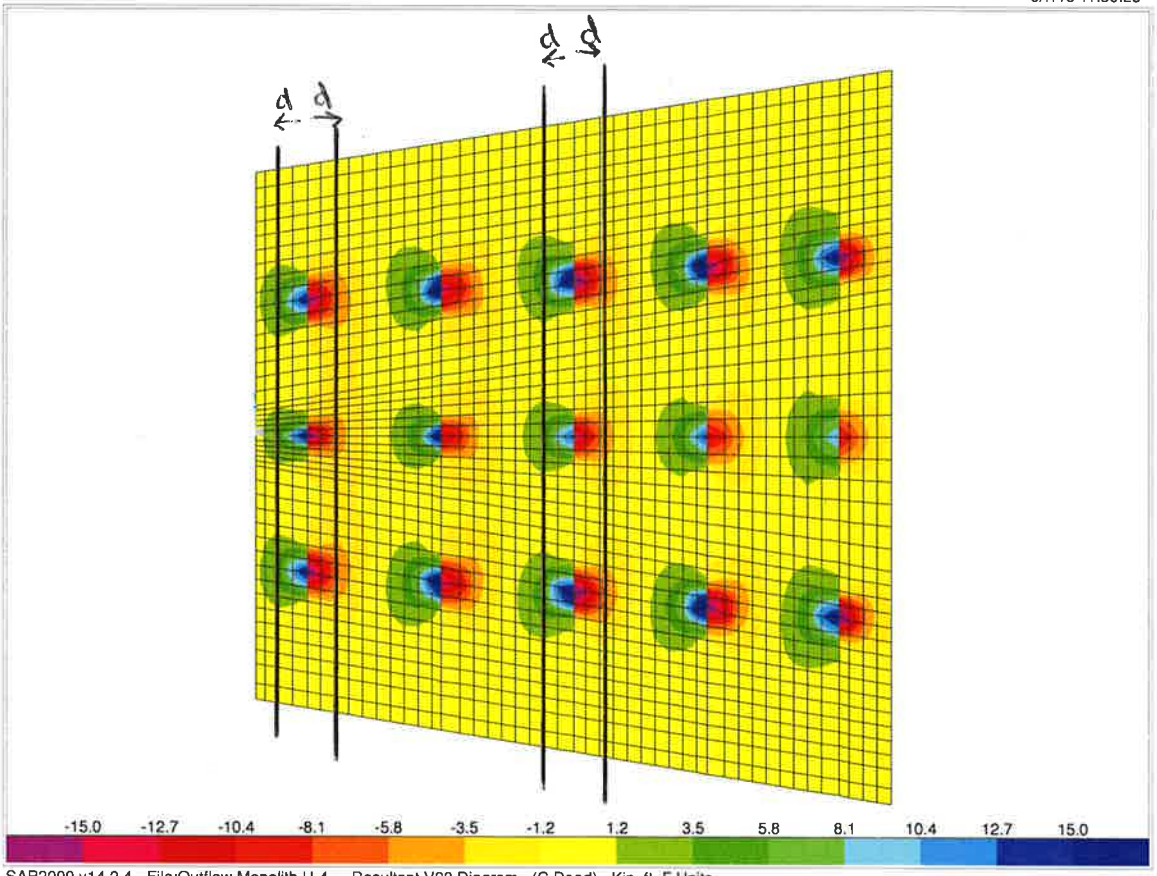
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

SAP2000 SHEAR RESULTS 8/7/13 11:12:28



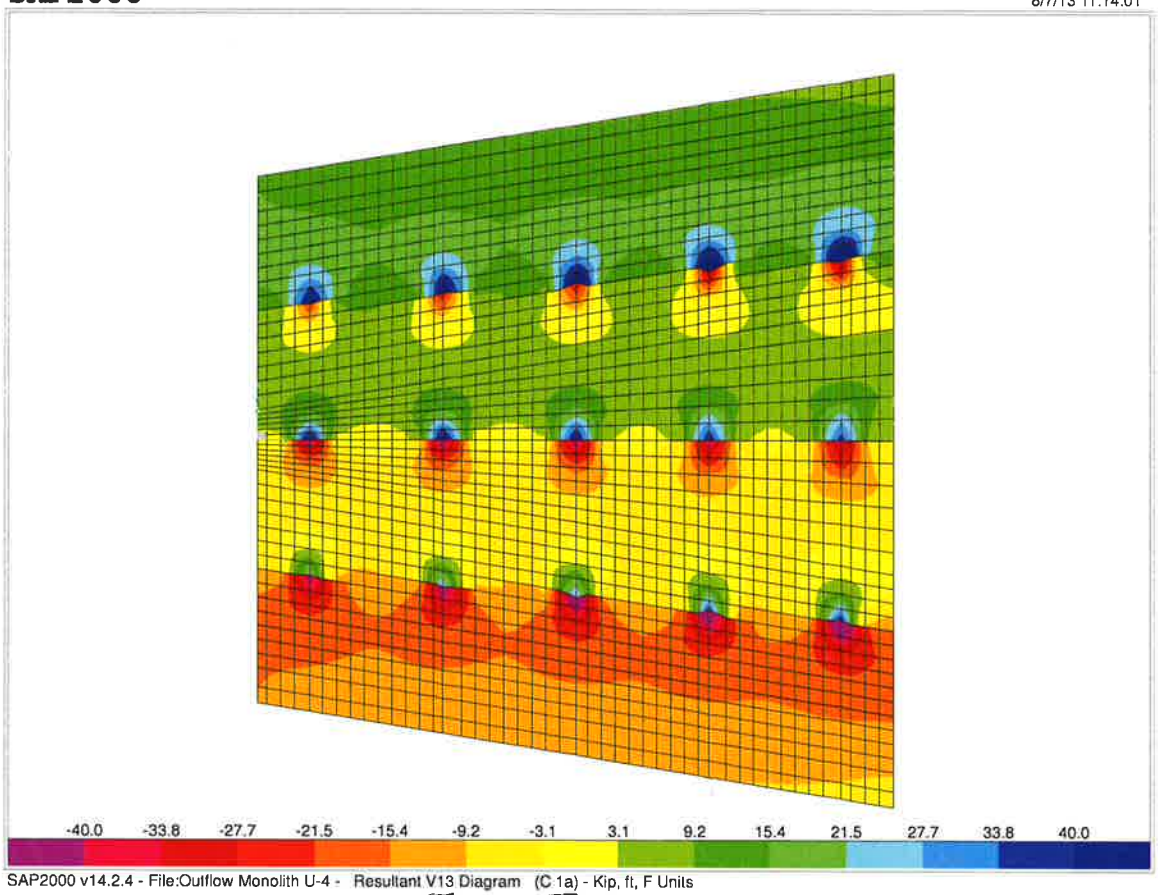
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C Dead) - Kip, ft, F Units

SAP2000 8/7/13 11:30:28



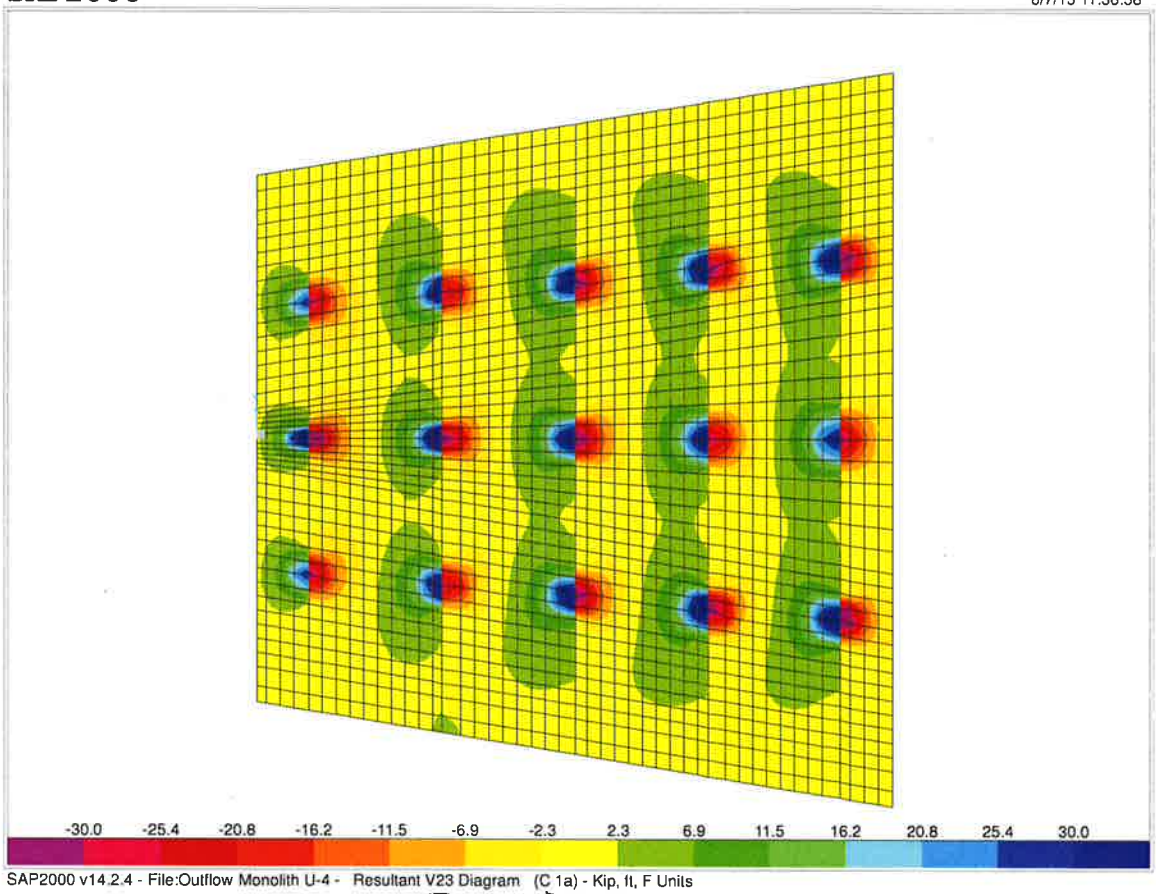
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C Dead) - Kip, ft, F Units

SAP2000 8/7/13 11:14:01



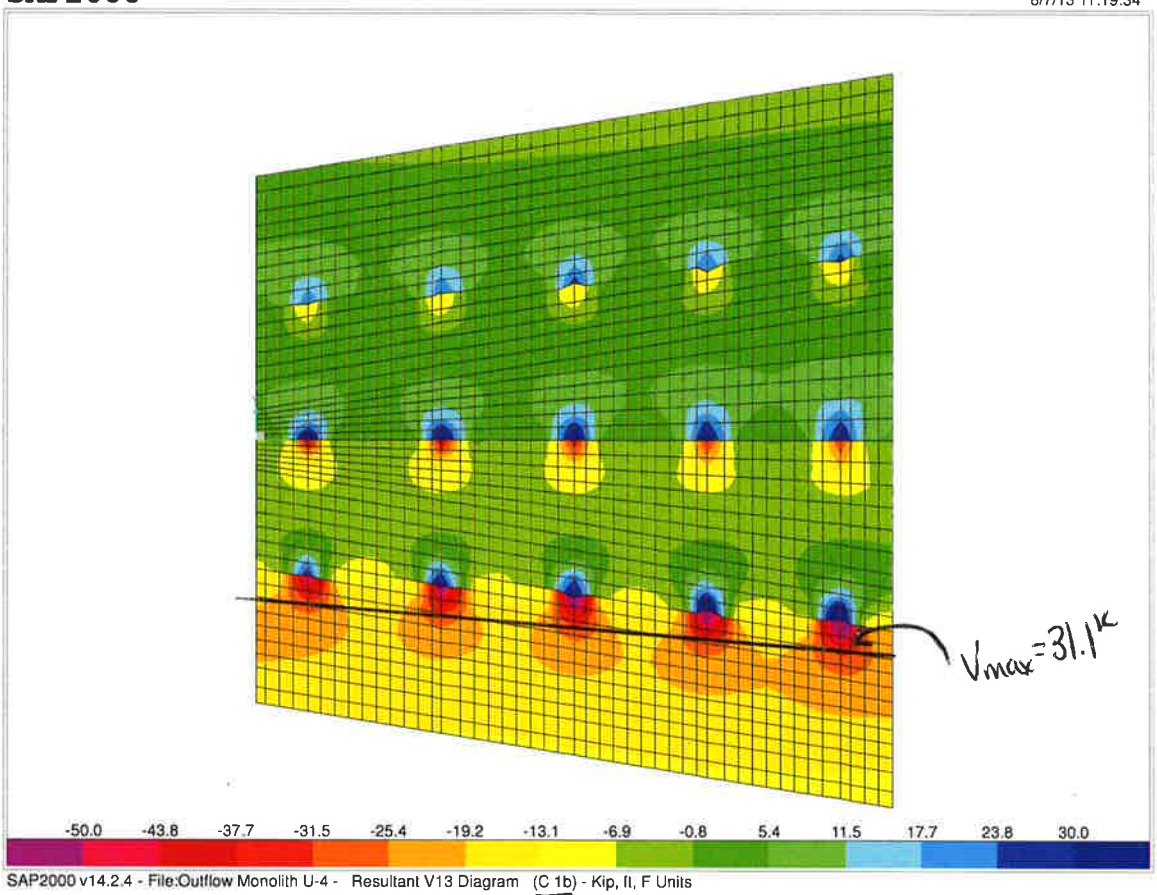
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/7/13 11:36:58



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

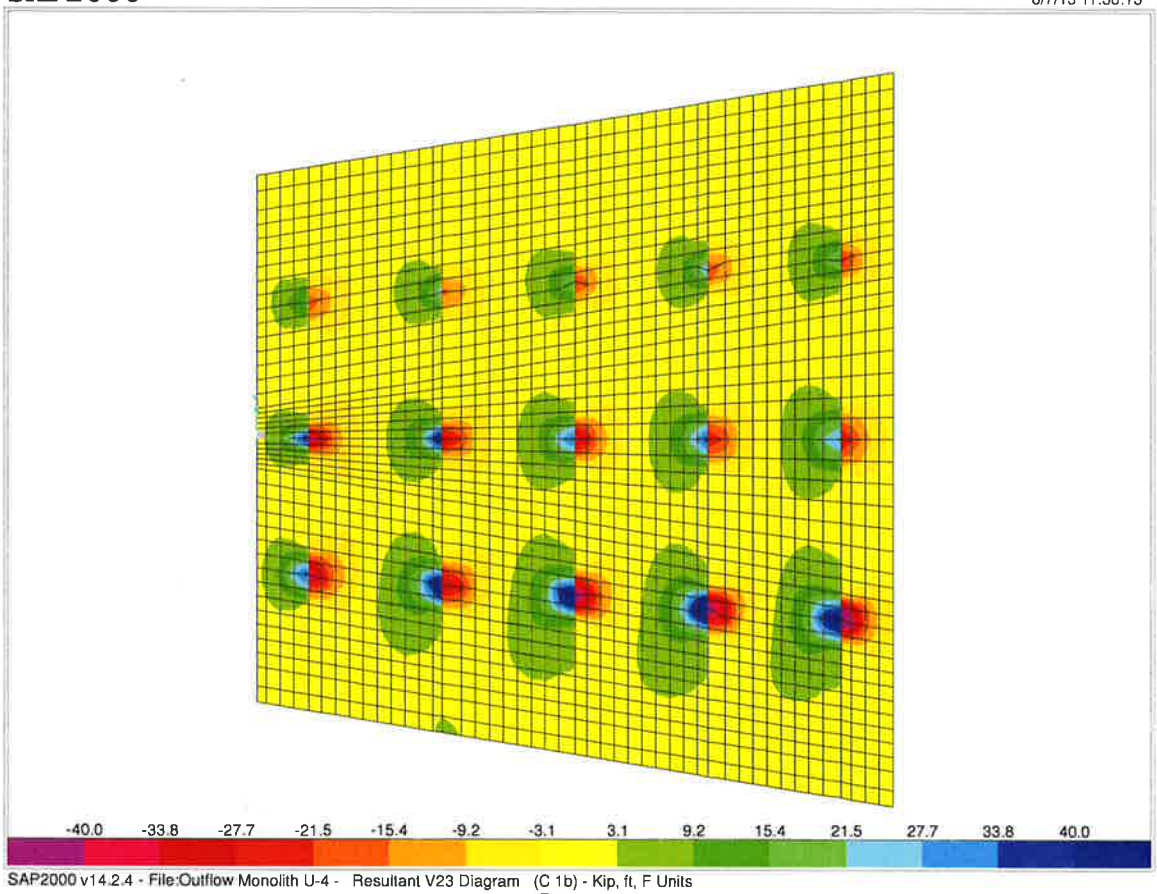
SAP2000 8/7/13 11:19:34



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 1b) - Kip, ft, F Units

3

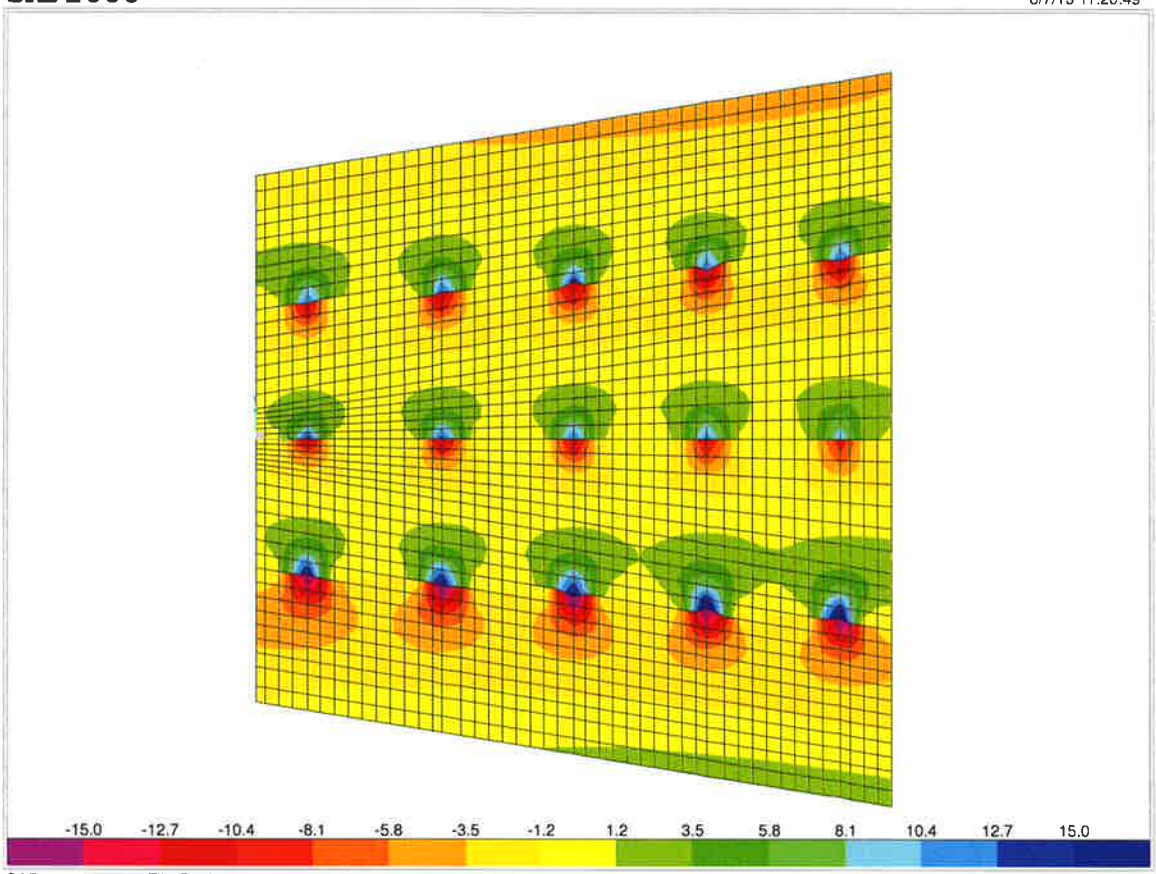
SAP2000 8/7/13 11:38:13



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

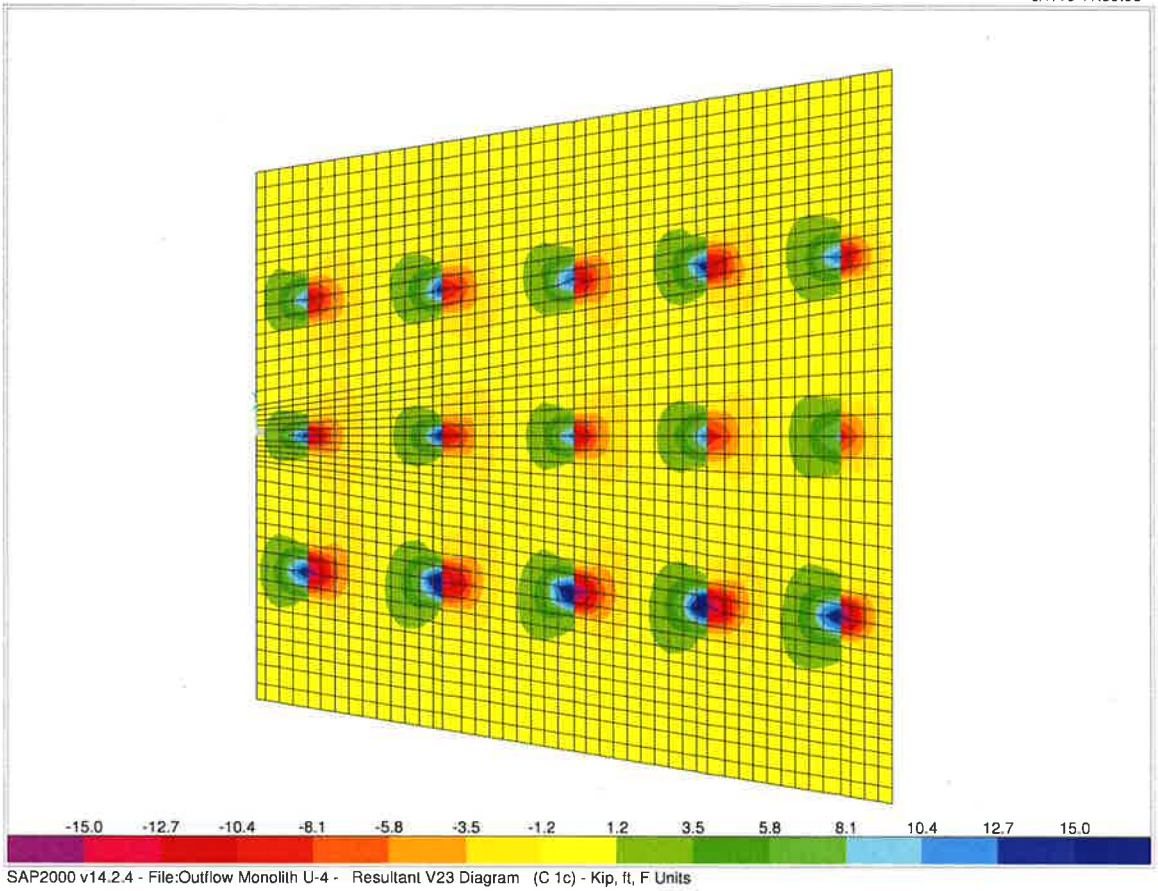
4

SAP2000 8/7/13 11:20:49



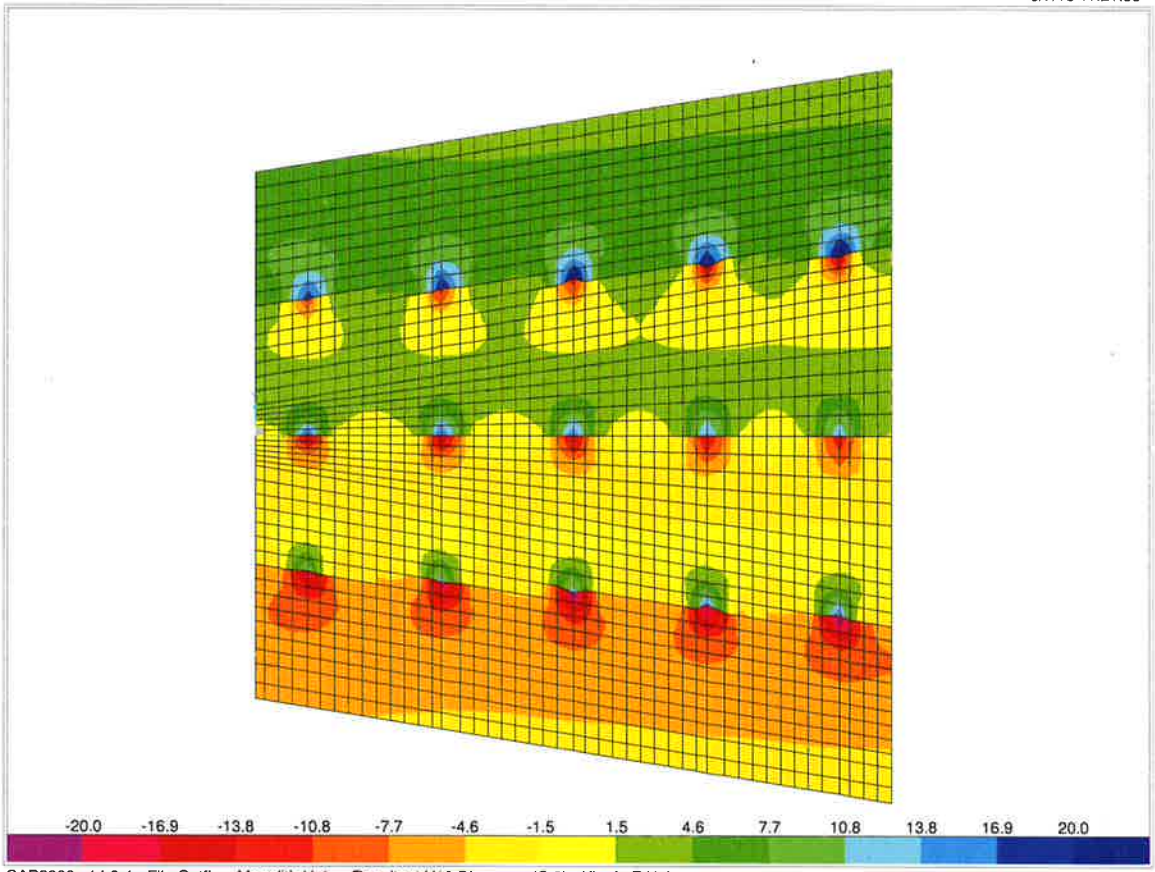
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/7/13 11:38:53



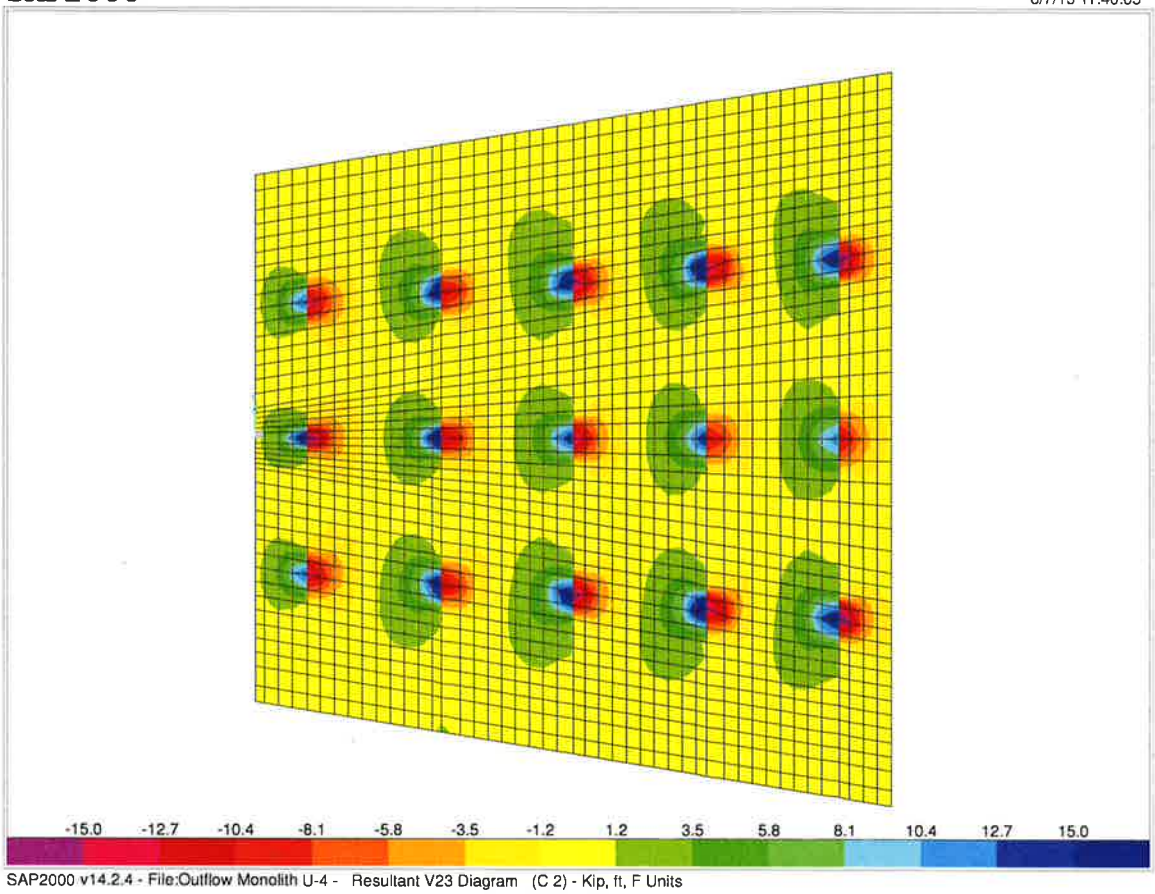
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/7/13 11:21:53



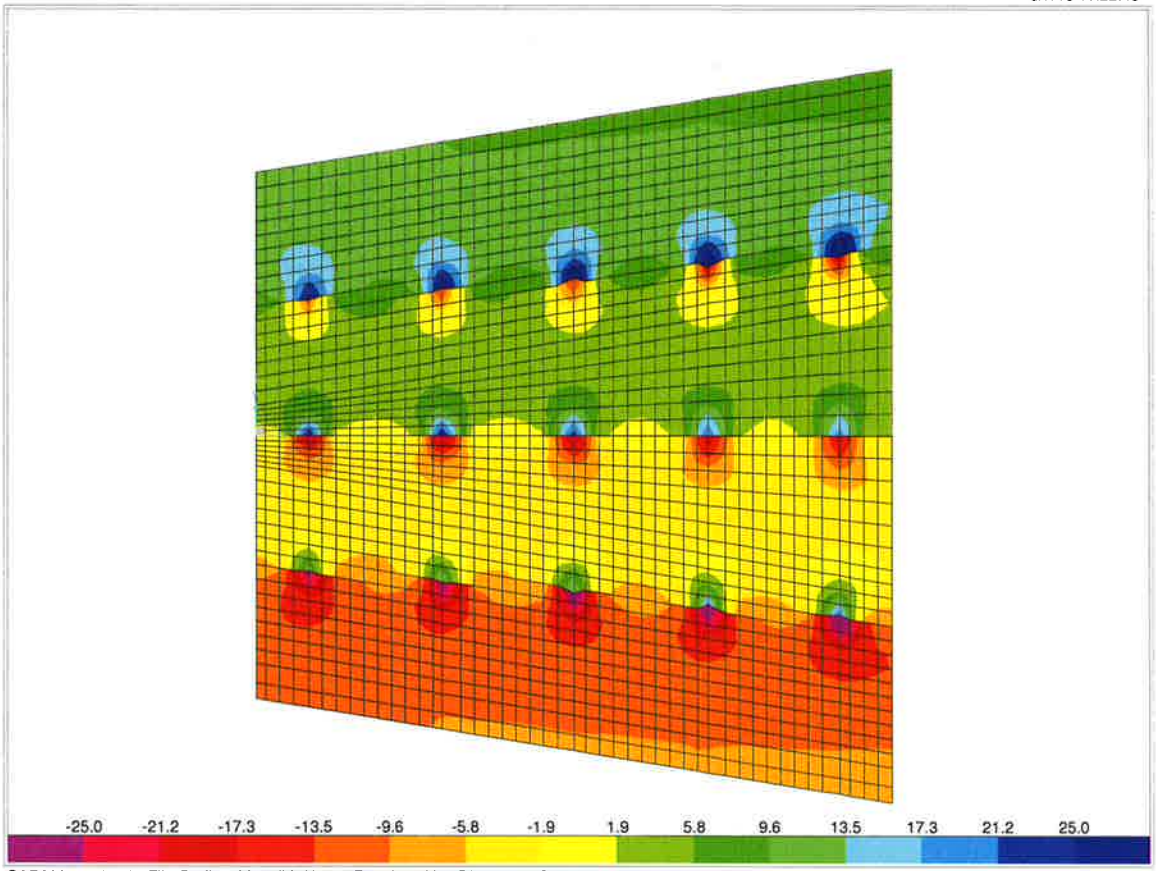
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/7/13 11:40:05



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 2) - Kip, ft, F Units

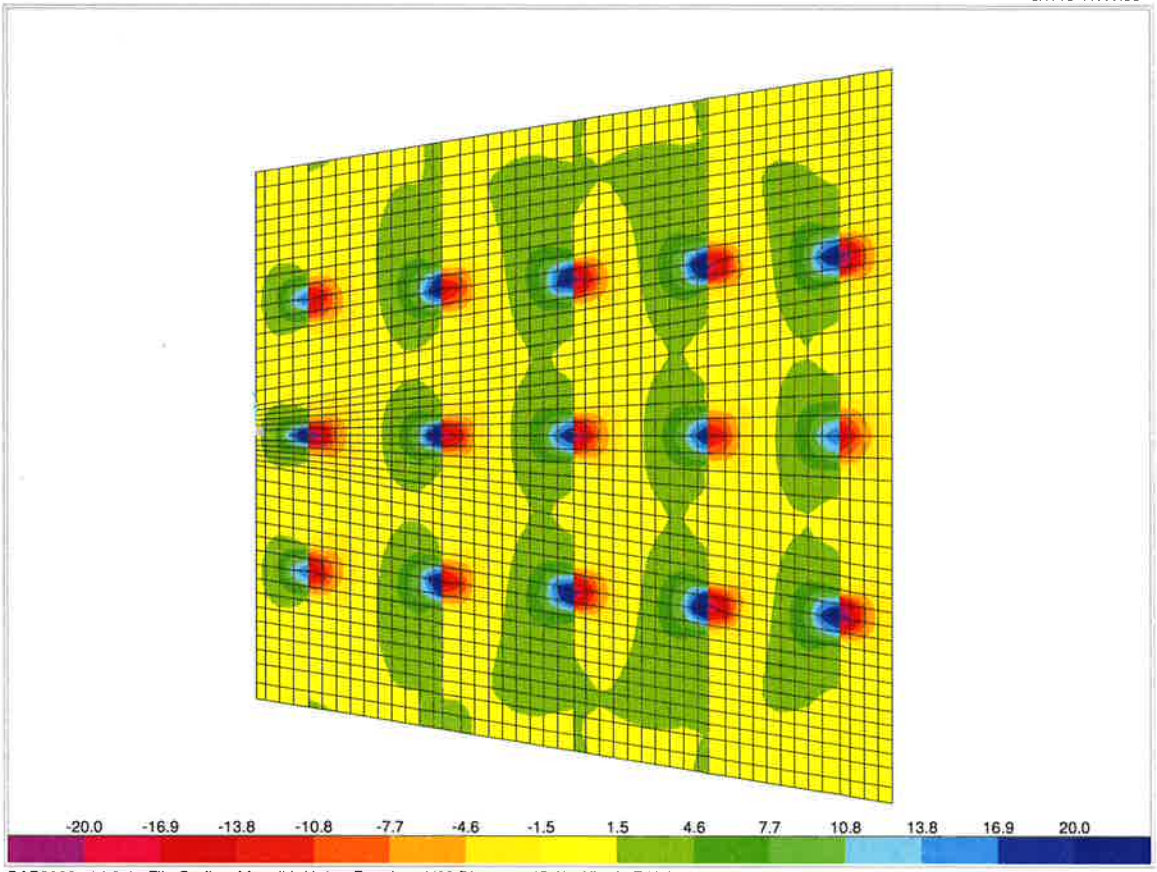
SAP2000 8/7/13 11:22:43



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 3) - Kip, ft, F Units

3

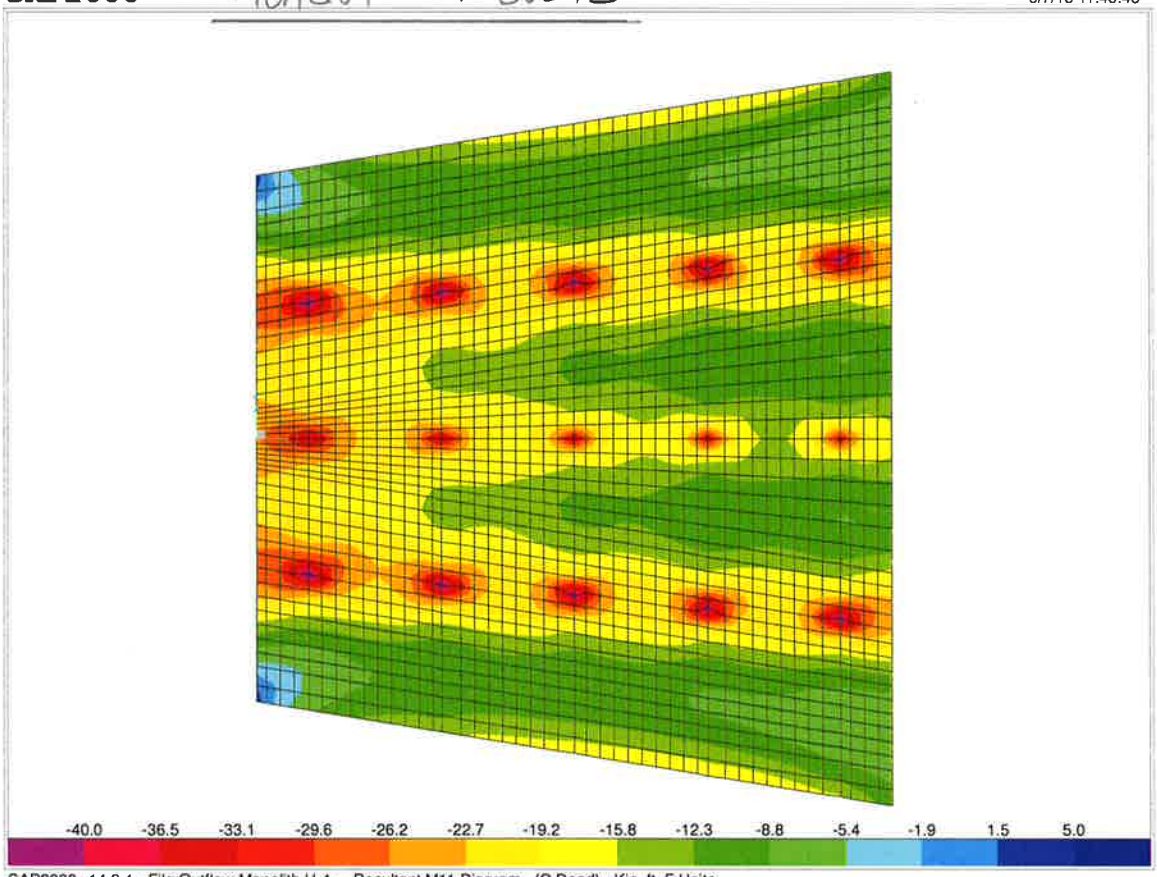
SAP2000 8/7/13 11:41:05



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

3

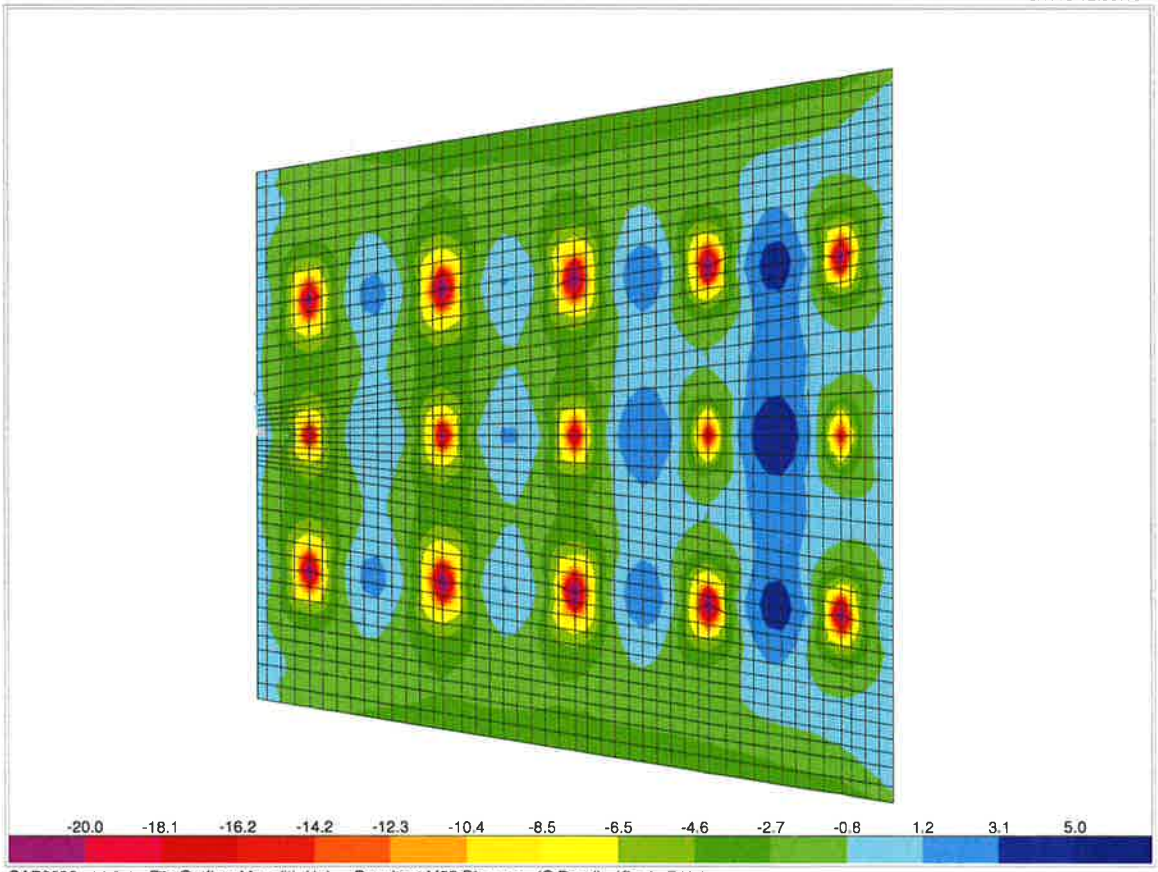
SAP2000 MOMENT RESULTS 8/7/13 11:46:46



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C Dead) - Kip, ft, F Units

TRANSVERSE (PRIMARY)

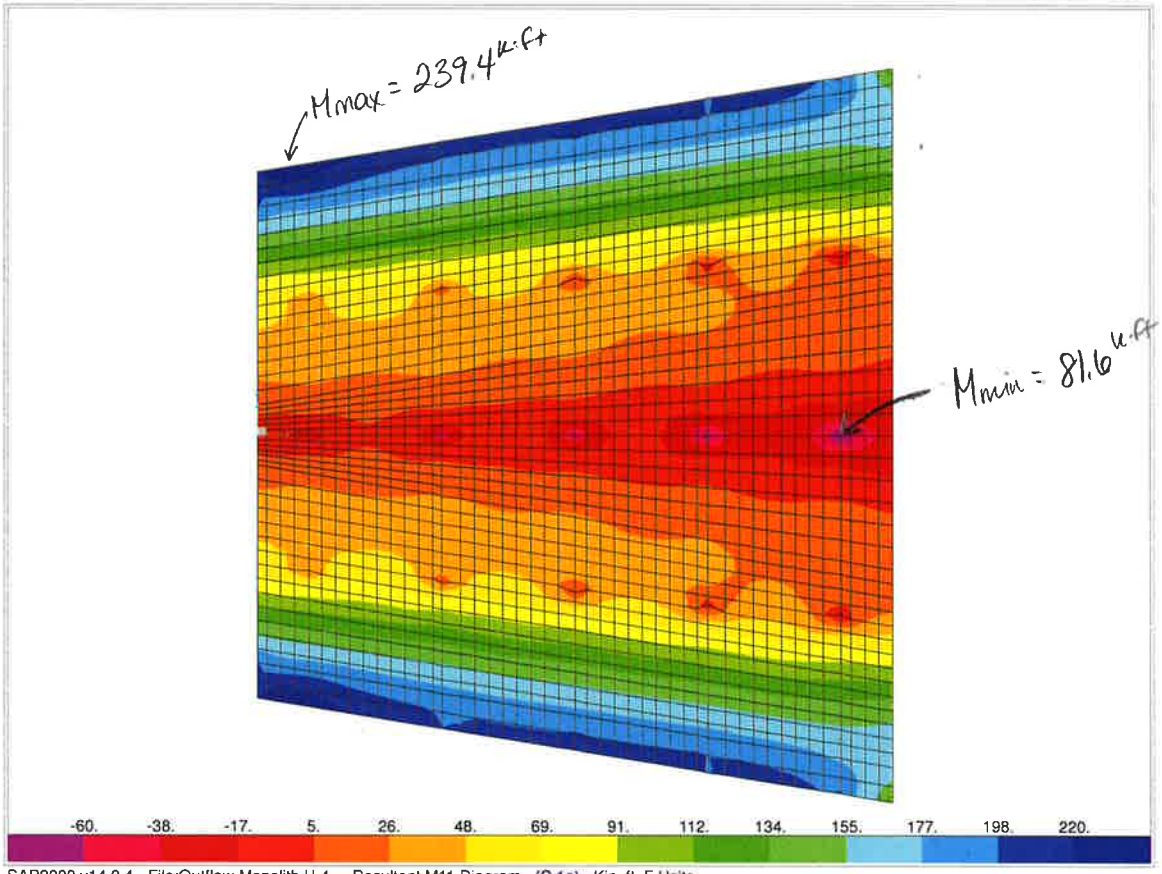
SAP2000 8/7/13 12:00:16



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C Dead) - Kip, ft, F Units

LONGITUDINAL (SECONDARY)

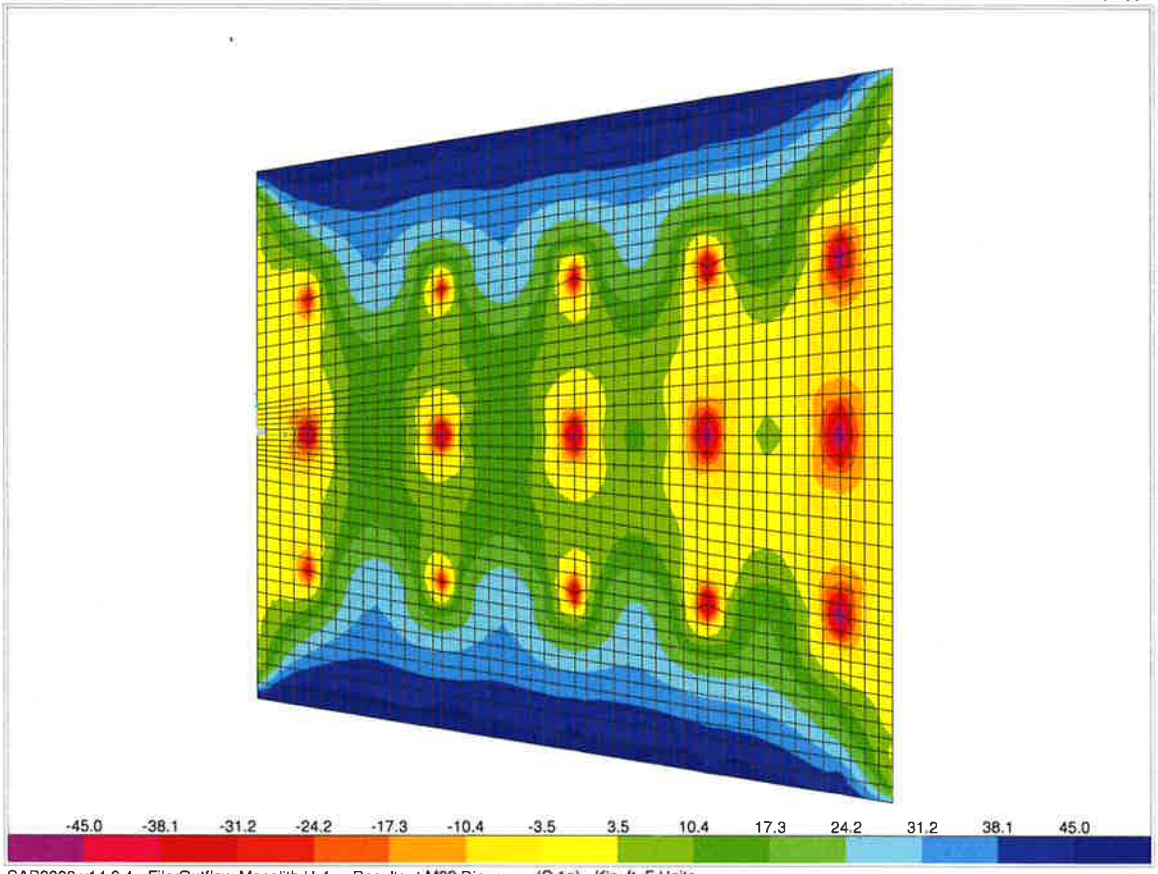
SAP2000 8/7/13 11:48:36



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

TRANSVERSE

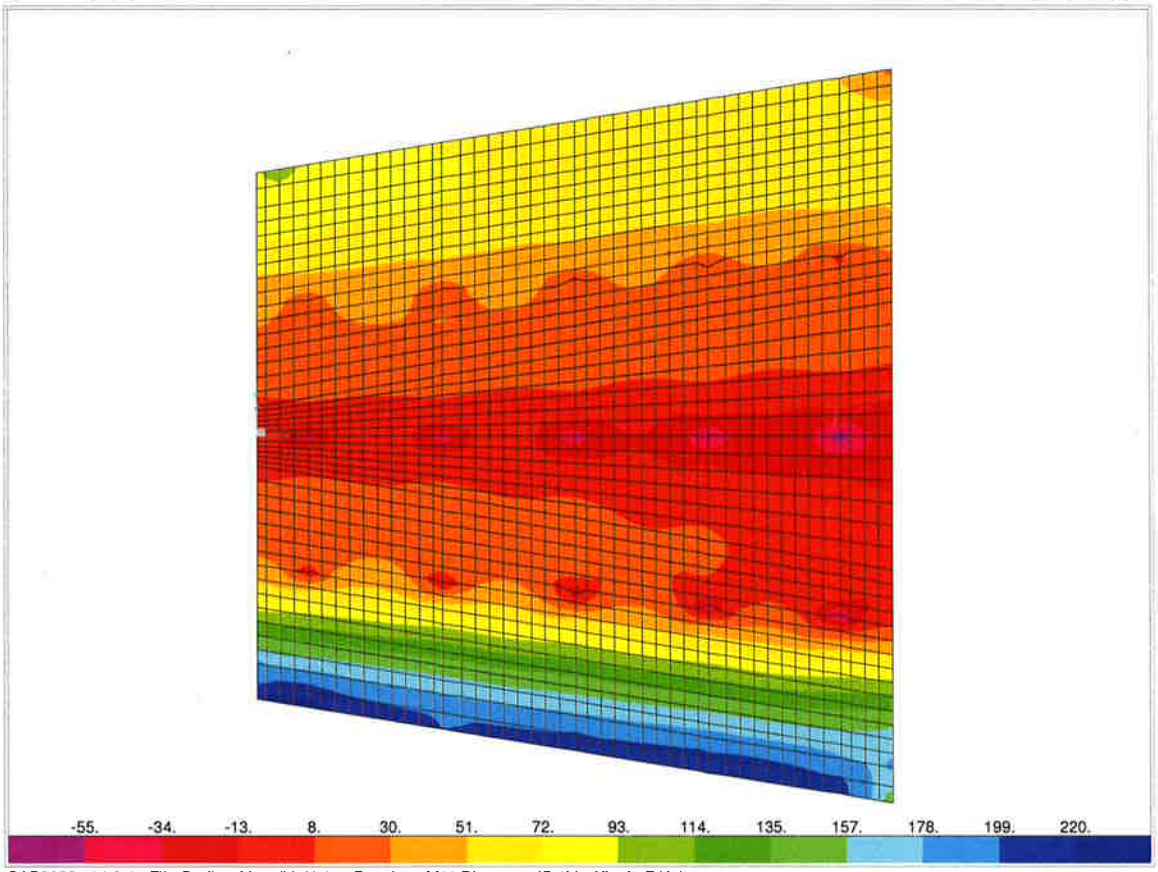
SAP2000 8/7/13 12:01:53



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

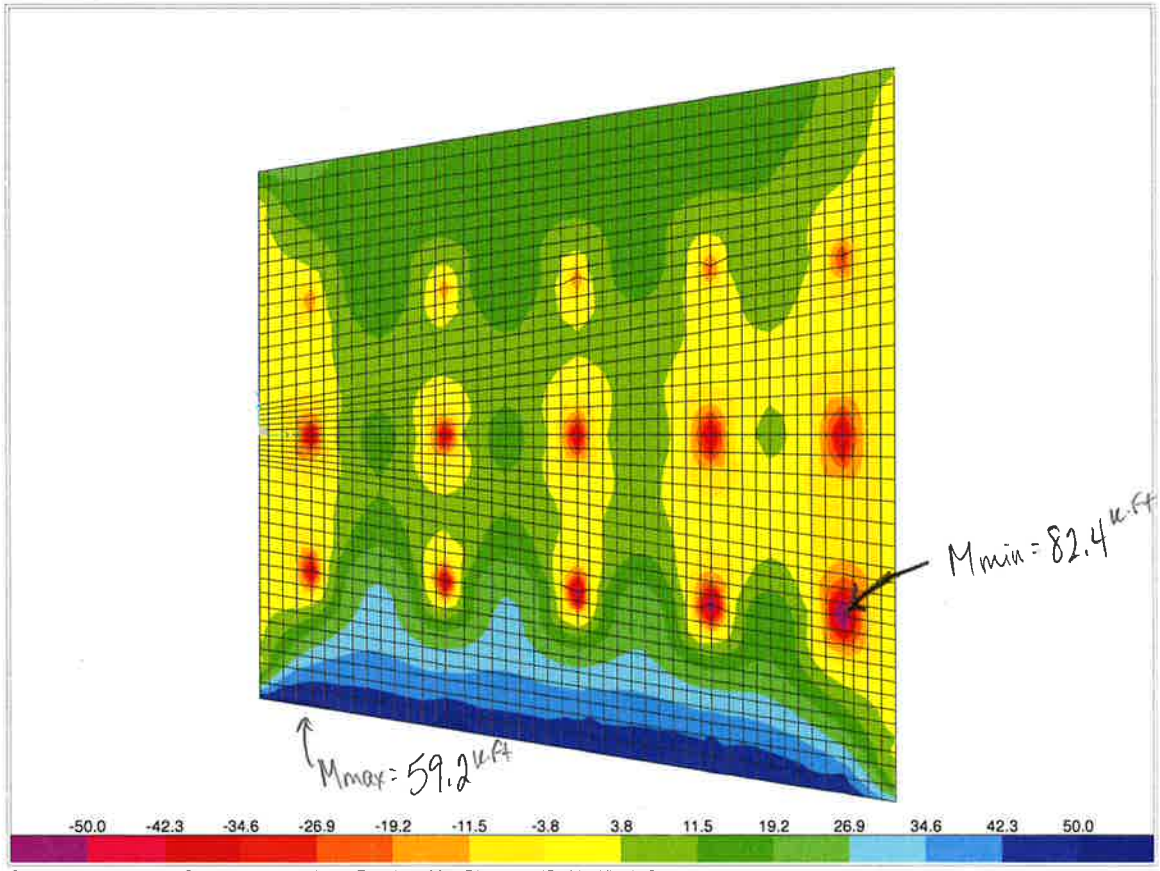
LONGITUDINAL

SAP2000 8/7/13 11:49:51



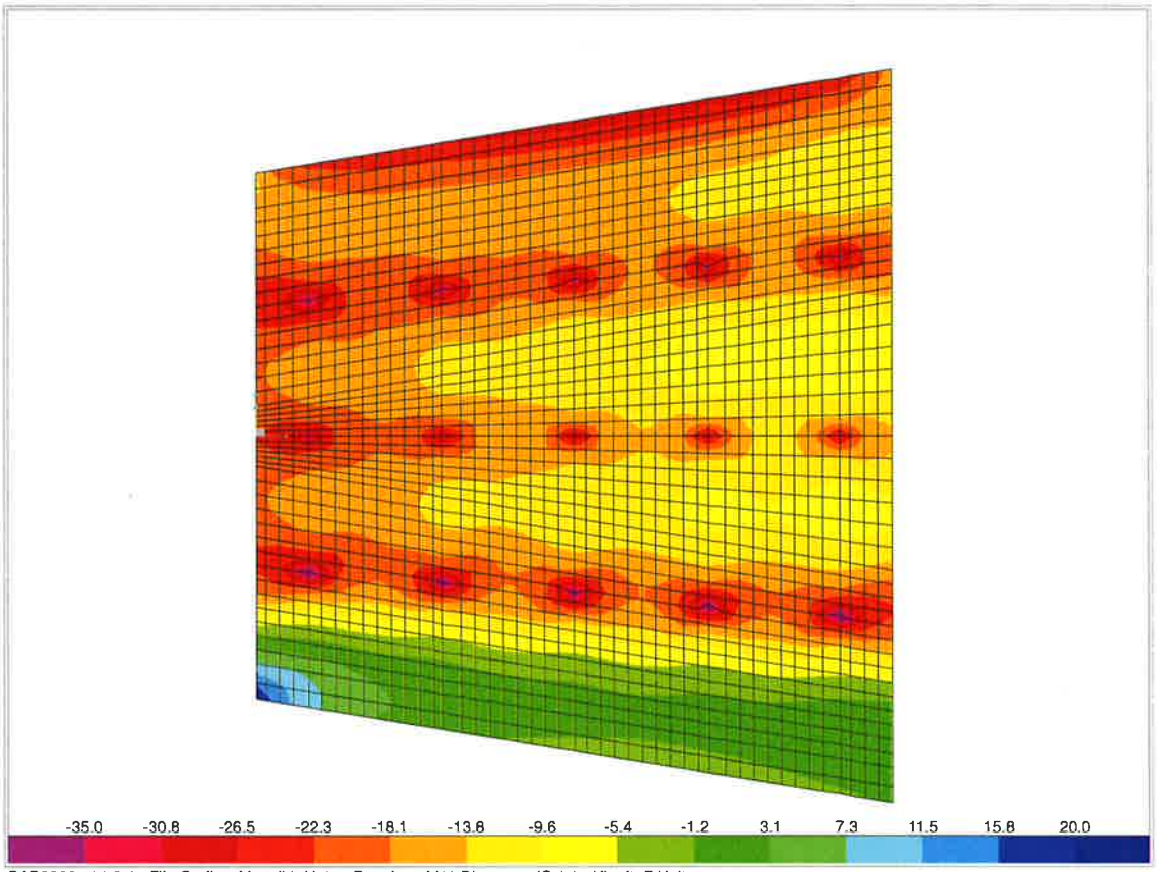
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/7/13 12:03:13



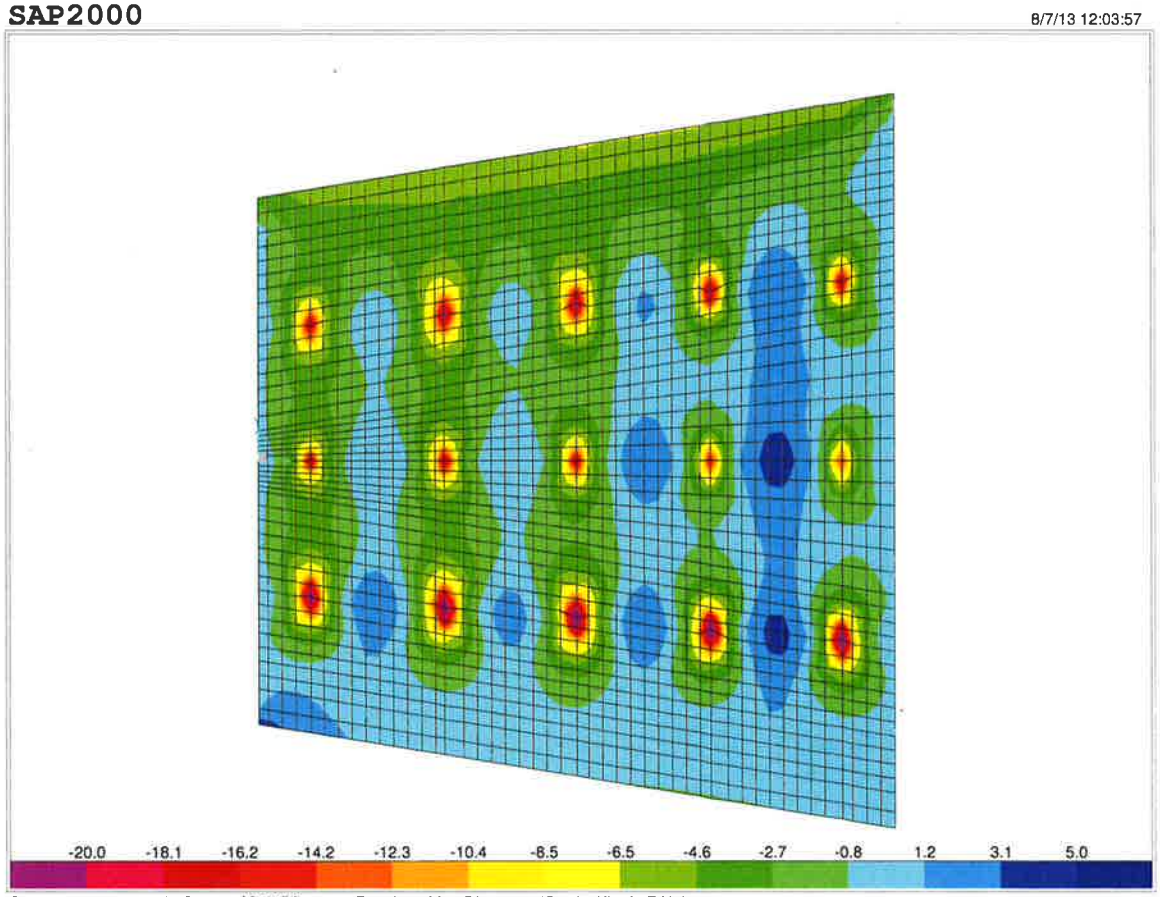
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/7/13 11:50:49



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/7/13 12:03:57



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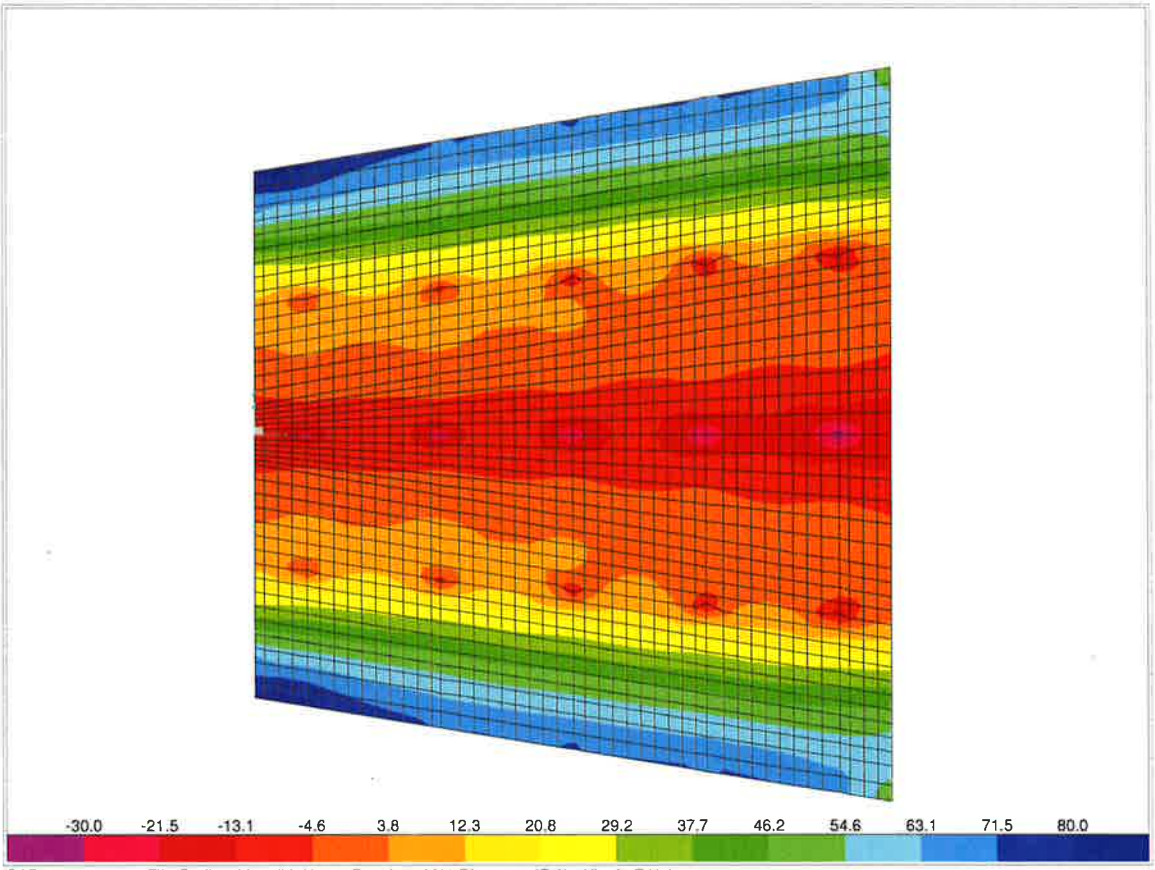
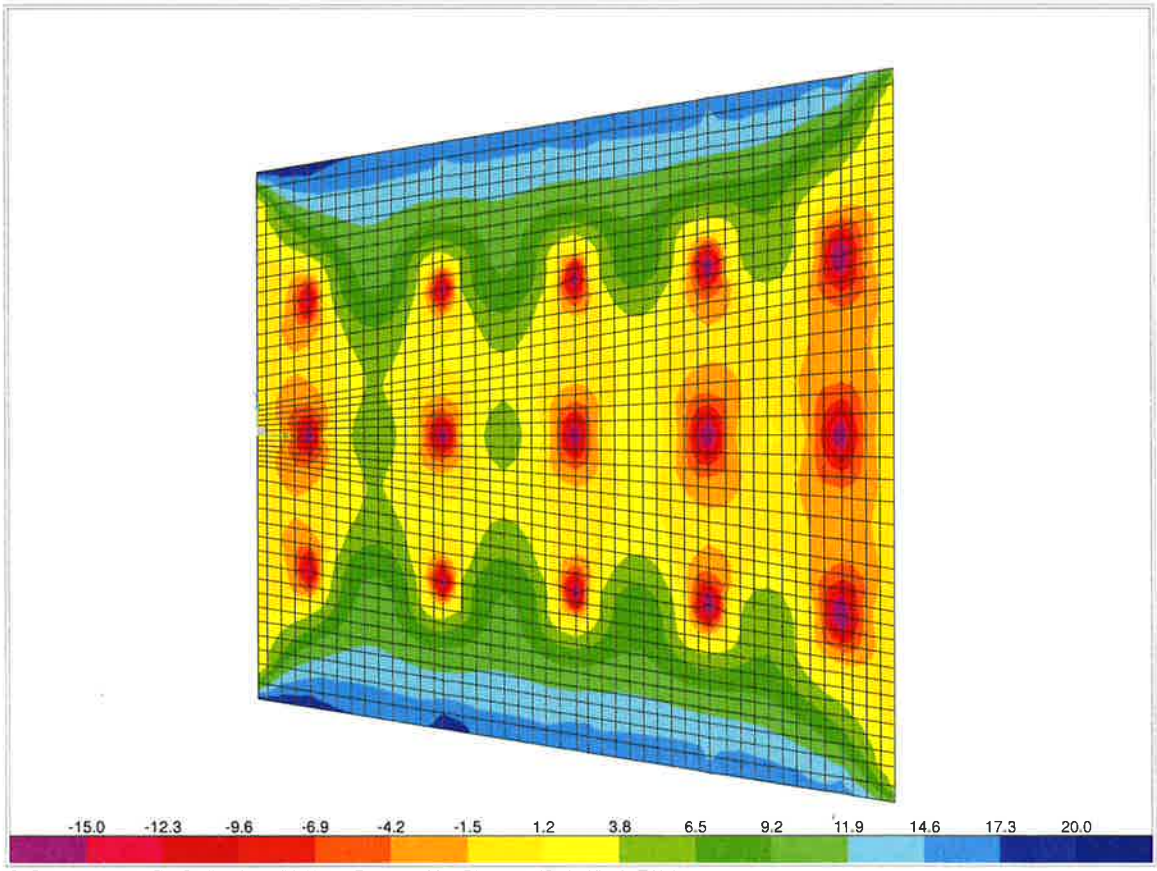
SAP2000 8/7/13 11:51:50



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/7/13 12:05:16



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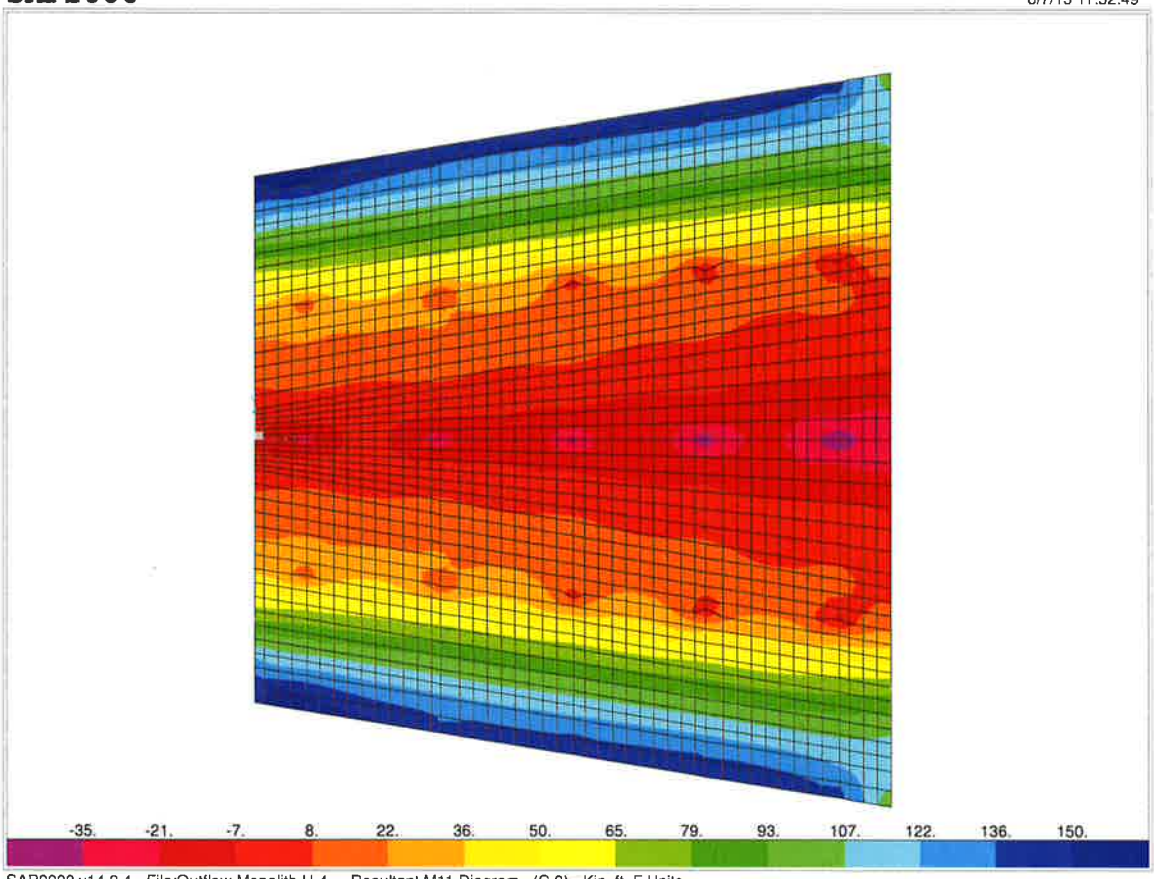
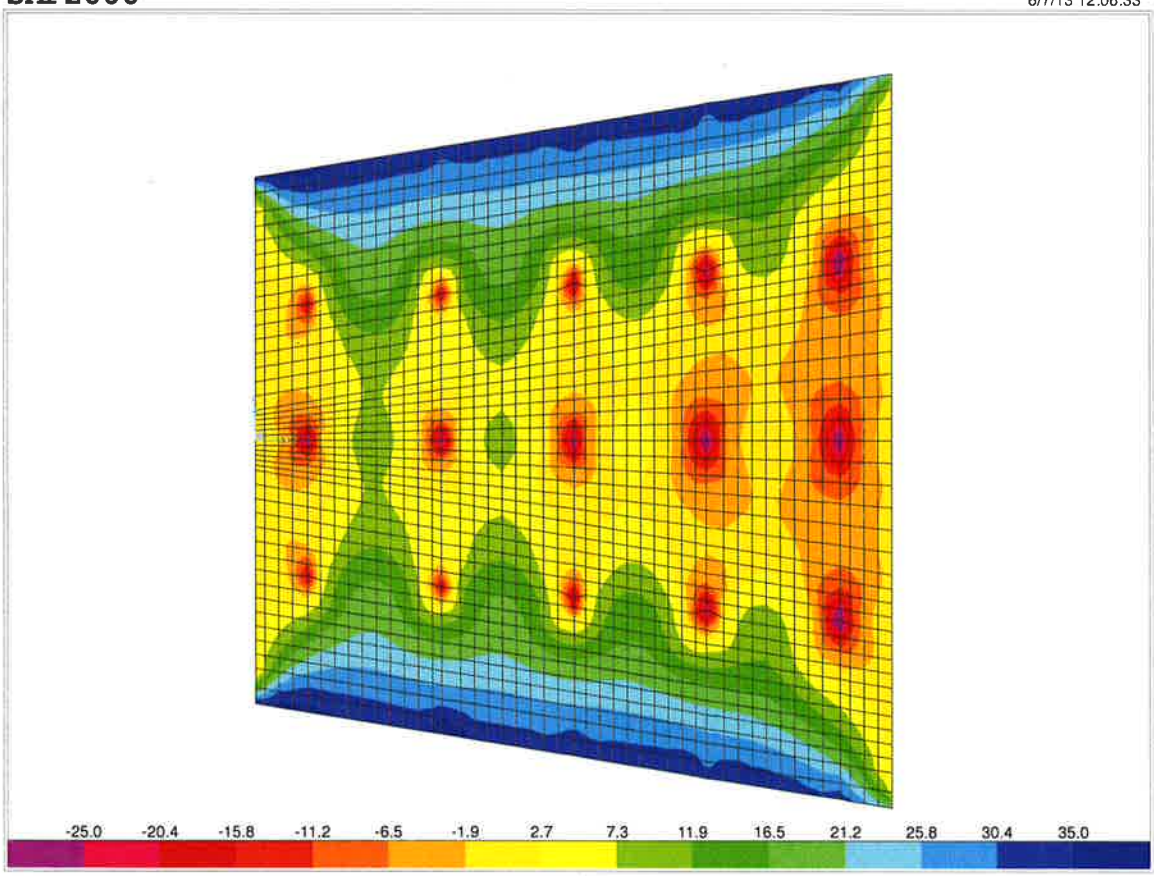
SAP2000 8/7/13 11:52:49



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/7/13 12:06:33



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Results indicate a slab thicker than 2'-6" is necessary

SETTLEMENT CASES

Bottom Slab Thickness =	3	ft
Wall Thickness =	2.5	ft
Design Width =	12	in
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

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
1a-ST	27.10	200.1	0.7	40.5	4.3
1b-ST	27.10	200.1	0.7	40.5	4.3
2-ST	11.00	79.0	0.5	14.8	1.4
3-ST	20.50	153.5	-1.1	28.2	2.8

* Shear values taken at a distance 'd'= 25.37in from the face of the slab.

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

Max. Shear =	**27.1**	**kip**	
Max. Moment, Primary =	**200.1**	**kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**0.7**	**kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**40.5**	**kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**4.3**	**kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.848 in^2

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

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.848** in^2	- half each face
	Min. T&S Rebar =	**1.008** in^2	- half each face
	Min. Flexural Rebar =	**1.015** in^2	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 27.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Exterior Face:

* Will try **#10 @ 8"** to start: As, #10 @ 8" = 1.9 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1.905 * 60ksi / (0.85 * 4ksi * 12in) = 2.801 in

ϕMn = 0.9 * 1.905in^2 * 60ksi * (25.365in - 2.801in / 2)

= 2465.2 kip-in/ft

= 205.43 kip-ft/ft

ϕMn = 205.4kip-ft > Mu = 200.1kip-ft → Use #10 @ 8"

Primary Interior Face:

* Will try **#6 @ 8"** to start: As, #6 @ 8" = 0.66 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.66 * 60ksi / (0.85 * 4ksi * 12in) = 0.971 in

ϕMn = 0.9 * 0.66in^2 * 60ksi * (25.365in - 0.971in / 2)

= 886.71 kip-in/ft

= 73.89 kip-ft/ft

ϕMn = 73.9kip-ft > Mu = 0.7kip-ft → Use #6 @ 8"

FLEXURAL REQUIREMENT NEGLECTED B/C Mu×1.33 < CAPACITY.

Secondary Interior & Exterior Faces: * $M_{max, secondary}$ = 40.5 k-ft

* Will try **#6 @ 8"** to start: As, #6 @ 8" = 0.66 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.66 * 60ksi / (0.85 * 4ksi * 12in) = 0.971 in

ϕMn = 0.9 * 0.66in^2 * 60ksi * (25.365in - 0.971in / 2)

= 886.71 kip-in/ft

= 73.89 kip-ft/ft

ϕMn = 73.9kip-ft > Mu = 40.5kip-ft → Use #6 @ 8"

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
1a-ST	27.7	13.50	226.5	95.6	53.5	71.0
1b-ST	32.7	16.10	223.1	109.6	53.7	91.0
2-ST	13.5	5.90	78.3	71.3	17.9	38.1
3-ST	18.7	8.80	155.1	75.2	35.0	44.5

* Shear taken at a distance 'd' = 31.37 inch from piles.

CONTROLS OVER REG. CASES

Max. Shear =	**32.7 kip**	
Max. Moment, Primary =	**226.5 kip-ft**	(SAP M11, controls *bottom transverse* reinforcement)
Min. Moment, Primary =	**109.6 kip-ft**	(SAP M11, controls *top transverse* reinforcement)
Max. Moment, Secondary =	**53.7 kip-ft**	(SAP M22, controls *bottom longitudinal* reinforcement)
Min. Moment, Secondary =	**91.0 kip-ft**	(SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

A_{gross} = 36in * 12in strip = 432 in^2

d = 36in - 4in cover - 1/2 bar diameter = 31.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 4.617 in^2

Limits of Minimum Reinforcement: $0.0028 \times A_{gross}$ = 1.210 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 1.190 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.255 in^2 ACI 318-02, 10.5, flexural member min.

Slab **Section Summary:**			
	Max. Rebar =	**4.617 in^2**	- half each face
	Min. T&S Rebar =	**1.210 in^2**	- half each face
	Min. Flexural Rebar =	**1.255 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 31.365in

= 40,467 lb

ϕVc = 40.5kip > Vu = 32.7kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try **#10 @ 8"** to start: As, #10 @ 8" = 1.905 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.905 * 60ksi / (0.85 * 4ksi * 12in) = 2.801 in

$\phi Mn =$ 0.9 * 1.905in^2 * 60ksi * (31.365in - 2.801in / 2)
= 3082.4 kip-in/ft
= 256.87 kip-ft/ft

ϕMn = 256.9kip-ft > Mu = 226.5kip-ft → Use #10 @ 8"

Primary Top Face:

* Will try **#8 @ 8"** to start: As, #8 @ 8" = 1.185 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.185 * 60ksi / (0.85 * 4ksi * 12in) = 1.743 in

$\phi Mn =$ 0.9 * 1.185in^2 * 60ksi * (31.365in - 1.743in / 2)
= 1951.3 kip-in/ft
= 162.61 kip-ft/ft

ϕMn = 162.6kip-ft > Mu = 109.6kip-ft → Use #8 @ 8"

FLEXURAL MINIMUM NEGLECTED B/C OF ACI 318 ALLOWANCE - 109.6$^{k\,ft}$ x 1.33 = 146.13$^{k\,ft}$, WHICH IS LESS THAN REINF CAPACITY.

Secondary Bottom Face: * $M_{max,\ secondary}$ = 91.0 k-ft

* Will try **#8 @ 8"** to start: As, #8 @ 8" = 1.185 in^2

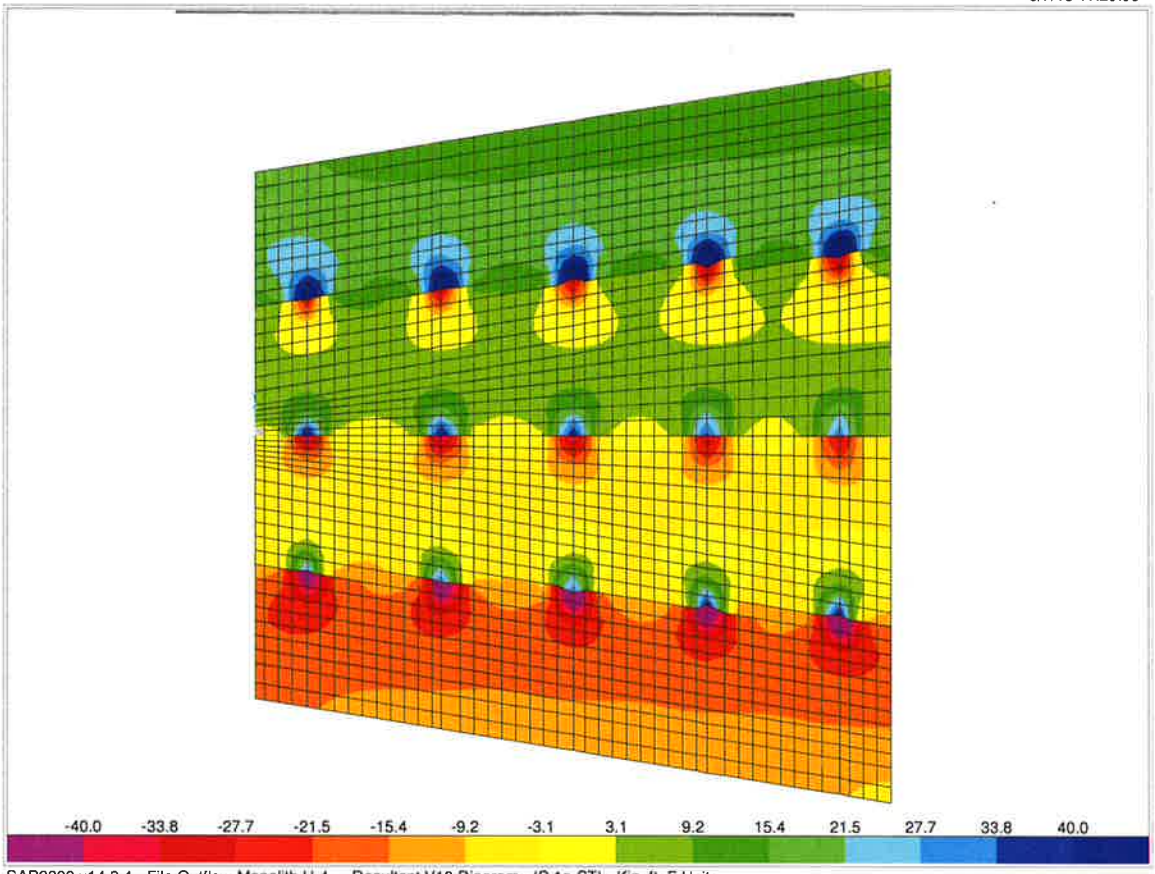
$a = A_s * f_y / (0.85 * f'_c * b) =$ 1.185 * 60ksi / (0.85 * 4ksi * 12in) = 1.743 in

$\phi Mn =$ 0.9 * 1.185in^2 * 60ksi * (31.365in - 1.743in / 2)
= 1951.3 kip-in/ft
= 162.61 kip-ft/ft

ϕMn = 162.6kip-ft > Mu = 91kip-ft → Use #8 @ 8"

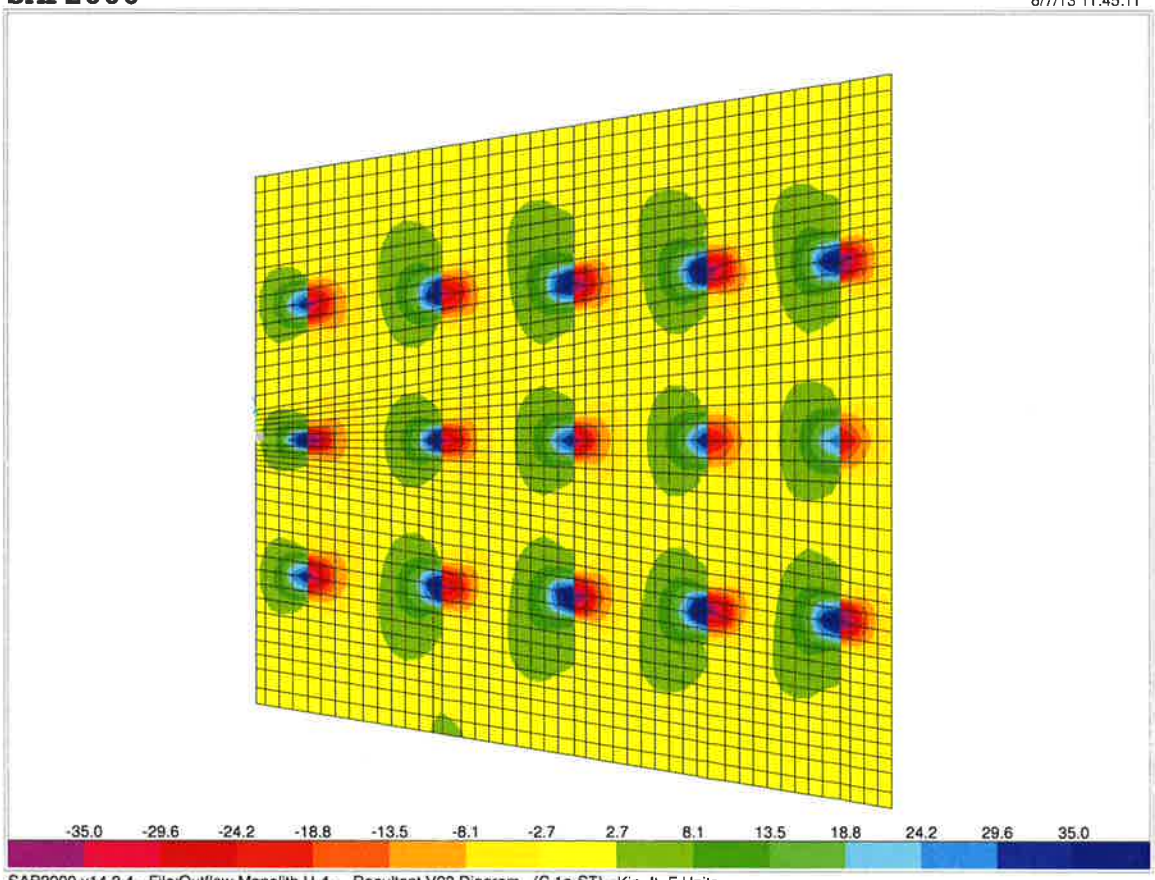
MOMENT & SHEAR IMAGES FOLLOW THIS SPREADSHEET - WALL RESULTS ARE NOT INCLUDED B/C THEY ARE UNCHANGED FROM TRADITIONAL CASES

SAP2000 SETTLEMENT CASES - SHEAR 8/7/13 11:29:08



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:45:11



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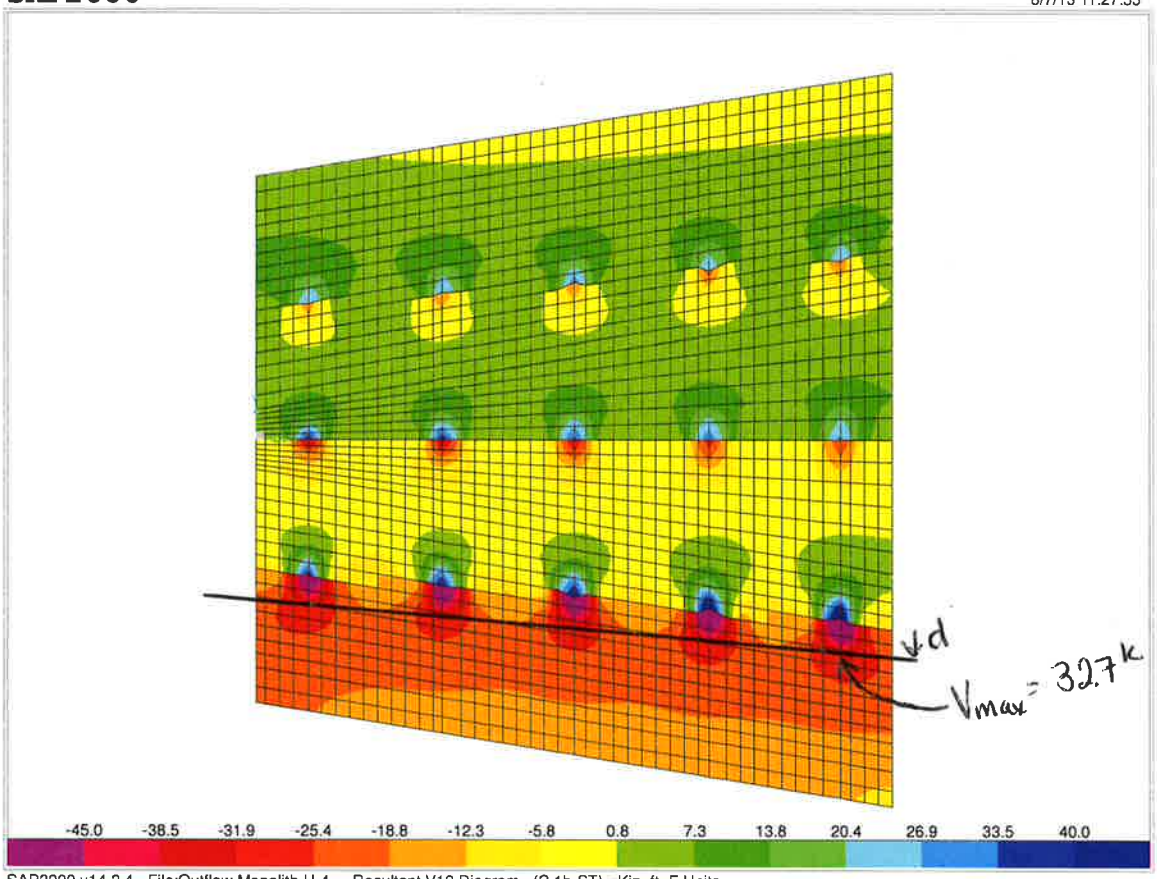
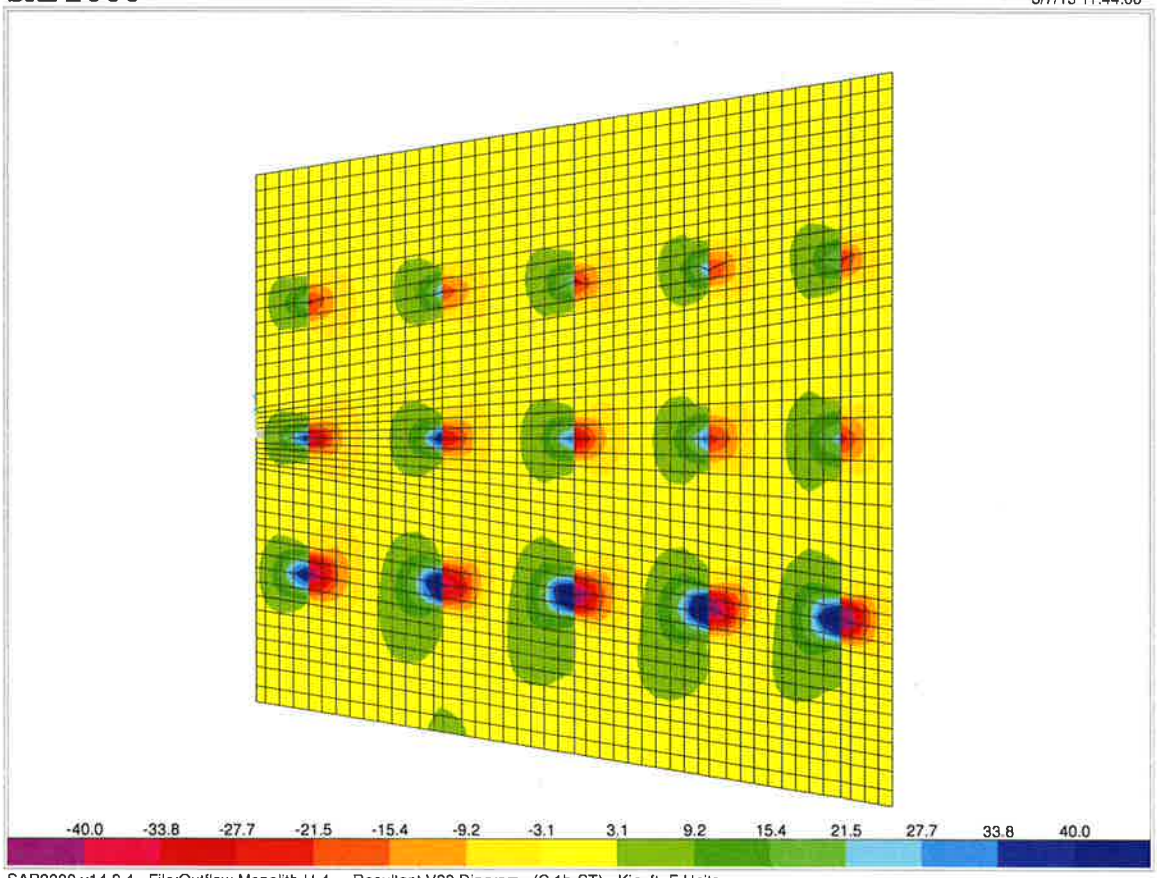
SAP2000 8/7/13 11:27:55



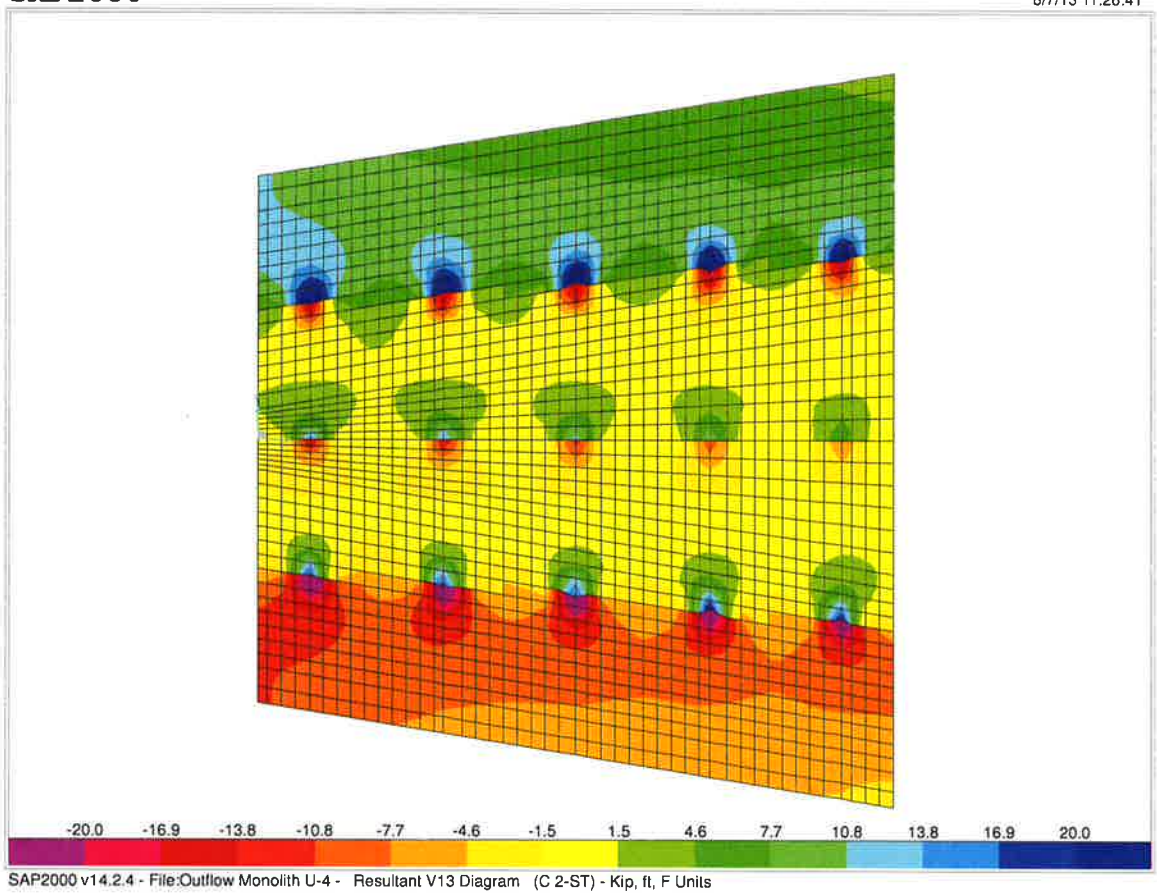
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:44:06



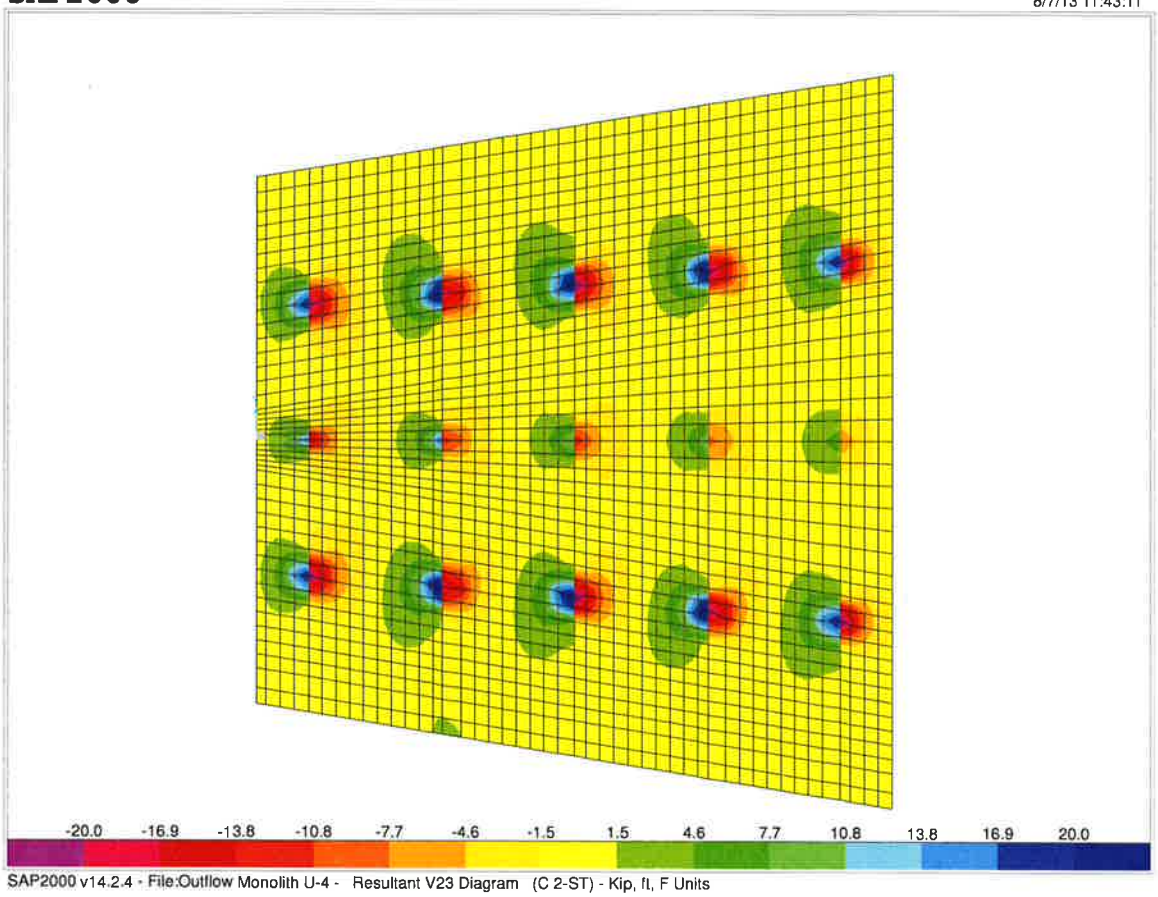
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:26:41



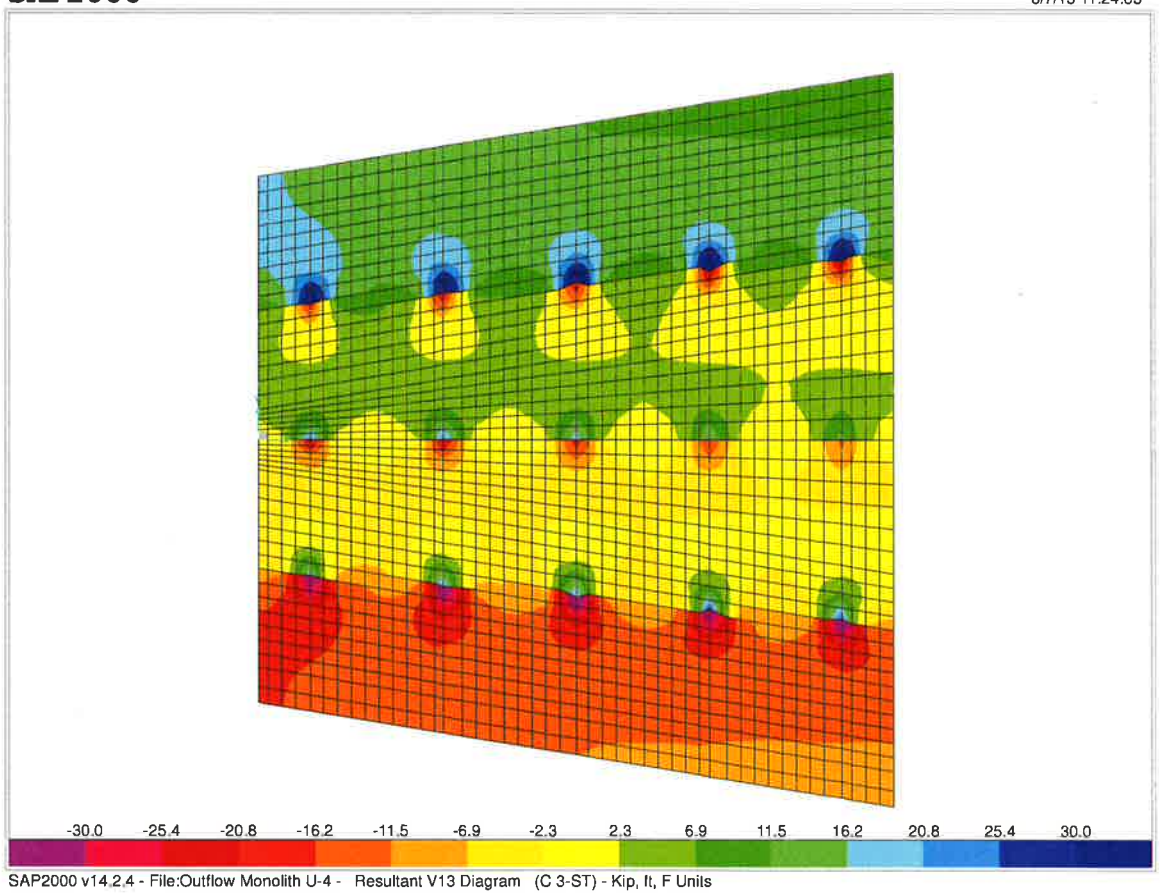
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:43:11



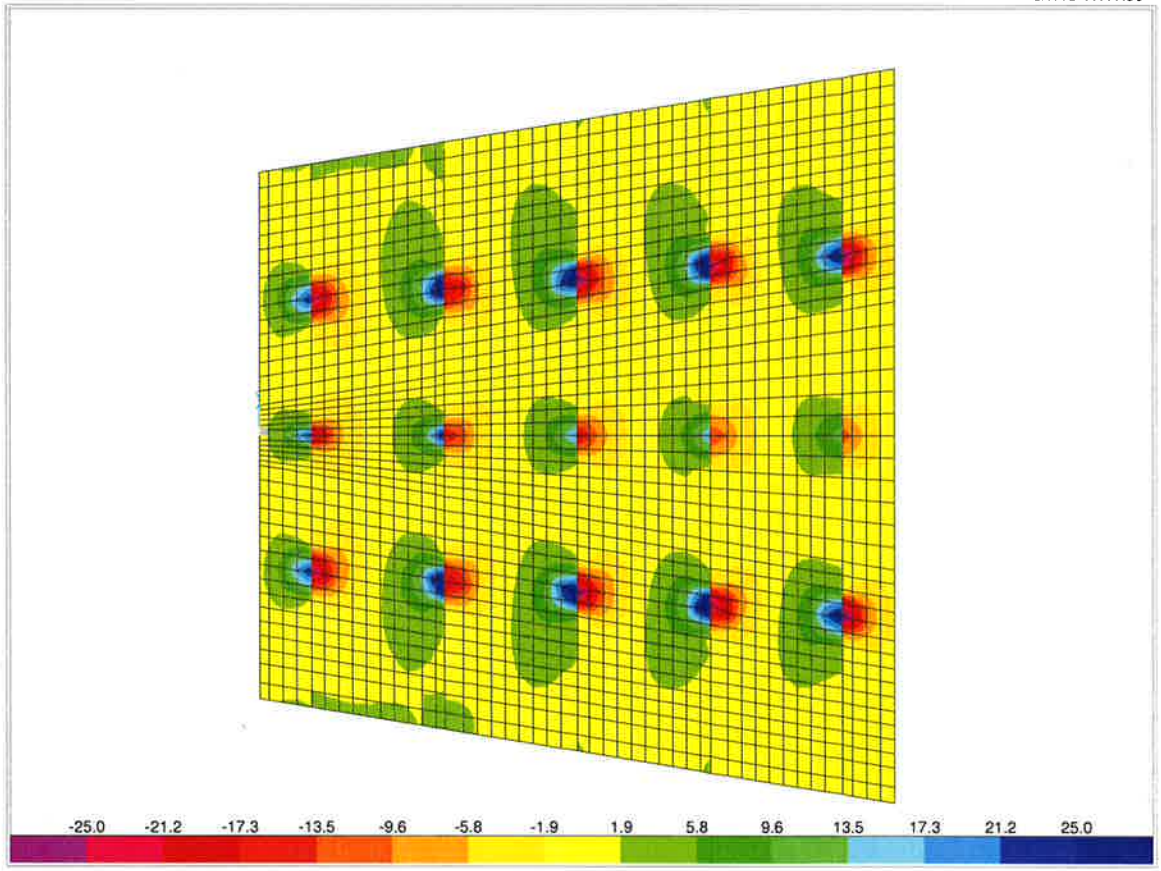
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:24:03



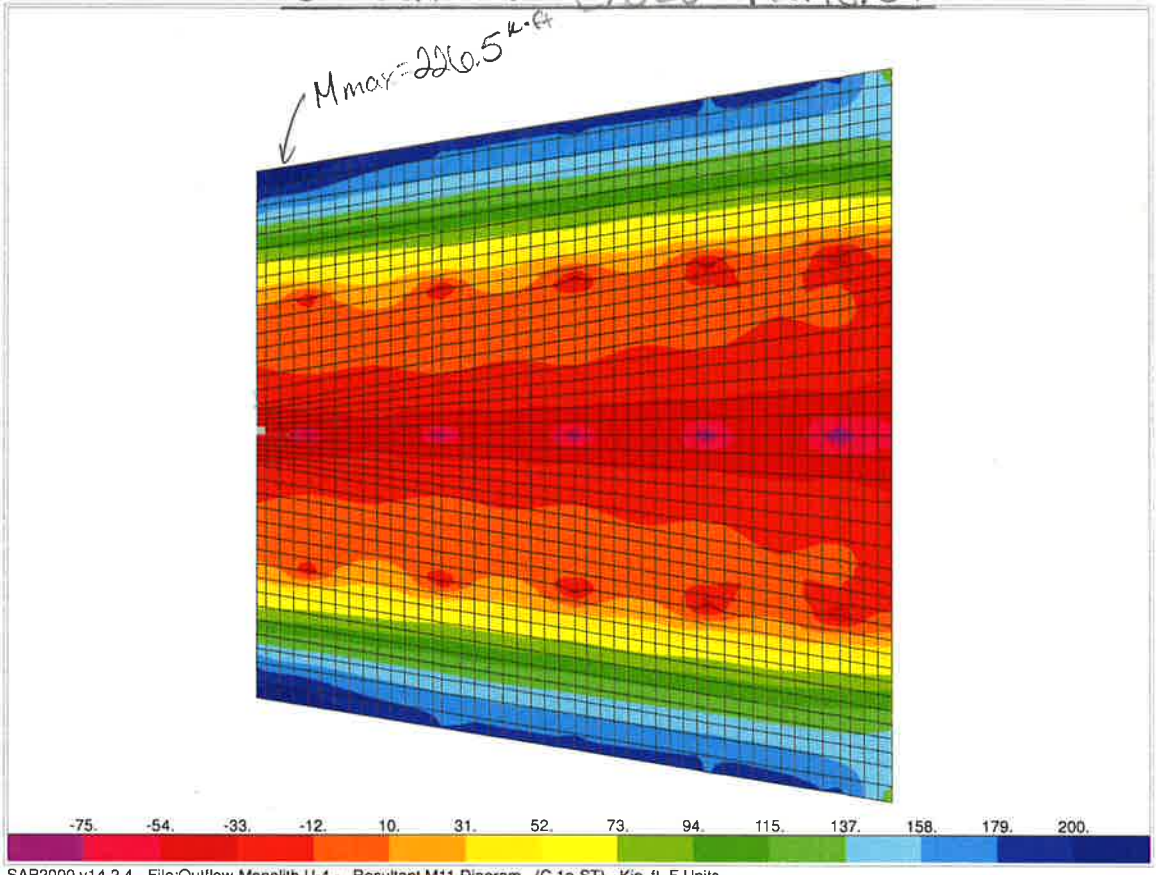
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V13 Diagram (C 3-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:41:56



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant V23 Diagram (C 3-ST) - Kip, ft, F Units

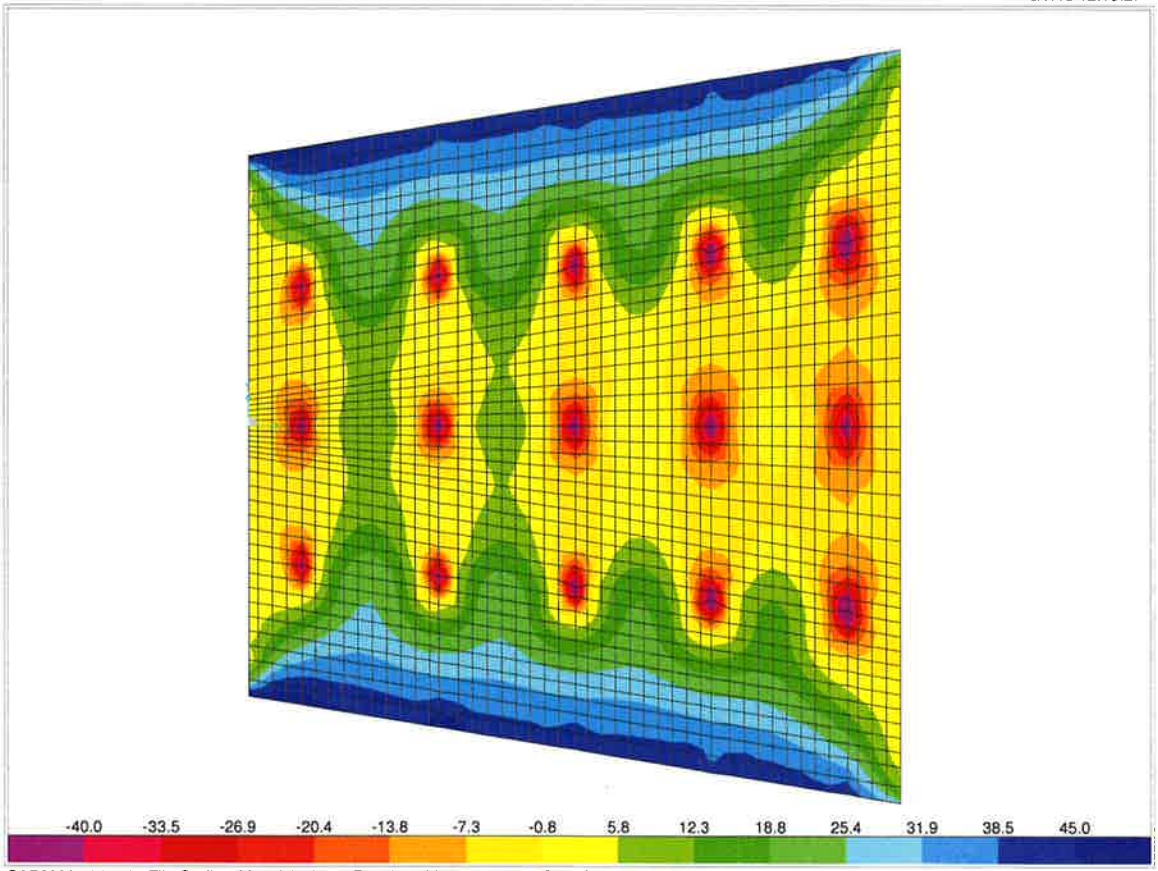
SAP2000 SETTLEMENT CASES - MOMENT 8/7/13 11:58:46



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1a-ST) - Kip, ft, F Units

TRANSVERSE

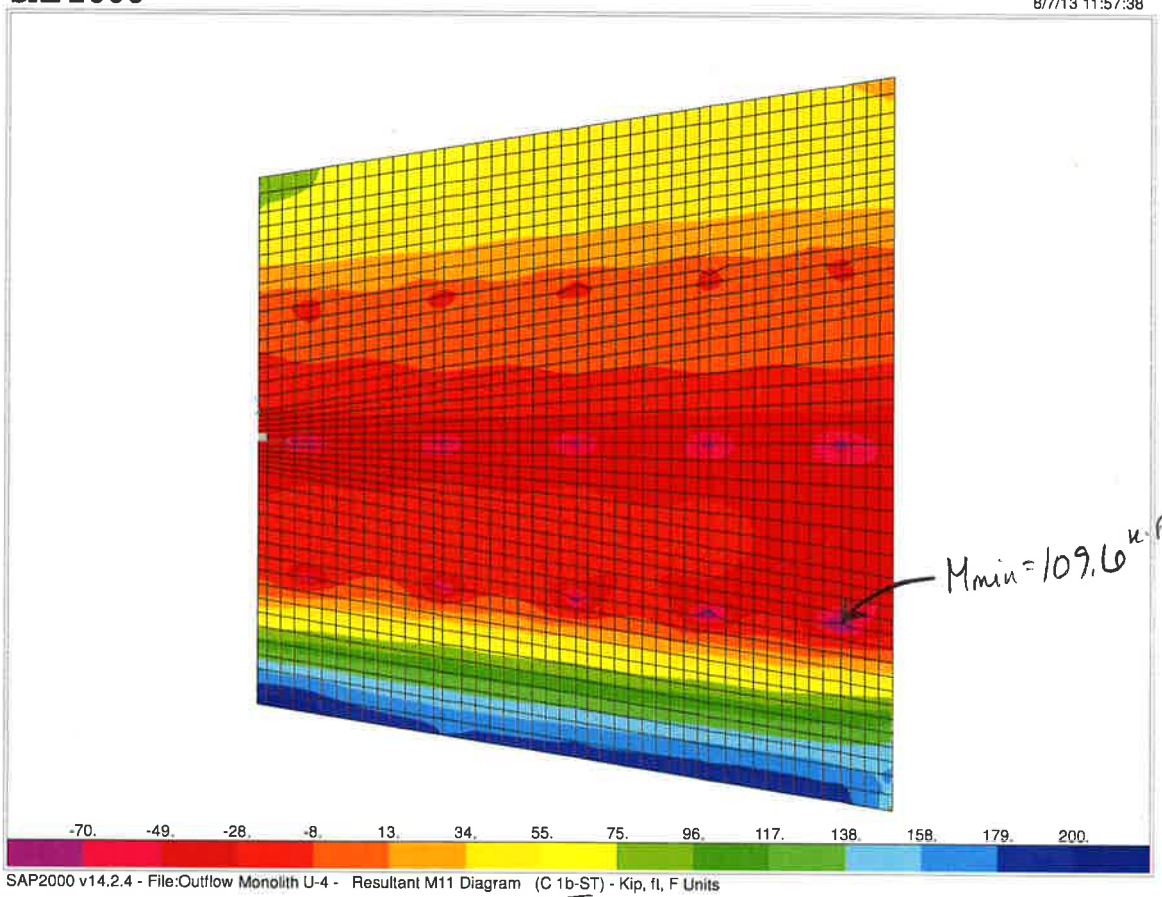
SAP2000 8/7/13 12:10:27



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1a-ST) - Kip, ft, F Units

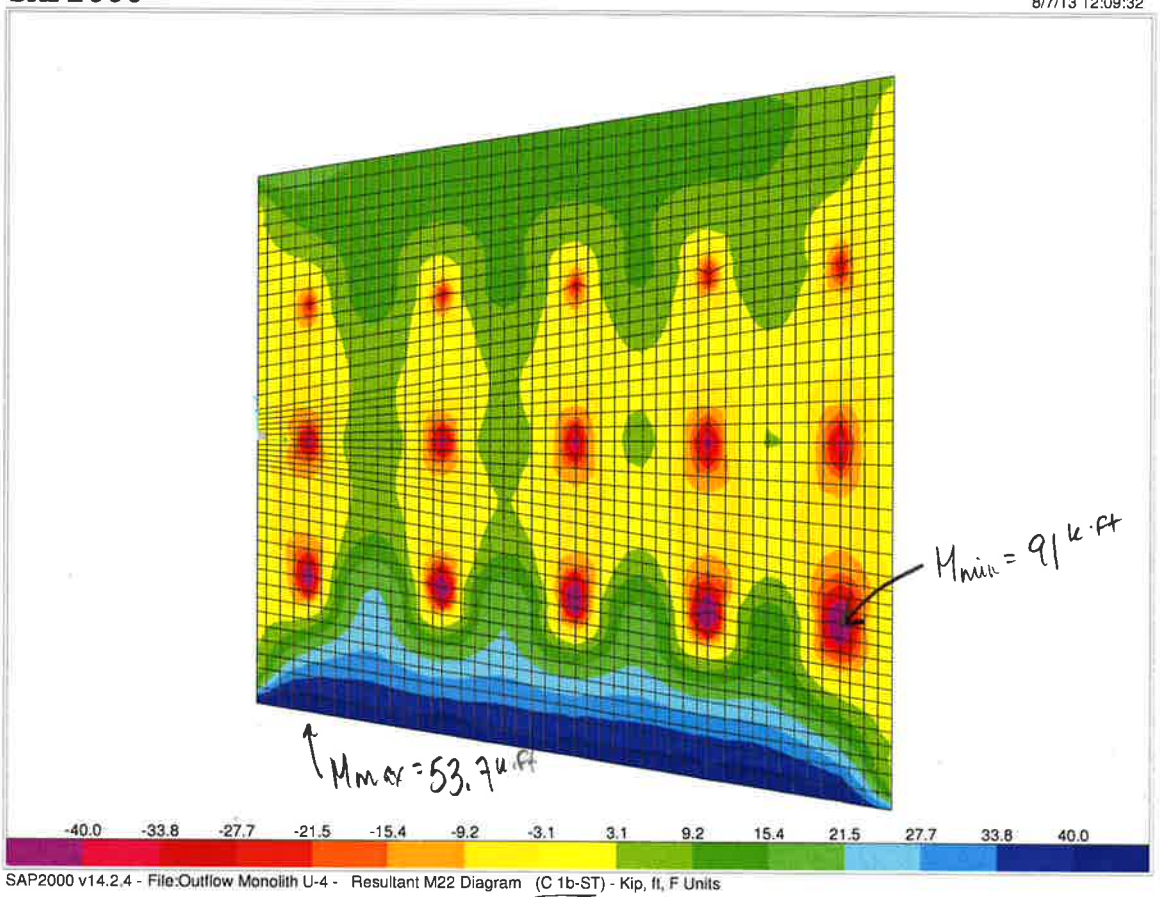
LONGITUDINAL

SAP2000 8/7/13 11:57:38



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 1b-ST) - Kip, ft, F Units

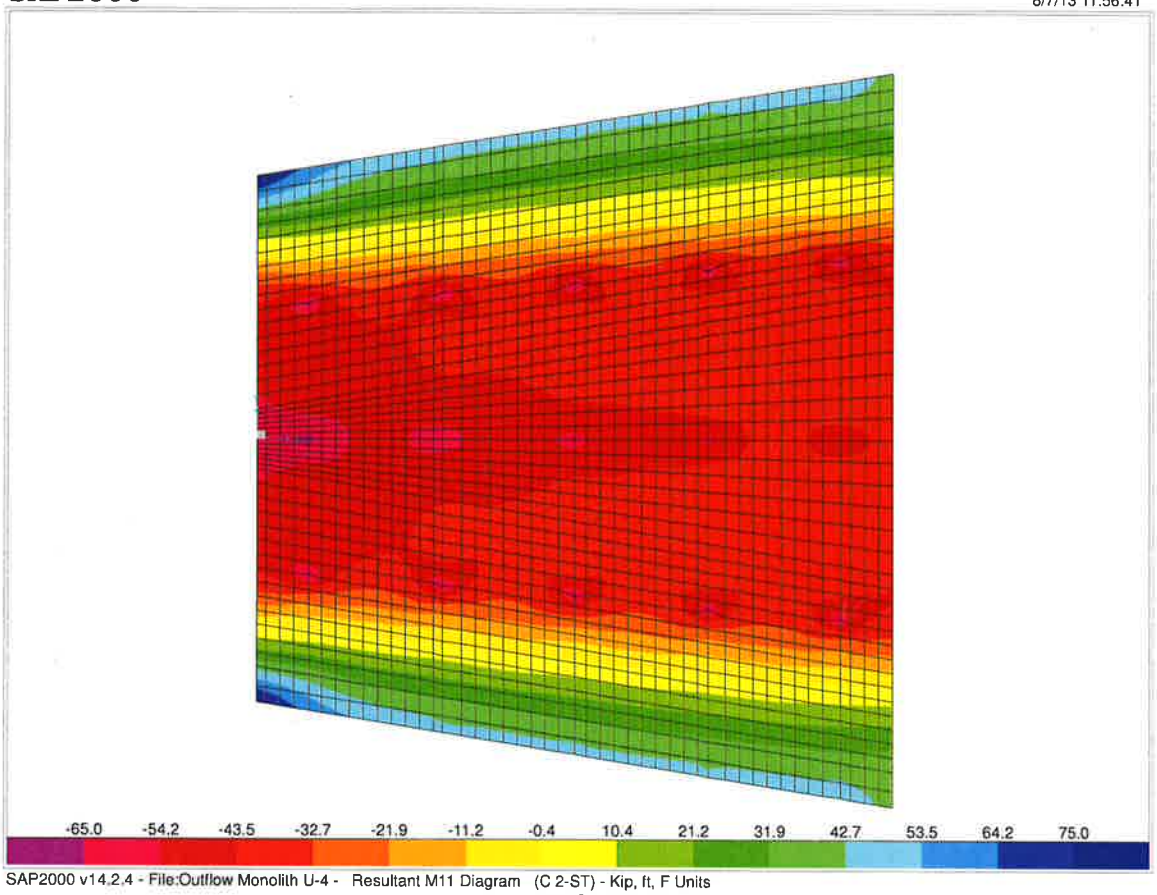
SAP2000 8/7/13 12:09:32



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000

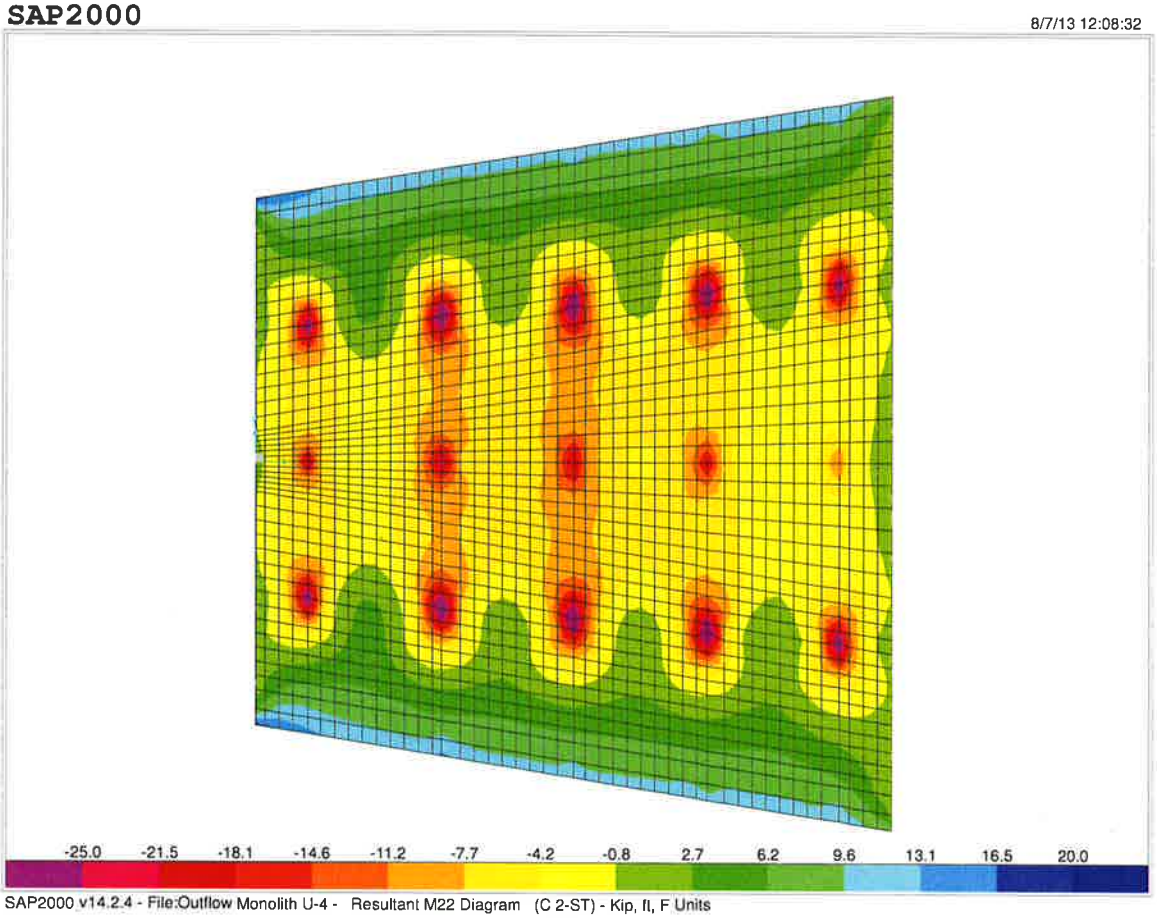
8/7/13 11:56:41



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 2-ST) - Kip, ft, F Units

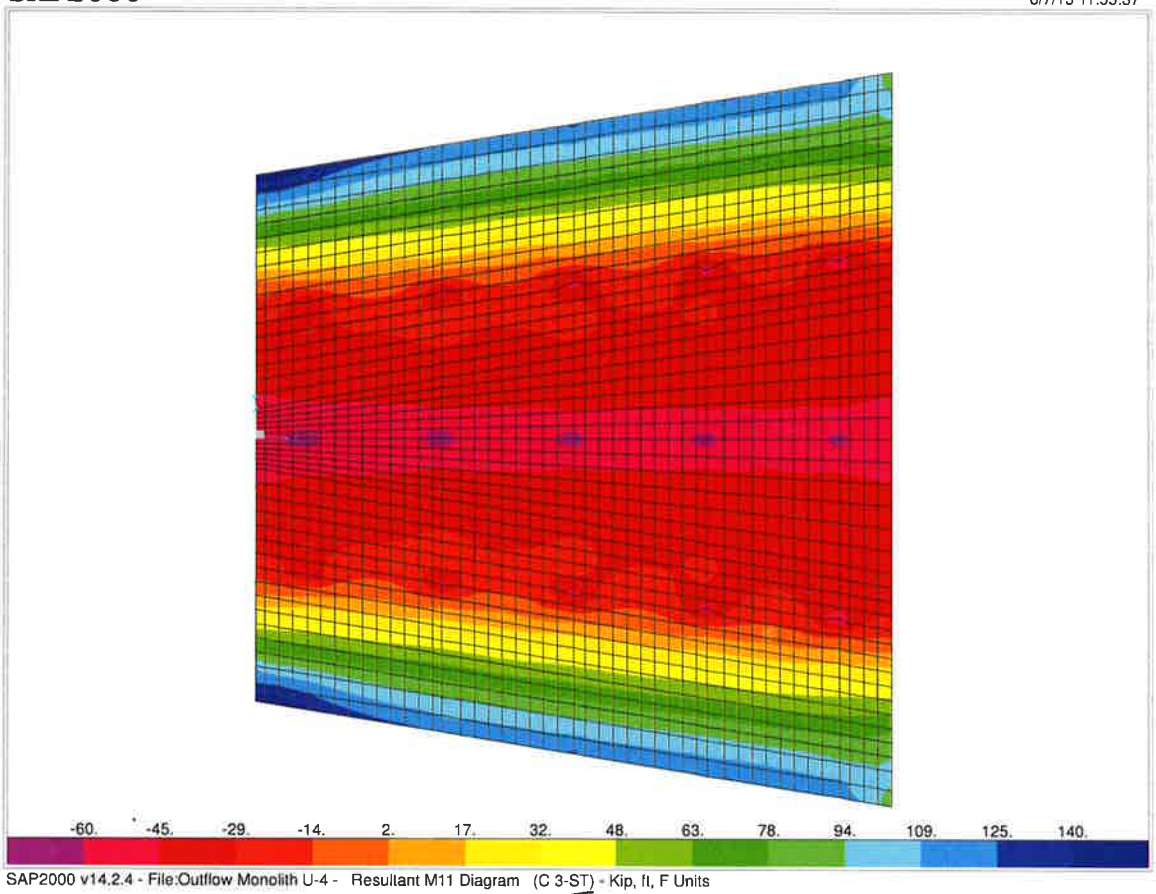
SAP2000

8/7/13 12:08:32



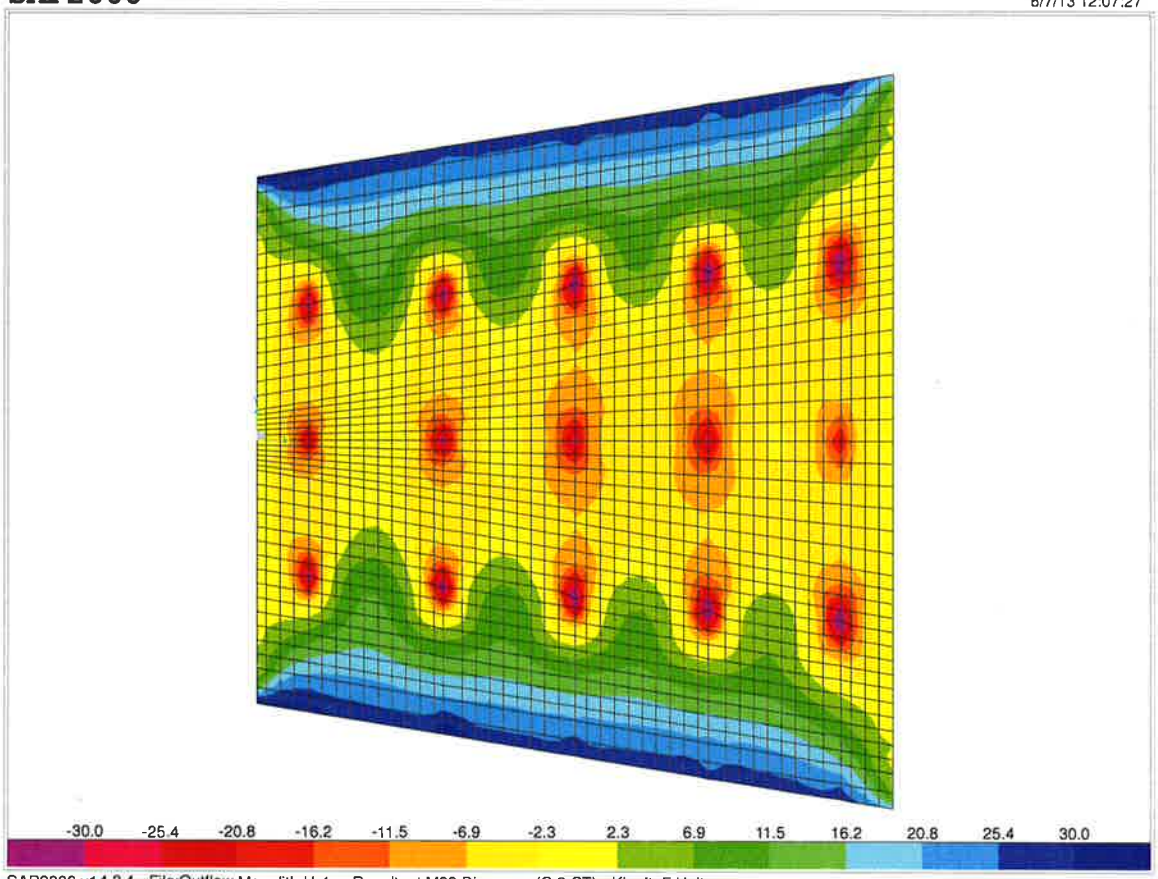
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/7/13 11:55:37



SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M11 Diagram (C 3-ST) - Kip, ft, F Units

SAP2000 8/7/13 12:07:27



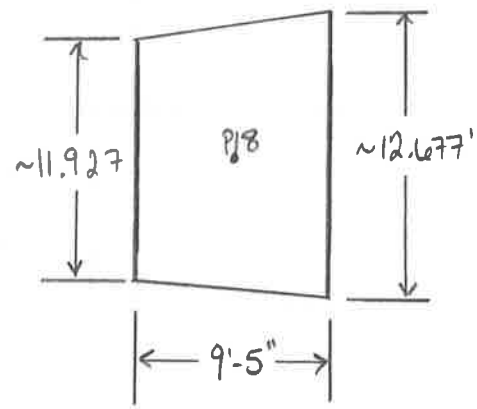
SAP2000 v14.2.4 - File:Outflow Monolith U-4 - Resultant M22 Diagram (C 3-ST) - Kip, ft, F Units

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: U-4 ~ PILE CHECK FOR SLAB ADDITIONAL THICKNESS | Computed by: LBR | Sheet ____ of ____
Checked by: BCB | Date: 8/2013 | Date: 8/2013
Reference

- LARGEST PILE TRIBUTARY AREA IS AROUND PILES 17, 18 & 19.
  (EDGE PILES 22-24 HAVE SMALLER LENGTH ALONG CHANNEL ℄)

APPROXIMATE SIZE:



$$\text{AREA} = (9'\text{-}5'') \times \left[\tfrac{1}{2}(11.927' + 12.677')\right]$$

$$= 115.84 \text{ FT}^2$$

ADD'L WEIGHT FROM 6" OF SLAB:

$$(115.84 \text{ FT}^2)(0.5 \text{ FT})(150 \text{ PCF}) = 8688.3^{\text{LB}} = \underline{8.69^k}$$

$$8.69^k \times H_F \times H_S = 8.69 \times 1.3 \times 1.7 = \underline{\underline{19.2^k}}$$

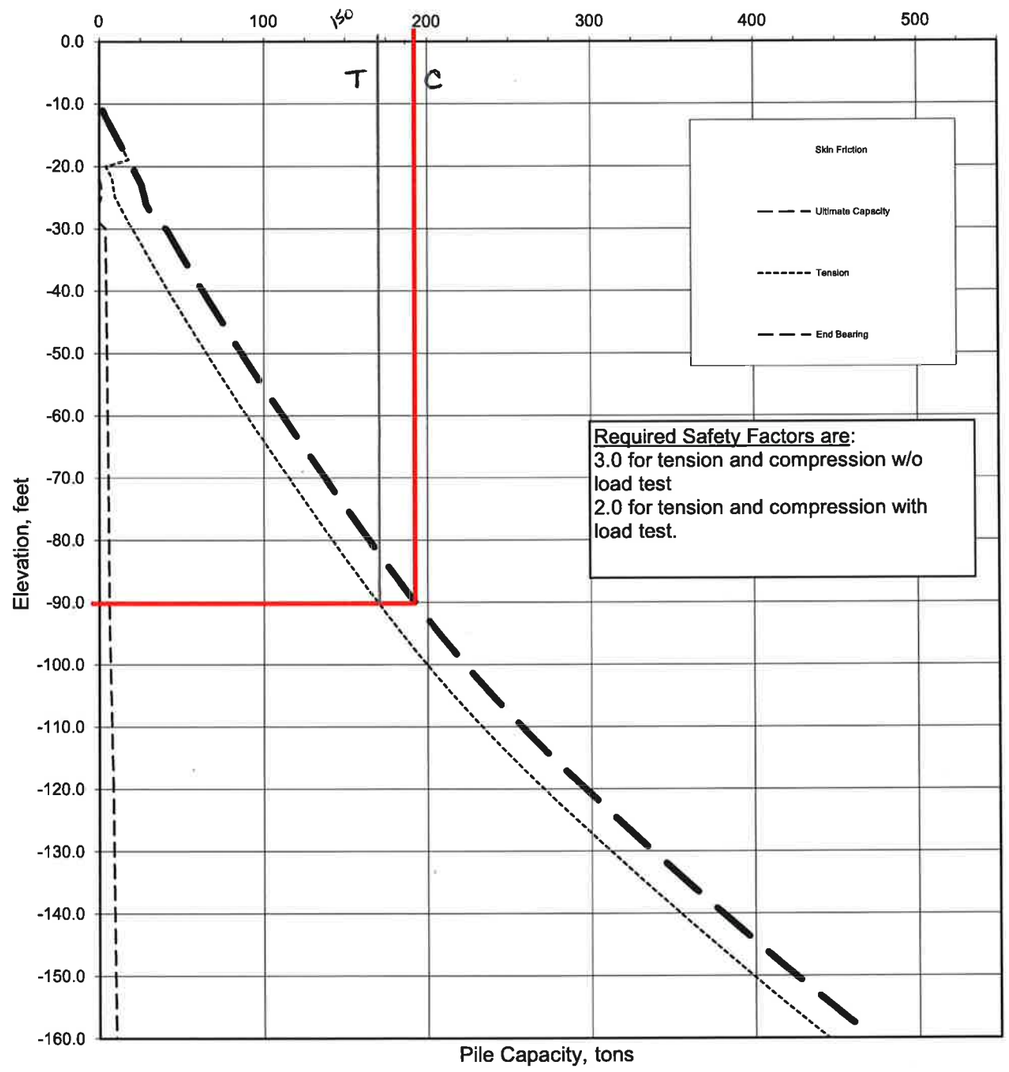
↳ MAX REACTION IS 160.4^k, + 19.2^k = $\underline{179.6^k = P_{max}}$

THIS REACTION IS LARGER THAN THE CAPACITY OF PILES TIPPED @ EL -85.0 ($C_{ALLOW} = 170.7^k$). ∴ EXTEND PILES DEEPER BY 5' & CHECK CAPACITY –
SEE CAPACITY CURVE ON FOLLOWING PAGE.

* FOR TIP EL -90.0, $C_{ALLOW} = 186.6^k > P_{max} = 179.6^k$

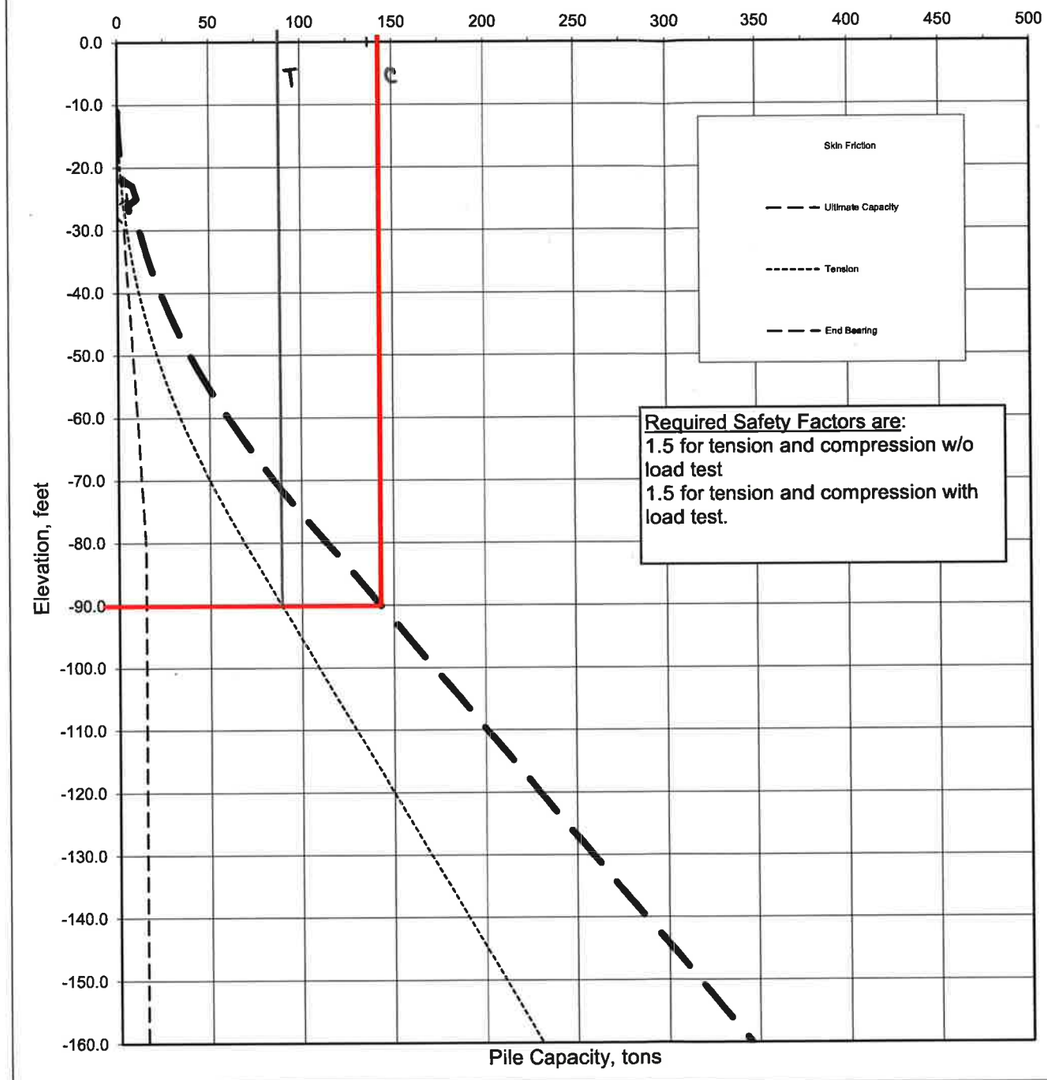
Undrained Strength Case with HP 14x89 Pile

EL-90.0 CAPACITY = 190 TON x 2 KIP / TON | 2 (F.O.S.) = 190 KIP



Drained Strength Case with HP 14x89 Pile

EL-90.0 CAPACITY = 140 TON x 2 KIP / 1 TON | 1.5 (F.O.S.) = 186.6 K ← CONTROLS.



Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

$T_{UNDRAINED}$ = 170 TON x 2 / 2 = 170 K

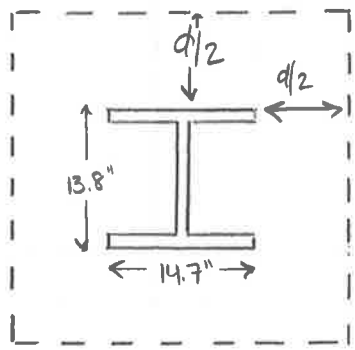
$T_{DRAINED}$ = 88 TON x 2 / 1.5 = 117.3 K

Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	URS	Figure No. 2

URS

Job: MAUREPAS DIVERSION
Project No.: 10001876
Page ____ of ____
Sheet ____ of ____
Description: U-4 SLAB CHECK PUNCHING SHEAR
Computed by: LBR
Date: 8/2013
Checked by: ____
Date: ____
Reference

$d_{SLAB} = 30" - 9"$ PILE EMBED $= 21"$



$b_o = 2\times(13.8" + d) + 2\times(14.7" + d)$
$= 2\times(13.8" + 21") + 2\times(14.7" + 21")$
$= 141"$

$\phi V_{c,min} = \phi 4\sqrt{f'_c}\, b_o d$ (ACI EQ 11-35)

NOTE: BY INSPECTION, THIS EQ'N CONTROLS OVER 11-33 & 11-34

$\phi V_c = (0.85)(4)\sqrt{4000}(141")(21") = \underline{\underline{636.72^k}}$

- MAX REACTION OVERALL = 174.03^k (SETTLEMENT RESULTS)
- IF TREATED AS AN ENVIRONMENTAL LOAD SUBJECT TO HYDRAULIC & SAFETY FACTORS, LOAD = $174 \times 1.3 \times 1.7 = \underline{384.6^k}$

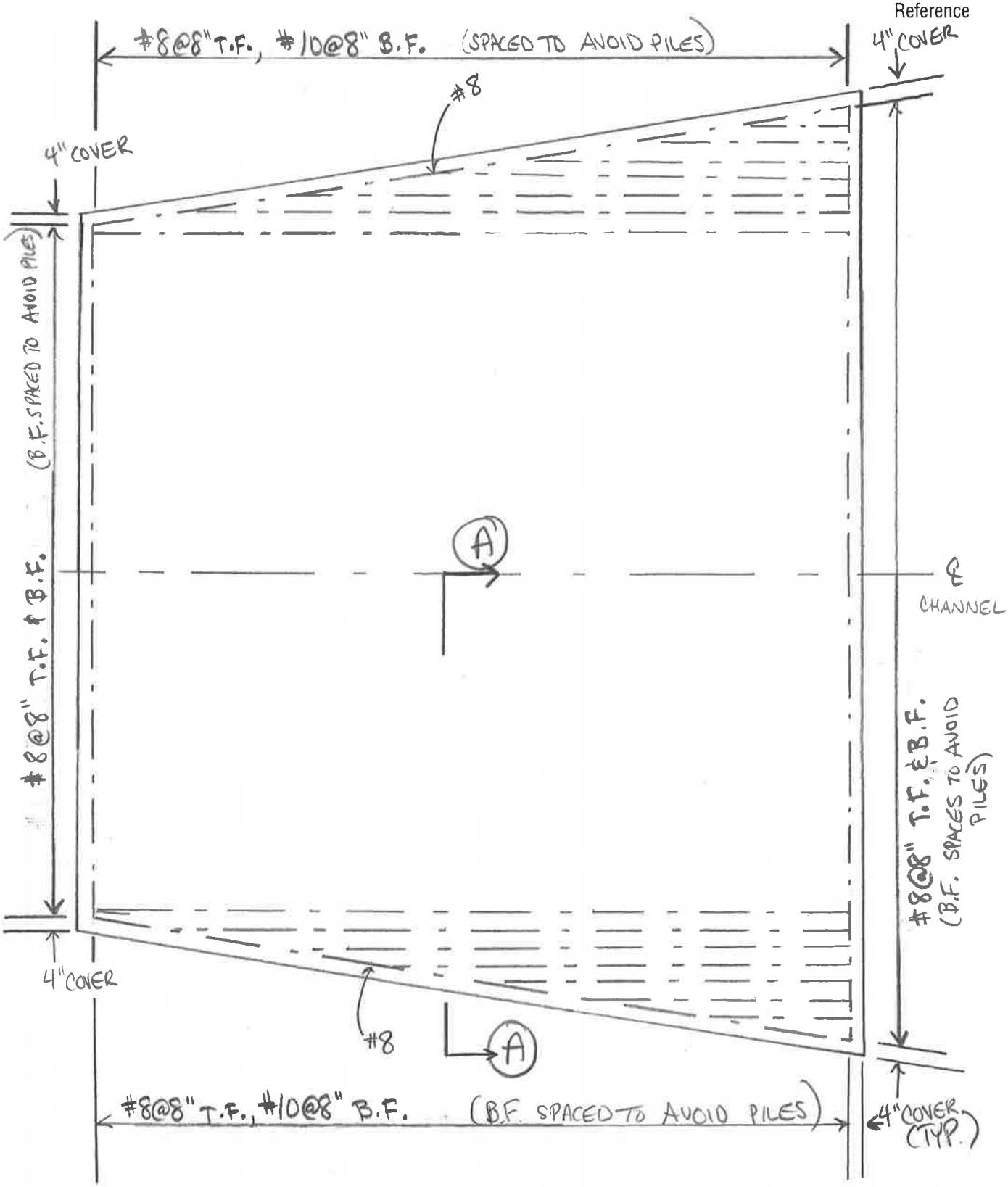
$\phi V_c = 636.7^k > V_u = 384.6^k \rightarrow \underline{\underline{OK}}$

* NOTE: CALC PERFORMED FOR 2'-6" SLAB. ACTUAL THICKNESS IS 3', WHICH MEANS MORE SHEAR CAPACITY THAN WHAT IS SHOWN HERE.

URS

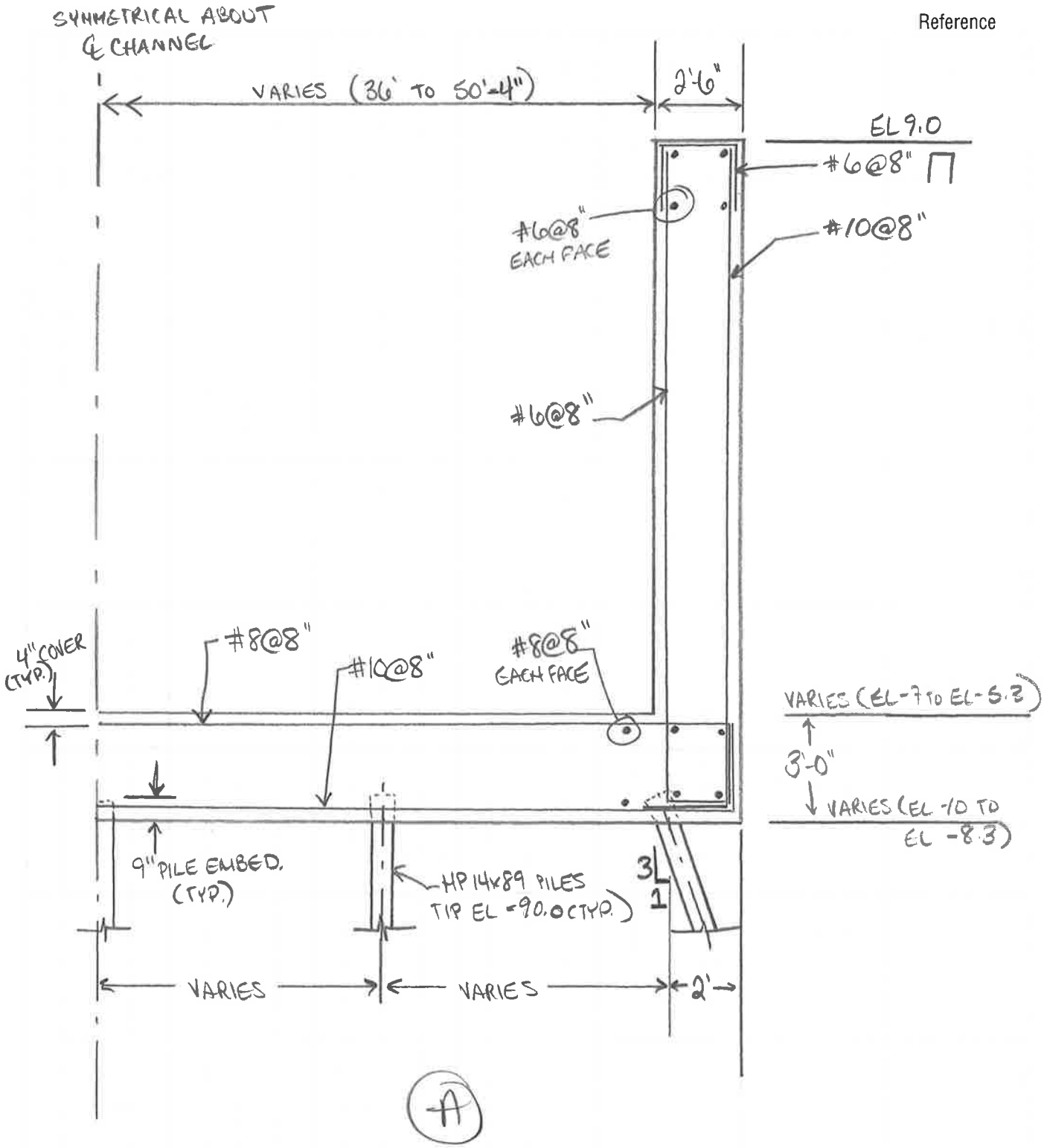
Job: MAUREPAS
Description: U-4 REINF.
Project No.: 10001876
Computed by: LBR
Checked by:
Page ___ of ___
Sheet ___ of ___
Date: 8/2013
Date:

Reference



URS

Job MAUREPAS | Project No. 10001876 | Page ___ of ___
Description U-4 REINF | Computed by LBR | Sheet ___ of ___
Checked by ___ | Date 8/2013
Date ___
Reference



SECTION 6

U-5 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	High Water Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
2-ST	High Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)
3	Low Water Condition	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2.0 NAVD88)
			Lateral Load from Soil Saturated below EL 2.0
3-ST	Low Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2 NAVD88)
			Lateral Load from Soil Saturated below EL 2.0
			Vertical Downdrag (600psf on walls/slab edges)

Notes: High Water is at EL 9.0 because this is the T.O. Levees adjacent to the outflow channel
Low Water is at EL 2.0 because this is the T.O. Weir separating the headworks from the sedimentation basin is EL 2.5. 6 inches of water is removed to conservatively account for evaporation.

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of

Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL 9.0
L_low water	Lateral & vertical loads from water to EL 2.0
U_high water	Uplift load from water to EL 9.0
U_low water	Uplift load from water to EL 2.0
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_high water	Soil pressure from saturated soil (water to EL 9.0)
S_low water	Soil pressure from saturated & dry soil (water to EL 2.0)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	U_high water
	S_high water
2-ST	DEAD
	L_high water
	U_high water
	S_high water
	ST_cohesion
3	DEAD
	L_low water
	U_low water
	S_low water

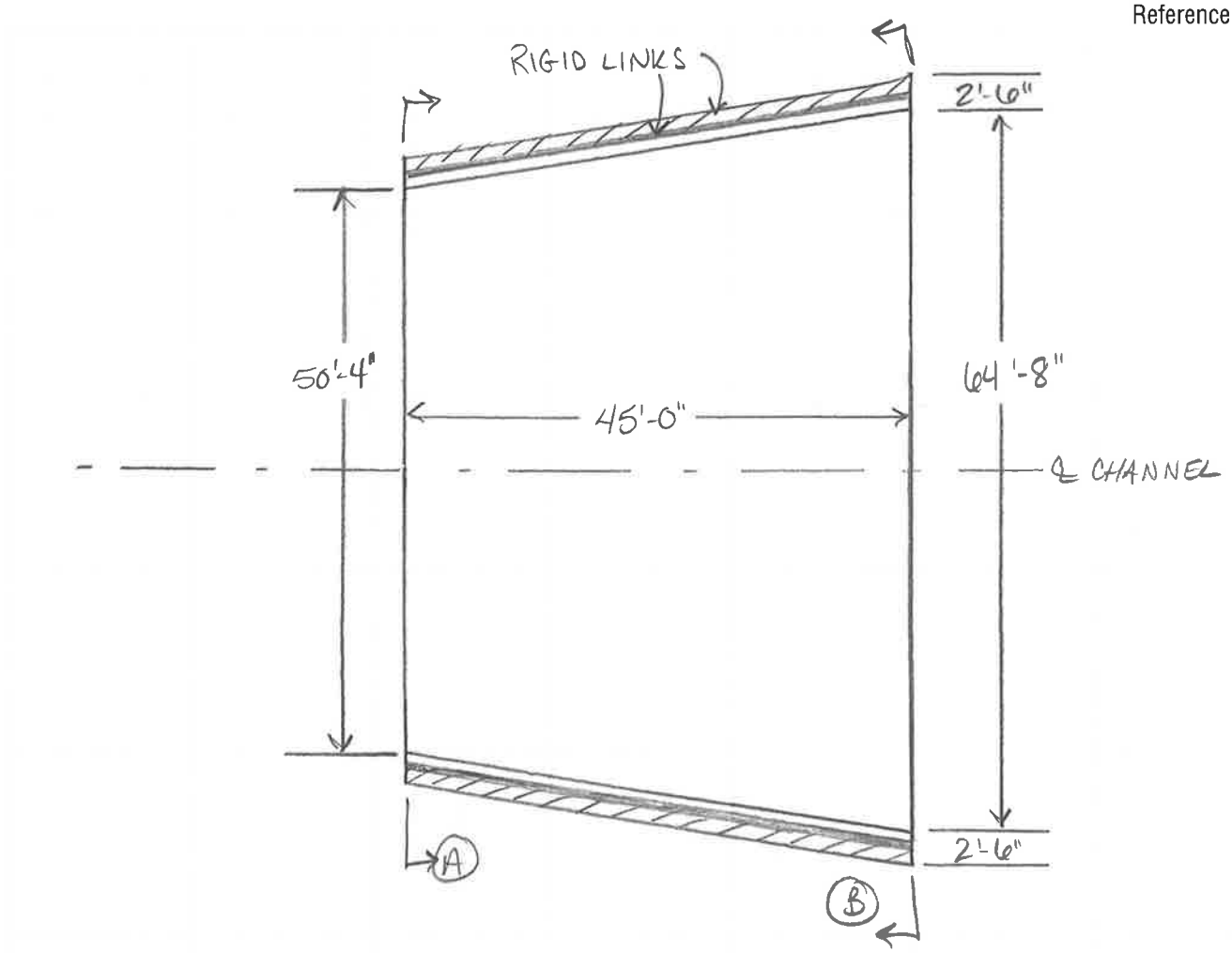
In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

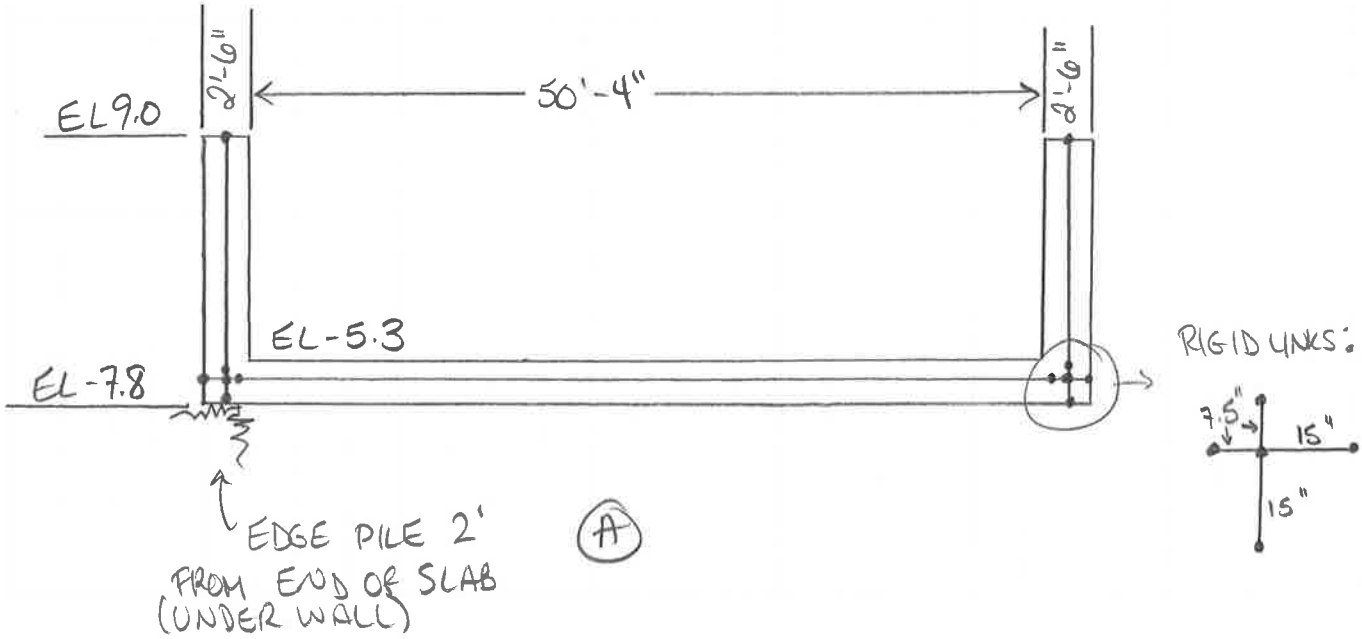
The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

LC #	Patterns Included
3-ST	DEAD
	L_low water
	U_low water
	S_low water
	ST_cohesion

URS

Job	MAUREPAS DIVERSION	Project No.	10008716	Page ____ of ____	
Description	MONOLITH 4-5	Computed by	LBR	Sheet ____ of ____	
	SAP MODEL LAYOUT	Checked by		Date	8/2013
				Reference	



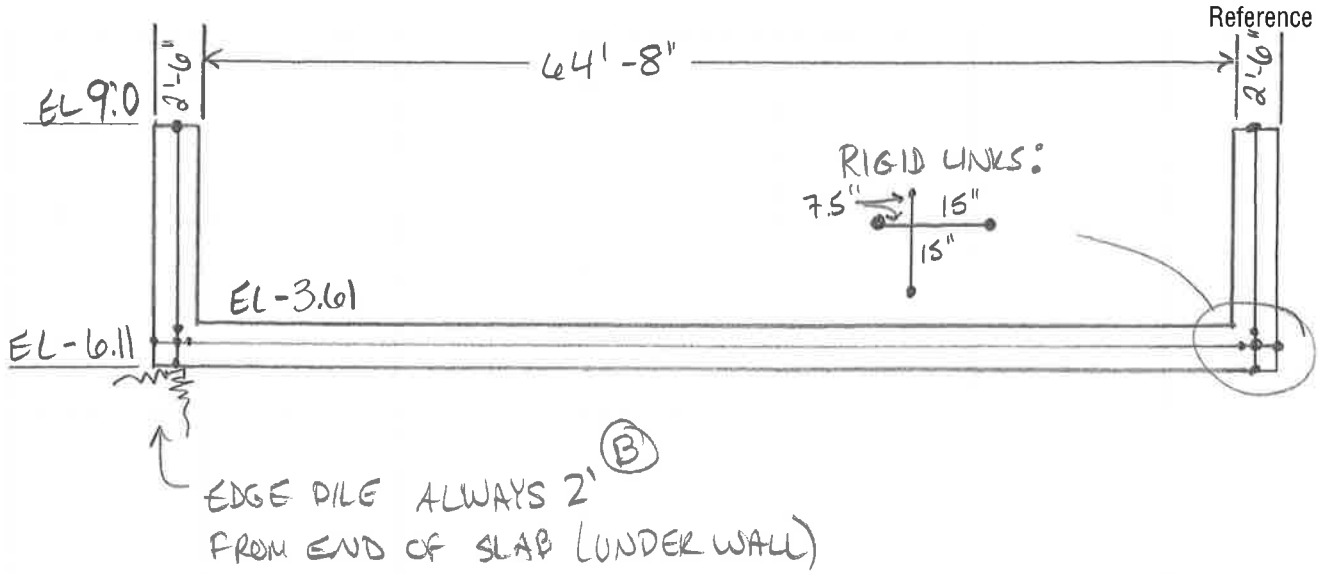


URS

Job: MAOREPAS DIVERSION | Project No. 10001876 | Page ____ of ____

Description: MONOLITH U-5 | Computed by: LBR | Sheet ____ of ____ | Date: 8/2013

SAP MODEL LAYOUT | Checked by: ____ | Date: ____



DEAD LOAD CALIBRATION:

↳ ACTUAL WEIGHT:

WALLS: $\left(\frac{14.3' + 12.61'}{2}\right)$ height × 2.5' thick × 45.6' long × 2 × 150 PCF = 460,161 LB

wall length from CAD

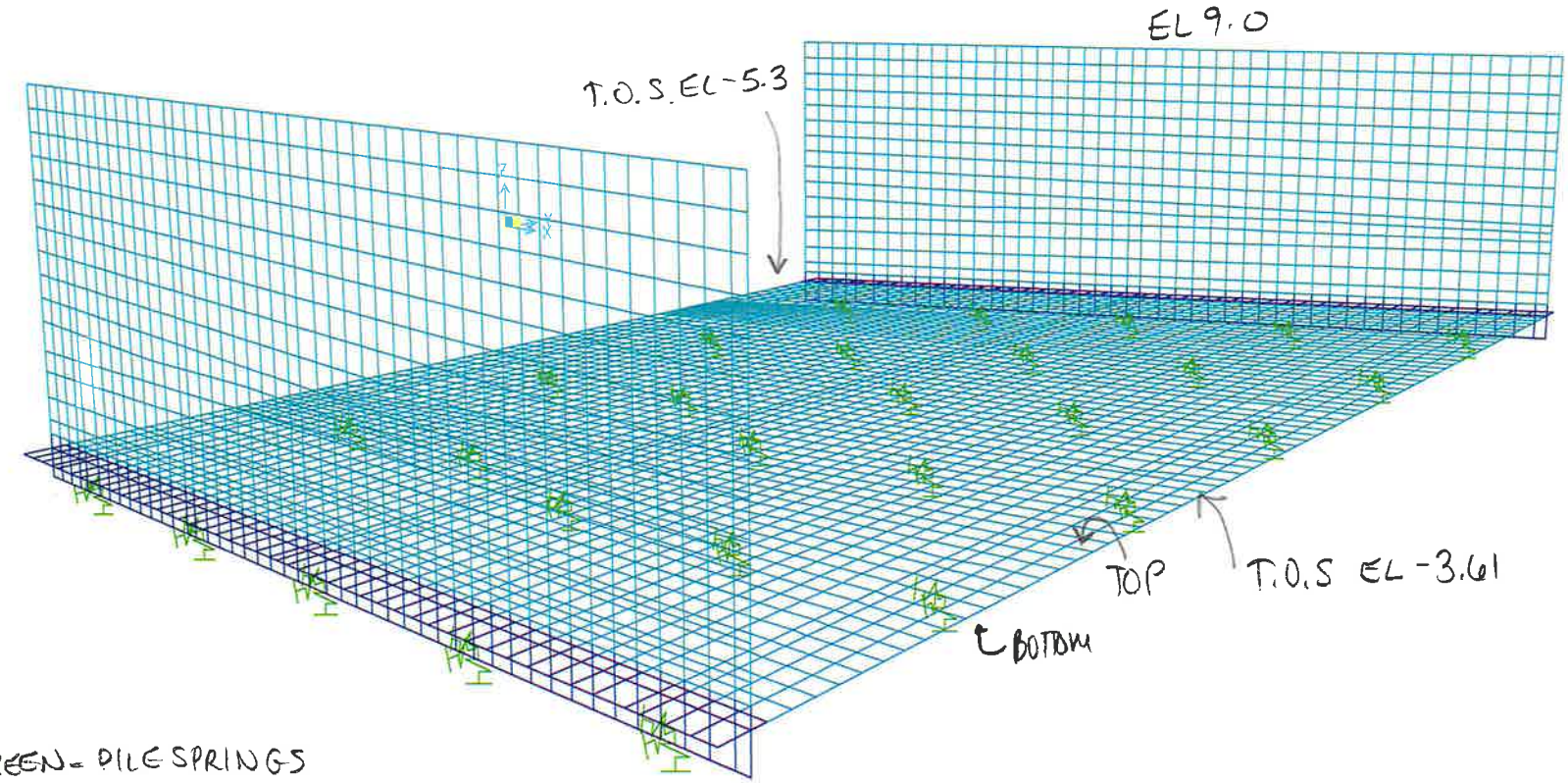
SLAB: $\left(\frac{55.33' + 69.67'}{2}\right)$ wide × 2.5' thick × 45' long × 150 PCF = 1,054,687.5 LB

$\Sigma = \underline{1{,}514{,}848.5^{LB}}$

↳ SAP DEAD LOAD = 1,515,305.7 LB

↳ DIFFERENCE OF 457.2 LB, OR 0.03% → OK

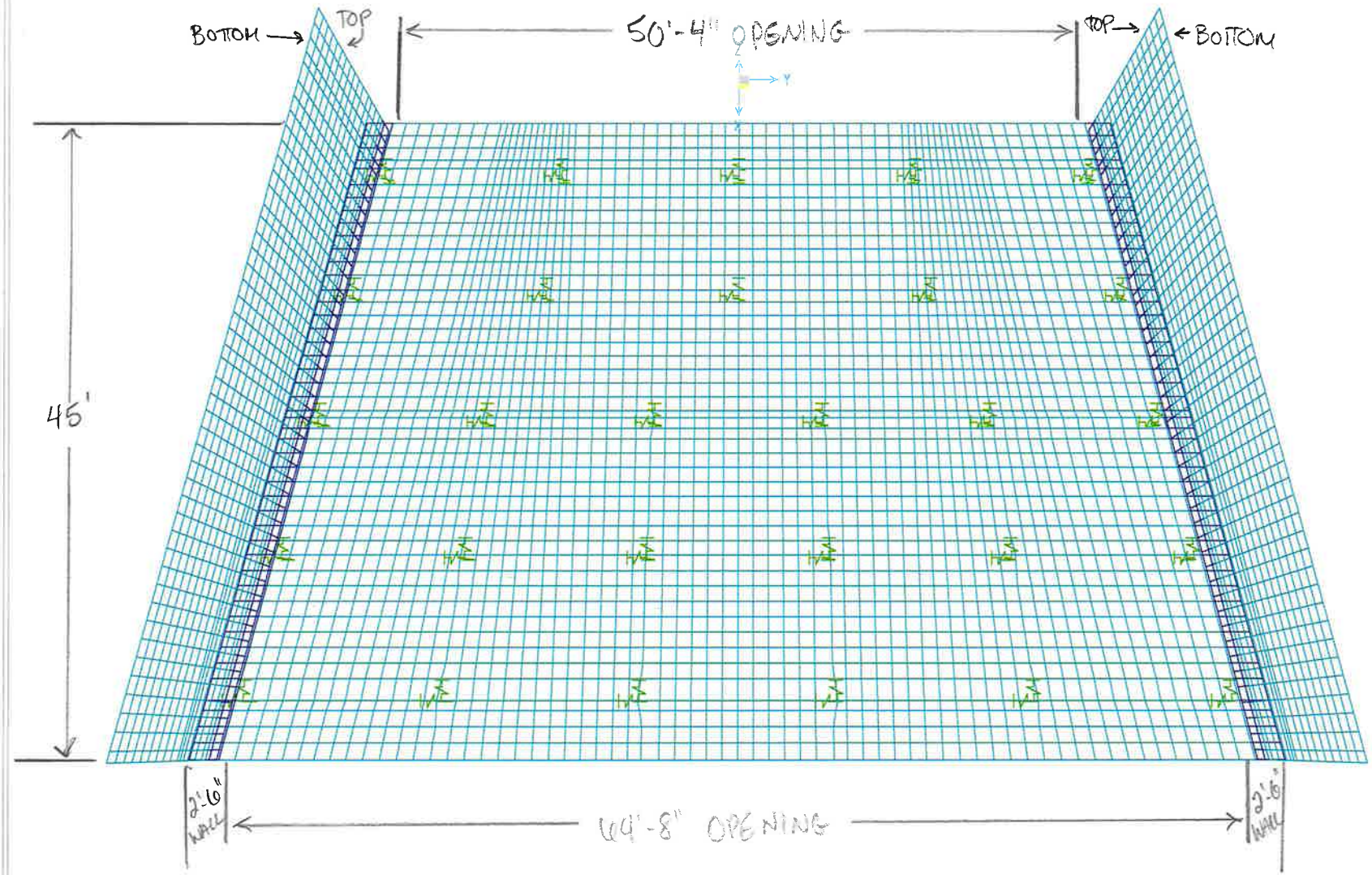
U-5 MODEL:

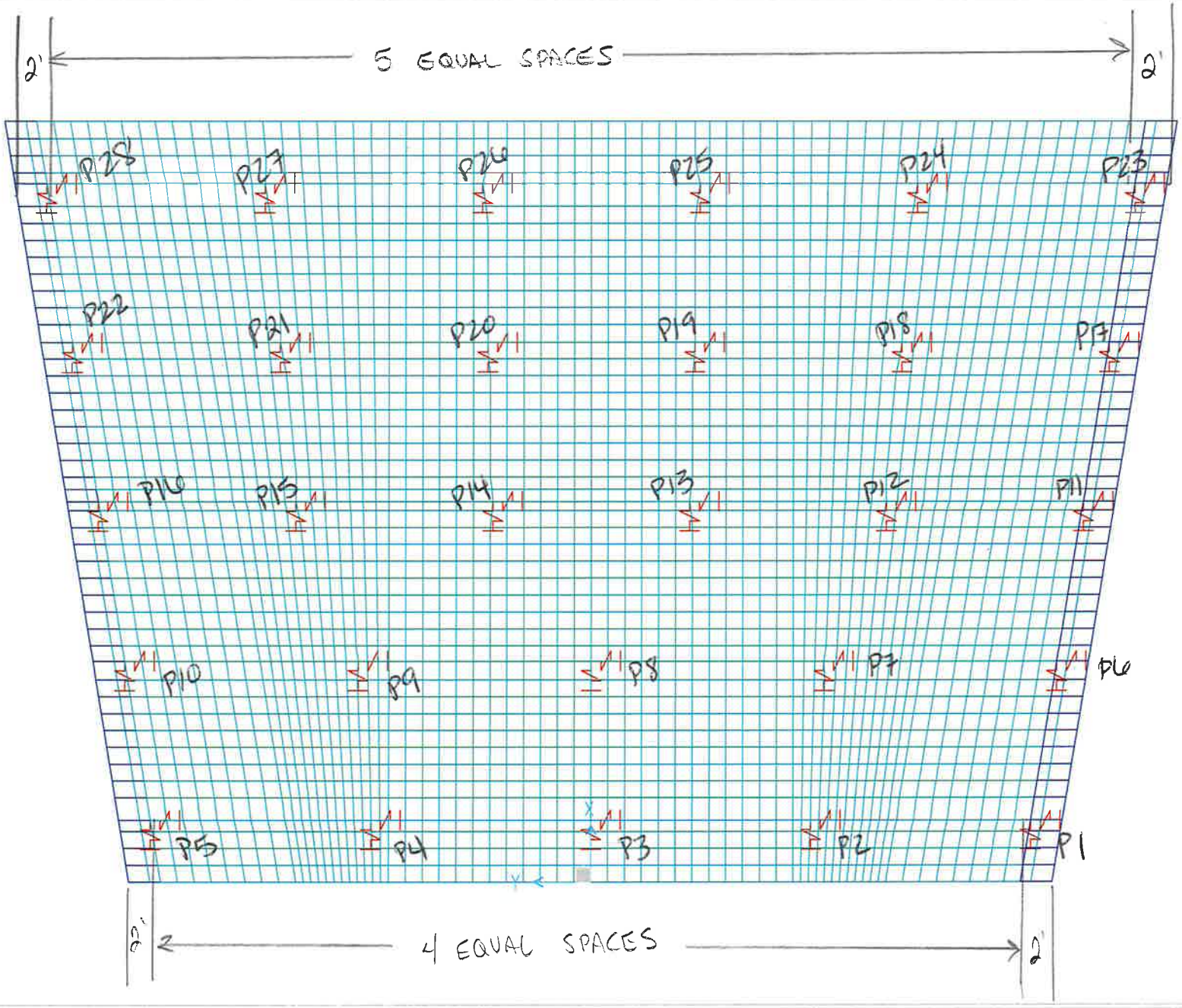


GREEN - PILE SPRINGS

DARK BLUE - "RIGID LINK" 2'-6" MEMBERS

LIGHT BLUE - NORMAL CONCRETE 2'-6" MEMBERS


BOTTOM
TOP
50'-4" OPENING
TOP
BOTTOM
45'
2'-6" WALL
44'-8" OPENING
2'-6" WALL


2'
5 EQUAL SPACES
2'
P28
P27
P26
P25
P24
P23
P22
P21
P20
P19
P18
P17
P16
P15
P14
P13
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P4
P3
P2
P1
2'
4 EQUAL SPACES
2'

U-5:

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page:	of
Description:	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

References

OUTFLOW MONOLITH - U-5 LOADS

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf
γ_{water} =	62.4	pcf
γ_{soil} =	115	pcf
γ' =	52.6	pcf
K_0 =	0.95	
Vert. Surcharge =	250	psf
Horiz. Surcharge =	300	psf

Top of Bank=	5.0	ft NAVD88
Top of Walls=	9.0	ft NAVD88
Top of Base Slab=	-5.3	ft NAVD88 @ start of Monolith
	-3.607	ft NAVD88 @ end of Monolith with 3.78% slope
Bottom of Slab=	-7.8	ft NAVD88 @ start of Monolith
	-6.107	ft NAVD88 @ end of Monolith with 3.78% slope
Minimum water level =	2.0	ft NAVD88
Maximum water level =	9.0	ft NAVD88
Wall thickness=	2.5	ft
Slab thickness=	2.5	ft

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure:

*Above water table: $P_y = \gamma_{fill,\ wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{fill,\ eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap:

*Above water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ eff} * Z_{fill})$

*** LOADS FOR SAP MODEL:**

* Construction Surcharge Loads: Below Top of Soil = $K_0 * q_{surcharge}$ = 285 ksf

* Soil Loads, Dry (Const.): Construction surcharge load applied separately

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
5.0	0.0
-4.232	1008.6
-4.857	1076.9
-5.925	1193.6
-6.107	1213.4
-6.55	1261.8
-7.8	1398.4

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* Soil Loads, UNEVEN Dry (Const.): Soil to EL 5.0 on one side (use pressures above), only to EL 0.0 on other side (use pressures calculated below)

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
5.0	0.0
0.0	0.0
-4.232	462.3
-4.86	530.6
-5.925	647.3
-6.1	667.2
-6.55	715.6
-7.8	852.2

* Soil Loads, Maximum & Minimum Water Levels:

Soil with Min Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
5.0	0.0
2.0	327.8
-4.232	639.2
-4.86	670.4
-5.925	723.8
-6.1	732.9
-6.55	755.0
-7.8	817.5

Soil with Max Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
5.0	0.0
-4.232	461.3
-4.86	492.6
-5.925	545.9
-6.1	555.0
-6.55	577.2
-7.8	639.6

* Water Loads:

- Water press. on **top** of base slab:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-5.3	455.52	892.32	(Pressure at upstream end)
-3.607	349.88	786.68	(Pressure at downstream end)

- Uplift at **bottom** of base slab/uplift:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-7.8	611.52	1048.32	(Pressure at upstream end)
-6.107	505.88	942.68	(Pressure at downstream end)

- Lateral Water Loads:

Min Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
5.0	0.0
2.0	0.0
-4.232	388.9
-4.86	427.9
-5.925	494.5
-6.11	505.9
-6.55	533.5
-7.8	611.5

Max Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
9.0	0.0
-4.232	825.7
-4.86	864.7
-5.925	931.3
-6.1	942.7
-6.55	970.3
-7.8	1048.3

Note: Water Pressure is equal on either side of the wall (as per hydraulics engineers). Most water pressure cancels out along walls.

URS

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Monolith U-5 SAP Data:

Outflow Monolith outer wall Joint Pattern for lateral force due to Construction Soil (dry): **"Lat Soil"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
5	0.00
-7.8	1398.40

Equations:

$$0 = C*5 + D$$
$$1398.4 = C*-7.8 + D$$

C =	-109.250
D =	546.250

Outflow Monolith outer wall Joint Pattern for lateral force due to Uneven Construction Soil: **"Lat Soil - Uneven"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
0	0.00
-7.8	852.15

Equations:

$$0 = C*0 + D$$
$$852.15 = C*-7.8 + D$$

C =	-109.250
D =	0.000

Outflow Monolith wall Joint Pattern for lateral **Soil** load due to **Min Water Level**: **"Lat Soil - Min Water"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
5.0	0.00
2.0	327.75

Equations:

$$0 = C*5 + D$$
$$327.75 = C*2 + D$$

C =	-109.250	Above Water Level
D =	546.250	

Z	P
2.0	327.75
-7.8	817.46

Equations:

327.75 = C*2 + D
817.46 = C*-7.8 + D

C =	-49.970	Below Water Level
D =	427.690	

Outflow Monolith wall Joint Pattern for lateral **Water** load due to **Min Water Level**: **"Lat Water - MIN"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
2.0	0.00
-7.8	611.52

Equations:

0 = C*2 + D
611.52 = C*-7.8 + D

C =	-62.400
D =	124.800

Outflow Monolith outer wall Joint Pattern for lateral **Soil** load due to **Max Water Level**:

The Joint Pattern created for the Lateral Construction Soil Load may be used for this load pattern with a scaling factor.

Soil Pressure @ EL -7.8, Construction Soil = 1398.4 psf
Soil Pressure @ EL -7.8, Saturated Soil = 639.616 psf

Scale factor = 639.62 / 1398.4
= **0.45739** * "Lat Soil" pattern

Outflow Monolith outer wall Joint Pattern for lateral **Water** load due to **Max Water Level**: **"Lat Water - MAX"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
9.0	0.00
-7.8	1048.32

Equations:

0 = C*9 + D
1048.32 = C*-7.8 + D

C =	-62.400
D =	561.600

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Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
Description	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
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Outflow Monolith Joint Pattern due to **Downward Water Pressure on Base Slab**:

Min Water: "Vert Water - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	455.52
45.0	349.88

Equations:

455.52 = A*0 + D
349.88 = A*45 + D

A =	-2.348
D =	455.520

Max Water: "Vert Water - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	892.32
45.0	786.68

Equations:

892.32 = A*0 + D
786.68 = A*45 + D

A =	-2.348
D =	892.320

Outflow MonolithJoint Pattern due to **Uplift Pressure on Base Slab**:

Min Water Uplift: "Uplift - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	611.52
45.0	505.88

Equations:

611.52 = A*0 + D
505.88 = A*45 + D

A =	-2.348
D =	611.520

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page	of
Description	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

Max Water Uplift: "Uplift - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	1048.32
45.0	942.68

Equations:

1048.32 = A*0 + D
942.68 = A*45 + D

A =	-2.348
D =	1048.320

SAP 2000

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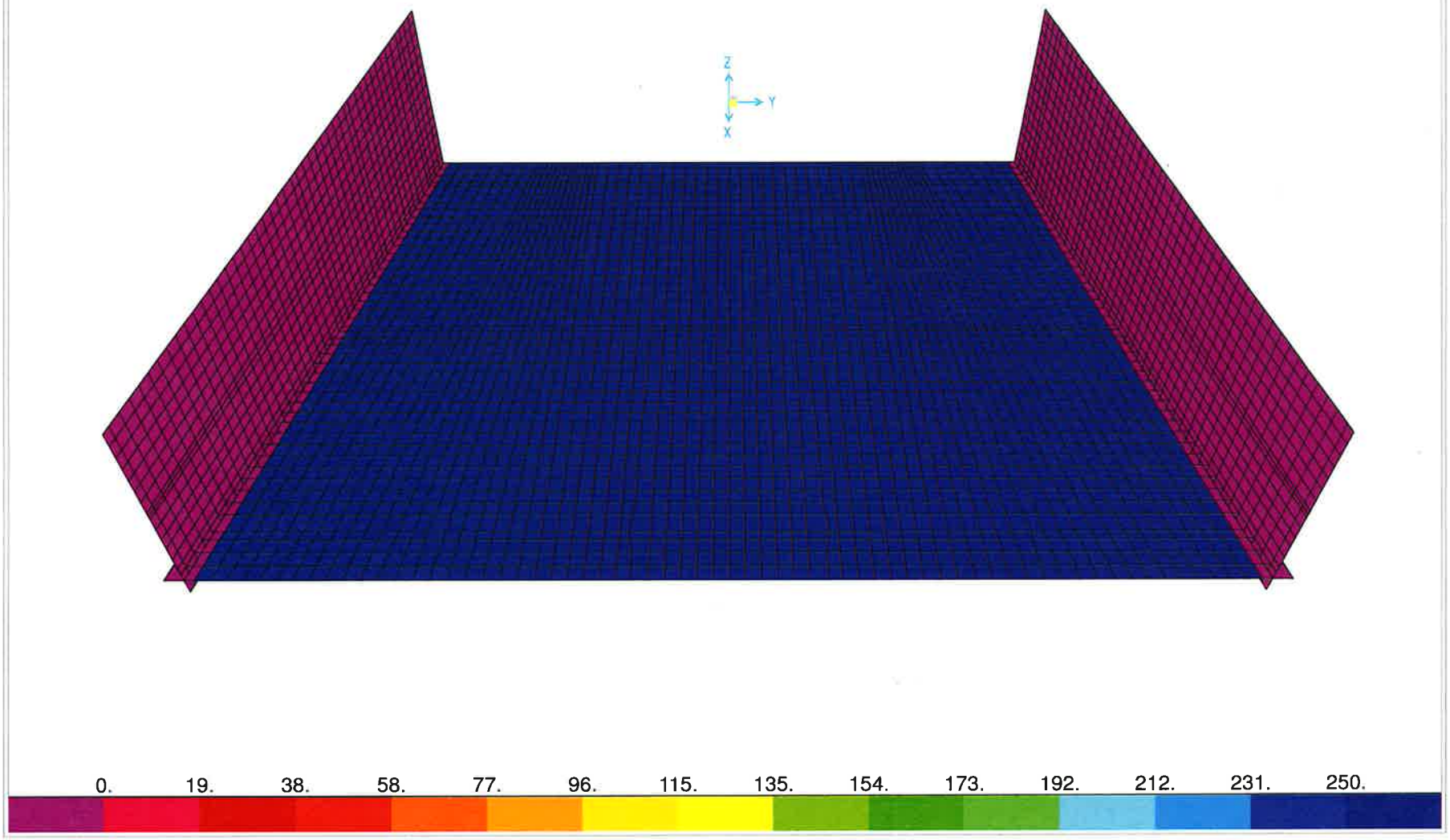
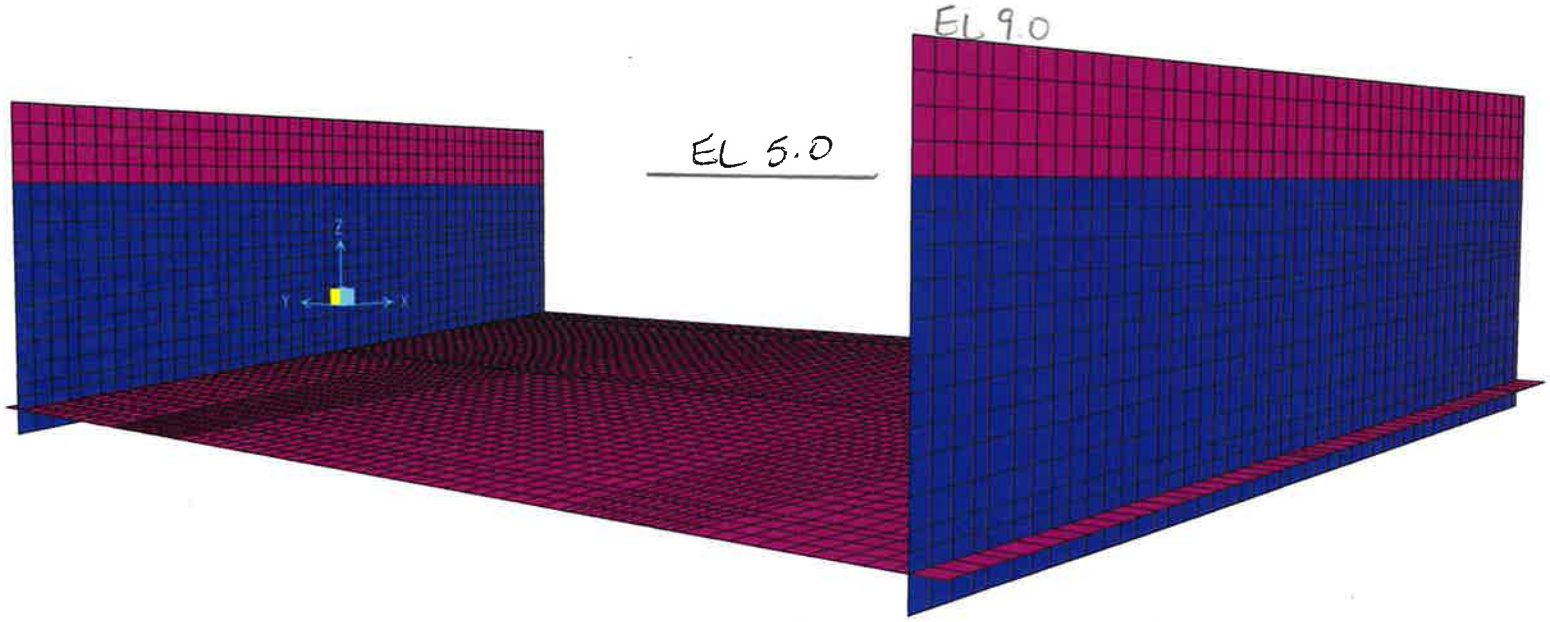
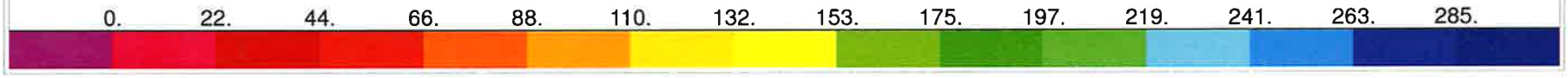
CONSTRUCTION SURCHARGE:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Top (LS_const) - lb, ft, F Units

CONST. SURCHARGE





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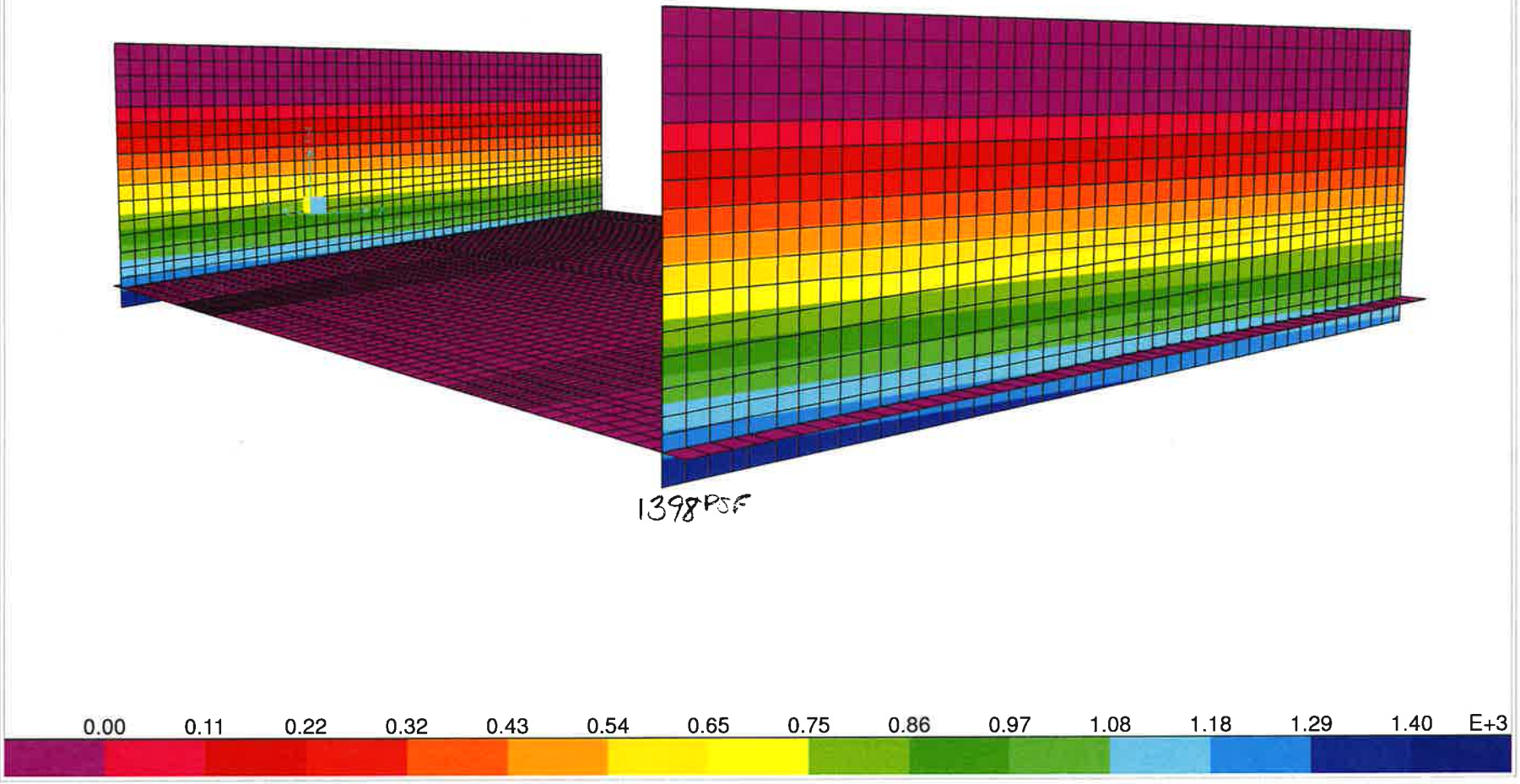
SAP2000 8/8/13 8:52:20

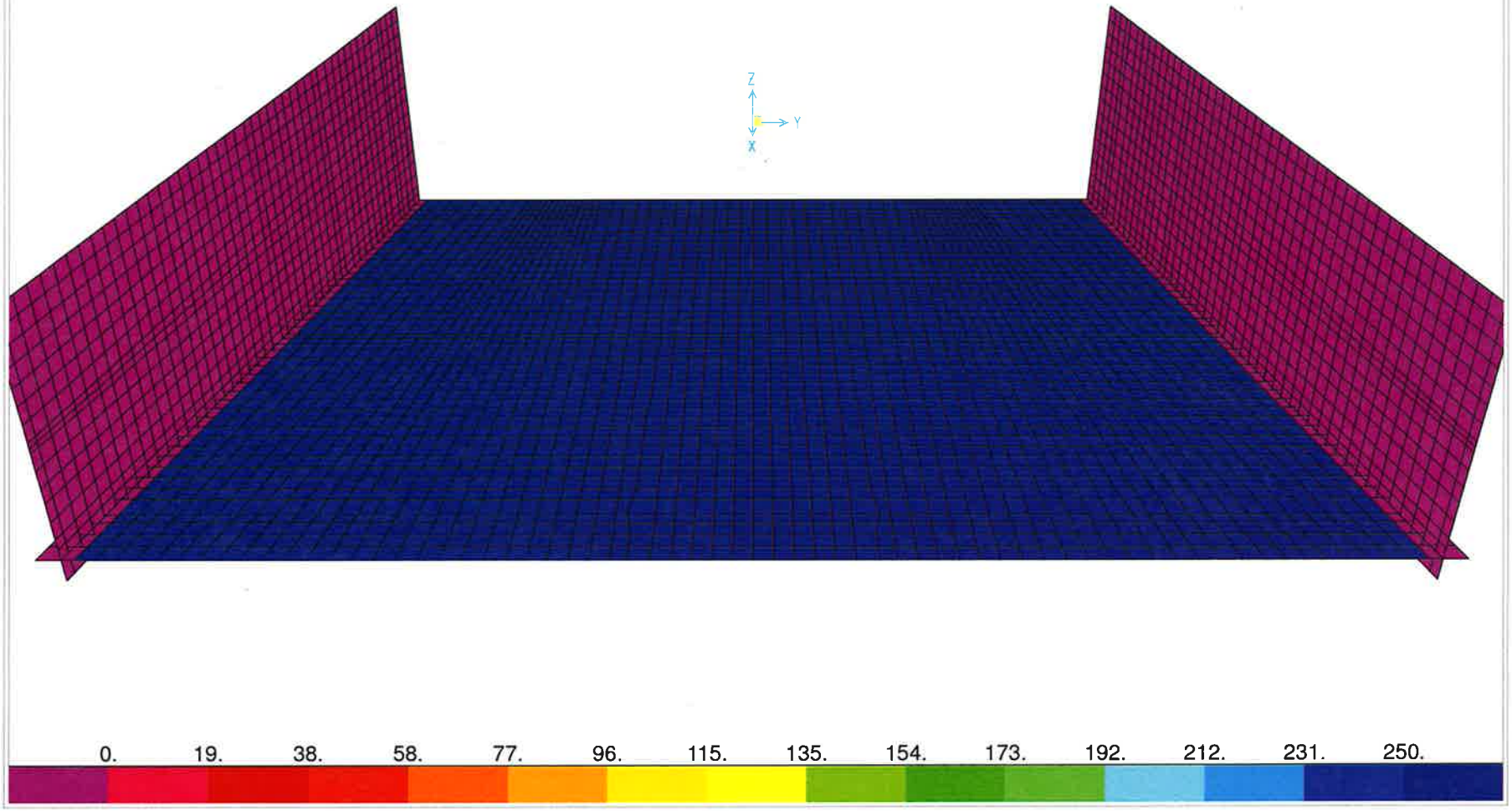
CONSTRUCTION SOIL:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (S_const) - lb, ft, F Units

SAP2000 8/7/13 17:00:06

UNEVEN CONST. SURCHARGE;



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Top (LS_const_uneven) - lb, ft, F Units

SAP2000

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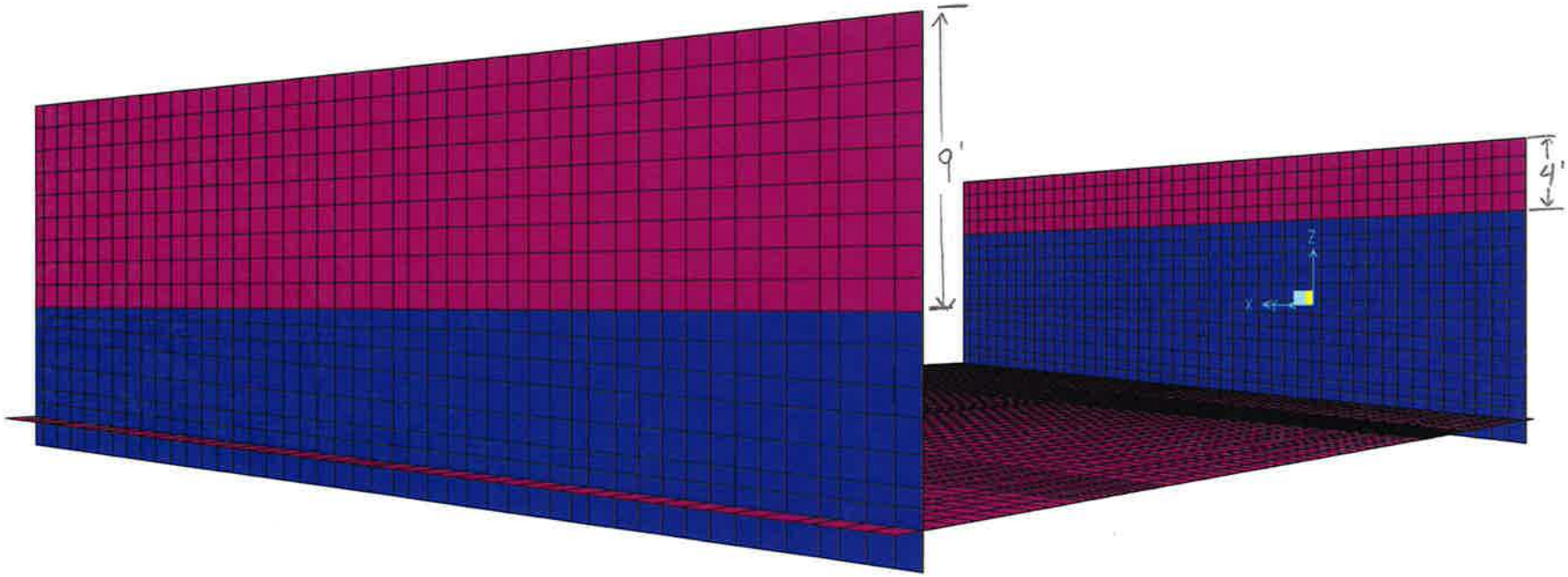
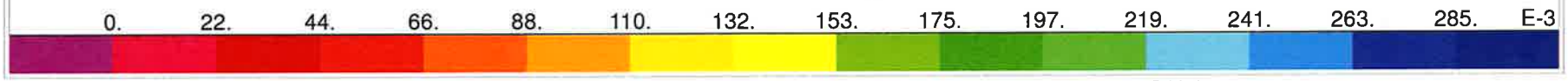
UNEVEN CONST SURCHARGE:





SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (LS_const_uneven) - Kip, ft, F Units

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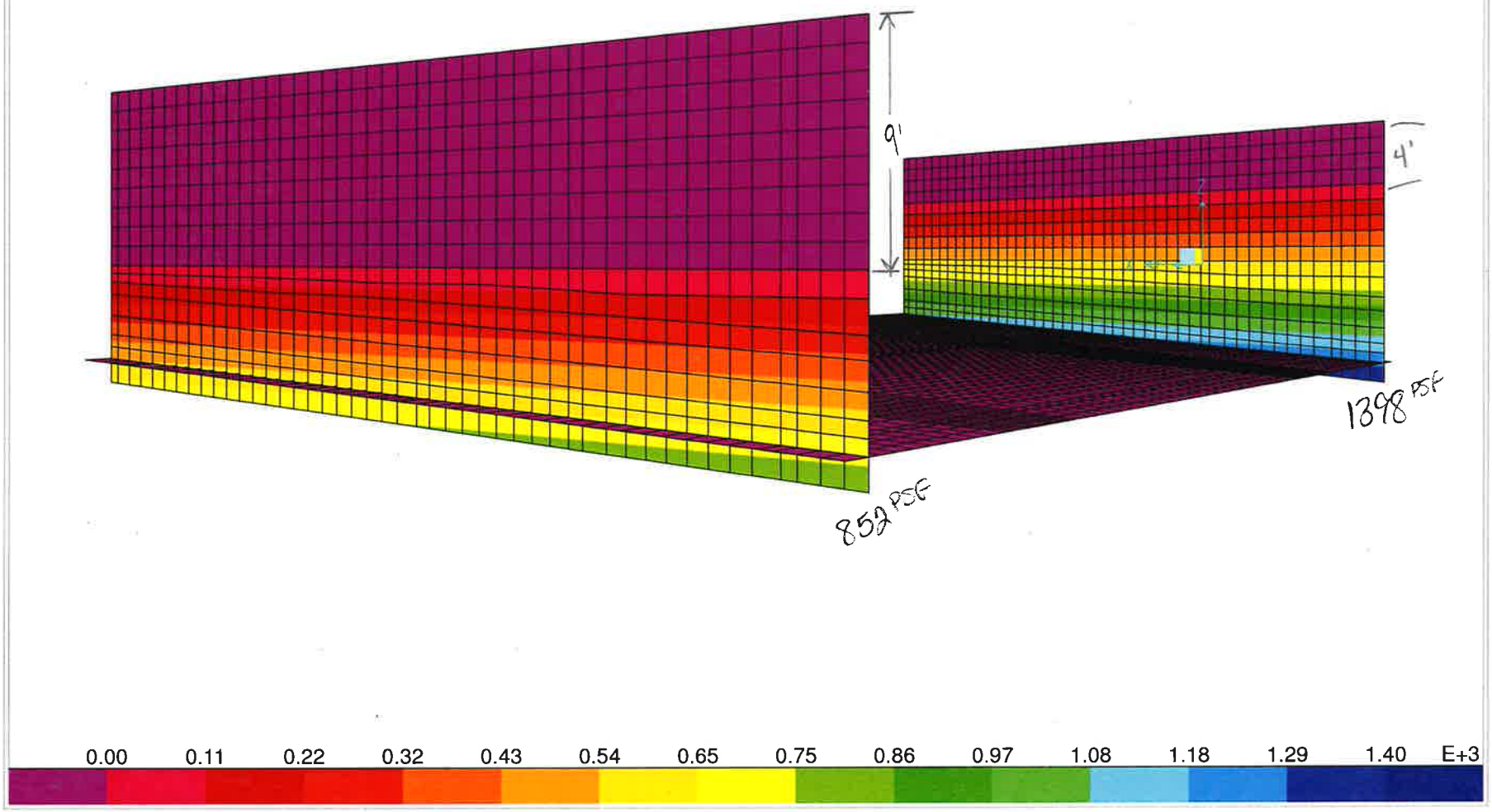
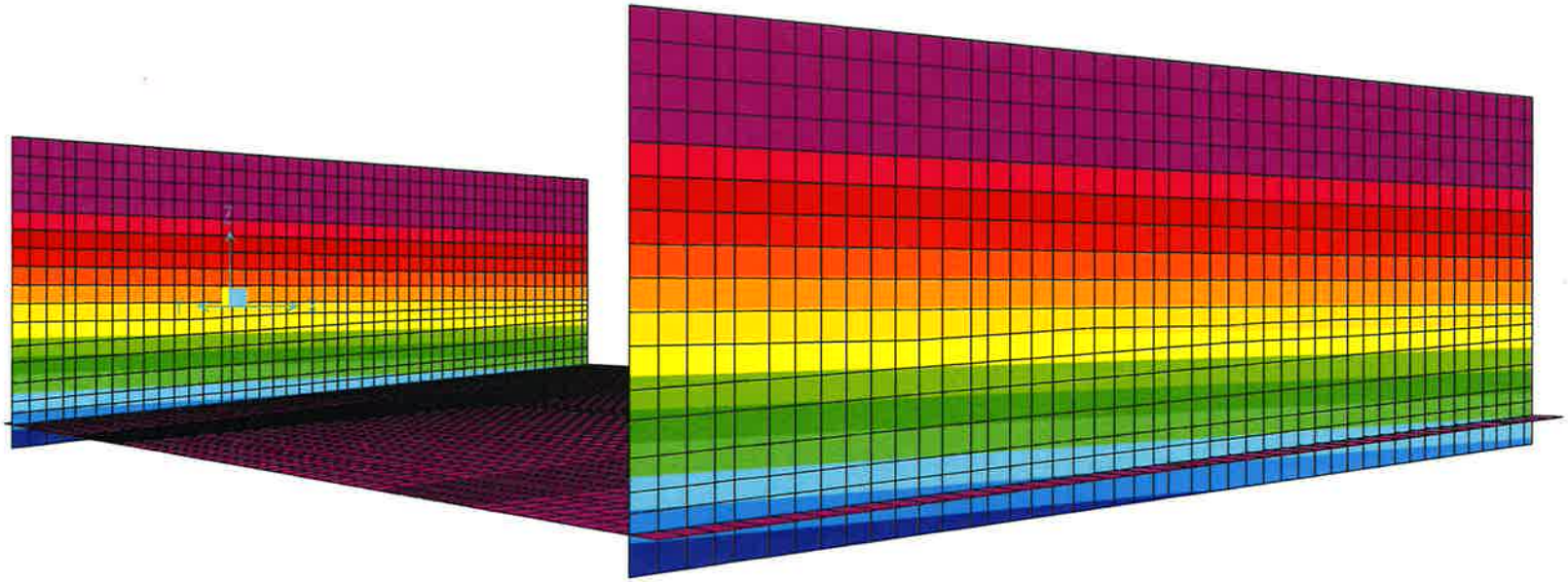
UNEVEN CONSTRUCTION SOIL:

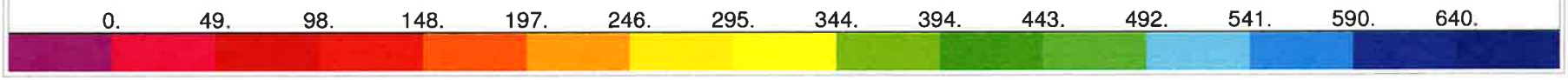


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (S_const_uneven) - lb, ft, F Units

SOIL LOAD-SATURATED (WATER EL 9.0):

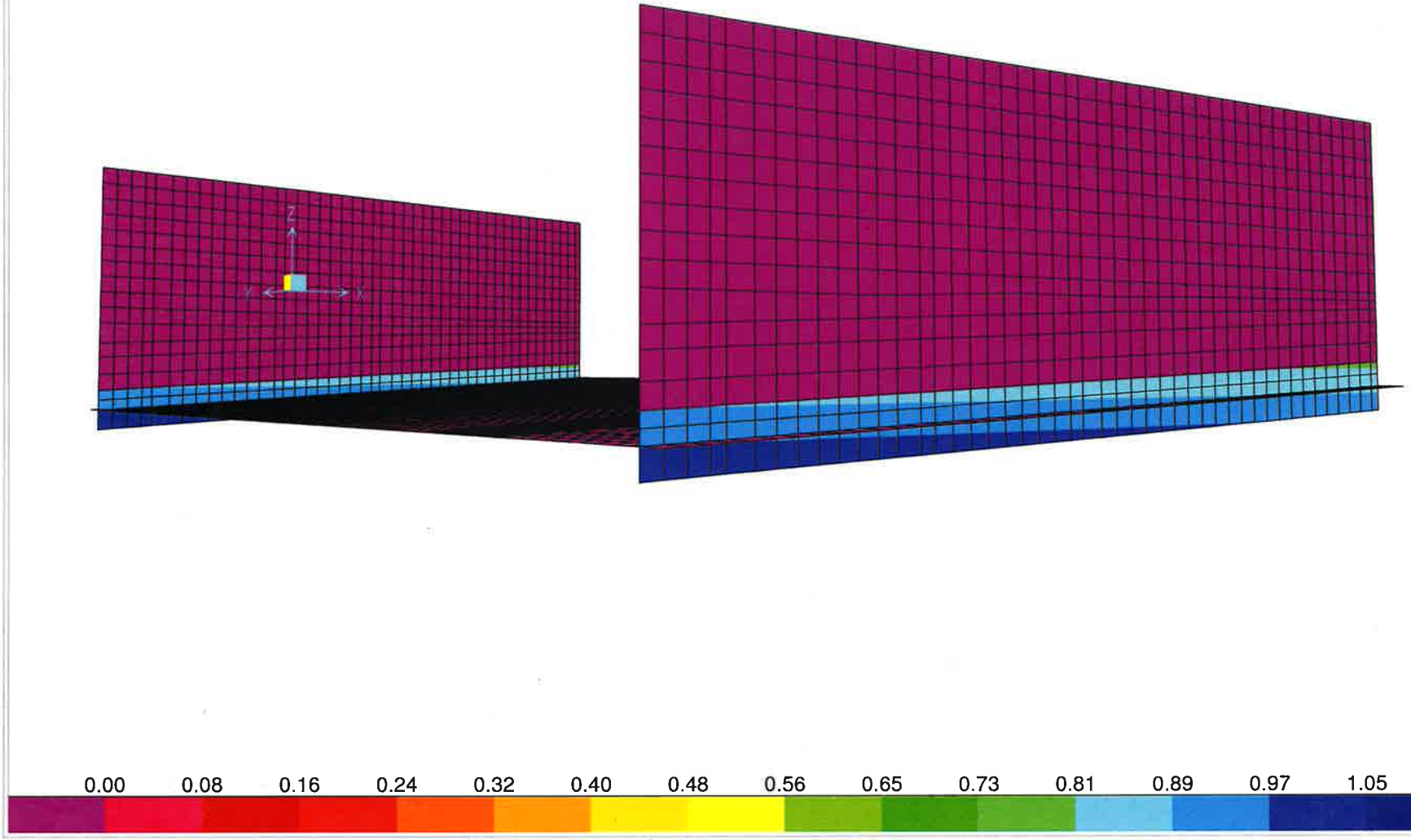


639.6 psf



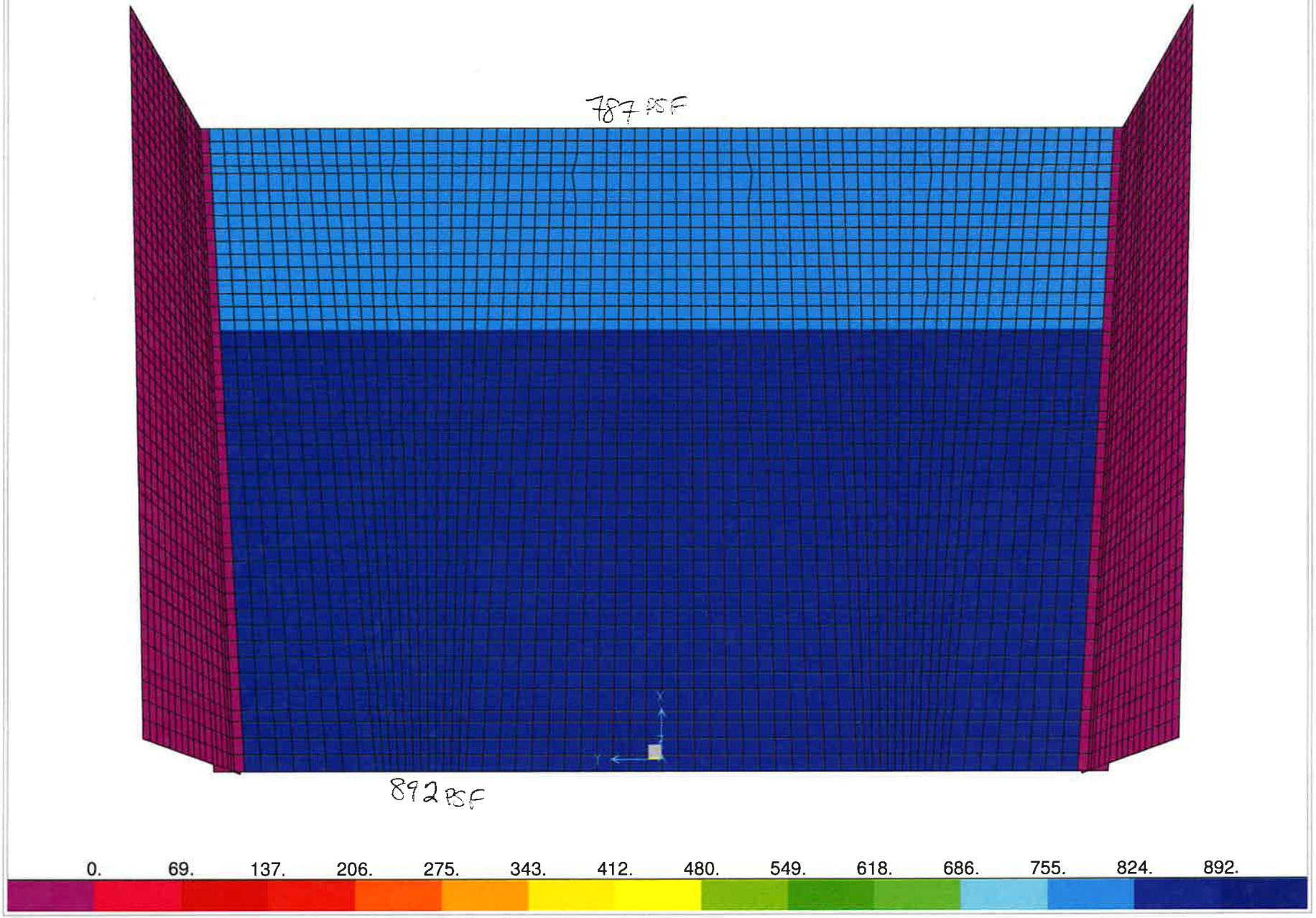
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (S_high water) - lb, ft, F Units

WATER TO EL 9.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (L_high water) - lb, ft, F Units

DOWNWARD FORCE - WATER TO EL9.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Top (L_high water) - lb, ft, F Units

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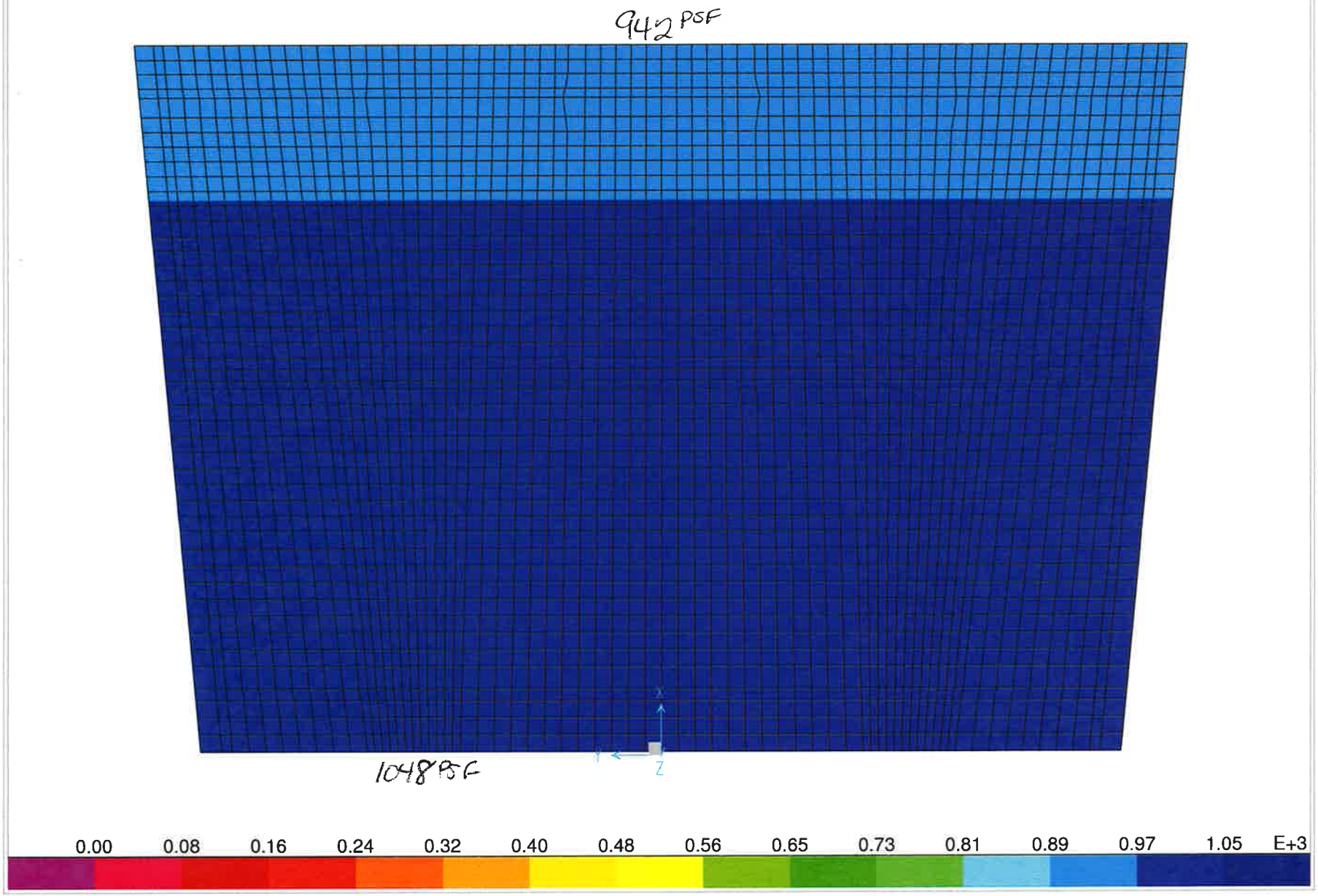
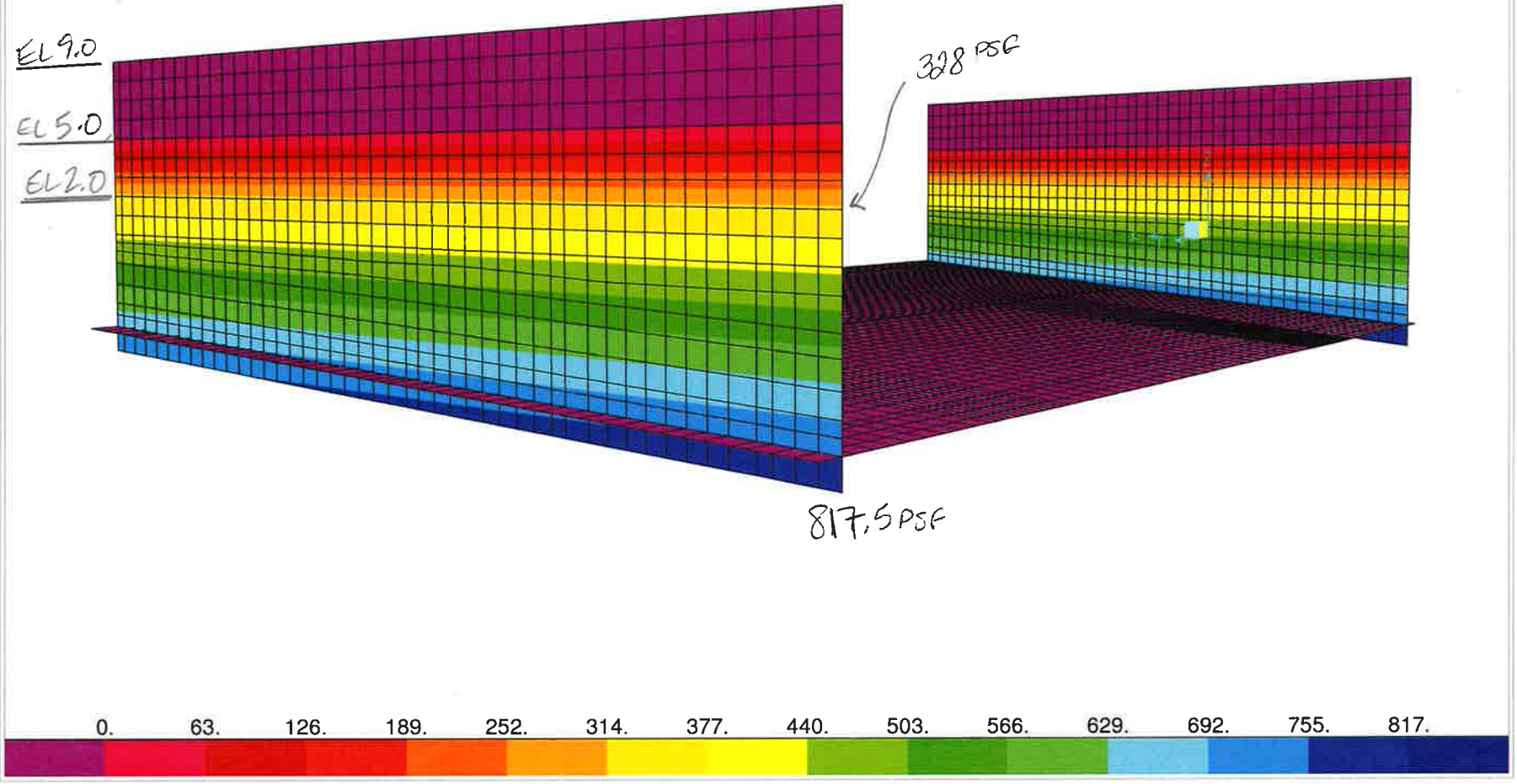
UPLIFT- WATER TO EL 9.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (U_high water) - lb, ft, F Units

SOIL LOAD- WATER TO EL 2.0



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (S_low water) - lb, ft, F Units

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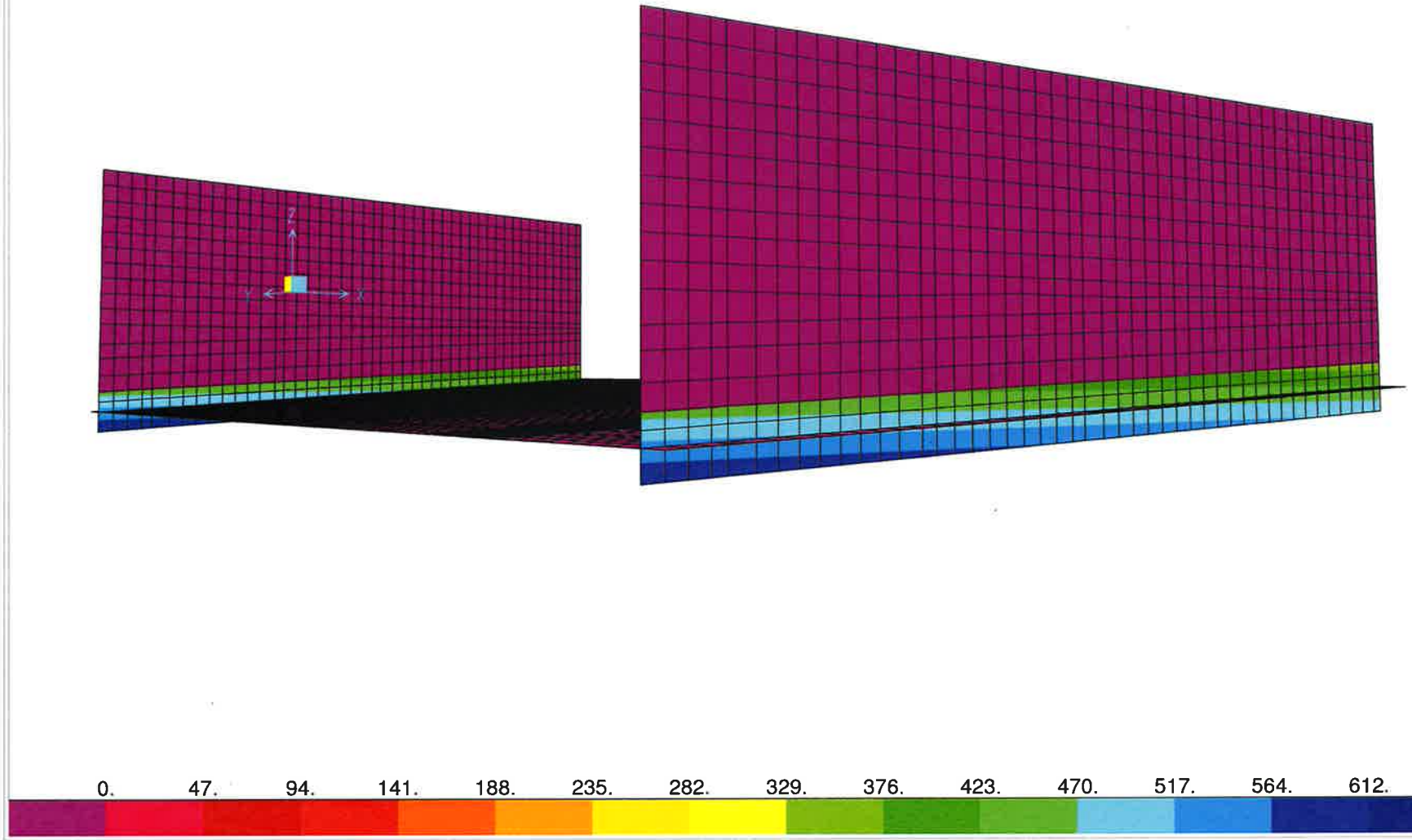
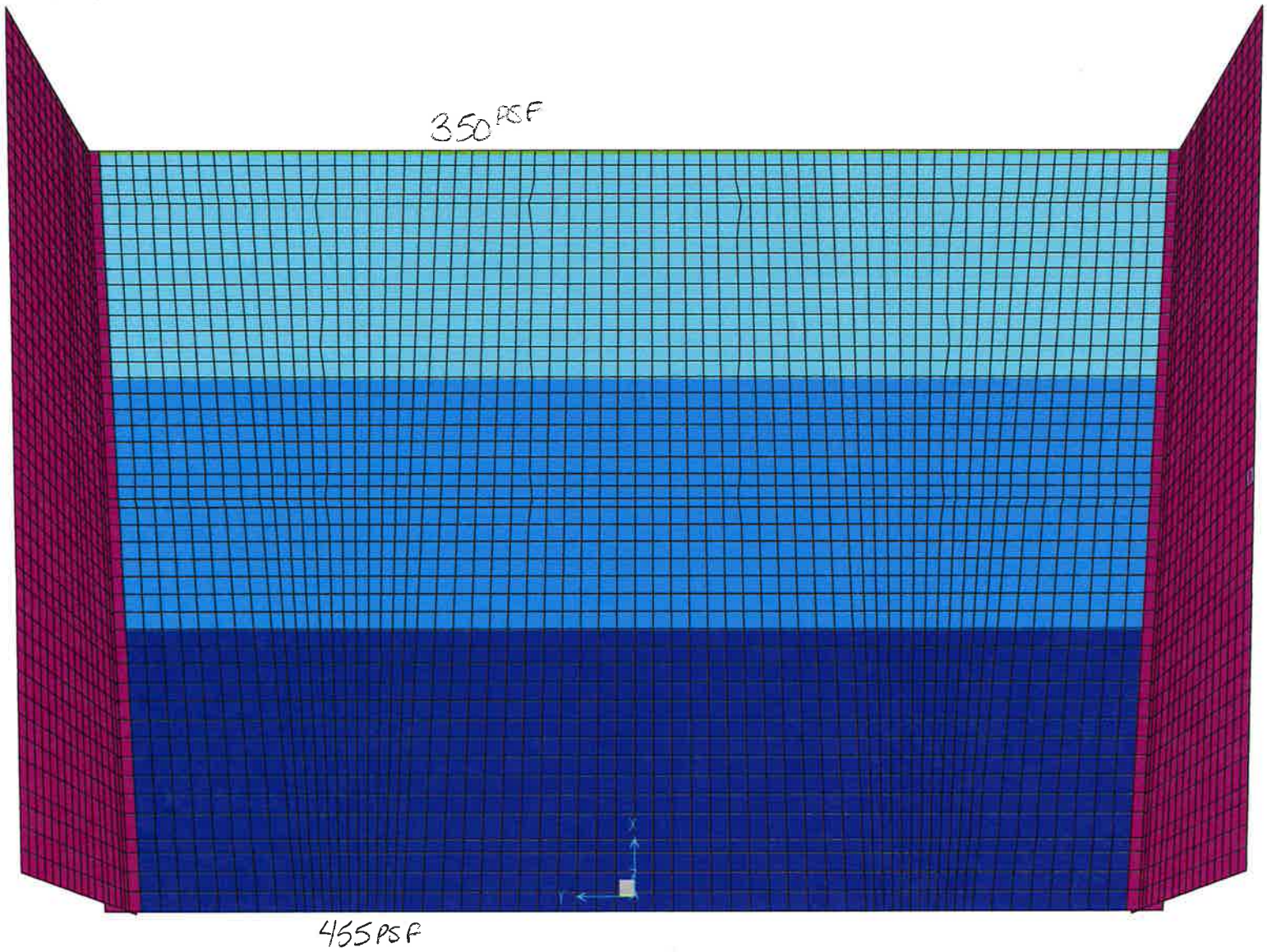
WATER TO EL 2.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (L_low water) - lb, ft, F Units

DOWNWARD FORCE - WATER TO EL 2.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Top (L_low water) - lb, ft, F Units

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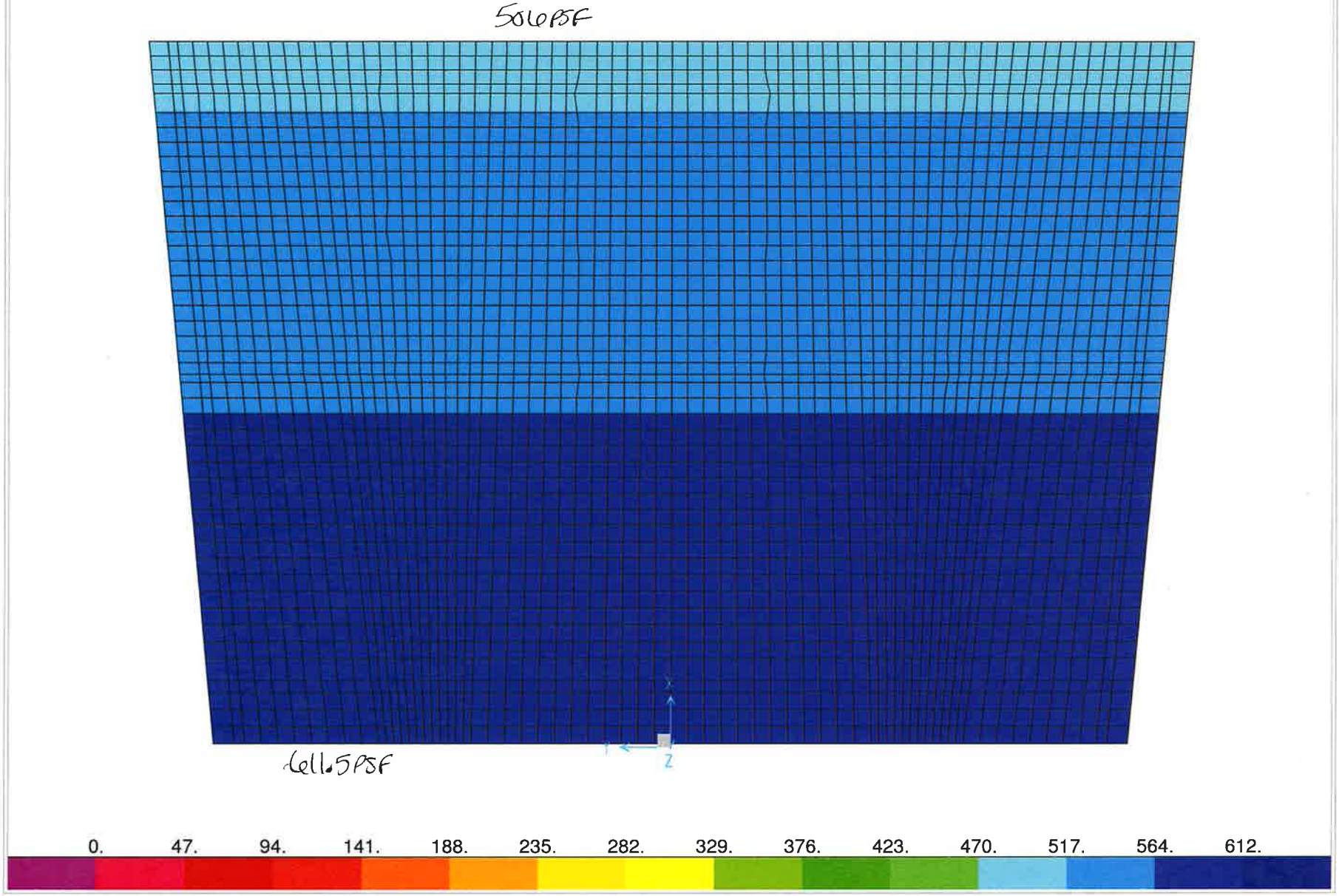
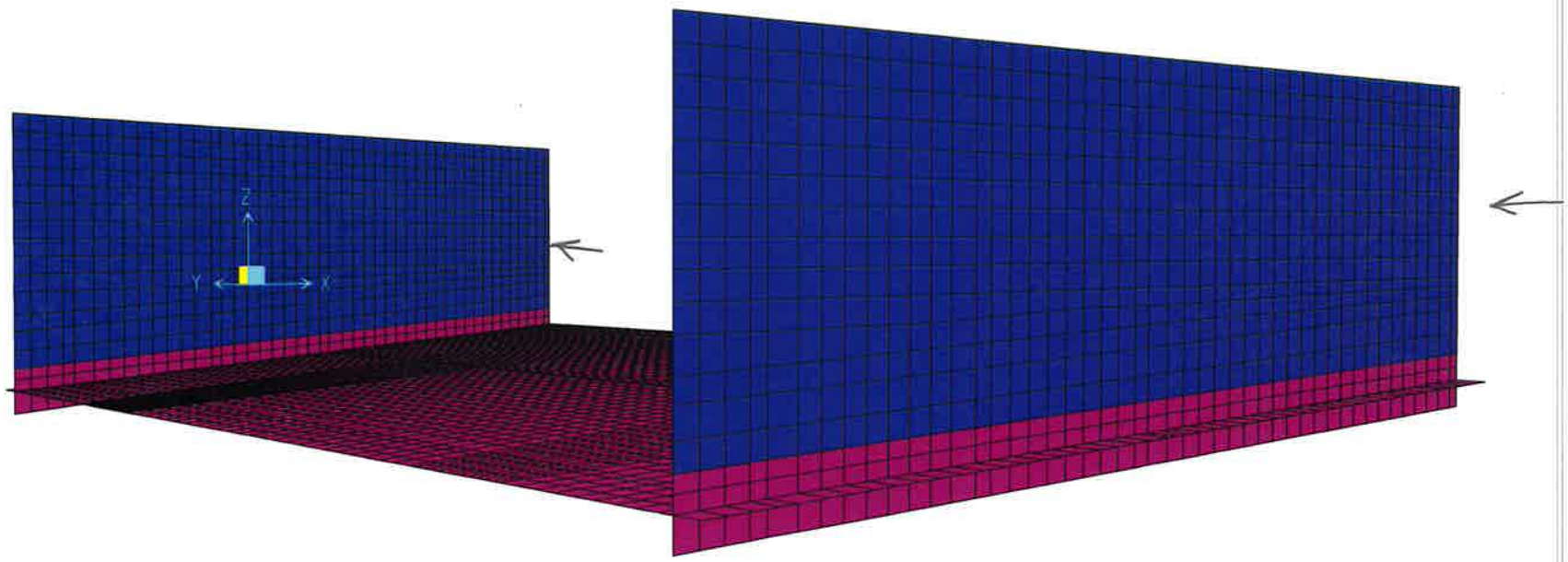
UPLIFT - WATER TO EL 2.0:

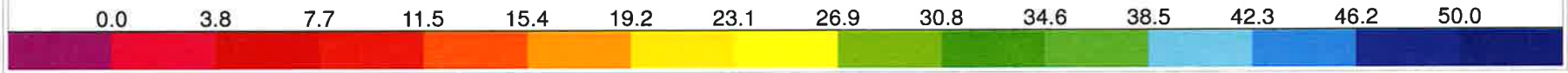


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Surface Pressure - Face Bottom (U_low water) - lb, ft, F Units

WIND DURING CONSTRUCTION:



+Y DIRECTION



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Uniform (W_construction) (GLOBAL - Y) - lb, ft, F Units

SAP 2000

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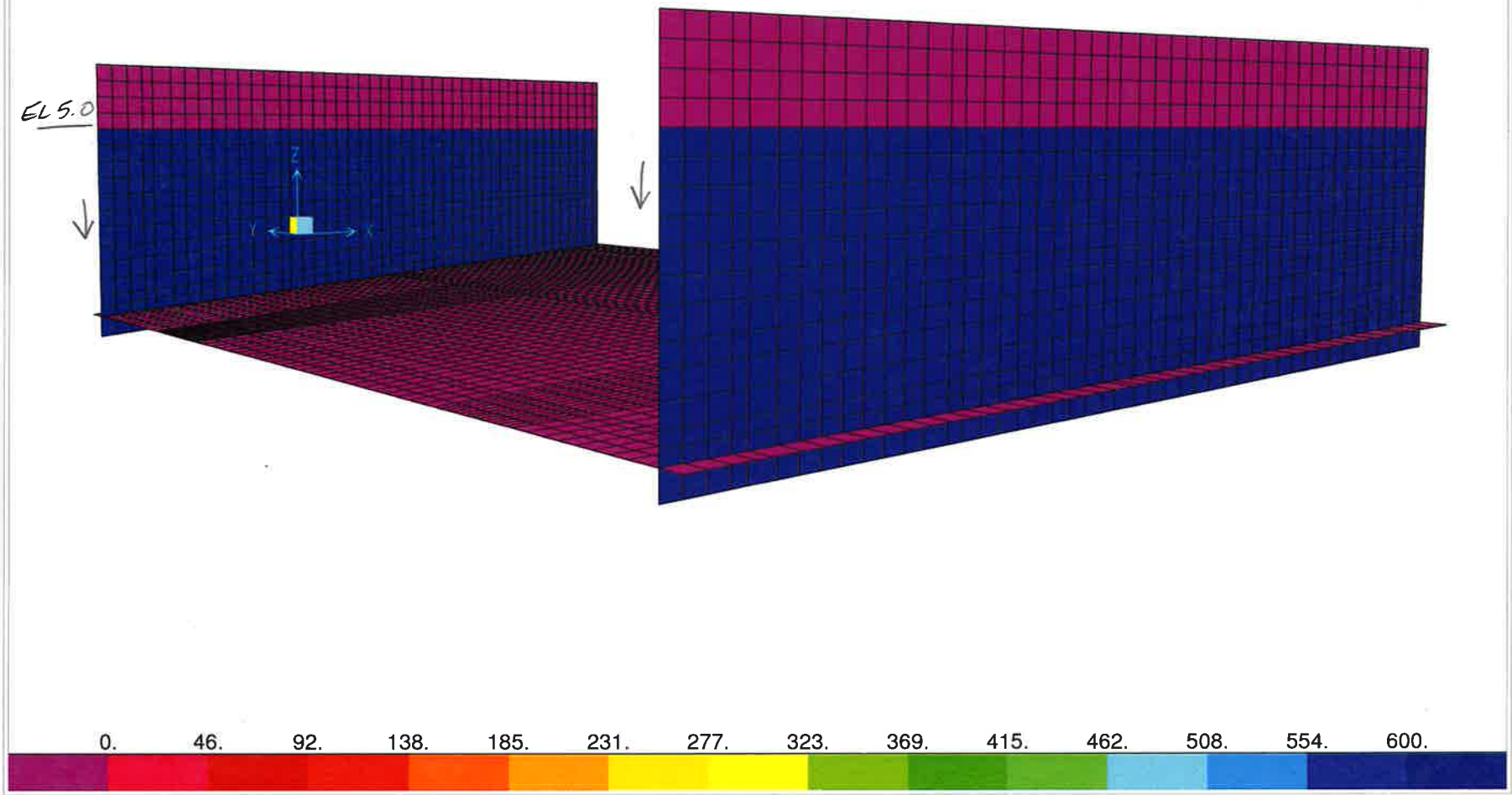
SETTLEMENT DUE TO CLAY ADHESION:



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Uniform (ST_cohesion) (GLOBAL - Gravity) - lb, ft, F Units

SAP 2000

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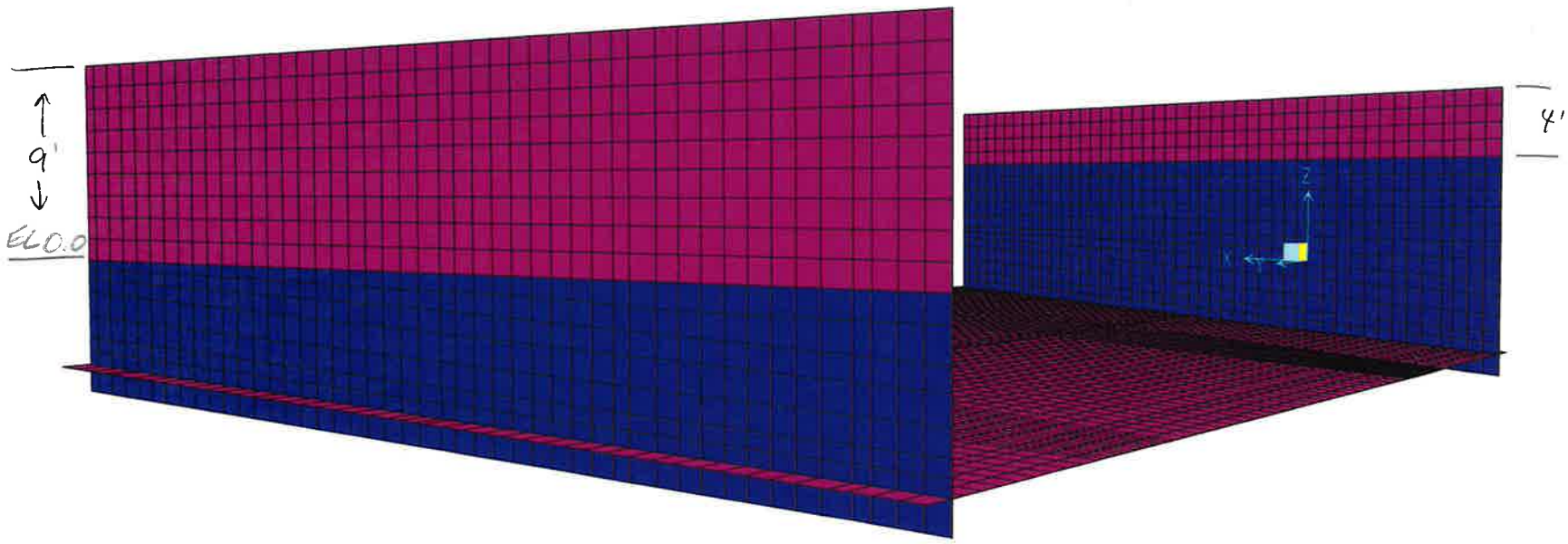
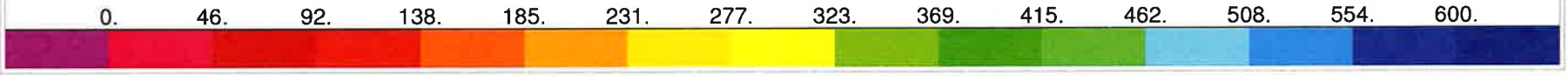
SETTLEMENT DURING UNEVEN CONSTRUCTION:





SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Area Uniform (ST_cohesion_uneven) (GLOBAL - Gravity) - lb, ft, F Units

PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-5 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use springs equivalent to a pile with tip EL -80.0 (1487.3 k/in) and lateral load of 10k (77.6 k/in)

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a	-6.73	0.27	62.85
P-2	LC1a	-6.77	-0.12	88.15
P-3	LC1a	-6.74	0.00	81.47
P-4	LC1a	-6.77	0.12	88.15
P-5	LC1a	-6.73	-0.27	62.85
P-6	LC1a	-6.73	0.26	62.77
P-7	LC1a	-6.81	-0.14	91.07
P-8	LC1a	-6.79	0.00	83.81
P-9	LC1a	-6.81	0.14	91.07
P-10	LC1a	-6.73	-0.26	62.77
P-11	LC1a	-6.74	0.23	62.27
P-12	LC1a	-6.85	-0.15	91.11
P-13	LC1a	-6.83	-0.09	83.11
P-14	LC1a	-6.83	0.09	83.11
P-15	LC1a	-6.85	0.15	91.11
P-16	LC1a	-6.74	-0.23	62.27
P-17	LC1a	-6.74	0.22	62.13
P-18	LC1a	-6.85	-0.17	90.20
P-19	LC1a	-6.83	-0.10	79.96
P-20	LC1a	-6.83	0.10	79.96
P-21	LC1a	-6.85	0.17	90.20
P-22	LC1a	-6.74	-0.22	62.13
P-23	LC1a	-6.74	0.20	62.07
P-24	LC1a	-6.85	-0.20	90.49
P-25	LC1a	-6.84	-0.11	77.10
P-26	LC1a	-6.84	0.11	77.10
P-27	LC1a	-6.85	0.20	90.49
P-28	LC1a	-6.74	-0.20	62.07

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1c	0.07	-2.47	141.88
P-2	LC1c	0.12	-2.48	99.69
P-3	LC1c	0.11	-2.33	83.09
P-4	LC1c	-0.01	-2.16	95.64
P-5	LC1c	-0.24	-2.04	147.65
P-6	LC1c	0.09	-2.42	139.66
P-7	LC1c	0.10	-2.41	100.16
P-8	LC1c	0.08	-2.28	84.85
P-9	LC1c	-0.04	-2.13	95.89
P-10	LC1c	-0.24	-1.99	145.78
P-11	LC1c	0.10	-2.37	137.56
P-12	LC1c	0.09	-2.37	102.97
P-13	LC1c	0.08	-2.27	85.40
P-14	LC1c	0.03	-2.19	83.32
P-15	LC1c	-0.08	-2.05	98.66
P-16	LC1c	-0.25	-1.94	144.15
P-17	LC1c	0.11	-2.32	135.36
P-18	LC1c	0.11	-2.32	99.40
P-19	LC1c	0.09	-2.21	82.07
P-20	LC1c	0.03	-2.14	80.04
P-21	LC1c	-0.08	-2.01	95.09
P-22	LC1c	-0.25	-1.89	142.31
P-23	LC1c	0.12	-2.27	133.14
P-24	LC1c	0.11	-2.27	94.80
P-25	LC1c	0.08	-2.16	76.87
P-26	LC1c	0.02	-2.09	74.71
P-27	LC1c	-0.09	-1.96	90.06
P-28	LC1c	-0.25	-1.84	140.42

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-5 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1b	-6.57	-9.13	62.16
P-2	LC1b	-5.83	-9.54	88.40
P-3	LC1b	-5.00	-9.47	77.62
P-4	LC1b	-4.23	-9.34	78.42
P-5	LC1b	-3.49	-9.40	82.96
P-6	LC1b	-6.66	-9.71	61.95
P-7	LC1b	-5.92	-10.13	91.32
P-8	LC1b	-5.04	-10.04	79.81
P-9	LC1b	-4.22	-9.91	79.90
P-10	LC1b	-3.40	-9.96	82.03
P-11	LC1b	-6.76	-10.30	61.30
P-12	LC1b	-6.17	-10.69	91.60
P-13	LC1b	-5.44	-10.67	82.00
P-14	LC1b	-4.71	-10.54	76.04
P-15	LC1b	-4.02	-10.45	79.39
P-16	LC1b	-3.30	-10.52	81.04
P-17	LC1b	-6.85	-10.88	61.01
P-18	LC1b	-6.23	-11.28	90.76
P-19	LC1b	-5.46	-11.25	79.27
P-20	LC1b	-4.70	-11.11	73.26
P-21	LC1b	-3.96	-11.01	77.66
P-22	LC1b	-3.21	-11.08	80.11
P-23	LC1b	-6.95	-11.46	60.81
P-24	LC1b	-6.28	-11.87	91.13
P-25	LC1b	-5.48	-11.83	76.68
P-26	LC1b	-4.69	-11.68	70.05
P-27	LC1b	-3.91	-11.57	75.82
P-28	LC1b	-3.12	-11.64	79.18

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC2	-2.33	-0.06	40.59
P-2	LC2	-2.28	-0.10	32.28
P-3	LC2	-2.25	0.00	26.22
P-4	LC2	-2.28	0.10	32.28
P-5	LC2	-2.33	0.06	40.59
P-6	LC2	-2.33	-0.07	40.34
P-7	LC2	-2.30	-0.11	32.86
P-8	LC2	-2.27	0.00	26.89
P-9	LC2	-2.30	0.11	32.86
P-10	LC2	-2.33	0.07	40.34
P-11	LC2	-2.33	-0.08	40.06
P-12	LC2	-2.32	-0.13	34.24
P-13	LC2	-2.29	-0.05	26.94
P-14	LC2	-2.29	0.05	26.94
P-15	LC2	-2.32	0.13	34.24
P-16	LC2	-2.33	0.08	40.06
P-17	LC2	-2.33	-0.09	39.80
P-18	LC2	-2.32	-0.14	33.34
P-19	LC2	-2.30	-0.05	25.68
P-20	LC2	-2.30	0.05	25.68
P-21	LC2	-2.32	0.14	33.34
P-22	LC2	-2.33	0.09	39.80
P-23	LC2	-2.33	-0.10	39.55
P-24	LC2	-2.33	-0.15	32.50
P-25	LC2	-2.31	-0.05	24.12
P-26	LC2	-2.31	0.05	24.12
P-27	LC2	-2.33	0.15	32.50
P-28	LC2	-2.33	0.10	39.55

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-5 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC3	-2.82	-0.02	42.67
P-2	LC3	-2.78	-0.13	35.45
P-3	LC3	-2.75	0.00	27.43
P-4	LC3	-2.78	0.13	35.45
P-5	LC3	-2.82	0.02	42.67
P-6	LC3	-2.82	-0.03	42.71
P-7	LC3	-2.81	-0.13	36.28
P-8	LC3	-2.78	0.00	28.13
P-9	LC3	-2.81	0.13	36.28
P-10	LC3	-2.82	0.03	42.71
P-11	LC3	-2.83	-0.04	42.67
P-12	LC3	-2.83	-0.15	38.34
P-13	LC3	-2.80	-0.06	28.33
P-14	LC3	-2.80	0.06	28.33
P-15	LC3	-2.83	0.15	38.35
P-16	LC3	-2.83	0.04	42.67
P-17	LC3	-2.83	-0.05	42.69
P-18	LC3	-2.83	-0.16	37.45
P-19	LC3	-2.80	-0.06	26.79
P-20	LC3	-2.80	0.06	26.79
P-21	LC3	-2.83	0.16	37.45
P-22	LC3	-2.83	0.05	42.69
P-23	LC3	-2.83	-0.06	42.73
P-24	LC3	-2.84	-0.18	36.82
P-25	LC3	-2.81	-0.07	24.98
P-26	LC3	-2.81	0.07	24.98
P-27	LC3	-2.84	0.18	36.82
P-28	LC3	-2.83	0.06	42.73

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	Dead	-0.04	-0.11	72.38
P-2	Dead	0.03	-0.08	48.83
P-3	Dead	0.05	0.00	41.54
P-4	Dead	0.03	0.08	48.83
P-5	Dead	-0.04	0.11	72.38
P-6	Dead	-0.04	-0.11	71.36
P-7	Dead	0.01	-0.07	49.01
P-8	Dead	0.04	0.00	42.43
P-9	Dead	0.01	0.07	49.01
P-10	Dead	-0.04	0.11	71.36
P-11	Dead	-0.04	-0.11	70.43
P-12	Dead	0.00	-0.08	50.41
P-13	Dead	0.03	-0.02	42.18
P-14	Dead	0.03	0.02	42.18
P-15	Dead	0.00	0.08	50.41
P-16	Dead	-0.04	0.11	70.43
P-17	Dead	-0.03	-0.11	69.42
P-18	Dead	0.01	-0.08	48.62
P-19	Dead	0.03	-0.02	40.53
P-20	Dead	0.03	0.02	40.53
P-21	Dead	0.01	0.08	48.62
P-22	Dead	-0.03	0.11	69.42
P-23	Dead	-0.03	-0.11	68.39
P-24	Dead	0.00	-0.08	46.21
P-25	Dead	0.02	-0.02	37.89
P-26	Dead	0.02	0.02	37.89
P-27	Dead	0.00	0.08	46.21
P-28	Dead	-0.03	0.11	68.39

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.1 kips
MINIMUM REACTION = -6.9 kips

Horizontal Reactions, Y-Direction:

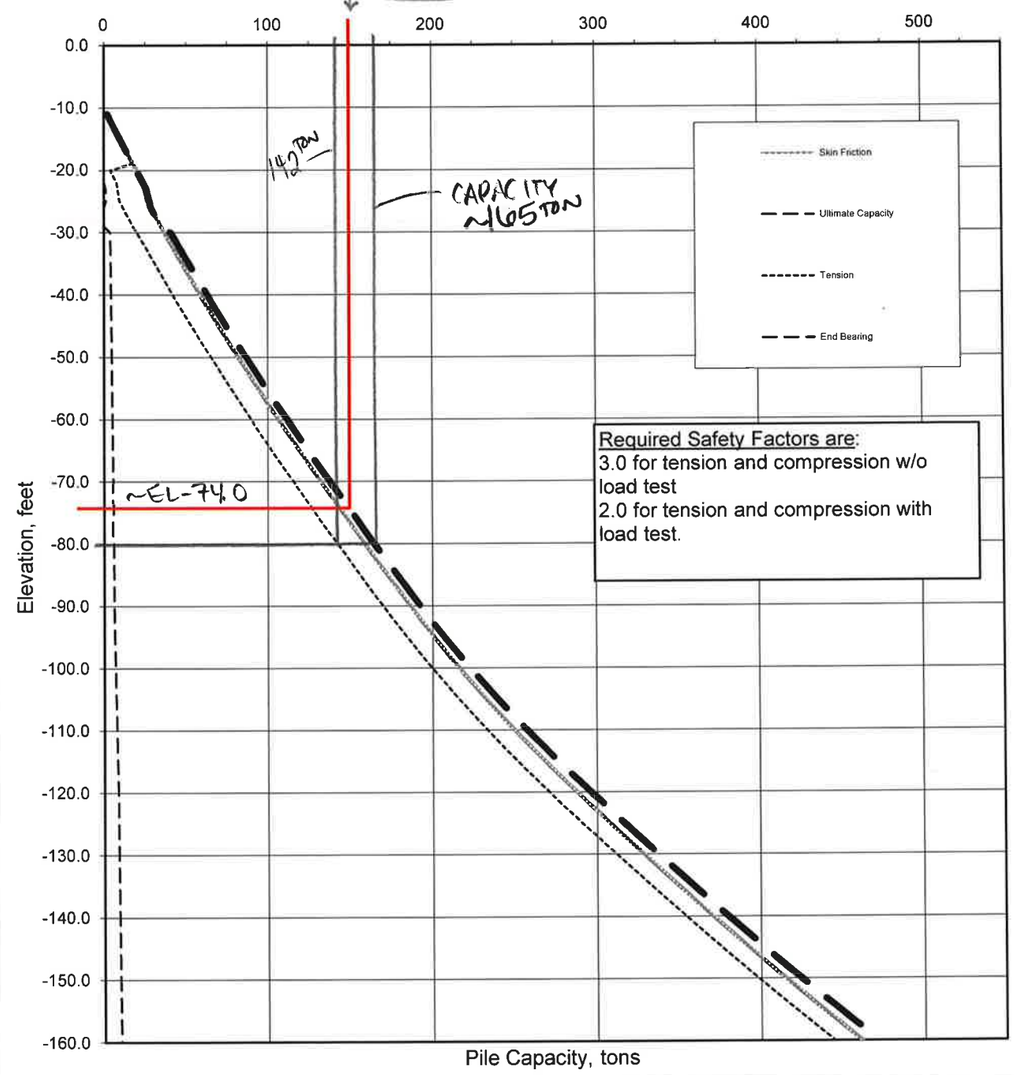
MAXIMUM REACTION = 0.3 kips
MINIMUM REACTION = -11.9 kips

Vertical Reactions:

MAXIMUM REACTION = 147.7 kips
MINIMUM REACTION = 24.1 kips

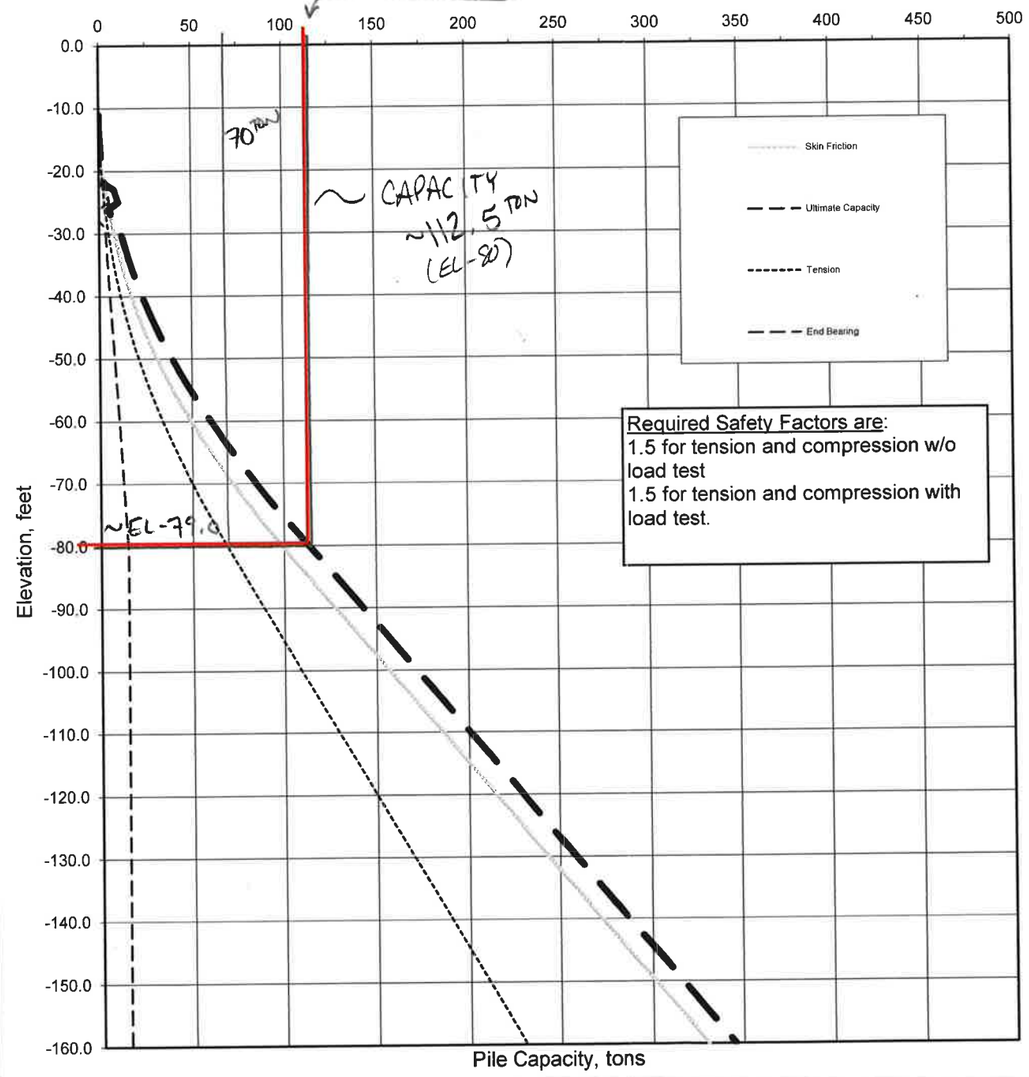
Undrained Strength Case with HP 14x89 Pile

148k REQ × 1 TON / 2 KIP × 2(F.O.S.) = 148 TON



Drained Strength Case with HP 14x89 Pile

148k REQ × 1 TON / 2 KIP × 1.5 (F.O.S.) = 111 TON



SET TIPS @EL-80.0

C_{ALLOW} = 150k (DRAINED CONTROLS)

T_{ALLOW} = 93.3k (DRAINED CONTROLS)

Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

Lake Maurepas Diversion Canal	Project No. 10001863	**Pile Capacities: Intake Structure HP - 14X89**	URS	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP **Computed By:** LBR **Date:** Aug-13 **Page:** of

Monolith U-5 Pile Springs **Checked By:** **Date:** **Sheet:** of

PILE/SPRING STIFFNESS INPUT IN SAP **HP14x89 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required from the pile capacity curves = -80.0 NAVD88

Top of pile Elevation including 9" Pile embedment = (-6.96 + 0.75) ft = -6.21 NAVD88 (-6.96 is avg. value)

Therefore, required length of pile = 73.79 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

Modulus of Elasticity of the pile (E) = 29,000 ksi

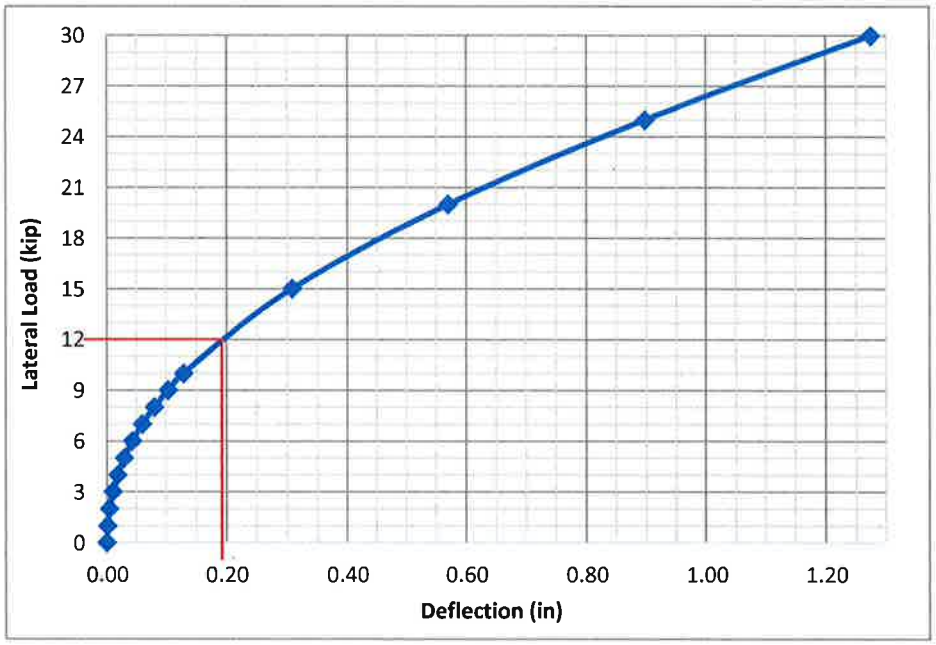
Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 1487.3 k/in

= **17848 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 12.0k reaction, deflection is about 0.19"

Spring = 12k/0.19" = 63.158 k/in = 757.89 k/ft

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-5 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

Checked By: **Date:** **Sheet:** of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a	-6.74	0.22	62.93
P-2	LC1a	-6.77	-0.10	88.05
P-3	LC1a	-6.75	0.00	81.60
P-4	LC1a	-6.77	0.10	88.05
P-5	LC1a	-6.74	-0.22	62.93
P-6	LC1a	-6.74	0.21	62.85
P-7	LC1a	-6.81	-0.11	90.92
P-8	LC1a	-6.79	0.00	83.89
P-9	LC1a	-6.81	0.11	90.92
P-10	LC1a	-6.74	-0.21	62.85
P-11	LC1a	-6.75	0.19	62.36
P-12	LC1a	-6.84	-0.12	90.91
P-13	LC1a	-6.82	-0.07	83.18
P-14	LC1a	-6.82	0.07	83.18
P-15	LC1a	-6.84	0.12	90.91
P-16	LC1a	-6.75	-0.19	62.36
P-17	LC1a	-6.75	0.18	62.21
P-18	LC1a	-6.84	-0.14	90.02
P-19	LC1a	-6.82	-0.08	80.06
P-20	LC1a	-6.82	0.08	80.06
P-21	LC1a	-6.84	0.14	90.01
P-22	LC1a	-6.75	-0.18	62.21
P-23	LC1a	-6.75	0.16	62.14
P-24	LC1a	-6.84	-0.16	90.31
P-25	LC1a	-6.83	-0.09	77.24
P-26	LC1a	-6.83	0.09	77.24
P-27	LC1a	-6.84	0.16	90.31
P-28	LC1a	-6.75	-0.16	62.14
P-1	LC1b	-6.58	-9.18	62.26
P-2	LC1b	-5.83	-9.51	88.26
P-3	LC1b	-5.01	-9.45	77.71
P-4	LC1b	-4.24	-9.35	78.46
P-5	LC1b	-3.49	-9.40	82.95
P-6	LC1b	-6.67	-9.75	62.04
P-7	LC1b	-5.91	-10.09	91.13
P-8	LC1b	-5.05	-10.03	79.85
P-9	LC1b	-4.22	-9.92	79.89
P-10	LC1b	-3.40	-9.96	82.02
P-11	LC1b	-6.77	-10.34	61.40
P-12	LC1b	-6.16	-10.66	91.38
P-13	LC1b	-5.44	-10.64	82.02
P-14	LC1b	-4.71	-10.54	76.10
P-15	LC1b	-4.01	-10.47	79.37
P-16	LC1b	-3.30	-10.52	81.03
P-17	LC1b	-6.86	-10.91	61.11
P-18	LC1b	-6.22	-11.25	90.56
P-19	LC1b	-5.45	-11.22	79.33
P-20	LC1b	-4.70	-11.11	73.33
P-21	LC1b	-3.96	-11.03	77.65
P-22	LC1b	-3.21	-11.08	80.10
P-23	LC1b	-6.96	-11.50	60.91
P-24	LC1b	-6.27	-11.83	90.93
P-25	LC1b	-5.48	-11.80	76.76
P-26	LC1b	-4.68	-11.67	70.14
P-27	LC1b	-3.91	-11.59	75.81
P-28	LC1b	-3.12	-11.65	79.17

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1c	0.09	-2.44	141.78
P-2	LC1c	0.11	-2.45	99.76
P-3	LC1c	0.09	-2.32	83.17
P-4	LC1c	-0.02	-2.18	95.77
P-5	LC1c	-0.22	-2.08	147.53
P-6	LC1c	0.10	-2.39	139.58
P-7	LC1c	0.09	-2.38	100.18
P-8	LC1c	0.06	-2.27	84.87
P-9	LC1c	-0.05	-2.15	95.97
P-10	LC1c	-0.23	-2.03	145.67
P-11	LC1c	0.11	-2.34	137.50
P-12	LC1c	0.09	-2.34	103.00
P-13	LC1c	0.07	-2.25	85.41
P-14	LC1c	0.02	-2.19	83.34
P-15	LC1c	-0.09	-2.08	98.76
P-16	LC1c	-0.23	-1.98	144.05
P-17	LC1c	0.12	-2.29	135.31
P-18	LC1c	0.11	-2.29	99.44
P-19	LC1c	0.08	-2.20	82.06
P-20	LC1c	0.02	-2.14	80.04
P-21	LC1c	-0.08	-2.03	95.19
P-22	LC1c	-0.24	-1.93	142.22
P-23	LC1c	0.13	-2.24	133.10
P-24	LC1c	0.11	-2.24	94.85
P-25	LC1c	0.07	-2.15	76.84
P-26	LC1c	0.01	-2.09	74.70
P-27	LC1c	-0.09	-1.98	90.17
P-28	LC1c	-0.24	-1.88	140.35
P-1	LC2	-2.32	-0.05	40.58
P-2	LC2	-2.28	-0.09	32.28
P-3	LC2	-2.26	0.00	26.26
P-4	LC2	-2.28	0.09	32.28
P-5	LC2	-2.32	0.05	40.58
P-6	LC2	-2.32	-0.06	40.34
P-7	LC2	-2.30	-0.09	32.84
P-8	LC2	-2.28	0.00	26.92
P-9	LC2	-2.30	0.09	32.84
P-10	LC2	-2.32	0.06	40.34
P-11	LC2	-2.33	-0.07	40.05
P-12	LC2	-2.32	-0.10	34.22
P-13	LC2	-2.30	-0.04	26.96
P-14	LC2	-2.30	0.04	26.96
P-15	LC2	-2.32	0.10	34.22
P-16	LC2	-2.33	0.07	40.05
P-17	LC2	-2.33	-0.07	39.80
P-18	LC2	-2.32	-0.11	33.32
P-19	LC2	-2.30	-0.04	25.71
P-20	LC2	-2.30	0.04	25.71
P-21	LC2	-2.32	0.11	33.32
P-22	LC2	-2.33	0.07	39.80
P-23	LC2	-2.33	-0.08	39.55
P-24	LC2	-2.32	-0.12	32.48
P-25	LC2	-2.31	-0.04	24.14
P-26	LC2	-2.31	0.04	24.14
P-27	LC2	-2.32	0.12	32.48
P-28	LC2	-2.33	0.08	39.55

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-5 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC3	-2.82	-0.02	42.67
P-2	LC3	-2.79	-0.10	35.44
P-3	LC3	-2.76	0.00	27.50
P-4	LC3	-2.79	0.10	35.44
P-5	LC3	-2.82	0.02	42.67
P-6	LC3	-2.82	-0.03	42.71
P-7	LC3	-2.81	-0.11	36.24
P-8	LC3	-2.78	0.00	28.17
P-9	LC3	-2.81	0.11	36.24
P-10	LC3	-2.82	0.03	42.71
P-11	LC3	-2.82	-0.04	42.67
P-12	LC3	-2.83	-0.12	38.29
P-13	LC3	-2.80	-0.05	28.37
P-14	LC3	-2.80	0.05	28.37
P-15	LC3	-2.83	0.12	38.29
P-16	LC3	-2.82	0.04	42.67
P-17	LC3	-2.82	-0.04	42.70
P-18	LC3	-2.83	-0.13	37.40
P-19	LC3	-2.80	-0.05	26.83
P-20	LC3	-2.80	0.05	26.83
P-21	LC3	-2.83	0.13	37.40
P-22	LC3	-2.82	0.04	42.70
P-23	LC3	-2.83	-0.05	42.74
P-24	LC3	-2.83	-0.14	36.77
P-25	LC3	-2.81	-0.06	25.03
P-26	LC3	-2.81	0.06	25.03
P-27	LC3	-2.83	0.14	36.77
P-28	LC3	-2.83	0.05	42.74

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	Dead	-0.03	-0.09	72.33
P-2	Dead	0.02	-0.07	48.88
P-3	Dead	0.04	0.00	41.58
P-4	Dead	0.02	0.07	48.88
P-5	Dead	-0.03	0.09	72.33
P-6	Dead	-0.03	-0.09	71.31
P-7	Dead	0.01	-0.06	49.04
P-8	Dead	0.03	0.00	42.43
P-9	Dead	0.01	0.06	49.04
P-10	Dead	-0.03	0.09	71.31
P-11	Dead	-0.03	-0.09	70.39
P-12	Dead	0.00	-0.07	50.44
P-13	Dead	0.02	-0.02	42.19
P-14	Dead	0.02	0.02	42.19
P-15	Dead	0.00	0.07	50.44
P-16	Dead	-0.03	0.09	70.39
P-17	Dead	-0.03	-0.09	69.38
P-18	Dead	0.01	-0.06	48.66
P-19	Dead	0.02	-0.01	40.52
P-20	Dead	0.02	0.01	40.52
P-21	Dead	0.01	0.06	48.66
P-22	Dead	-0.03	0.09	69.38
P-23	Dead	-0.03	-0.09	68.36
P-24	Dead	0.00	-0.07	46.25
P-25	Dead	0.02	-0.01	37.89
P-26	Dead	0.02	0.01	37.89
P-27	Dead	0.00	0.07	46.25
P-28	Dead	-0.03	0.09	68.36

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.1 kips
MINIMUM REACTION = -7.0 kips

Horizontal Reactions, Y-Direction:

MAXIMUM REACTION = 0.2 kips
MINIMUM REACTION = -11.8 kips

Vertical Reactions:

MAXIMUM REACTION = 147.5 kips
MINIMUM REACTION = 24.1 kips

$C_{allowable,\ EL\ -80.0}$ = **150 kips > Max Reaction = 147.5 kips** **OK**

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Desc.: Monolith U-5 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of
Checked By: **Date:** **Sheet:** of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1a	0.10675	-0.00350	-0.04231
P-2	LC1a	0.10722	0.00157	-0.05920
P-3	LC1a	0.10682	0.00000	-0.05486
P-4	LC1a	0.10722	-0.00157	-0.05920
P-5	LC1a	0.10675	0.00350	-0.04231
P-6	LC1a	0.10678	-0.00334	-0.04226
P-7	LC1a	0.10782	0.00180	-0.06113
P-8	LC1a	0.10750	0.00000	-0.05640
P-9	LC1a	0.10782	-0.00180	-0.06113
P-10	LC1a	0.10678	0.00334	-0.04226
P-11	LC1a	0.10682	-0.00303	-0.04193
P-12	LC1a	0.10823	0.00192	-0.06112
P-13	LC1a	0.10802	0.00114	-0.05592
P-14	LC1a	0.10802	-0.00114	-0.05592
P-15	LC1a	0.10823	-0.00192	-0.06112
P-16	LC1a	0.10682	0.00303	-0.04193
P-17	LC1a	0.10684	-0.00284	-0.04183
P-18	LC1a	0.10830	0.00223	-0.06052
P-19	LC1a	0.10806	0.00125	-0.05383
P-20	LC1a	0.10806	-0.00125	-0.05383
P-21	LC1a	0.10830	-0.00223	-0.06052
P-22	LC1a	0.10684	0.00284	-0.04183
P-23	LC1a	0.10689	-0.00256	-0.04178
P-24	LC1a	0.10827	0.00260	-0.06072
P-25	LC1a	0.10816	0.00142	-0.05193
P-26	LC1a	0.10816	-0.00142	-0.05193
P-27	LC1a	0.10827	-0.00260	-0.06072
P-28	LC1a	0.10689	0.00256	-0.04178
P-1	LC1b	0.10418	0.14528	-0.04186
P-2	LC1b	0.09233	0.15064	-0.05934
P-3	LC1b	0.07936	0.14970	-0.05225
P-4	LC1b	0.06709	0.14799	-0.05275
P-5	LC1b	0.05525	0.14877	-0.05577
P-6	LC1b	0.10565	0.15440	-0.04171
P-7	LC1b	0.09359	0.15983	-0.06127
P-8	LC1b	0.07992	0.15876	-0.05369
P-9	LC1b	0.06681	0.15700	-0.05372
P-10	LC1b	0.05378	0.15769	-0.05515
P-11	LC1b	0.10719	0.16367	-0.04128
P-12	LC1b	0.09751	0.16878	-0.06144
P-13	LC1b	0.08606	0.16853	-0.05515
P-14	LC1b	0.07462	0.16690	-0.05117
P-15	LC1b	0.06354	0.16572	-0.05337
P-16	LC1b	0.05227	0.16658	-0.05448
P-17	LC1b	0.10866	0.17281	-0.04109
P-18	LC1b	0.09844	0.17805	-0.06089
P-19	LC1b	0.08637	0.17762	-0.05333
P-20	LC1b	0.07435	0.17587	-0.04931
P-21	LC1b	0.06267	0.17460	-0.05221
P-22	LC1b	0.05080	0.17549	-0.05385
P-23	LC1b	0.11015	0.18205	-0.04095
P-24	LC1b	0.09925	0.18738	-0.06114
P-25	LC1b	0.08673	0.18680	-0.05161
P-26	LC1b	0.07417	0.18483	-0.04716
P-27	LC1b	0.06186	0.18344	-0.05097
P-28	LC1b	0.04934	0.18439	-0.05323

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1c	-0.00136	0.03863	-0.09533
P-2	LC1c	-0.00180	0.03876	-0.06707
P-3	LC1c	-0.00140	0.03679	-0.05592
P-4	LC1c	0.00032	0.03455	-0.06439
P-5	LC1c	0.00349	0.03298	-0.09919
P-6	LC1c	-0.00153	0.03785	-0.09385
P-7	LC1c	-0.00150	0.03771	-0.06736
P-8	LC1c	-0.00101	0.03599	-0.05706
P-9	LC1c	0.00074	0.03402	-0.06453
P-10	LC1c	0.00358	0.03214	-0.09794
P-11	LC1c	-0.00173	0.03702	-0.09245
P-12	LC1c	-0.00149	0.03707	-0.06926
P-13	LC1c	-0.00118	0.03570	-0.05743
P-14	LC1c	-0.00027	0.03462	-0.05603
P-15	LC1c	0.00137	0.03289	-0.06640
P-16	LC1c	0.00366	0.03139	-0.09686
P-17	LC1c	-0.00191	0.03624	-0.09098
P-18	LC1c	-0.00169	0.03622	-0.06686
P-19	LC1c	-0.00126	0.03482	-0.05517
P-20	LC1c	-0.00029	0.03388	-0.05381
P-21	LC1c	0.00133	0.03216	-0.06400
P-22	LC1c	0.00375	0.03057	-0.09562
P-23	LC1c	-0.00210	0.03542	-0.08949
P-24	LC1c	-0.00173	0.03547	-0.06377
P-25	LC1c	-0.00118	0.03399	-0.05167
P-26	LC1c	-0.00014	0.03313	-0.05022
P-27	LC1c	0.00150	0.03133	-0.06063
P-28	LC1c	0.00382	0.02980	-0.09436
P-1	LC2	0.03679	0.00080	-0.02729
P-2	LC2	0.03617	0.00135	-0.02170
P-3	LC2	0.03583	0.00000	-0.01766
P-4	LC2	0.03617	-0.00135	-0.02170
P-5	LC2	0.03679	-0.00080	-0.02729
P-6	LC2	0.03680	0.00092	-0.02712
P-7	LC2	0.03644	0.00142	-0.02208
P-8	LC2	0.03611	0.00000	-0.01810
P-9	LC2	0.03644	-0.00142	-0.02208
P-10	LC2	0.03680	-0.00092	-0.02712
P-11	LC2	0.03682	0.00106	-0.02693
P-12	LC2	0.03668	0.00166	-0.02301
P-13	LC2	0.03634	0.00062	-0.01813
P-14	LC2	0.03634	-0.00062	-0.01813
P-15	LC2	0.03668	-0.00166	-0.02301
P-16	LC2	0.03682	-0.00106	-0.02693
P-17	LC2	0.03683	0.00118	-0.02676
P-18	LC2	0.03672	0.00175	-0.02240
P-19	LC2	0.03640	0.00064	-0.01728
P-20	LC2	0.03640	-0.00064	-0.01728
P-21	LC2	0.03672	-0.00175	-0.02240
P-22	LC2	0.03683	-0.00118	-0.02676
P-23	LC2	0.03685	0.00131	-0.02659
P-24	LC2	0.03678	0.00188	-0.02184
P-25	LC2	0.03651	0.00068	-0.01623
P-26	LC2	0.03651	-0.00068	-0.01623
P-27	LC2	0.03678	-0.00188	-0.02184
P-28	LC2	0.03685	-0.00131	-0.02659

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	After Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC3	0.04466	0.00028	-0.02869
P-2	LC3	0.04414	0.00163	-0.02383
P-3	LC3	0.04373	0.00000	-0.01849
P-4	LC3	0.04414	-0.00163	-0.02383
P-5	LC3	0.04466	-0.00027	-0.02869
P-6	LC3	0.04468	0.00040	-0.02872
P-7	LC3	0.04445	0.00172	-0.02437
P-8	LC3	0.04405	0.00000	-0.01894
P-9	LC3	0.04445	-0.00172	-0.02437
P-10	LC3	0.04468	-0.00040	-0.02872
P-11	LC3	0.04471	0.00056	-0.02869
P-12	LC3	0.04474	0.00197	-0.02575
P-13	LC3	0.04432	0.00079	-0.01907
P-14	LC3	0.04432	-0.00079	-0.01907
P-15	LC3	0.04474	-0.00197	-0.02575
P-16	LC3	0.04471	-0.00056	-0.02869
P-17	LC3	0.04473	0.00069	-0.02871
P-18	LC3	0.04478	0.00210	-0.02515
P-19	LC3	0.04438	0.00082	-0.01804
P-20	LC3	0.04438	-0.00082	-0.01804
P-21	LC3	0.04478	-0.00210	-0.02515
P-22	LC3	0.04473	-0.00069	-0.02871
P-23	LC3	0.04475	0.00085	-0.02874
P-24	LC3	0.04483	0.00227	-0.02472
P-25	LC3	0.04450	0.00087	-0.01683
P-26	LC3	0.04450	-0.00087	-0.01683
P-27	LC3	0.04483	-0.00227	-0.02472
P-28	LC3	0.04475	-0.00085	-0.02874

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	Dead	0.00053	0.00141	-0.04863
P-2	Dead	-0.00037	0.00105	-0.03287
P-3	Dead	-0.00070	0.00000	-0.02796
P-4	Dead	-0.00037	-0.00105	-0.03287
P-5	Dead	0.00053	-0.00141	-0.04863
P-6	Dead	0.00051	0.00143	-0.04795
P-7	Dead	-0.00019	0.00092	-0.03297
P-8	Dead	-0.00050	0.00000	-0.02853
P-9	Dead	-0.00019	-0.00092	-0.03297
P-10	Dead	0.00051	-0.00143	-0.04795
P-11	Dead	0.00048	0.00141	-0.04733
P-12	Dead	-0.00003	0.00104	-0.03392
P-13	Dead	-0.00036	0.00027	-0.02836
P-14	Dead	-0.00036	-0.00027	-0.02836
P-15	Dead	-0.00003	-0.00104	-0.03392
P-16	Dead	0.00048	-0.00141	-0.04733
P-17	Dead	0.00046	0.00142	-0.04665
P-18	Dead	-0.00009	0.00102	-0.03272
P-19	Dead	-0.00039	0.00024	-0.02725
P-20	Dead	-0.00039	-0.00024	-0.02725
P-21	Dead	-0.00009	-0.00102	-0.03272
P-22	Dead	0.00046	-0.00142	-0.04665
P-23	Dead	0.00043	0.00141	-0.04596
P-24	Dead	-0.00006	0.00104	-0.03110
P-25	Dead	-0.00033	0.00021	-0.02547
P-26	Dead	-0.00033	-0.00021	-0.02547
P-27	Dead	-0.00006	-0.00104	-0.03110
P-28	Dead	0.00043	-0.00141	-0.04596

Horizontal Displacement, X-Direction:

MAXIMUM = 0.1101 inch
MINIMUM = -0.0021 inch

Horizontal Displacement, Y-Direction:

MAXIMUM = 0.1874 inch
MINIMUM = -0.0035 inch

Vertical Displacement:

MAXIMUM = -0.0162 inch
MINIMUM = -0.0992 inch

Maximum horizontal displacement is 0.1874". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.0992". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.19". The spring has converged.

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U5 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

Checked By: **Date:** **Sheet:** of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a-ST	-6.82	-0.04	124.87
P-2	LC1a-ST	-6.73	-0.24	96.99
P-3	LC1a-ST	-6.67	0.00	76.04
P-4	LC1a-ST	-6.73	0.24	96.99
P-5	LC1a-ST	-6.82	0.04	124.87
P-6	LC1a-ST	-6.82	-0.06	124.12
P-7	LC1a-ST	-6.78	-0.24	98.60
P-8	LC1a-ST	-6.72	0.00	77.80
P-9	LC1a-ST	-6.78	0.24	98.60
P-10	LC1a-ST	-6.82	0.06	124.12
P-11	LC1a-ST	-6.82	-0.07	123.25
P-12	LC1a-ST	-6.82	-0.27	103.66
P-13	LC1a-ST	-6.75	-0.11	78.15
P-14	LC1a-ST	-6.75	0.11	78.15
P-15	LC1a-ST	-6.82	0.27	103.66
P-16	LC1a-ST	-6.82	0.07	123.25
P-17	LC1a-ST	-6.83	-0.09	122.48
P-18	LC1a-ST	-6.82	-0.28	100.76
P-19	LC1a-ST	-6.76	-0.11	74.12
P-20	LC1a-ST	-6.76	0.11	74.12
P-21	LC1a-ST	-6.82	0.28	100.76
P-22	LC1a-ST	-6.83	0.09	122.48
P-23	LC1a-ST	-6.83	-0.10	121.74
P-24	LC1a-ST	-6.82	-0.30	98.14
P-25	LC1a-ST	-6.77	-0.11	69.09
P-26	LC1a-ST	-6.77	0.11	69.09
P-27	LC1a-ST	-6.82	0.30	98.14
P-28	LC1a-ST	-6.83	0.10	121.74
P-1	LC1b-ST	-6.66	-9.42	124.18
P-2	LC1b-ST	-5.80	-9.63	97.90
P-3	LC1b-ST	-4.95	-9.44	73.41
P-4	LC1b-ST	-4.21	-9.24	83.42
P-5	LC1b-ST	-3.54	-9.22	119.98
P-6	LC1b-ST	-6.75	-9.99	123.25
P-7	LC1b-ST	-5.89	-10.20	99.43
P-8	LC1b-ST	-4.99	-10.01	75.06
P-9	LC1b-ST	-4.19	-9.81	83.98
P-10	LC1b-ST	-3.45	-9.78	118.21
P-11	LC1b-ST	-6.84	-10.57	122.17
P-12	LC1b-ST	-6.15	-10.78	104.46
P-13	LC1b-ST	-5.38	-10.65	78.14
P-14	LC1b-ST	-4.66	-10.49	72.06
P-15	LC1b-ST	-4.00	-10.35	86.48
P-16	LC1b-ST	-3.35	-10.34	116.55
P-17	LC1b-ST	-6.94	-11.14	121.21
P-18	LC1b-ST	-6.20	-11.35	101.56
P-19	LC1b-ST	-5.40	-11.21	74.50
P-20	LC1b-ST	-4.64	-11.05	68.72
P-21	LC1b-ST	-3.94	-10.91	83.42
P-22	LC1b-ST	-3.26	-10.89	114.80
P-23	LC1b-ST	-7.03	-11.72	120.28
P-24	LC1b-ST	-6.25	-11.93	98.98
P-25	LC1b-ST	-5.43	-11.77	69.87
P-26	LC1b-ST	-4.64	-11.62	64.06
P-27	LC1b-ST	-3.89	-11.47	79.67
P-28	LC1b-ST	-3.16	-11.45	113.03

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC2-ST	-2.40	-0.32	102.52
P-2	LC2-ST	-2.25	-0.22	41.22
P-3	LC2-ST	-2.19	0.00	20.71
P-4	LC2-ST	-2.25	0.22	41.22
P-5	LC2-ST	-2.40	0.32	102.52
P-6	LC2-ST	-2.40	-0.33	101.60
P-7	LC2-ST	-2.27	-0.22	40.53
P-8	LC2-ST	-2.21	0.00	20.83
P-9	LC2-ST	-2.27	0.22	40.53
P-10	LC2-ST	-2.40	0.33	101.60
P-11	LC2-ST	-2.40	-0.33	100.94
P-12	LC2-ST	-2.30	-0.25	46.97
P-13	LC2-ST	-2.23	-0.07	21.94
P-14	LC2-ST	-2.23	0.07	21.94
P-15	LC2-ST	-2.30	0.25	46.97
P-16	LC2-ST	-2.40	0.33	100.94
P-17	LC2-ST	-2.40	-0.34	100.06
P-18	LC2-ST	-2.30	-0.25	44.06
P-19	LC2-ST	-2.23	-0.07	19.76
P-20	LC2-ST	-2.23	0.07	19.76
P-21	LC2-ST	-2.30	0.25	44.06
P-22	LC2-ST	-2.40	0.34	100.06
P-23	LC2-ST	-2.40	-0.35	99.15
P-24	LC2-ST	-2.31	-0.26	40.30
P-25	LC2-ST	-2.25	-0.06	16.00
P-26	LC2-ST	-2.25	0.06	16.00
P-27	LC2-ST	-2.31	0.26	40.30
P-28	LC2-ST	-2.40	0.35	99.15
P-1	LC3-ST	-2.90	-0.28	104.60
P-2	LC3-ST	-2.75	-0.24	44.38
P-3	LC3-ST	-2.69	0.00	21.95
P-4	LC3-ST	-2.75	0.24	44.38
P-5	LC3-ST	-2.90	0.28	104.60
P-6	LC3-ST	-2.90	-0.29	103.98
P-7	LC3-ST	-2.78	-0.24	43.93
P-8	LC3-ST	-2.71	0.00	22.08
P-9	LC3-ST	-2.78	0.24	43.93
P-10	LC3-ST	-2.90	0.29	103.98
P-11	LC3-ST	-2.90	-0.30	103.56
P-12	LC3-ST	-2.81	-0.27	51.04
P-13	LC3-ST	-2.73	-0.08	23.35
P-14	LC3-ST	-2.73	0.08	23.35
P-15	LC3-ST	-2.81	0.27	51.04
P-16	LC3-ST	-2.90	0.30	103.56
P-17	LC3-ST	-2.90	-0.31	102.96
P-18	LC3-ST	-2.81	-0.27	48.15
P-19	LC3-ST	-2.74	-0.08	20.88
P-20	LC3-ST	-2.74	0.08	20.88
P-21	LC3-ST	-2.81	0.27	48.15
P-22	LC3-ST	-2.90	0.31	102.96
P-23	LC3-ST	-2.90	-0.32	102.34
P-24	LC3-ST	-2.82	-0.28	44.60
P-25	LC3-ST	-2.75	-0.08	16.88
P-26	LC3-ST	-2.75	0.08	16.88
P-27	LC3-ST	-2.82	0.28	44.60
P-28	LC3-ST	-2.90	0.32	102.34

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-5 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

Checked By: **Date:** **Sheet:** of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1a-ST	0.10801	0.00069	-0.08395
P-2	LC1a-ST	0.10663	0.00376	-0.06521
P-3	LC1a-ST	0.10565	0.00000	-0.05113
P-4	LC1a-ST	0.10663	-0.00376	-0.06521
P-5	LC1a-ST	0.10801	-0.00069	-0.08395
P-6	LC1a-ST	0.10803	0.00090	-0.08345
P-7	LC1a-ST	0.10732	0.00381	-0.06630
P-8	LC1a-ST	0.10638	0.00000	-0.05231
P-9	LC1a-ST	0.10732	-0.00381	-0.06630
P-10	LC1a-ST	0.10803	-0.00090	-0.08345
P-11	LC1a-ST	0.10805	0.00115	-0.08287
P-12	LC1a-ST	0.10795	0.00428	-0.06970
P-13	LC1a-ST	0.10695	0.00166	-0.05255
P-14	LC1a-ST	0.10695	-0.00166	-0.05255
P-15	LC1a-ST	0.10795	-0.00428	-0.06970
P-16	LC1a-ST	0.10805	-0.00115	-0.08287
P-17	LC1a-ST	0.10806	0.00136	-0.08235
P-18	LC1a-ST	0.10796	0.00448	-0.06774
P-19	LC1a-ST	0.10701	0.00168	-0.04983
P-20	LC1a-ST	0.10701	-0.00168	-0.04983
P-21	LC1a-ST	0.10796	-0.00448	-0.06774
P-22	LC1a-ST	0.10806	-0.00136	-0.08235
P-23	LC1a-ST	0.10808	0.00161	-0.08185
P-24	LC1a-ST	0.10802	0.00477	-0.06598
P-25	LC1a-ST	0.10724	0.00176	-0.04645
P-26	LC1a-ST	0.10724	-0.00176	-0.04645
P-27	LC1a-ST	0.10802	-0.00477	-0.06598
P-28	LC1a-ST	0.10808	-0.00161	-0.08185
P-1	LC1b-ST	0.10541	0.14916	-0.08349
P-2	LC1b-ST	0.09185	0.15248	-0.06583
P-3	LC1b-ST	0.07843	0.14947	-0.04935
P-4	LC1b-ST	0.06665	0.14633	-0.05609
P-5	LC1b-ST	0.05605	0.14603	-0.08067
P-6	LC1b-ST	0.10686	0.15824	-0.08287
P-7	LC1b-ST	0.09319	0.16143	-0.06685
P-8	LC1b-ST	0.07902	0.15842	-0.05047
P-9	LC1b-ST	0.06642	0.15538	-0.05647
P-10	LC1b-ST	0.05458	0.15484	-0.07948
P-11	LC1b-ST	0.10836	0.16737	-0.08214
P-12	LC1b-ST	0.09730	0.17064	-0.07023
P-13	LC1b-ST	0.08517	0.16855	-0.05254
P-14	LC1b-ST	0.07379	0.16609	-0.04845
P-15	LC1b-ST	0.06332	0.16385	-0.05815
P-16	LC1b-ST	0.05306	0.16368	-0.07837
P-17	LC1b-ST	0.10981	0.17645	-0.08150
P-18	LC1b-ST	0.09815	0.17973	-0.06829
P-19	LC1b-ST	0.08549	0.17745	-0.05009
P-20	LC1b-ST	0.07355	0.17502	-0.04621
P-21	LC1b-ST	0.06241	0.17275	-0.05609
P-22	LC1b-ST	0.05158	0.17249	-0.07719
P-23	LC1b-ST	0.11126	0.18557	-0.08087
P-24	LC1b-ST	0.09904	0.18890	-0.06655
P-25	LC1b-ST	0.08595	0.18643	-0.04698
P-26	LC1b-ST	0.07345	0.18393	-0.04307
P-27	LC1b-ST	0.06166	0.18156	-0.05357
P-28	LC1b-ST	0.05011	0.18133	-0.07600

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC2-ST	0.03805	0.00499	-0.06893
P-2	LC2-ST	0.03558	0.00353	-0.02772
P-3	LC2-ST	0.03467	0.00000	-0.01392
P-4	LC2-ST	0.03558	-0.00353	-0.02772
P-5	LC2-ST	0.03805	-0.00499	-0.06893
P-6	LC2-ST	0.03805	0.00516	-0.06832
P-7	LC2-ST	0.03593	0.00344	-0.02725
P-8	LC2-ST	0.03499	0.00000	-0.01400
P-9	LC2-ST	0.03593	-0.00344	-0.02725
P-10	LC2-ST	0.03805	-0.00516	-0.06832
P-11	LC2-ST	0.03805	0.00524	-0.06787
P-12	LC2-ST	0.03640	0.00402	-0.03158
P-13	LC2-ST	0.03527	0.00114	-0.01475
P-14	LC2-ST	0.03527	-0.00114	-0.01475
P-15	LC2-ST	0.03640	-0.00402	-0.03158
P-16	LC2-ST	0.03805	-0.00524	-0.06787
P-17	LC2-ST	0.03805	0.00539	-0.06728
P-18	LC2-ST	0.03638	0.00400	-0.02962
P-19	LC2-ST	0.03535	0.00107	-0.01329
P-20	LC2-ST	0.03535	-0.00107	-0.01329
P-21	LC2-ST	0.03638	-0.00400	-0.02962
P-22	LC2-ST	0.03805	-0.00539	-0.06728
P-23	LC2-ST	0.03804	0.00548	-0.06666
P-24	LC2-ST	0.03653	0.00406	-0.02710
P-25	LC2-ST	0.03558	0.00102	-0.01076
P-26	LC2-ST	0.03558	-0.00102	-0.01076
P-27	LC2-ST	0.03653	-0.00406	-0.02710
P-28	LC2-ST	0.03804	-0.00548	-0.06666
P-1	LC3-ST	0.04592	0.00446	-0.07033
P-2	LC3-ST	0.04354	0.00381	-0.02984
P-3	LC3-ST	0.04256	0.00000	-0.01476
P-4	LC3-ST	0.04354	-0.00381	-0.02984
P-5	LC3-ST	0.04592	-0.00446	-0.07033
P-6	LC3-ST	0.04593	0.00464	-0.06991
P-7	LC3-ST	0.04394	0.00374	-0.02954
P-8	LC3-ST	0.04294	0.00000	-0.01485
P-9	LC3-ST	0.04394	-0.00374	-0.02954
P-10	LC3-ST	0.04593	-0.00464	-0.06991
P-11	LC3-ST	0.04594	0.00474	-0.06963
P-12	LC3-ST	0.04446	0.00434	-0.03432
P-13	LC3-ST	0.04325	0.00131	-0.01570
P-14	LC3-ST	0.04325	-0.00131	-0.01570
P-15	LC3-ST	0.04446	-0.00434	-0.03432
P-16	LC3-ST	0.04594	-0.00474	-0.06963
P-17	LC3-ST	0.04595	0.00490	-0.06923
P-18	LC3-ST	0.04444	0.00435	-0.03237
P-19	LC3-ST	0.04334	0.00125	-0.01404
P-20	LC3-ST	0.04334	-0.00125	-0.01404
P-21	LC3-ST	0.04444	-0.00435	-0.03237
P-22	LC3-ST	0.04595	-0.00490	-0.06923
P-23	LC3-ST	0.04595	0.00502	-0.06881
P-24	LC3-ST	0.04458	0.00444	-0.02999
P-25	LC3-ST	0.04357	0.00122	-0.01135
P-26	LC3-ST	0.04357	-0.00122	-0.01135
P-27	LC3-ST	0.04458	-0.00444	-0.02999
P-28	LC3-ST	0.04595	-0.00502	-0.06881

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U5 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

Horizontal Reactions, X-Direction:

MAXIMUM REACTION =	-2.19	kips
MINIMUM REACTION =	-7.03	kips

Vertical Reactions:

MAXIMUM REACTION =	124.87	kips
MINIMUM REACTION =	16.00	kips

Horizontal Reactions, Y-Direction:

MAXIMUM REACTION =	0.35	kips
MINIMUM REACTION =	-11.93	kips

$C_{allowable,\ EL\ -80.0}$ = 150 kips > Max Reaction = 124.9 kips OK

Horizontal Displacement, X-Direction:

MAXIMUM =	0.1113	inch
MINIMUM =	0.0347	inch

Vertical Displacement:

MAXIMUM =	-0.0108	inch
MINIMUM =	-0.0840	inch

Horizontal Displacement, Y-Direction:

MAXIMUM =	0.1889	inch
MINIMUM =	-0.0055	inch

Maximum horizontal displacement is 0.1889". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.084". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____
Description: U-5 SOIL & PILE INFO | Computed by: LBR | Sheet ____ of ____
STRUCTURAL CHECK | Checked by ____ | Date: 8/2013 | Date ____
Reference

- E_s: USING P-y CURVE DATA:

↳ CALIBRATED SPRING IN SAP = $63.158^{k}/_{IN}$

↳ FROM CPGA MANUAL: $K = \frac{C_0 E I}{R^3}$

$C_0 = 0.707$ - PINNED FIXETY, CONSTANT E_s
$E = 29{,}000{,}000$ PSI
$I = 904_{IN}^4$
$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 63{,}157.89^{lb}/_{IN} = \frac{(0.707)(29{,}000{,}000^{PSI})(904_{IN}^4)}{\left(\sqrt[4]{\frac{29{,}000{,}000 \times 904}{E_s}}\right)^3}$$

SOLVING FOR E_s IN EXCEL $\Rightarrow$ $E_s = 1344.3^{PSI} = \underline{1.344^{KSI}}$

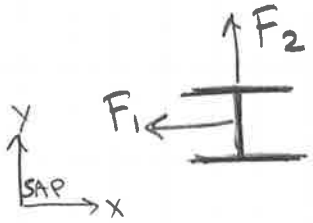
- CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONST E_s & UNSOPPORTED PILE (CONSERVATIVE)

$PCR = n\sqrt{E_s E I}$, $n = 1$ - PINNED

$PCR_{,STRONG\ AXIS} = \sqrt{(1.344^{KSI})(29{,}000^{KSI})(904_{IN}^4)} = \underline{5935.8^{k}}$

$PCR_{,WEAK\ AXIS} = \sqrt{(1.344^{KSI})(29{,}000^{KSI})(326_{IN}^4)} = \underline{3564.6^{k}}$

ORIENTATION OF PILES:



F_1 (F_x) FORCES ARE COORDINATED w/ WEAK AXIS (& M1 MOMENTS)

F_2 (F_y) FORCES COORDINATED w/ STRONG AXIS. (& M2 MOMENTS)

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: PILE PROPERTIES FOR STRUCTURAL CHECK | Computed by: LBK | Sheet ___ of ___
Checked by: ___ | Date: 8/2013 | Date: ___

Reference

*ACC: CPGA MANUAL PG 42-43

- IF - $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

- THEN - $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

↳ $\sqrt{\frac{2\pi^2 \cdot 29{,}000\,KSI}{50\,KSI}} = 106.99$ > ↳ $\sqrt{\frac{\pi^2 \cdot 29{,}000 \cdot 26.1\,IN^2}{2979.3^k}} = 50.07$ ← SMALLER PCR = LARGER RESULT

→ $\therefore ACC_S = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 4961}\right] = \underline{\underline{609.6^k}}$ STRONG AXIS

→ $\therefore ACC_W = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 2979}\right] = \underline{\underline{581.0^k}}$ WEAK AXIS

$ATT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,IN^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$ BOTH AXIS

*CBF - COMBINED BENDING: CPGA PG 32

$COMP = \left[\frac{F3}{ACC} + MF1\left(\frac{M1}{AM1}\right) + MF2\left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$

$TENSION = \left[\frac{-F3}{ATT} + \text{"} + \text{"}\right]\left(\frac{1}{OSF}\right) \leq 1.0$

↳ AM2: $S_x F_y = 131\,IN^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{3638.9^{k \cdot IN}}$ STRONG

USAGE FACTOR; AISC FACTOR

↳ AM1 $S_y F_y = 44.3\,IN^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{1230.56^{k \cdot IN}}$ WEAK

x & y from AISC table - opposite of SAP orientation

*AXIAL LOAD FACTOR: $ALF = \frac{F3}{AC} \times \frac{1}{OSF}$ (COMP) -OR- $\frac{-F3}{AT} \times \frac{1}{OSF}$ (TENS.)

Maurepas Diversion
Monolith U-5: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1a	-6.7	0.2	62.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.56	-16.56	0.27	0.36
P-2	1a	-6.8	-0.1	88.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.00	-20.39	0.30	0.50
P-3	1a	-6.7	0.0	81.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.76	-23.48	0.29	0.47
P-4	1a	-6.8	0.1	88.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.00	-20.39	0.30	0.50
P-5	1a	-6.7	-0.2	62.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.56	-16.56	0.27	0.36
P-6	1a	-6.7	0.2	62.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.64	-16.88	0.27	0.36
P-7	1a	-6.8	-0.1	90.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	248.86	-19.95	0.31	0.52
P-8	1a	-6.8	0.0	83.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.85	-23.48	0.30	0.48
P-9	1a	-6.8	0.1	90.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	248.86	-19.95	0.31	0.52
P-10	1a	-6.7	-0.2	62.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.64	-16.88	0.27	0.36
P-11	1a	-6.7	0.2	62.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.76	-17.49	0.27	0.36
P-12	1a	-6.8	-0.1	90.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.12	-19.71	0.31	0.52
P-13	1a	-6.8	-0.1	83.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.47	-21.24	0.30	0.48
P-14	1a	-6.8	0.1	83.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.47	-21.24	0.30	0.48
P-15	1a	-6.8	0.1	90.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.12	-19.71	0.31	0.52
P-16	1a	-6.7	-0.2	62.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.76	-17.49	0.27	0.36
P-17	1a	-6.7	0.2	62.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.84	-17.87	0.27	0.36
P-18	1a	-6.8	-0.1	90.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.33	-19.08	0.31	0.51
P-19	1a	-6.8	-0.1	80.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.61	-21.03	0.29	0.46
P-20	1a	-6.8	0.1	80.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.61	-21.03	0.29	0.46
P-21	1a	-6.8	0.1	90.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.33	-19.08	0.31	0.51
P-22	1a	-6.7	-0.2	62.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.84	-17.87	0.27	0.36
P-23	1a	-6.8	0.2	62.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.97	-18.42	0.27	0.36
P-24	1a	-6.8	-0.2	90.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.25	-18.36	0.31	0.52
P-25	1a	-6.8	-0.1	77.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.92	-20.69	0.29	0.44
P-26	1a	-6.8	0.1	77.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.92	-20.69	0.29	0.44
P-27	1a	-6.8	0.2	90.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.25	-18.36	0.31	0.52
P-28	1a	-6.8	-0.2	62.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.97	-18.42	0.27	0.36
P-1	1b	-6.6	-9.2	62.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	237.67	372.07	0.34	0.36
P-2	1b	-5.8	-9.5	88.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	202.22	390.90	0.36	0.50
P-3	1b	-5.0	-9.5	77.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	165.10	387.58	0.32	0.44
P-4	1b	-4.2	-9.3	78.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	131.62	381.55	0.29	0.45
P-5	1b	-3.5	-9.4	82.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	100.80	384.31	0.28	0.47
P-6	1b	-6.7	-9.8	62.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	242.17	404.29	0.35	0.35
P-7	1b	-5.9	-10.1	91.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	205.93	423.91	0.38	0.52
P-8	1b	-5.0	-10.0	79.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	166.66	420.00	0.33	0.46
P-9	1b	-4.2	-9.9	79.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	130.87	413.65	0.30	0.46
P-10	1b	-3.4	-10.0	82.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	97.10	416.13	0.28	0.47
P-11	1b	-6.8	-10.3	61.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	246.90	437.94	0.36	0.35
P-12	1b	-6.2	-10.7	91.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	217.55	456.88	0.39	0.52
P-13	1b	-5.4	-10.6	82.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	184.05	455.96	0.35	0.47
P-14	1b	-4.7	-10.5	76.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	151.98	449.89	0.32	0.43
P-15	1b	-4.0	-10.5	79.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	122.24	445.50	0.30	0.45
P-16	1b	-3.3	-10.5	81.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	93.28	448.70	0.29	0.46
P-17	1b	-6.9	-10.9	61.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	251.47	472.02	0.37	0.35
P-18	1b	-6.2	-11.2	90.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	220.30	491.96	0.40	0.52
P-19	1b	-5.5	-11.2	79.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	184.94	490.29	0.36	0.45
P-20	1b	-4.7	-11.1	73.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	151.24	483.60	0.33	0.42
P-21	1b	-4.0	-11.0	77.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	119.94	478.81	0.31	0.44
P-22	1b	-3.2	-11.1	80.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	89.60	482.18	0.29	0.46
P-23	1b	-7.0	-11.5	60.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	256.09	507.34	0.39	0.35
P-24	1b	-6.3	-11.8	90.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	222.73	528.15	0.41	0.52

Maurepas Diversion
Monolith U-5: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-25	1b	-5.5	-11.8	76.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	185.97	525.85	0.36	0.44
P-26	1b	-4.7	-11.7	70.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	150.74	518.15	0.33	0.40
P-27	1b	-3.9	-11.6	75.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	117.83	512.73	0.31	0.43
P-28	1b	-3.1	-11.6	79.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	85.97	516.44	0.30	0.45
P-1	1c	0.1	-2.4	141.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.82	60.04	0.23	0.81
P-2	1c	0.1	-2.4	99.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-19.94	60.35	0.17	0.57
P-3	1c	0.1	-2.3	83.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.74	55.71	0.15	0.48
P-4	1c	0.0	-2.2	95.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-22.85	50.50	0.17	0.55
P-5	1c	-0.2	-2.1	147.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-16.59	46.85	0.24	0.84
P-6	1c	0.1	-2.4	139.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.46	58.20	0.23	0.80
P-7	1c	0.1	-2.4	100.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.53	57.87	0.17	0.57
P-8	1c	0.1	-2.3	84.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-21.51	53.83	0.15	0.48
P-9	1c	0.0	-2.1	96.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-22.03	49.26	0.17	0.55
P-10	1c	-0.2	-2.0	145.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-16.41	44.92	0.23	0.83
P-11	1c	0.1	-2.3	137.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.08	56.26	0.23	0.79
P-12	1c	0.1	-2.3	103.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.56	56.38	0.18	0.59
P-13	1c	0.1	-2.3	85.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-21.16	53.16	0.15	0.49
P-14	1c	0.0	-2.2	83.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-22.96	50.65	0.15	0.48
P-15	1c	-0.1	-2.1	98.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.79	46.66	0.17	0.56
P-16	1c	-0.2	-2.0	144.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-16.24	43.20	0.23	0.82
P-17	1c	0.1	-2.3	135.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-19.72	54.42	0.22	0.77
P-18	1c	0.1	-2.3	99.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.15	54.38	0.17	0.57
P-19	1c	0.1	-2.2	82.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-21.00	51.12	0.15	0.47
P-20	1c	0.0	-2.1	80.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-22.91	48.94	0.14	0.46
P-21	1c	-0.1	-2.0	95.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.88	44.97	0.16	0.54
P-22	1c	-0.2	-1.9	142.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-16.07	41.32	0.23	0.81
P-23	1c	0.1	-2.2	133.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-19.35	52.51	0.22	0.76
P-24	1c	0.1	-2.2	94.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.08	52.62	0.16	0.54
P-25	1c	0.1	-2.1	76.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-21.17	49.19	0.14	0.44
P-26	1c	0.0	-2.1	74.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-23.22	47.20	0.14	0.43
P-27	1c	-0.1	-2.0	90.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-20.53	43.05	0.15	0.52
P-28	1c	-0.2	-1.9	140.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	-15.92	39.57	0.22	0.80
P-1	2	-2.3	-0.1	40.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.71	-21.91	0.12	0.27
P-2	2	-2.3	-0.1	32.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.27	-20.82	0.10	0.22
P-3	2	-2.3	0.0	26.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	53.48	-23.48	0.09	0.18
P-4	2	-2.3	0.1	32.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.27	-20.82	0.10	0.22
P-5	2	-2.3	0.1	40.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.71	-21.91	0.12	0.27
P-6	2	-2.3	-0.1	40.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.74	-21.67	0.12	0.27
P-7	2	-2.3	-0.1	32.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.88	-20.70	0.11	0.22
P-8	2	-2.3	0.0	26.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.12	-23.48	0.10	0.18
P-9	2	-2.3	0.1	32.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.88	-20.70	0.11	0.22
P-10	2	-2.3	0.1	40.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.74	-21.67	0.12	0.27
P-11	2	-2.3	-0.1	40.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.78	-21.40	0.12	0.27
P-12	2	-2.3	-0.1	34.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.46	-20.22	0.11	0.23
P-13	2	-2.3	0.0	27.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.66	-22.26	0.10	0.18
P-14	2	-2.3	0.0	27.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.66	-22.26	0.10	0.18
P-15	2	-2.3	0.1	34.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.46	-20.22	0.11	0.23
P-16	2	-2.3	0.1	40.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.78	-21.40	0.12	0.27
P-17	2	-2.3	-0.1	39.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.81	-21.16	0.12	0.27
P-18	2	-2.3	-0.1	33.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.55	-20.03	0.11	0.22
P-19	2	-2.3	0.0	25.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.80	-22.23	0.09	0.17

Maurepas Diversion
Monolith U-5: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-20	2	-2.3	0.0	25.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.80	-22.23	0.09	0.17
P-21	2	-2.3	0.1	33.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.55	-20.03	0.11	0.22
P-22	2	-2.3	0.1	39.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.81	-21.16	0.12	0.27
P-23	2	-2.3	-0.1	39.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.85	-20.90	0.12	0.26
P-24	2	-2.3	-0.1	32.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.70	-19.77	0.11	0.22
P-25	2	-2.3	0.0	24.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.06	-22.15	0.09	0.16
P-26	2	-2.3	0.0	24.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.06	-22.15	0.09	0.16
P-27	2	-2.3	0.1	32.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.70	-19.77	0.11	0.22
P-28	2	-2.3	0.1	39.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.84	-20.90	0.12	0.26
P-1	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.50	-22.94	0.14	0.28
P-2	3	-2.8	-0.1	35.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.23	-20.28	0.12	0.24
P-3	3	-2.8	0.0	27.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	72.25	-23.48	0.11	0.18
P-4	3	-2.8	0.1	35.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.23	-20.28	0.12	0.24
P-5	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.50	-22.94	0.14	0.28
P-6	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.55	-22.69	0.14	0.28
P-7	3	-2.8	-0.1	36.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.98	-20.09	0.13	0.24
P-8	3	-2.8	0.0	28.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.03	-23.48	0.11	0.19
P-9	3	-2.8	0.1	36.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.98	-20.09	0.13	0.24
P-10	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.55	-22.69	0.14	0.28
P-11	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.62	-22.38	0.14	0.28
P-12	3	-2.8	-0.1	38.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.69	-19.59	0.13	0.26
P-13	3	-2.8	0.0	28.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.68	-21.93	0.11	0.19
P-14	3	-2.8	0.0	28.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.68	-21.93	0.11	0.19
P-15	3	-2.8	0.1	38.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.69	-19.59	0.13	0.26
P-16	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.62	-22.38	0.14	0.28
P-17	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.67	-22.12	0.14	0.28
P-18	3	-2.8	-0.1	37.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.79	-19.34	0.13	0.25
P-19	3	-2.8	-0.1	26.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.83	-21.88	0.11	0.18
P-20	3	-2.8	0.1	26.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.83	-21.88	0.11	0.18
P-21	3	-2.8	0.1	37.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.79	-19.34	0.13	0.25
P-22	3	-2.8	0.0	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.67	-22.12	0.14	0.28
P-23	3	-2.8	-0.1	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.73	-21.82	0.14	0.28
P-24	3	-2.8	-0.1	36.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.91	-19.00	0.13	0.25
P-25	3	-2.8	-0.1	25.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.11	-21.77	0.11	0.17
P-26	3	-2.8	0.1	25.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.11	-21.77	0.11	0.17
P-27	3	-2.8	0.1	36.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.91	-19.00	0.13	0.25
P-28	3	-2.8	0.1	42.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.73	-21.82	0.14	0.28
P-1	1a-ST	-6.8	0.0	124.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.45	-22.14	0.36	0.71
P-2	1a-ST	-6.7	-0.2	97.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.17	-16.05	0.31	0.55
P-3	1a-ST	-6.7	0.0	76.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	242.17	-23.48	0.28	0.43
P-4	1a-ST	-6.7	0.2	97.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.17	-16.05	0.31	0.55
P-5	1a-ST	-6.8	0.0	124.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.45	-22.14	0.36	0.71
P-6	1a-ST	-6.8	-0.1	124.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.50	-21.72	0.36	0.71
P-7	1a-ST	-6.8	-0.2	98.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.31	-15.93	0.32	0.56
P-8	1a-ST	-6.7	0.0	77.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	244.40	-23.48	0.29	0.44
P-9	1a-ST	-6.8	0.2	98.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.31	-15.93	0.32	0.56
P-10	1a-ST	-6.8	0.1	124.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.50	-21.72	0.36	0.71
P-11	1a-ST	-6.8	-0.1	123.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.56	-21.23	0.36	0.70
P-12	1a-ST	-6.8	-0.3	103.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.26	-15.01	0.33	0.59
P-13	1a-ST	-6.8	-0.1	78.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	246.16	-20.21	0.29	0.45
P-14	1a-ST	-6.8	0.1	78.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	246.16	-20.21	0.29	0.45

Maurepas Diversion
Monolith U-5: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-15	1a-ST	-6.8	0.3	103.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.26	-15.01	0.33	0.59
P-16	1a-ST	-6.8	0.1	123.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.56	-21.23	0.36	0.70
P-17	1a-ST	-6.8	-0.1	122.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.61	-20.80	0.36	0.70
P-18	1a-ST	-6.8	-0.3	100.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.28	-14.61	0.32	0.58
P-19	1a-ST	-6.8	-0.1	74.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	246.37	-20.17	0.28	0.42
P-20	1a-ST	-6.8	0.1	74.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	246.37	-20.17	0.28	0.42
P-21	1a-ST	-6.8	0.3	100.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.28	-14.61	0.32	0.58
P-22	1a-ST	-6.8	0.1	122.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.61	-20.80	0.36	0.70
P-23	1a-ST	-6.8	-0.1	121.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.67	-20.32	0.35	0.70
P-24	1a-ST	-6.8	-0.3	98.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.48	-14.02	0.32	0.56
P-25	1a-ST	-6.8	-0.1	69.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.05	-20.01	0.28	0.39
P-26	1a-ST	-6.8	0.1	69.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	247.05	-20.01	0.28	0.39
P-27	1a-ST	-6.8	0.3	98.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.48	-14.02	0.32	0.56
P-28	1a-ST	-6.8	0.1	121.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	249.67	-20.32	0.35	0.70
P-1	1b-ST	-6.7	-9.4	124.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	241.45	385.67	0.44	0.71
P-2	1b-ST	-5.8	-9.6	97.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	200.81	397.43	0.38	0.56
P-3	1b-ST	-5.0	-9.4	73.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	162.51	386.77	0.31	0.42
P-4	1b-ST	-4.2	-9.2	83.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	130.44	375.75	0.30	0.48
P-5	1b-ST	-3.5	-9.2	120.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	102.84	374.69	0.33	0.69
P-6	1b-ST	-6.7	-10.0	123.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	245.89	418.13	0.45	0.70
P-7	1b-ST	-5.9	-10.2	99.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	204.75	429.72	0.39	0.57
P-8	1b-ST	-5.0	-10.0	75.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	164.16	418.79	0.32	0.43
P-9	1b-ST	-4.2	-9.8	84.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	129.83	407.81	0.31	0.48
P-10	1b-ST	-3.4	-9.8	118.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	99.12	405.86	0.34	0.68
P-11	1b-ST	-6.8	-10.6	122.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	250.53	451.63	0.46	0.70
P-12	1b-ST	-6.1	-10.8	104.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	216.90	463.87	0.41	0.60
P-13	1b-ST	-5.4	-10.6	78.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	181.51	456.03	0.35	0.45
P-14	1b-ST	-4.7	-10.5	72.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	149.71	446.88	0.31	0.41
P-15	1b-ST	-4.0	-10.3	86.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	121.64	438.61	0.31	0.49
P-16	1b-ST	-3.4	-10.3	116.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	95.27	437.98	0.34	0.67
P-17	1b-ST	-6.9	-11.1	121.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	255.04	485.85	0.47	0.69
P-18	1b-ST	-6.2	-11.4	101.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	219.44	498.38	0.42	0.58
P-19	1b-ST	-5.4	-11.2	74.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	182.43	489.64	0.35	0.43
P-20	1b-ST	-4.6	-11.1	68.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	149.04	480.37	0.32	0.39
P-21	1b-ST	-3.9	-10.9	83.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	119.27	471.78	0.31	0.48
P-22	1b-ST	-3.3	-10.9	114.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	91.57	470.82	0.34	0.66
P-23	1b-ST	-7.0	-11.7	120.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	259.56	521.06	0.48	0.69
P-24	1b-ST	-6.3	-11.9	99.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	222.10	534.12	0.42	0.57
P-25	1b-ST	-5.4	-11.8	69.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	183.75	524.42	0.35	0.40
P-26	1b-ST	-4.6	-11.6	64.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	148.78	514.66	0.32	0.37
P-27	1b-ST	-3.9	-11.5	79.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	117.31	505.45	0.32	0.46
P-28	1b-ST	-3.2	-11.5	113.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1.17	87.89	504.55	0.34	0.65
P-1	2-ST	-2.4	-0.3	102.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.67	-13.58	0.22	0.68
P-2	2-ST	-2.2	-0.2	41.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.89	-16.49	0.12	0.27
P-3	2-ST	-2.2	0.0	20.7	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	50.76	-23.48	0.08	0.14
P-4	2-ST	-2.2	0.2	41.2	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.89	-16.49	0.12	0.27
P-5	2-ST	-2.4	0.3	102.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.67	-13.58	0.22	0.68
P-6	2-ST	-2.4	-0.3	101.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.68	-13.24	0.22	0.68
P-7	2-ST	-2.3	-0.2	40.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	53.71	-16.69	0.12	0.27
P-8	2-ST	-2.2	0.0	20.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	51.51	-23.48	0.08	0.14
P-9	2-ST	-2.3	0.2	40.5	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	53.71	-16.69	0.12	0.27

Maurepas Diversion
Monolith U-5: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-10	2-ST	-2.4	0.3	101.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.68	-13.24	0.22	0.68
P-11	2-ST	-2.4	-0.3	100.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.67	-13.08	0.22	0.67
P-12	2-ST	-2.3	-0.3	47.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.81	-15.52	0.13	0.31
P-13	2-ST	-2.2	-0.1	21.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.15	-21.23	0.09	0.15
P-14	2-ST	-2.2	0.1	21.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.15	-21.23	0.09	0.15
P-15	2-ST	-2.3	0.3	47.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.81	-15.52	0.13	0.31
P-16	2-ST	-2.4	0.3	100.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.67	-13.08	0.22	0.67
P-17	2-ST	-2.4	-0.3	100.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.68	-12.78	0.22	0.67
P-18	2-ST	-2.3	-0.3	44.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.76	-15.56	0.12	0.29
P-19	2-ST	-2.2	-0.1	19.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.35	-21.37	0.08	0.13
P-20	2-ST	-2.2	0.1	19.8	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.35	-21.37	0.08	0.13
P-21	2-ST	-2.3	0.3	44.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	54.76	-15.56	0.12	0.29
P-22	2-ST	-2.4	0.3	100.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.68	-12.78	0.22	0.67
P-23	2-ST	-2.4	-0.3	99.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.66	-12.58	0.22	0.66
P-24	2-ST	-2.3	-0.3	40.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.12	-15.45	0.12	0.27
P-25	2-ST	-2.2	-0.1	16.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.89	-21.47	0.08	0.11
P-26	2-ST	-2.2	0.1	16.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	52.89	-21.47	0.08	0.11
P-27	2-ST	-2.3	0.3	40.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	55.11	-15.45	0.12	0.27
P-28	2-ST	-2.4	0.3	99.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	58.66	-12.58	0.22	0.66
P-1	3-ST	-2.9	-0.3	104.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.57	-14.63	0.24	0.70
P-2	3-ST	-2.8	-0.2	44.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.80	-15.94	0.14	0.30
P-3	3-ST	-2.7	0.0	21.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	69.43	-23.48	0.10	0.15
P-4	3-ST	-2.8	0.2	44.4	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.80	-15.94	0.14	0.30
P-5	3-ST	-2.9	0.3	104.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.57	-14.63	0.24	0.70
P-6	3-ST	-2.9	-0.3	104.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.60	-14.28	0.24	0.69
P-7	3-ST	-2.8	-0.2	43.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	72.77	-16.08	0.14	0.29
P-8	3-ST	-2.7	0.0	22.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	70.33	-23.48	0.10	0.15
P-9	3-ST	-2.8	0.2	43.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	72.77	-16.08	0.14	0.29
P-10	3-ST	-2.9	0.3	104.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.60	-14.28	0.24	0.69
P-11	3-ST	-2.9	-0.3	103.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.61	-14.08	0.24	0.69
P-12	3-ST	-2.8	-0.3	51.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.01	-14.89	0.15	0.34
P-13	3-ST	-2.7	-0.1	23.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.09	-20.90	0.10	0.16
P-14	3-ST	-2.7	0.1	23.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.09	-20.90	0.10	0.16
P-15	3-ST	-2.8	0.3	51.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.01	-14.89	0.15	0.34
P-16	3-ST	-2.9	0.3	103.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.61	-14.08	0.24	0.69
P-17	3-ST	-2.9	-0.3	103.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.64	-13.76	0.24	0.69
P-18	3-ST	-2.8	-0.3	48.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.97	-14.86	0.15	0.32
P-19	3-ST	-2.7	-0.1	20.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.30	-21.02	0.10	0.14
P-20	3-ST	-2.7	0.1	20.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.30	-21.03	0.10	0.14
P-21	3-ST	-2.8	0.3	48.1	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	73.97	-14.86	0.15	0.32
P-22	3-ST	-2.9	0.3	103.0	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.64	-13.76	0.24	0.69
P-23	3-ST	-2.9	-0.3	102.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.64	-13.52	0.24	0.68
P-24	3-ST	-2.8	-0.3	44.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.31	-14.67	0.14	0.30
P-25	3-ST	-2.8	-0.1	16.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.86	-21.09	0.09	0.11
P-26	3-ST	-2.8	0.1	16.9	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	71.86	-21.09	0.09	0.11
P-27	3-ST	-2.8	0.3	44.6	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	74.31	-14.67	0.14	0.30
P-28	3-ST	-2.9	0.3	102.3	50	26.1	904	326	131	44.3	29000	1.344	1	1	150.0	-93.3	3565	5936	107	46	2	593	617	653	1231	3639	1	77.64	-13.52	0.24	0.68

NO ALF OR CBF FAILURES

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

TRADITIONAL CASES

Bottom Slab Thickness =	2.5	ft	
Wall Thickness =	2.5	ft	
Design Width =	12	in	
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

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
Dead	0.00	0.0	0.0	0.0	0.0
1a	10.73	72.0	1.1	14.3	1.1
1b	10.73	72.0	1.1	14.3	1.1
1c	1.10	9.8	9.8	2.0	2.0
2	3.50	22.6	0.4	4.5	0.3
3	5.98	38.9	0.7	7.8	0.5

* Shear values taken at a distance 'd'= 25.37in from the face of the slab.
^ Moment values taken at faces of connections (where slab meets wall).

Max. Shear =	**10.7 kip**	
Max. Moment, Primary =	**72.0 kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**9.8 kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**14.3 kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**2.0 kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 3.848 in^2

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

(3 * √(f'_c) * b * d) / f_y = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 10.7kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Exterior Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

ϕMn = 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)

= 1330 kip-in/ft

= 110.83 kip-ft/ft

72 x 1.33 = 95.8 k-ft

ϕMn = 110.8kip-ft > Mu = 72kip-ft → Use #9 @ 12"

FLEXURAL MIN. NEGLECTED B/C OF ACI 318 ALLOWANCE - CAPACITIES > THAN 33% INCREASES IN MOMENTS (ACI 318 10.5.3)

Primary Interior Face:

* Will try **#7 @ 12"** to start: As, #7 @ 12" = 0.6 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.6 * 60ksi / (0.85 * 4ksi * 12in) = 0.882 in

ϕMn = 0.9 * $0.6in^2$ * 60ksi * (25.365in - 0.882in / 2)

= 807.53 kip-in/ft

= 67.29 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 9.8kip-ft → Use #7 @ 12"

Secondary Interior & Exterior Faces: * $M_{max, secondary}$ = 14.3 k-ft

* Will try **#7 @ 12"** to start: As, #7 @ 12" = 0.60 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.6 * 60ksi / (0.85 * 4ksi * 12in) = 0.882 in

ϕMn = 0.9 * $0.6in^2$ * 60ksi * (25.365in - 0.882in / 2)

= 807.53 kip-in/ft

= 67.29 kip-ft/ft

14.3 x 1.33 = 19 k-ft

ϕMn = 67.3kip-ft > Mu = 14.3kip-ft → Use #7 @ 12"

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
Dead	6.6	5.5	4.7	42.9	5.1	34.7
1a	14.3	9.4	73.5	54.2	16.5	49.1
1b	14.5	9.2	76.8	50.2	17.2	49.0
1c	11.9	10.1	16.6	74.9	9.4	59.8
2	6.0	4.0	22.4	25.3	4.9	22.5
3	7.2	4.7	38.5	26.9	8.4	24.7

* Shear taken at a distance 'd' = 25.37 inch from piles.

CONTROL OVER SETTLEMENT CASES

Max. Shear = 14.5 kip
Max. Moment, Primary = 76.8 kip-ft (SAP M11, controls *bottom transverse* reinforcement)
Min. Moment, Primary = 74.9 kip-ft (SAP M11, controls *top transverse* reinforcement)
Max. Moment, Secondary = 17.2 kip-ft (SAP M22, controls *bottom longitudinal* reinforcement
Min. Moment, Secondary = 59.8 kip-ft (SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.848 in^2

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

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 14.5kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try #9 @ 12" to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * 1in² * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

76.8 x 1.33 = 102.4 k·ft

ϕMn = 110.8kip-ft > Mu = 76.8kip-ft → Use #9 @ 12"

Primary Top Face:

* Will try #9 @ 12" to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * 1in² * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

74.9 x 1.33 = 99.9 k·ft

ϕMn = 110.8kip-ft > Mu = 74.9kip-ft → Use #9 @ 12"

Secondary Both Faces: * $M_{max, secondary}$ = 59.8 k-ft

* Will try #8 @ 12" to start: As, #8 @ 12" = 0.79 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

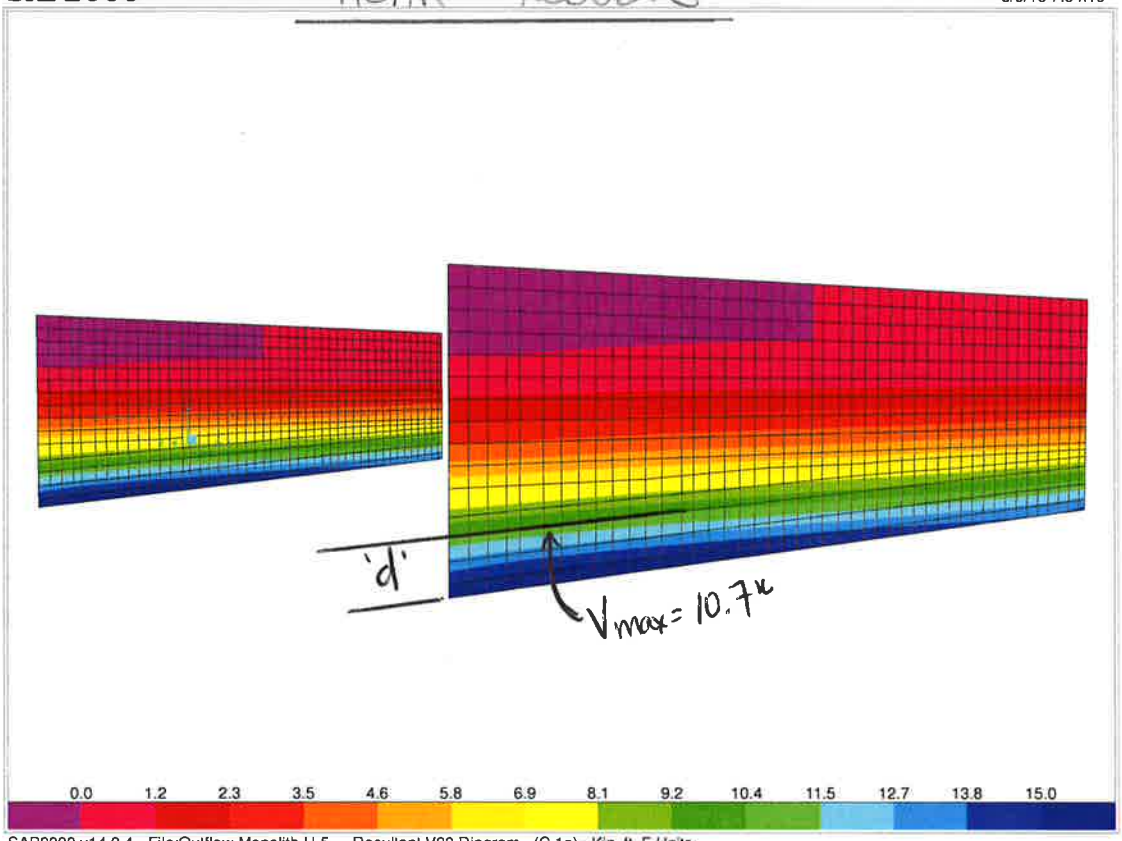
$\phi Mn =$ 0.9 * 0.79in² * 60ksi * (25.365in - 1.162in / 2)
= 1057.3 kip-in/ft
= 88.11 kip-ft/ft

59.8 x 1.33 = 79.7 k·ft

ϕMn = 88.1kip-ft > Mu = 59.8kip-ft → Use #8 @ 12"

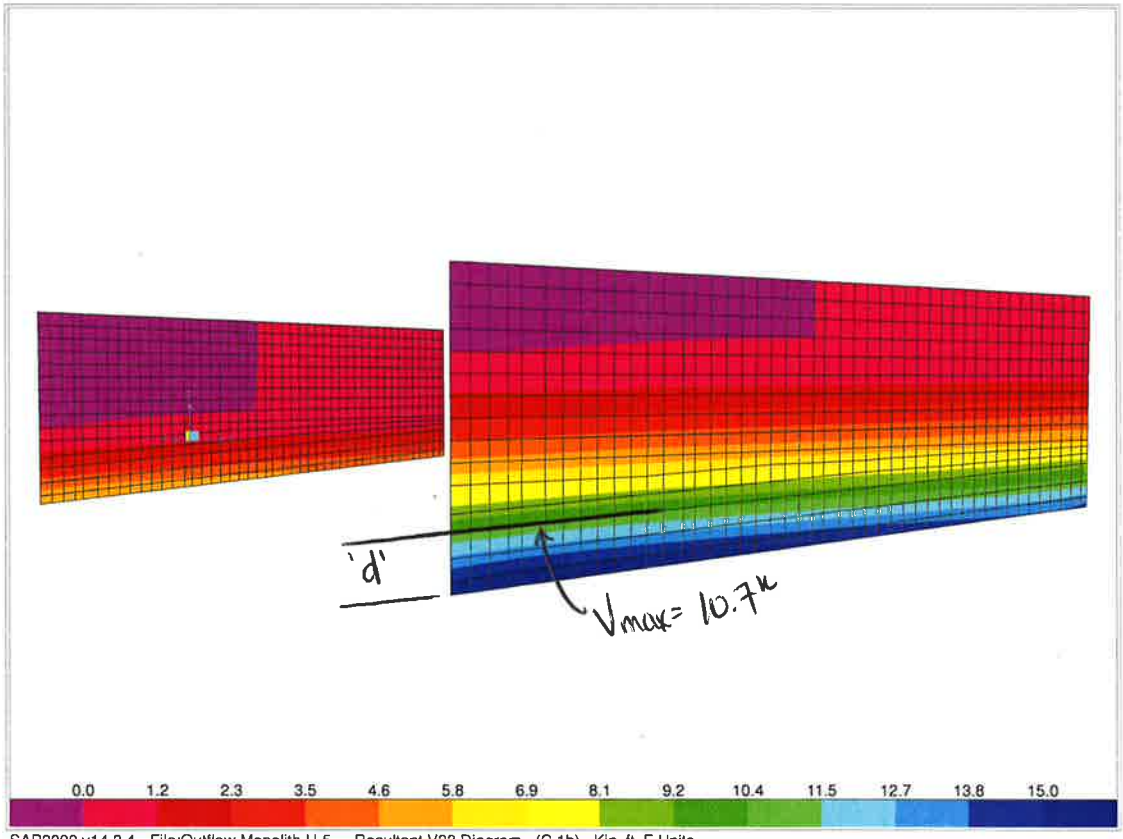
FLEXURAL MINIMUMS NEGLECTED B/C OF ACI 33% ALLOWANCE - CAPACITIES > 1.33xMu

SAP2000 SHEAR RESULTS 8/9/13 7:34:10



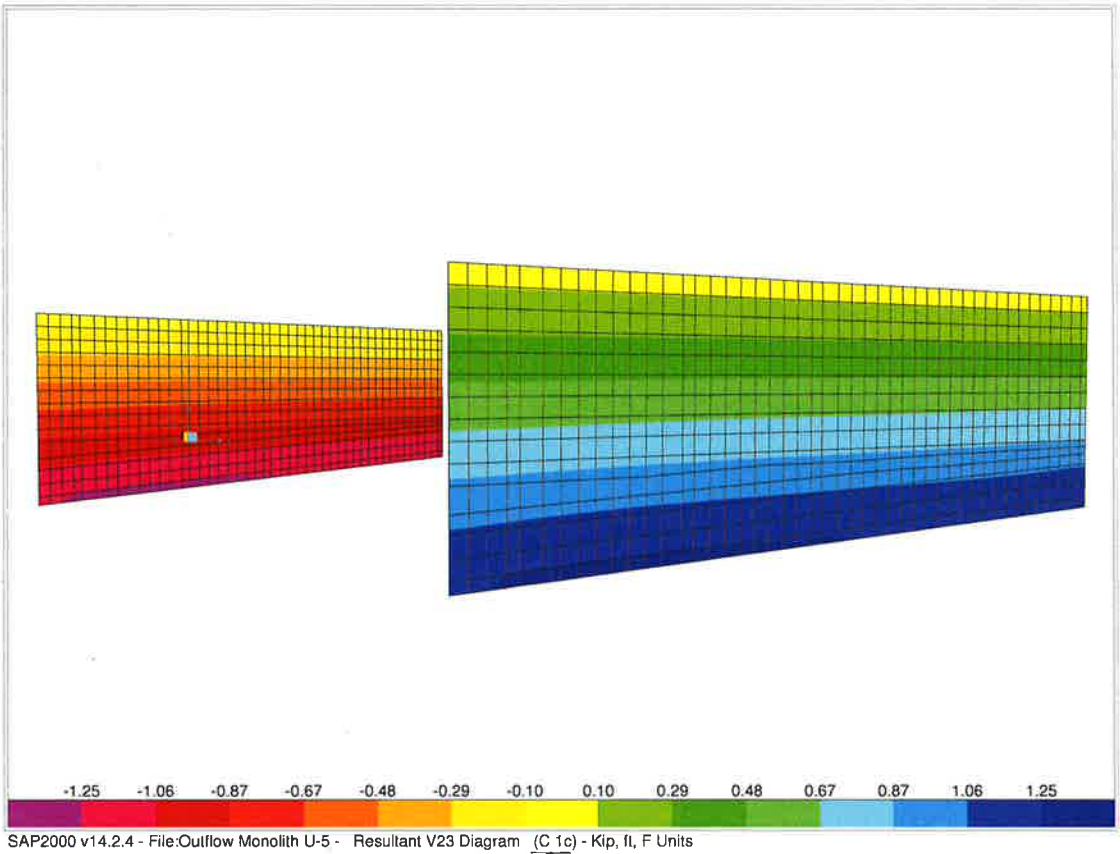
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/9/13 7:34:48



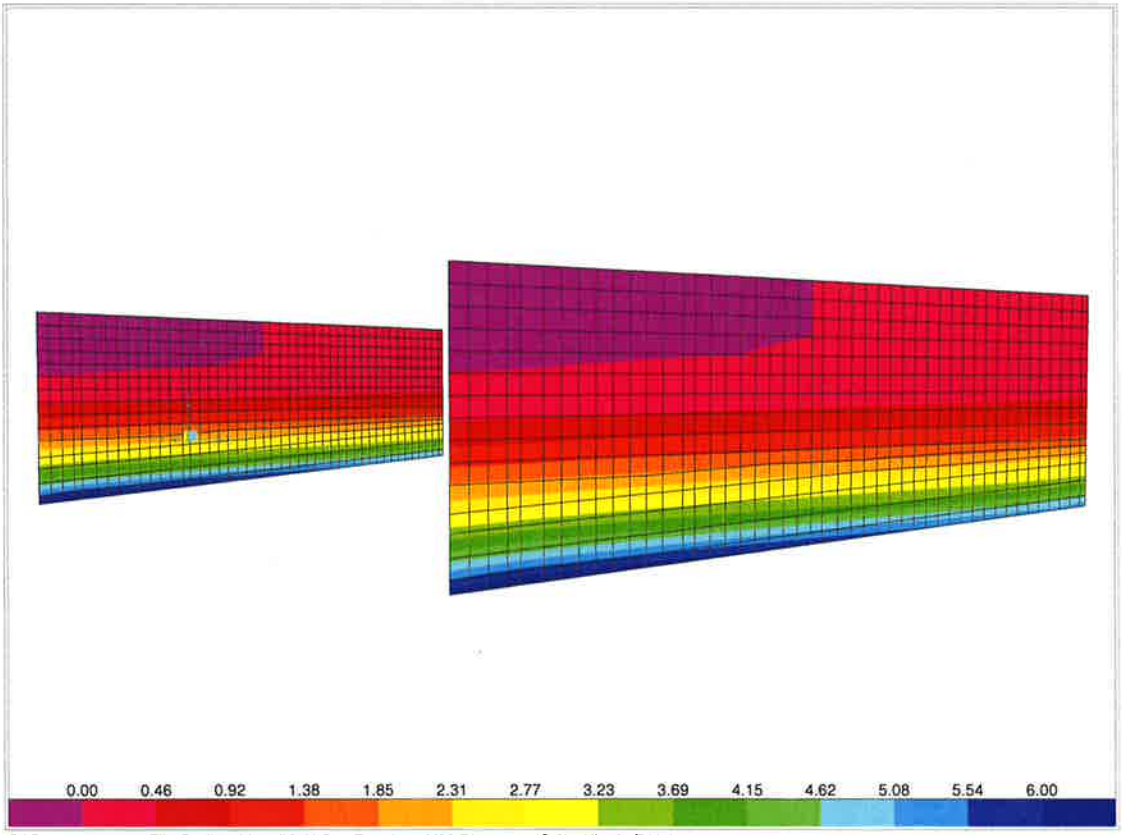
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/9/13 7:35:59

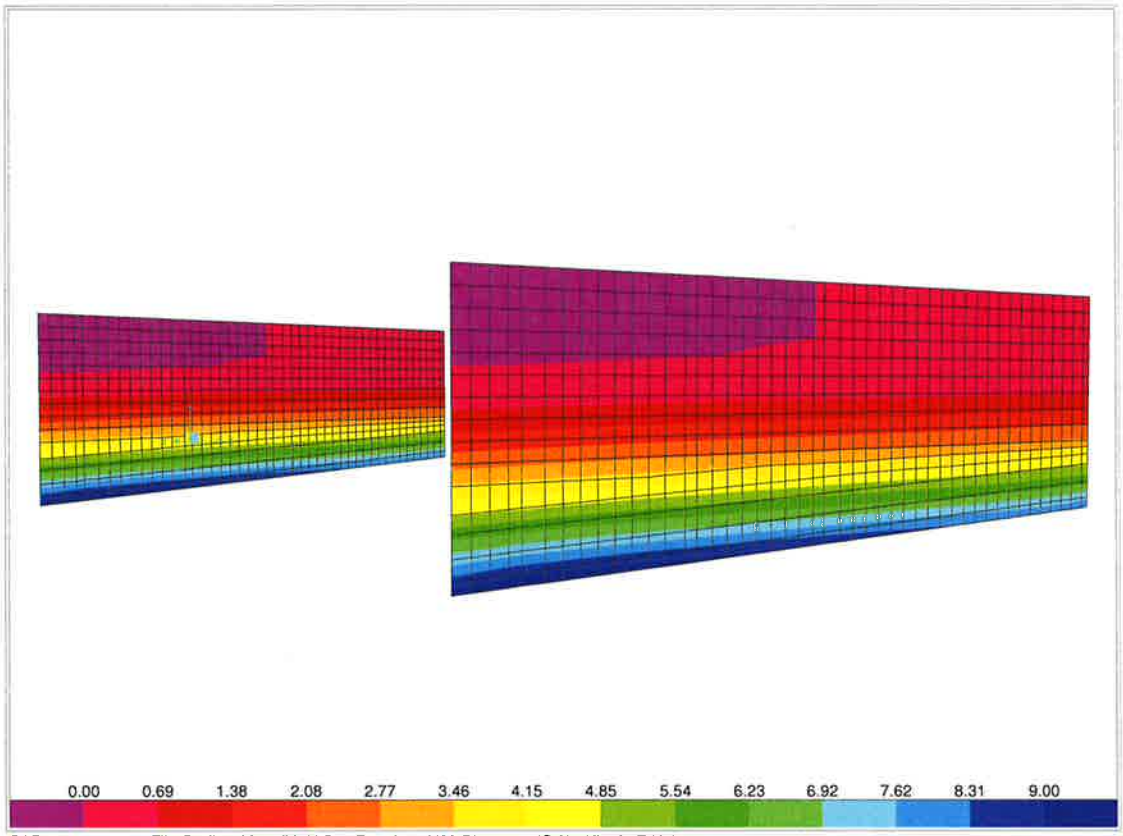


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/9/13 7:39:32

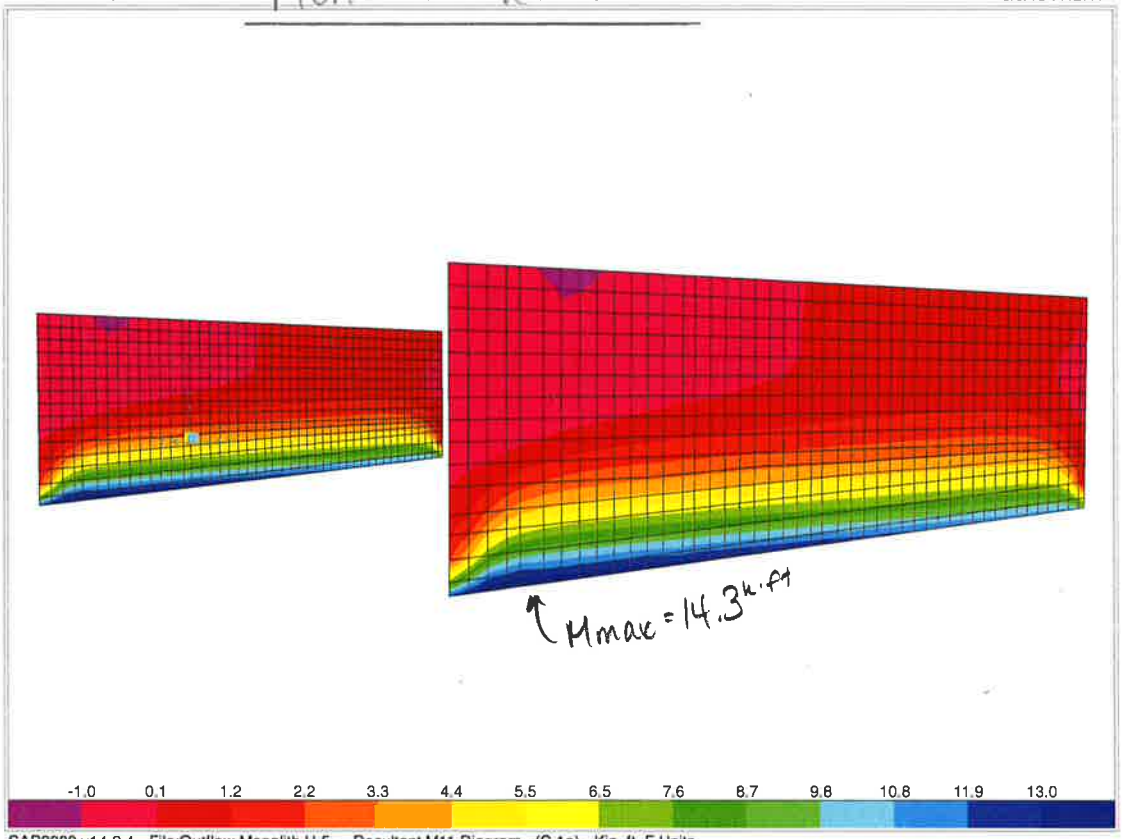


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 2) - Kip, ft, F Units



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

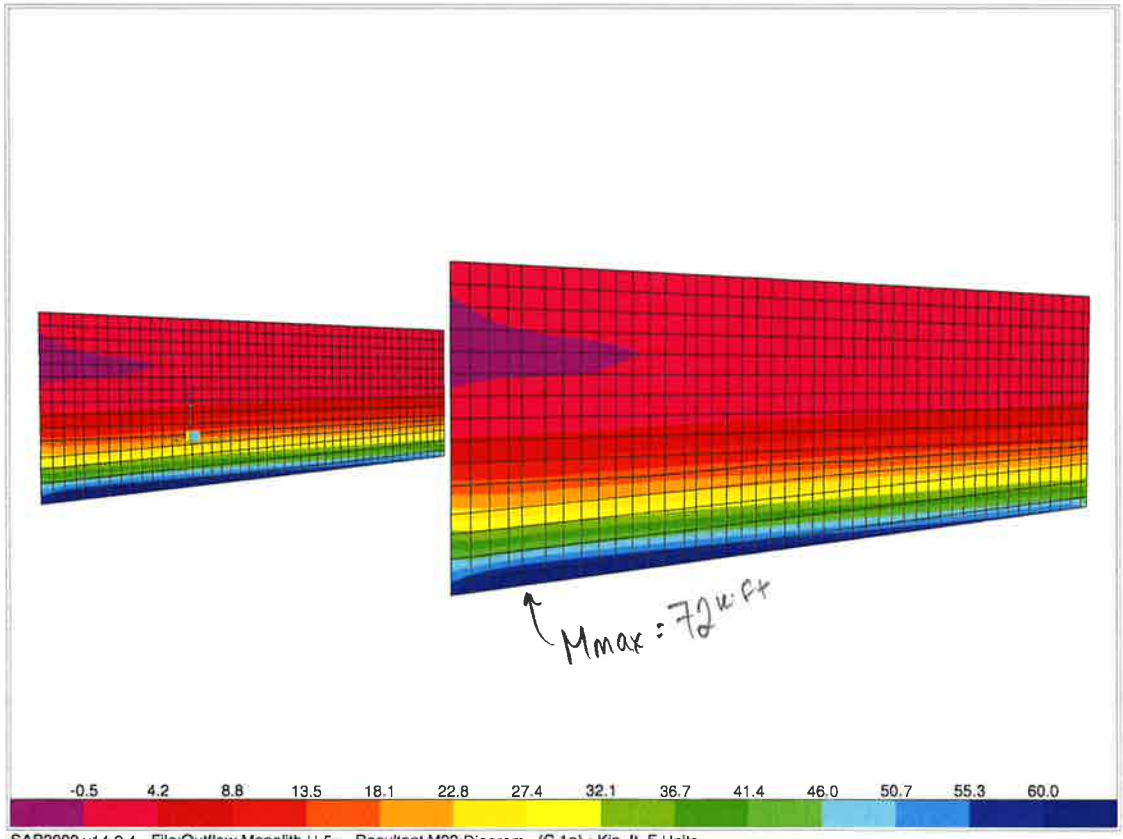
SAP2000 MOMENT RESULTS 8/9/13 7:42:41



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

Secondary (Horizontal)

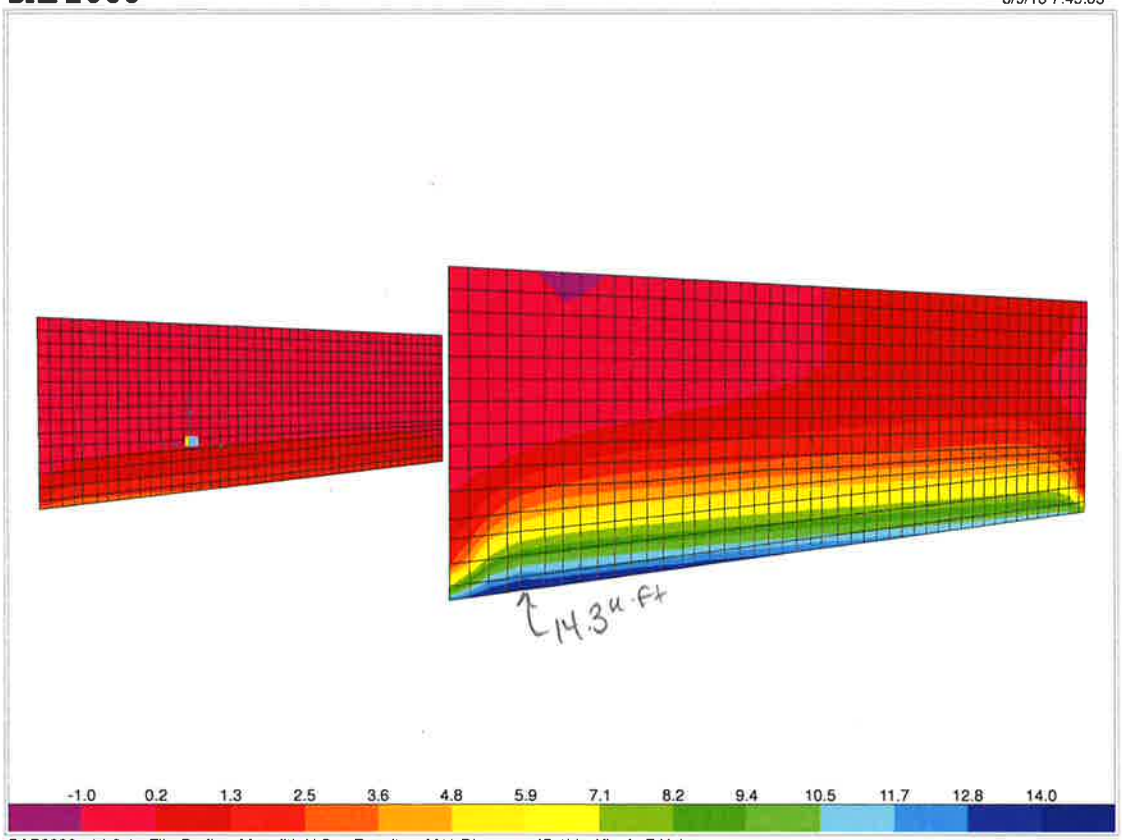
SAP2000 8/9/13 7:51:07



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

Primary (Vertical)

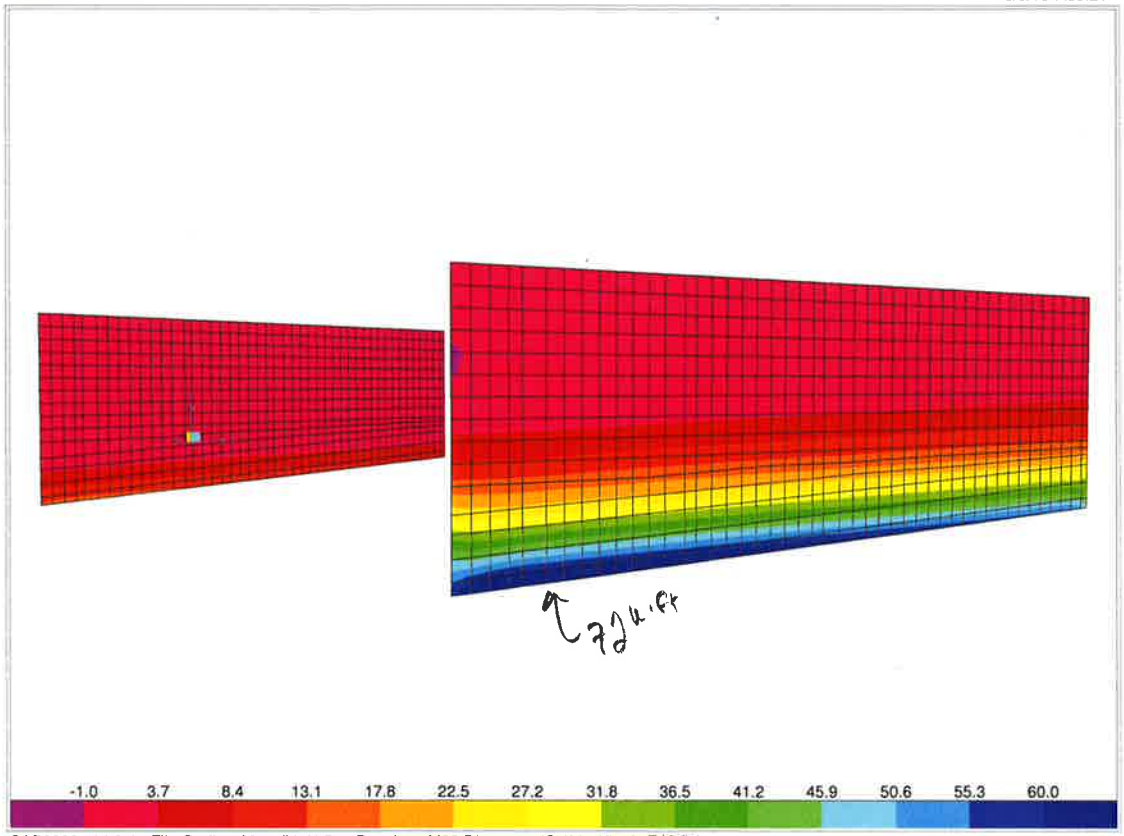
SAP2000 8/9/13 7:45:05



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

Horizontal

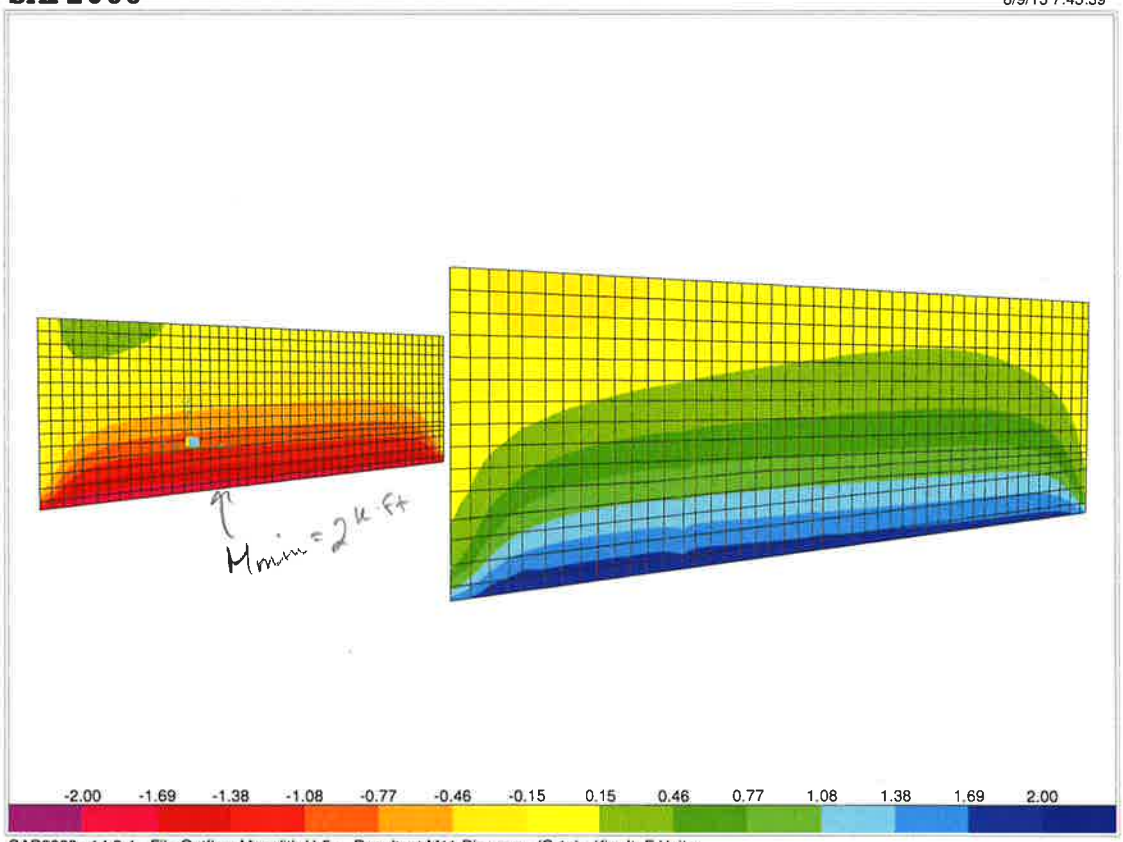
SAP2000 8/9/13 7:53:21



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

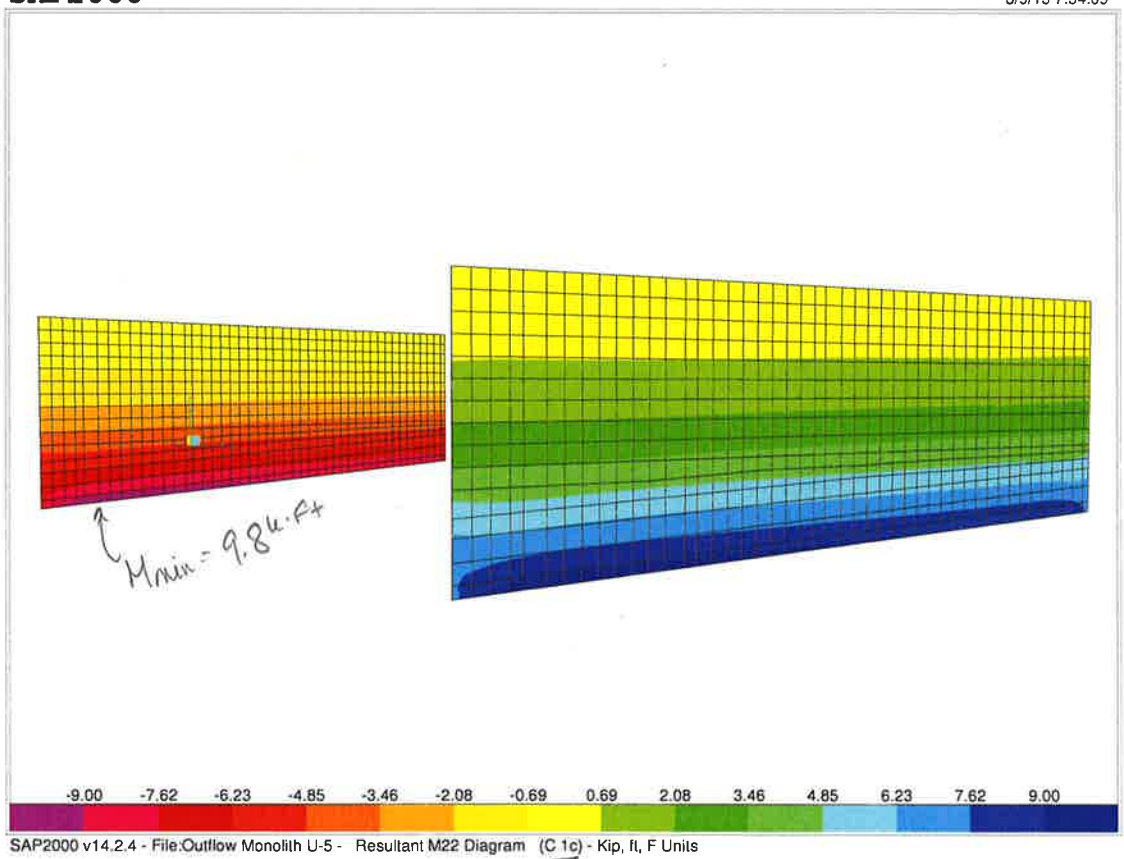
Vertical

SAP2000 8/9/13 7:45:39



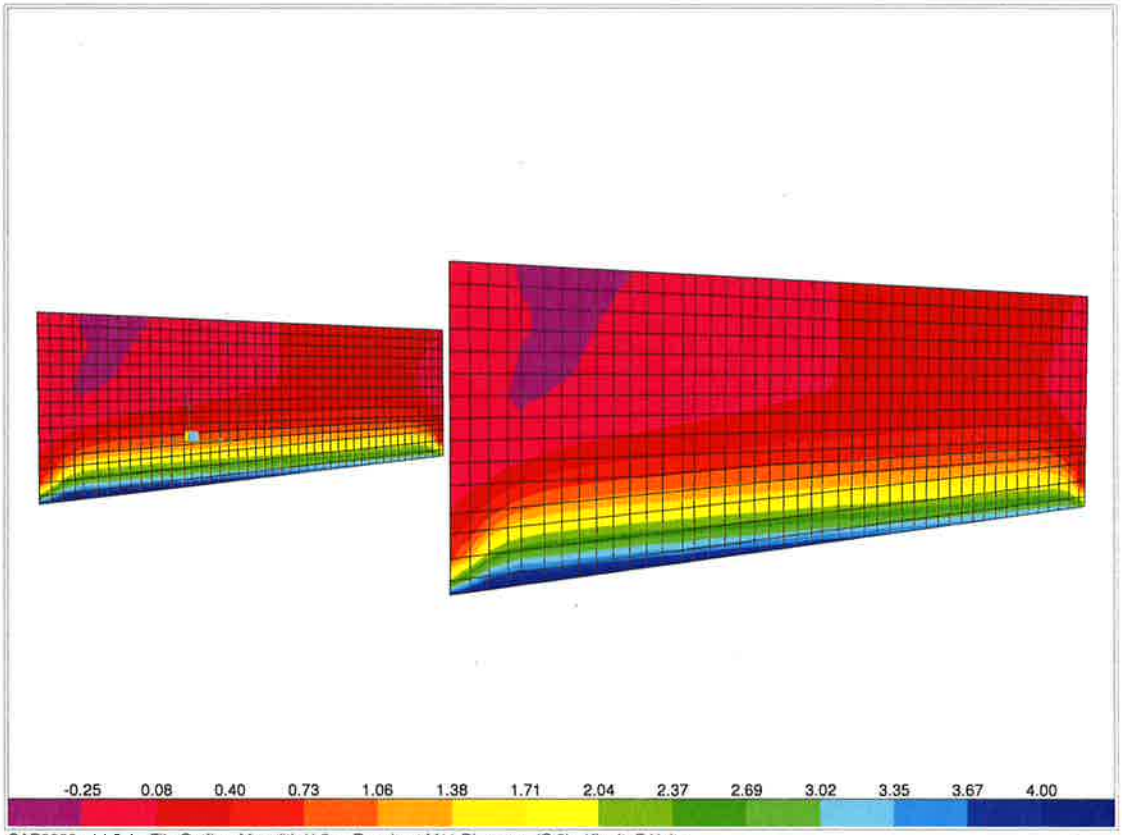
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/9/13 7:54:09



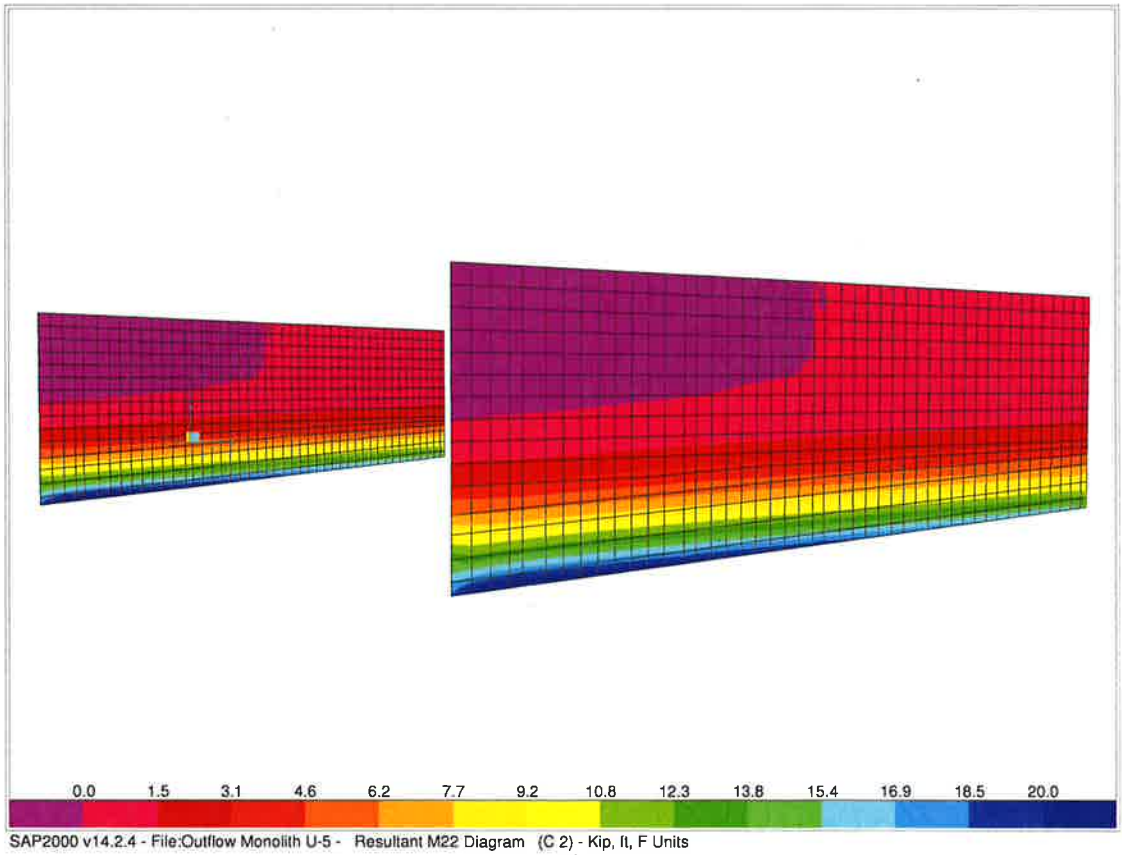
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/9/13 7:47:06



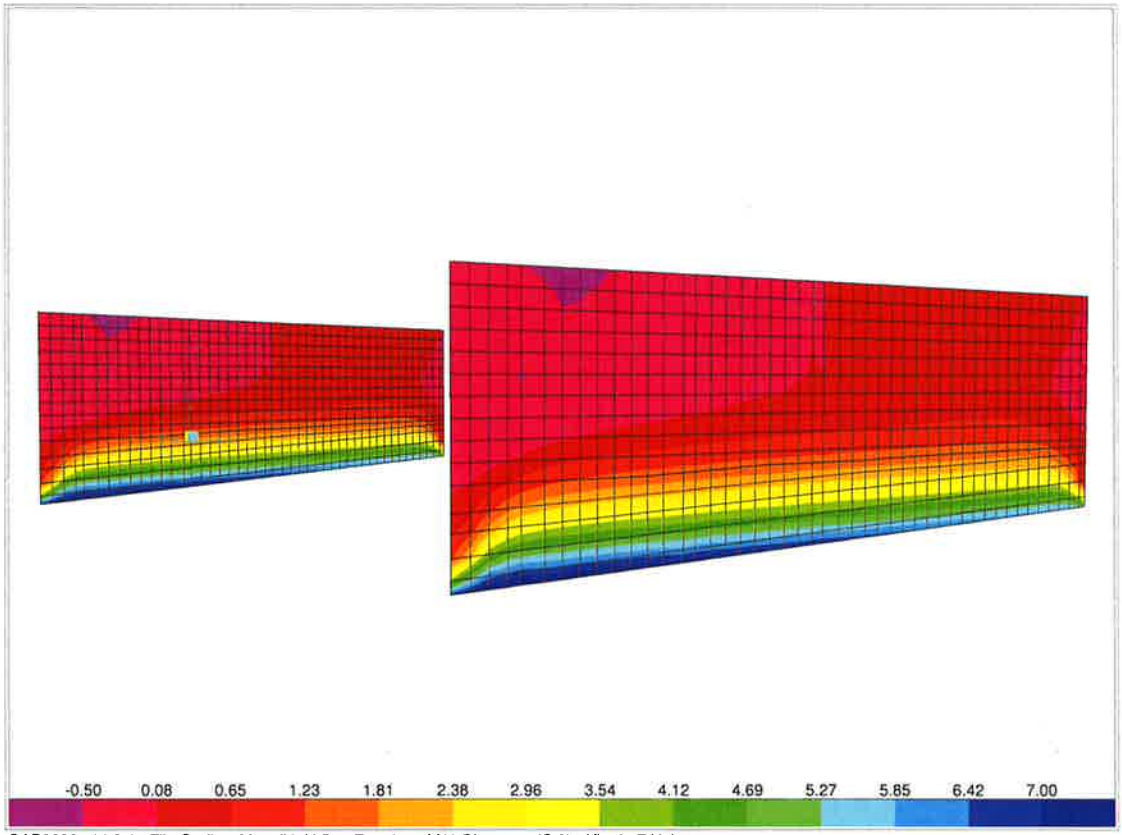
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/9/13 7:55:45



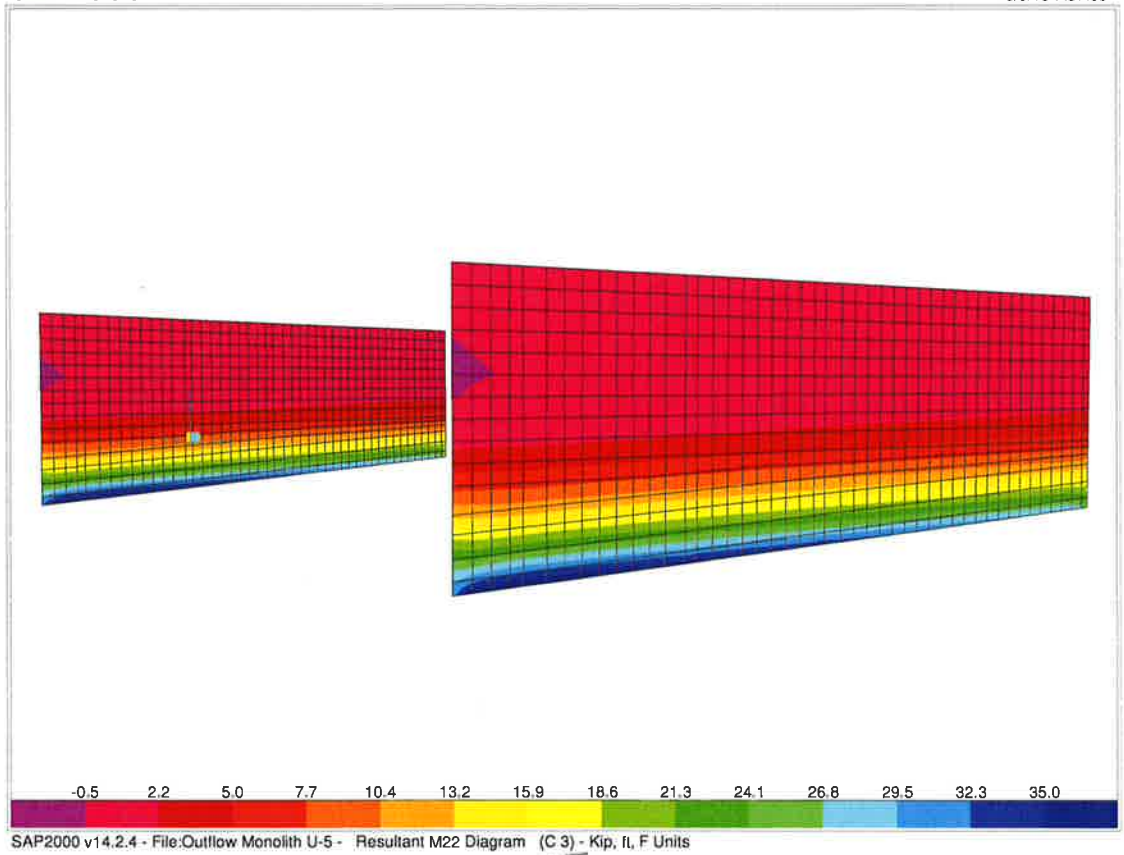
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/9/13 7:49:09



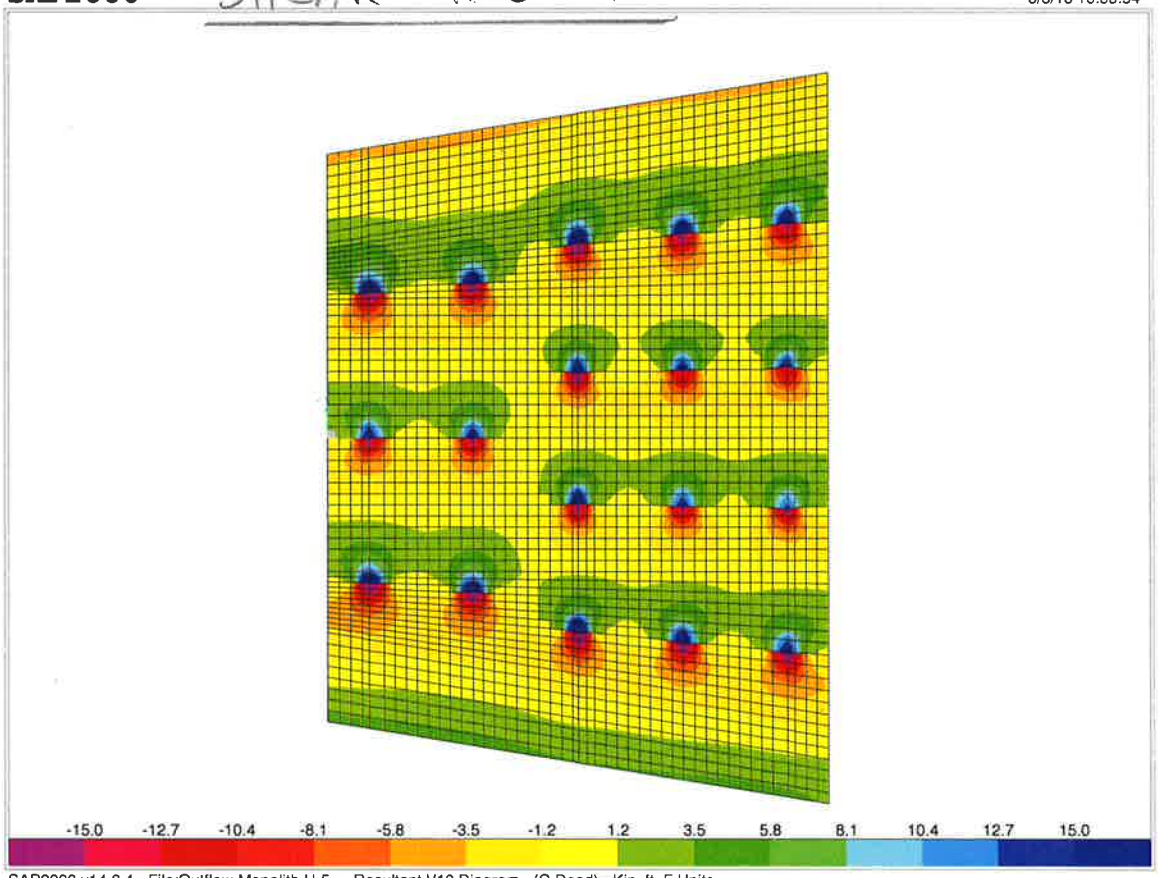
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/9/13 7:57:05



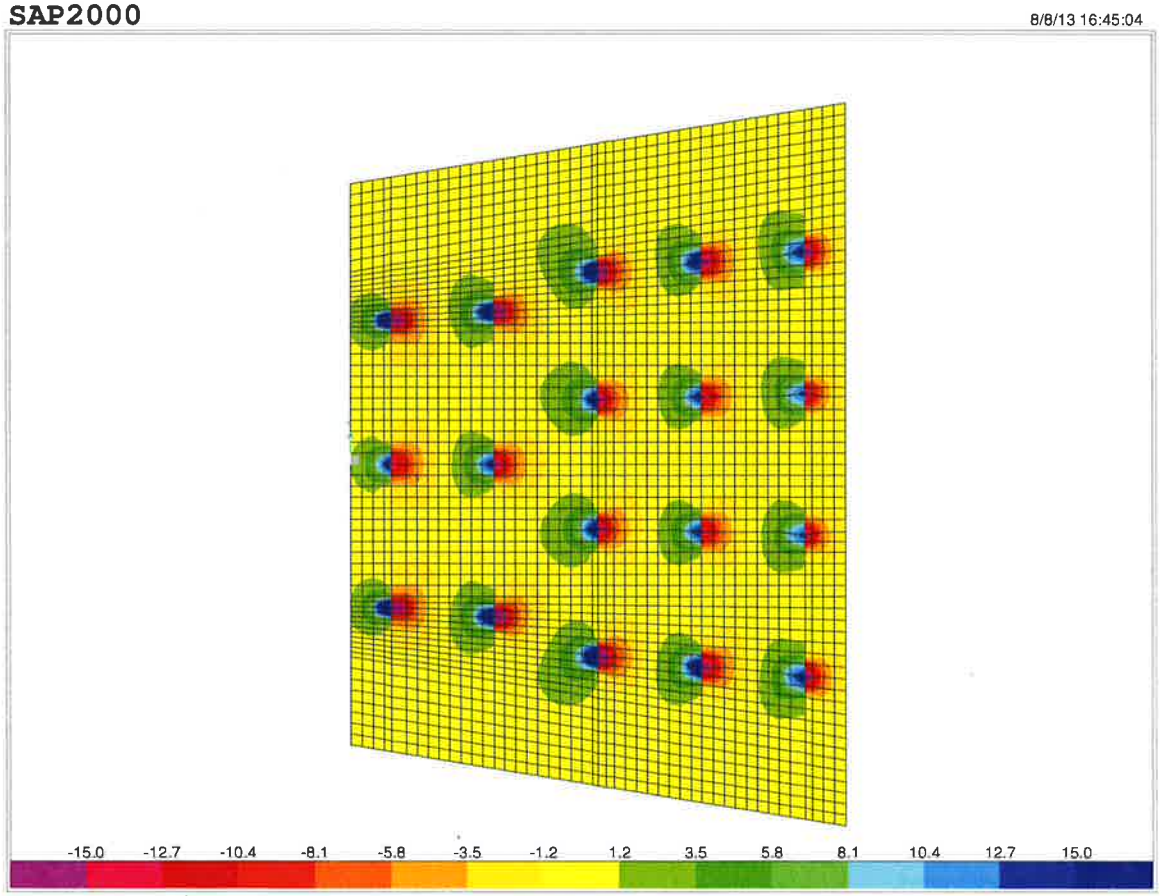
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

SAP2000 SHEAR RESULTS 8/8/13 16:33:54



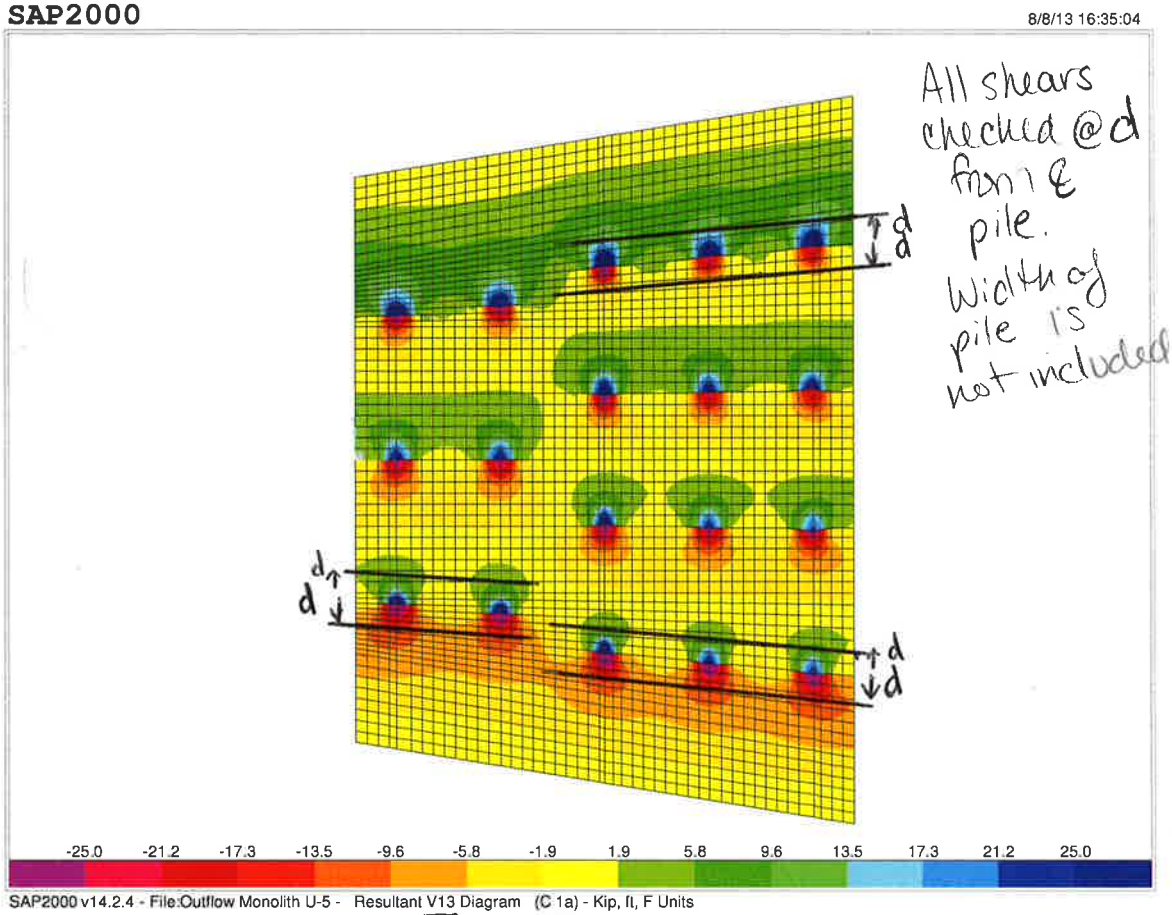
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C Dead) - Kip, ft, F Units

SAP2000 8/8/13 16:45:04



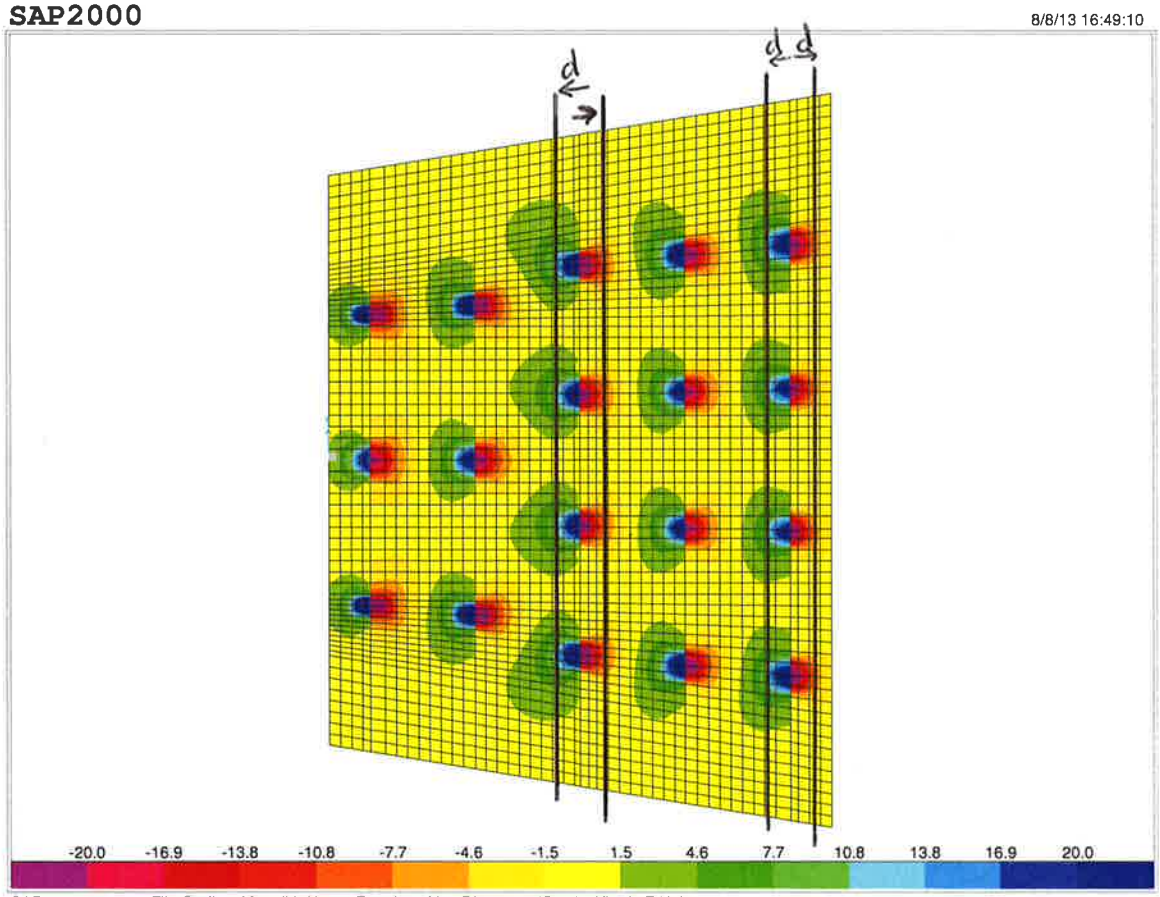
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C Dead) - Kip, ft, F Units

SAP2000 8/8/13 16:35:04



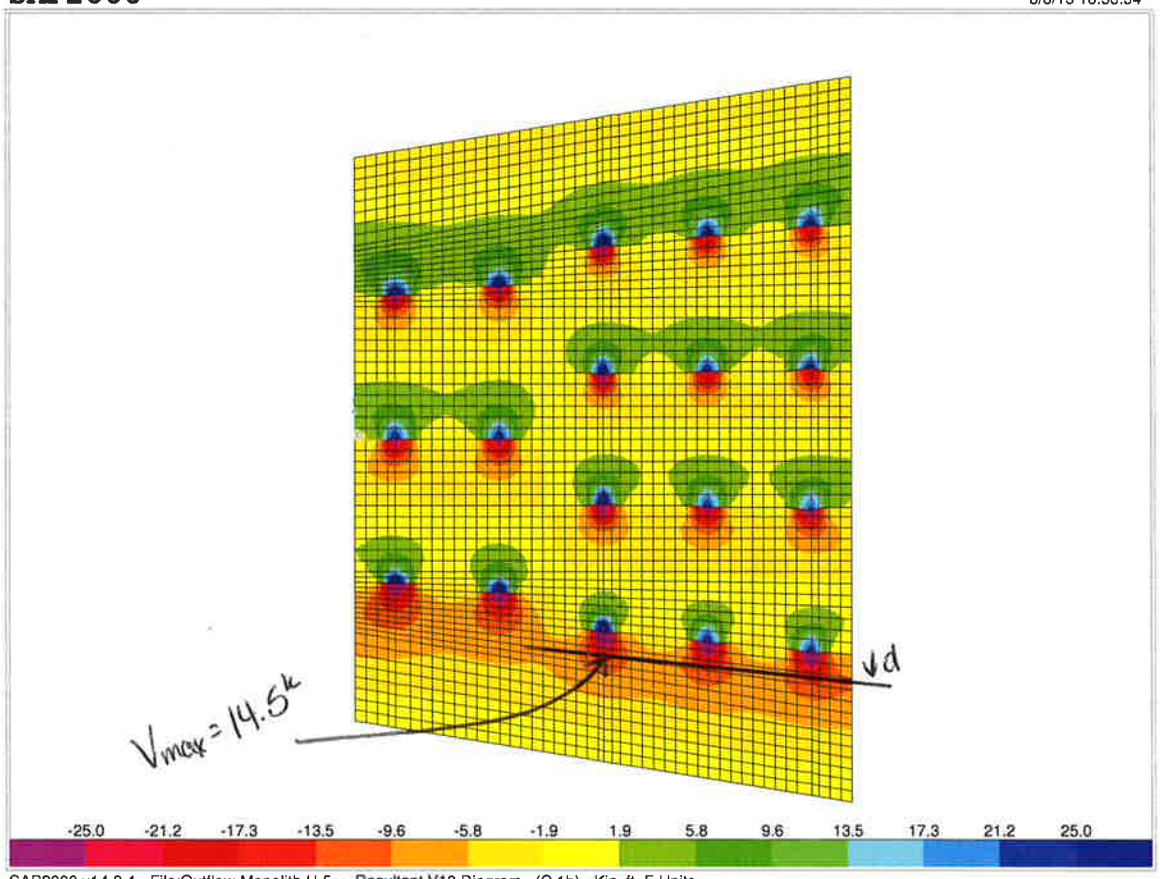
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/8/13 16:49:10



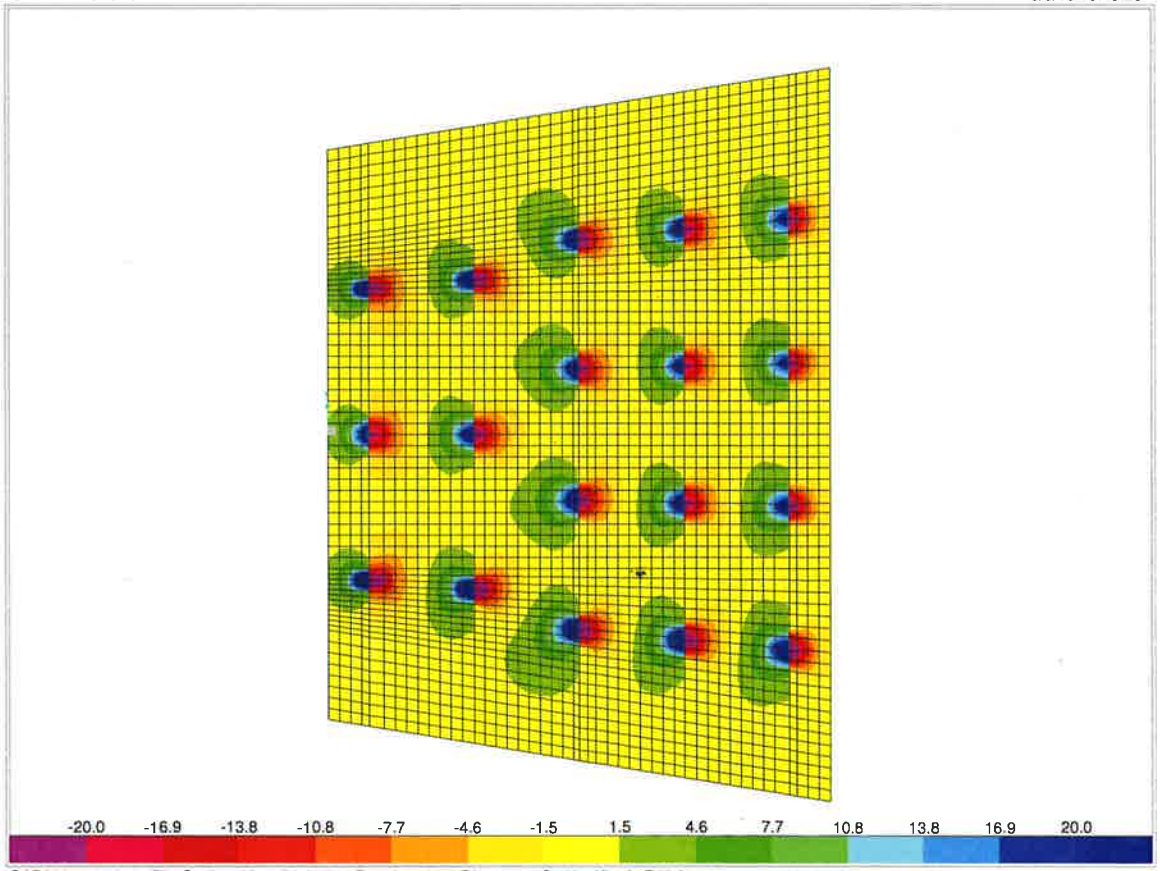
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/8/13 16:36:34



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 1b) - Kip, ft, F Units

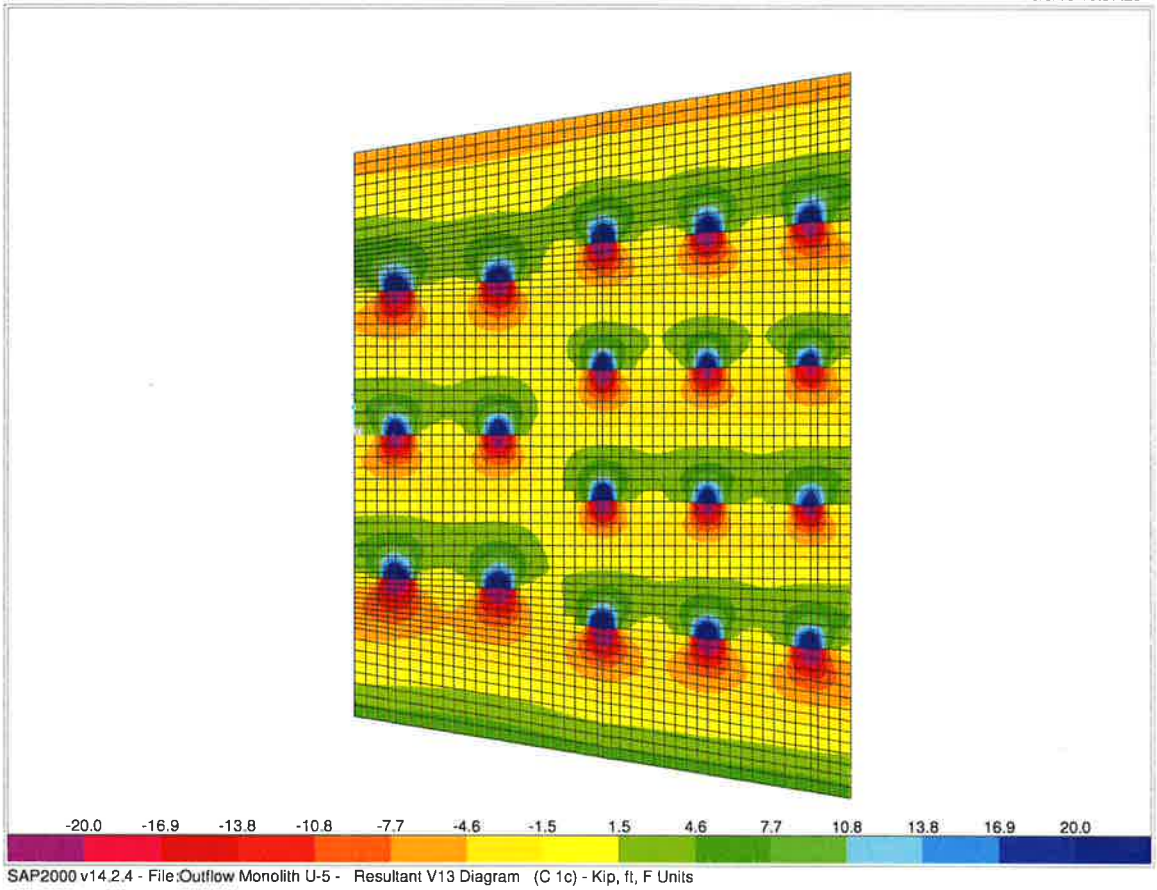
SAP2000 8/8/13 16:49:28



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

SAP2000

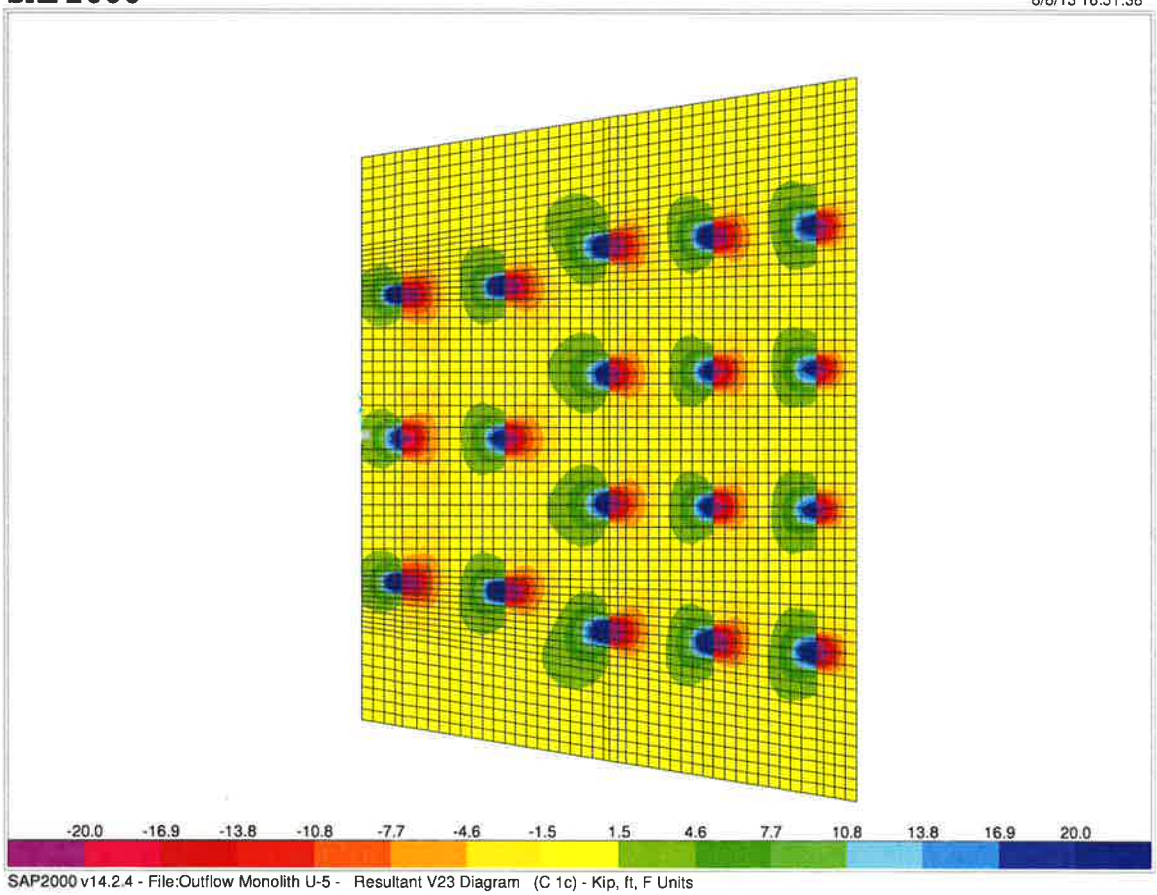
8/8/13 16:37:23



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 1c) - Kip, ft, F Units

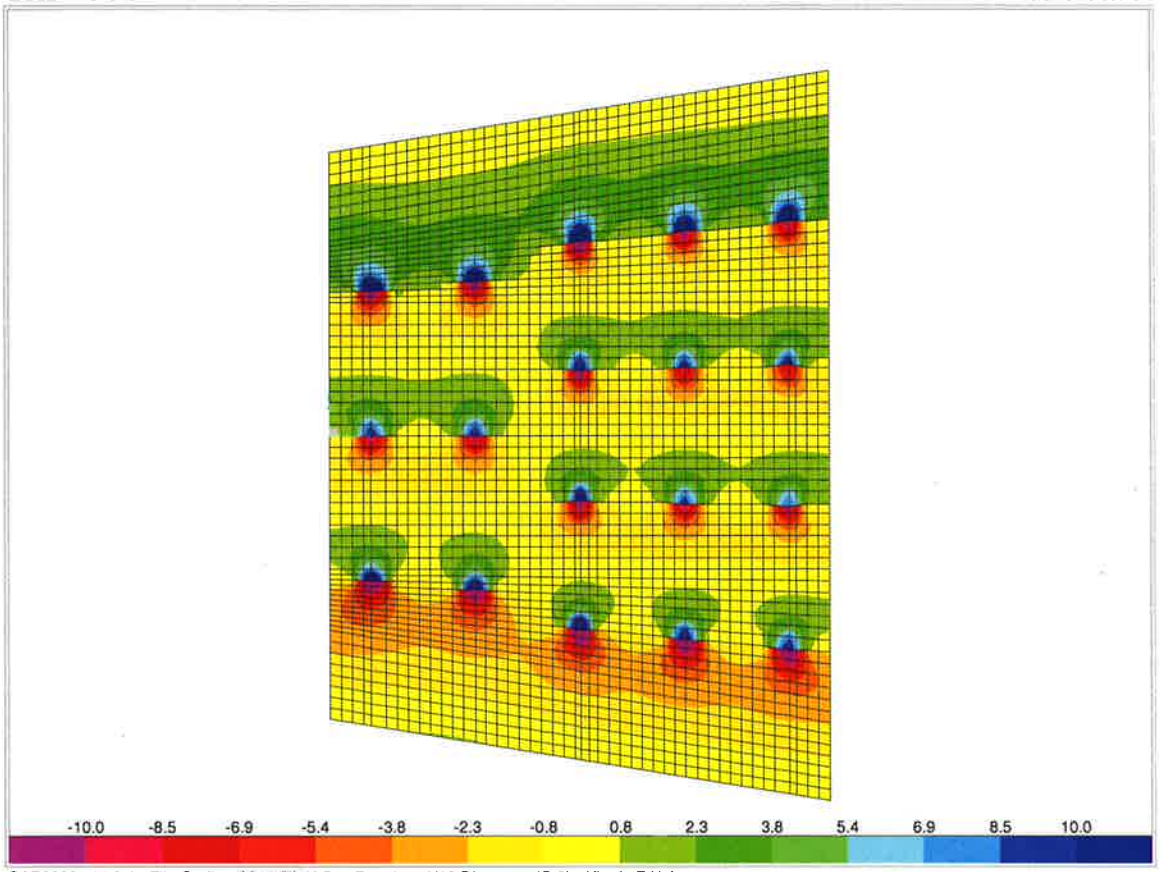
SAP2000

8/8/13 16:51:38



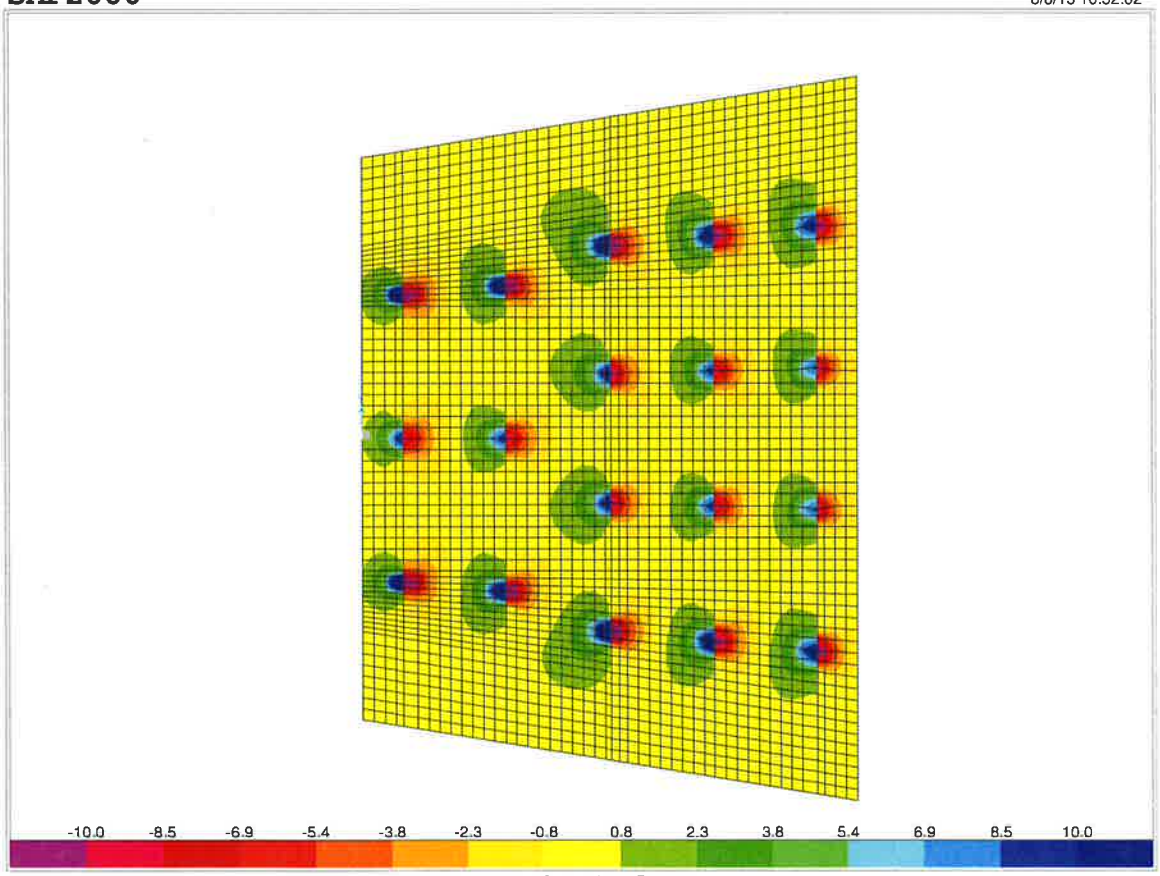
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/8/13 16:39:18



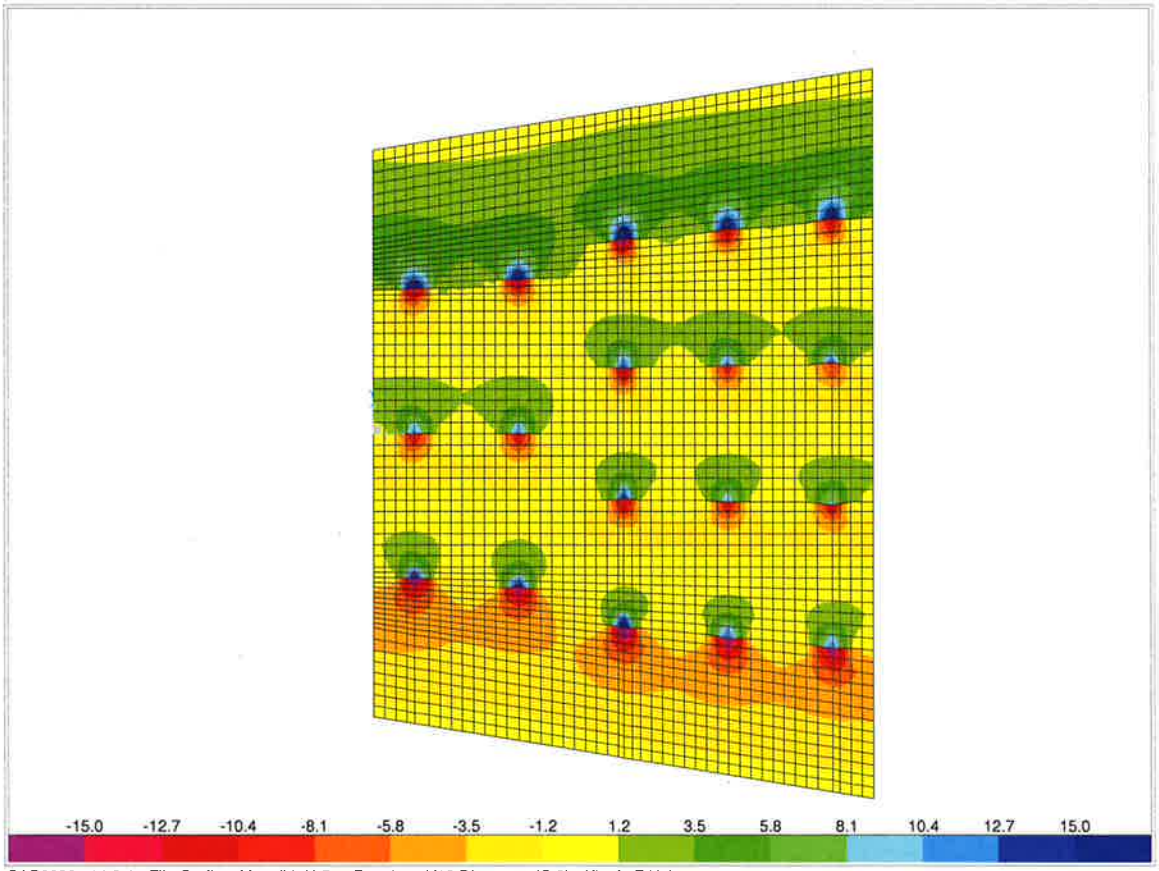
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/8/13 16:52:02



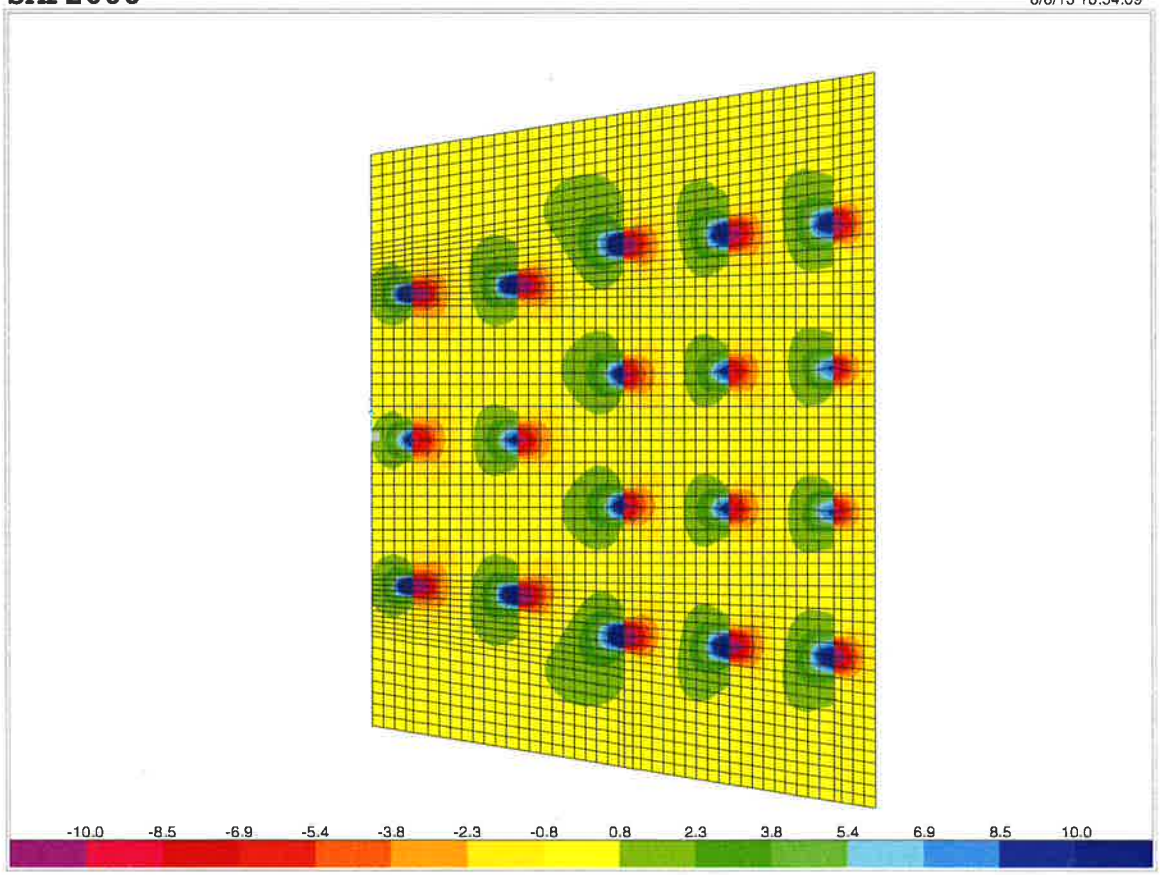
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/8/13 16:40:16



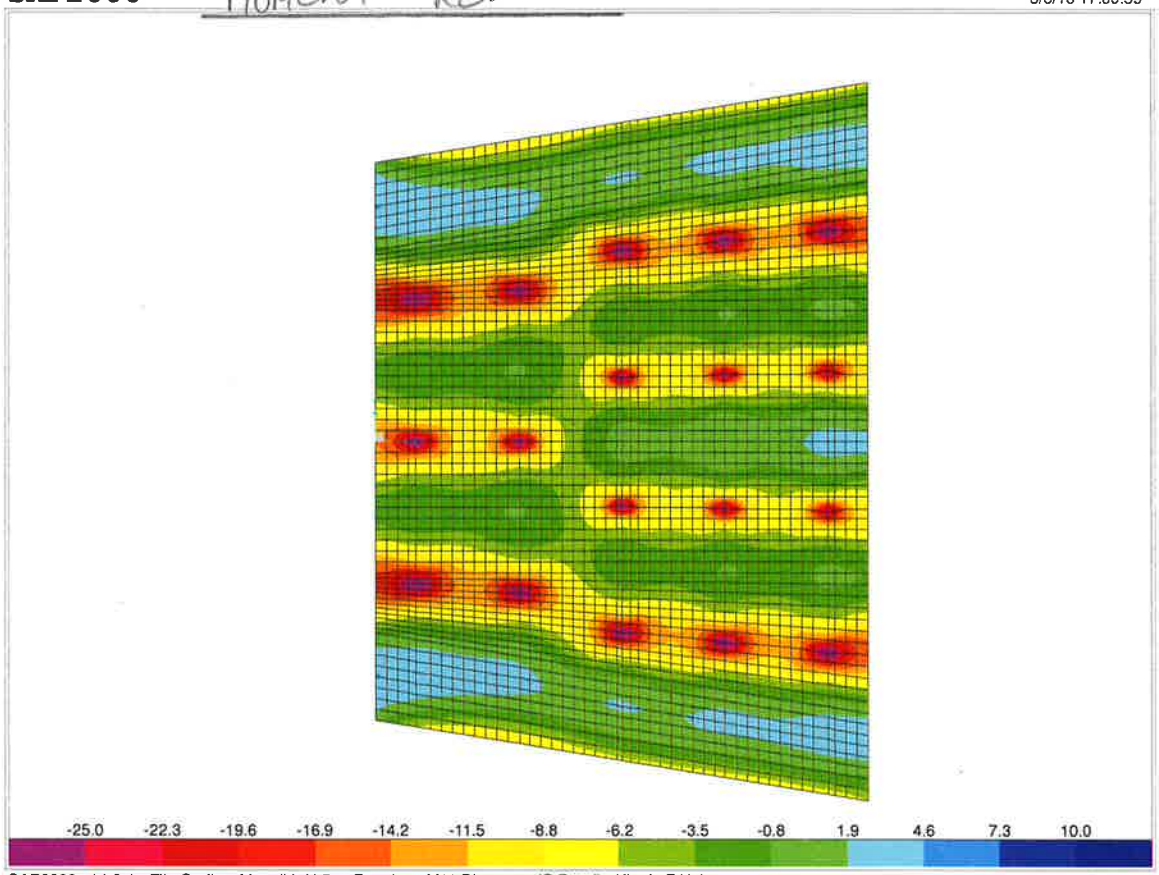
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/8/13 16:54:09



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

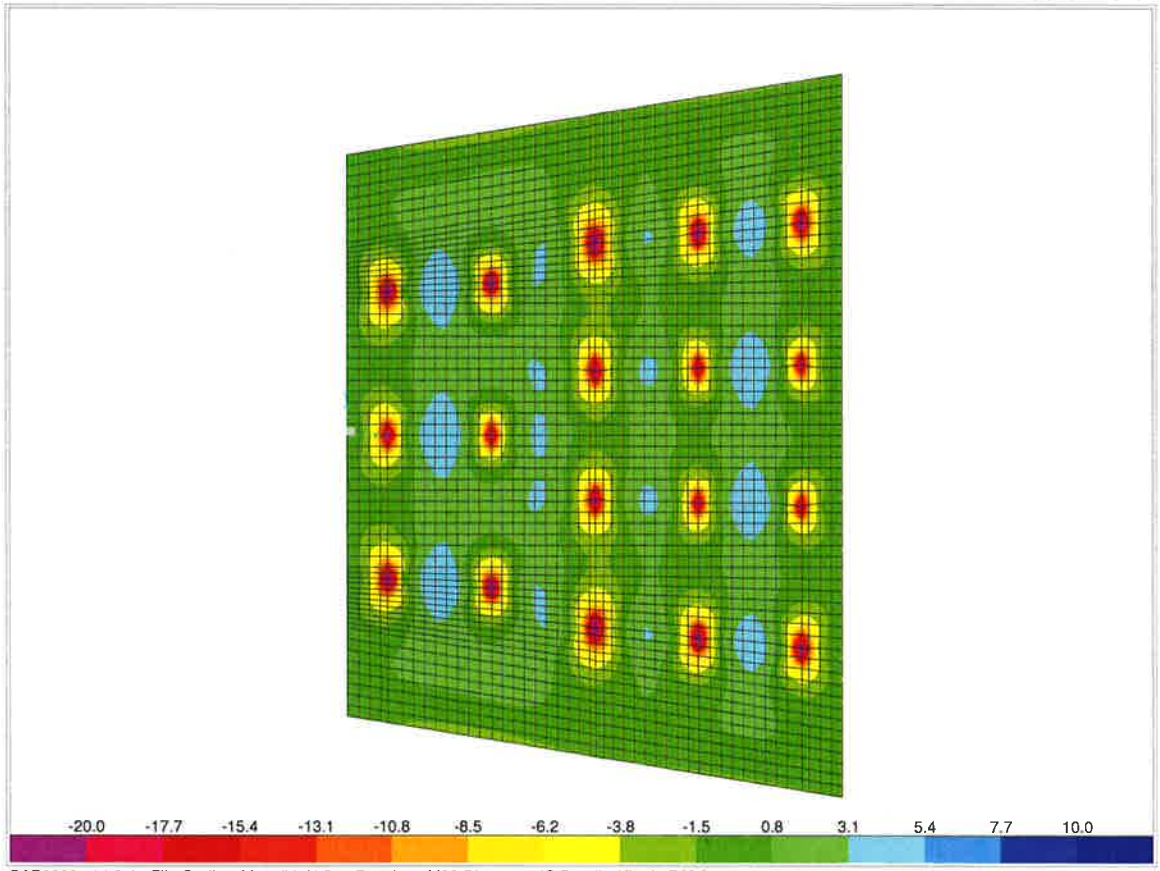
SAP2000 MOMENT RESULTS 8/8/13 17:00:59



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C Dead) - Kip, ft, F Units

TRANSVERSE

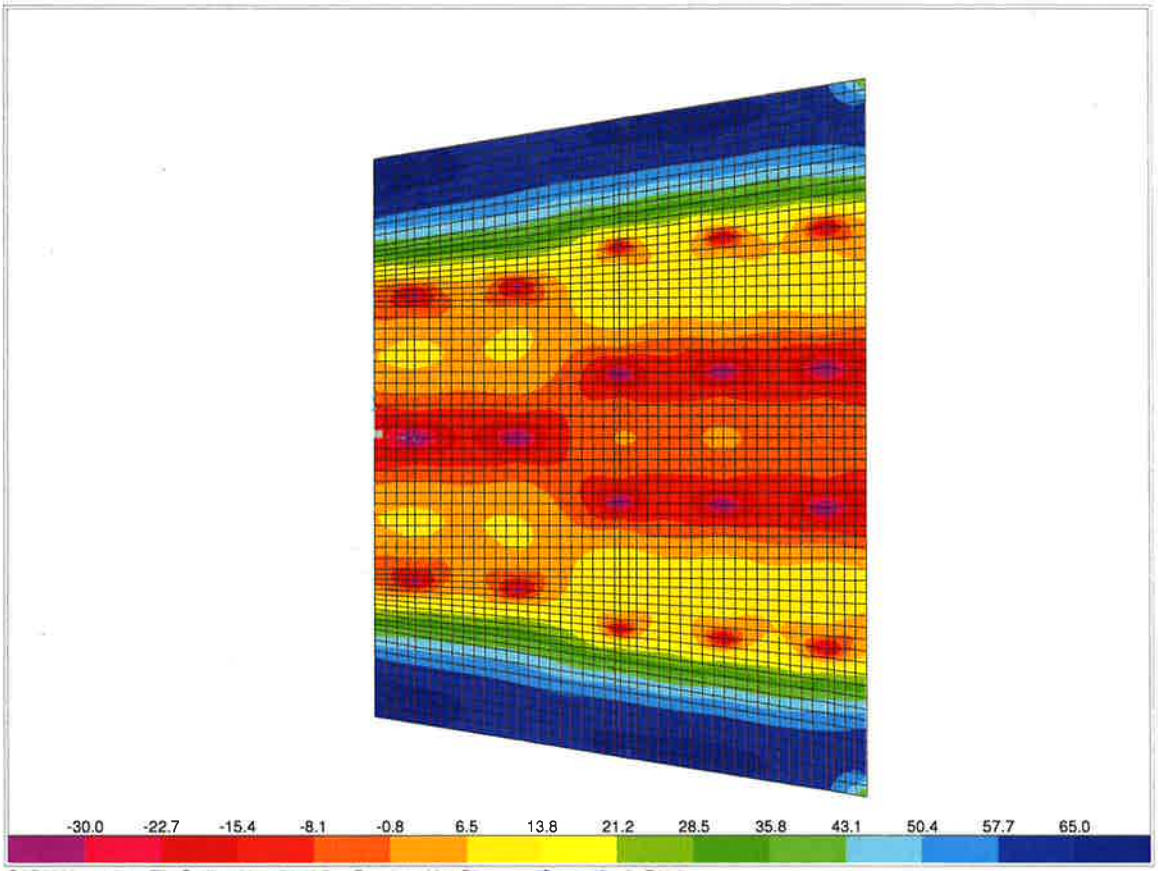
SAP2000 8/8/13 17:15:16



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C Dead) - Kip, ft, F Units

LONGITUDINAL

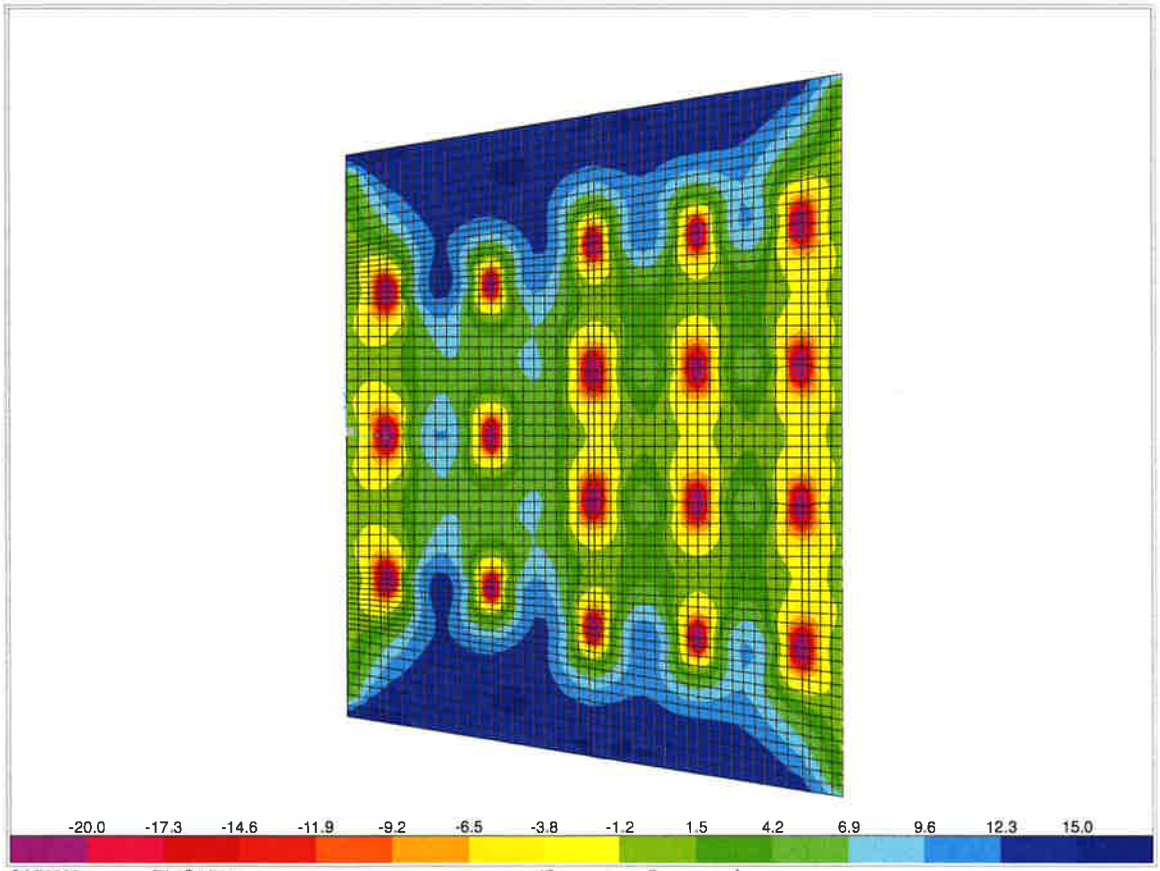
SAP2000 8/8/13 17:02:33



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

TRANSVERSE

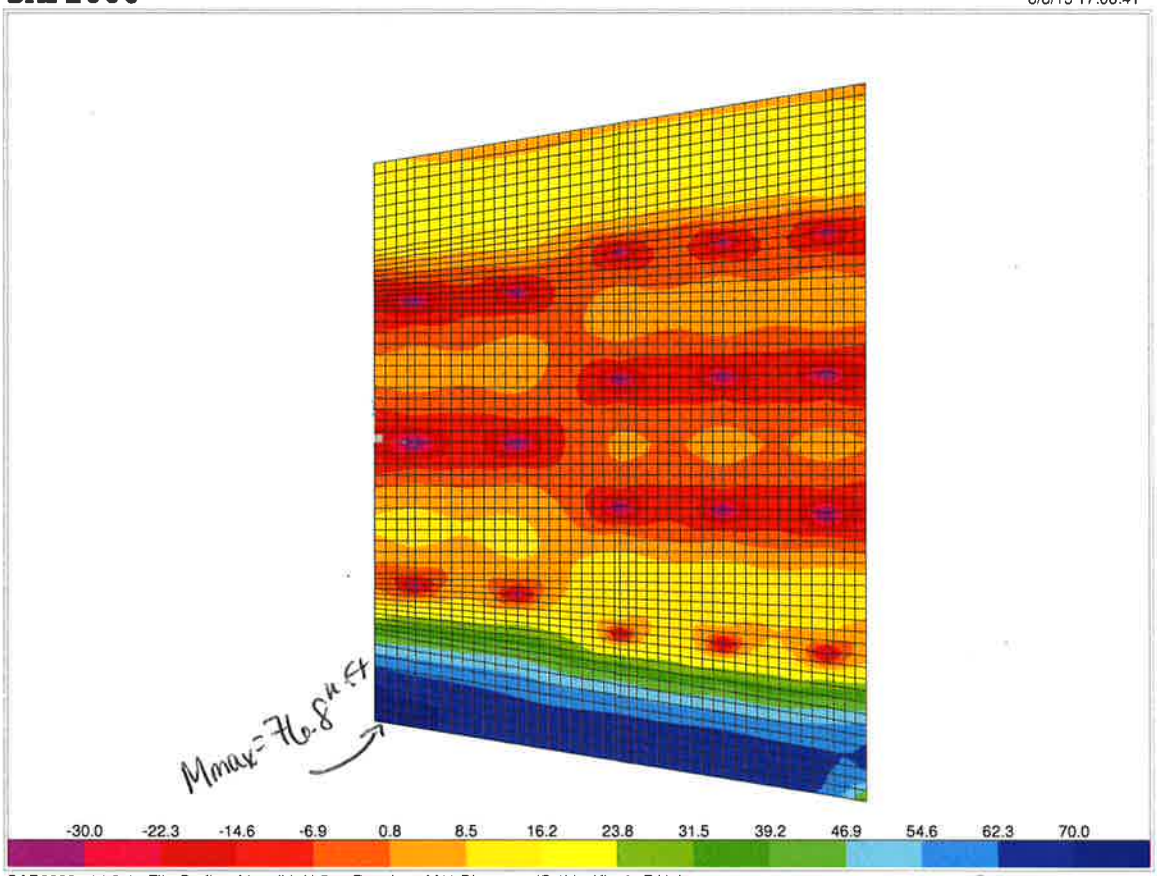
SAP2000 8/8/13 17:16:40



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

LONGITUDINAL

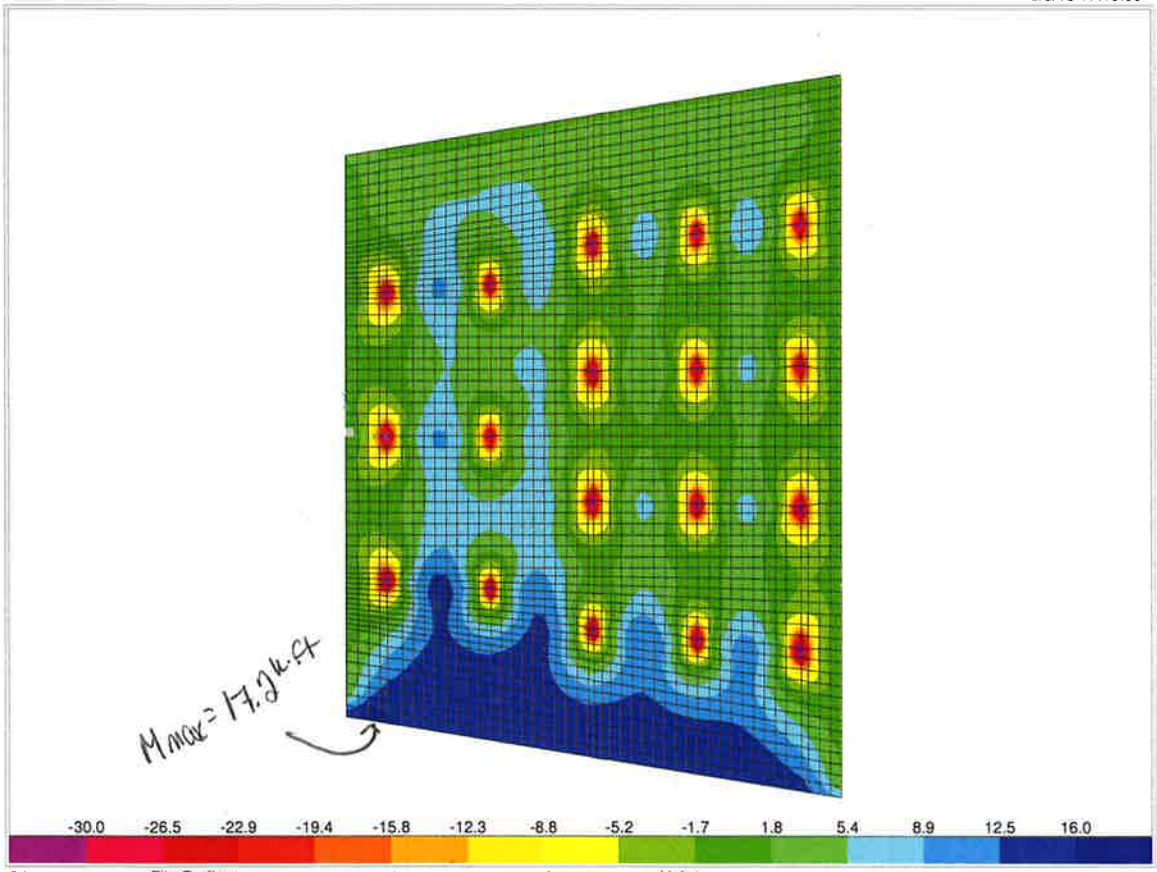
SAP2000 8/8/13 17:06:41



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

TRANS

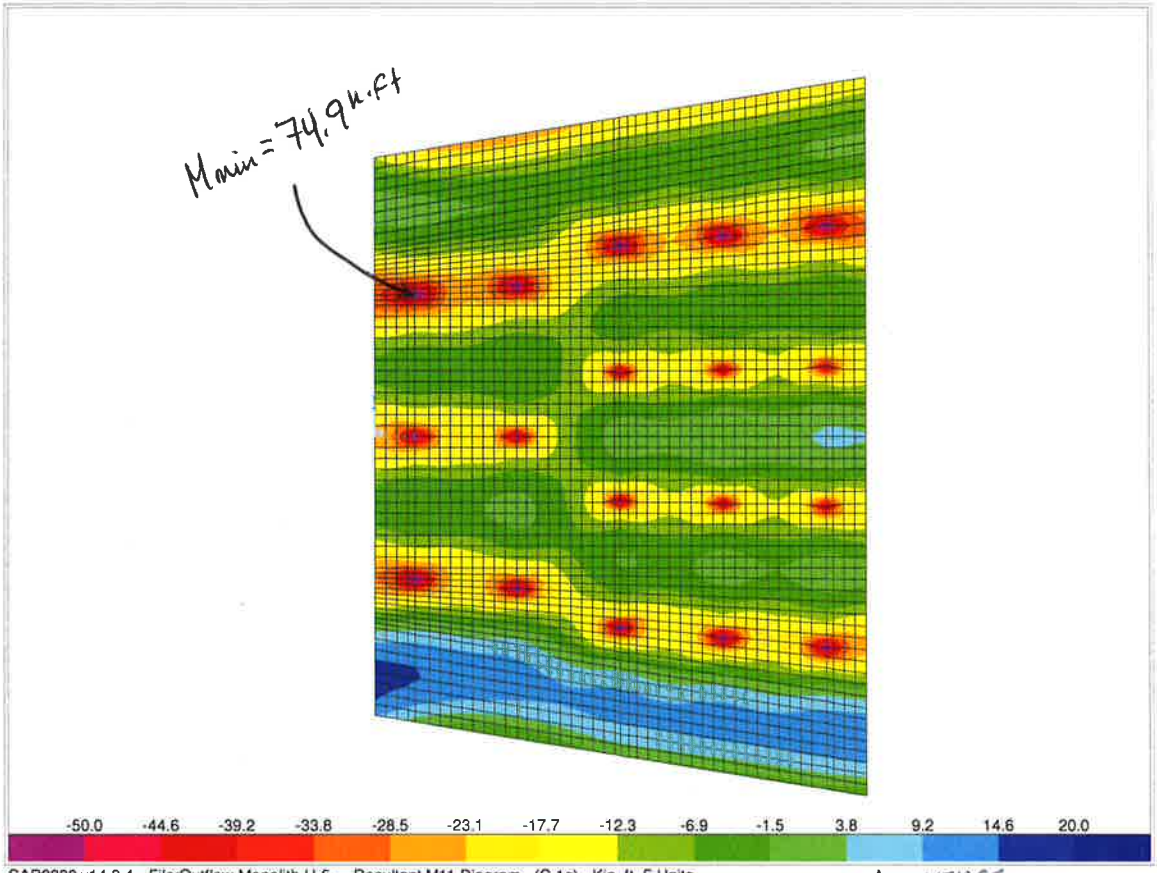
SAP2000 8/8/13 17:18:06



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

LONG

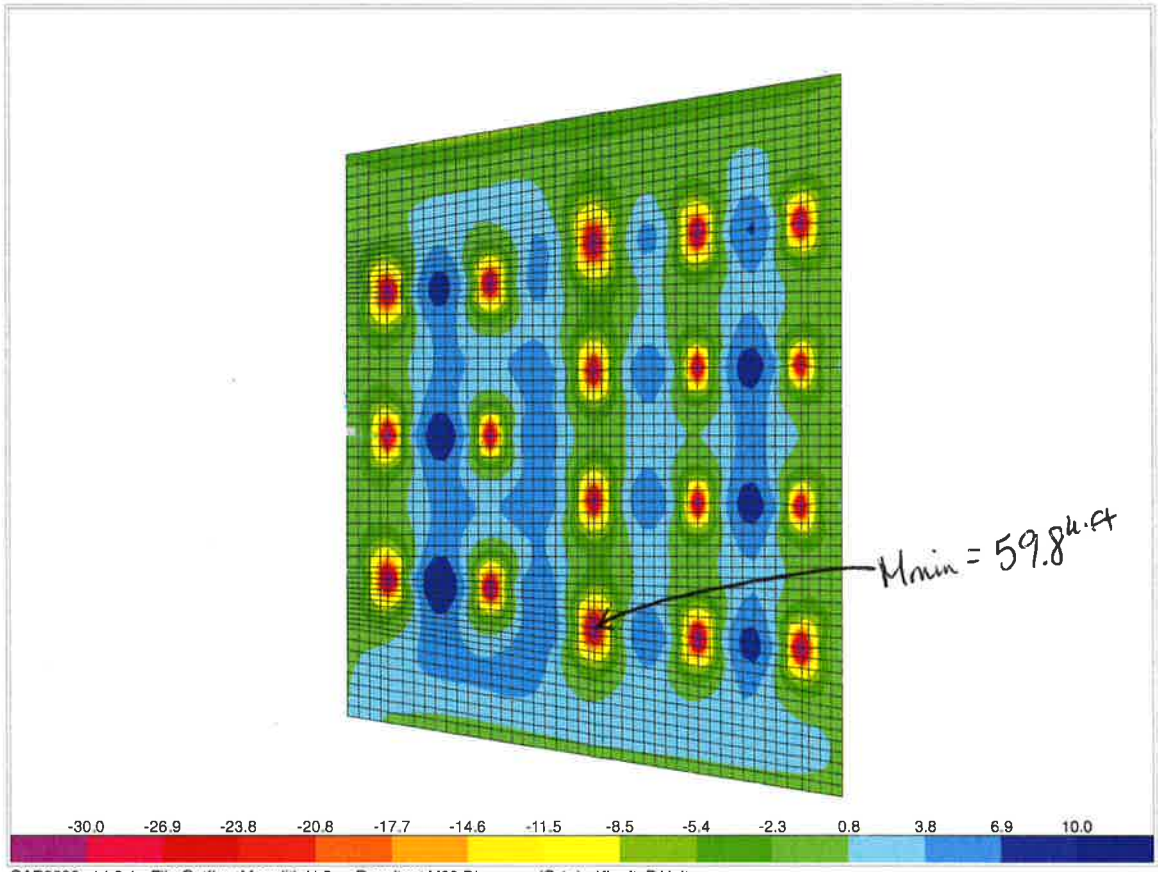
SAP2000 8/8/13 17:08:32



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

TRANSVERSE

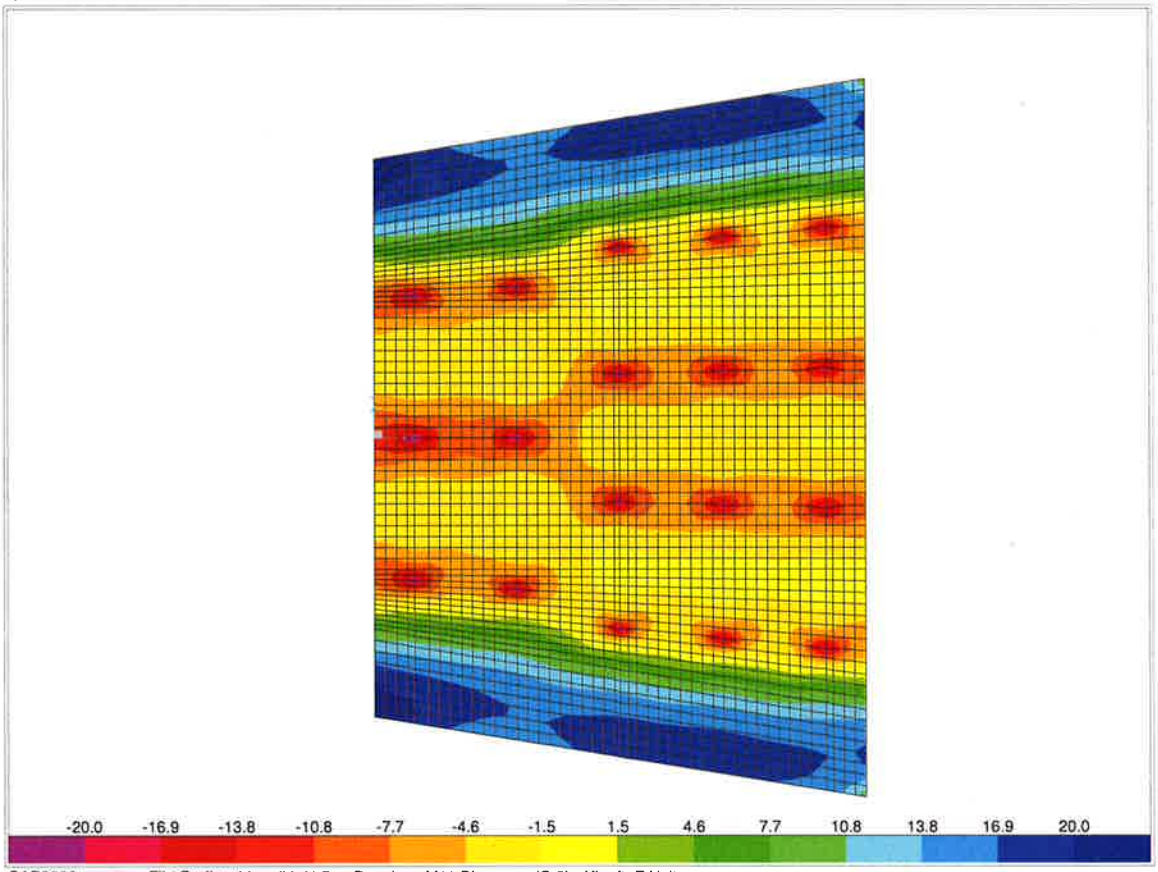
SAP2000 8/8/13 17:19:11



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 1c) - Kip, ft, F Units

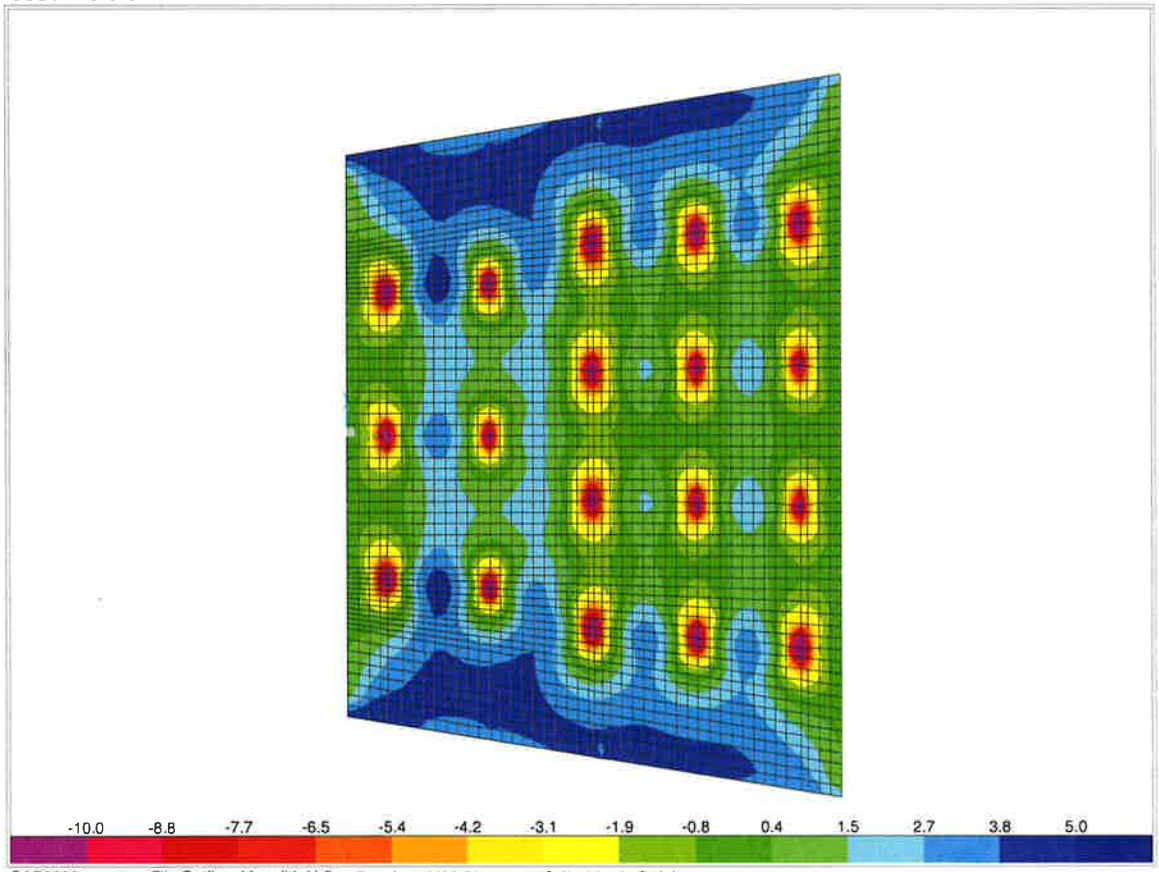
LONGITUDINAL

SAP2000 8/8/13 17:11:28



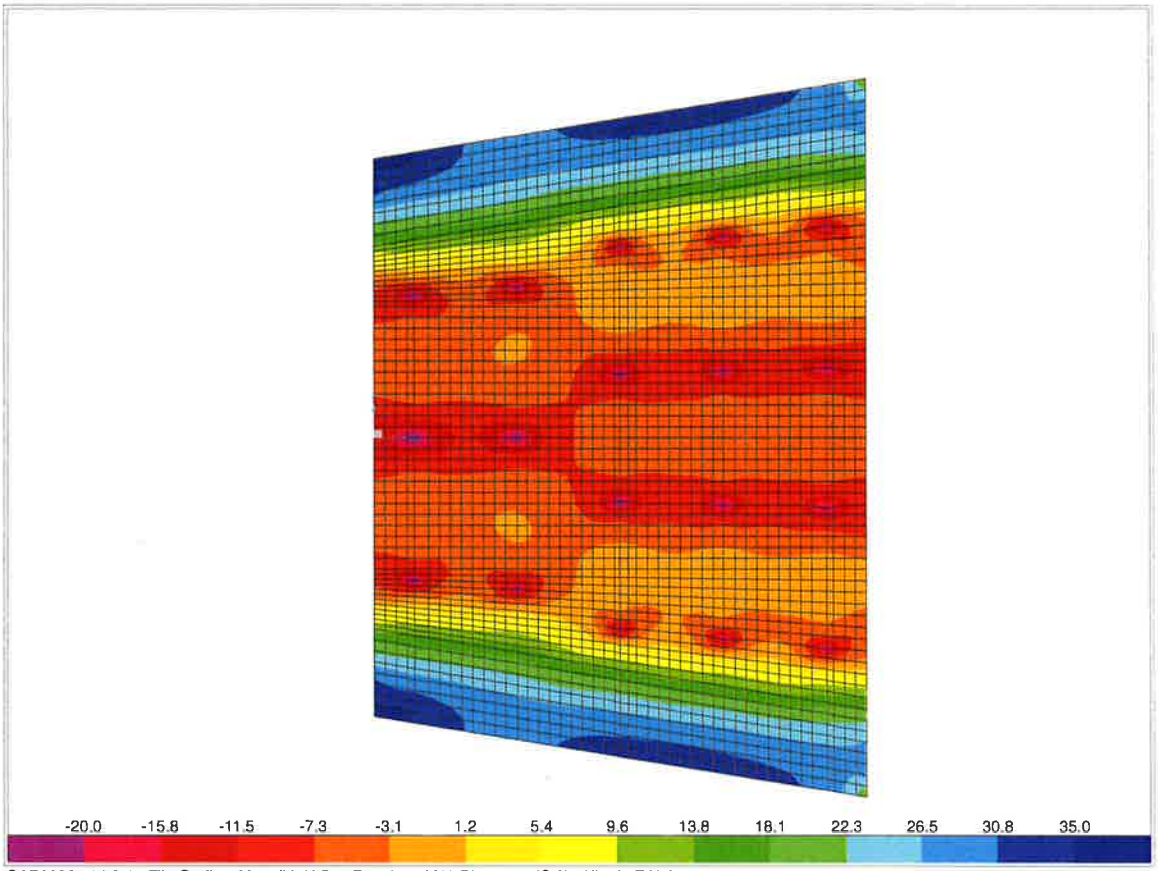
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/8/13 17:20:43



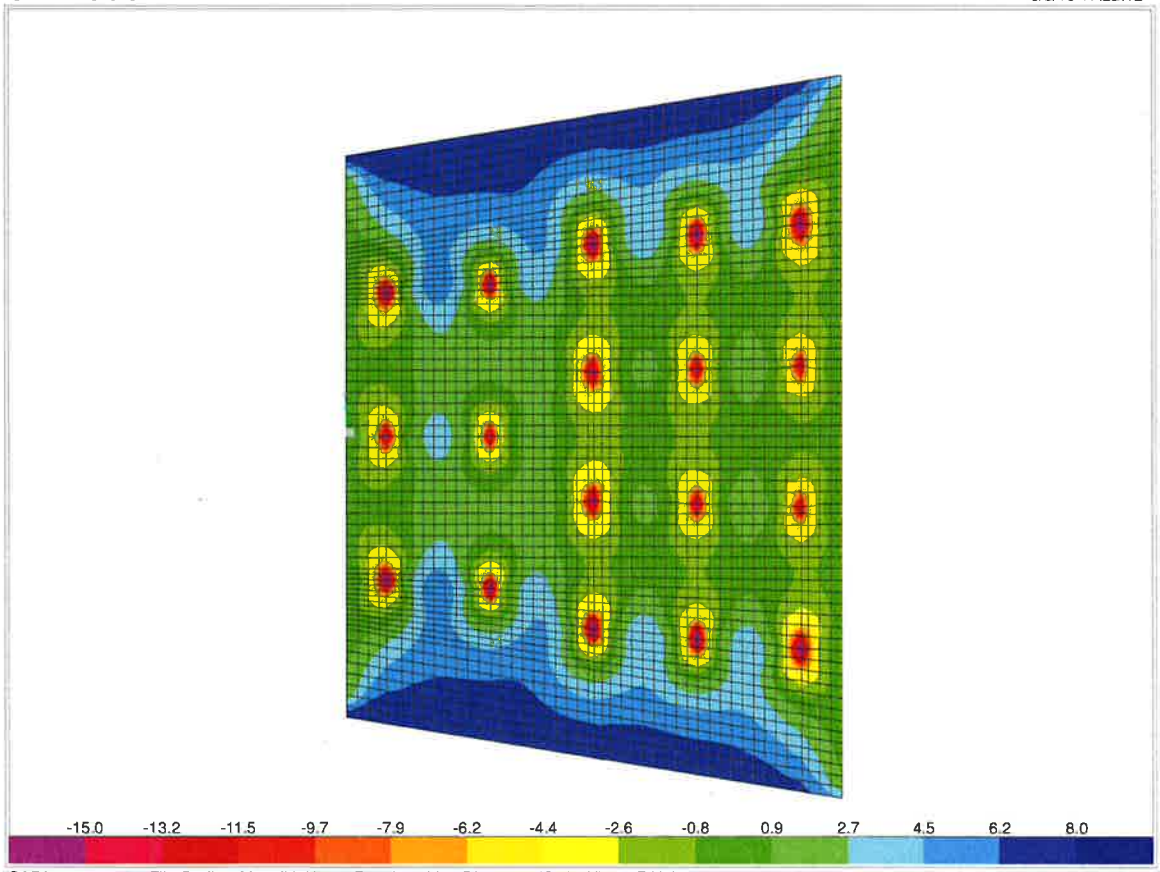
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/8/13 17:13:00



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/8/13 17:22:12



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-4 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	2.5	ft
Wall Thickness =	2.5	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

SETTLEMENT CASES

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
1a-ST	10.73	72.0	1.1	14.3	1.1
1b-ST	10.73	72.0	1.1	14.3	1.1
2-ST	3.50	22.6	0.4	4.5	0.3
3-ST	5.98	38.9	0.7	7.8	0.5

* Shear values taken at a distance 'd'= 25.37in from the face of the slab.

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

Max. Shear =	**10.7 kip**	
Max. Moment, Primary =	**72.0 kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**1.1 kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**14.3 kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**1.1 kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 3.848 in^2

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

(3 * √(f'_c) * b * d) / f_y = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 10.7kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Exterior Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.0 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

ϕMn = 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)

= 1330 kip-in/ft

= 110.83 kip-ft/ft

ϕMn = 110.8kip-ft > Mu = 72kip-ft → Use #9 @ 12"

* SAME NOTE - ACI 33% ALLOWANCE

Primary Interior Face:

* Will try **#7 @ 12"** to start: As, #7 @ 12" = 0.6 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.6 * 60ksi / (0.85 * 4ksi * 12in) = 0.882 in

ϕMn = 0.9 * $0.6in^2$ * 60ksi * (25.365in - 0.882in / 2)

= 807.53 kip-in/ft

= 67.29 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 1.1kip-ft → Use #7 @ 12"

Secondary Interior & Exterior Faces: * $M_{max, secondary}$ = 14.3 k-ft

* Will try **#7 @ 12"** to start: As, #7 @ 12" = 0.60 in^2

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.6 * 60ksi / (0.85 * 4ksi * 12in) = 0.882 in

ϕMn = 0.9 * $0.6in^2$ * 60ksi * (25.365in - 0.882in / 2)

= 807.53 kip-in/ft

= 67.29 kip-ft/ft

ϕMn = 67.3kip-ft > Mu = 14.3kip-ft → Use #7 @ 12"

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
1a-ST	15.3	10.2	71.1	66.0	15.7	58.3
1b-ST	15.2	10.5	73.9	64.2	16.2	58.2
2-ST	7.7	5.4	23.1	52.8	4.8	35.9
3-ST	9.0	5.9	37.5	54.3	8.4	38.1

* Shear taken at a distance 'd' = 25.37 inch from piles.

Max. Shear = **15.3 kip** ← CONTROLS

Max. Moment, Primary = **73.9 kip-ft** (SAP M11, controls *bottom transverse* reinforcement)

Min. Moment, Primary = **66.0 kip-ft** (SAP M11, controls *top transverse* reinforcement)

Max. Moment, Secondary = **16.2 kip-ft** (SAP M22, controls *bottom longitudinal* reinforcement

Min. Moment, Secondary = **58.3 kip-ft** (SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.848 in^2

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

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= $0.85 * 2 * \sqrt{4000} * 12in * 25.365in$

= 32,726 lb

ϕVc = 32.7kip > Vu = 15.3kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

ϕMn = 110.8kip-ft > Mu = 73.9kip-ft → Use #9 @ 12"

Primary Top Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

ϕMn = 110.8kip-ft > Mu = 66kip-ft → Use #9 @ 12"

Secondary Bottom & Top Faces: * $M_{max, secondary}$ = 58.3 k-ft

* Will try **#8 @ 12"** to start: As, #8 @ 12" = 0.79 in^2

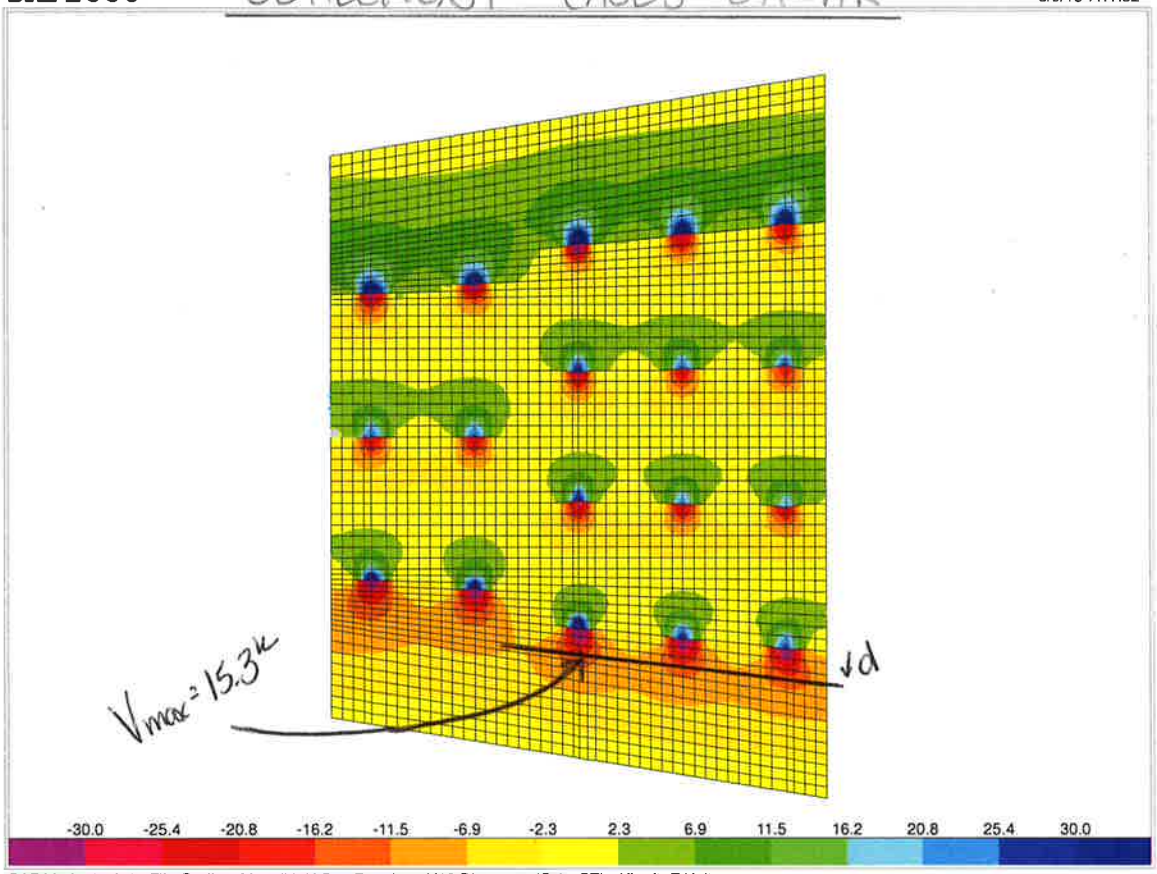
$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.79 * 60ksi / (0.85 * 4ksi * 12in) = 1.162 in

$\phi Mn =$ 0.9 * $0.79in^2$ * 60ksi * (25.365in - 1.162in / 2)
= 1057.3 kip-in/ft
= 88.11 kip-ft/ft

ϕMn = 88.1kip-ft > Mu = 58.3kip-ft → Use #8 @ 12"

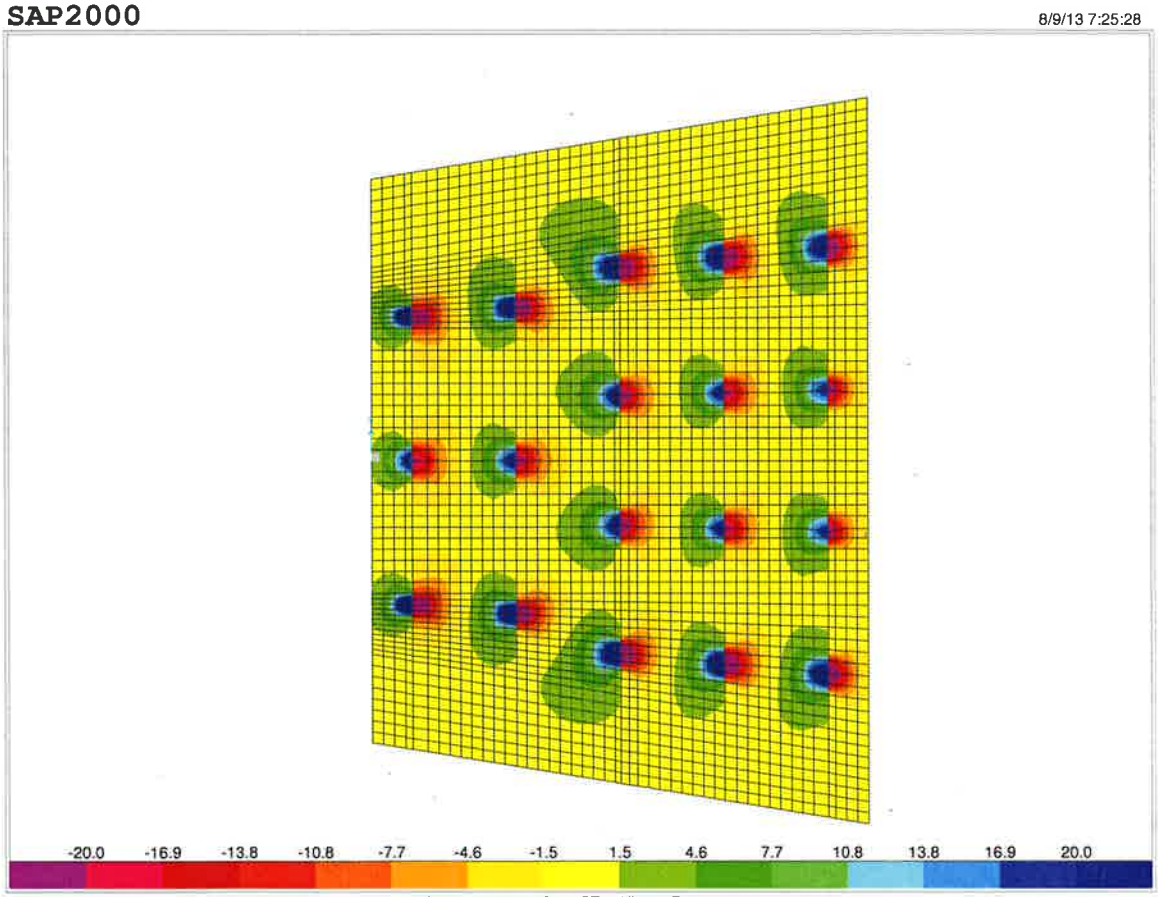
RESULT IMAGES FOLLOW THIS SPREADSHEET. WALL RESULTS FOR "ST" CASES NOT INCLUDED B/C THEY ARE THE SAME AS THE TRADITIONAL CASES.

SAP2000 SETTLEMENT CASES - SHEAR 8/9/13 7:11:32



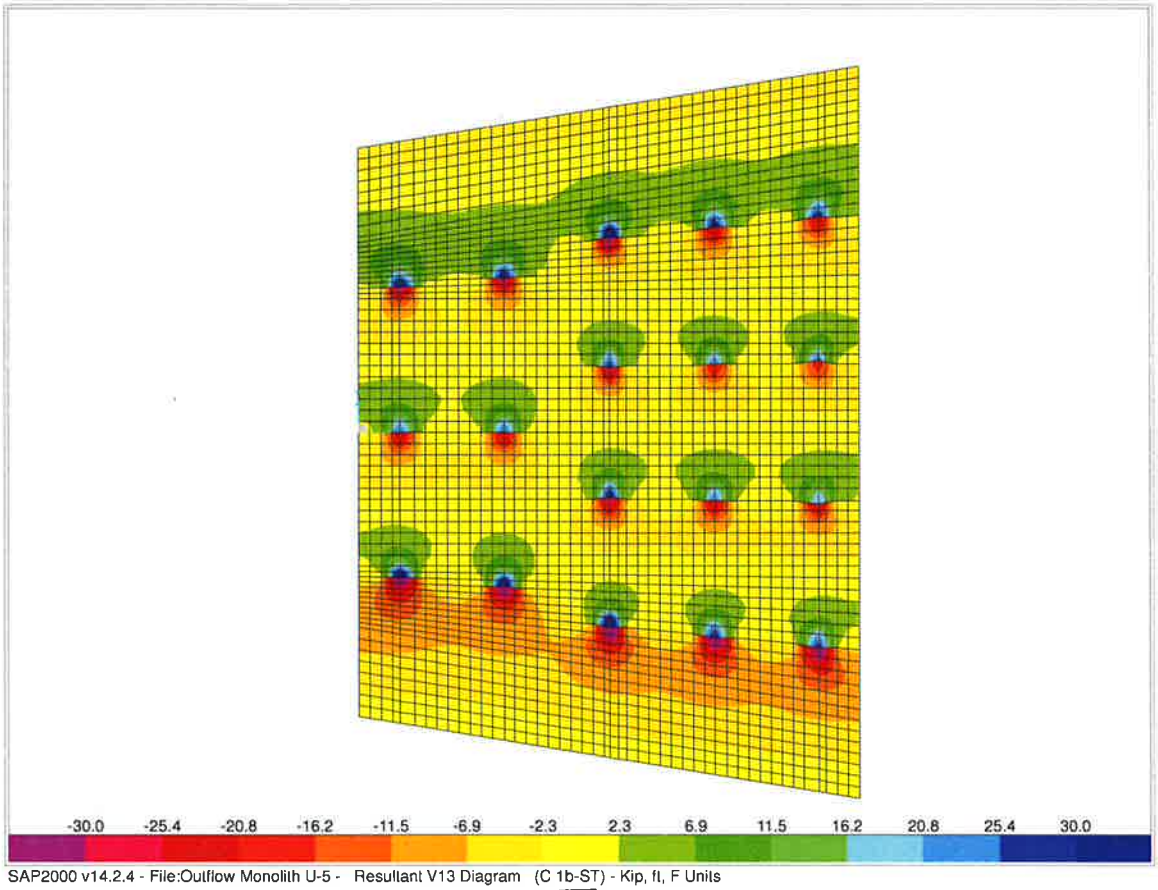
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 8/9/13 7:25:28



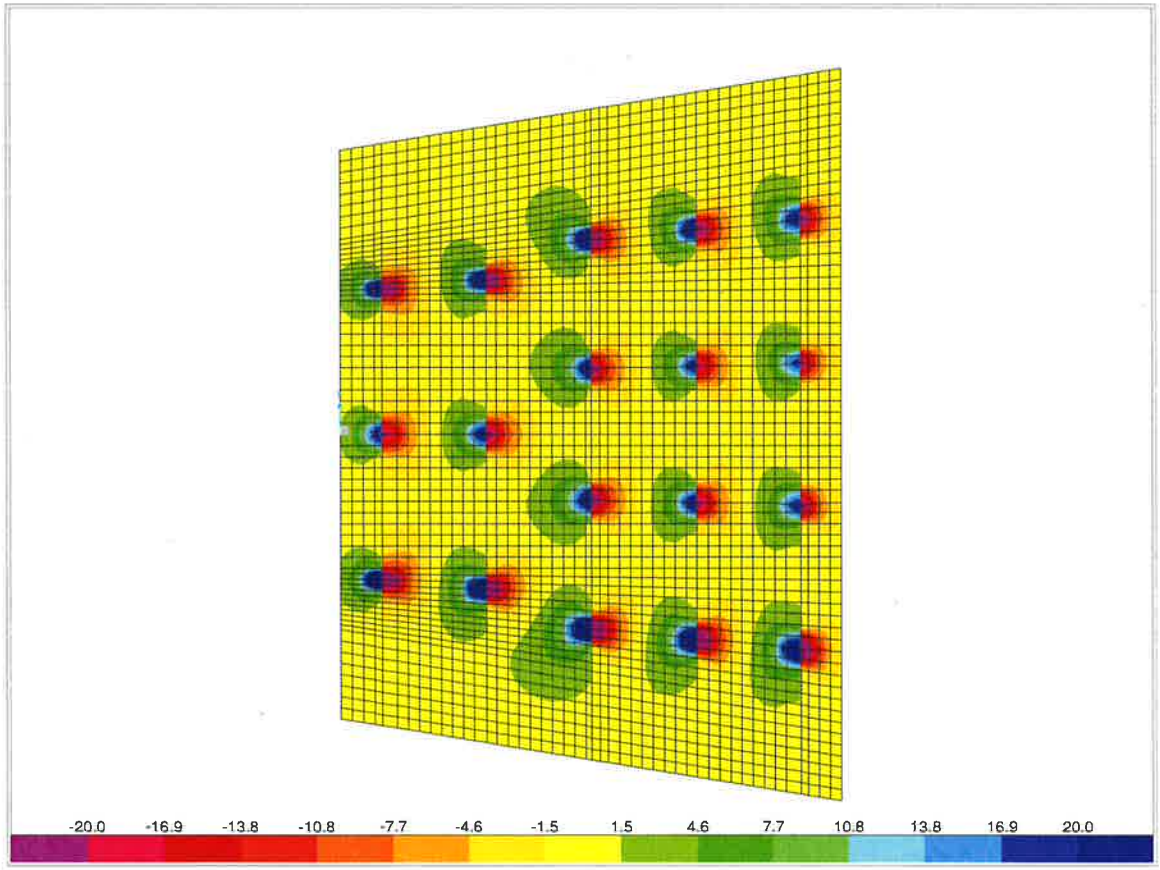
SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V23 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 8/9/13 7:13:06



SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant V13 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 8/9/13 7:23:10



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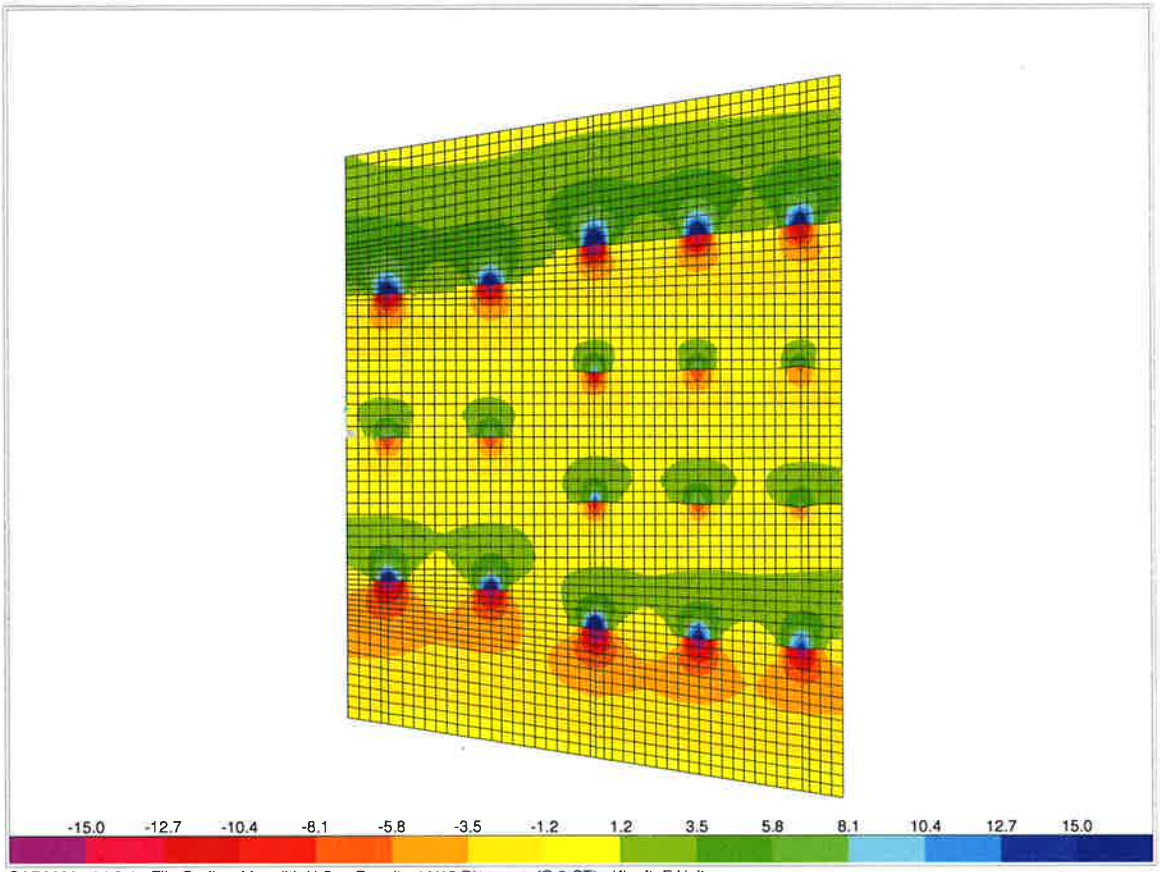
SAP2000 8/9/13 7:15:14



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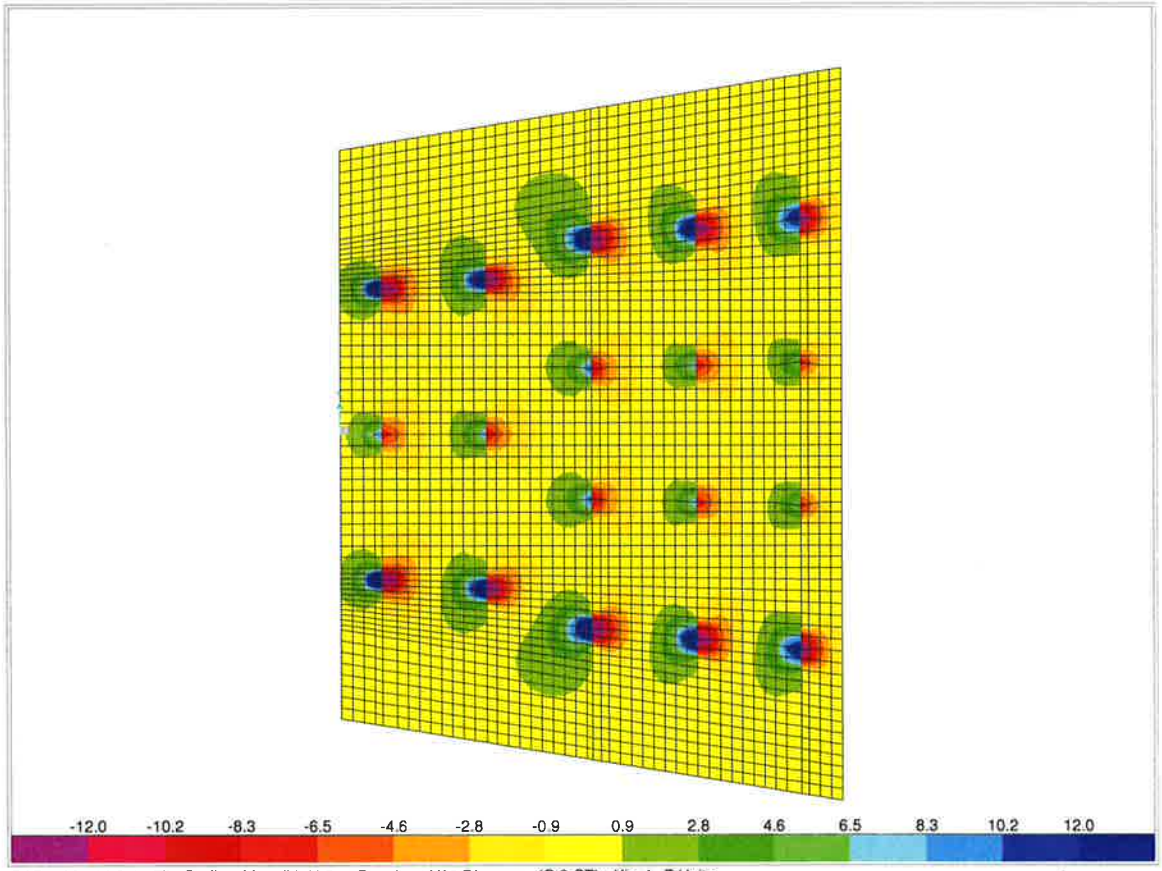

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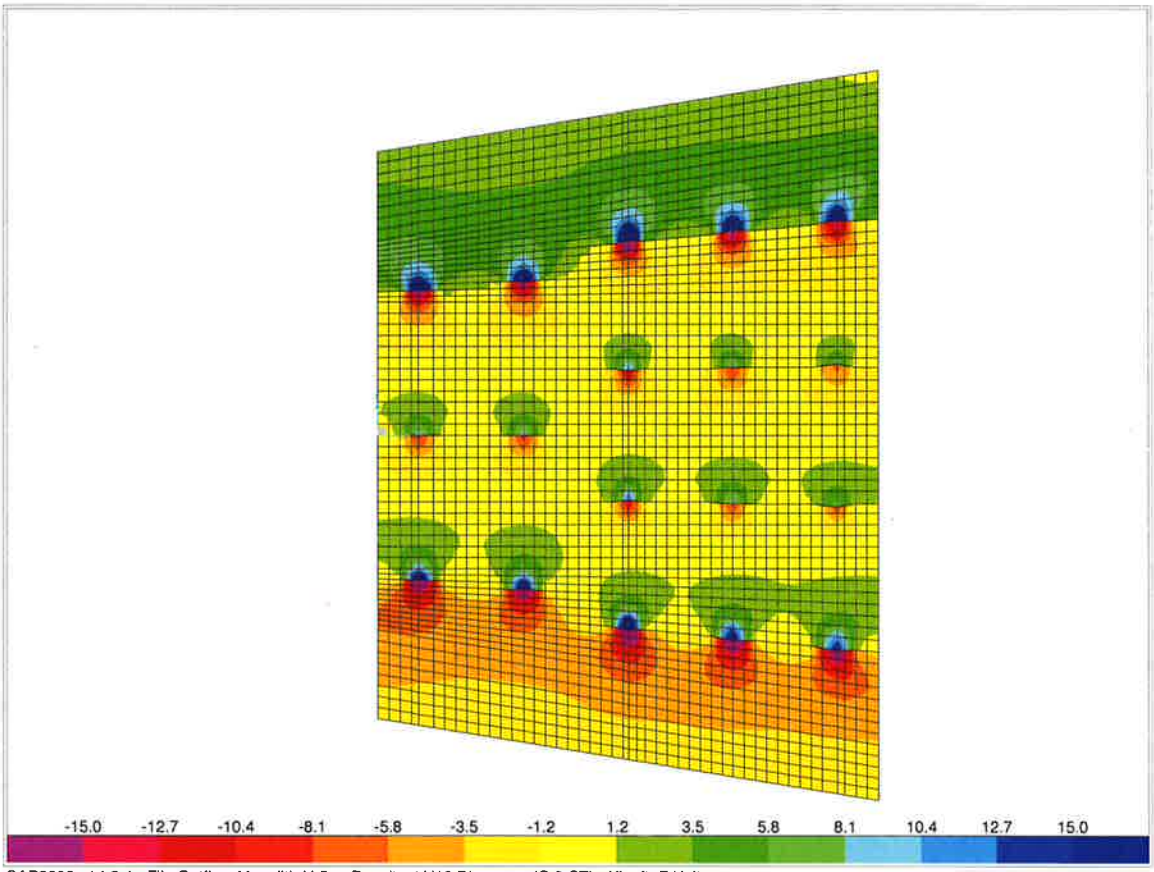

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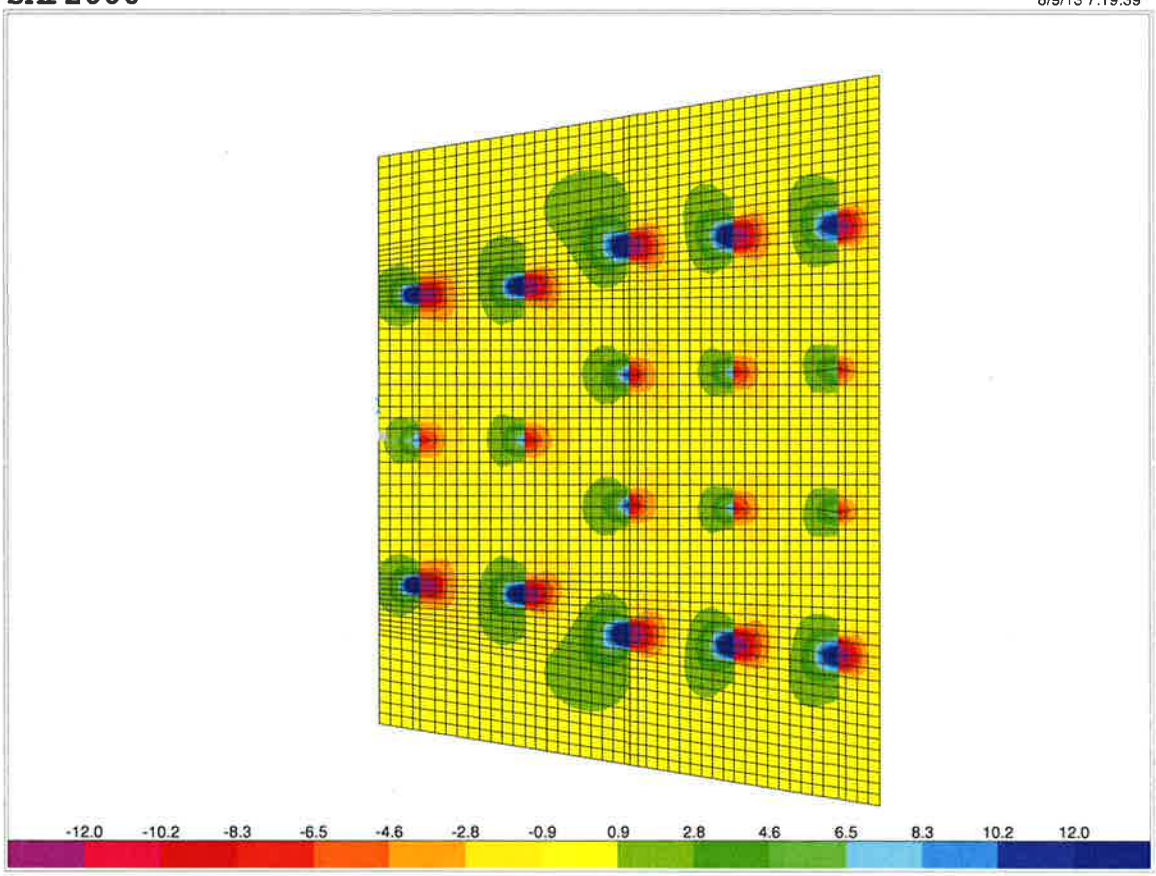
SAP2000 8/9/13 7:19:39



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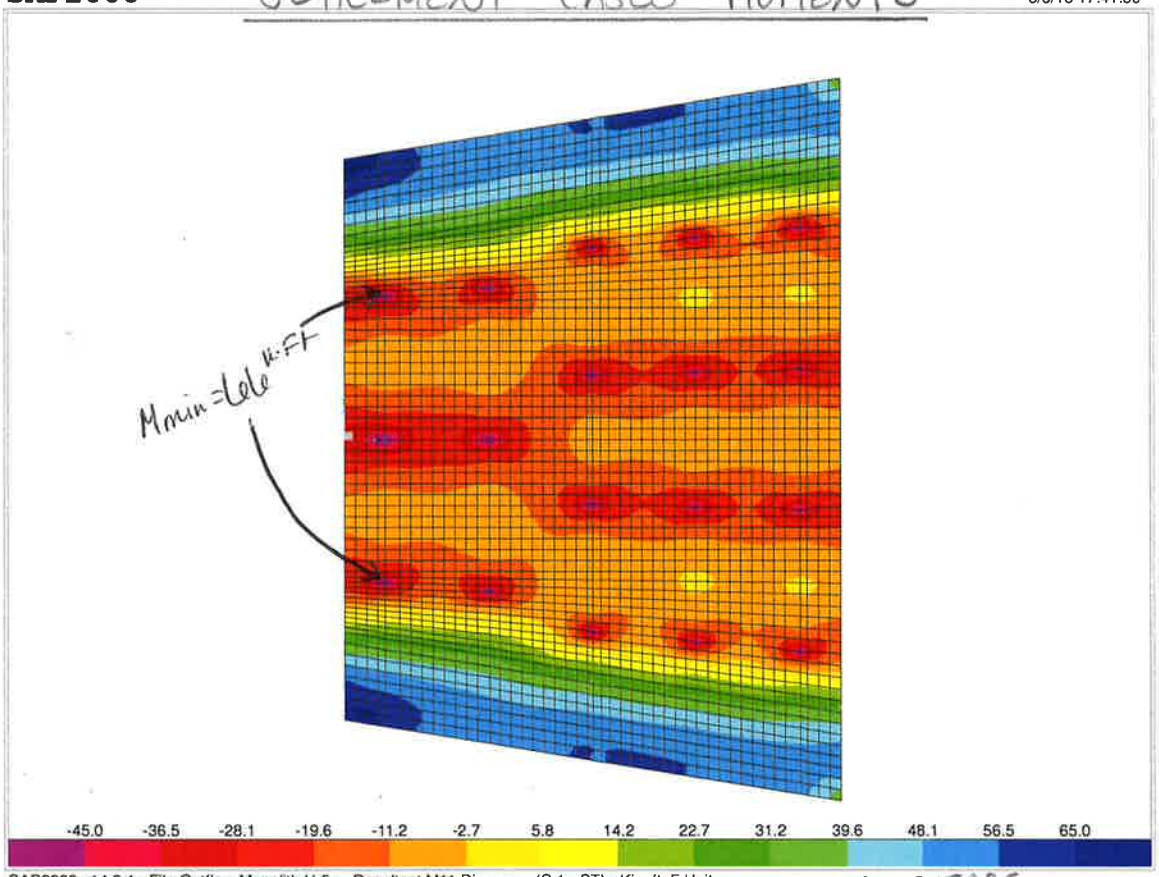
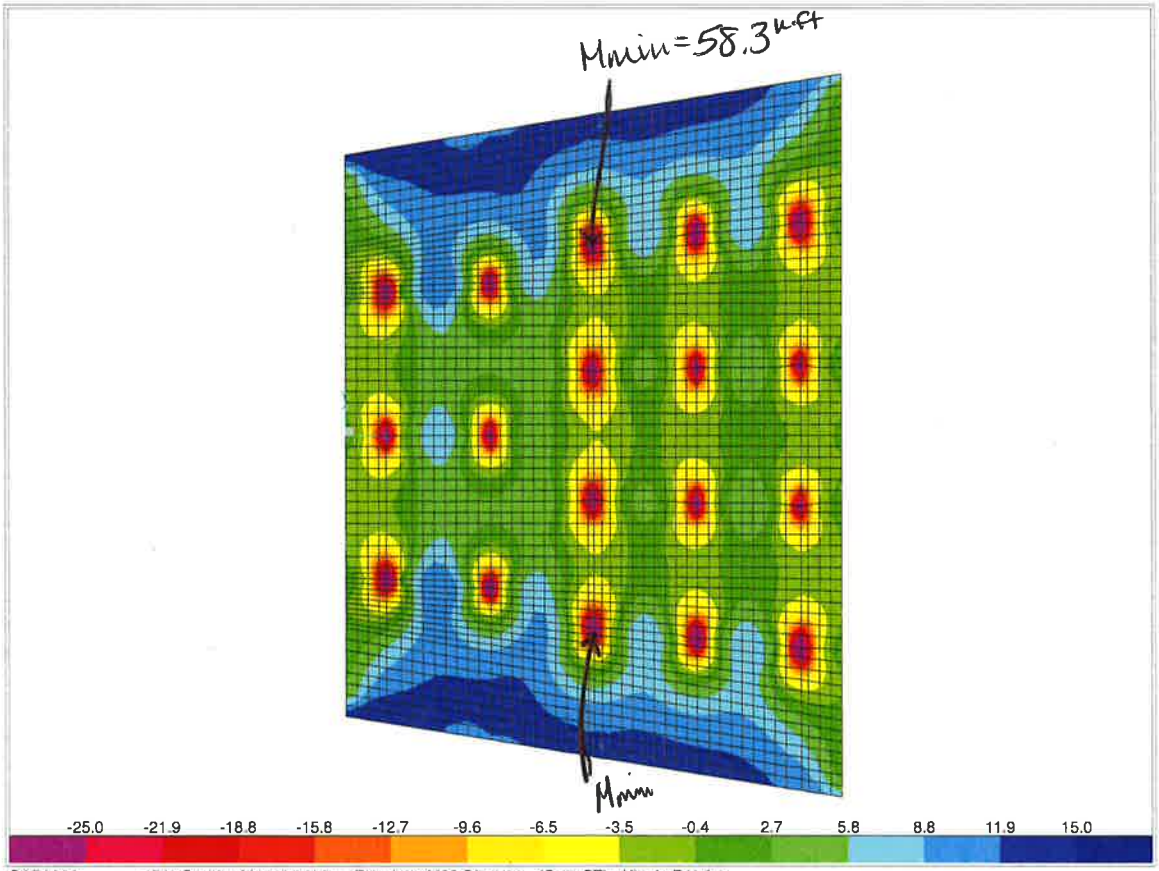
SAP2000 SETTLEMENT CASES - MOMENTS 8/8/13 17:41:50



TRANSVERSE

SAP2000 8/8/13 17:28:29



LONGITUDINAL

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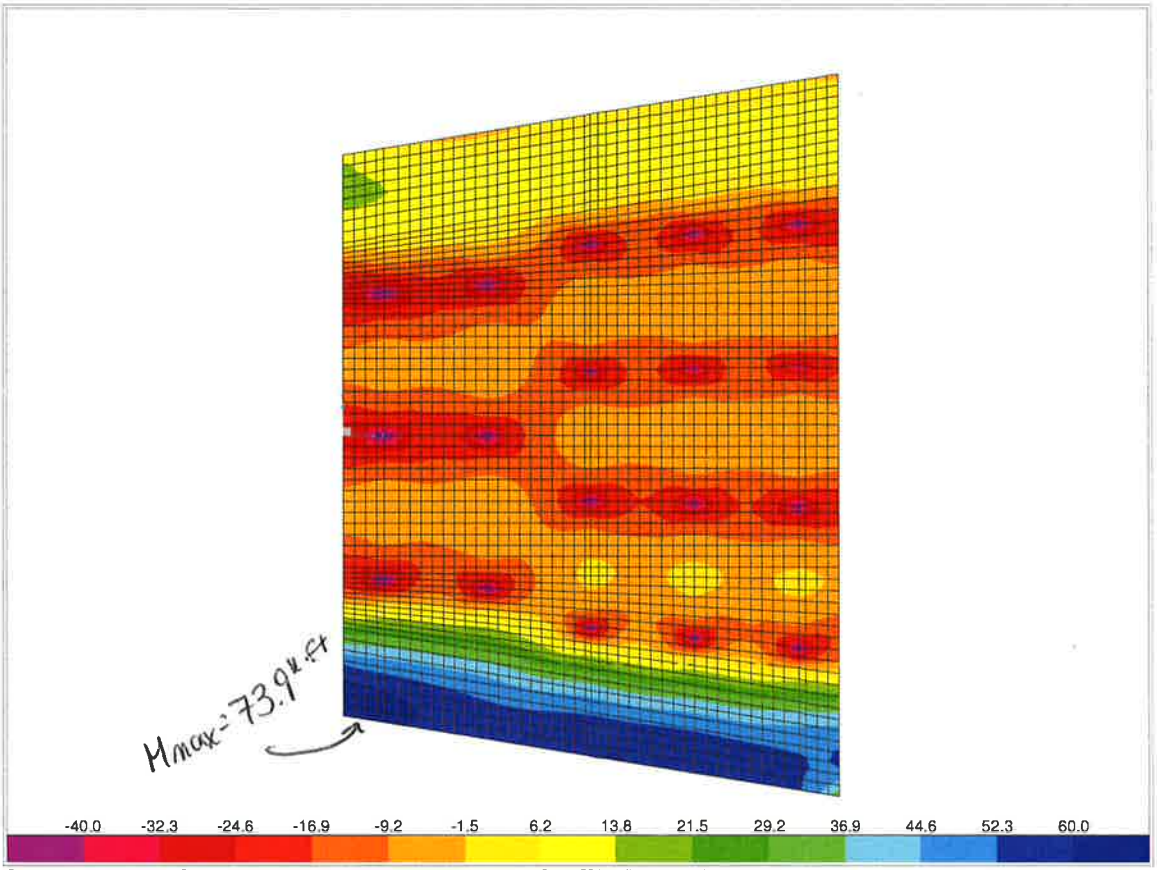
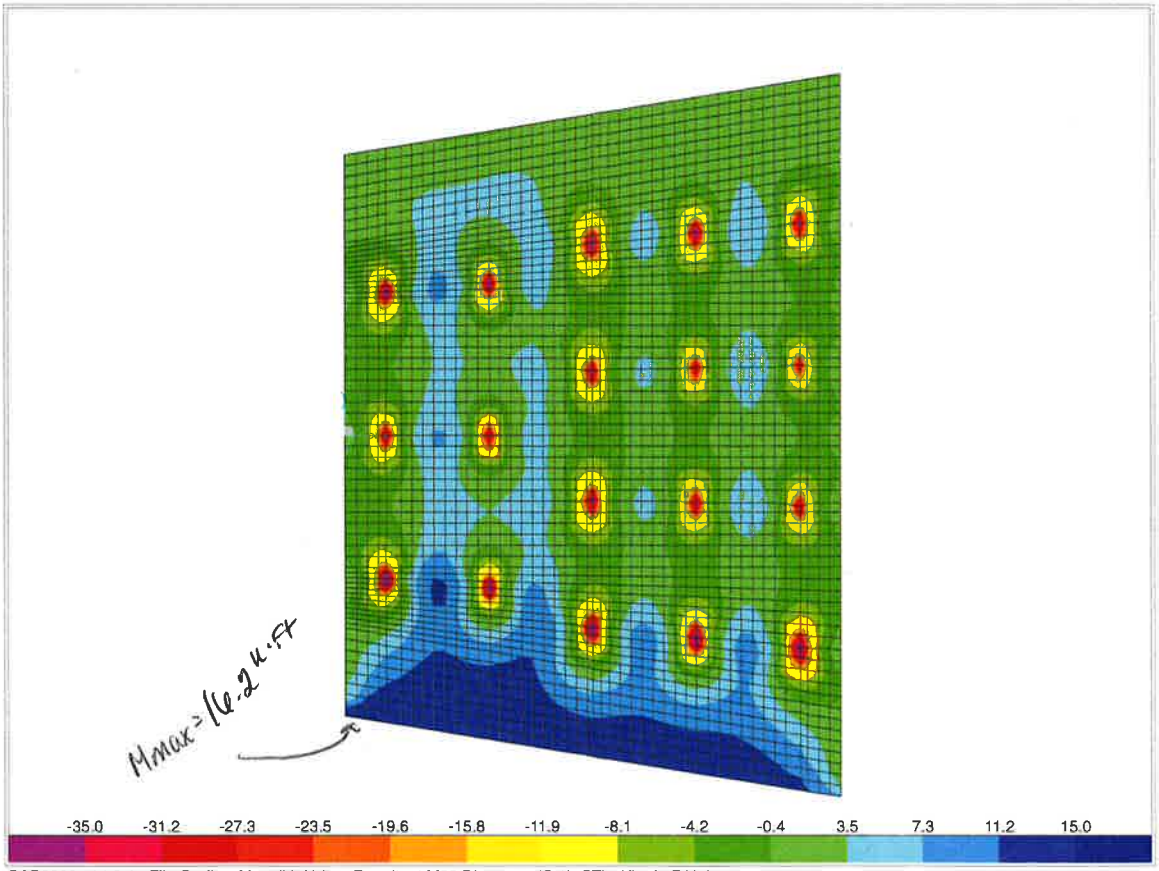


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 1b-ST) - Kip, ft, F Units

TRANSVERSE

SAP2000 8/8/13 17:30:13



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LONGITUDINAL

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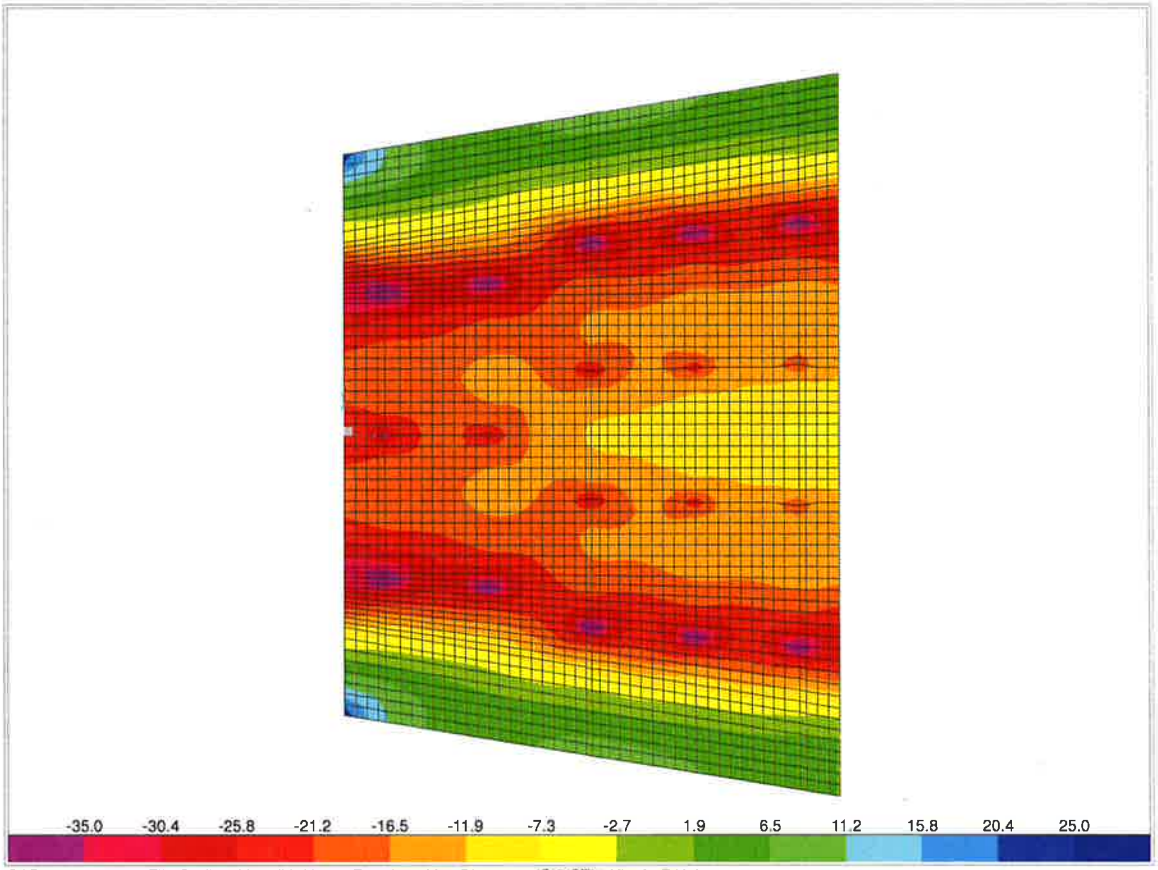

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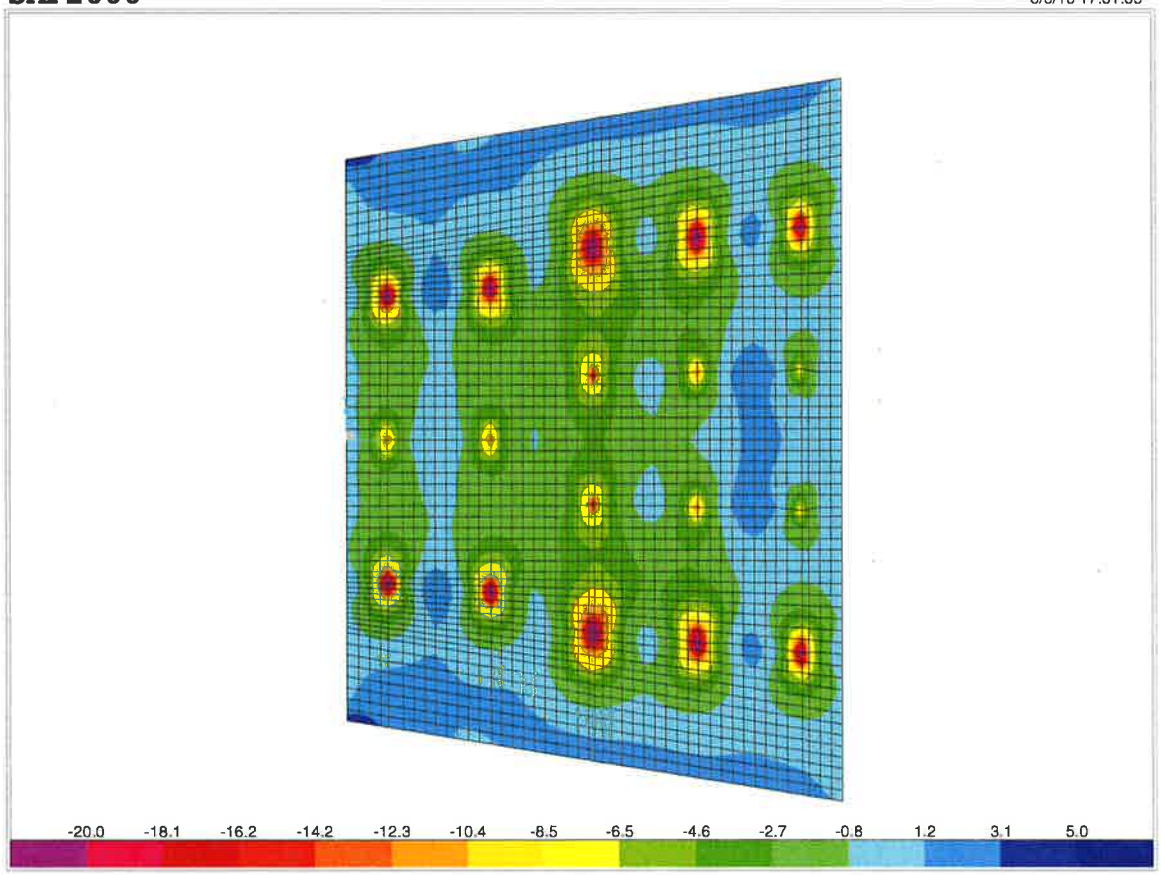
SAP2000 8/8/13 17:31:33



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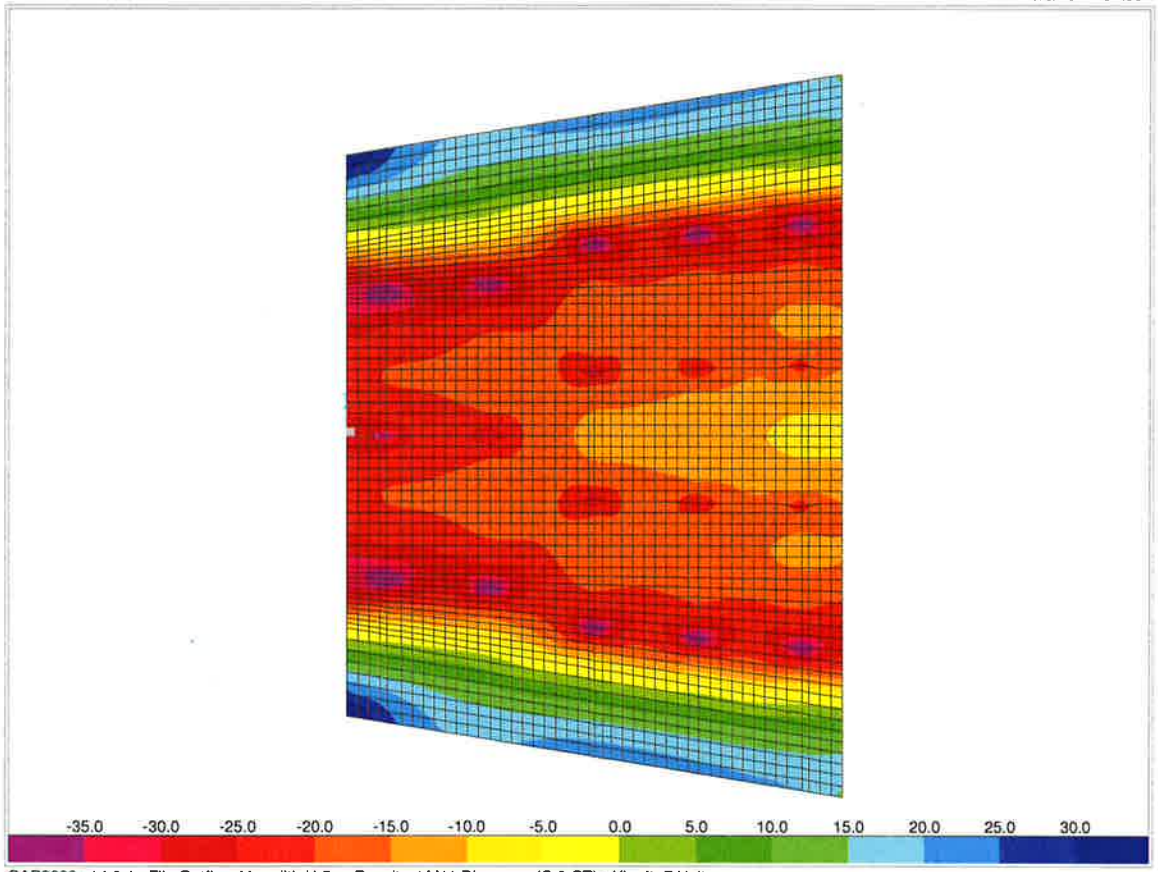
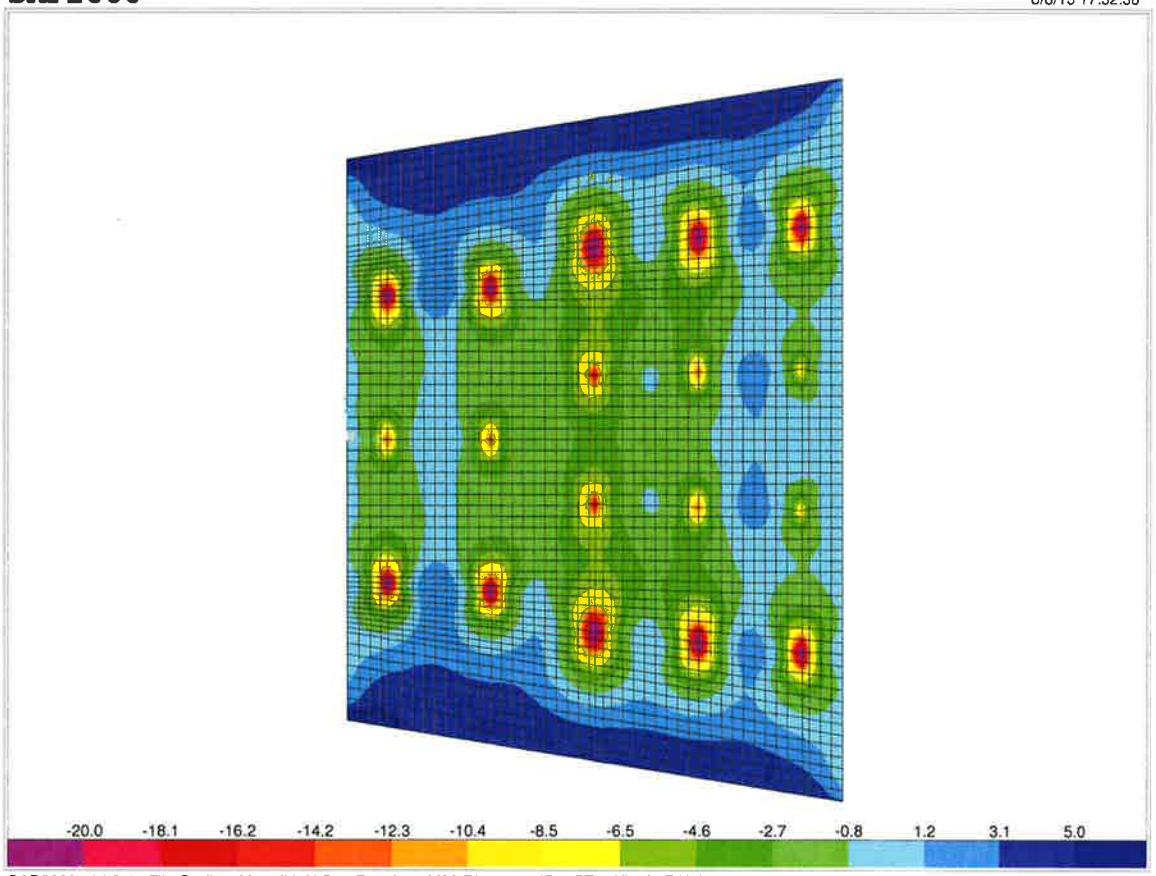


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M11 Diagram (C 3-ST) - Kip, ft, F Units

SAP2000 8/8/13 17:32:38

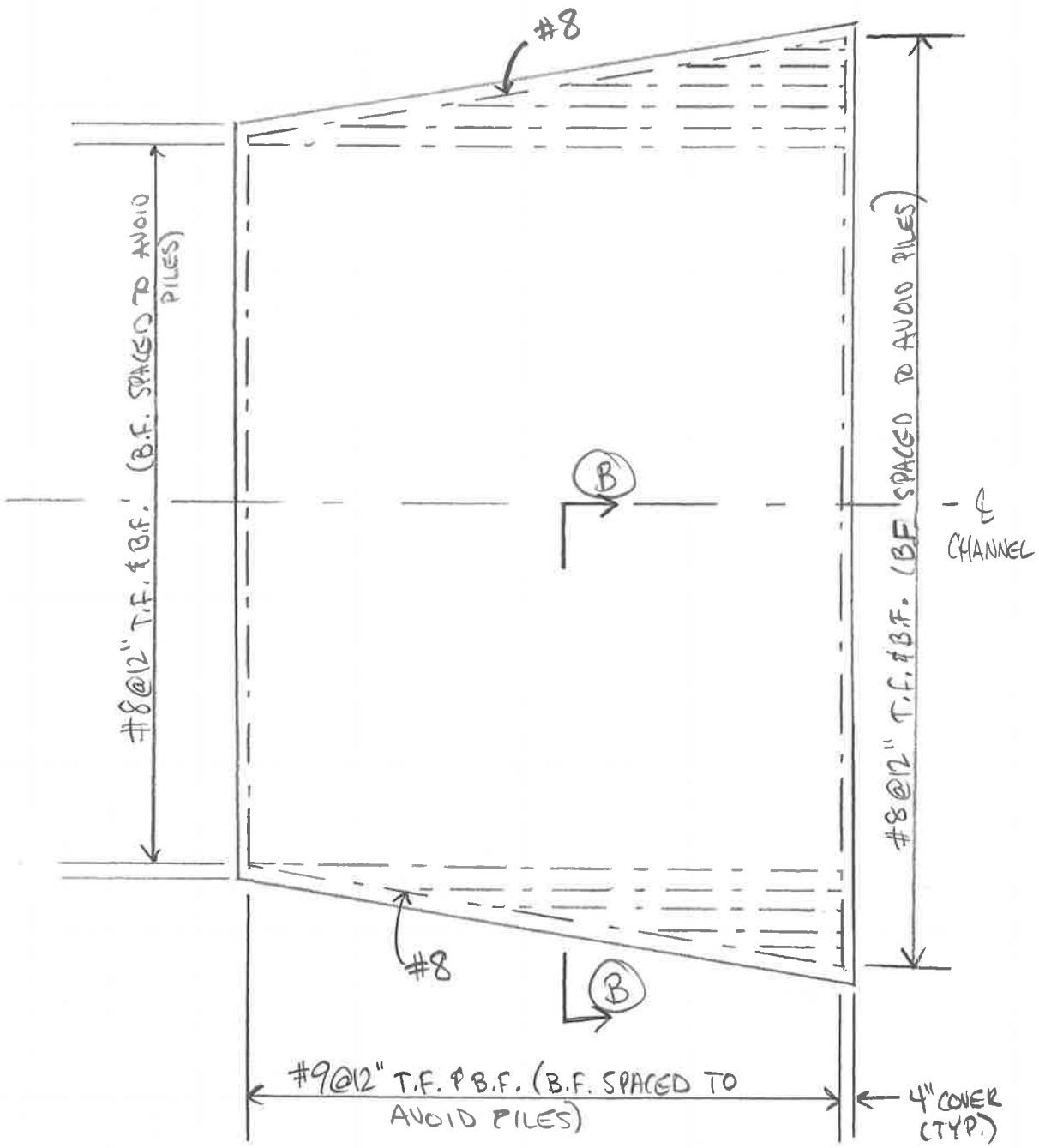


SAP2000 v14.2.4 - File:Outflow Monolith U-5 - Resultant M22 Diagram (C 3-ST) - Kip, ft, F Units

URS

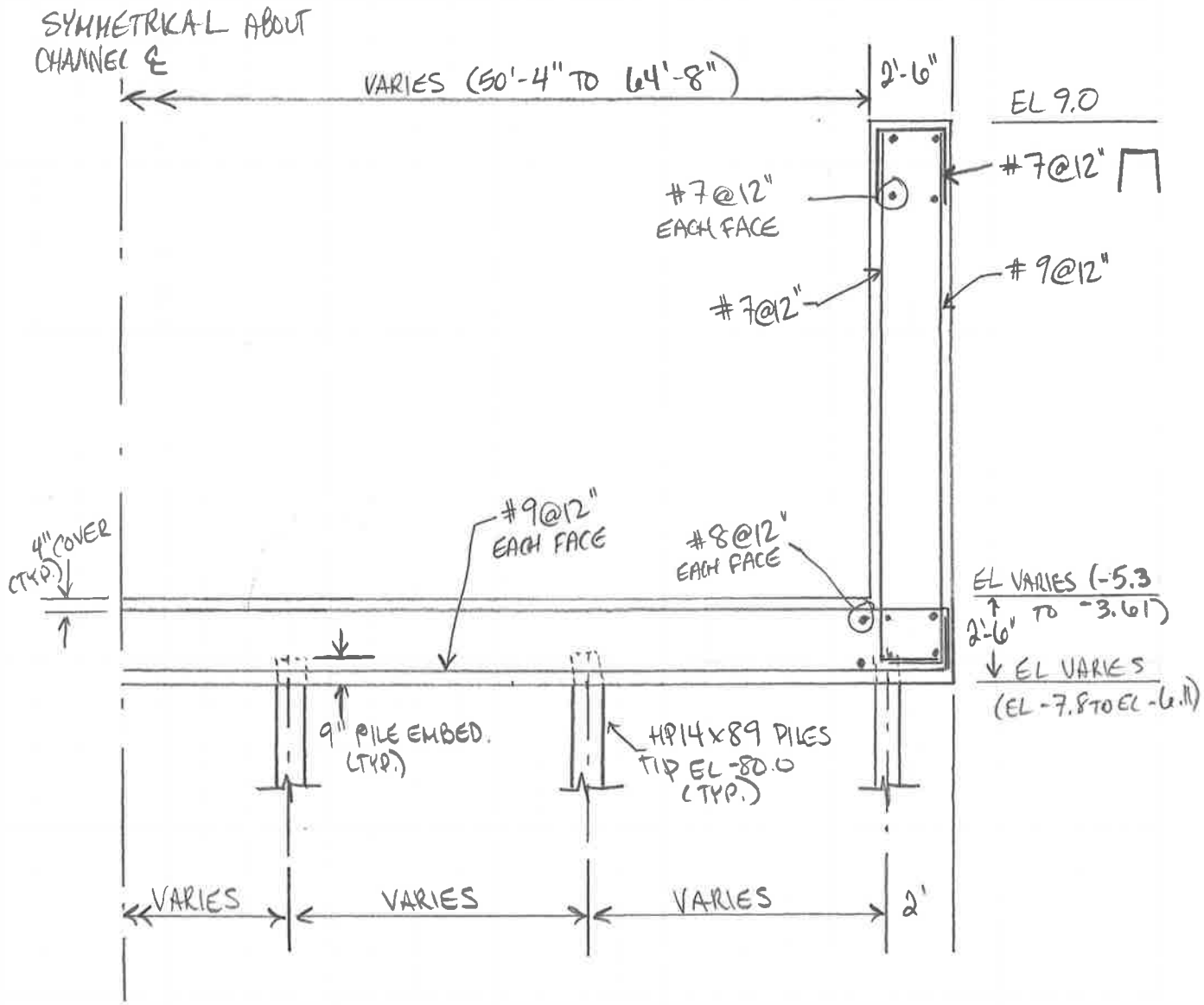
Job MAUREPAS | Project No. 10001876 | Page ___ of ___
Description U-5 REINF. | Computed by LBR | Sheet ___ of ___
Checked by ___ | Date 8/2013
Date ___

Reference



URS

Job: MAUREPAS
Description: U-5 REINF.
Project No.: 10001876
Computed by: LBR
Checked by:
Page ___ of ___
Sheet ___ of ___
Date: 8/2013
Date:
Reference



(B)

NOTE: NUMBER OF PILES & SPACING DIFFER ALONG LENGTH OF MONOLITH. SEE SHEET HS-X.XX FOR PILE LAYOUT.

SECTION 7

U-6 MONOLITH DESIGN

PART 1

SAP Model Overview & Load Input

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876
Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of
Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

LC #	Description	Allowable Overstress	Applicable Loads
Dead	Dead Load	0.00%	Dead Load (concrete)
1a	Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
1a-ST	Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Dry Backfill
			Vertical Downdrag (600psf on walls/slab edges)
1b	Uneven Construction Condition	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
1b-ST	Uneven Construction Condition + Settlement of Adjacent Clay	16.67%	Dead Load (concrete)
			Vertical Surcharge (250psf on slab)
			Horizontal Surcharge (300psf on walls)
			Lateral Load from Uneven Dry Backfill (5ft differential)
			Vertical Downdrag (600psf on walls/slab edges)
1c	Construction with Wind	16.67%	Dead Load (concrete)
			Wind (50psf) on walls before backfilling
2	High Water Condition	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
2-ST	High Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water to T.O. Protection (EL. 9.0 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)
3	Low Water Condition	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2.0 NAVD88)
			Lateral Load from Saturated Soil
3-ST	Low Water Condition + Settlement of Adjacent Clay	0.00%	Dead Load (concrete)
			Water at Minimum Operation Level (EL. 2.0 NAVD88)
			Lateral Load from Saturated Soil
			Vertical Downdrag (600psf on walls/slab edges)

Notes: High Water is at EL 9.0 because this is the T.O. Levees adjacent to the outflow channel
Low Water is at EL 2.0 because this is the T.O. Weir separating the headworks from the sedimentation basin is EL 2.5. 6 inches of water is removed to conservatively account for evaporation.

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Design Load Cases **Computed By:** LBR **Date:** Jul-13 **Page:** of

Outflow U-Frame Monoliths **Checked By:** **Date:** **Sheet:** of

Load Pattern Name	Pattern Description
DEAD	Dead load of concrete structure
ST_cohesion	Downdrag force due to cohesive clay soils settling against walls
ST_cohesion_uneven	Downdrag force due to clay soils settling against walls for uneven backfill
LS_const	Construction surcharge loads (horizontal & vertical)
LS_const_uneven	Construction surcharge loads (horizontal & vertical) for uneven backfill
L_high water	Lateral & vertical loads from water to EL 9.0
L_low water	Lateral & vertical loads from water to EL 2.0
U_high water	Uplift load from water to EL 9.0
U_low water	Uplift load from water to EL 2.0
S_const	Soil pressure from dry backfill during construction
S_const_uneven	Soil pressure from dry uneven backfill during construction (5ft differential)
S_saturated	Soil pressure from saturated soil (water to EL 9.0 and EL 2.0)
W_construction	Wind load during construction before backfilling of soil - applied to front face of one wall, back face of the other

LC #	Patterns Included
Dead	DEAD
1a	DEAD
	LS_const
	S_const
1a-ST	DEAD
	LS_const
	S_const
	ST_cohesion
1b	DEAD
	LS_const_uneven
	S_const_uneven
1b-ST	DEAD
	LS_const_uneven
	S_const_uneven
	ST_cohesion_uneven
1c	DEAD
	W_construction
2	DEAD
	L_high water
	U_high water
	S_saturated
2-ST	DEAD
	L_high water
	U_high water
	S_saturated
	ST_cohesion
3	DEAD
	L_low water
	U_low water
	S_saturated

In the SAP model Load "Cases" and Load "Combinations" are created. The Load Cases are labeled 1a, 1b, etc. & are the superimposed addition of the patterns listed to the left. Pile reactions are taken from these Load Cases.

The Combinations include the hydraulic & safety factors as well as the allowable overstress. These "Combinations" are labeled C 1a, C 1b, etc. Shear & Moment results in the concrete members are taken from these Load Combinations.

LC #	Patterns Included
3-ST	DEAD
	L_low water
	U_low water
	S_saturated
	ST_cohesion

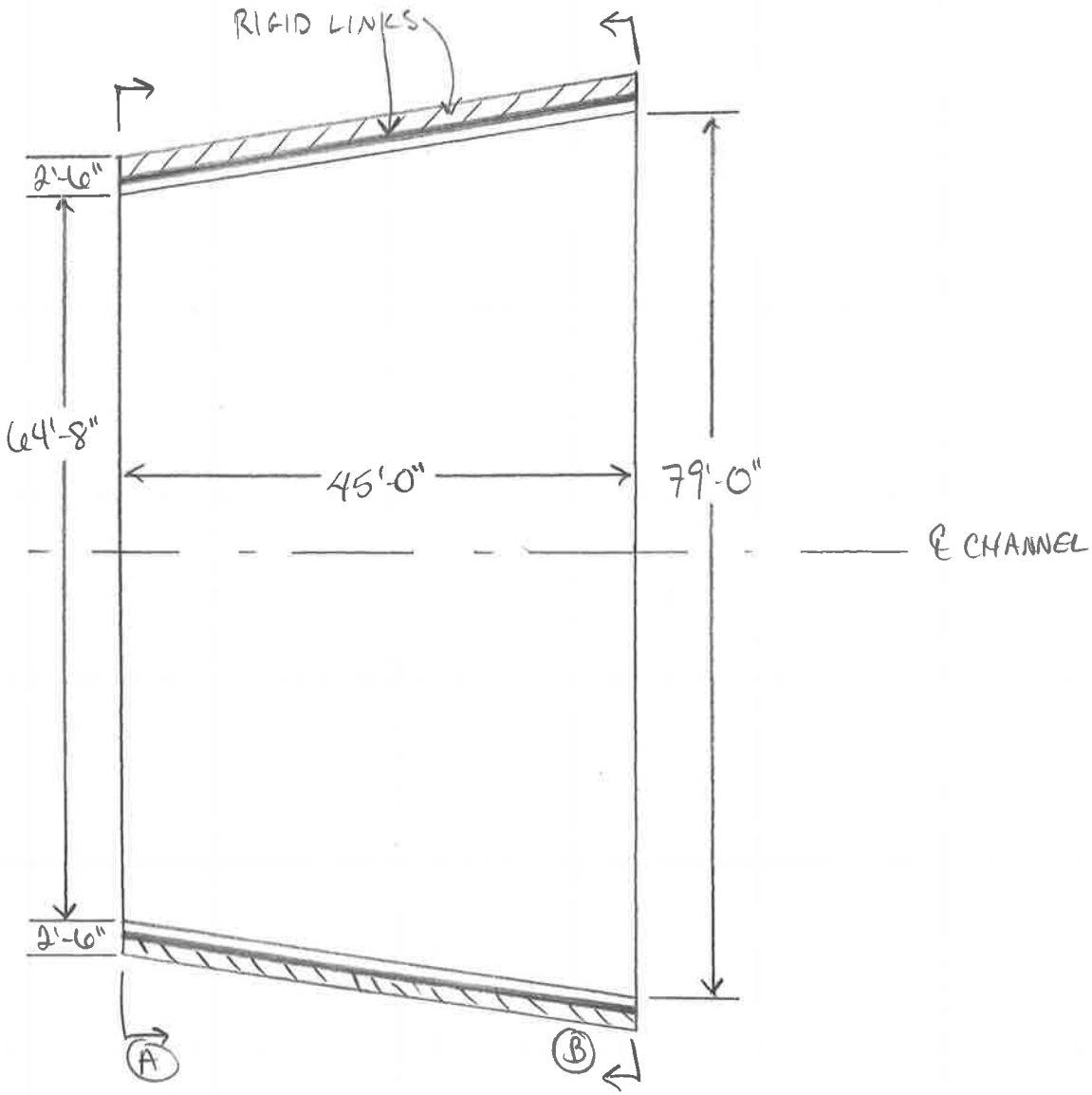
URS

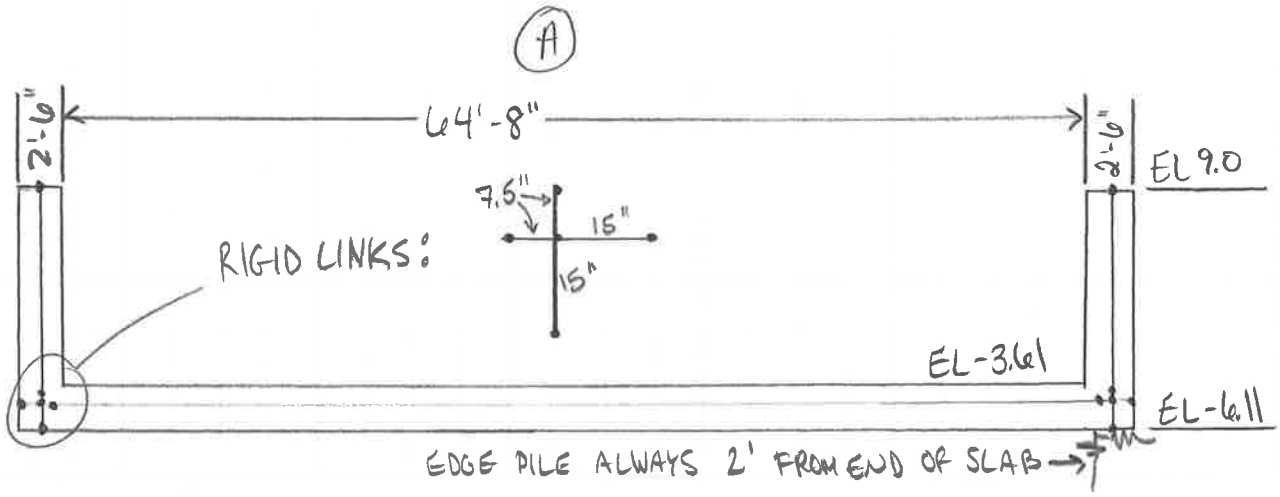
Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____

Description: MONOLITH U-6 | Computed by: LBR | Sheet ____ of ____

SAP MODEL LAYOUT | Checked by: ____ | Date: 8/2013

Reference





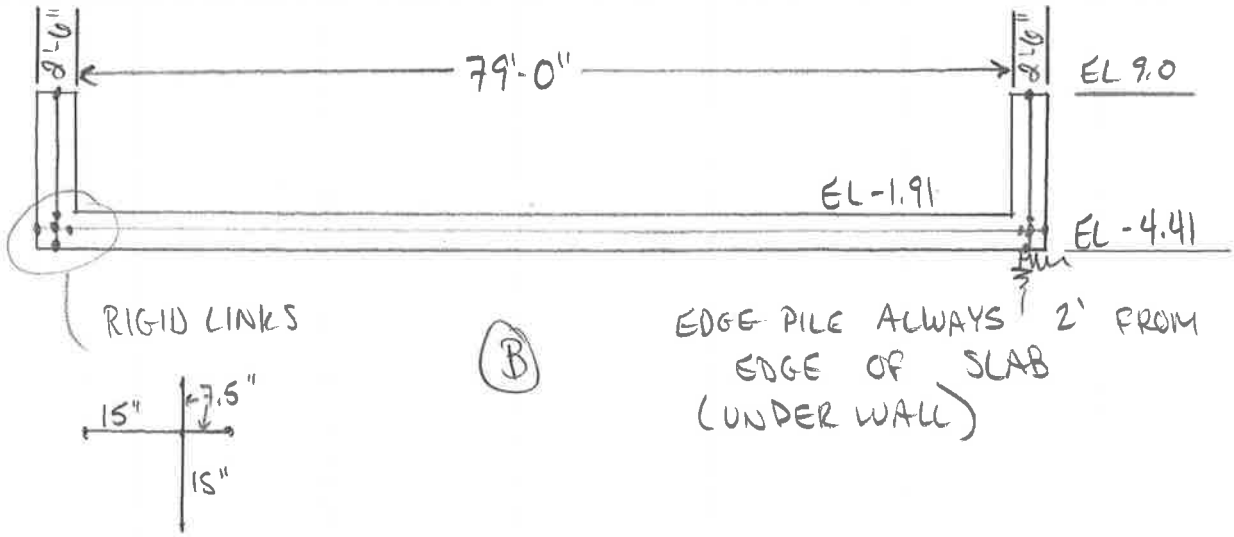
URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ____ of ____

Description: MONOLITH U-6 | Computed by: LBR | Sheet ____ of ____

SAP MODEL LAYOUT | Checked by: ____ | Date: 8/2013

Reference



DEAD LOAD CALIBRATION:

↳ ACTUAL WEIGHT:

wall length from CAD

WALLS: $\left(\frac{12.61' + 10.91'}{2}\right)$ height × 2.5' thick × 45.6' long × 2 × 150 PCF = 402,192 LB

SLAB: $\left(\frac{69.67' + 84'}{2}\right)$ wide × 2.5' thick × 45' long × 150 PCF = 1,296,590.6 LB

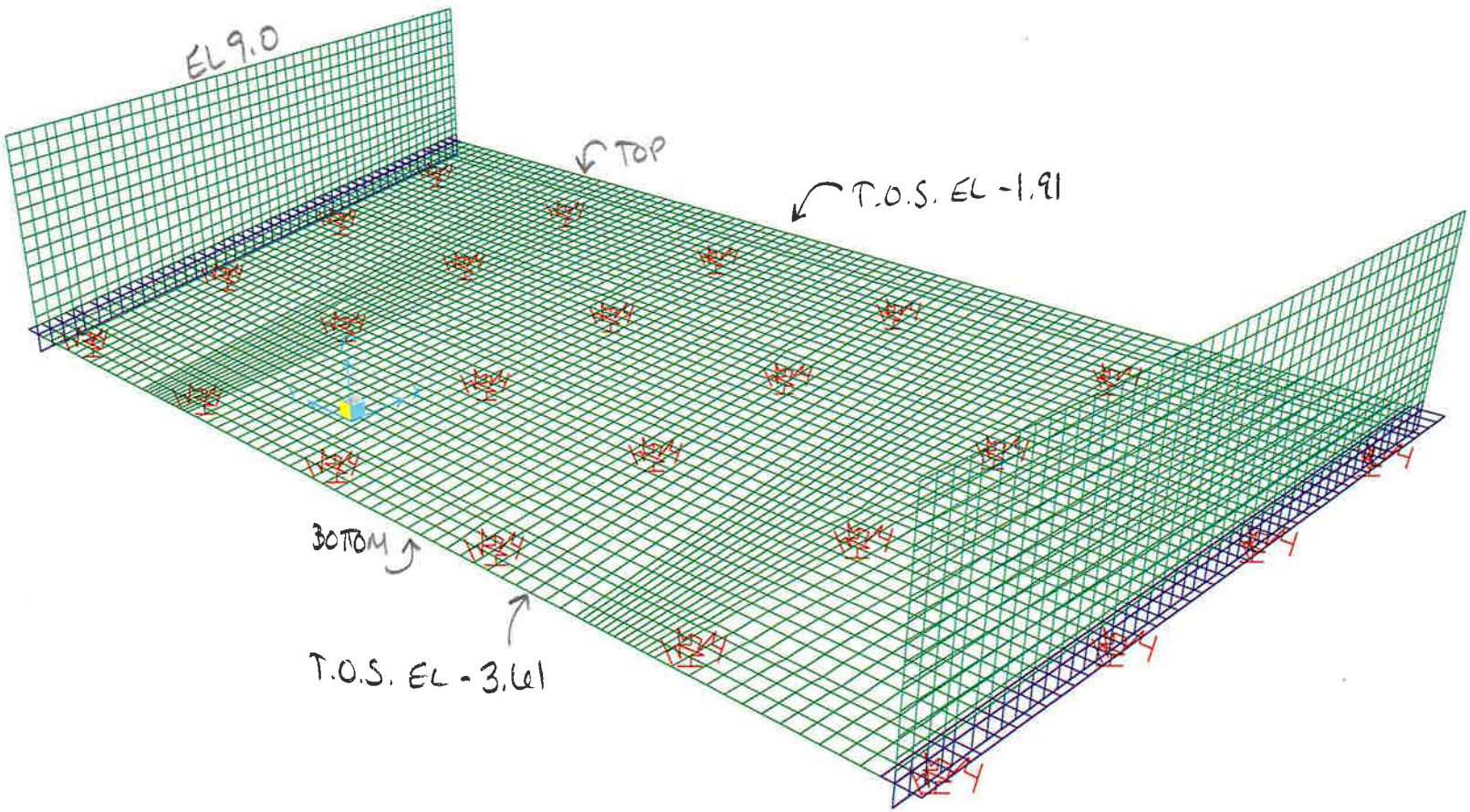
Σ = 1,698,782.6 LB

↳ SAP DEAD LOAD = 1,699,236.1 LB

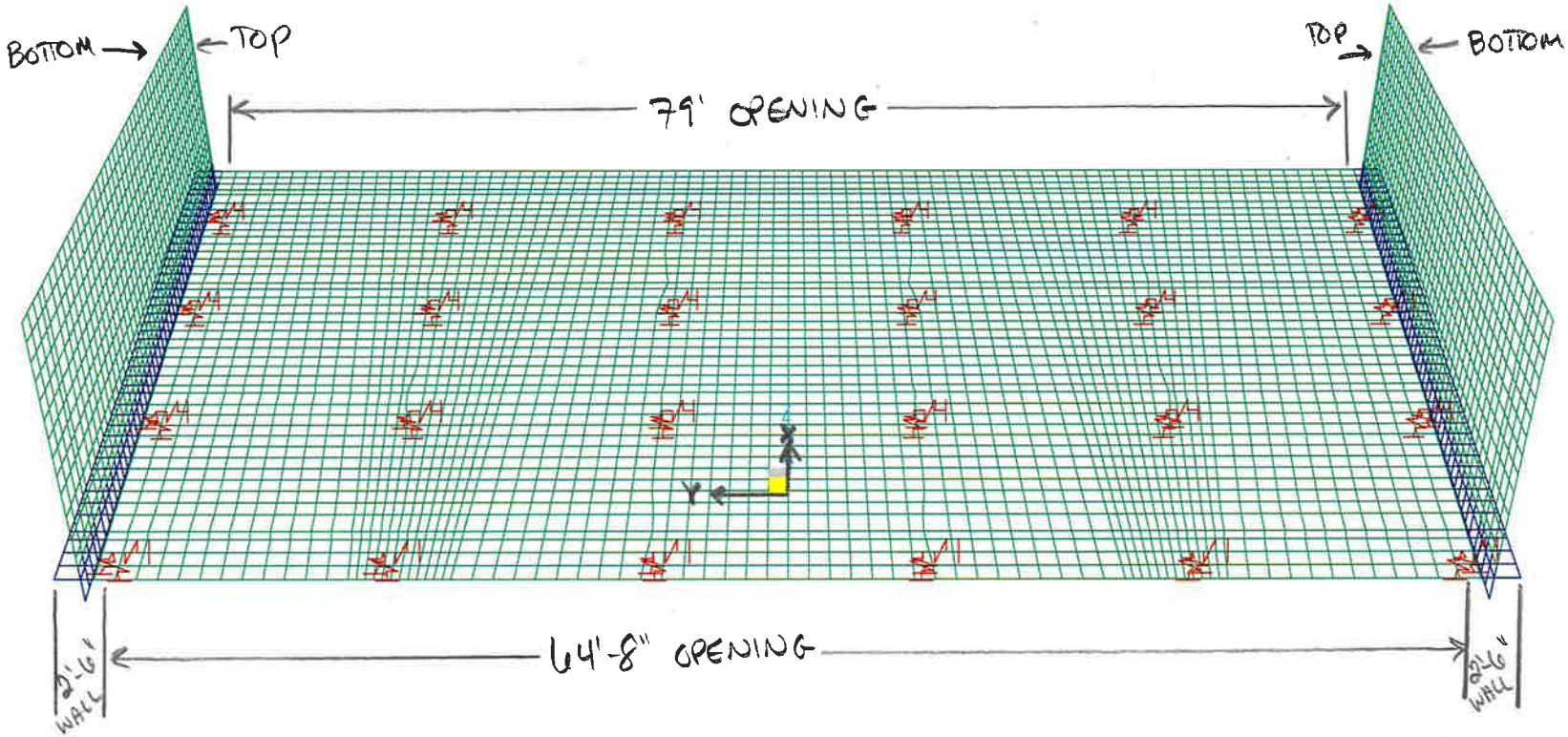
↳ DIFFERENCE OF 453.5 LB, OR 0.027% → OK

U-6 MODEL:

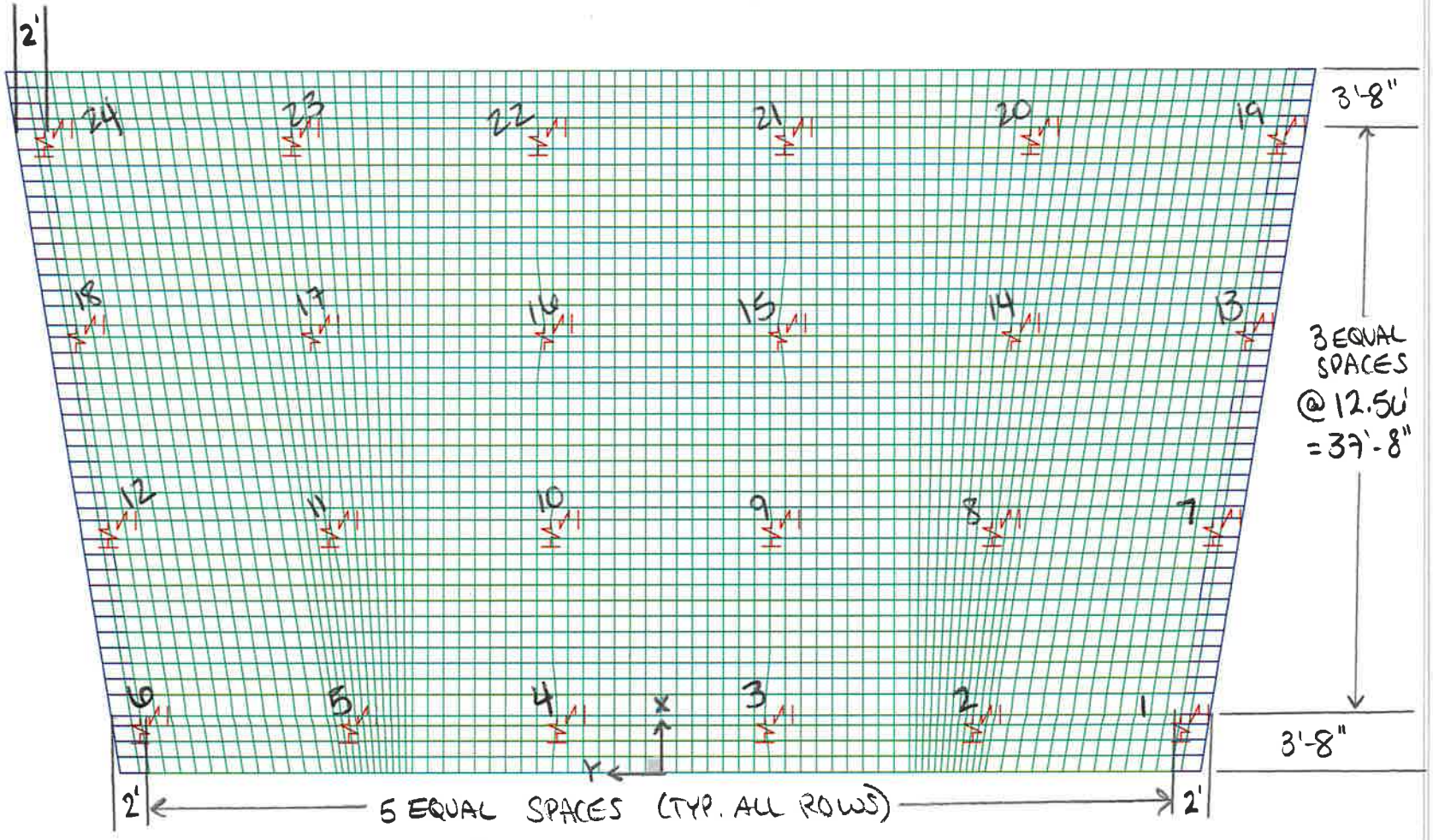
RED = PILE SPRINGS
LIGHT BLUE = NORMAL 4000PSI CONC. 2'-6" MEMBERS
DARK BLUE = "RIGID LINK" 2'-6" MEMBERS

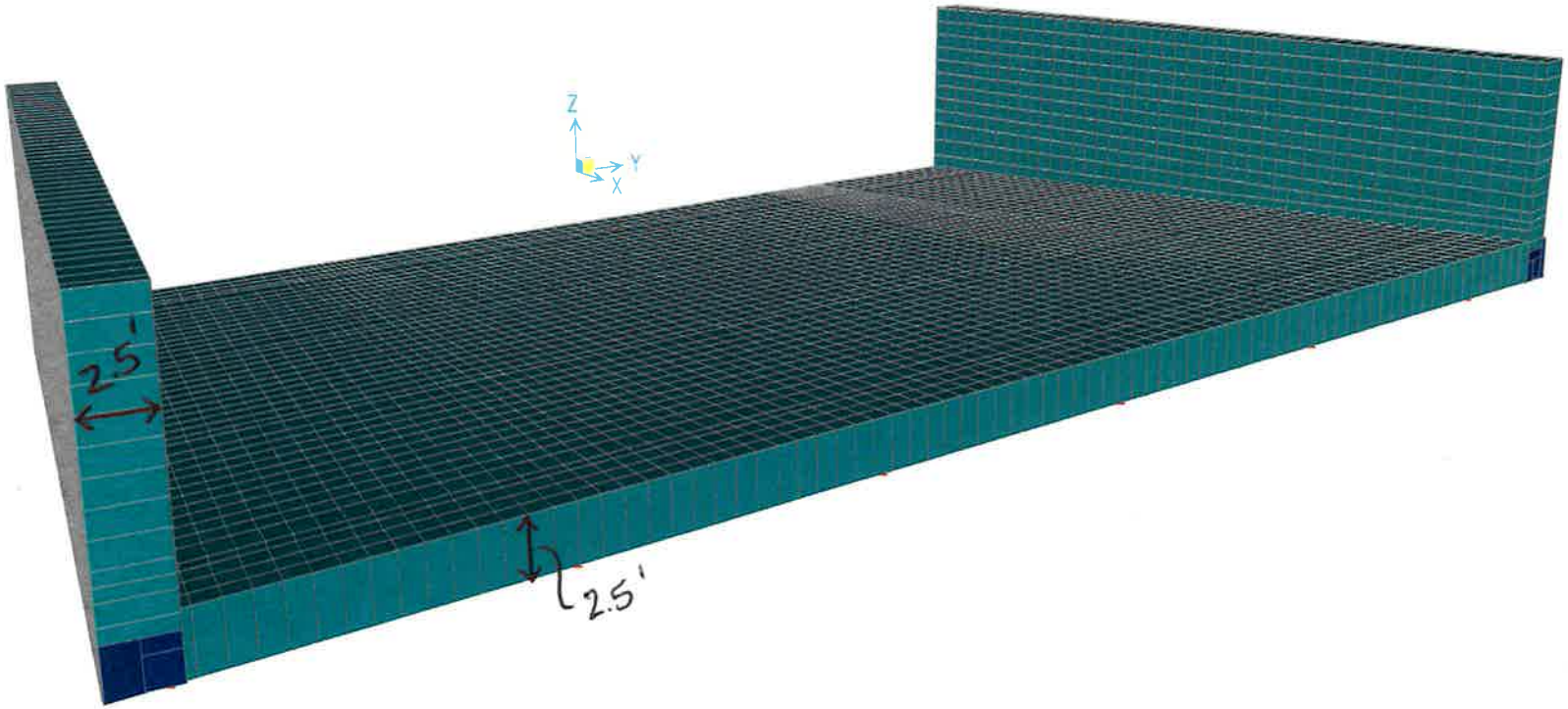


U-6 MODEL:


BOTTOM
TOP
TOP
BOTTOM
79' OPENING
64'-8" OPENING
2'-6" WALL
2'-6" WALL
X
Y

U-6 PILE LAYOUT




Z
Y
X
2.5'
2.5'

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page:	of
Description:	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

References

OUTFLOW MONOLITH - U-6 LOADS

*** PROPERTIES:**

$\gamma_{concrete}$ =	150	pcf
γ_{water} =	62.4	pcf
γ_{soil} =	115	pcf
γ' =	52.6	pcf
K_0 =	0.95	
Vert. Surcharge =	250	psf
Horiz. Surcharge =	300	psf

Top of Bank=	2.0	ft NAVD88
Top of Walls=	9.0	ft NAVD88
Top of Base Slab=	-3.607	ft NAVD88 @ start of Monolith
	-1.91	ft NAVD88 @ end of Monolith with 3.78% slope
Bottom of Slab=	-6.107	ft NAVD88 @ start of Monolith
	-4.41	ft NAVD88 @ end of Monolith with 3.78% slope
Minimum water level =	2.0	ft NAVD88
Maximum water level =	9.0	ft NAVD88
Wall thickness=	2.5	ft
Slab thickness=	2.5	ft

*** EQUATIONS USED:**

* Water Pressure (Lateral & Vertical):

*Water Pressure: $P = \gamma_{water} * Z_{water}$

* Vertical Soil Pressure:

*Above water table: $P_y = \gamma_{fill,\ wet} * Z_{fill}$

*Below water table: $P_y = \gamma_{fill,\ eff} * Z_{fill}$

* Lateral Soil Pressure Including Riprap:

*Above water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ wet} * Z_{fill})$ (EM 1110-2-2502 Eq 3-43)

*Below water table: $P_y = K_0 * (q_{surch,\ const} + \gamma_{fill,\ eff} * Z_{fill})$

*** LOADS FOR SAP MODEL:**

* Construction Surcharge Loads: Below Top of Soil = $K_0 * q_{surcharge}$ = 285 ksf

* Soil Loads, Dry (Const.): Construction surcharge load applied separately

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
2.0	0.0
-2.535	495.4
-3.16	563.7
-4.232	680.8
-4.41	700.3
-4.857	749.1
-6.1	885.7

URS

Job:	Reintroduction of Maurepas Swamp - Head Works	Project No.	10001876	Page:	of
Description:	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

* Soil Loads, UNEVEN Dry (Const.): Soil to EL 2.0 on one side (use pressures above), only to EL -3.0 on other side (use pressures calculated below)

Elevation (NAVD 88)	Lateral Pressure (lb/ft²)
2.0	0.0
-2.535	0.0
-3.0	0.0
-3.16	17.5
-4.232	134.6
-4.4	154.0
-4.86	202.9
-6.1	339.4

* Soil Loads, Maximum & Minimum Water Levels: (Because loads are the same for both water levels, using one common Load Pattern in SAP called "S_saturated")

Soil with Min Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
2.0	0.0
2.0	0.0
-2.535	226.6
-3.16	257.8
-4.232	311.4
-4.4	320.3
-4.86	342.6
-6.1	405.1

Soil with Max Water Level

Elevation (NAVD 88)	Lateral Soil Pressure (lb/ft²)
2.0	0.0
-2.535	226.6
-3.16	257.8
-4.232	311.4
-4.4	320.3
-4.86	342.6
-6.1	405.1

* Water Loads:

- Water press. on **top** of base slab:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-3.6	349.88	786.68	(Pressure at upstream end)
-1.91	243.98	680.78	(Pressure at downstream end)

- Uplift at **bottom** of base slab/uplift:

Elevation (NAVD 88)	Min Water (lb/ft²)	Max Water (lb/ft²)	
-6.1	505.88	942.68	(Pressure at upstream end)
-4.41	399.98	836.78	(Pressure at downstream end)

- Lateral Water Loads:

Min Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
2.0	0.0
2.0	0.0
-2.535	283.0
-3.16	322.0
-4.232	388.9
-4.41	400.0
-4.86	427.9
-6.1	505.9

Max Water Level

Elevation (NAVD 88)	Lateral Water Pressure (lb/ft²)
9.0	0.0
-2.535	719.8
-3.16	758.8
-4.232	825.7
-4.4	836.8
-4.86	864.7
-6.1	942.7

Note: Water Pressure is equal on either side of the wall (as per hydraulics engineers). Most water pressure cancels out along walls.

URS

Job:	Reintroduction of Maurepas Swamp Head Works	Project No.	10001876	Page	of
Descriptior	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

Monolith U-6 SAP Data:

Outflow Monolith outer wall Joint Pattern for lateral force due to Construction Soil (dry): **"Lat Soil"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
2	0.00
-6.107	885.69

Equations:

$$0 = C*2 + D$$
$$885.69 = C*-6.107 + D$$

C =	-109.250
D =	218.500

Outflow Monolith outer wall Joint Pattern for lateral force due to Uneven Construction Soil: **"Lat Soil - Uneven"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
-3	0.00
-6.107	339.44

Equations:

$$0 = C*-3 + D$$
$$339.44 = C*-6.107 + D$$

C =	-109.250
D =	-327.750

Outflow Monolith outer wall Joint Pattern for lateral **Saturated Soil** load due to **Both Water Levels:**

The Joint Pattern created for the Lateral Construction Soil Load may be used for this load pattern with a scaling factor.

Soil Pressure @ EL -6.107, Construction Soil = 885.6898 psf
Soil Pressure @ EL -6.107, Saturated Soil = 405.1068 psf

Scale factor = 405.11 / 885.69
= **0.45739** * "Lat Soil" pattern

URS

Job:	Reintroduction of Maurepas Swamp Head Works	Project No.	10001876	Page	of
Descriptior	Design Criteria and Load Analysis for Outflow Monoliths	Computed By:	LBR	Date:	August-13
		Checked By:		Date:	

Outflow Monolith wall Joint Pattern for lateral **Water** load due to **Min Water Level**: **"Lat Water - MIN"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
2.0	0.00
-6.1	505.88

Equations:

$$0 = C*2 + D$$
$$505.88 = C*-6.107 + D$$

C =	-62.400
D =	124.800

Outflow Monolith outer wall Joint Pattern for lateral **Water** load due to **Max Water Level**: **"Lat Water - MAX"**

Equation: P=Cz+D where P = Pressure at Coordinate z
z = z coordinate of model
C & D = constants

Z	P
9.0	0.00
-6.1	942.68

Equations:

$$0 = C*9 + D$$
$$942.68 = C*-6.107 + D$$

C =	-62.400
D =	561.600

Outflow Monolith Joint Pattern due to **Downward Water Pressure on Base Slab**:

Min Water: "Vert Water - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	349.88
45.0	243.98

Equations:

$$349.88 = A*0 + D$$
$$243.98 = A*45 + D$$

A =	-2.353
D =	349.877

Max Water: "Vert Water - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	786.68
45.0	680.78

Equations:

786.68 = A*0 + D
680.78 = A*45 + D

A =	-2.353
D =	786.677

Outflow MonolithJoint Pattern due to **Uplift Pressure on Base Slab**:

Min Water Uplift: "Uplift - MIN"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	505.88
45.0	399.98

Equations:

505.88 = A*0 + D
399.98 = A*45 + D

A =	-2.353
D =	505.877

Max Water Uplift: "Uplift - MAX"

Equation: P=Ax+D where P = Pressure at Coordinate x
x = x coordinate of model
A & D = constants

X	P
0	942.68
45.0	836.78

Equations:

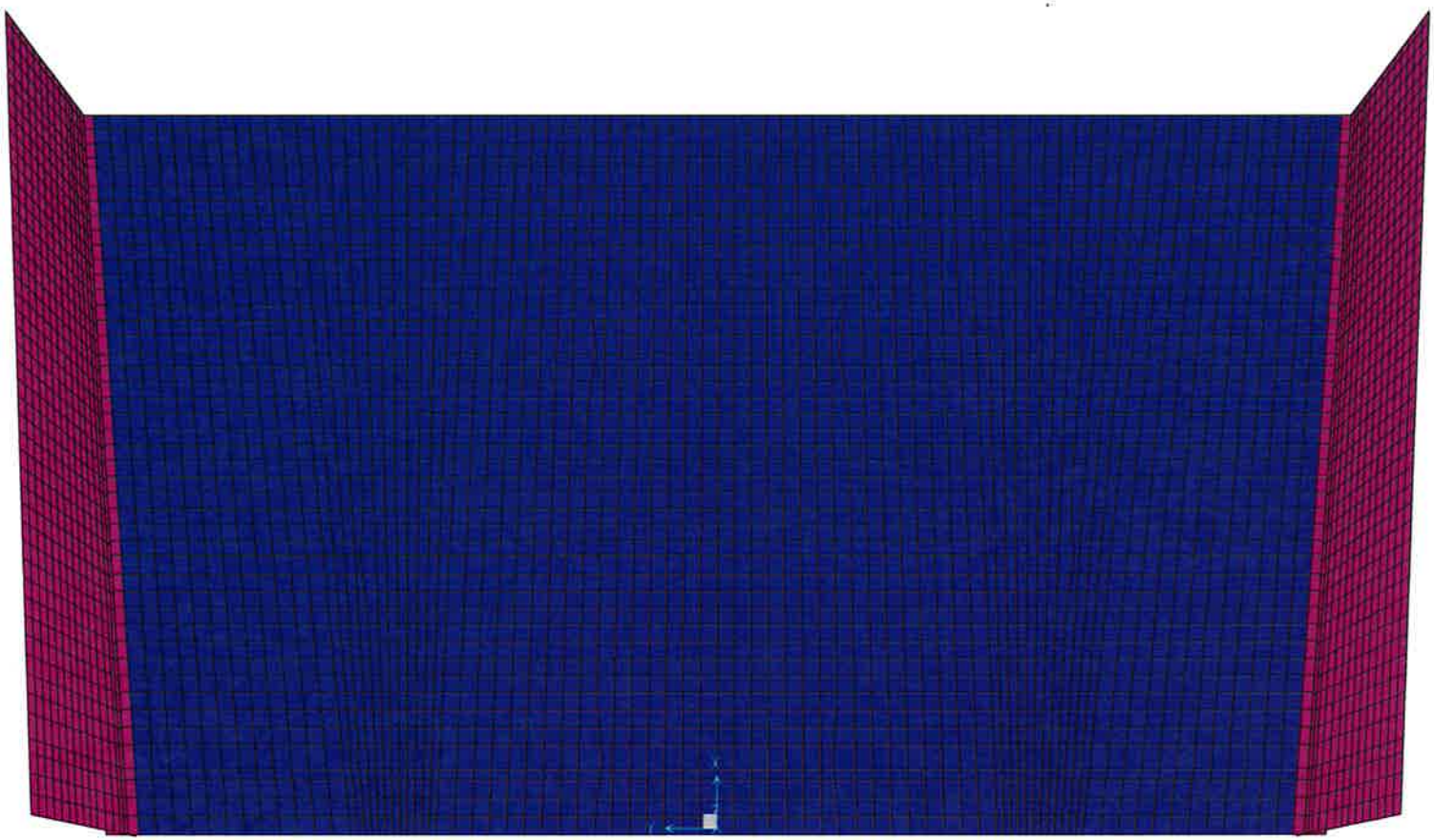
942.68 = A*0 + D
836.78 = A*45 + D

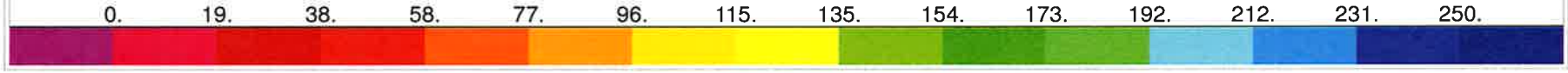
A =	-2.353
D =	942.677

SAP 2000

8/9/13 12:32:19

CONSTRUCTION SURCHARGE:

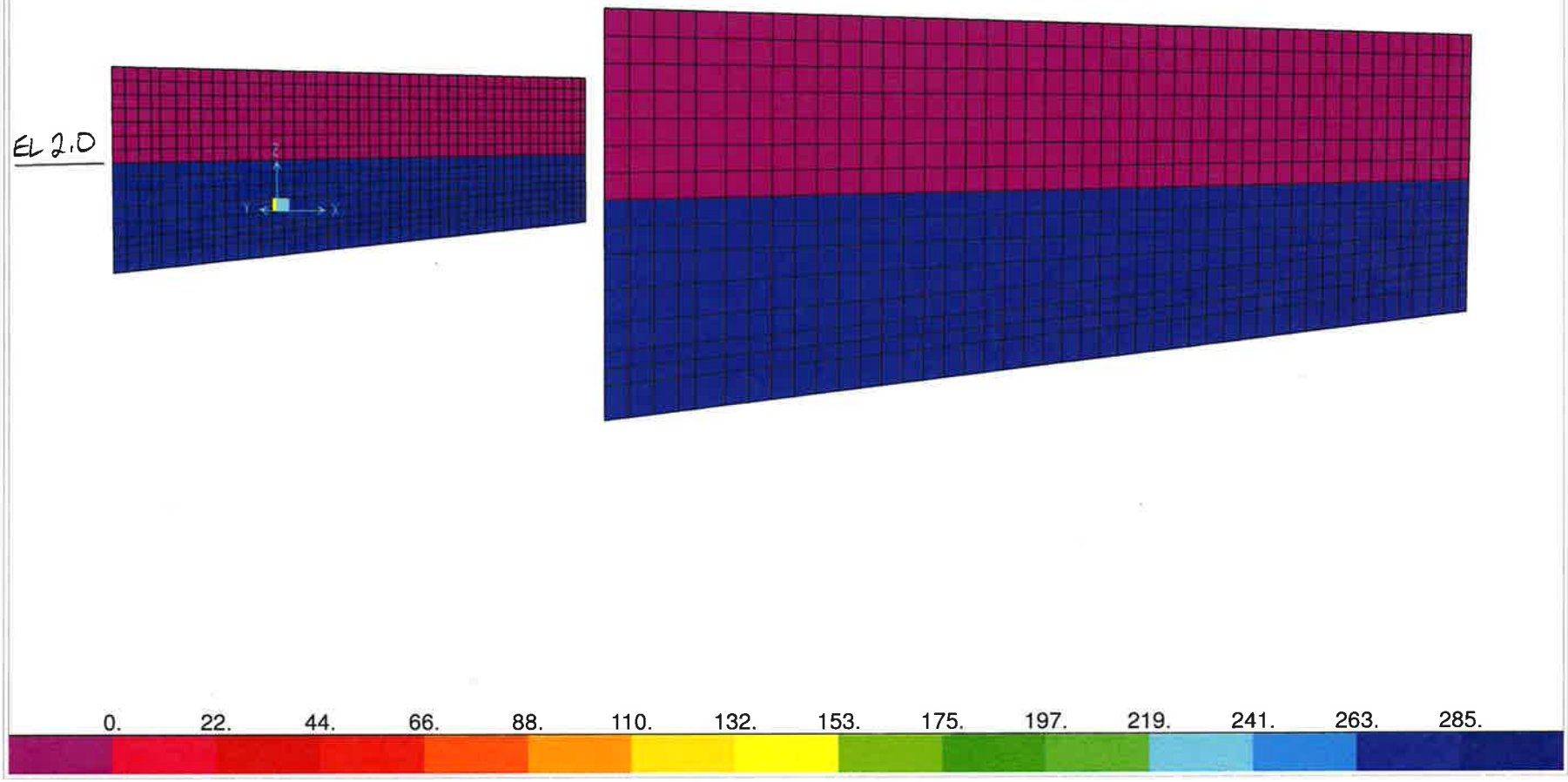




SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Top (LS_const) - lb, ft, F Units

CONSTRUCTION SURCHARGE:

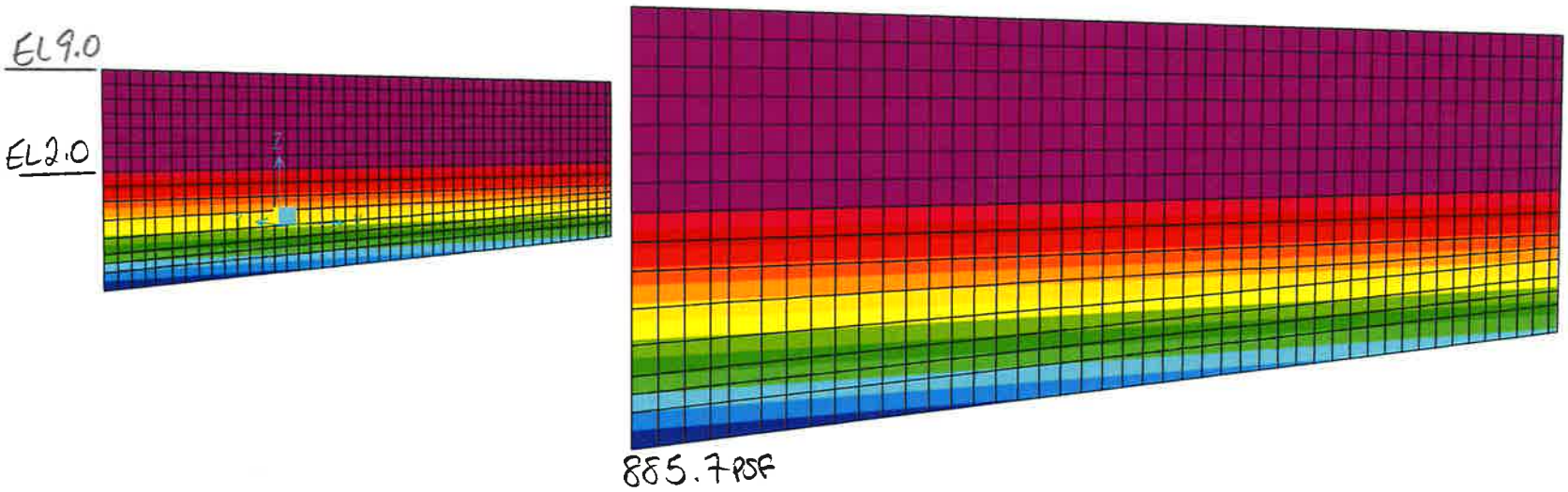
EL 2.0

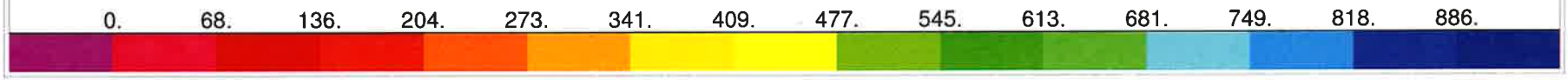


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (LS_const) - lb, ft, F Units

SAP2000 8/10/13 8:38:49

CONSTRUCTION SOIL:



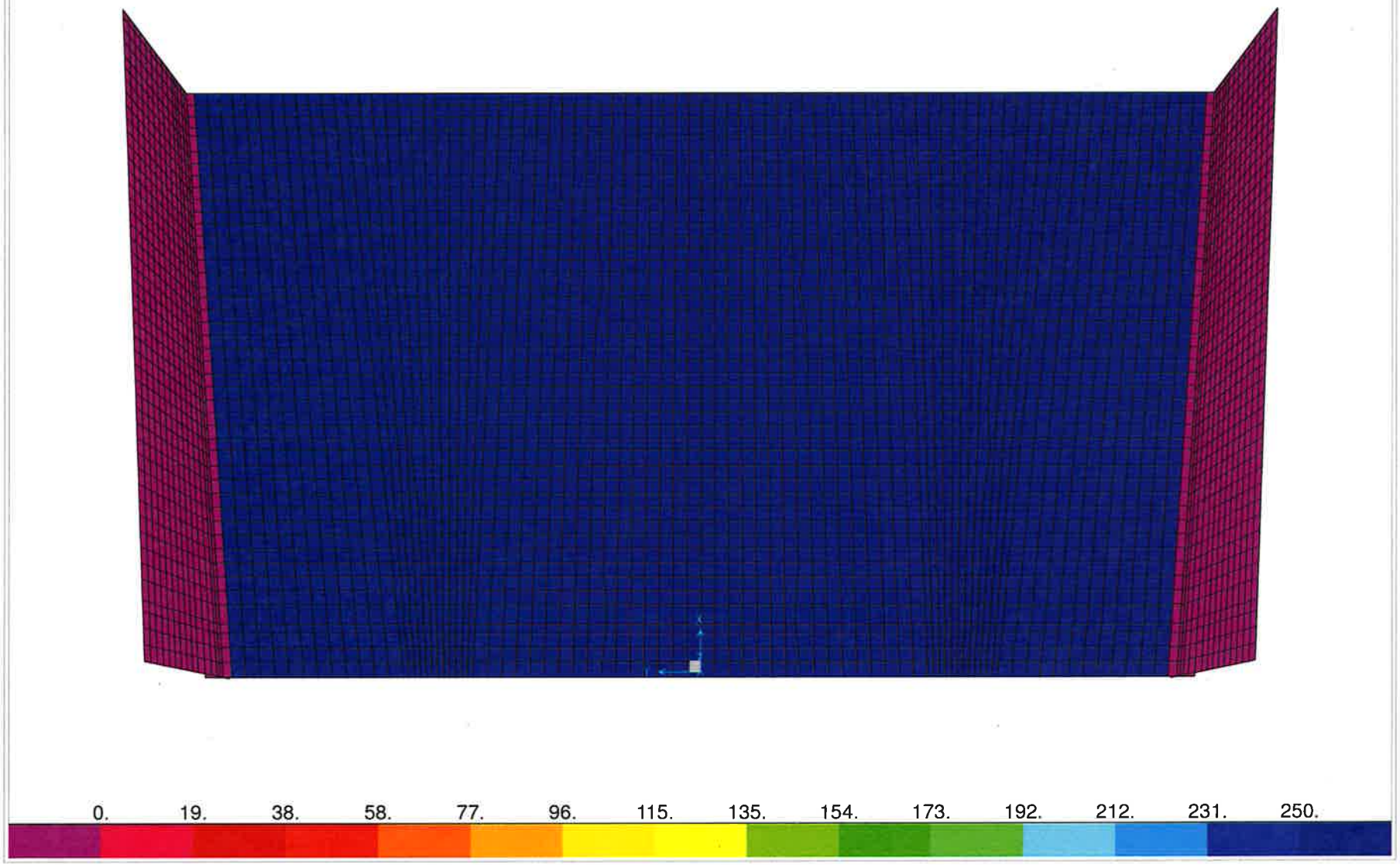


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (S_const) - lb, ft, F Units

SAP 2000

8/9/13 12:33:47

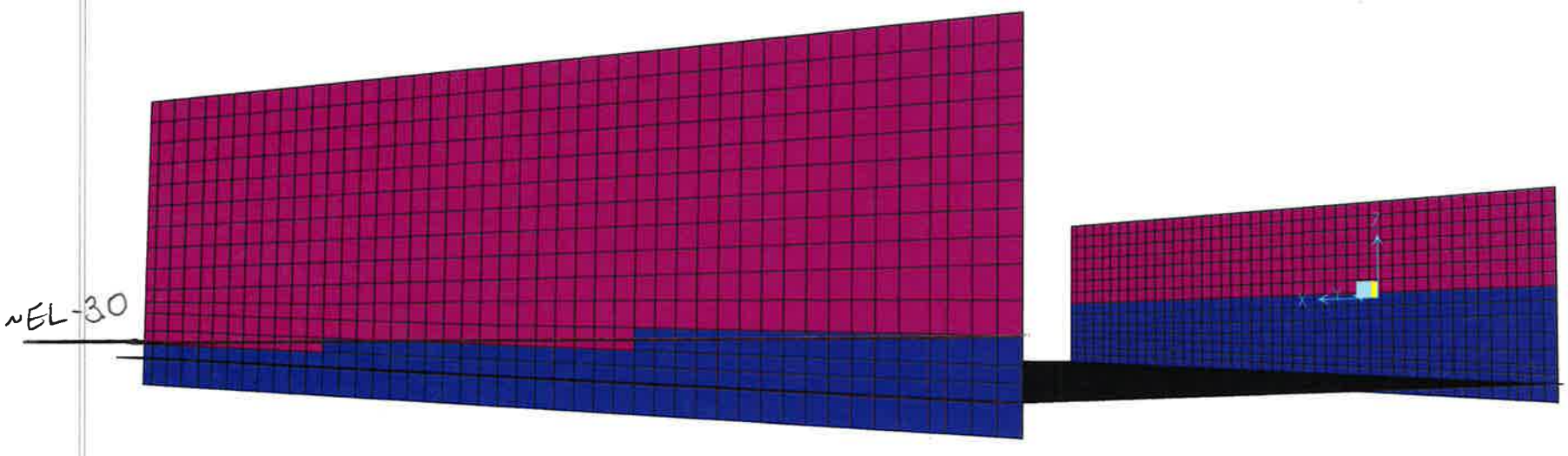
UNEVEN CONSTRUCTION SURCHARGE:

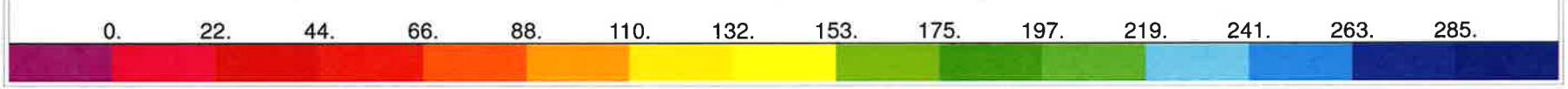


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Top (LS_const_uneven) - lb, ft, F Units

SAP2000 8/10/13 9:41:02

UNEVEN CONST. SURCHARGE:



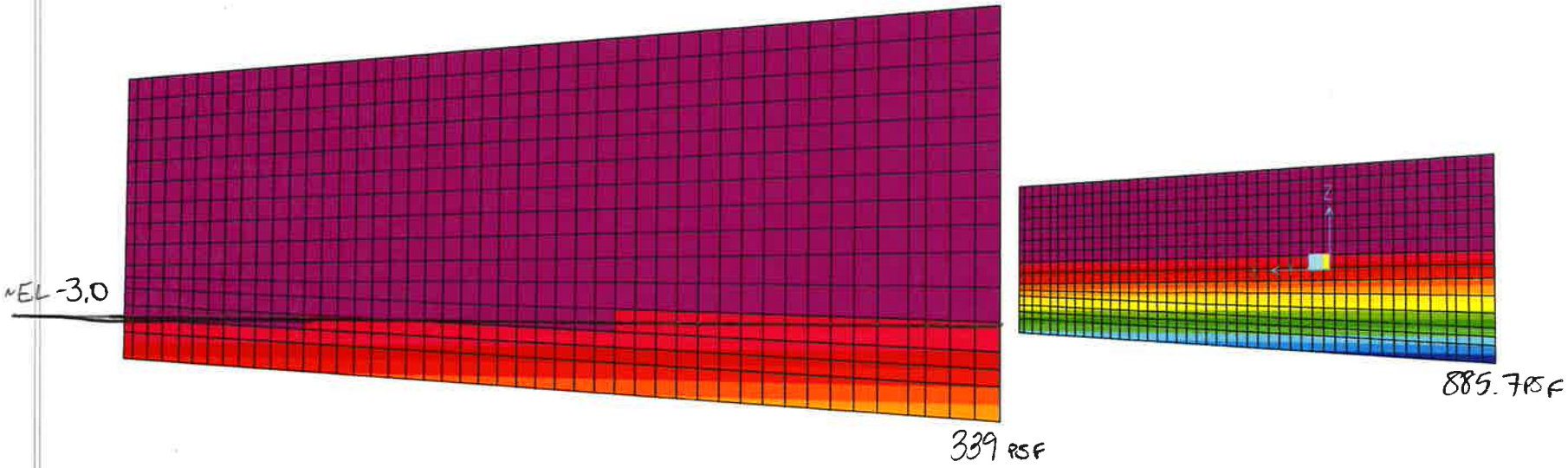


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (LS_const_uneven) - lb, ft, F Units

SA 2000

8/10/13 8:45:49

UNEVEN CONST. SOIL:

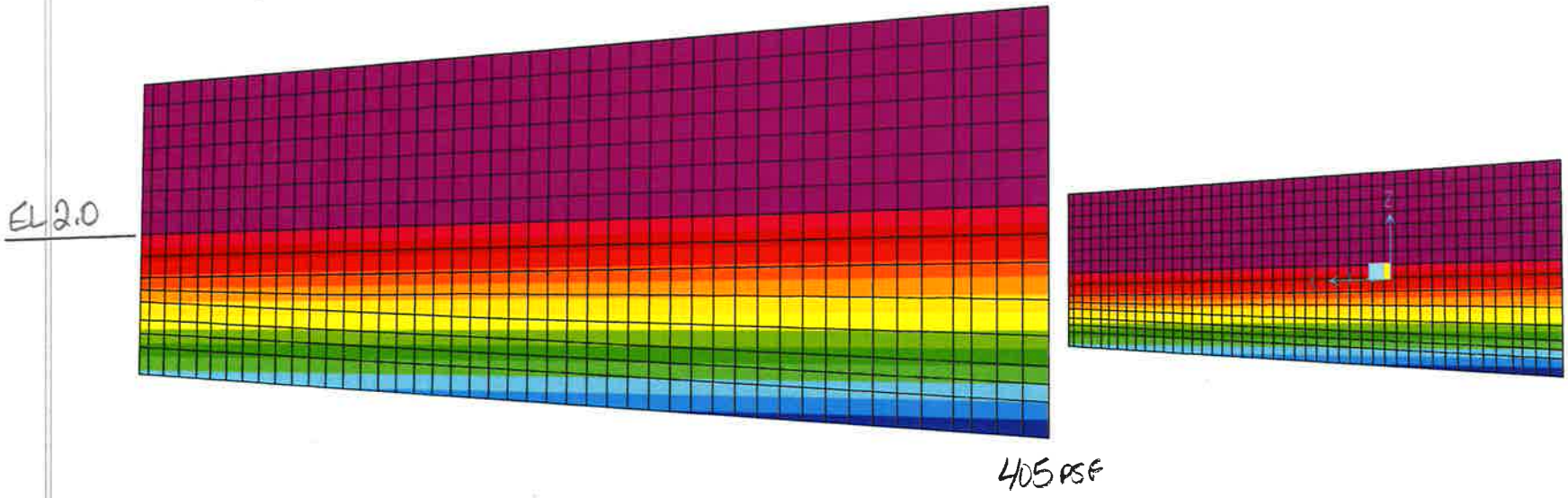


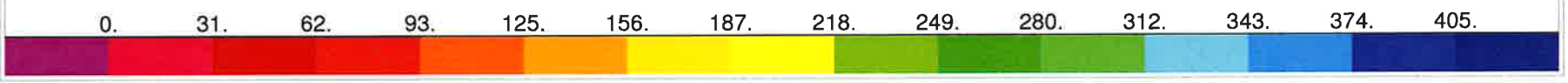
0. 68. 136. 204. 273. 341. 409. 477. 545. 613. 681. 749. 818. 886.

SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (S_const_uneven) - lb, ft, F Units

SAP2000 8/10/13 8:51:08

SATURATED SOIL (HIGH & LOW WATER CONDITION):

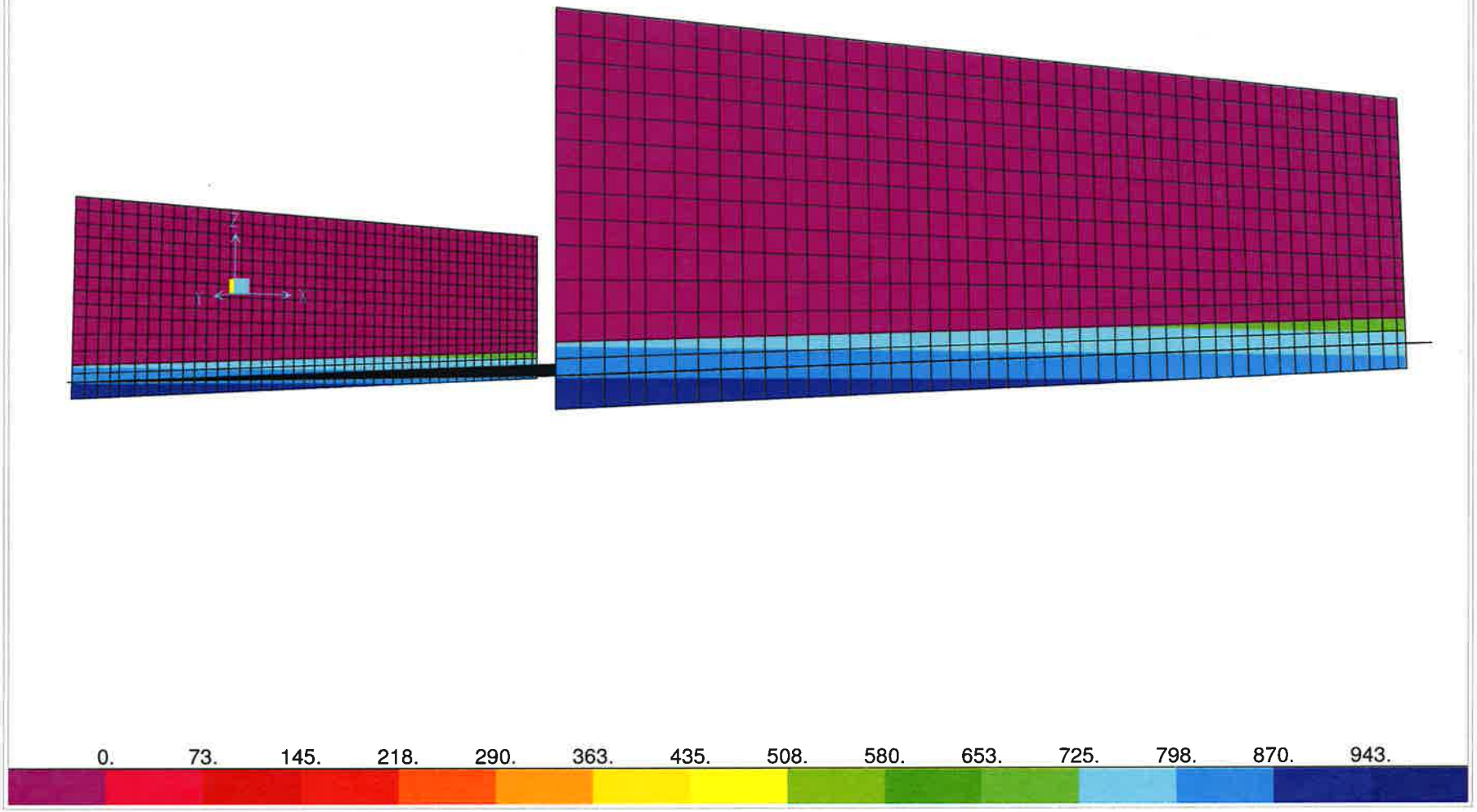




SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (S_saturated) - lb, ft, F Units

SAP2000 8/10/13 8:59:52

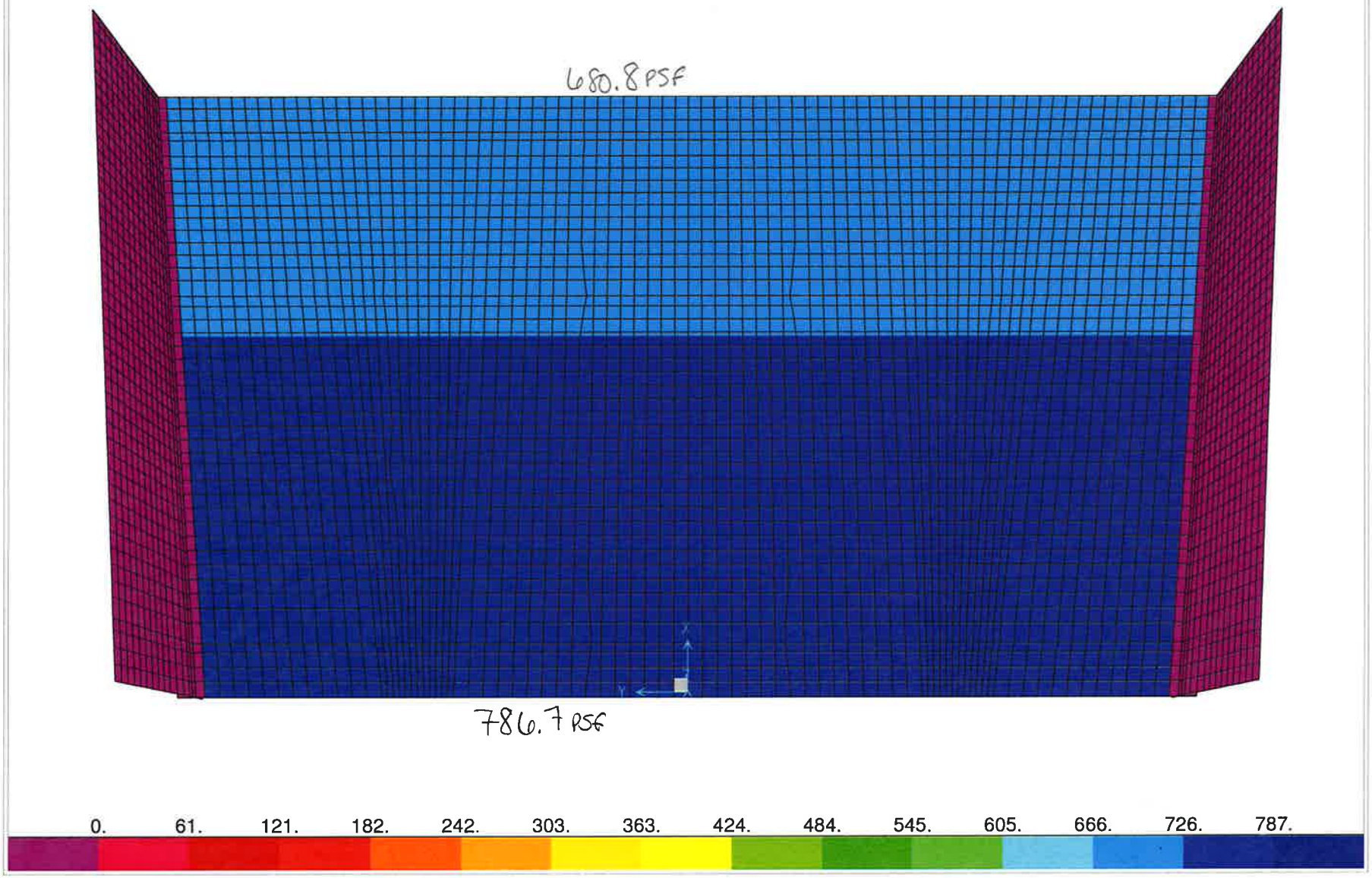
WATER TO EL 9.0;



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (L_high water) - lb, ft, F Units

SAP2000 8/10/13 9:17:51

DOWNWARD FORCE - WATER TO EL 9.0:

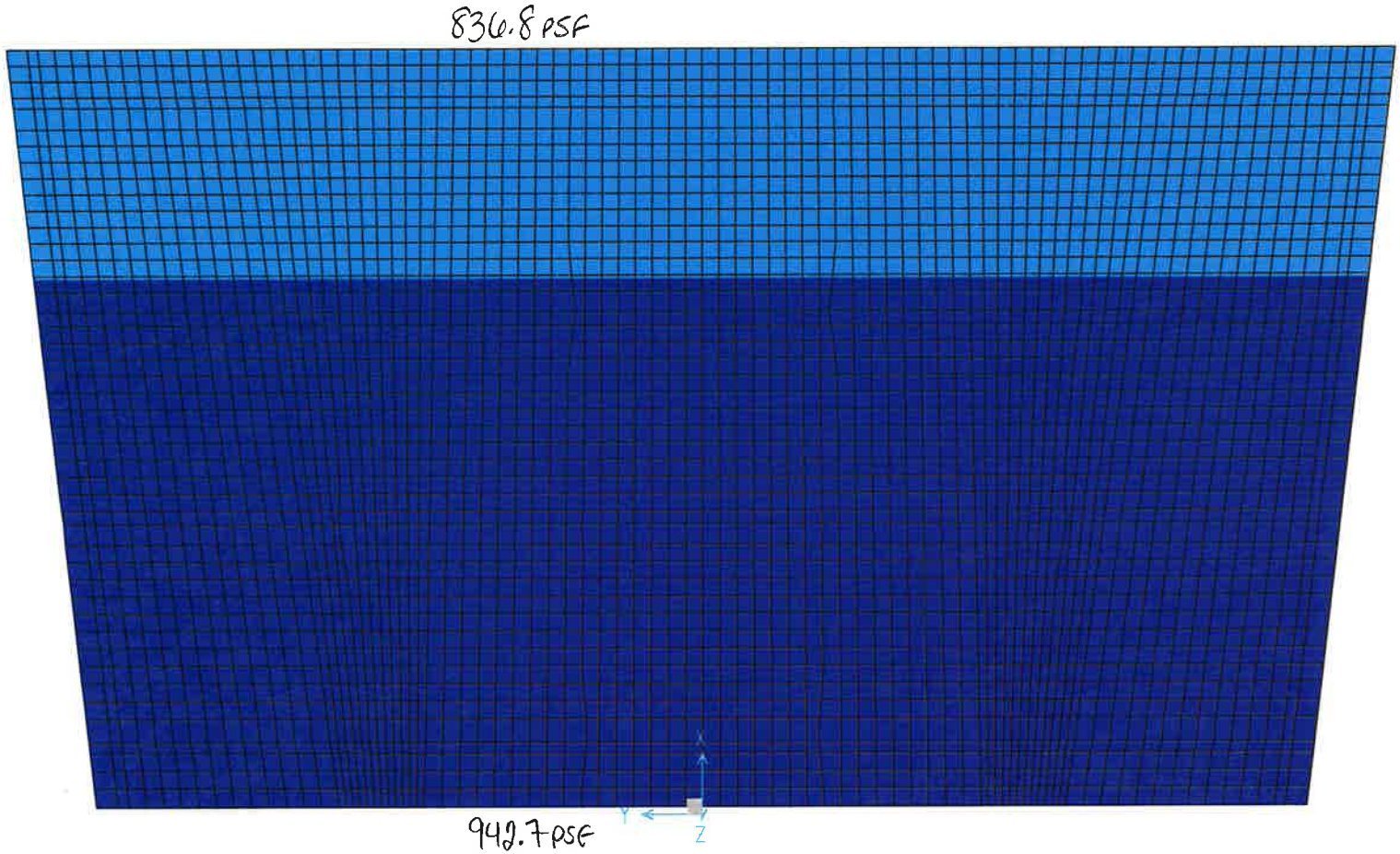


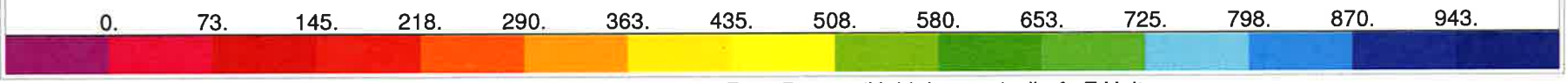
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Top (L_high water) - lb, ft, F Units

SAP 2000

8/10/13 9:23:03

UPLIFT - WATER TO EL 9.0:

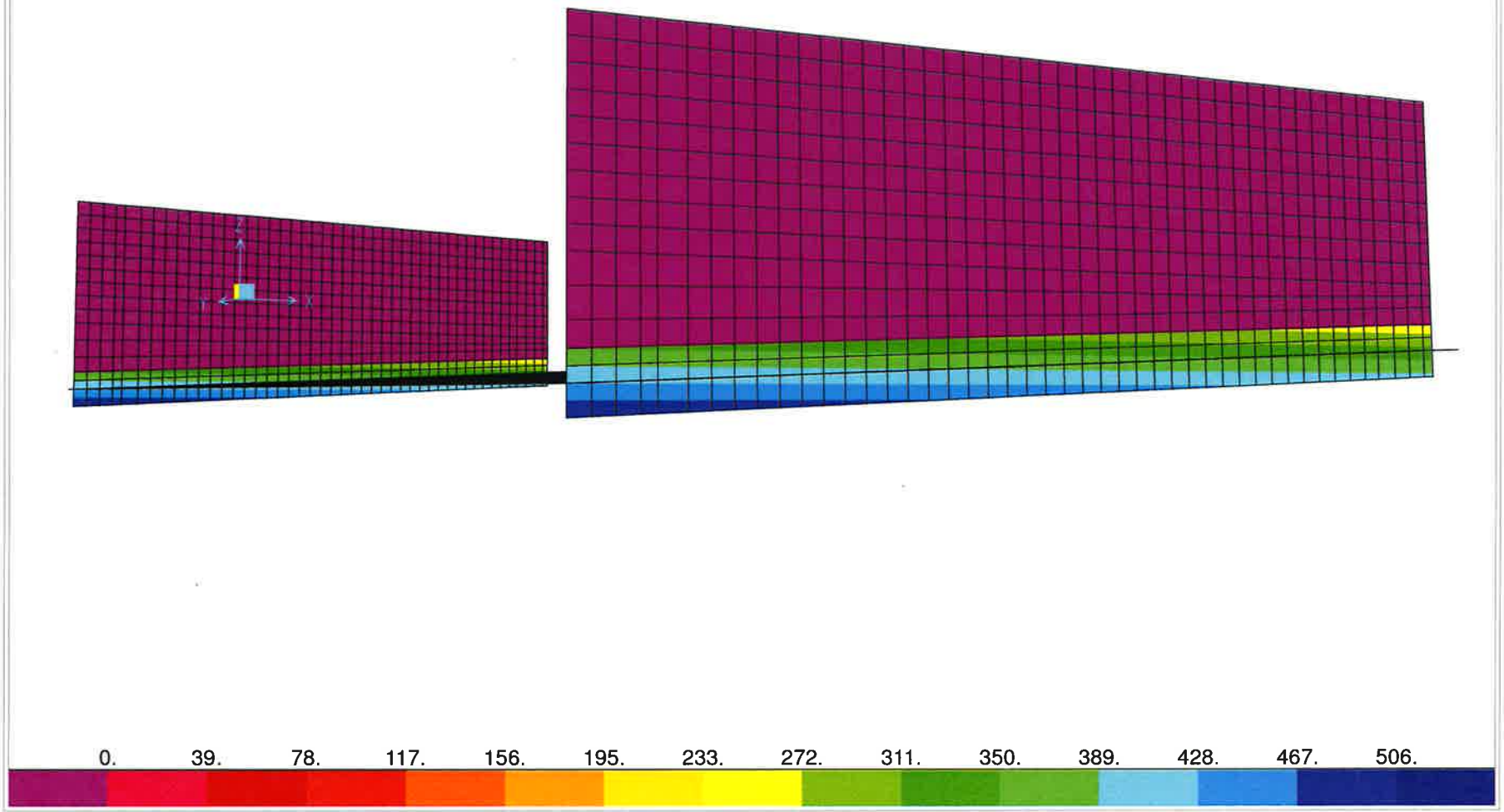




SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (U_high water) - lb, ft, F Units

SAP2000 8/10/13 9:04:16

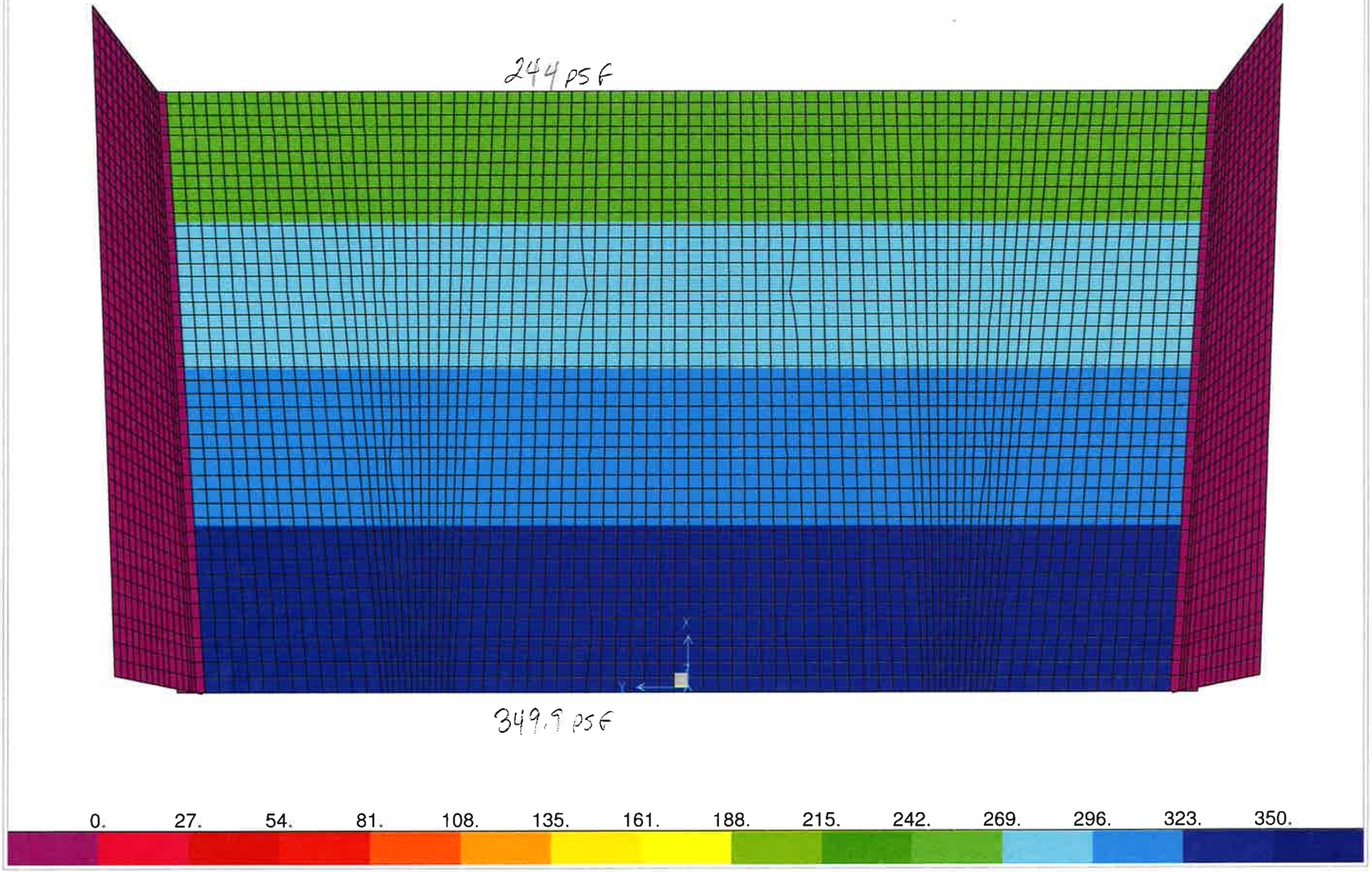
WATER TO EL 2.0:



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (L_low water) - lb, ft, F Units

SAP2000 8/10/13 9:14:55

DOWNWARD FACE - WATER TO EL 2.0:

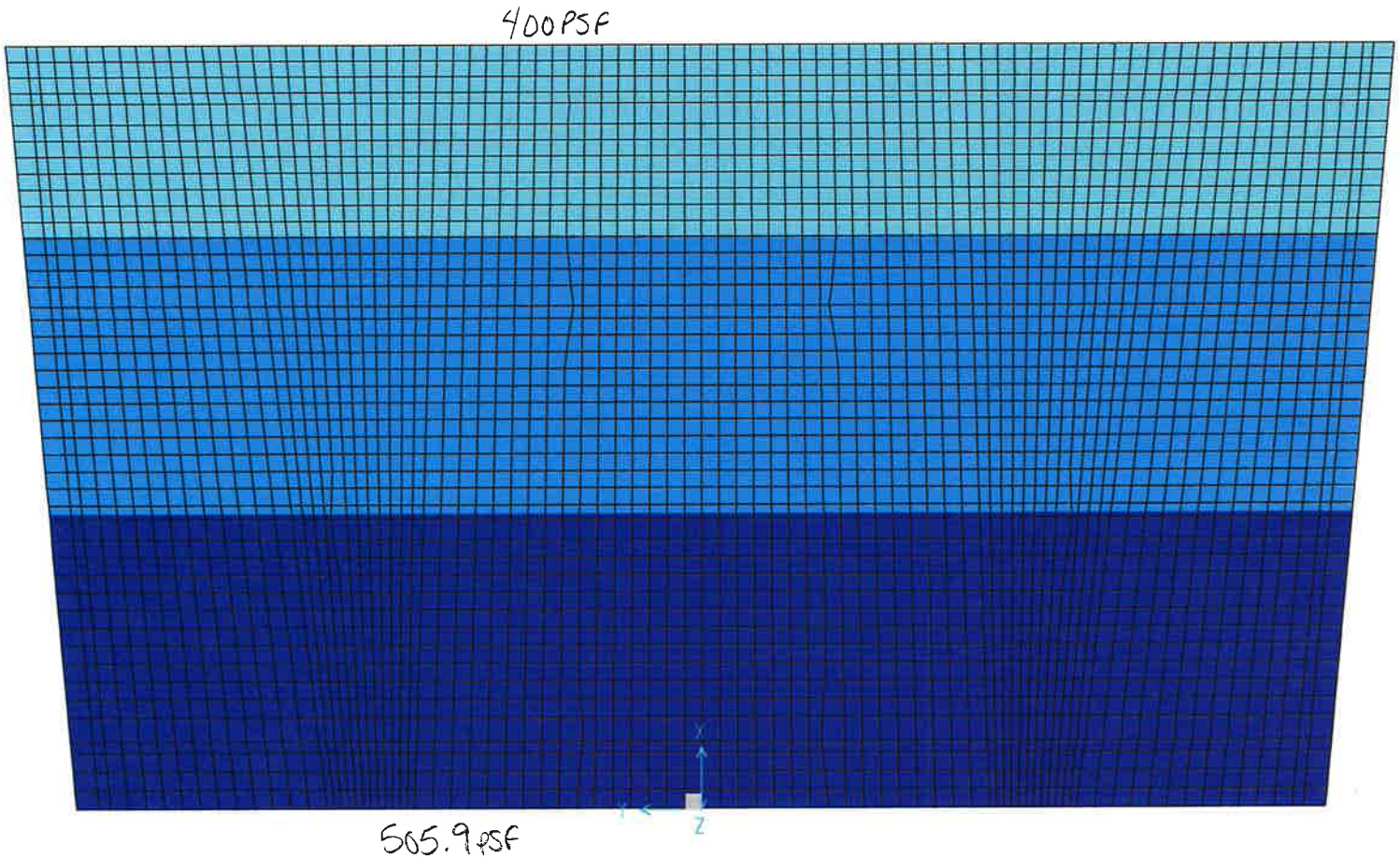


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Top (L_low water) - lb, ft, F Units

SAP 2000

8/10/13 9:26:27

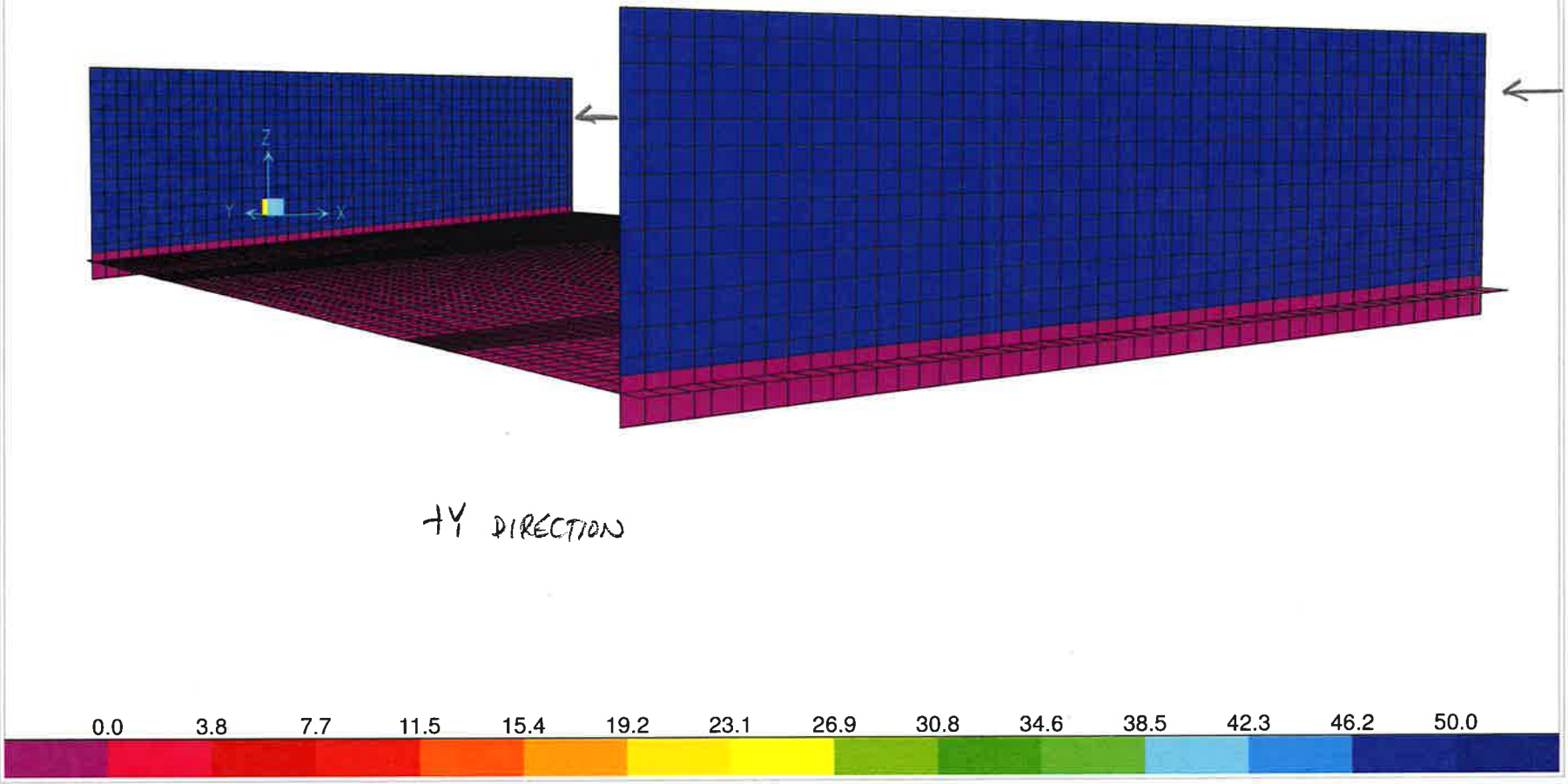
UPLIFT- WATER TO EL 2.0:



0. 39. 78. 117. 156. 195. 233. 272. 311. 350. 389. 428. 467. 506.

SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Surface Pressure - Face Bottom (U_low water) - lb, ft, F Units

WIND DURING CONSTRUCTION:

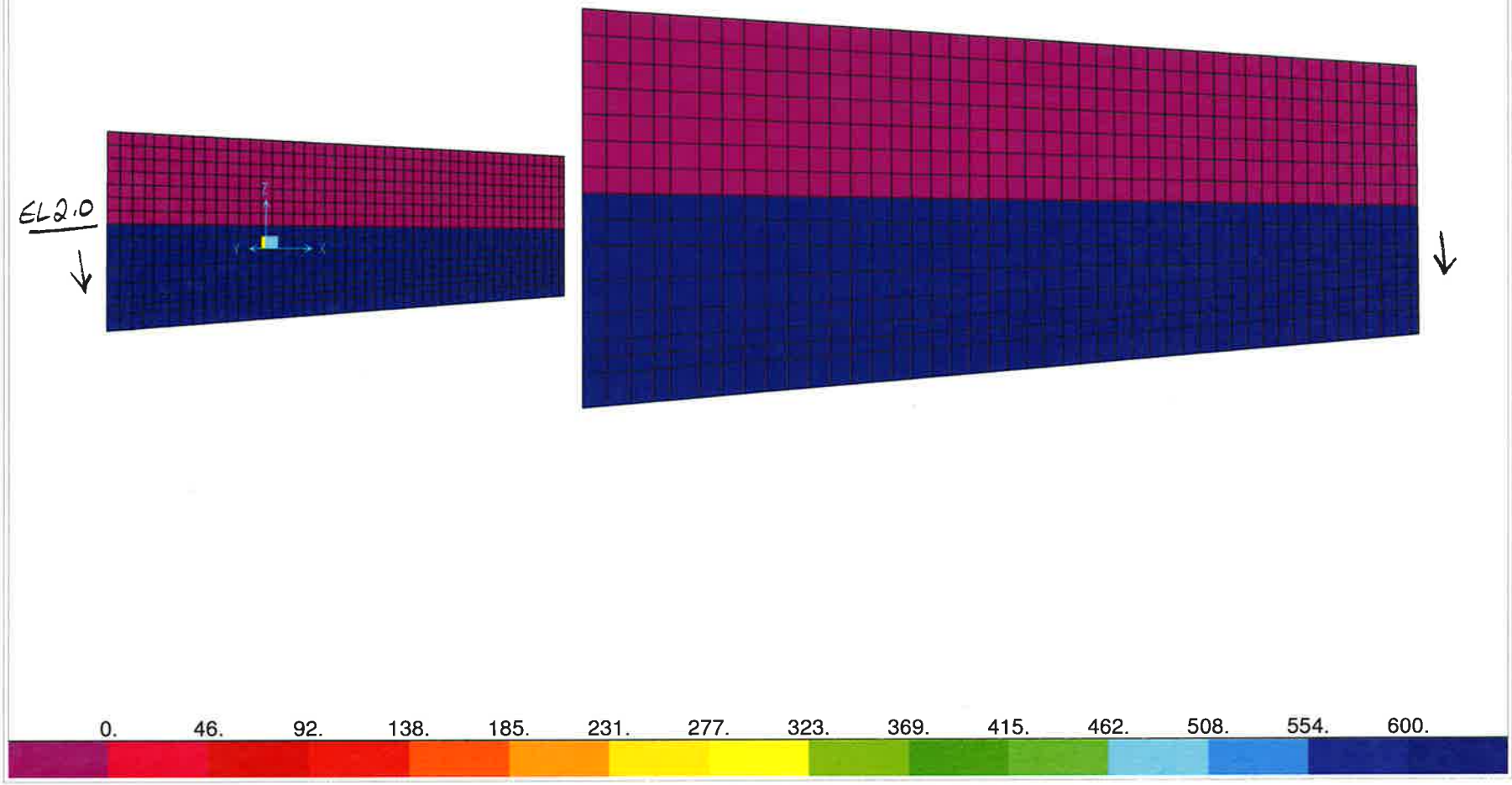


SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Uniform (W_construction) (GLOBAL - Y) - lb, ft, F Units

SAP 2000

8/9/13 12:47:48

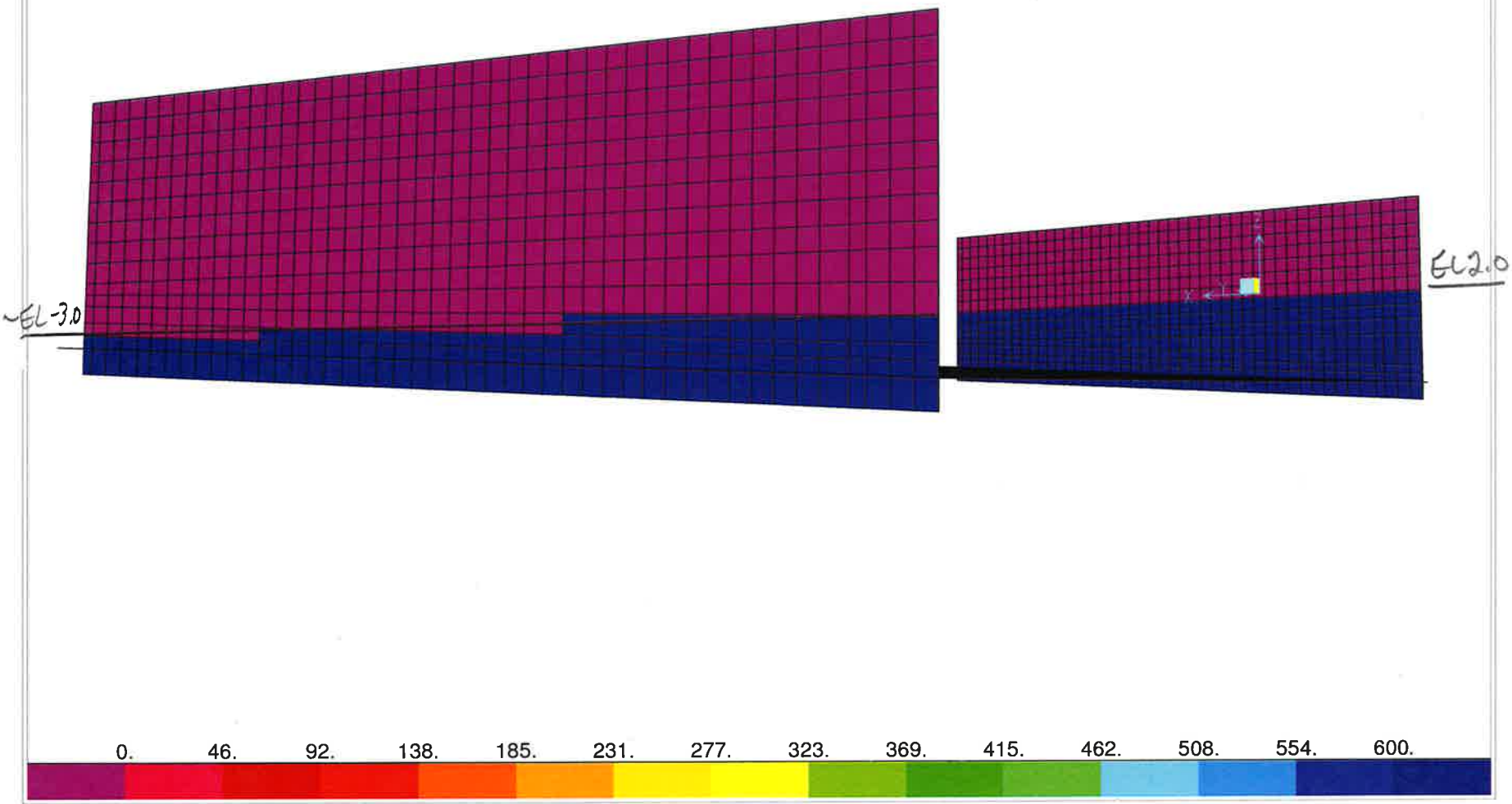
SETTLEMENT DUE TO CLAY ADHESION:



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Uniform (ST_cohesion) (GLOBAL - Gravity) - lb, ft, F Units

SAP 2000 8/10/13 9:51:20

SETTLEMENT DURING UNEVEN CONSTRUCTION:



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Area Uniform (ST_cohesion_uneven) (GLOBAL - Gravity) - lb, ft, F Units

PART 2

Pile Foundation Analysis & Results

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

A few iterations were performed in the SAP model in order to converge on the appropriate lateral pile spring. Only the last few iterations are shown in this design package. The results below use springs equivalent to a pile with tip EL -75.0 (1557.0 k/in) and lateral load of 10k (77.6 k/in)

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a	-4.31	0.09	94.64
P-2	LC1a	-4.23	-0.12	98.21
P-3	LC1a	-4.15	-0.05	88.62
P-4	LC1a	-4.15	0.05	88.62
P-5	LC1a	-4.23	0.12	98.21
P-6	LC1a	-4.31	-0.09	94.63
P-7	LC1a	-4.32	0.09	97.49
P-8	LC1a	-4.33	-0.07	114.51
P-9	LC1a	-4.29	-0.04	111.77
P-10	LC1a	-4.29	0.04	111.77
P-11	LC1a	-4.33	0.07	114.51
P-12	LC1a	-4.32	-0.09	97.48
P-13	LC1a	-4.33	0.08	100.33
P-14	LC1a	-4.40	-0.07	118.73
P-15	LC1a	-4.41	-0.04	116.95
P-16	LC1a	-4.41	0.04	116.95
P-17	LC1a	-4.40	0.07	118.73
P-18	LC1a	-4.33	-0.08	100.33
P-19	LC1a	-4.33	0.07	103.18
P-20	LC1a	-4.45	-0.12	112.19
P-21	LC1a	-4.48	-0.05	104.17
P-22	LC1a	-4.48	0.05	104.17
P-23	LC1a	-4.45	0.12	112.19
P-24	LC1a	-4.33	-0.07	103.18
P-1	LC1b	-4.69	-6.30	93.85
P-2	LC1b	-3.98	-6.51	98.48
P-3	LC1b	-3.28	-6.46	88.82
P-4	LC1b	-2.65	-6.38	87.39
P-5	LC1b	-2.09	-6.32	95.30
P-6	LC1b	-1.56	-6.45	101.77
P-7	LC1b	-4.79	-6.89	96.68
P-8	LC1b	-4.14	-7.05	114.75
P-9	LC1b	-3.44	-7.04	111.79
P-10	LC1b	-2.77	-6.99	110.03
P-11	LC1b	-2.13	-6.97	110.54
P-12	LC1b	-1.47	-7.04	104.01
P-13	LC1b	-4.89	-7.48	99.50
P-14	LC1b	-4.27	-7.64	118.98
P-15	LC1b	-3.57	-7.63	117.02
P-16	LC1b	-2.85	-7.58	115.18
P-17	LC1b	-2.13	-7.57	114.24
P-18	LC1b	-1.38	-7.63	106.26
P-19	LC1b	-4.99	-8.08	102.32
P-20	LC1b	-4.37	-8.27	112.47
P-21	LC1b	-3.65	-8.23	104.32
P-22	LC1b	-2.90	-8.16	102.40
P-23	LC1b	-2.12	-8.12	106.98
P-24	LC1b	-1.29	-8.22	108.50

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1c	0.03	-2.38	79.69
P-2	LC1c	0.10	-2.48	63.23
P-3	LC1c	0.13	-2.42	51.84
P-4	LC1c	0.12	-2.38	50.34
P-5	LC1c	0.05	-2.31	59.47
P-6	LC1c	-0.08	-2.30	85.31
P-7	LC1c	0.03	-2.37	80.87
P-8	LC1c	0.04	-2.42	72.37
P-9	LC1c	0.06	-2.39	65.22
P-10	LC1c	0.04	-2.37	63.52
P-11	LC1c	-0.01	-2.33	68.08
P-12	LC1c	-0.09	-2.28	86.76
P-13	LC1c	0.03	-2.35	82.06
P-14	LC1c	0.00	-2.40	74.12
P-15	LC1c	-0.01	-2.37	68.13
P-16	LC1c	-0.02	-2.36	66.42
P-17	LC1c	-0.04	-2.32	69.69
P-18	LC1c	-0.10	-2.26	88.21
P-19	LC1c	0.03	-2.33	83.25
P-20	LC1c	-0.02	-2.41	68.81
P-21	LC1c	-0.05	-2.36	59.88
P-22	LC1c	-0.06	-2.34	58.22
P-23	LC1c	-0.08	-2.28	64.11
P-24	LC1c	-0.10	-2.25	89.66
P-1	LC2	-1.05	-0.10	51.86
P-2	LC2	-0.96	-0.10	37.34
P-3	LC2	-0.92	-0.03	29.62
P-4	LC2	-0.92	0.03	29.62
P-5	LC2	-0.96	0.10	37.34
P-6	LC2	-1.05	0.09	51.87
P-7	LC2	-1.05	-0.10	52.77
P-8	LC2	-1.00	-0.09	42.76
P-9	LC2	-0.97	-0.03	37.55
P-10	LC2	-0.97	0.03	37.55
P-11	LC2	-1.00	0.09	42.76
P-12	LC2	-1.05	0.10	52.78
P-13	LC2	-1.05	-0.11	53.69
P-14	LC2	-1.03	-0.09	43.74
P-15	LC2	-1.01	-0.03	39.23
P-16	LC2	-1.01	0.03	39.23
P-17	LC2	-1.03	0.09	43.74
P-18	LC2	-1.05	0.11	53.70
P-19	LC2	-1.05	-0.12	54.60
P-20	LC2	-1.05	-0.11	40.50
P-21	LC2	-1.04	-0.03	34.33
P-22	LC2	-1.04	0.03	34.33
P-23	LC2	-1.05	0.11	40.50
P-24	LC2	-1.05	0.12	54.61

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Before Spring Calibration	**Checked By:**		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC3	-0.50	-0.12	60.40
P-2	LC3	-0.41	-0.11	38.72
P-3	LC3	-0.36	-0.03	29.00
P-4	LC3	-0.36	0.03	29.00
P-5	LC3	-0.41	0.11	38.72
P-6	LC3	-0.50	0.12	60.41
P-7	LC3	-0.50	-0.12	61.49
P-8	LC3	-0.45	-0.09	44.09
P-9	LC3	-0.41	-0.02	36.85
P-10	LC3	-0.41	0.02	36.85
P-11	LC3	-0.45	0.09	44.09
P-12	LC3	-0.50	0.12	61.50
P-13	LC3	-0.50	-0.13	62.58
P-14	LC3	-0.47	-0.09	44.93
P-15	LC3	-0.45	-0.02	38.45
P-16	LC3	-0.45	0.02	38.45
P-17	LC3	-0.47	0.09	44.93
P-18	LC3	-0.50	0.13	62.59
P-19	LC3	-0.51	-0.13	63.67
P-20	LC3	-0.49	-0.11	41.32
P-21	LC3	-0.48	-0.02	33.32
P-22	LC3	-0.48	0.02	33.32
P-23	LC3	-0.49	0.11	41.32
P-24	LC3	-0.51	0.13	63.68

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	Dead	-0.03	-0.04	82.50
P-2	Dead	0.07	-0.09	61.35
P-3	Dead	0.12	-0.02	51.09
P-4	Dead	0.12	0.02	51.09
P-5	Dead	0.07	0.09	61.35
P-6	Dead	-0.03	0.04	82.50
P-7	Dead	-0.03	-0.04	83.82
P-8	Dead	0.02	-0.04	70.23
P-9	Dead	0.05	-0.01	64.37
P-10	Dead	0.05	0.01	64.37
P-11	Dead	0.02	0.04	70.23
P-12	Dead	-0.03	0.04	83.81
P-13	Dead	-0.03	-0.04	85.13
P-14	Dead	-0.02	-0.04	71.91
P-15	Dead	-0.01	-0.01	67.28
P-16	Dead	-0.01	0.01	67.28
P-17	Dead	-0.02	0.04	71.90
P-18	Dead	-0.03	0.04	85.13
P-19	Dead	-0.03	-0.04	86.45
P-20	Dead	-0.05	-0.06	66.46
P-21	Dead	-0.05	-0.01	59.05
P-22	Dead	-0.05	0.01	59.05
P-23	Dead	-0.05	0.06	66.46
P-24	Dead	-0.03	0.04	86.45

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.13 kips
MINIMUM REACTION = -4.99 kips

Horizontal Reactions, Y-Direction:

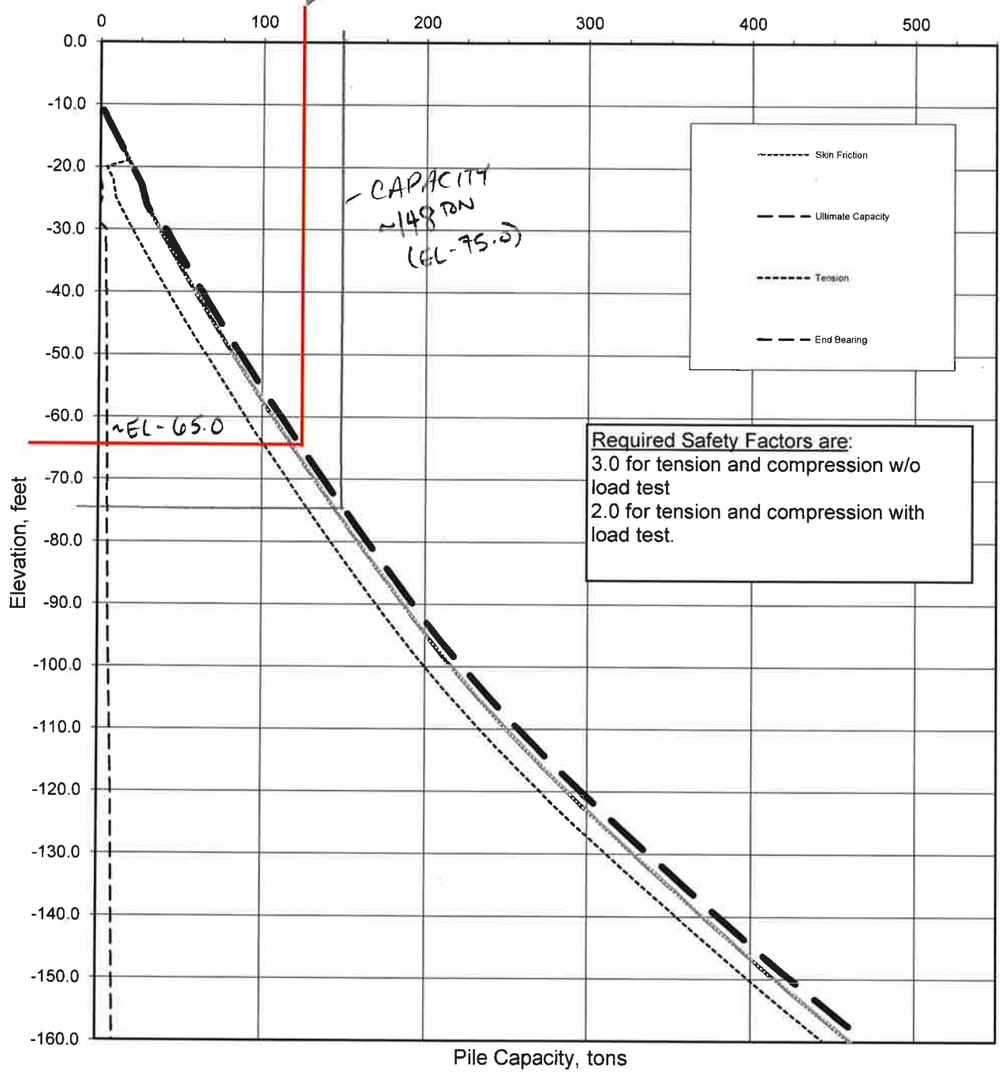
MAXIMUM REACTION = 0.13 kips
MINIMUM REACTION = -8.27 kips

Vertical Reactions:

MAXIMUM REACTION = 118.98 kips
MINIMUM REACTION = 29.00 kips

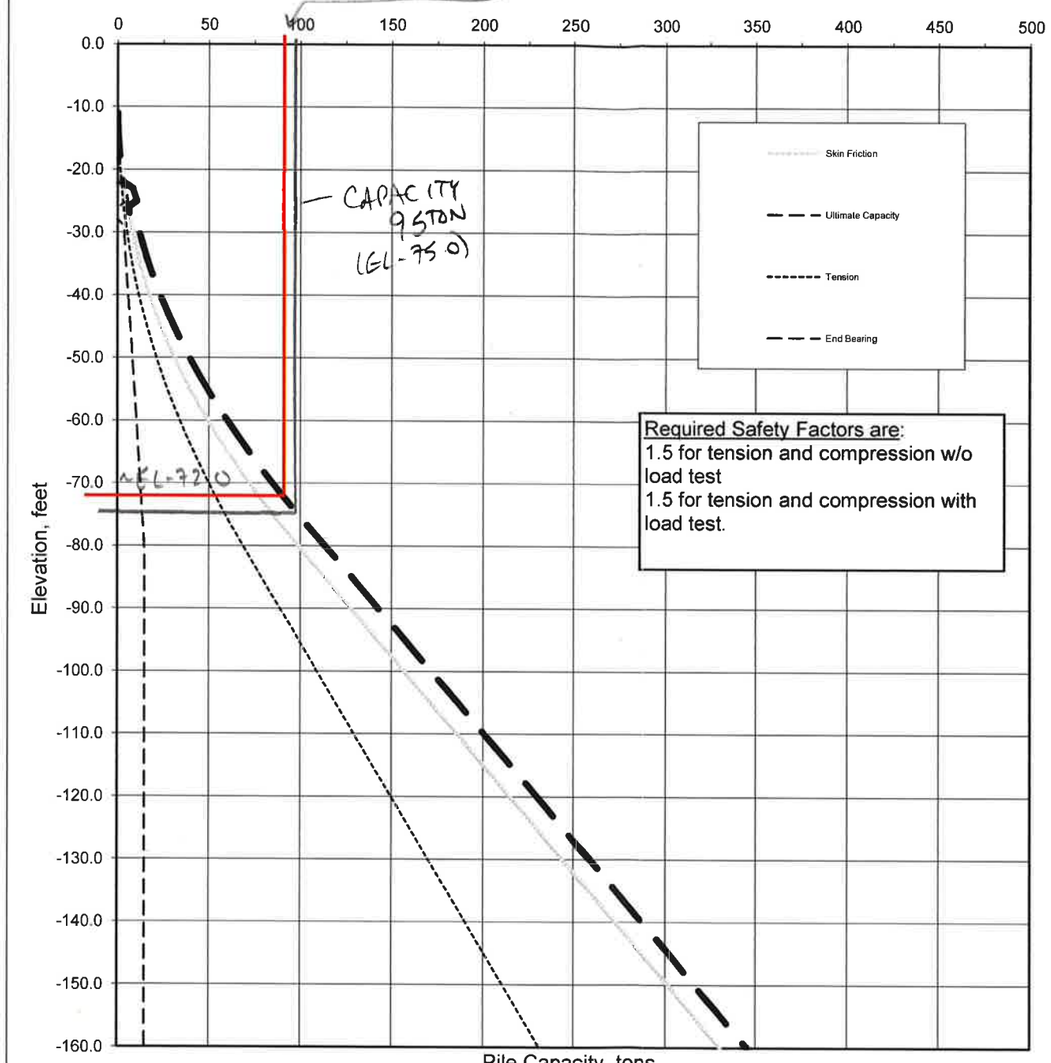
Undrained Strength Case with HP 14x89 Pile

119K REQUIRED × 1 TON / 2KIP × 2(F.O.S.) = 119 TON



Drained Strength Case with HP 14x89 Pile

119K REQUIRED × 1 TON / 2KIP × 1.5(F.O.S.) = 89.25 TON



Notes:
1. Pile capacity curves represent axial resistance for a sigle pile and do not consider group effects.
2. Curves indicate Ultimate Capacity; the appropriate safety factors should be applied to arrive at the Allowable Capacity

SET TIPS @ EL -75.0

CALLOW = 126.6K (DRAINED CONTROLS)

Lake Maurepas Diversion Canal	Project No. 10001863	Pile Capacities: Intake Structure HP - 14X89	URS	Figure No. 2

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Description: Load Calculations for SAP **Computed By:** LBR **Date:** Aug-13 **Page:** of

Monolith U-6 Pile Springs **Checked By:** **Date:** **Sheet:** of

PILE/SPRING STIFFNESS INPUT IN SAP **HP14x89 Piles Used**

Axial Pile Stiffness (b33 = C33 (AE/L)):

Pile tip elevation required from the pile capacity curves = -75.0 NAVD88

Top of pile Elevation including 9" Pile embedment = (-5.26 + 0.75) ft = -4.51 NAVD88 (-5.26 is avg. value)

Therefore, required length of pile = 70.49 ft

Axial stiffness modifier (C33) that for interaction between soil & pile = 1.74 (from geotech analysis)

Cross-section area of the pile 'A' = 26.1 in^2

Modulus of Elasticity of the pile (E) = 29,000 ksi

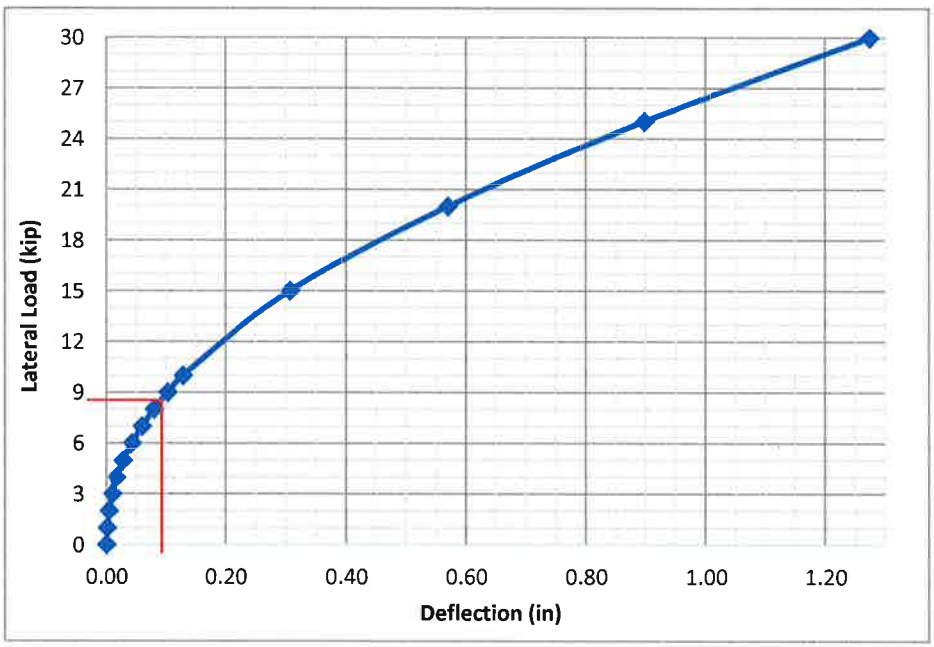
Therefore, axial spring stiffness for SAP: b33 = C33 * (A*E/L) = 1557.0 k/in

= **18684 k/ft**

Lateral Pile Stiffness:

Lateral pile stiffness is determined from the L-Pile data attached (provided by geotech analysis).
Lateral pile stiffnesses for the loading curves are as follows:

Load curve (F)	Avg. Pile Head Deflection (x)	Stiffness (k = F/x)
(k)	(in)	(k/in)
0	0.00000	-
1	0.00103	975.4
2	0.00409	488.5
3	0.00978	306.9
4	0.01820	219.8
5	0.02924	171.0
6	0.04343	138.2
7	0.06009	116.5
8	0.08048	99.4
9	0.10349	87.0
10	0.12881	77.6
15	0.30791	48.7
20	0.57012	35.1
25	0.89728	27.9
30	1.27460	23.5



For 8.5k reaction, deflection is about 0.09"

Spring = 8.5k/0.09" = 94.444 k/in = 1133.3 k/ft

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a	-4.31	0.11	94.64
P-2	LC1a	-4.20	-0.14	98.21
P-3	LC1a	-4.11	-0.06	88.63
P-4	LC1a	-4.11	0.06	88.63
P-5	LC1a	-4.20	0.14	98.21
P-6	LC1a	-4.31	-0.12	94.64
P-7	LC1a	-4.32	0.10	97.49
P-8	LC1a	-4.33	-0.08	114.50
P-9	LC1a	-4.28	-0.05	111.77
P-10	LC1a	-4.28	0.05	111.77
P-11	LC1a	-4.33	0.08	114.50
P-12	LC1a	-4.32	-0.10	97.48
P-13	LC1a	-4.33	0.09	100.33
P-14	LC1a	-4.42	-0.08	118.73
P-15	LC1a	-4.42	-0.05	116.95
P-16	LC1a	-4.42	0.05	116.95
P-17	LC1a	-4.42	0.08	118.72
P-18	LC1a	-4.33	-0.09	100.33
P-19	LC1a	-4.33	0.08	103.18
P-20	LC1a	-4.48	-0.15	112.19
P-21	LC1a	-4.51	-0.06	104.17
P-22	LC1a	-4.51	0.06	104.17
P-23	LC1a	-4.48	0.15	112.19
P-24	LC1a	-4.33	-0.08	103.18
P-1	LC1b	-4.68	-6.27	93.85
P-2	LC1b	-3.96	-6.53	98.48
P-3	LC1b	-3.24	-6.47	88.82
P-4	LC1b	-2.61	-6.38	87.40
P-5	LC1b	-2.07	-6.31	95.30
P-6	LC1b	-1.56	-6.46	101.77
P-7	LC1b	-4.78	-6.87	96.68
P-8	LC1b	-4.14	-7.06	114.75
P-9	LC1b	-3.43	-7.05	111.79
P-10	LC1b	-2.76	-6.99	110.03
P-11	LC1b	-2.12	-6.97	110.54
P-12	LC1b	-1.47	-7.05	104.01
P-13	LC1b	-4.89	-7.46	99.50
P-14	LC1b	-4.28	-7.65	118.98
P-15	LC1b	-3.58	-7.64	117.02
P-16	LC1b	-2.87	-7.58	115.18
P-17	LC1b	-2.14	-7.57	114.24
P-18	LC1b	-1.38	-7.64	106.26
P-19	LC1b	-4.99	-8.06	102.32
P-20	LC1b	-4.40	-8.29	112.47
P-21	LC1b	-3.68	-8.24	104.32
P-22	LC1b	-2.93	-8.16	102.40
P-23	LC1b	-2.14	-8.10	106.98
P-24	LC1b	-1.29	-8.23	108.50

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1c	0.03	-2.38	79.69
P-2	LC1c	0.11	-2.50	63.23
P-3	LC1c	0.16	-2.43	51.85
P-4	LC1c	0.14	-2.38	50.34
P-5	LC1c	0.06	-2.29	59.47
P-6	LC1c	-0.09	-2.28	85.30
P-7	LC1c	0.03	-2.37	80.87
P-8	LC1c	0.04	-2.43	72.37
P-9	LC1c	0.07	-2.40	65.22
P-10	LC1c	0.05	-2.37	63.52
P-11	LC1c	0.00	-2.32	68.08
P-12	LC1c	-0.10	-2.26	86.75
P-13	LC1c	0.03	-2.35	82.06
P-14	LC1c	0.00	-2.41	74.12
P-15	LC1c	-0.01	-2.38	68.13
P-16	LC1c	-0.02	-2.36	66.42
P-17	LC1c	-0.05	-2.32	69.69
P-18	LC1c	-0.10	-2.25	88.20
P-19	LC1c	0.03	-2.34	83.25
P-20	LC1c	-0.04	-2.42	68.81
P-21	LC1c	-0.06	-2.37	59.88
P-22	LC1c	-0.07	-2.34	58.22
P-23	LC1c	-0.09	-2.28	64.11
P-24	LC1c	-0.11	-2.23	89.65
P-1	LC2	-1.05	-0.12	51.86
P-2	LC2	-0.95	-0.13	37.34
P-3	LC2	-0.90	-0.04	29.62
P-4	LC2	-0.90	0.04	29.62
P-5	LC2	-0.95	0.13	37.34
P-6	LC2	-1.05	0.12	51.87
P-7	LC2	-1.06	-0.13	52.77
P-8	LC2	-1.00	-0.11	42.76
P-9	LC2	-0.96	-0.03	37.56
P-10	LC2	-0.96	0.03	37.56
P-11	LC2	-1.00	0.11	42.76
P-12	LC2	-1.06	0.13	52.78
P-13	LC2	-1.06	-0.14	53.68
P-14	LC2	-1.03	-0.11	43.74
P-15	LC2	-1.01	-0.03	39.23
P-16	LC2	-1.01	0.03	39.23
P-17	LC2	-1.03	0.11	43.74
P-18	LC2	-1.06	0.14	53.69
P-19	LC2	-1.06	-0.15	54.60
P-20	LC2	-1.06	-0.14	40.51
P-21	LC2	-1.05	-0.04	34.33
P-22	LC2	-1.05	0.04	34.33
P-23	LC2	-1.06	0.13	40.50
P-24	LC2	-1.06	0.15	54.61

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC3	-0.51	-0.14	60.40
P-2	LC3	-0.39	-0.14	38.72
P-3	LC3	-0.34	-0.04	29.00
P-4	LC3	-0.34	0.03	29.00
P-5	LC3	-0.39	0.14	38.72
P-6	LC3	-0.51	0.14	60.41
P-7	LC3	-0.51	-0.15	61.49
P-8	LC3	-0.44	-0.11	44.09
P-9	LC3	-0.40	-0.03	36.85
P-10	LC3	-0.40	0.03	36.85
P-11	LC3	-0.44	0.11	44.09
P-12	LC3	-0.51	0.15	61.49
P-13	LC3	-0.51	-0.15	62.58
P-14	LC3	-0.47	-0.11	44.93
P-15	LC3	-0.45	-0.03	38.45
P-16	LC3	-0.45	0.03	38.45
P-17	LC3	-0.47	0.11	44.93
P-18	LC3	-0.51	0.15	62.58
P-19	LC3	-0.52	-0.16	63.67
P-20	LC3	-0.50	-0.13	41.32
P-21	LC3	-0.48	-0.03	33.32
P-22	LC3	-0.48	0.03	33.32
P-23	LC3	-0.50	0.13	41.32
P-24	LC3	-0.52	0.16	63.67

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	Dead	-0.03	-0.05	82.50
P-2	Dead	0.09	-0.10	61.35
P-3	Dead	0.15	-0.03	51.09
P-4	Dead	0.15	0.03	51.09
P-5	Dead	0.09	0.10	61.35
P-6	Dead	-0.03	0.05	82.49
P-7	Dead	-0.04	-0.05	83.81
P-8	Dead	0.02	-0.05	70.23
P-9	Dead	0.06	-0.01	64.37
P-10	Dead	0.06	0.01	64.37
P-11	Dead	0.02	0.05	70.23
P-12	Dead	-0.04	0.05	83.81
P-13	Dead	-0.04	-0.05	85.13
P-14	Dead	-0.02	-0.04	71.91
P-15	Dead	-0.02	-0.01	67.28
P-16	Dead	-0.02	0.01	67.28
P-17	Dead	-0.02	0.04	71.90
P-18	Dead	-0.04	0.05	85.13
P-19	Dead	-0.04	-0.05	86.45
P-20	Dead	-0.06	-0.07	66.46
P-21	Dead	-0.06	-0.01	59.05
P-22	Dead	-0.06	0.01	59.05
P-23	Dead	-0.06	0.07	66.46
P-24	Dead	-0.04	0.05	86.45

Horizontal Reactions, X-Direction:

MAXIMUM REACTION = 0.16 kips
MINIMUM REACTION = -4.99 kips

Horizontal Reactions, Y-Direction:

MAXIMUM REACTION = 0.16 kips
MINIMUM REACTION = -8.29 kips

Vertical Reactions:

MAXIMUM REACTION = 118.98 kips
MINIMUM REACTION = 29.00 kips

$C_{allowable,\ EL\ -75.0}$ = **126.6 kips > Max Reaction = 119.0 kips** **OK**

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-6 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

Checked By: **Date:** **Sheet:** of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1a	0.04563	-0.00122	-0.06078
P-2	LC1a	0.04451	0.00149	-0.06308
P-3	LC1a	0.04353	0.00064	-0.05692
P-4	LC1a	0.04353	-0.00064	-0.05692
P-5	LC1a	0.04451	-0.00149	-0.06308
P-6	LC1a	0.04563	0.00122	-0.06078
P-7	LC1a	0.04572	-0.00110	-0.06261
P-8	LC1a	0.04585	0.00086	-0.07354
P-9	LC1a	0.04535	0.00051	-0.07178
P-10	LC1a	0.04535	-0.00051	-0.07178
P-11	LC1a	0.04585	-0.00086	-0.07354
P-12	LC1a	0.04572	0.00110	-0.06261
P-13	LC1a	0.04581	-0.00099	-0.06444
P-14	LC1a	0.04676	0.00087	-0.07625
P-15	LC1a	0.04680	0.00051	-0.07511
P-16	LC1a	0.04680	-0.00050	-0.07511
P-17	LC1a	0.04676	-0.00087	-0.07625
P-18	LC1a	0.04580	0.00099	-0.06444
P-19	LC1a	0.04590	-0.00086	-0.06627
P-20	LC1a	0.04741	0.00154	-0.07206
P-21	LC1a	0.04772	0.00068	-0.06690
P-22	LC1a	0.04772	-0.00068	-0.06690
P-23	LC1a	0.04741	-0.00154	-0.07206
P-24	LC1a	0.04589	0.00086	-0.06627
P-1	LC1b	0.04956	0.06641	-0.06028
P-2	LC1b	0.04192	0.06917	-0.06325
P-3	LC1b	0.03435	0.06852	-0.05705
P-4	LC1b	0.02768	0.06752	-0.05613
P-5	LC1b	0.02190	0.06676	-0.06121
P-6	LC1b	0.01654	0.06843	-0.06536
P-7	LC1b	0.05066	0.07272	-0.06209
P-8	LC1b	0.04383	0.07475	-0.07370
P-9	LC1b	0.03632	0.07464	-0.07180
P-10	LC1b	0.02919	0.07398	-0.07067
P-11	LC1b	0.02249	0.07378	-0.07100
P-12	LC1b	0.01557	0.07467	-0.06680
P-13	LC1b	0.05176	0.07902	-0.06390
P-14	LC1b	0.04533	0.08096	-0.07642
P-15	LC1b	0.03792	0.08086	-0.07516
P-16	LC1b	0.03036	0.08026	-0.07397
P-17	LC1b	0.02269	0.08012	-0.07337
P-18	LC1b	0.01460	0.08091	-0.06824
P-19	LC1b	0.05286	0.08533	-0.06572
P-20	LC1b	0.04657	0.08782	-0.07223
P-21	LC1b	0.03901	0.08725	-0.06700
P-22	LC1b	0.03102	0.08637	-0.06577
P-23	LC1b	0.02271	0.08581	-0.06871
P-24	LC1b	0.01364	0.08715	-0.06969

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1c	-0.00029	0.02523	-0.05118
P-2	LC1c	-0.00116	0.02645	-0.04061
P-3	LC1c	-0.00166	0.02570	-0.03330
P-4	LC1c	-0.00151	0.02515	-0.03233
P-5	LC1c	-0.00068	0.02425	-0.03820
P-6	LC1c	0.00098	0.02411	-0.05479
P-7	LC1c	-0.00029	0.02506	-0.05194
P-8	LC1c	-0.00044	0.02577	-0.04648
P-9	LC1c	-0.00069	0.02542	-0.04189
P-10	LC1c	-0.00055	0.02513	-0.04079
P-11	LC1c	0.00004	0.02462	-0.04373
P-12	LC1c	0.00104	0.02395	-0.05572
P-13	LC1c	-0.00029	0.02490	-0.05270
P-14	LC1c	0.00002	0.02551	-0.04760
P-15	LC1c	0.00009	0.02520	-0.04376
P-16	LC1c	0.00023	0.02501	-0.04266
P-17	LC1c	0.00050	0.02456	-0.04476
P-18	LC1c	0.00110	0.02379	-0.05665
P-19	LC1c	-0.00028	0.02474	-0.05347
P-20	LC1c	0.00039	0.02565	-0.04419
P-21	LC1c	0.00061	0.02507	-0.03846
P-22	LC1c	0.00076	0.02480	-0.03739
P-23	LC1c	0.00092	0.02410	-0.04117
P-24	LC1c	0.00116	0.02363	-0.05758
P-1	LC2	0.01113	0.00123	-0.03331
P-2	LC2	0.01006	0.00134	-0.02398
P-3	LC2	0.00951	0.00039	-0.01903
P-4	LC2	0.00951	-0.00038	-0.01903
P-5	LC2	0.01006	-0.00133	-0.02398
P-6	LC2	0.01113	-0.00122	-0.03331
P-7	LC2	0.01117	0.00134	-0.03389
P-8	LC2	0.01060	0.00114	-0.02746
P-9	LC2	0.01018	0.00035	-0.02412
P-10	LC2	0.01018	-0.00035	-0.02412
P-11	LC2	0.01060	-0.00113	-0.02746
P-12	LC2	0.01117	-0.00134	-0.03390
P-13	LC2	0.01121	0.00146	-0.03448
P-14	LC2	0.01094	0.00116	-0.02809
P-15	LC2	0.01072	0.00035	-0.02519
P-16	LC2	0.01072	-0.00034	-0.02519
P-17	LC2	0.01094	-0.00115	-0.02809
P-18	LC2	0.01121	-0.00146	-0.03448
P-19	LC2	0.01126	0.00159	-0.03507
P-20	LC2	0.01125	0.00143	-0.02601
P-21	LC2	0.01111	0.00040	-0.02205
P-22	LC2	0.01111	-0.00039	-0.02205
P-23	LC2	0.01125	-0.00142	-0.02601
P-24	LC2	0.01126	-0.00158	-0.03507

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC3	0.00537	0.00150	-0.03879
P-2	LC3	0.00417	0.00144	-0.02487
P-3	LC3	0.00360	0.00037	-0.01863
P-4	LC3	0.00359	-0.00037	-0.01863
P-5	LC3	0.00417	-0.00144	-0.02487
P-6	LC3	0.00537	-0.00150	-0.03880
P-7	LC3	0.00540	0.00156	-0.03949
P-8	LC3	0.00469	0.00119	-0.02832
P-9	LC3	0.00424	0.00032	-0.02367
P-10	LC3	0.00424	-0.00032	-0.02367
P-11	LC3	0.00469	-0.00118	-0.02832
P-12	LC3	0.00540	-0.00156	-0.03949
P-13	LC3	0.00544	0.00162	-0.04019
P-14	LC3	0.00501	0.00116	-0.02886
P-15	LC3	0.00476	0.00030	-0.02470
P-16	LC3	0.00476	-0.00029	-0.02470
P-17	LC3	0.00501	-0.00115	-0.02886
P-18	LC3	0.00544	-0.00162	-0.04019
P-19	LC3	0.00547	0.00168	-0.04089
P-20	LC3	0.00532	0.00139	-0.02654
P-21	LC3	0.00513	0.00032	-0.02140
P-22	LC3	0.00513	-0.00032	-0.02140
P-23	LC3	0.00532	-0.00138	-0.02654
P-24	LC3	0.00547	-0.00168	-0.04090

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	Dead	0.00034	0.00056	-0.05298
P-2	Dead	-0.00092	0.00110	-0.03940
P-3	Dead	-0.00159	0.00028	-0.03282
P-4	Dead	-0.00159	-0.00028	-0.03282
P-5	Dead	-0.00092	-0.00110	-0.03940
P-6	Dead	0.00034	-0.00056	-0.05298
P-7	Dead	0.00037	0.00056	-0.05383
P-8	Dead	-0.00020	0.00058	-0.04510
P-9	Dead	-0.00062	0.00015	-0.04134
P-10	Dead	-0.00062	-0.00015	-0.04134
P-11	Dead	-0.00020	-0.00058	-0.04510
P-12	Dead	0.00037	-0.00056	-0.05383
P-13	Dead	0.00041	0.00056	-0.05468
P-14	Dead	0.00026	0.00048	-0.04618
P-15	Dead	0.00016	0.00010	-0.04321
P-16	Dead	0.00016	-0.00010	-0.04321
P-17	Dead	0.00026	-0.00048	-0.04618
P-18	Dead	0.00041	-0.00056	-0.05468
P-19	Dead	0.00044	0.00055	-0.05552
P-20	Dead	0.00066	0.00078	-0.04268
P-21	Dead	0.00069	0.00013	-0.03793
P-22	Dead	0.00069	-0.00013	-0.03793
P-23	Dead	0.00066	-0.00078	-0.04268
P-24	Dead	0.00044	-0.00055	-0.05552

Horizontal Displacement, X-Direction:

MAXIMUM = 0.0529 inch
MINIMUM = -0.0017 inch

Horizontal Displacement, Y-Direction:

MAXIMUM = 0.0878 inch
MINIMUM = -0.0017 inch

Vertical Displacement:

MAXIMUM = -0.0186 inch
MINIMUM = -0.0764 inch

Maximum horizontal displacement is 0.088". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.076". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

Also note that the lateral deflection is very close to the assumed spring value of 0.09". The spring has converged.

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-6 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

Checked By: **Date:** **Sheet:** of

Settlement Cases

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC1a-ST	-4.40	-0.15	142.31
P-2	LC1a-ST	-4.17	-0.29	107.07
P-3	LC1a-ST	-4.04	-0.08	85.26
P-4	LC1a-ST	-4.04	0.08	85.26
P-5	LC1a-ST	-4.17	0.29	107.07
P-6	LC1a-ST	-4.40	0.14	142.31
P-7	LC1a-ST	-4.41	-0.16	144.45
P-8	LC1a-ST	-4.31	-0.21	122.70
P-9	LC1a-ST	-4.22	-0.07	108.17
P-10	LC1a-ST	-4.22	0.07	108.17
P-11	LC1a-ST	-4.31	0.21	122.70
P-12	LC1a-ST	-4.41	0.15	144.45
P-13	LC1a-ST	-4.42	-0.17	146.59
P-14	LC1a-ST	-4.39	-0.20	125.50
P-15	LC1a-ST	-4.35	-0.06	112.98
P-16	LC1a-ST	-4.35	0.06	112.98
P-17	LC1a-ST	-4.39	0.20	125.50
P-18	LC1a-ST	-4.42	0.17	146.59
P-19	LC1a-ST	-4.42	-0.18	148.73
P-20	LC1a-ST	-4.46	-0.26	116.48
P-21	LC1a-ST	-4.44	-0.07	99.09
P-22	LC1a-ST	-4.44	0.07	99.09
P-23	LC1a-ST	-4.46	0.26	116.48
P-24	LC1a-ST	-4.42	0.18	148.73
P-1	LC1b-ST	-4.77	-6.51	141.43
P-2	LC1b-ST	-3.93	-6.65	107.44
P-3	LC1b-ST	-3.19	-6.46	86.34
P-4	LC1b-ST	-2.57	-6.33	85.44
P-5	LC1b-ST	-2.06	-6.21	99.58
P-6	LC1b-ST	-1.61	-6.34	122.02
P-7	LC1b-ST	-4.87	-7.09	143.55
P-8	LC1b-ST	-4.12	-7.15	123.03
P-9	LC1b-ST	-3.38	-7.03	109.06
P-10	LC1b-ST	-2.71	-6.94	107.85
P-11	LC1b-ST	-2.11	-6.88	113.90
P-12	LC1b-ST	-1.52	-6.92	122.37
P-13	LC1b-ST	-4.97	-7.68	145.66
P-14	LC1b-ST	-4.26	-7.72	125.81
P-15	LC1b-ST	-3.53	-7.60	113.88
P-16	LC1b-ST	-2.82	-7.52	112.82
P-17	LC1b-ST	-2.13	-7.48	116.41
P-18	LC1b-ST	-1.43	-7.50	122.72
P-19	LC1b-ST	-5.07	-8.26	147.78
P-20	LC1b-ST	-4.38	-8.36	116.77
P-21	LC1b-ST	-3.63	-8.19	100.09
P-22	LC1b-ST	-2.89	-8.10	99.55
P-23	LC1b-ST	-2.13	-8.01	107.59
P-24	LC1b-ST	-1.33	-8.08	123.07

TABLE: Joint Reactions

Joint	OutputCase	F1	F2	F3
Text	Text	Kip	Kip	Kip
P-1	LC2-ST	-1.14	-0.38	99.53
P-2	LC2-ST	-0.92	-0.27	46.20
P-3	LC2-ST	-0.83	-0.06	26.26
P-4	LC2-ST	-0.83	0.06	26.26
P-5	LC2-ST	-0.92	0.27	46.20
P-6	LC2-ST	-1.14	0.38	99.54
P-7	LC2-ST	-1.15	-0.39	99.73
P-8	LC2-ST	-0.98	-0.24	50.95
P-9	LC2-ST	-0.89	-0.05	33.96
P-10	LC2-ST	-0.89	0.05	33.96
P-11	LC2-ST	-0.98	0.24	50.95
P-12	LC2-ST	-1.15	0.39	99.74
P-13	LC2-ST	-1.15	-0.40	99.94
P-14	LC2-ST	-1.01	-0.23	50.51
P-15	LC2-ST	-0.95	-0.05	35.25
P-16	LC2-ST	-0.95	0.05	35.25
P-17	LC2-ST	-1.01	0.23	50.51
P-18	LC2-ST	-1.15	0.40	99.95
P-19	LC2-ST	-1.15	-0.41	100.15
P-20	LC2-ST	-1.05	-0.25	44.80
P-21	LC2-ST	-0.99	-0.05	29.25
P-22	LC2-ST	-0.99	0.05	29.25
P-23	LC2-ST	-1.05	0.25	44.79
P-24	LC2-ST	-1.15	0.41	100.16
P-1	LC3-ST	-0.60	-0.40	108.07
P-2	LC3-ST	-0.36	-0.28	47.58
P-3	LC3-ST	-0.27	-0.06	25.64
P-4	LC3-ST	-0.27	0.06	25.64
P-5	LC3-ST	-0.36	0.28	47.58
P-6	LC3-ST	-0.60	0.40	108.08
P-7	LC3-ST	-0.60	-0.41	108.45
P-8	LC3-ST	-0.42	-0.24	52.29
P-9	LC3-ST	-0.33	-0.05	33.26
P-10	LC3-ST	-0.33	0.05	33.26
P-11	LC3-ST	-0.42	0.24	52.29
P-12	LC3-ST	-0.60	0.41	108.46
P-13	LC3-ST	-0.60	-0.41	108.83
P-14	LC3-ST	-0.45	-0.23	51.70
P-15	LC3-ST	-0.38	-0.04	34.48
P-16	LC3-ST	-0.38	0.04	34.48
P-17	LC3-ST	-0.45	0.23	51.70
P-18	LC3-ST	-0.60	0.41	108.84
P-19	LC3-ST	-0.60	-0.42	109.22
P-20	LC3-ST	-0.49	-0.25	45.61
P-21	LC3-ST	-0.42	-0.04	28.24
P-22	LC3-ST	-0.42	0.04	28.24
P-23	LC3-ST	-0.49	0.25	45.61
P-24	LC3-ST	-0.60	0.42	109.22

URS

Job: Maurepas Freshwater Diversion **Project #:** 10001876

Desc.: Monolith U-6 Model Pile Reactions After Spring Calibration **Computed By:** LBR **Date:** Aug-13 **Page:** of

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TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC1a-ST	0.04661	0.00154	-0.09140
P-2	LC1a-ST	0.04419	0.00303	-0.06877
P-3	LC1a-ST	0.04280	0.00090	-0.05476
P-4	LC1a-ST	0.04279	-0.00090	-0.05476
P-5	LC1a-ST	0.04419	-0.00303	-0.06877
P-6	LC1a-ST	0.04661	-0.00153	-0.09140
P-7	LC1a-ST	0.04668	0.00164	-0.09277
P-8	LC1a-ST	0.04561	0.00226	-0.07880
P-9	LC1a-ST	0.04464	0.00073	-0.06948
P-10	LC1a-ST	0.04464	-0.00073	-0.06948
P-11	LC1a-ST	0.04561	-0.00226	-0.07880
P-12	LC1a-ST	0.04668	-0.00164	-0.09277
P-13	LC1a-ST	0.04675	0.00175	-0.09415
P-14	LC1a-ST	0.04650	0.00216	-0.08060
P-15	LC1a-ST	0.04609	0.00067	-0.07256
P-16	LC1a-ST	0.04609	-0.00067	-0.07256
P-17	LC1a-ST	0.04650	-0.00216	-0.08060
P-18	LC1a-ST	0.04675	-0.00175	-0.09415
P-19	LC1a-ST	0.04682	0.00187	-0.09552
P-20	LC1a-ST	0.04724	0.00276	-0.07481
P-21	LC1a-ST	0.04706	0.00076	-0.06364
P-22	LC1a-ST	0.04706	-0.00076	-0.06364
P-23	LC1a-ST	0.04723	-0.00276	-0.07481
P-24	LC1a-ST	0.04682	-0.00187	-0.09552
P-1	LC1b-ST	0.05046	0.06889	-0.09084
P-2	LC1b-ST	0.04162	0.07041	-0.06900
P-3	LC1b-ST	0.03377	0.06843	-0.05545
P-4	LC1b-ST	0.02722	0.06706	-0.05487
P-5	LC1b-ST	0.02178	0.06580	-0.06396
P-6	LC1b-ST	0.01709	0.06714	-0.07837
P-7	LC1b-ST	0.05153	0.07509	-0.09219
P-8	LC1b-ST	0.04362	0.07576	-0.07902
P-9	LC1b-ST	0.03575	0.07443	-0.07005
P-10	LC1b-ST	0.02873	0.07345	-0.06927
P-11	LC1b-ST	0.02239	0.07283	-0.07315
P-12	LC1b-ST	0.01609	0.07329	-0.07859
P-13	LC1b-ST	0.05260	0.08129	-0.09355
P-14	LC1b-ST	0.04509	0.08176	-0.08080
P-15	LC1b-ST	0.03735	0.08049	-0.07314
P-16	LC1b-ST	0.02990	0.07967	-0.07246
P-17	LC1b-ST	0.02257	0.07918	-0.07477
P-18	LC1b-ST	0.01509	0.07943	-0.07882
P-19	LC1b-ST	0.05367	0.08750	-0.09491
P-20	LC1b-ST	0.04639	0.08847	-0.07500
P-21	LC1b-ST	0.03848	0.08670	-0.06429
P-22	LC1b-ST	0.03059	0.08572	-0.06394
P-23	LC1b-ST	0.02260	0.08486	-0.06910
P-24	LC1b-ST	0.01409	0.08558	-0.07904

TABLE: Joint Displacements

Joint	OutputCase	u1	u2	u3
Text	Text	in	in	in
P-1	LC2-ST	0.01211	0.00398	-0.06392
P-2	LC2-ST	0.00974	0.00287	-0.02967
P-3	LC2-ST	0.00877	0.00064	-0.01686
P-4	LC2-ST	0.00877	-0.00063	-0.01686
P-5	LC2-ST	0.00974	-0.00287	-0.02967
P-6	LC2-ST	0.01211	-0.00397	-0.06393
P-7	LC2-ST	0.01213	0.00409	-0.06405
P-8	LC2-ST	0.01036	0.00254	-0.03272
P-9	LC2-ST	0.00946	0.00058	-0.02181
P-10	LC2-ST	0.00946	-0.00057	-0.02181
P-11	LC2-ST	0.01036	-0.00253	-0.03272
P-12	LC2-ST	0.01213	-0.00408	-0.06406
P-13	LC2-ST	0.01216	0.00421	-0.06419
P-14	LC2-ST	0.01069	0.00245	-0.03244
P-15	LC2-ST	0.01001	0.00052	-0.02264
P-16	LC2-ST	0.01001	-0.00051	-0.02264
P-17	LC2-ST	0.01069	-0.00244	-0.03244
P-18	LC2-ST	0.01216	-0.00420	-0.06419
P-19	LC2-ST	0.01218	0.00432	-0.06432
P-20	LC2-ST	0.01107	0.00265	-0.02877
P-21	LC2-ST	0.01045	0.00049	-0.01879
P-22	LC2-ST	0.01045	-0.00048	-0.01879
P-23	LC2-ST	0.01107	-0.00264	-0.02877
P-24	LC2-ST	0.01218	-0.00431	-0.06433
P-1	LC3-ST	0.00635	0.00426	-0.06941
P-2	LC3-ST	0.00385	0.00298	-0.03056
P-3	LC3-ST	0.00286	0.00063	-0.01647
P-4	LC3-ST	0.00286	-0.00062	-0.01647
P-5	LC3-ST	0.00385	-0.00298	-0.03056
P-6	LC3-ST	0.00635	-0.00425	-0.06941
P-7	LC3-ST	0.00636	0.00430	-0.06965
P-8	LC3-ST	0.00446	0.00259	-0.03358
P-9	LC3-ST	0.00353	0.00054	-0.02136
P-10	LC3-ST	0.00353	-0.00054	-0.02136
P-11	LC3-ST	0.00446	-0.00259	-0.03358
P-12	LC3-ST	0.00636	-0.00430	-0.06966
P-13	LC3-ST	0.00638	0.00436	-0.06990
P-14	LC3-ST	0.00476	0.00245	-0.03321
P-15	LC3-ST	0.00405	0.00046	-0.02214
P-16	LC3-ST	0.00405	-0.00046	-0.02214
P-17	LC3-ST	0.00476	-0.00244	-0.03321
P-18	LC3-ST	0.00638	-0.00436	-0.06990
P-19	LC3-ST	0.00640	0.00441	-0.07015
P-20	LC3-ST	0.00514	0.00260	-0.02929
P-21	LC3-ST	0.00447	0.00040	-0.01814
P-22	LC3-ST	0.00447	-0.00040	-0.01814
P-23	LC3-ST	0.00514	-0.00260	-0.02929
P-24	LC3-ST	0.00640	-0.00441	-0.07015

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model Pile Reactions After Spring Calibration	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
		Checked By:		**Date:**		**Sheet:**	of

Horizontal Reactions, X-Direction:

MAXIMUM REACTION =	-0.27	kips
MINIMUM REACTION =	-5.07	kips

Vertical Reactions:

MAXIMUM REACTION =	**148.73**	**kips**
MINIMUM REACTION =	25.64	kips

Horizontal Reactions, Y-Direction:

MAXIMUM REACTION =	0.42	kips
MINIMUM REACTION =	-8.36	kips

Horizontal Displacement, X-Direction:

MAXIMUM =	0.0537	inch
MINIMUM =	0.0029	inch

Vertical Displacement:

MAXIMUM =	-0.0165	inch
MINIMUM =	-0.0955	inch

Horizontal Displacement, Y-Direction:

MAXIMUM =	0.0885	inch
MINIMUM =	-0.0044	inch

Maximum horizontal displacement is 0.089". Maximum allowable horizontal deflection is 0.75" (for load cases without allowable overstress). Maximum vertical deflection is 0.096". Maximum allowable vertical deflection is 0.5". Therefore, all deflections OK.

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___ | Sheet ___ of ___

Description: U-6 SOIL & PILE INFO | Computed by: LBR | Date: 8/2013

STRUCTURAL CHECK | Checked by: | Date:

Reference

- E_s: USING P-y CURVE DATA:

↳ CALIBRATED SPRING IN SAP = 94.44 k/IN

↳ FROM CPGA MANUAL: $K = \frac{C_o EI}{R^3}$

$C_o = 0.707$ - PINNED, CONSTANT E_s

$E = 29{,}000{,}000$ PSI

$I = 904\ IN^4$

$R = \sqrt[4]{\frac{EI}{E_s}}$ (INCH)

$$\Rightarrow K = 94{,}444\ LB/IN = \frac{(0.707)(29{,}000{,}000\ PSI)(904\ IN^4)}{\left(\sqrt[4]{\frac{29{,}000{,}000 \times 904}{E_s}}\right)^3}$$

SOLVING FOR E_s IN EXCEL $\Rightarrow E_s = 2298.7\ PSI = \underline{2.298\ KSI}$

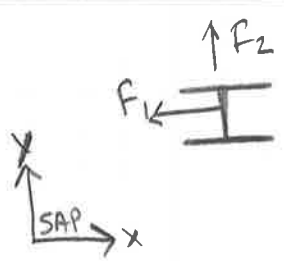
- CRITICAL BUCKLING LOAD: CPGA MANUAL PG 40 - FOR CONST E_s & UNSUPPORTED PILE (CONSERVATIVE)

$PCR = n\sqrt{E_s EI}$, $n = 1$ - PINNED

PCR, STRONG AXIS $= \sqrt{(2.298\ KSI)(29{,}000\ KSI)(904\ IN^4)} = \underline{7761.7^k}$

PCR, WEAK AXIS $= \sqrt{(2.298\ KSI)(29{,}000\ KSI)(326\ IN^4)} = \underline{4661.04^k}$

ORIENTATION OF PILES:



F_1 (F_x) FORCES ARE COORDINATED W/ WEAK AXIS (& M1 MOMENTS)

F_2 (F_y) FORCES ARE COORDINATED W/ STRONG AXIS (& M2 MOMENTS)

URS

Job: MAUREPAS DIVERSION | Project No. 10001876 | Page ___ of ___
Description: PILE PROPERTIES FOR STRUCTURAL CHECK | Computed by: LBR | Sheet ___ of ___
Checked by: ___ | Date: 8/2013 | Date: ___

Reference

*ACC: CPGA MANUAL PG 42-43

- IF - $\sqrt{\frac{2\pi^2 E}{F_y}} > \sqrt{\frac{\pi^2 EA}{PCR}}$

- THEN - $ACC = \left[\frac{F_y \cdot A}{S.F.}\right]\left[1 - \frac{F_y \cdot A}{4 \cdot PCR}\right]$

↳ $\sqrt{\frac{2\pi^2 \cdot 29{,}000\,KSI}{50\,KSI}} = 106.99$ > ↳ $\sqrt{\frac{\pi^2 \cdot 29{,}000 \cdot 26.1\,in^2}{4661^k}} = 40.03$ ← SMALLER PCR = LARGER RESULT

→ ∴ $ACC_S = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 7761.7^k}\right] = \underline{\underline{625.07^k}}$ STRONG AXIS

→ ∴ $ACC_W = \left[\frac{50 \cdot 26.1}{2}\right]\left[1 - \frac{50 \cdot 26.1}{4 \cdot 4661^k}\right] = \underline{\underline{606.8^k}}$ WEAK AXIS

$ATT = \frac{A \cdot F_y}{S.F.} = \frac{26.1\,in^2 \times 50\,KSI}{2} = \underline{\underline{652.5^k}}$ BOTH AXIS

*CBF - COMBINED BENDING: CPGA PG 32

$$COMP = \left[\frac{F3}{ACC} + MF1\left(\frac{M1}{AM1}\right) + MF2\left(\frac{M2}{AM2}\right)\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

$$TENSION = \left[\frac{-F3}{ATT} + \text{"} + \text{"}\right]\left(\frac{1}{OSF}\right) \leq 1.0$$

↳ $\underline{AM2}: S_x F_y = 131\,in^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{3638.9\,k \cdot in}$ STRONG

USAGE FACTOR — AISC FACTOR

x fy from AISC table - opposite of SAP orientation

↳ $\underline{AM1}\ S_y F_y = 44.3\,in^3 \times 50\,KSI \times 5/6 \times 2/3 = \underline{1230.56^{k \cdot in}}$ WEAK

*AXIAL LOAD FACTOR:

$ALF = \frac{F3}{AC} \times \frac{1}{OSF}$ (COMP) -OR- $\frac{-F3}{AT} \times \frac{1}{OSF}$ (TENS.)

Maurepas Diversion
Monolith U-6: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1a	-4.3	0.1	94.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	134.68	-19.90	0.23	0.64
P-2	1a	-4.2	-0.1	98.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	130.21	-19.09	0.23	0.66
P-3	1a	-4.1	-0.1	88.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	126.33	-21.59	0.22	0.60
P-4	1a	-4.1	0.1	88.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	126.33	-21.60	0.22	0.60
P-5	1a	-4.2	0.1	98.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	130.21	-19.09	0.23	0.66
P-6	1a	-4.3	-0.1	94.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	134.67	-19.90	0.23	0.64
P-7	1a	-4.3	0.1	97.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.03	-20.24	0.24	0.66
P-8	1a	-4.3	-0.1	114.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.54	-20.96	0.26	0.78
P-9	1a	-4.3	0.0	111.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	133.57	-21.99	0.26	0.76
P-10	1a	-4.3	0.0	111.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	133.57	-21.99	0.26	0.76
P-11	1a	-4.3	0.1	114.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.54	-20.97	0.26	0.78
P-12	1a	-4.3	-0.1	97.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.03	-20.24	0.24	0.66
P-13	1a	-4.3	0.1	100.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.38	-20.57	0.24	0.68
P-14	1a	-4.4	-0.1	118.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.20	-20.93	0.27	0.80
P-15	1a	-4.4	0.0	117.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.38	-22.00	0.27	0.79
P-16	1a	-4.4	0.0	117.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.38	-22.00	0.27	0.79
P-17	1a	-4.4	0.1	118.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.20	-20.93	0.27	0.80
P-18	1a	-4.3	-0.1	100.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.37	-20.57	0.24	0.68
P-19	1a	-4.3	0.1	103.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.74	-20.95	0.25	0.70
P-20	1a	-4.5	-0.1	112.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	141.85	-18.93	0.26	0.76
P-21	1a	-4.5	-0.1	104.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	143.10	-21.48	0.25	0.71
P-22	1a	-4.5	0.1	104.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	143.10	-21.49	0.25	0.71
P-23	1a	-4.5	0.1	112.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	141.85	-18.94	0.26	0.76
P-24	1a	-4.3	-0.1	103.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	135.74	-20.95	0.25	0.70
P-1	1b	-4.7	-6.3	93.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	150.59	222.92	0.29	0.64
P-2	1b	-4.0	-6.5	98.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	119.98	235.39	0.28	0.67
P-3	1b	-3.2	-6.5	88.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	91.04	232.45	0.24	0.60
P-4	1b	-2.6	-6.4	87.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	66.61	227.93	0.22	0.59
P-5	1b	-2.1	-6.3	95.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	46.33	224.49	0.22	0.65
P-6	1b	-1.6	-6.5	101.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	28.19	232.06	0.22	0.69
P-7	1b	-4.8	-6.9	96.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	155.11	251.70	0.30	0.65
P-8	1b	-4.1	-7.1	114.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	127.53	261.18	0.31	0.78
P-9	1b	-3.4	-7.0	111.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	98.42	260.66	0.29	0.76
P-10	1b	-2.8	-7.0	110.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	72.04	257.56	0.27	0.74
P-11	1b	-2.1	-7.0	110.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	48.36	256.65	0.25	0.75
P-12	1b	-1.5	-7.1	104.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	24.99	260.82	0.23	0.70
P-13	1b	-4.9	-7.5	99.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	159.66	281.38	0.32	0.67
P-14	1b	-4.3	-7.6	119.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	133.48	290.74	0.33	0.81
P-15	1b	-3.6	-7.6	117.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	104.53	290.26	0.31	0.79
P-16	1b	-2.9	-7.6	115.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	76.29	287.35	0.28	0.78
P-17	1b	-2.1	-7.6	114.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	49.06	286.67	0.26	0.77
P-18	1b	-1.4	-7.6	106.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	21.81	290.52	0.23	0.72
P-19	1b	-5.0	-8.1	102.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	164.25	312.09	0.33	0.69
P-20	1b	-4.4	-8.3	112.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.44	324.46	0.33	0.76
P-21	1b	-3.7	-8.2	104.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	108.68	321.62	0.30	0.71
P-22	1b	-2.9	-8.2	102.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	78.73	317.22	0.27	0.69
P-23	1b	-2.1	-8.1	107.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	49.11	314.43	0.26	0.72
P-24	1b	-1.3	-8.2	108.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	18.66	321.09	0.24	0.73

Maurepas Diversion
Monolith U-6: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1c	0.0	-2.4	79.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.63	57.92	0.14	0.54
P-2	1c	0.1	-2.5	63.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.07	62.23	0.12	0.43
P-3	1c	0.2	-2.4	51.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-18.58	59.59	0.10	0.35
P-4	1c	0.1	-2.4	50.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-19.03	57.64	0.10	0.34
P-5	1c	0.1	-2.3	59.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-21.50	54.48	0.11	0.40
P-6	1c	-0.1	-2.3	85.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.61	54.00	0.15	0.58
P-7	1c	0.0	-2.4	80.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.64	57.34	0.14	0.55
P-8	1c	0.0	-2.4	72.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.20	59.84	0.13	0.49
P-9	1c	0.1	-2.4	65.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-21.46	58.59	0.12	0.44
P-10	1c	0.1	-2.4	63.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-21.88	57.55	0.12	0.43
P-11	1c	0.0	-2.3	68.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-23.37	55.76	0.13	0.46
P-12	1c	-0.1	-2.3	86.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.43	53.44	0.15	0.59
P-13	1c	0.0	-2.4	82.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.64	56.76	0.15	0.56
P-14	1c	0.0	-2.4	74.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-23.42	58.91	0.13	0.50
P-15	1c	0.0	-2.4	68.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-23.21	57.82	0.13	0.46
P-16	1c	0.0	-2.4	66.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.80	57.14	0.12	0.45
P-17	1c	0.0	-2.3	69.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.02	55.56	0.13	0.47
P-18	1c	-0.1	-2.2	88.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.25	52.87	0.15	0.60
P-19	1c	0.0	-2.3	83.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.65	56.19	0.15	0.56
P-20	1c	0.0	-2.4	68.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-22.35	59.42	0.13	0.47
P-21	1c	-0.1	-2.4	59.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-21.69	57.34	0.11	0.41
P-22	1c	-0.1	-2.3	58.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-21.25	56.42	0.11	0.39
P-23	1c	-0.1	-2.3	64.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.77	53.96	0.12	0.43
P-24	1c	-0.1	-2.2	89.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	-20.07	52.32	0.15	0.61
P-1	2	-1.1	-0.1	51.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.59	-19.87	0.10	0.41
P-2	2	-1.0	-0.1	37.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.20	-19.55	0.07	0.29
P-3	2	-0.9	0.0	29.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	5.44	-22.35	0.06	0.23
P-4	2	-0.9	0.0	29.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	5.44	-22.37	0.06	0.23
P-5	2	-1.0	0.1	37.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.19	-19.57	0.07	0.29
P-6	2	-1.1	0.1	51.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.59	-19.89	0.10	0.41
P-7	2	-1.1	-0.1	52.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.72	-19.52	0.10	0.42
P-8	2	-1.0	-0.1	42.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.89	-20.12	0.08	0.34
P-9	2	-1.0	0.0	37.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.56	-22.44	0.07	0.30
P-10	2	-1.0	0.0	37.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.56	-22.47	0.07	0.30
P-11	2	-1.0	0.1	42.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.89	-20.15	0.08	0.34
P-12	2	-1.1	0.1	52.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.72	-19.55	0.10	0.42
P-13	2	-1.1	-0.1	53.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.85	-19.17	0.10	0.42
P-14	2	-1.0	-0.1	43.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.99	-20.07	0.09	0.35
P-15	2	-1.0	0.0	39.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.29	-22.45	0.08	0.31
P-16	2	-1.0	0.0	39.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.29	-22.48	0.08	0.31
P-17	2	-1.0	0.1	43.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.98	-20.09	0.09	0.35
P-18	2	-1.1	0.1	53.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.85	-19.19	0.10	0.42
P-19	2	-1.1	-0.1	54.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.99	-18.80	0.10	0.43
P-20	2	-1.1	-0.1	40.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.97	-19.27	0.08	0.32
P-21	2	-1.0	0.0	34.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.52	-22.30	0.07	0.27
P-22	2	-1.0	0.0	34.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.52	-22.32	0.07	0.27
P-23	2	-1.1	0.1	40.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.97	-19.29	0.08	0.32
P-24	2	-1.1	0.1	54.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.99	-18.83	0.10	0.43

Maurepas Diversion
Monolith U-6: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc=\sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	3	-0.5	-0.1	60.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.42	-19.05	0.11	0.48
P-2	3	-0.4	-0.1	38.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-11.05	-19.23	0.08	0.31
P-3	3	-0.3	0.0	29.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-12.80	-22.39	0.06	0.23
P-4	3	-0.3	0.0	29.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-12.80	-22.40	0.06	0.23
P-5	3	-0.4	0.1	38.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-11.05	-19.24	0.08	0.31
P-6	3	-0.5	0.1	60.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.42	-19.06	0.11	0.48
P-7	3	-0.5	-0.1	61.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.31	-18.88	0.11	0.49
P-8	3	-0.4	-0.1	44.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.48	-19.99	0.09	0.35
P-9	3	-0.4	0.0	36.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.85	-22.54	0.08	0.29
P-10	3	-0.4	0.0	36.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.85	-22.56	0.08	0.29
P-11	3	-0.4	0.1	44.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.48	-20.00	0.09	0.35
P-12	3	-0.5	0.1	61.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.31	-18.90	0.11	0.49
P-13	3	-0.5	-0.2	62.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.20	-18.70	0.11	0.49
P-14	3	-0.5	-0.1	44.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.50	-20.07	0.09	0.35
P-15	3	-0.4	0.0	38.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.28	-22.62	0.08	0.30
P-16	3	-0.4	0.0	38.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.28	-22.63	0.08	0.30
P-17	3	-0.5	0.1	44.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.50	-20.08	0.09	0.35
P-18	3	-0.5	0.2	62.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.20	-18.71	0.11	0.49
P-19	3	-0.5	-0.2	63.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.09	-18.53	0.12	0.50
P-20	3	-0.5	-0.1	41.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.58	-19.40	0.08	0.33
P-21	3	-0.5	0.0	33.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.15	-22.54	0.07	0.26
P-22	3	-0.5	0.0	33.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.15	-22.56	0.07	0.26
P-23	3	-0.5	0.1	41.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.58	-19.41	0.08	0.33
P-24	3	-0.5	0.2	63.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-7.09	-18.54	0.12	0.50
P-1	1a-ST	-4.4	-0.1	142.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.61	-18.95	0.30	0.96
P-2	1a-ST	-4.2	-0.3	107.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	128.93	-14.50	0.24	0.72
P-3	1a-ST	-4.0	-0.1	85.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	123.43	-20.84	0.21	0.58
P-4	1a-ST	-4.0	0.1	85.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	123.43	-20.84	0.21	0.58
P-5	1a-ST	-4.2	0.3	107.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	128.93	-14.50	0.24	0.72
P-6	1a-ST	-4.4	0.1	142.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.60	-18.96	0.30	0.96
P-7	1a-ST	-4.4	-0.2	144.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.89	-18.64	0.31	0.98
P-8	1a-ST	-4.3	-0.2	122.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	134.61	-16.80	0.27	0.83
P-9	1a-ST	-4.2	-0.1	108.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	130.72	-21.33	0.25	0.73
P-10	1a-ST	-4.2	0.1	108.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	130.72	-21.33	0.25	0.73
P-11	1a-ST	-4.3	0.2	122.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	134.61	-16.81	0.27	0.83
P-12	1a-ST	-4.4	0.2	144.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.89	-18.64	0.31	0.98
P-13	1a-ST	-4.4	-0.2	146.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.17	-18.30	0.31	0.99
P-14	1a-ST	-4.4	-0.2	125.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.18	-17.10	0.28	0.85
P-15	1a-ST	-4.4	-0.1	113.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	136.52	-21.51	0.26	0.76
P-16	1a-ST	-4.4	0.1	113.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	136.52	-21.52	0.26	0.76
P-17	1a-ST	-4.4	0.2	125.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	138.17	-17.11	0.28	0.85
P-18	1a-ST	-4.4	0.2	146.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.16	-18.31	0.31	0.99
P-19	1a-ST	-4.4	-0.2	148.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.46	-17.96	0.31	1.01
P-20	1a-ST	-4.5	-0.3	116.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	141.13	-15.31	0.27	0.79
P-21	1a-ST	-4.4	-0.1	99.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	140.43	-21.24	0.24	0.67
P-22	1a-ST	-4.4	0.1	99.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	140.43	-21.24	0.24	0.67
P-23	1a-ST	-4.5	0.3	116.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	141.13	-15.32	0.27	0.79
P-24	1a-ST	-4.4	0.2	148.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	139.45	-17.97	0.31	1.01

1% OVERSTRESS ON
ALF IS OK - NEGLIGIBLE

Maurepas Diversion
Monolith U-6: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_s EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	1b-ST	-4.8	-6.5	141.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	154.30	234.11	0.36	0.96
P-2	1b-ST	-3.9	-6.6	107.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	118.83	241.05	0.29	0.73
P-3	1b-ST	-3.2	-6.5	86.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	88.85	232.05	0.24	0.58
P-4	1b-ST	-2.6	-6.3	85.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	64.97	225.84	0.22	0.58
P-5	1b-ST	-2.1	-6.2	99.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	45.92	220.17	0.22	0.67
P-6	1b-ST	-1.6	-6.3	122.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	30.01	226.19	0.25	0.83
P-7	1b-ST	-4.9	-7.1	143.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	158.71	262.77	0.38	0.97
P-8	1b-ST	-4.1	-7.2	123.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	126.69	265.92	0.32	0.83
P-9	1b-ST	-3.4	-7.0	109.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	96.28	259.67	0.28	0.74
P-10	1b-ST	-2.7	-6.9	107.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	70.39	255.09	0.26	0.73
P-11	1b-ST	-2.1	-6.9	113.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	48.02	252.25	0.25	0.77
P-12	1b-ST	-1.5	-6.9	122.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	26.70	254.34	0.25	0.83
P-13	1b-ST	-5.0	-7.7	145.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	163.14	292.35	0.39	0.99
P-14	1b-ST	-4.3	-7.7	125.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	132.51	294.63	0.34	0.85
P-15	1b-ST	-3.5	-7.6	113.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	102.36	288.48	0.30	0.77
P-16	1b-ST	-2.8	-7.5	112.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	74.62	284.51	0.28	0.76
P-17	1b-ST	-2.1	-7.5	116.4	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	48.63	282.17	0.26	0.79
P-18	1b-ST	-1.4	-7.5	122.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	23.41	283.38	0.26	0.83
P-19	1b-ST	-5.1	-8.3	147.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	167.60	322.86	0.40	1.00
P-20	1b-ST	-4.4	-8.4	116.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	137.74	327.67	0.34	0.79
P-21	1b-ST	-3.6	-8.2	100.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	106.68	318.85	0.29	0.68
P-22	1b-ST	-2.9	-8.1	99.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	77.15	313.99	0.27	0.67
P-23	1b-ST	-2.1	-8.0	107.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	48.74	309.76	0.26	0.73
P-24	1b-ST	-1.3	-8.1	123.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1.17	20.14	313.29	0.26	0.83
P-1	2-ST	-1.1	-0.4	99.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.72	-11.64	0.18	0.79
P-2	2-ST	-0.9	-0.3	46.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	6.18	-14.96	0.09	0.36
P-3	2-ST	-0.8	-0.1	26.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	3.12	-21.60	0.05	0.21
P-4	2-ST	-0.8	0.1	26.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	3.12	-21.62	0.05	0.21
P-5	2-ST	-0.9	0.3	46.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	6.18	-14.99	0.09	0.36
P-6	2-ST	-1.1	0.4	99.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.72	-11.66	0.18	0.79
P-7	2-ST	-1.1	-0.4	99.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.80	-11.31	0.18	0.79
P-8	2-ST	-1.0	-0.2	50.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.15	-15.96	0.09	0.40
P-9	2-ST	-0.9	-0.1	34.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	5.30	-21.79	0.07	0.27
P-10	2-ST	-0.9	0.1	34.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	5.30	-21.81	0.07	0.27
P-11	2-ST	-1.0	0.2	51.0	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.15	-15.98	0.09	0.40
P-12	2-ST	-1.1	0.4	99.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.80	-11.33	0.18	0.79
P-13	2-ST	-1.1	-0.4	99.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.88	-10.94	0.18	0.79
P-14	2-ST	-1.0	-0.2	50.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.18	-16.24	0.10	0.40
P-15	2-ST	-0.9	0.0	35.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.03	-21.97	0.07	0.28
P-16	2-ST	-0.9	0.0	35.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	7.03	-21.99	0.07	0.28
P-17	2-ST	-1.0	0.2	50.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	9.17	-16.26	0.10	0.40
P-18	2-ST	-1.1	0.4	99.9	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.87	-10.97	0.18	0.79
P-19	2-ST	-1.2	-0.4	100.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.95	-10.61	0.18	0.79
P-20	2-ST	-1.0	-0.2	44.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.41	-15.64	0.09	0.35
P-21	2-ST	-1.0	0.0	29.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.42	-22.05	0.06	0.23
P-22	2-ST	-1.0	0.0	29.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	8.42	-22.08	0.06	0.23
P-23	2-ST	-1.0	0.2	44.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	10.41	-15.67	0.09	0.35
P-24	2-ST	-1.2	0.4	100.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	13.95	-10.64	0.18	0.79

Maurepas Diversion
Monolith U-6: Structural Check of Piles

Job No. 10001876

Calc By: LBR 8/2013
Check By: _____

Sap2000 Data					Pile Properties (Note: x & y are from AISC table - opposite orientation of design)							Soil Data	Pile Group Factors		Soil Capacity		Critical Buckling Load		Slenderness Parameters		Structural Check							Design Moments (from Lateral Loads)		Struct. Capacity	Soil Capacity
Pile #	Load Case	F1	F2	F3	fy	A	Ix	Iy	Sx	Sy	E	Es w/out Group Reaction Factor	Group Vertical Reduction Factor	Group Lateral Reduction Factor	AC=Allow Comp. Load (FoS = 2)	AT=Allow Comp. Load (FoS = 2)	$n\sqrt{E_S EI}$ X-axis PCR	Y-axis PCR	$Cc = \sqrt{\frac{2\pi^2 E}{fy}}$ (AISC)	$\sqrt{\frac{\pi^2 EA}{PCR}}$ (CPGA)	Comp. Factor of Safety	ACC = Allow Comp Stress, X-Axis	ACC = Allow Comp Stress, Y-Axis	ATT = Allow. Axial Tension Stress	AM1 Allowable Bending Moment	AM2 Allowable Bending Moment	OSF	M = 1.3171*F² + 31.024*F - 23.482 M1	M2	Factor CBF	ALF Factor
Pile		(Kip)	(Kip)	(Kip)	(ksi)	(in^2)	(in^4)	(in^4)	(in^3)	(in^3)	(ksi)	(ksi)			(kips)	(kips)	(kips)	(kips)				(kips)	(kips)	(kips)	(kip-in)	(kip-in)		Kips-in	Kips-in		
P-1	3-ST	-0.6	-0.4	108.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.42	-10.80	0.18	0.85
P-2	3-ST	-0.4	-0.3	47.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-12.02	-14.64	0.09	0.38
P-3	3-ST	-0.3	-0.1	25.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-15.01	-21.64	0.06	0.20
P-4	3-ST	-0.3	0.1	25.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-15.01	-21.65	0.06	0.20
P-5	3-ST	-0.4	0.3	47.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-12.02	-14.65	0.09	0.38
P-6	3-ST	-0.6	0.4	108.1	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.42	-10.81	0.18	0.85
P-7	3-ST	-0.6	-0.4	108.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.36	-10.66	0.19	0.86
P-8	3-ST	-0.4	-0.2	52.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.18	-15.82	0.10	0.41
P-9	3-ST	-0.3	-0.1	33.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-13.01	-21.89	0.07	0.26
P-10	3-ST	-0.3	0.1	33.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-13.01	-21.90	0.07	0.26
P-11	3-ST	-0.4	0.2	52.3	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.18	-15.83	0.10	0.41
P-12	3-ST	-0.6	0.4	108.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.36	-10.67	0.19	0.86
P-13	3-ST	-0.6	-0.4	108.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.31	-10.47	0.19	0.86
P-14	3-ST	-0.4	-0.2	51.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.28	-16.24	0.10	0.41
P-15	3-ST	-0.4	0.0	34.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-11.44	-22.13	0.07	0.27
P-16	3-ST	-0.4	0.0	34.5	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-11.44	-22.14	0.07	0.27
P-17	3-ST	-0.4	0.2	51.7	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-9.28	-16.25	0.10	0.41
P-18	3-ST	-0.6	0.4	108.8	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.31	-10.48	0.19	0.86
P-19	3-ST	-0.6	-0.4	109.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.25	-10.33	0.19	0.86
P-20	3-ST	-0.5	-0.2	45.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.12	-15.78	0.09	0.36
P-21	3-ST	-0.4	0.0	28.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.15	-22.30	0.06	0.22
P-22	3-ST	-0.4	0.0	28.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-10.15	-22.31	0.06	0.22
P-23	3-ST	-0.5	0.2	45.6	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-8.12	-15.79	0.09	0.36
P-24	3-ST	-0.6	0.4	109.2	50	26.1	904	326	131	44.3	29000	2.298	1	1	126.6	0.0	4661	7762	107	40	2	607	625	653	1231	3639	1	-4.25	-10.34	0.19	0.86

NO CBF FAILURES

PART 3

Member Design, Traditional Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-U Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	2.5	ft
Wall Thickness =	2	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

Results indicate a wall thinner than 2'-6" is adequate

TRADITIONAL CASES

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
Dead	0.00	0.0	0.0	0.0	0.0
1a	4.10	17.1	0.5	3.4	0.2
1b	4.10	17.1	0.5	3.4	0.2
1c	1.02	7.7	7.7	1.5	1.5
2	1.02	4.4	0.1	0.9	0.0
3	1.04	4.2	0.1	0.8	0.0

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

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

Max. Shear =	**4.1 kip**	
Max. Moment, Primary =	**17.1 kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**7.7 kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**3.4 kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**1.5 kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

* Reinforcing Limits:

A_{gross} = 24in * 12in strip = 288 in^2

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 3.078 in^2

Limits of Minimum Reinforcement: 0.0028 x A_{gross} = 0.806 in^2 EM 1110-2-2104, 2-8a, temp. & shrinkage

(3 * √(f'_c) * b * d) / f_y = 0.735 in^2 ACI 318-02, 10.5, flexural member min.

(200 * b * d) / f_y = 0.775 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**3.078 in^2**	- half each face
	Min. T&S Rebar =	**0.806 in^2**	- half each face
	Min. Flexural Rebar =	**0.775 in^2**	- per face

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

* Section Design:

Shear:

Shear Capacity (ϕV_c) = ϕ * 2 * $\sqrt{(f'_c)}$ * b * d
= 0.85 * 2 * √4000 * 12in * 19.365in
= 24,985 lb

ϕVc = 25kip > 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))

Primary Exterior Face:

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

a = A_s * f_y / (0.85 * f'_c * b) = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)
= 452.43 kip-in/ft
= 37.70 kip-ft/ft

17.1×1.33 = 22.8 k-ft

ϕMn = 37.7kip-ft > Mu = 17.1kip-ft → Use #6 @ 12"

FLEXURAL MIN. NEGLECTED B/C OF ACI 318 ALLOWANCE - CAPACITIES > THAN 33% INCREASE IN MOMENT (ACI 318 - 10.5.3)

Primary Interior Face:

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

a = A_s * f_y / (0.85 * f'_c * b) = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)
= 452.43 kip-in/ft
= 37.70 kip-ft/ft

ϕMn = 37.7kip-ft > Mu = 7.7kip-ft → Use #6 @ 12"

Secondary Interior & Exterior Faces: * $M_{max, secondary}$ = 3.4 k-ft

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

a = A_s * f_y / (0.85 * f'_c * b) = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)
= 452.43 kip-in/ft
= 37.70 kip-ft/ft

ϕMn = 37.7kip-ft > Mu = 3.4kip-ft → Use #6 @ 12"

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
Dead	9.0	8.5	21.0	51.9	12.7	50.8
1a	13.8	11.3	45.1	66.5	18.9	68.0
1b	13.9	11.2	46.4	69.6	18.9	68.8
1c	8.3	7.2	26.2	44.4	10.9	41.2
2	5.7	4.9	16.6	31.8	7.3	28.7
3	5.8	5.1	16.2	34.7	7.3	30.1

* Shear taken at a distance 'd' = 25.37 inch from piles.

CONTROLS OVER SETTLEMENT

Max. Shear = **13.9 kip**

Max. Moment, Primary = **46.4 kip-ft** (SAP M11, controls *bottom transverse* reinforcement)

Min. Moment, Primary = **69.6 kip-ft** (SAP M11, controls *top transverse* reinforcement)

Max. Moment, Secondary = **18.9 kip-ft** (SAP M22, controls *bottom longitudinal* reinforcement

Min. Moment, Secondary = **68.8 kip-ft** (SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.848 in^2

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

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 13.9kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * 1in² * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

ϕMn = 110.8kip-ft > Mu = 46.4kip-ft → Use #9 @ 12"

Primary Top Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * 1in² * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

69.6 k·ft × 1.33 = 92.8 k·ft

ϕMn = 110.8kip-ft > Mu = 69.6kip-ft → Use #9 @ 12"

Secondary Both Faces: * $M_{max, secondary}$ = 68.8 k-ft

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

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.88 * 60ksi / (0.85 * 4ksi * 12in) = 1.294 in

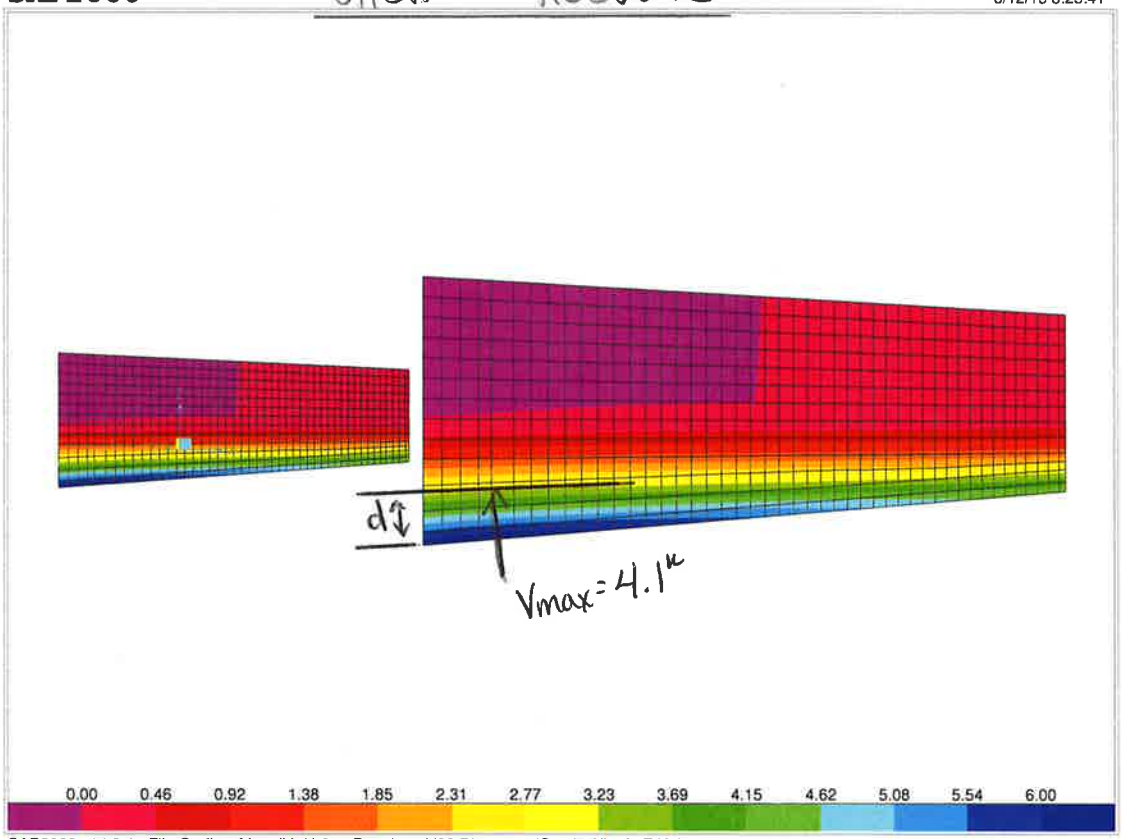
$\phi Mn =$ 0.9 * 0.88in² * 60ksi * (25.365in - 1.294in / 2)
= 1174.6 kip-in/ft
= 97.88 kip-ft/ft

ϕMn = 97.9kip-ft > Mu = 68.8kip-ft → Use #6 @ 6"

FLEXURAL MINIMUM NEGLECTED B/C OF ACI 318 ALLOWANCE - (10.5.3)
CAPACITY > 1.33 × Mu

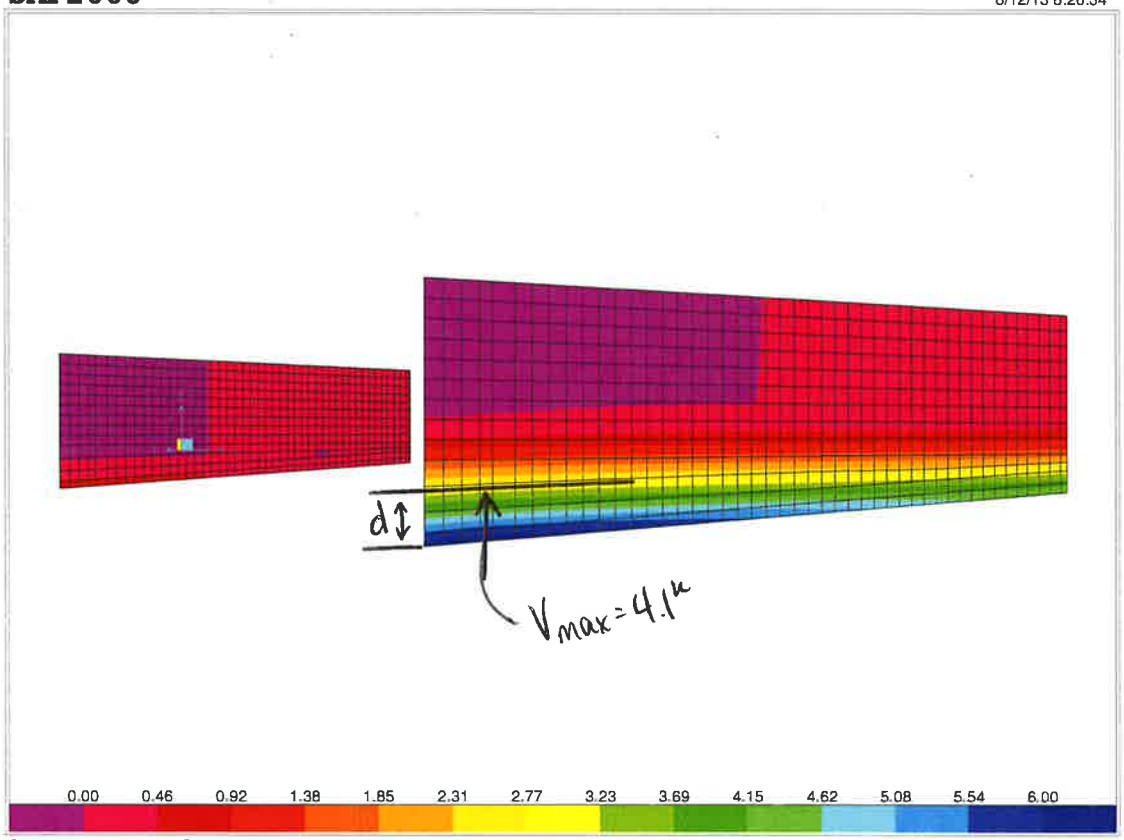
SHEAR RESULTS

SAP2000 8/12/13 8:25:41



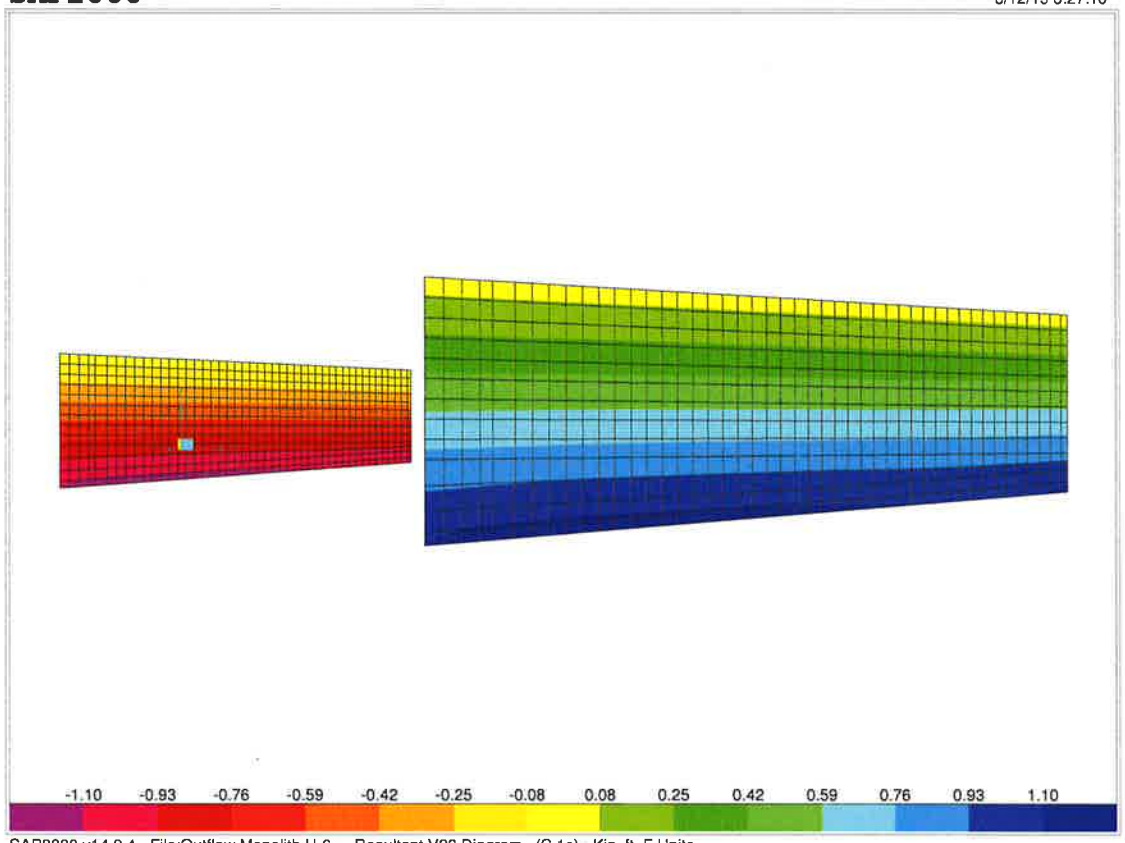
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/12/13 8:26:34



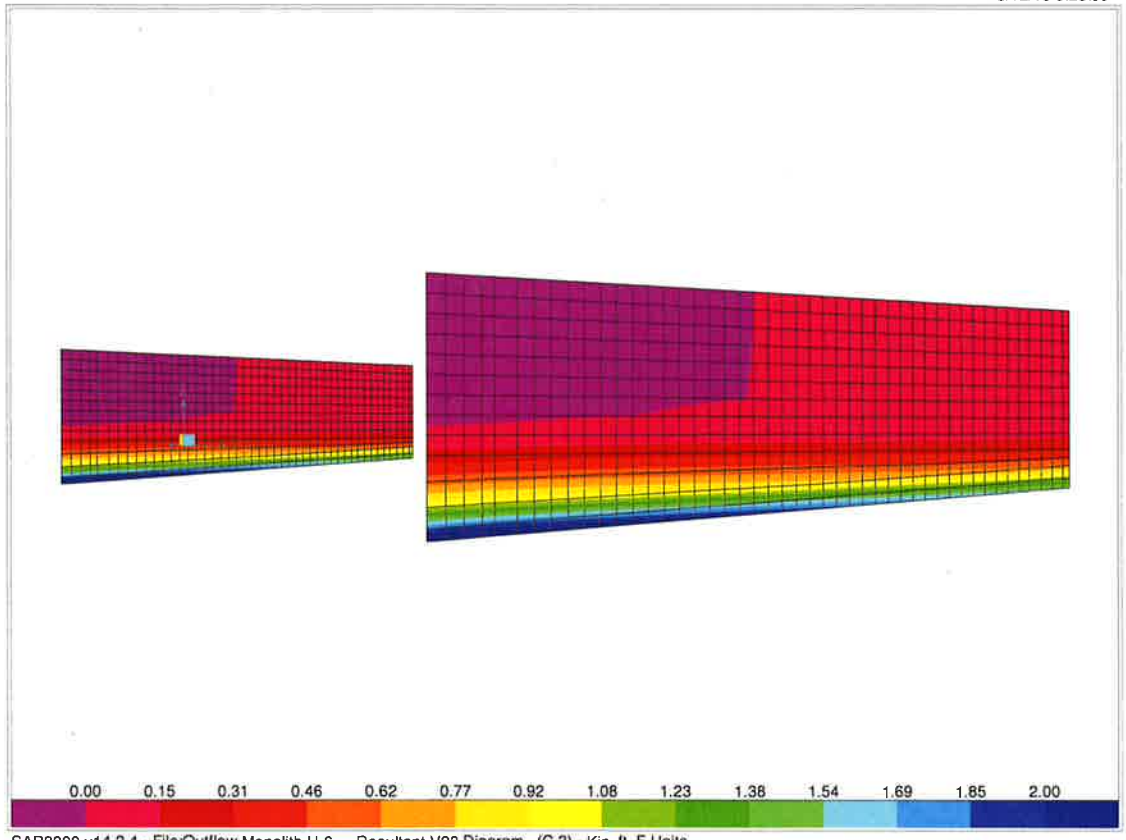
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/12/13 8:27:10



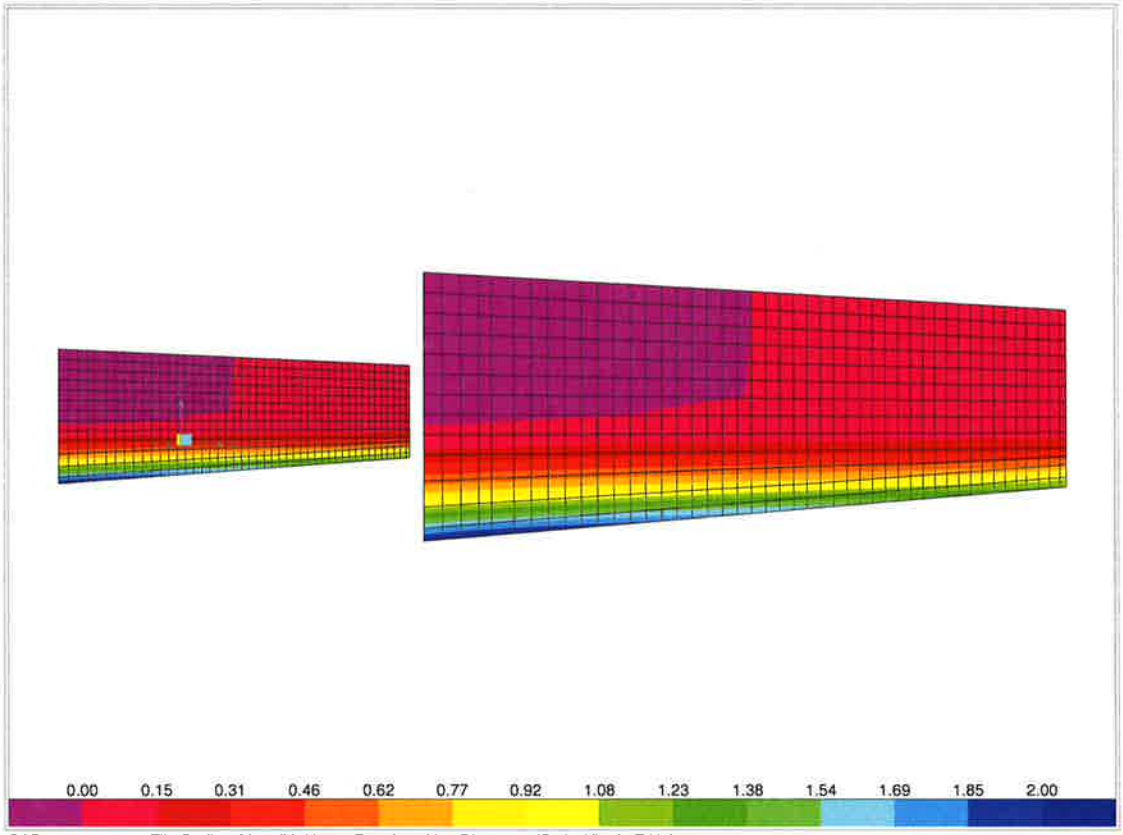
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/12/13 8:28:09



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 2) - Kip, ft, F Units

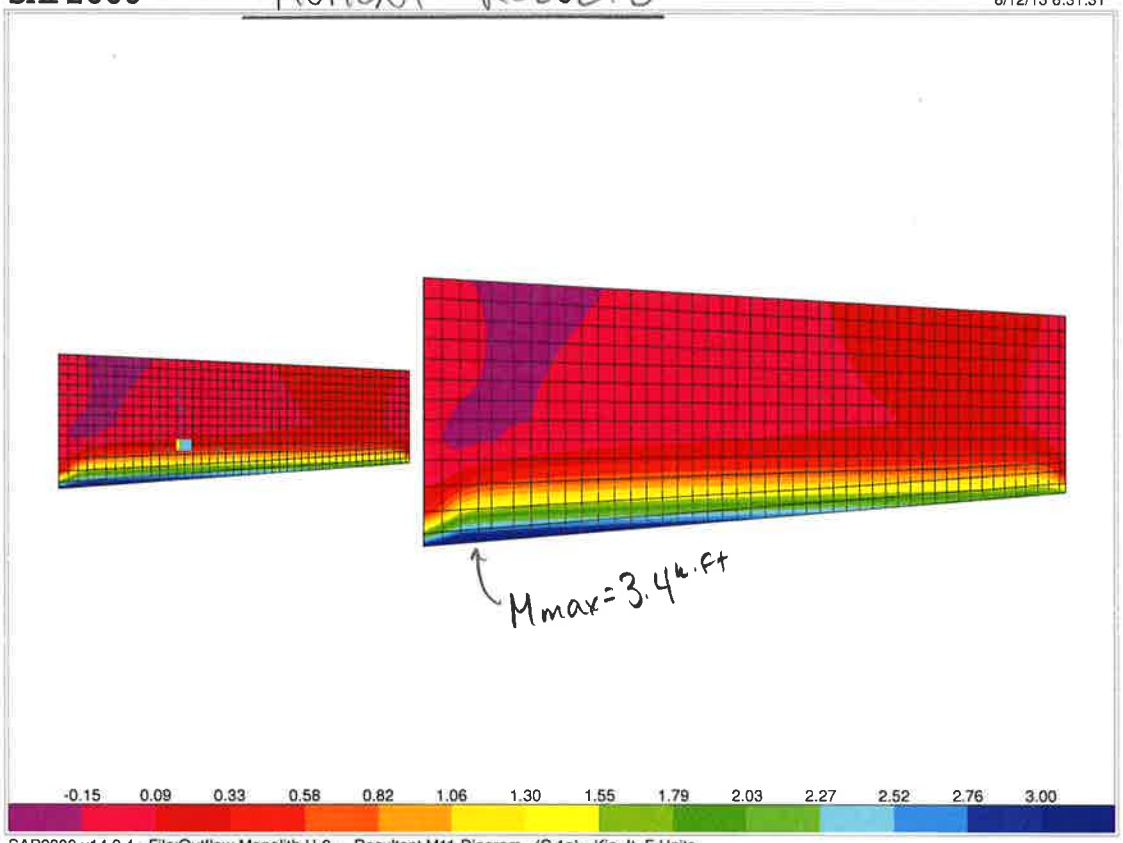
SAP2000 8/12/13 8:29:19



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

4

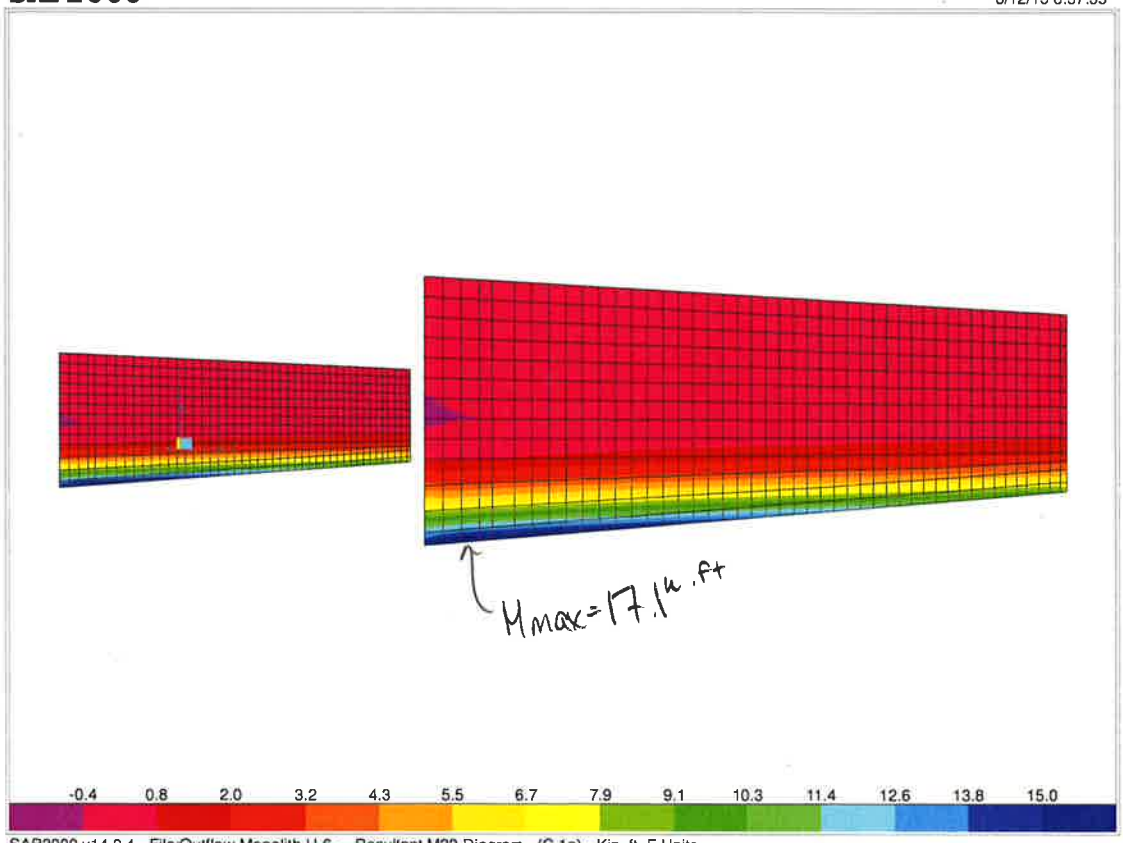
SAP2000 MOMENT RESULTS 8/12/13 8:31:31



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

HORIZONTAL

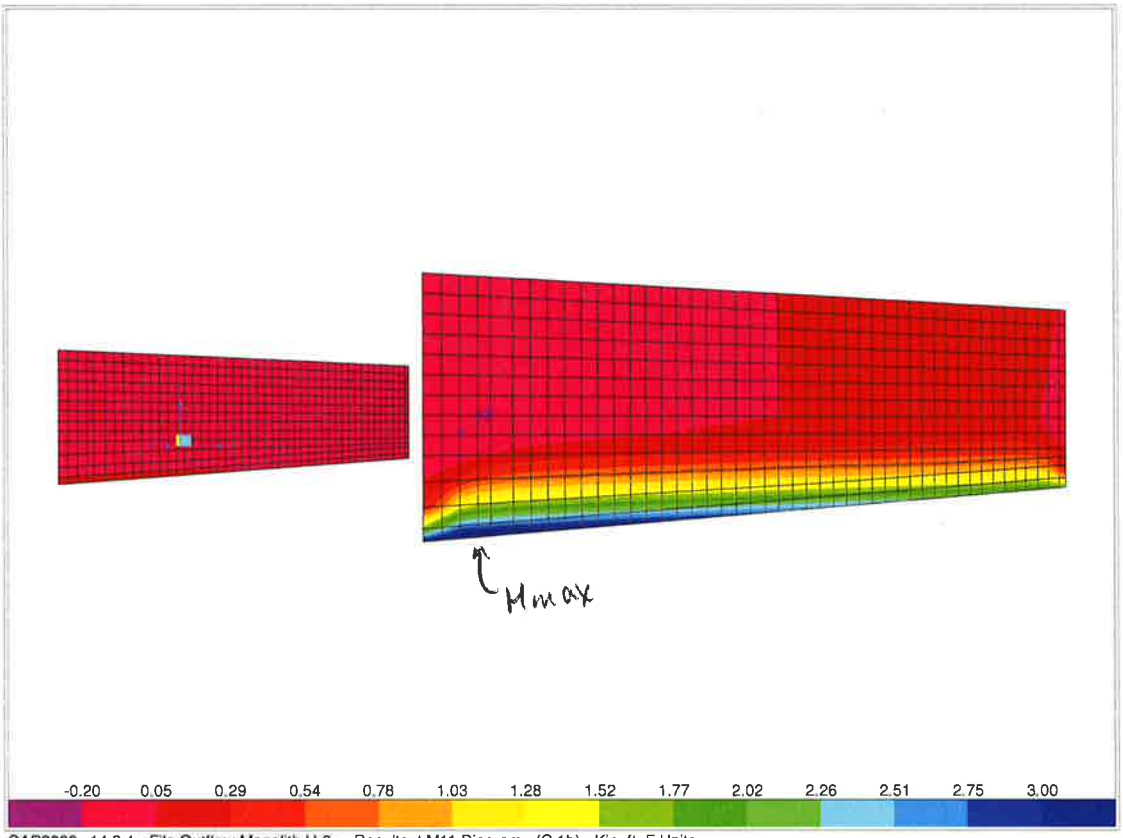
SAP2000 8/12/13 8:37:35



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

VERTICAL

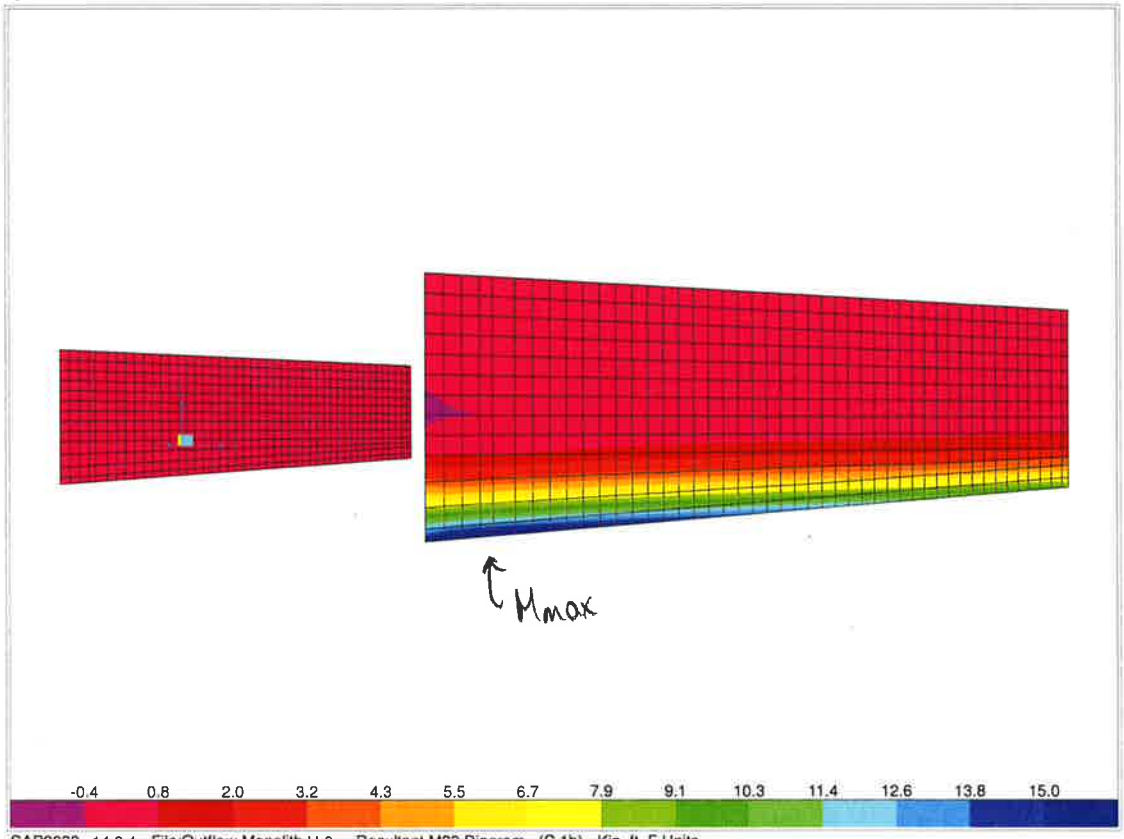
SAP2000 8/12/13 8:32:59



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

HORIZ.

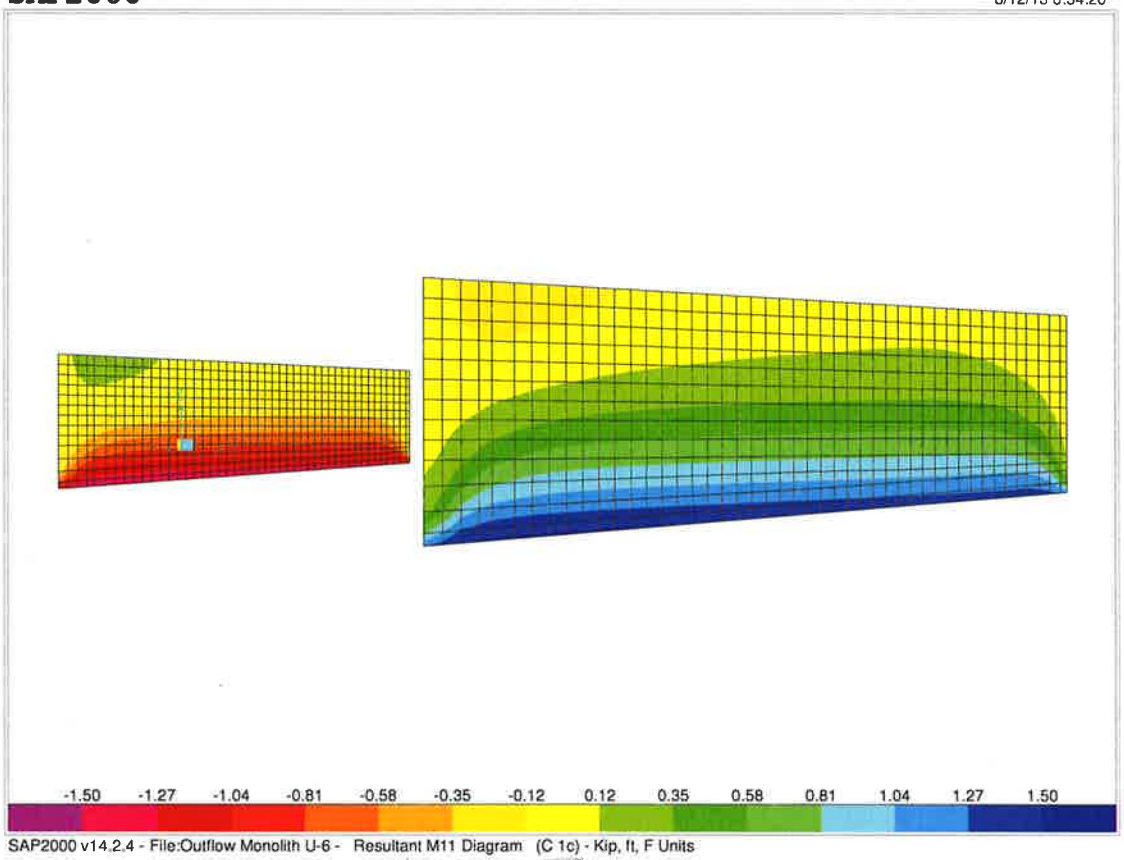
SAP2000 8/12/13 8:38:26



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

VERTICAL

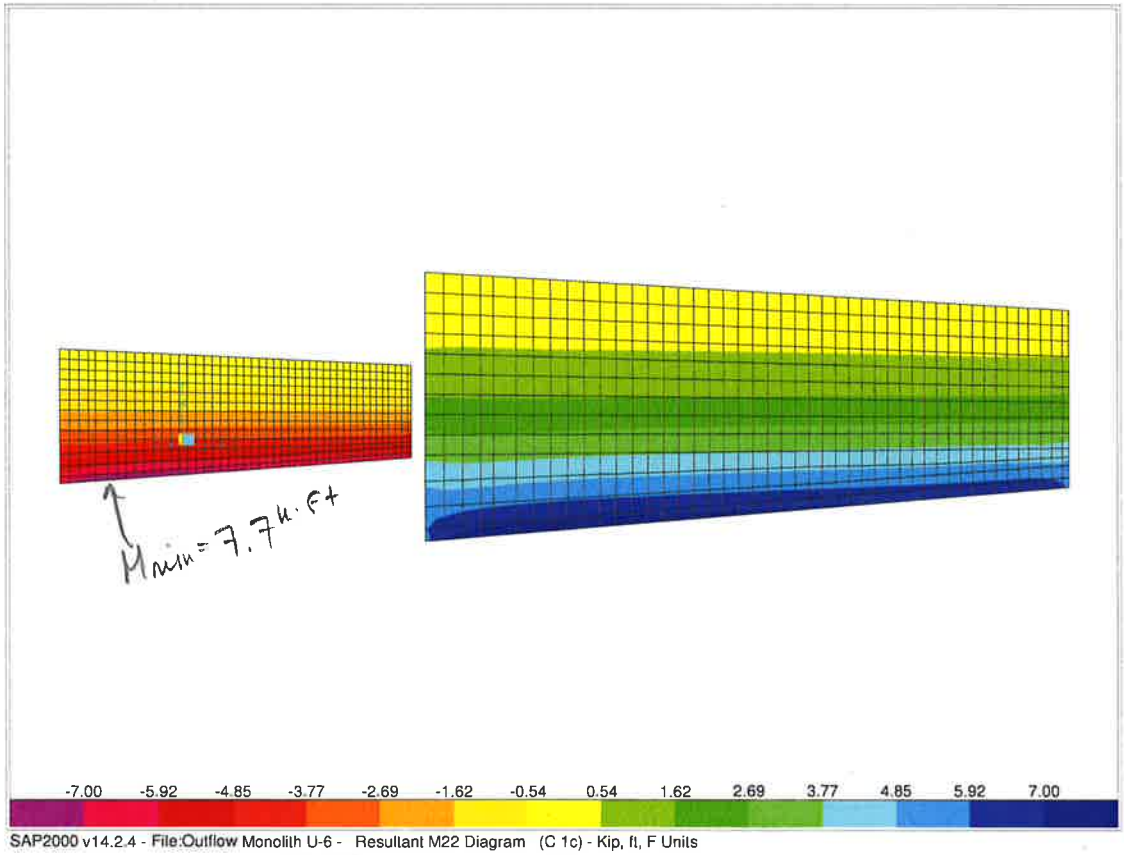
SAP2000 8/12/13 8:34:20



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

HORIZ.

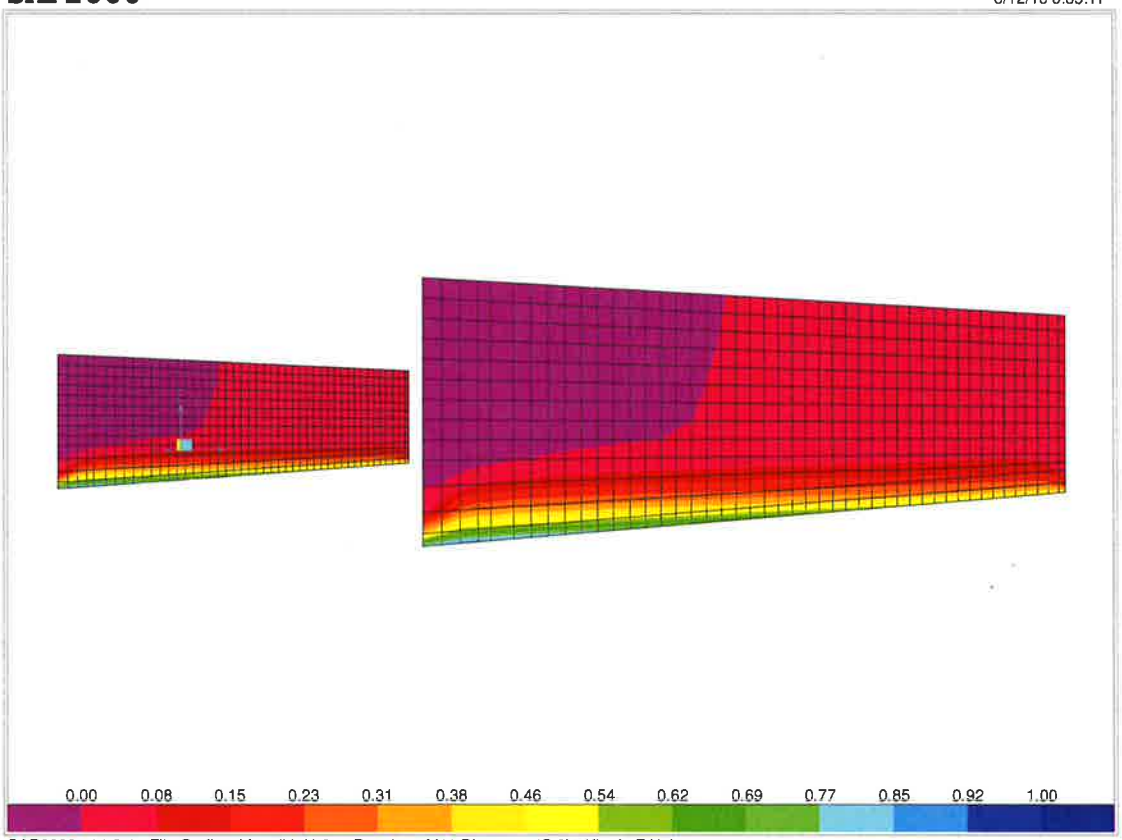
SAP2000 8/12/13 8:39:21



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1c) - Kip, ft, F Units

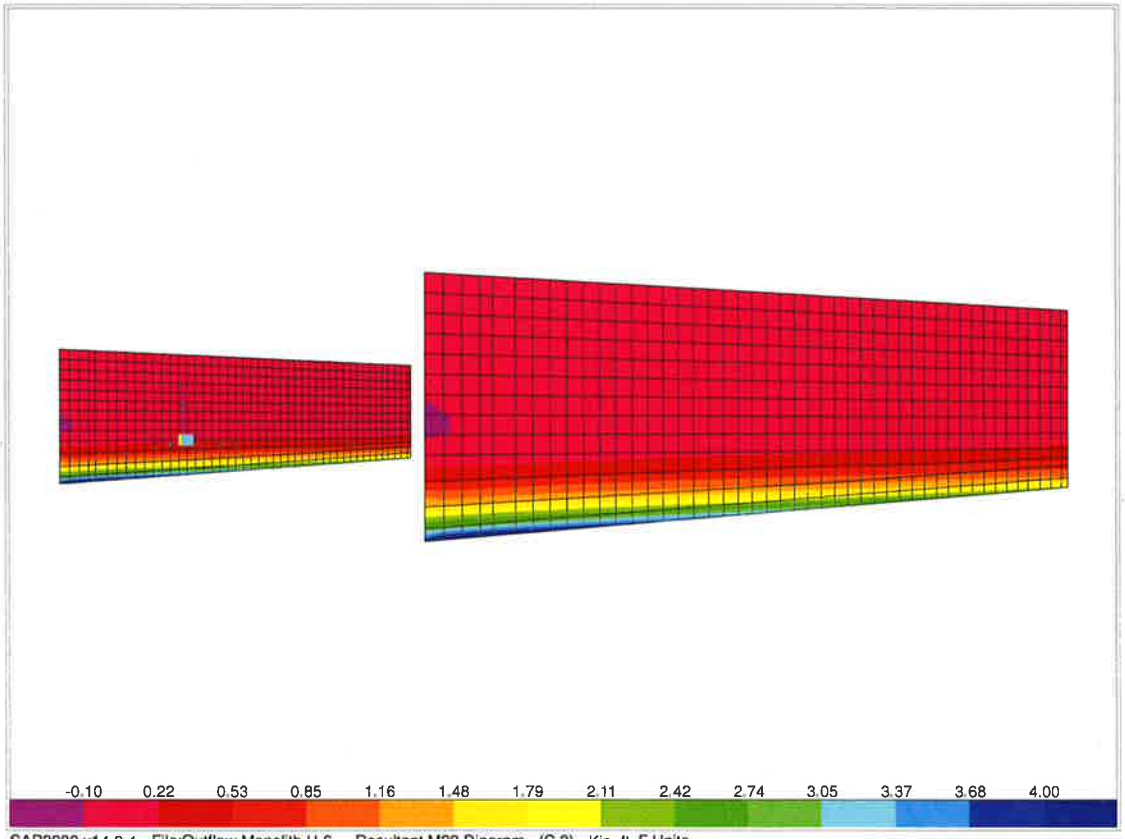
VERT.

SAP2000 8/12/13 8:35:11



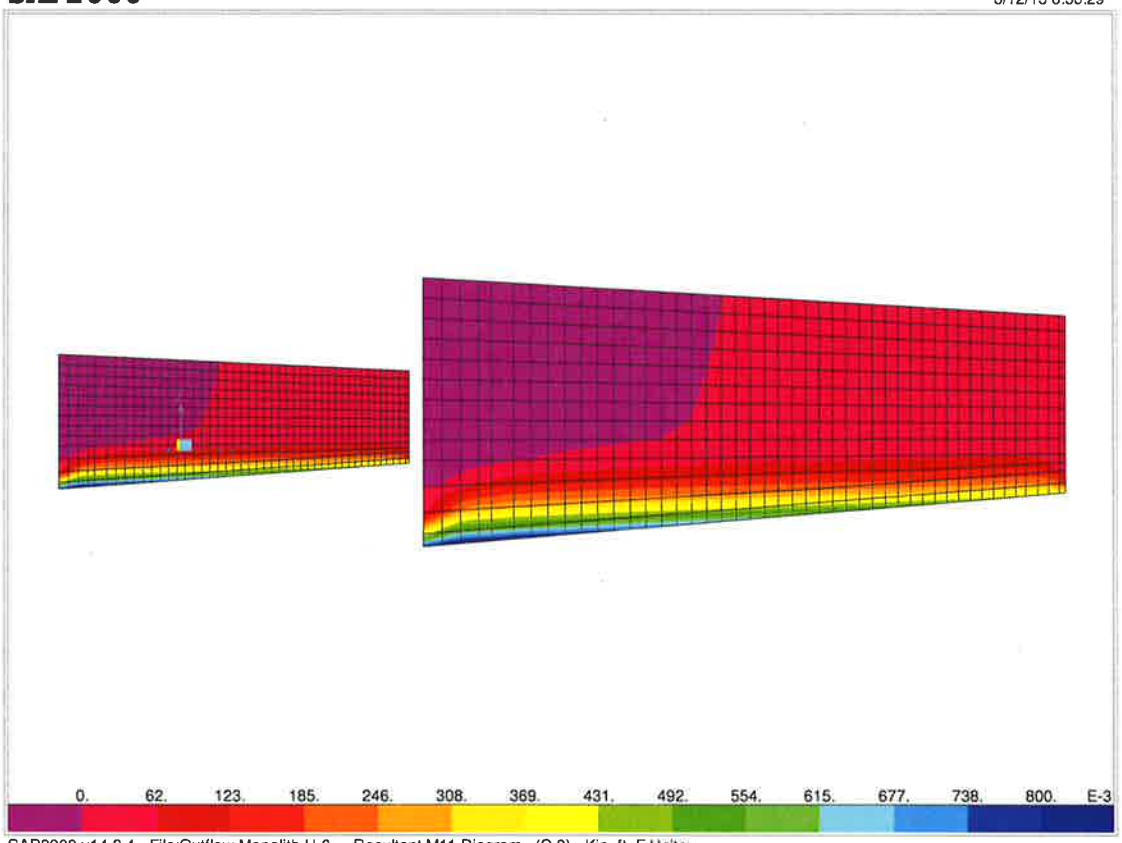
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/12/13 8:40:23



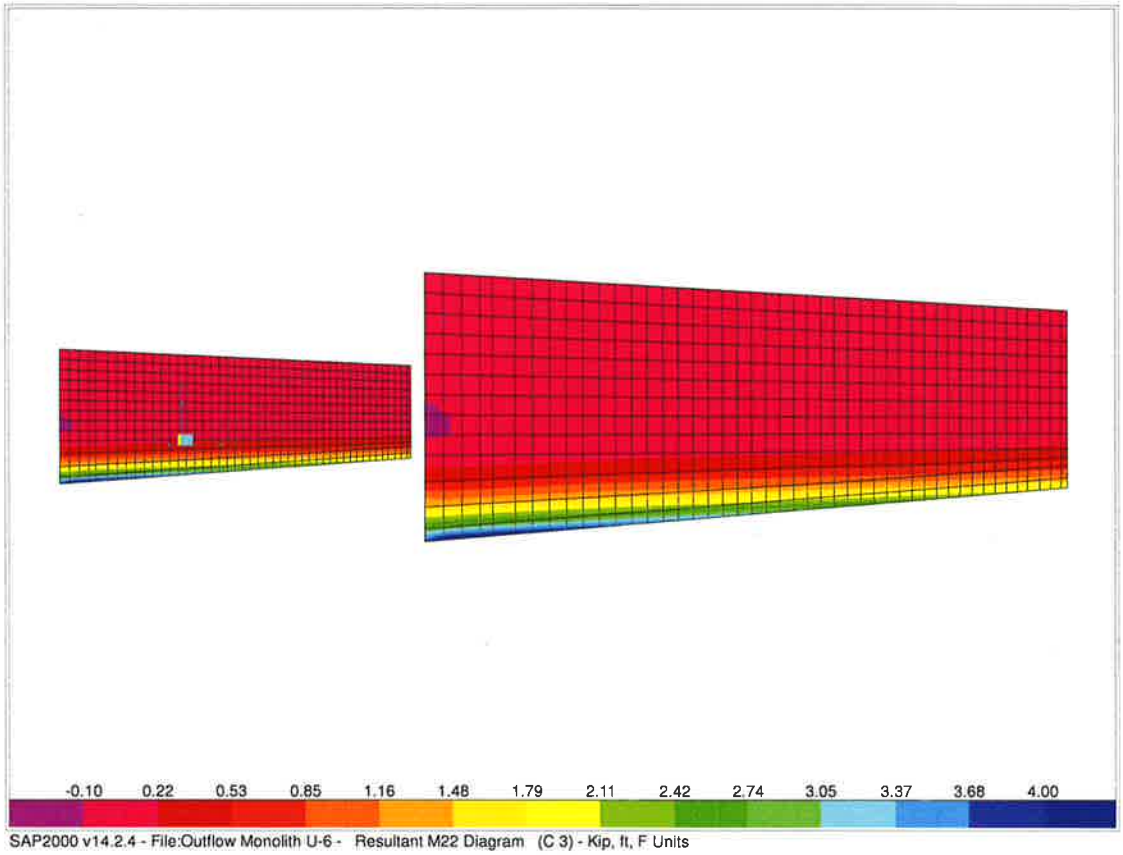
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/12/13 8:36:29



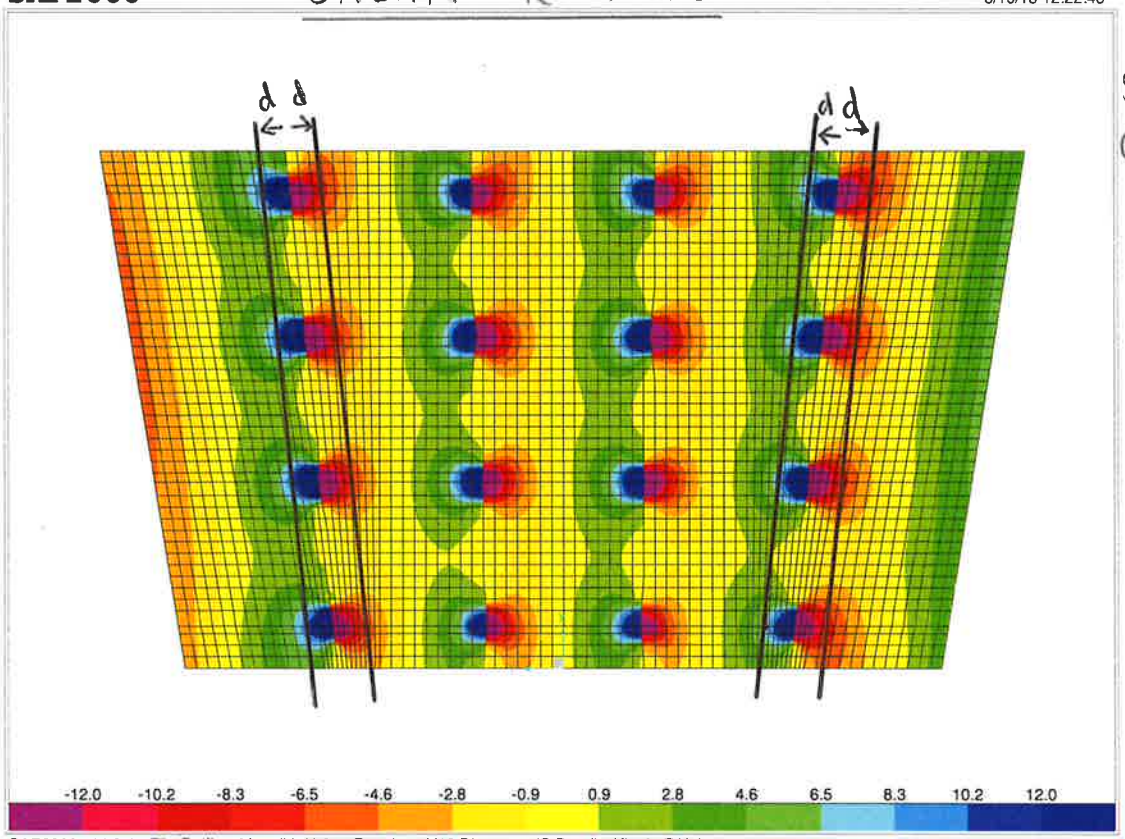
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/12/13 8:41:24



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

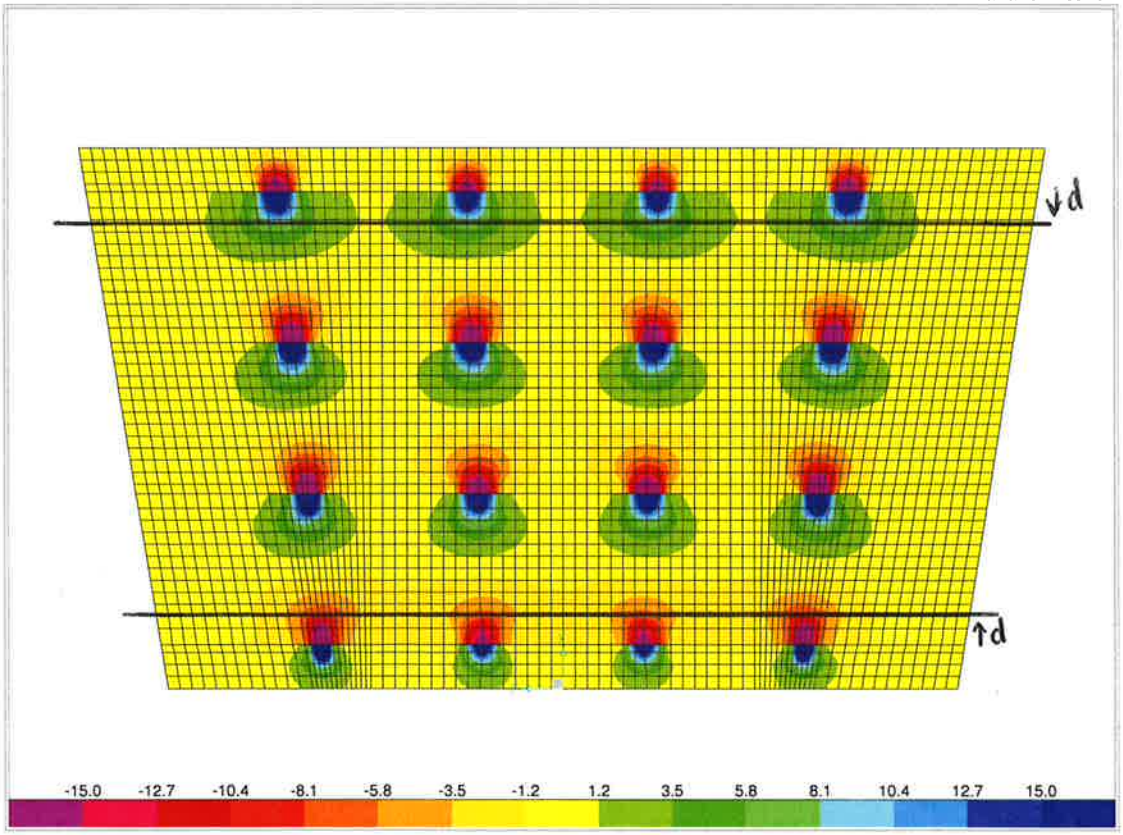
SAP2000 SHEAR RESULTS 8/10/13 12:22:43



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C Dead) - Kip, ft, F Units

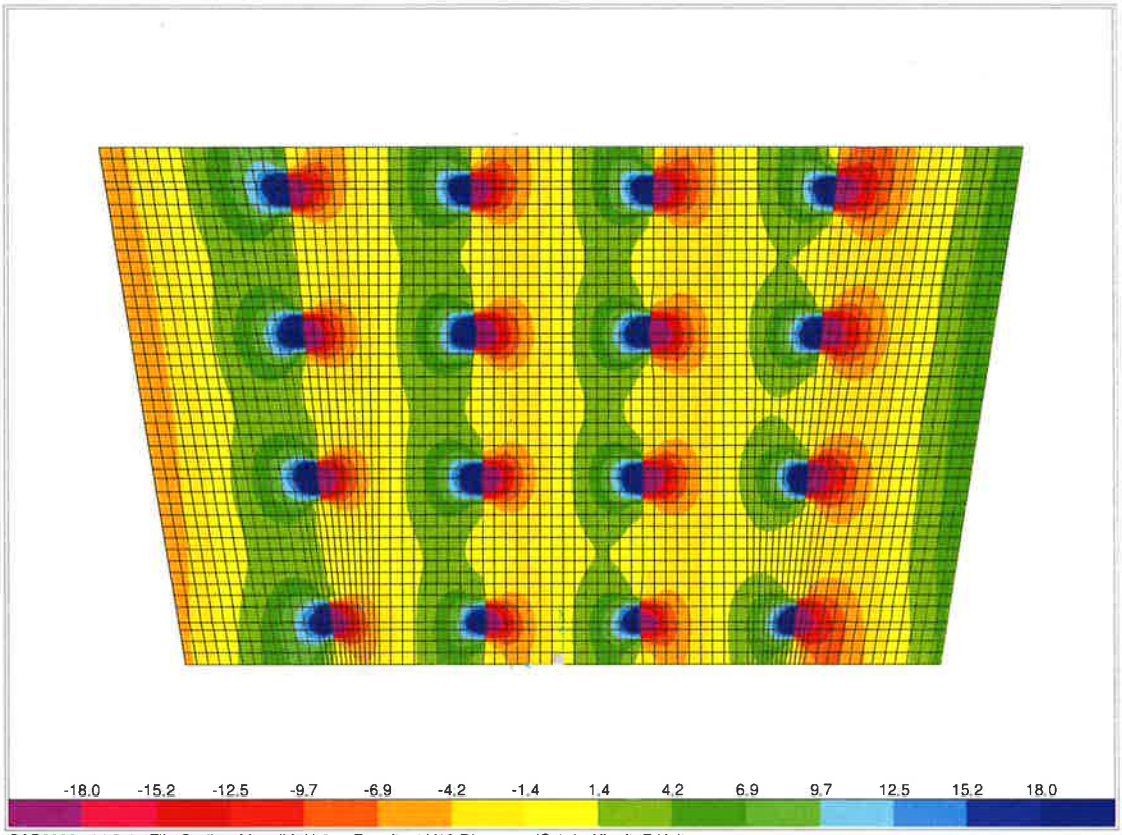
Shear always taken @ d from ℄ of pile (pile width is not included).

SAP2000 8/10/13 12:33:49



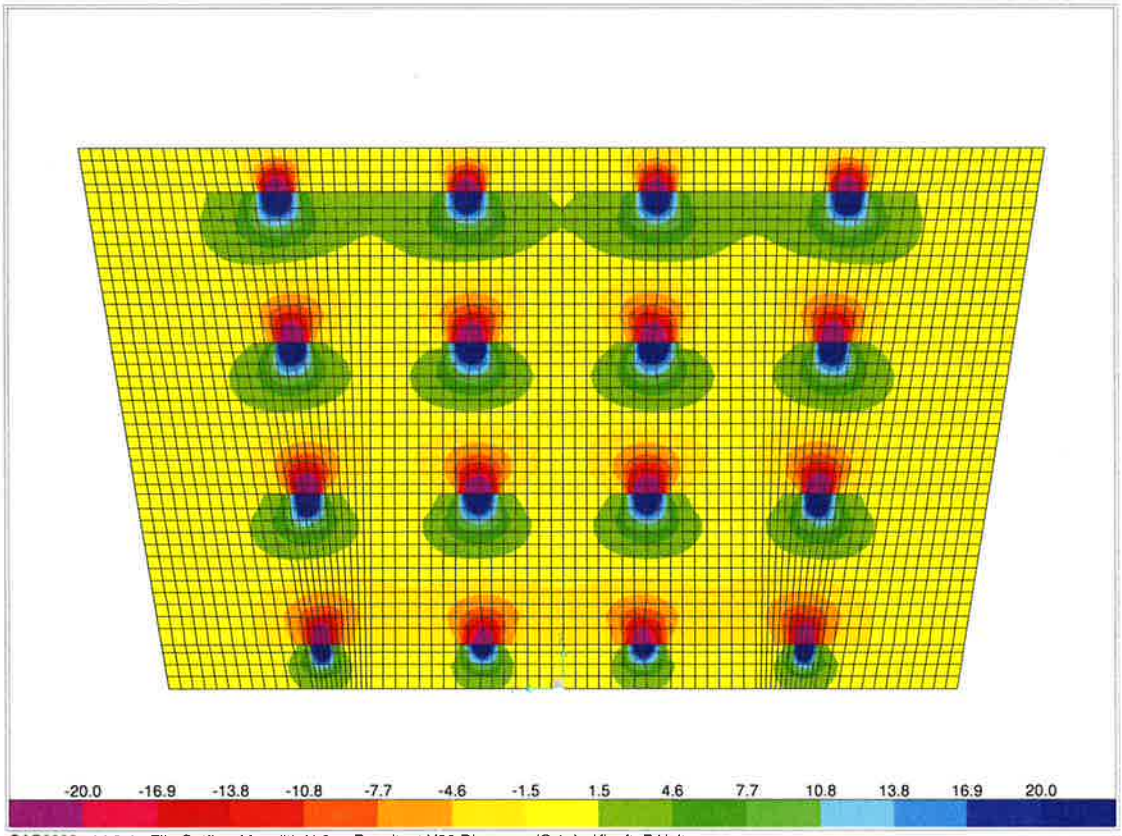
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C Dead) - Kip, ft, F Units

SAP2000 8/10/13 12:23:31



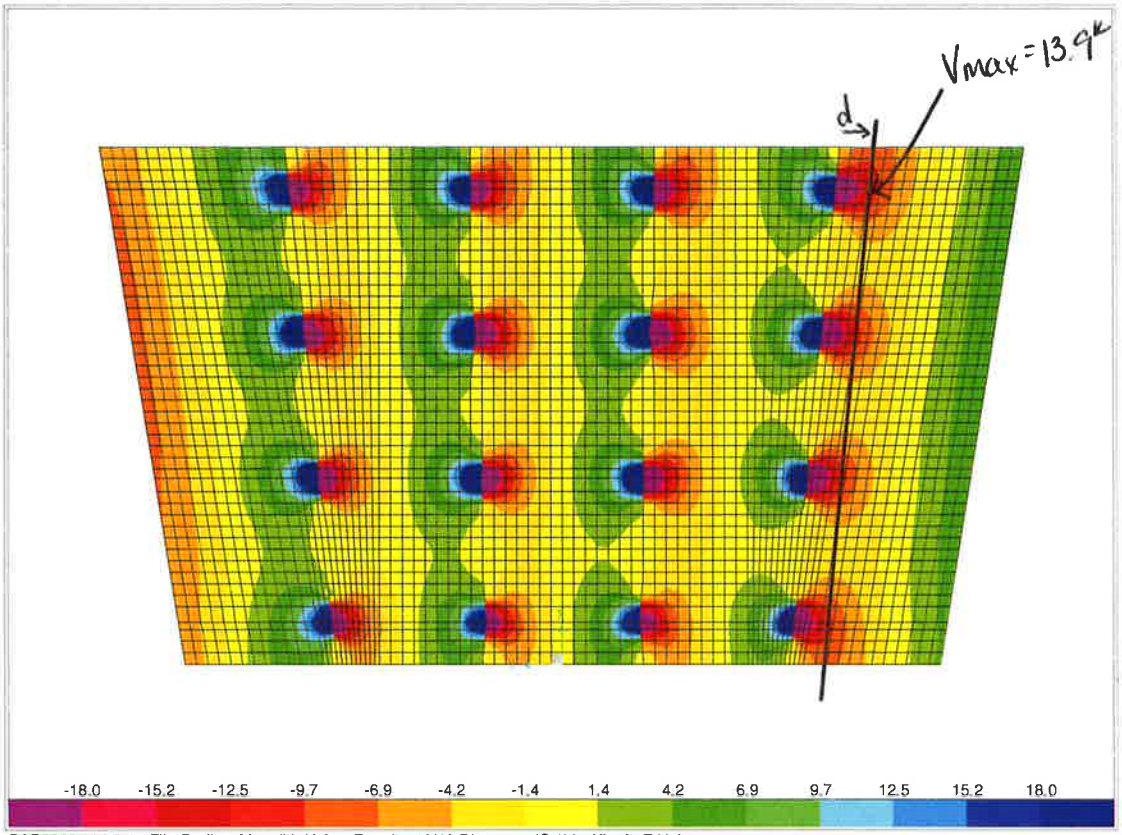
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/10/13 12:34:13



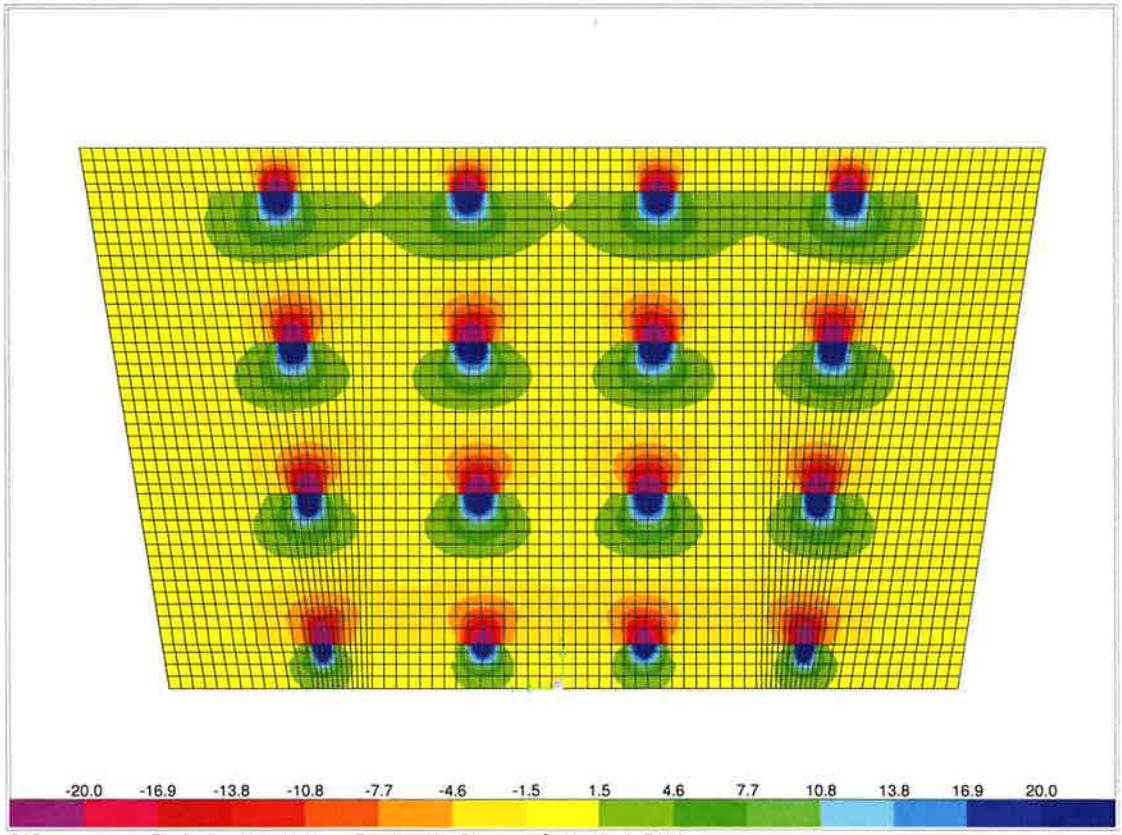
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/10/13 12:23:54



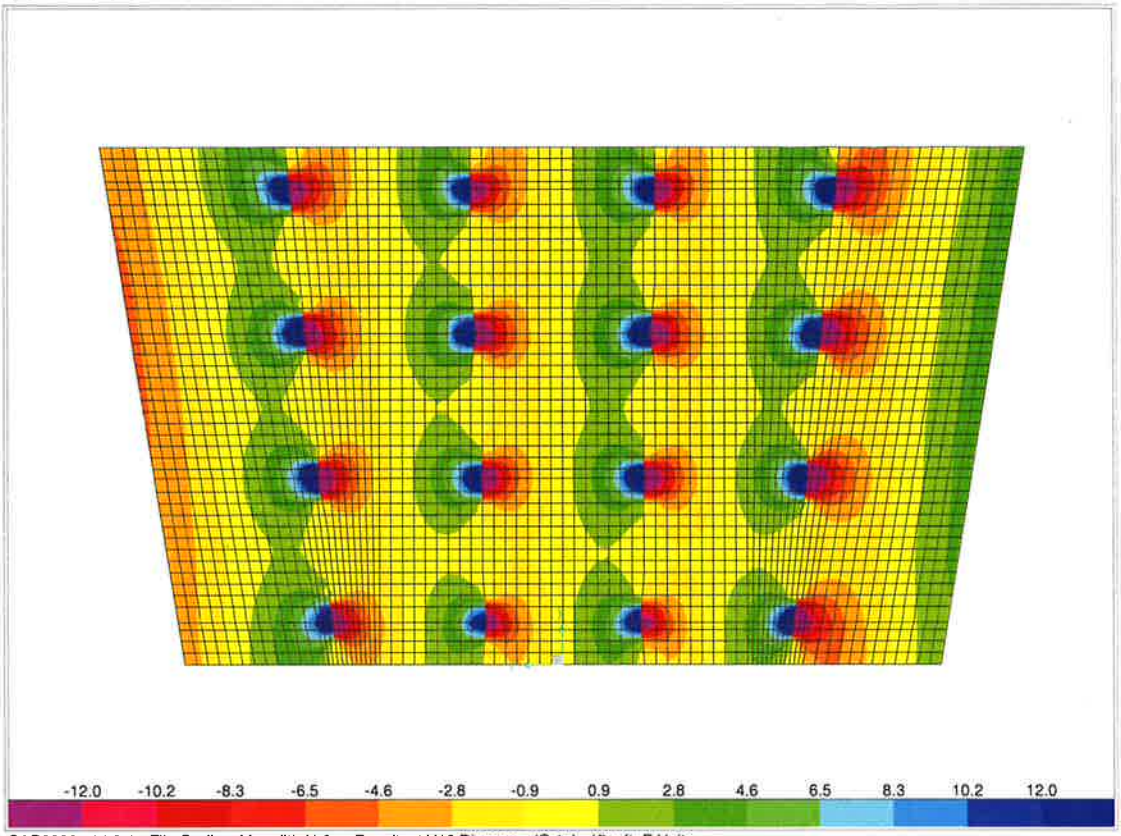
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/10/13 12:34:47



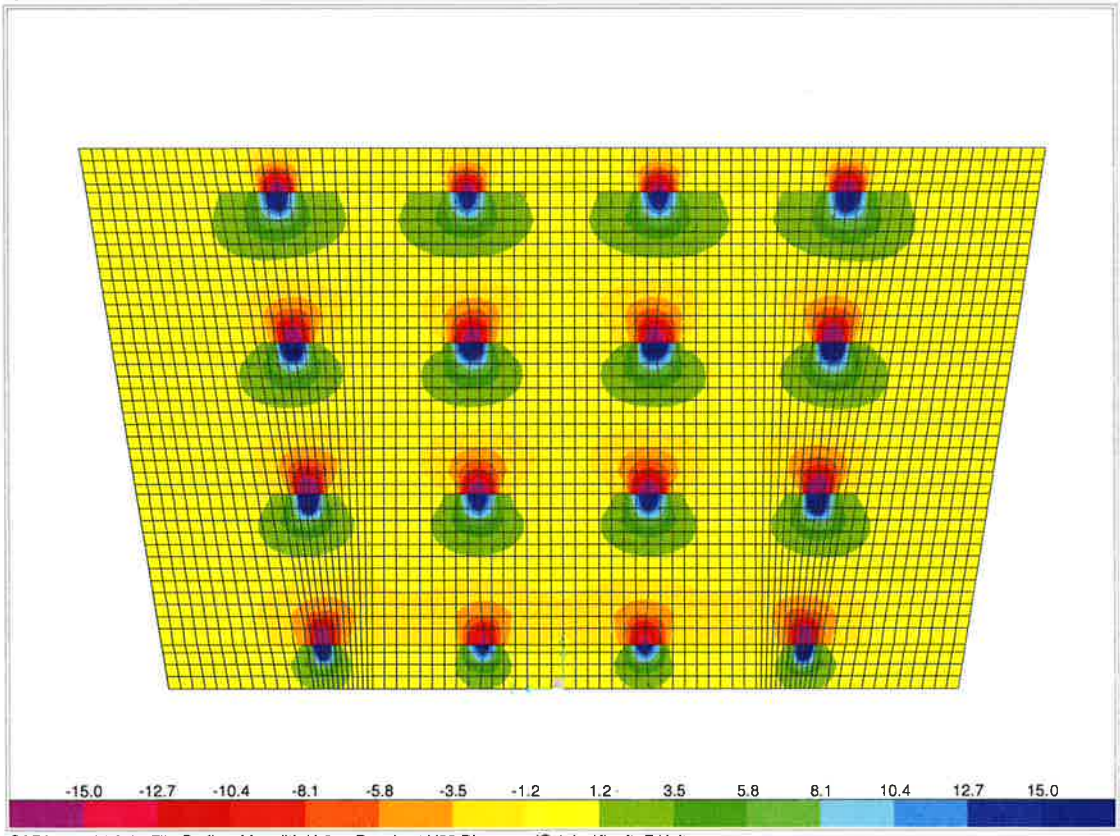
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1b) - Kip, ft, F Units

SAP2000 8/10/13 12:24:12



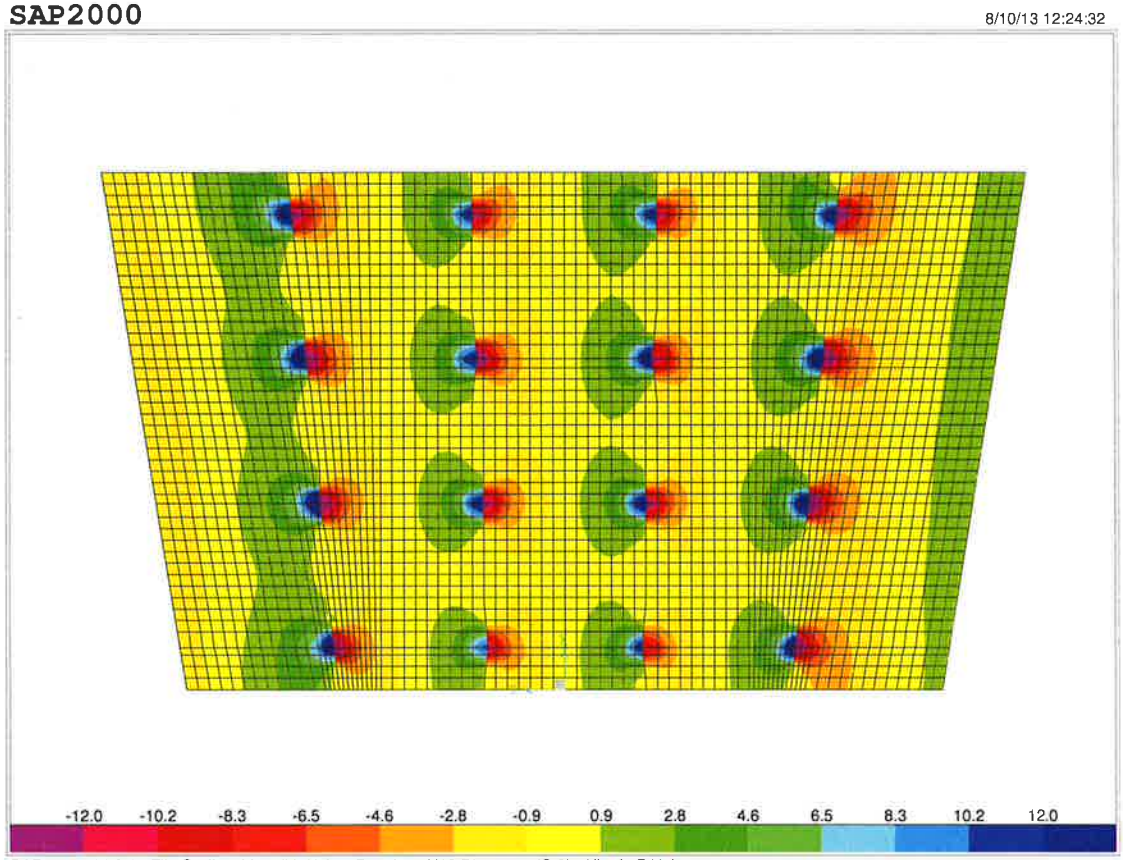
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/10/13 12:35:08



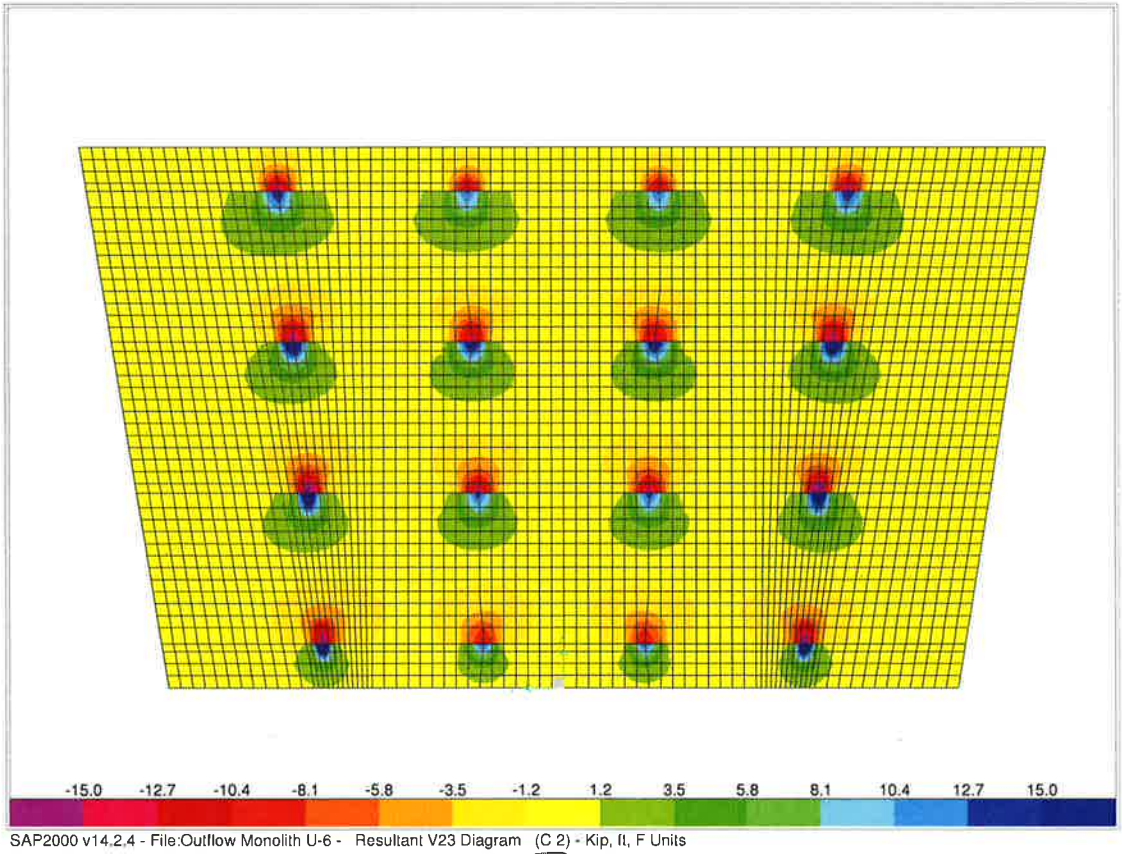
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/10/13 12:24:32



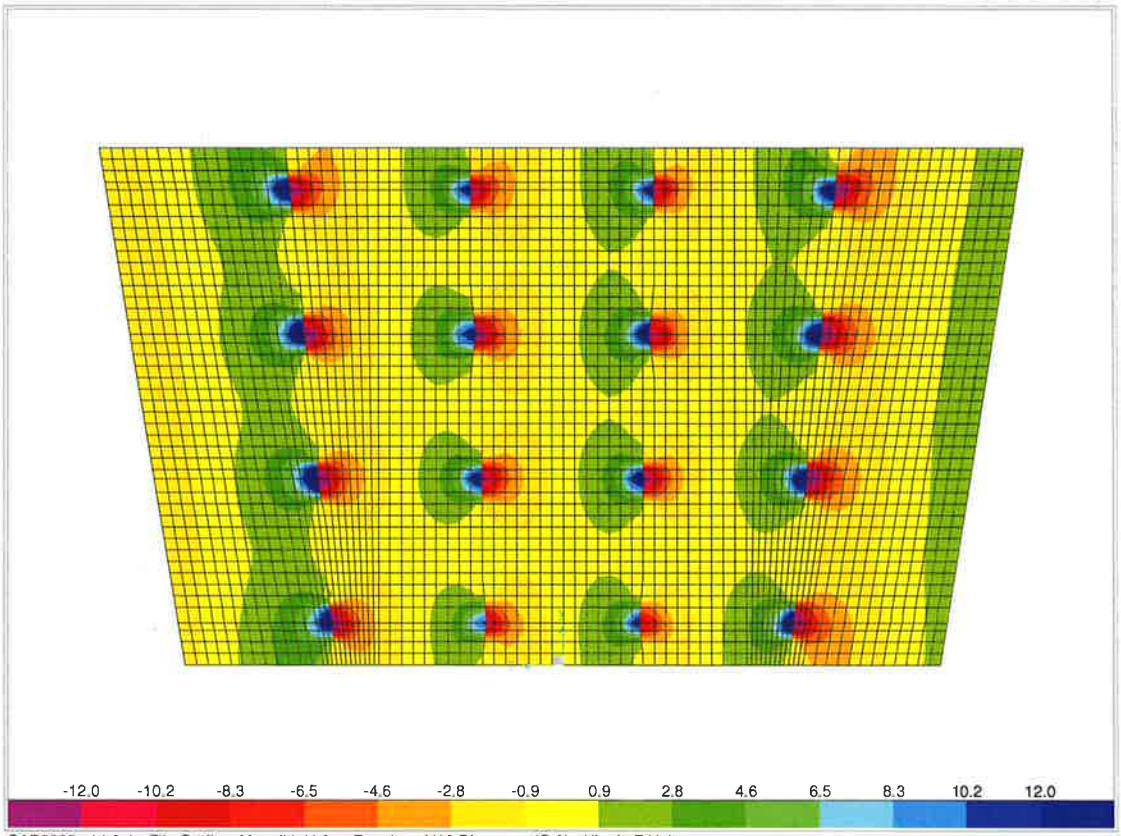
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/10/13 12:35:35



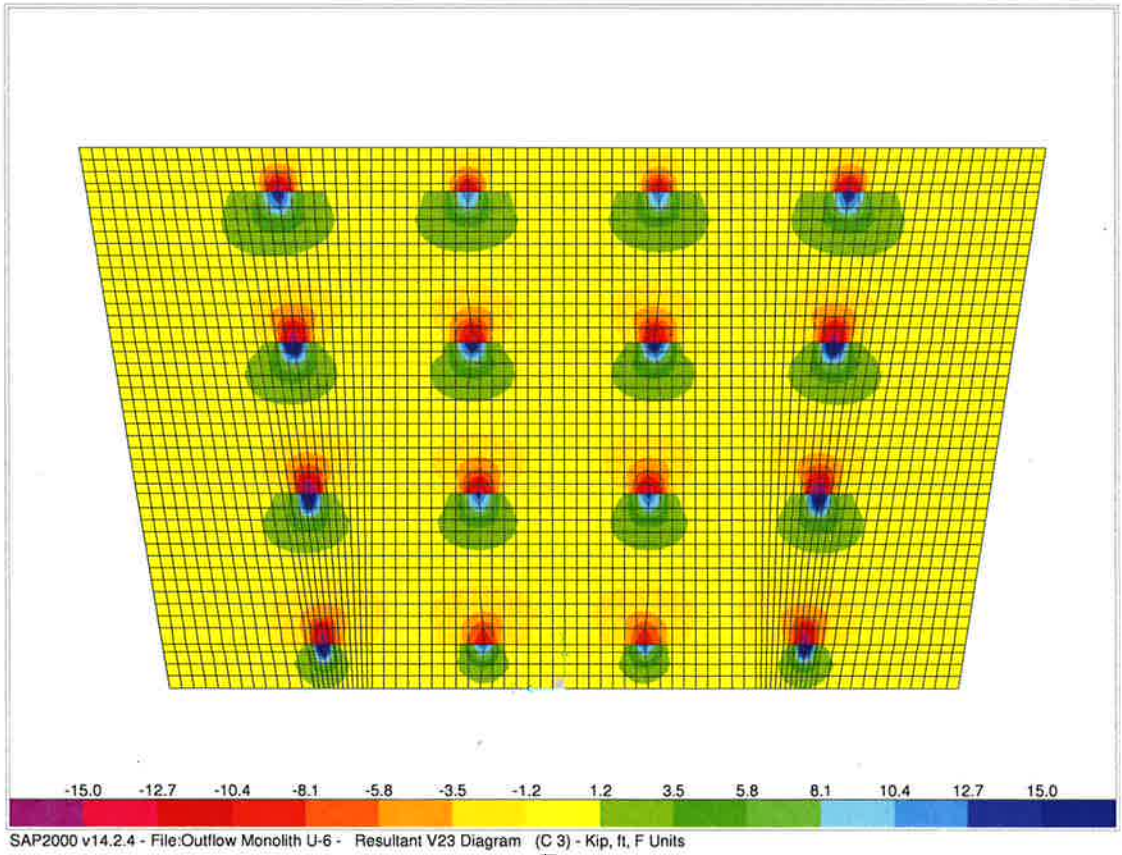
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/10/13 12:24:49



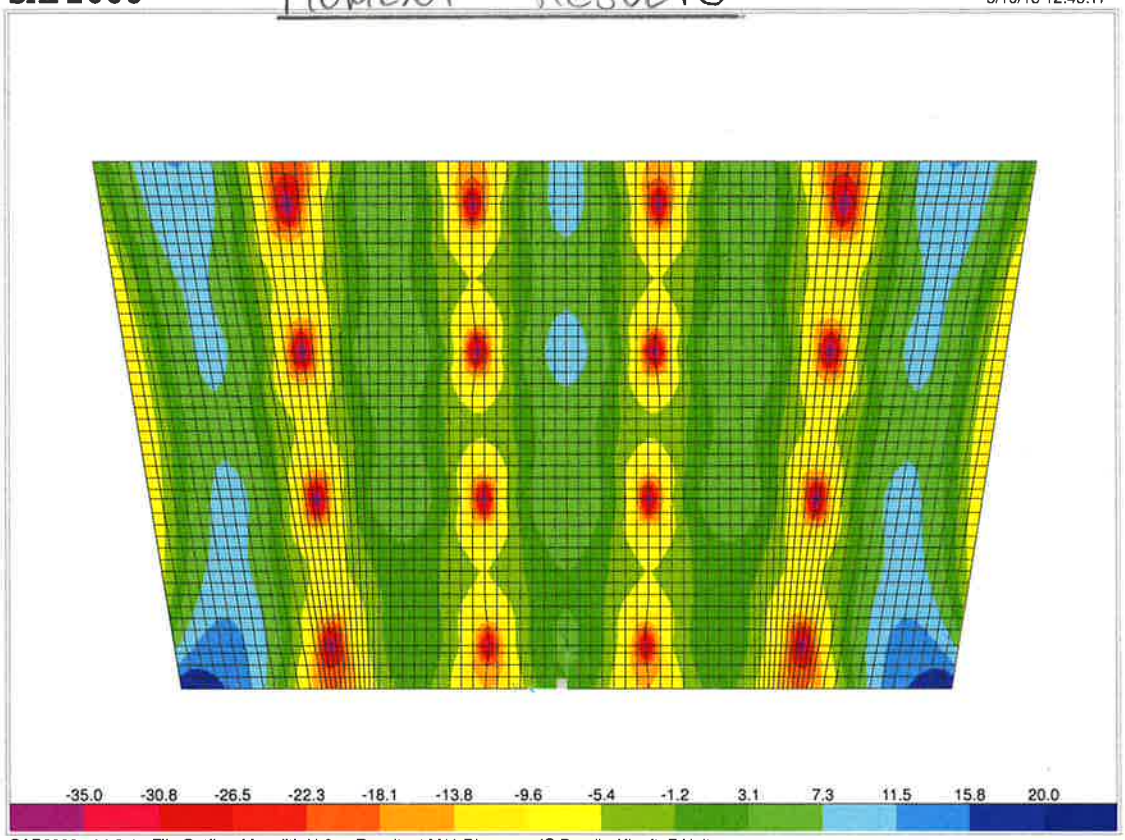
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/10/13 12:35:54



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 3) - Kip, ft, F Units

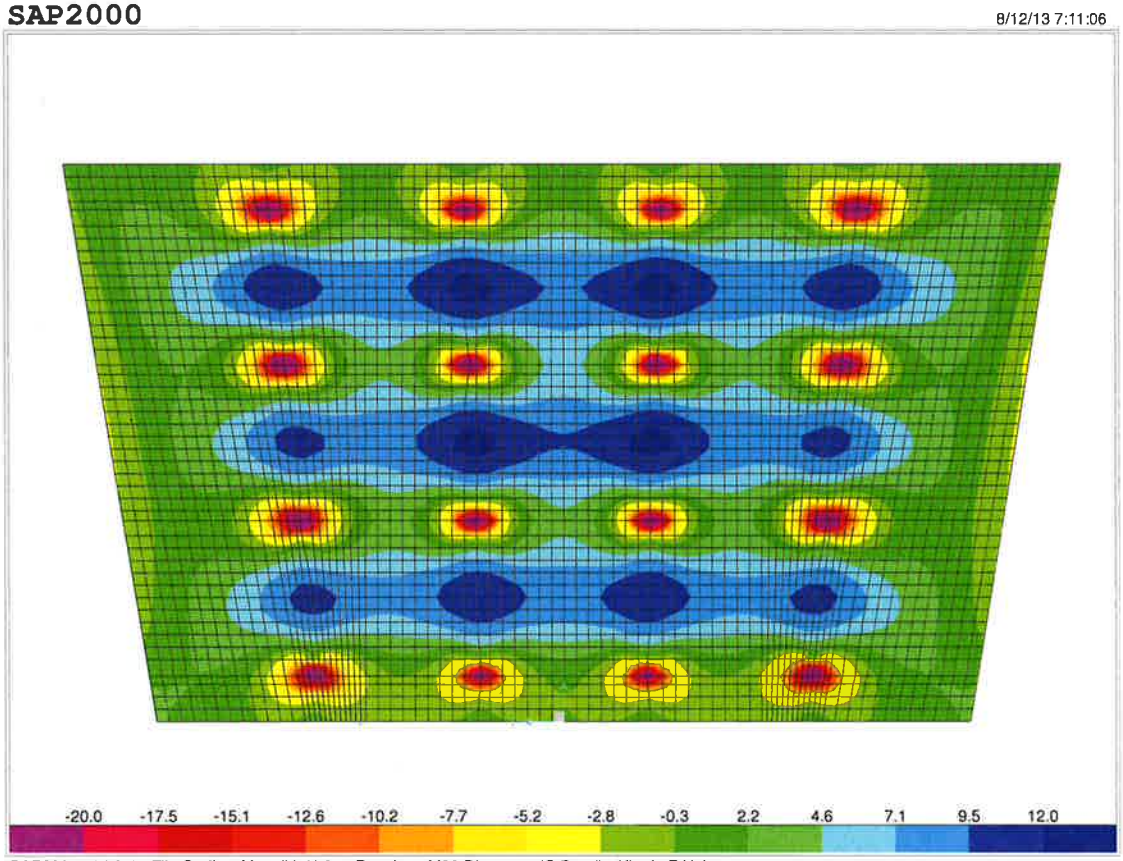
SAP2000 MOMENT RESULTS 8/10/13 12:43:17



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C Dead) - Kip, ft, F Units

TRANSVERSE

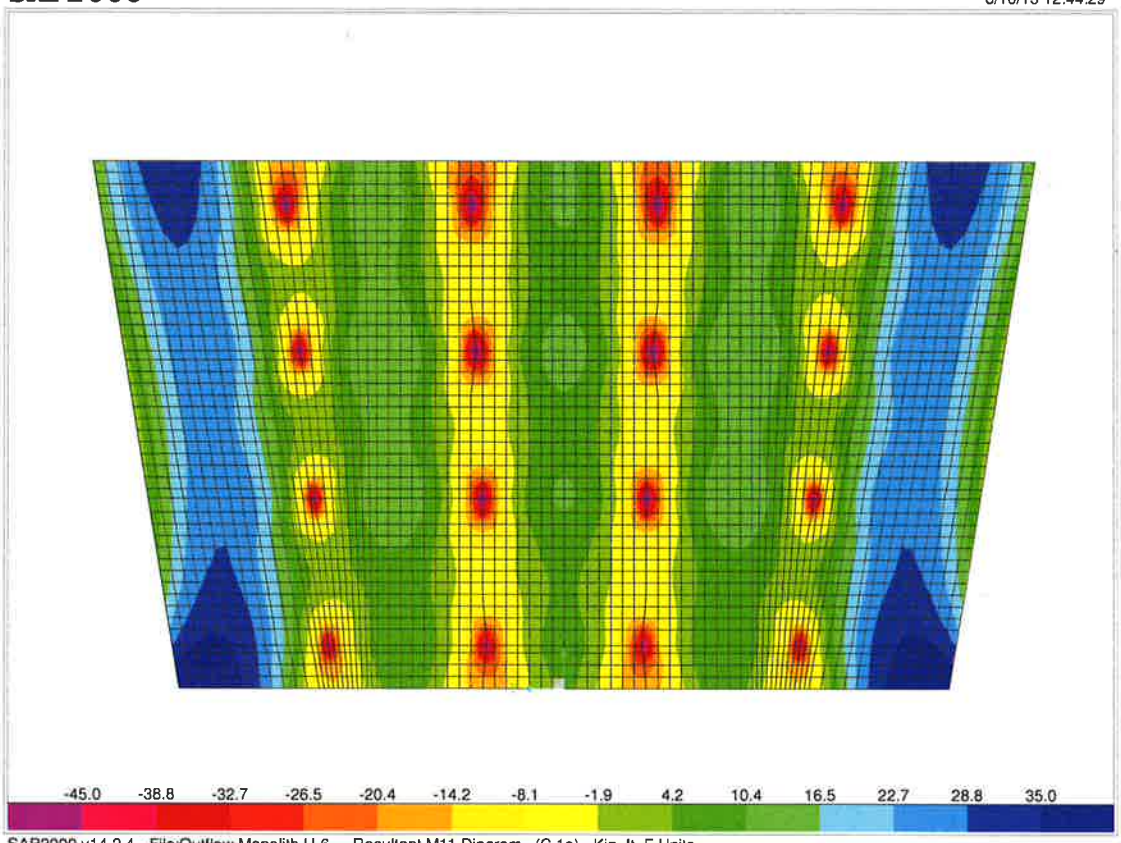
SAP2000 8/12/13 7:11:06



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C Dead) - Kip, ft, F Units

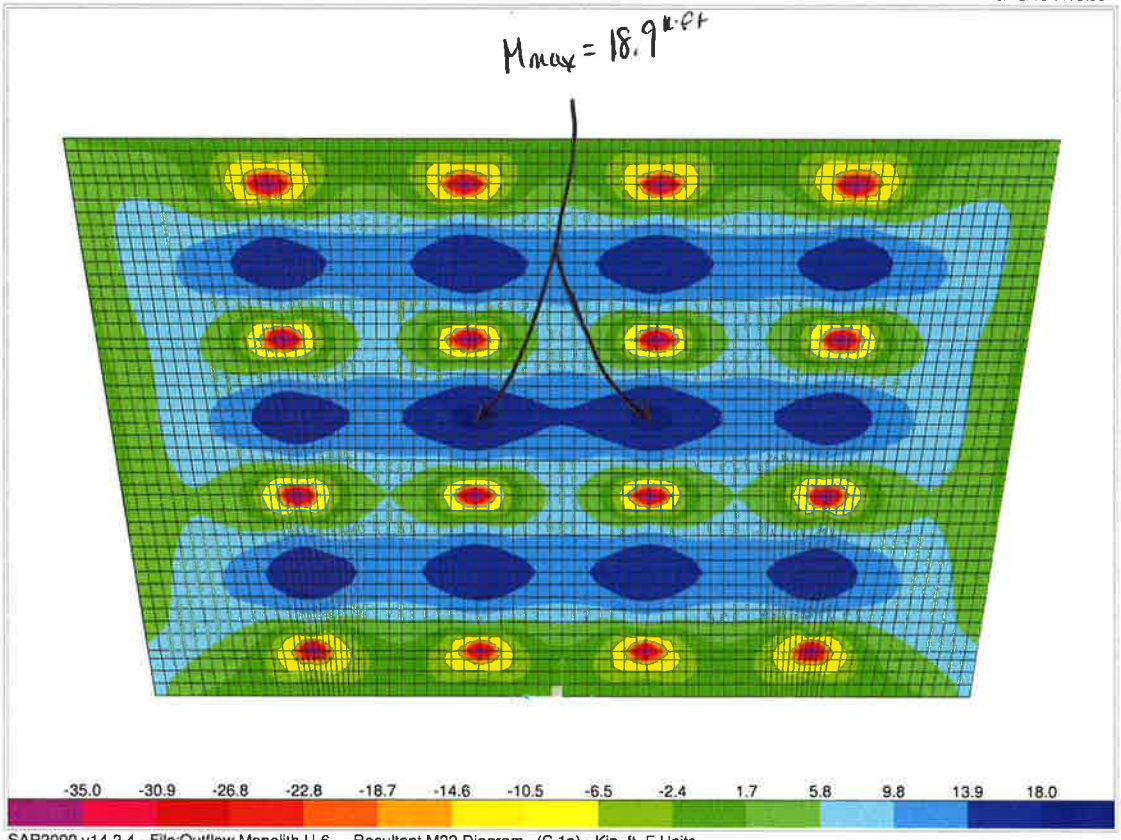
LONGITUDINAL

SAP2000 8/10/13 12:44:29



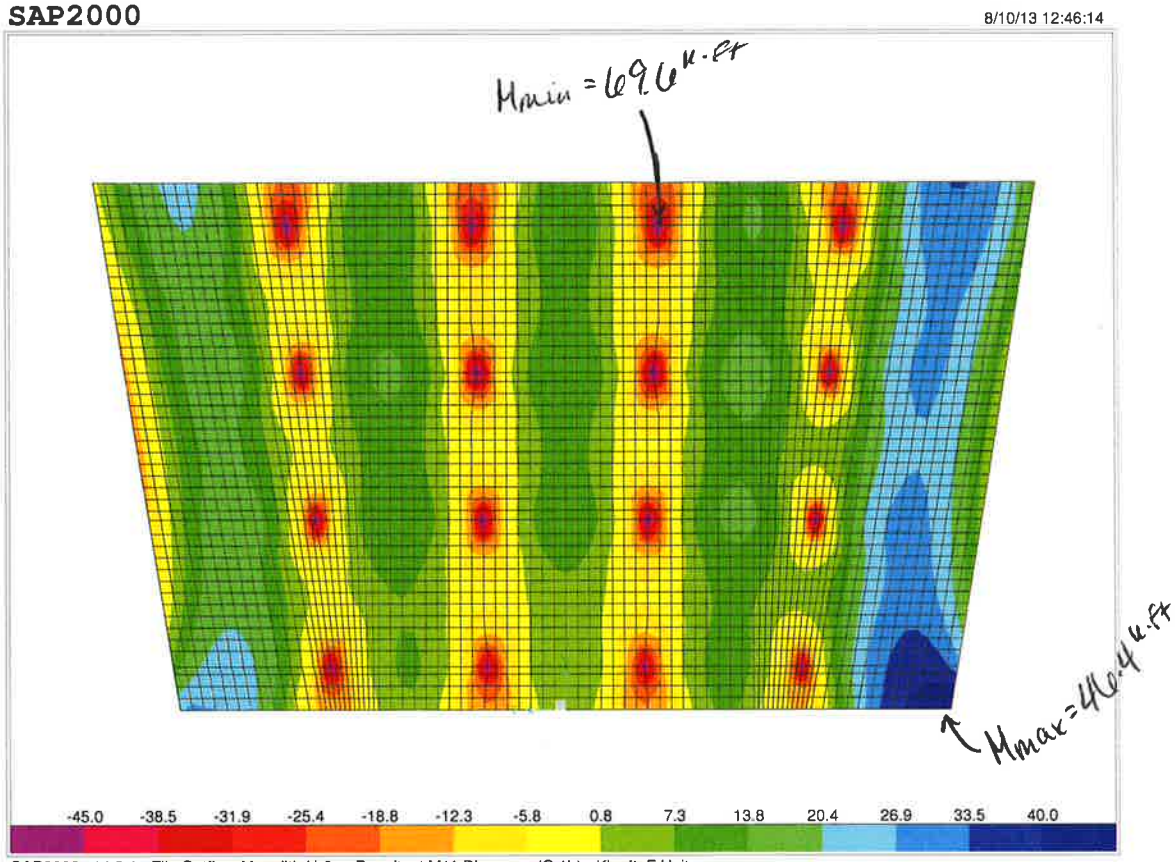
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1a) - Kip, ft, F Units

SAP2000 8/12/13 7:13:59



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1a) - Kip, ft, F Units

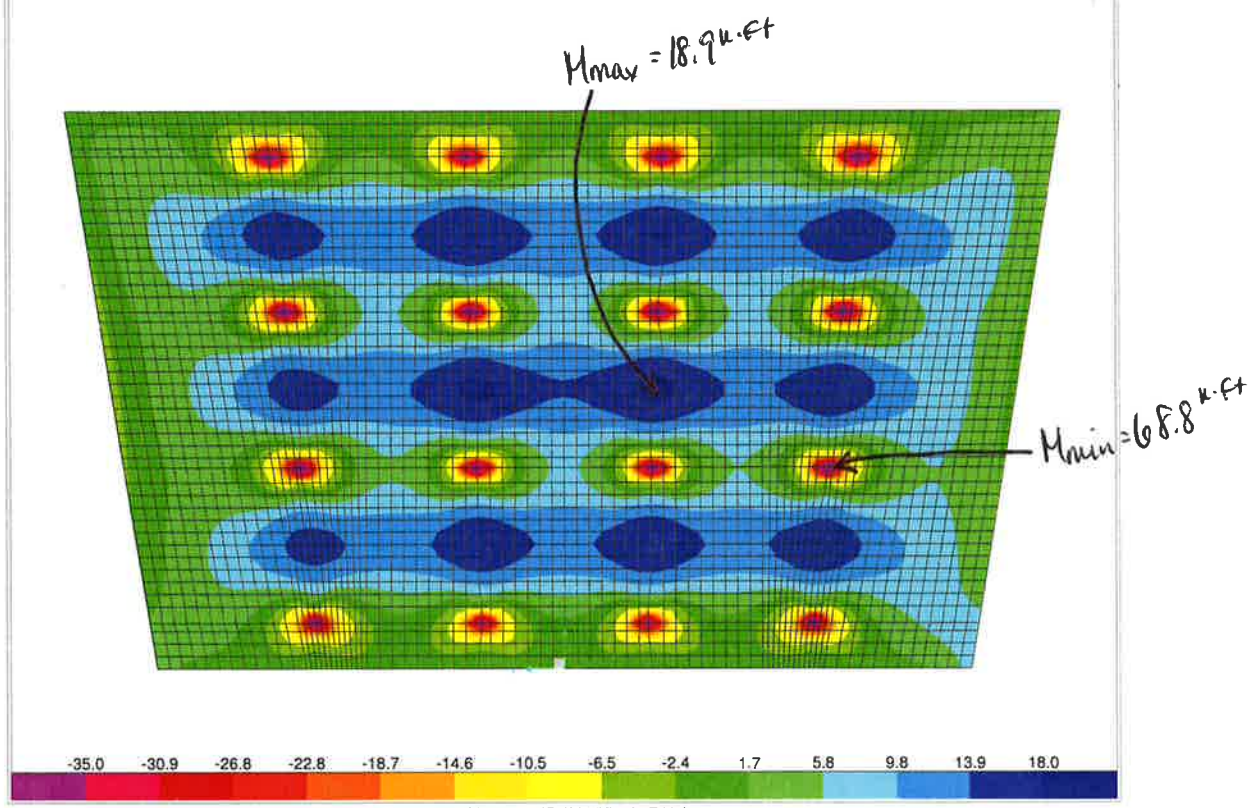
SAP2000 8/10/13 12:46:14



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1b) - Kip, ft, F Units

TRANS.

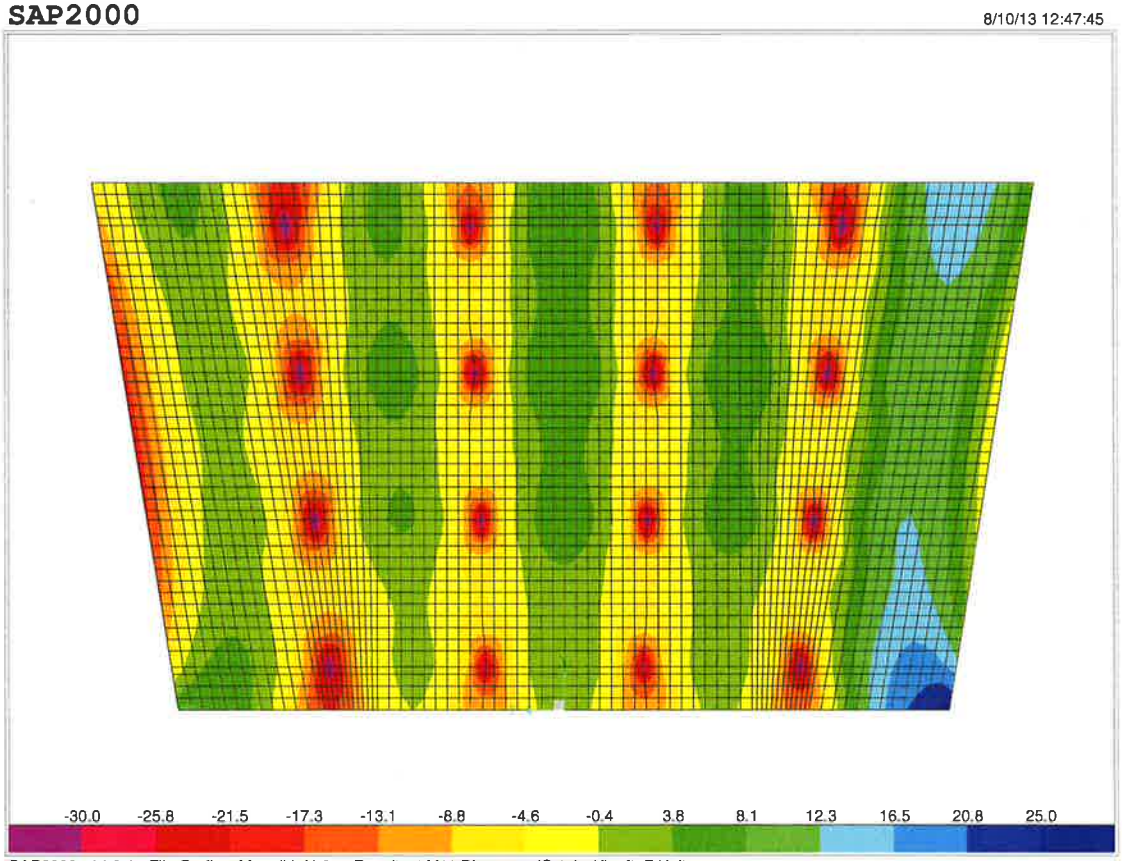
SAP2000 8/12/13 7:16:22



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1b) - Kip, ft, F Units

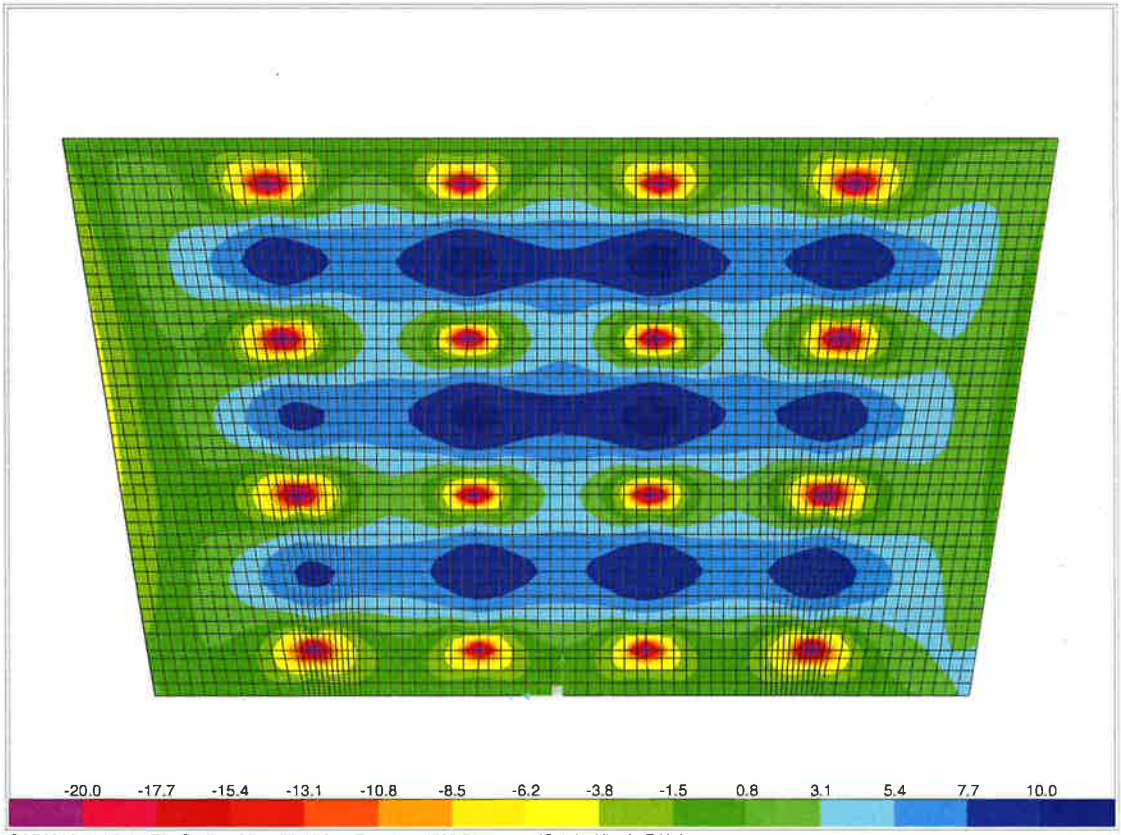
LONG.

SAP2000 8/10/13 12:47:45



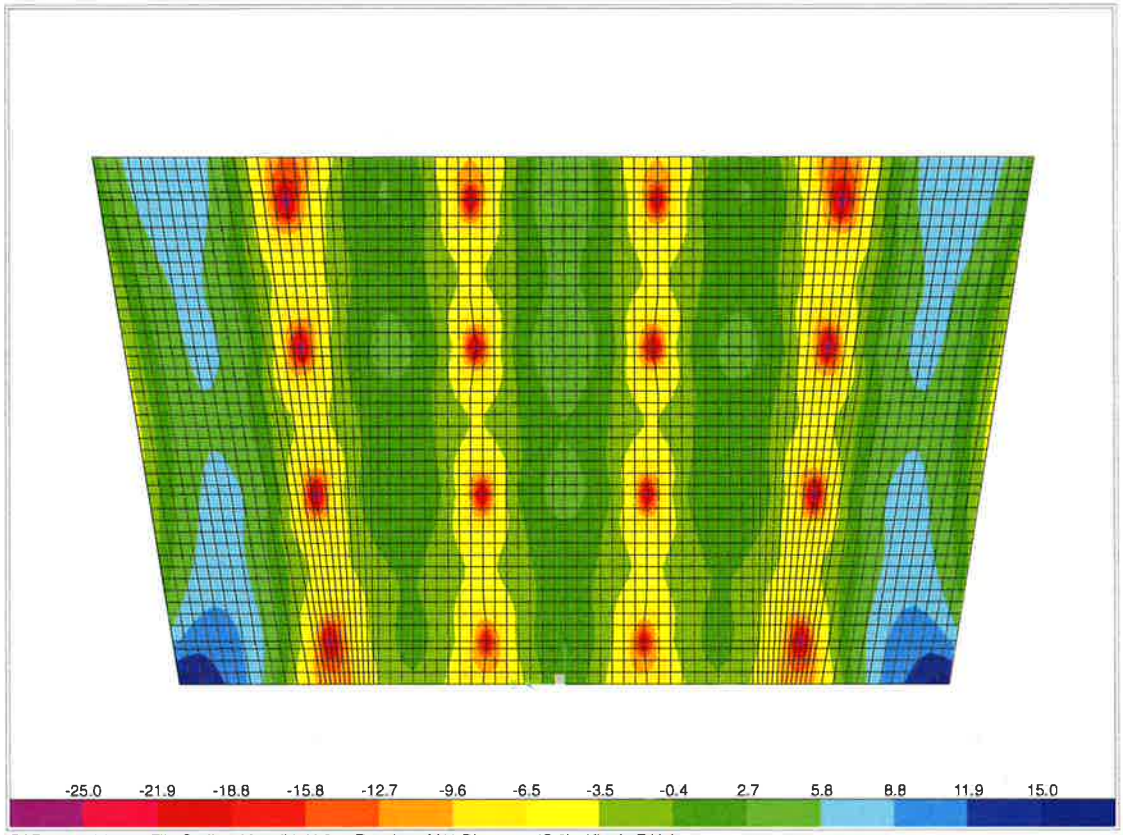
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/12/13 7:20:24



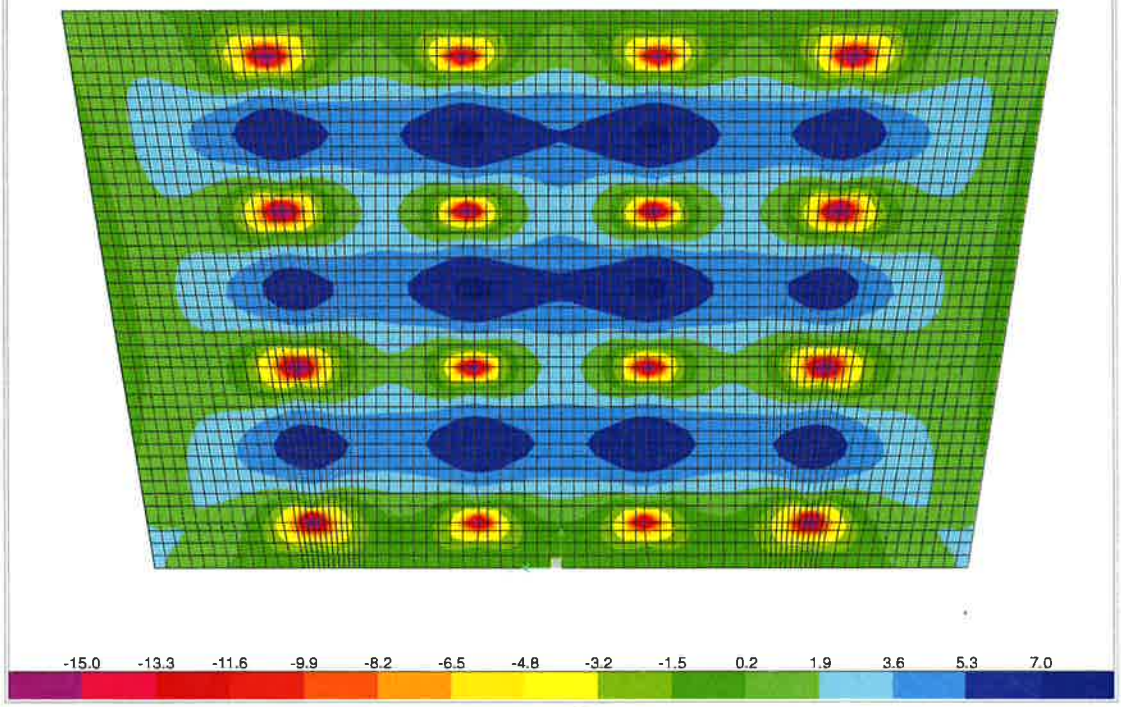
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1c) - Kip, ft, F Units

SAP2000 8/10/13 12:48:51



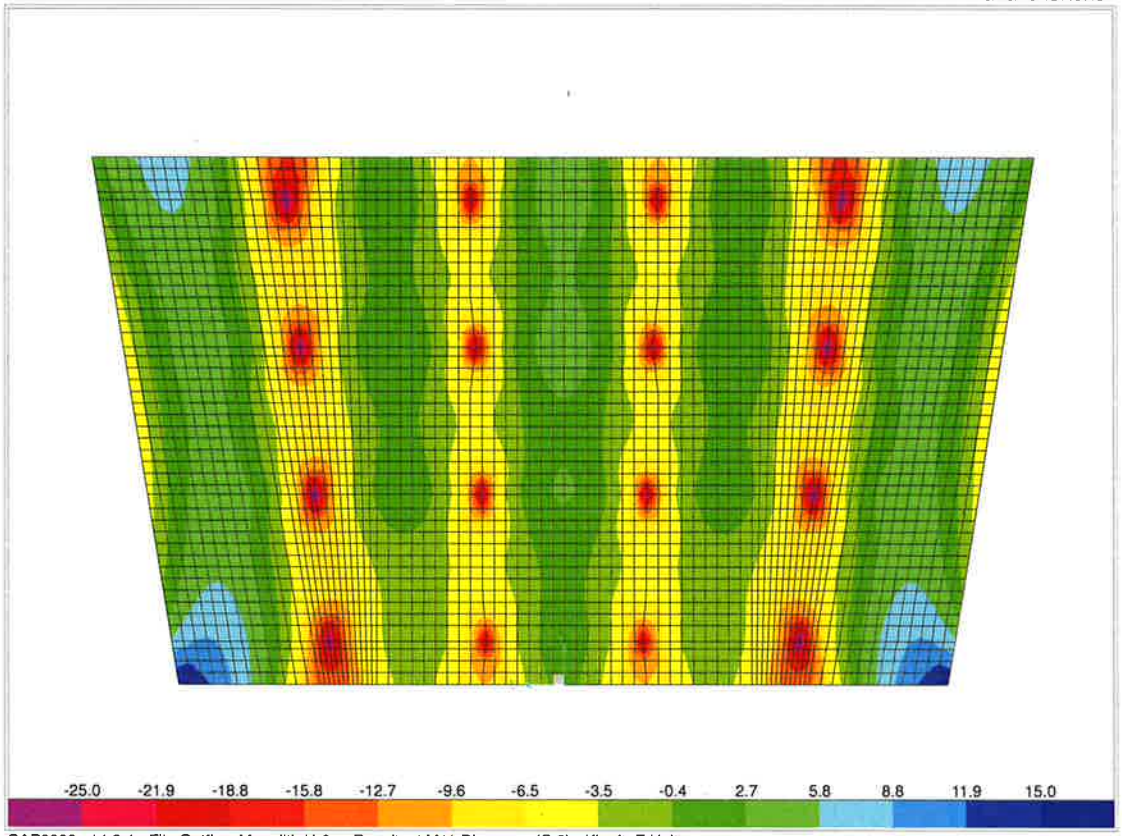
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/12/13 7:23:01



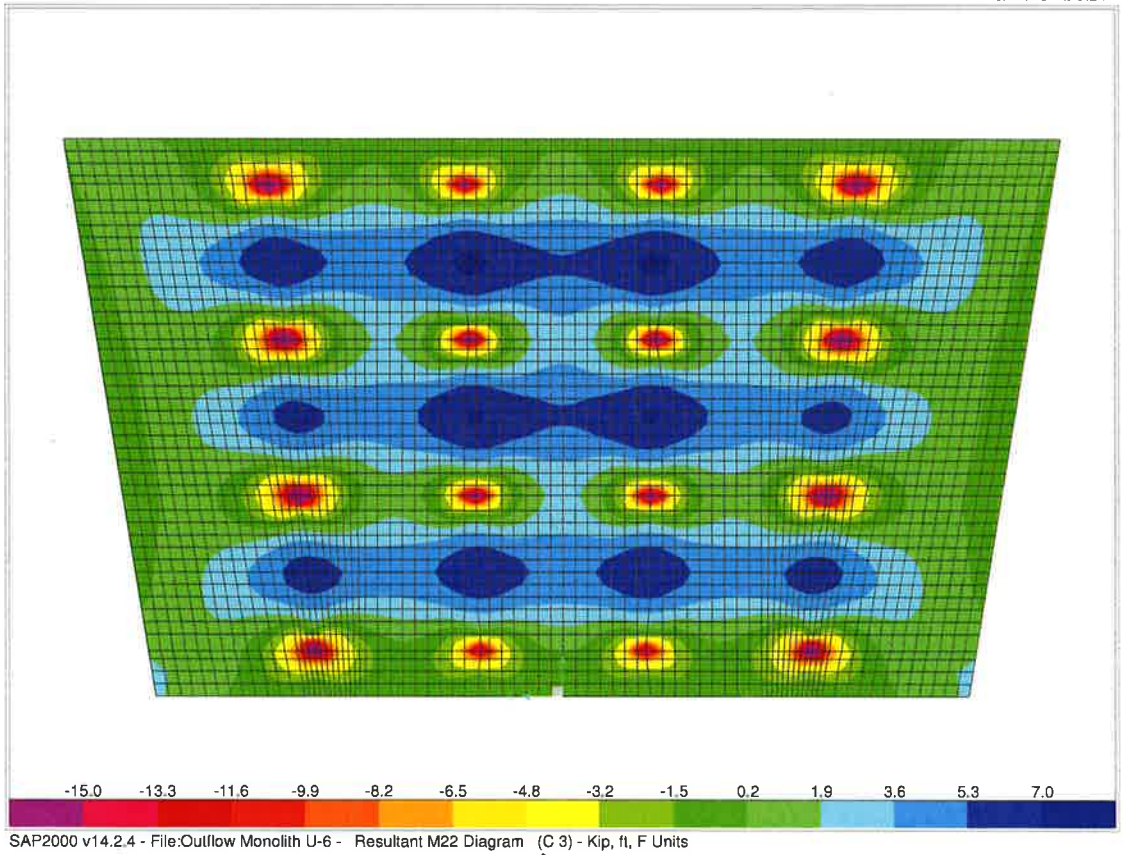
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 2) - Kip, ft, F Units

SAP2000 8/10/13 12:49:48



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 3) - Kip, ft, F Units

SAP2000 8/12/13 7:25:24



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 3) - Kip, ft, F Units

PART 4

Member Design, Settlement Load Cases

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Given Information:**

Notes / References

Bottom Slab Thickness =	2.5	ft
Wall Thickness =	2	ft
Design Width =	12	in
f'_c =	4	ksi
f_y =	60	ksi
ϕ, shear =	0.85	
ϕ, moment =	0.90	
ρ_{bal} =	0.0285	

Results indicate a wall thinner than 2'-6" is adequate

SETTLEMENT CASES

EM 1110-2-2104

EM 1110-2-2104

For f'_c = 4000 psi & f_y = 60,000 psi

*** Walls:**

Load Case	Max. Shear* (kip)	Max Moment, Primary^ (kip-ft)	Min Moment, Primary^ (kip-ft)	Max Moment, Secondary^ (kip-ft)	Min Moment, Secondary^ (kip-ft)
1a-ST	4.10	17.1	0.5	3.4	0.2
1b-ST	4.10	17.1	0.5	3.4	0.2
2-ST	1.02	4.4	0.1	0.9	0.0
3-ST	1.04	4.2	0.1	0.8	0.0

* Shear values taken at a distance 'd'= 19.37in from the face of the slab.

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

Max. Shear =	**4.1**	**kip**	
Max. Moment, Primary =	**17.1**	**kip-ft**	(SAP M22, controls *exterior vertical* reinforcement)
Min. Moment, Primary =	**0.5**	**kip-ft**	(SAP M22, controls *interior vertical* reinforcement)
Max. Moment, Secondary =	**3.4**	**kip-ft**	(SAP M11, controls *exterior horizontal* reinforcement)
Min. Moment, Secondary =	**0.2**	**kip-ft**	(SAP M11, controls *interior horizontal* reinforcement)

*** Reinforcing Limits:**

A_{gross} = 24in * 12in strip = 288 in^2

d = 24in - 4in cover - 1/2 bar diameter = 19.37 in — #10 bar assumed

Limit of Maximum Reinforcement = 0.375 * ρ_{bal} * A_{gross} = 3.078 in^2

Limits of Minimum Reinforcement:

0.0028 x A_{gross} =	0.806 in^2	EM 1110-2-2104, 2-8a, temp. & shrinkage
(3 * √(f'_c) * b * d) / f_y =	0.735 in^2	ACI 318-02, 10.5, flexural member min.
(200 * b * d) / f_y =	0.775 in^2	ACI 318-02, 10.5, flexural member min.

Wall Section Summary:			
	Max. Rebar =	**3.078 in^2**	- half each face
	Min. T&S Rebar =	**0.806 in^2**	- half each face
	Min. Flexural Rebar =	**0.775 in^2**	- per face

* Section Design:

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{(f'_c)} * b * d$

= 0.85 * 2 * √4000 * 12in * 19.365in

= 24,985 lb

ϕVc = 25kip > Vu = 4.1kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2))$ $= \phi * As * fy * (d - (a / 2))$

Primary Exterior Face:

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

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)

= 452.43 kip-in/ft

= 37.70 kip-ft/ft

ϕMn = 37.7kip-ft > Mu = 17.1kip-ft → Use #6 @ 12"

*SAME NOTE - ACI 33% ALLOWANCE

Primary Interior Face:

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

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)

= 452.43 kip-in/ft

= 37.70 kip-ft/ft

ϕMn = 37.7kip-ft > Mu = 0.5kip-ft → Use #6 @ 12"

Secondary Interior & Exterior Faces: * $M_{max, secondary}$ = 3.4 k-ft

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

$a = A_s * f_y / (0.85 * f'_c * b)$ = 0.44 * 60ksi / (0.85 * 4ksi * 12in) = 0.647 in

ϕMn = 0.9 * 0.44in^2 * 60ksi * (19.365in - 0.647in / 2)

= 452.43 kip-in/ft

= 37.70 kip-ft/ft

ϕMn = 37.7kip-ft > Mu = 3.4kip-ft → Use #6 @ 12"

URS

Job:	Maurepas Freshwater Diversion	**Project #:**	10001876				
Desc.:	Monolith U-6 Model	**Computed By:**	LBR	**Date:**	Aug-13	**Page:**	of
	Member Design	**Checked By:**		**Date:**		**Sheet:**	of

*** Slab:**

Load Case	Max. Shear* (kips)		Max Moment, Primary (kip-ft)	Min Moment, Primary (kip-ft)	Max Moment, Secondary (kip-ft)	Min Moment, Secondary (kip-ft)
	V13	V23				
1a-ST	14.3	12.1	46.9	76.6	17.9	75.5
1b-ST	14.3	12.1	48.3	82.5	18.3	76.4
2-ST	6.9	6.1	21.6	50.4	7.0	37.0
3-ST	7.1	6.1	21.2	54.0	7.0	38.5

* Shear taken at a distance 'd' = 25.37 inch from piles.

CONTROLS

Max. Shear = **14.3 kip**
Max. Moment, Primary = **48.3 kip-ft** (SAP M11, controls *bottom transverse* reinforcement)
Min. Moment, Primary = **82.5 kip-ft** (SAP M11, controls *top transverse* reinforcement)
Max. Moment, Secondary = **18.3 kip-ft** (SAP M22, controls *bottom longitudinal* reinforcement
Min. Moment, Secondary = **76.4 kip-ft** (SAP M22, controls *top longitudinal* reinforcement)

*** Reinforcing Limits:**

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

d = 30in - 4in cover - 1/2 bar diameter = 25.37 in #10 bar assumed

Limit of Maximum Reinforcement = $0.375 * \rho_{bal} * A_{gross}$ = 3.848 in^2

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

$(3 * \sqrt{f'_c} * b * d) / f_y$ = 0.963 in^2 ACI 318-02, 10.5, flexural member min.

$(200 * b * d) / f_y$ = 1.015 in^2 ACI 318-02, 10.5, flexural member min.

Wall Section Summary:	**Max. Rebar =**	**3.848 in^2**	- half each face
	Min. T&S Rebar =	**1.008 in^2**	- half each face
	Min. Flexural Rebar =	**1.015 in^2**	- per face

*** Section Design:**

Shear:

Shear Capacity (ϕV_c) = $\phi * 2 * \sqrt{f'_c} * b * d$

= 0.85 * 2 * √4000 * 12in * 25.365in

= 32,726 lb

ϕVc = 32.7kip > Vu = 14.3kip → Section OK

Moment:

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

* Assuming Tension = Compression → $\phi Mn = \phi * T * (d - (a / 2)) = \phi * As * fy * (d - (a / 2))$

Primary Bottom Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

ϕMn = 110.8kip-ft > Mu = 48.3kip-ft → Use #9 @ 12"

Primary Top Face:

* Will try **#9 @ 12"** to start: As, #9 @ 12" = 1.00 in^2

$a = A_s * f_y / (0.85 * f'_c * b) =$ 1 * 60ksi / (0.85 * 4ksi * 12in) = 1.471 in

$\phi Mn =$ 0.9 * $1in^2$ * 60ksi * (25.365in - 1.471in / 2)
= 1330 kip-in/ft
= 110.83 kip-ft/ft

82.5 x 1.33 = 110.0 k·ft

ϕMn = 110.8kip-ft > Mu = 82.5kip-ft → Use #9 @ 12"

Secondary Bottom & Top Faces: * $M_{max, secondary}$ = 76.4 k-ft

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

$a = A_s * f_y / (0.85 * f'_c * b) =$ 0.88 * 60ksi / (0.85 * 4ksi * 12in) = 1.294 in

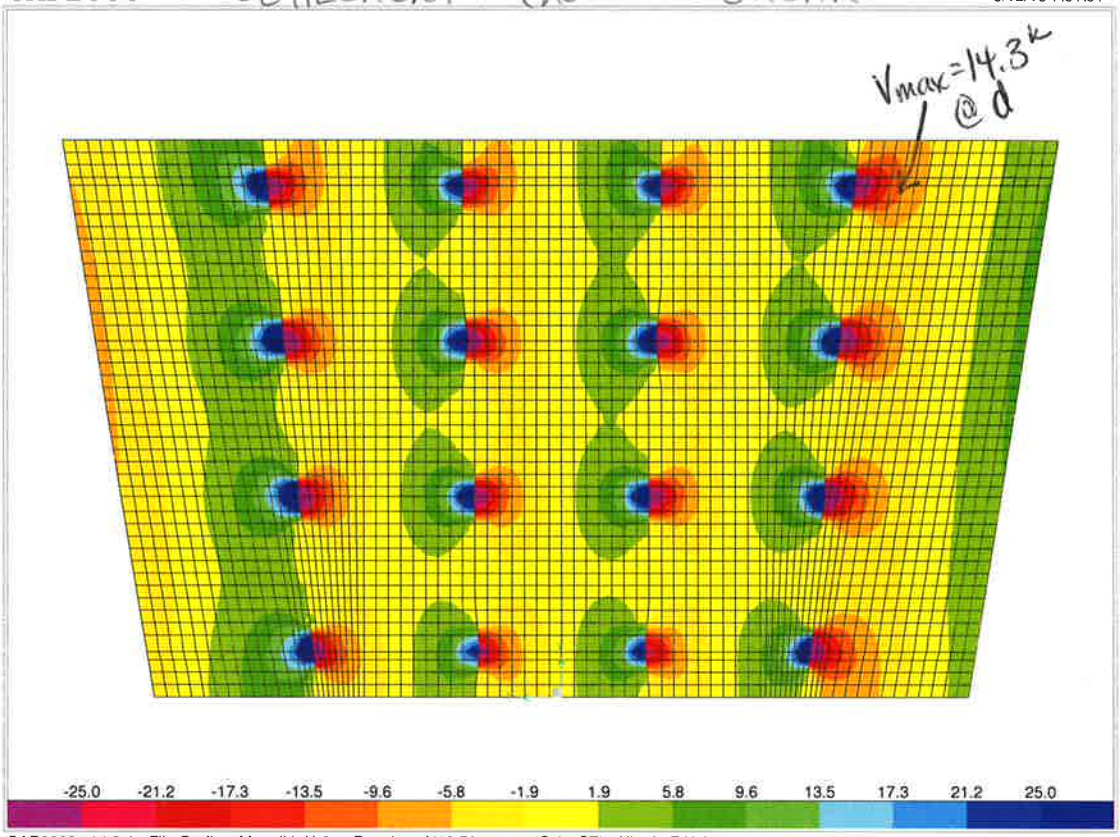
$\phi Mn =$ 0.9 * $0.88in^2$ * 60ksi * (25.365in - 1.294in / 2)
= 1174.6 kip-in/ft
= 97.88 kip-ft/ft

ϕMn = 97.9kip-ft > Mu = 76.4kip-ft → Use #6 @ 6"

FLEXURAL MINIMUM NEGLECTED B/C OF ACI 318 ALLOWANCE
CAPACITY > Mu x 1.33

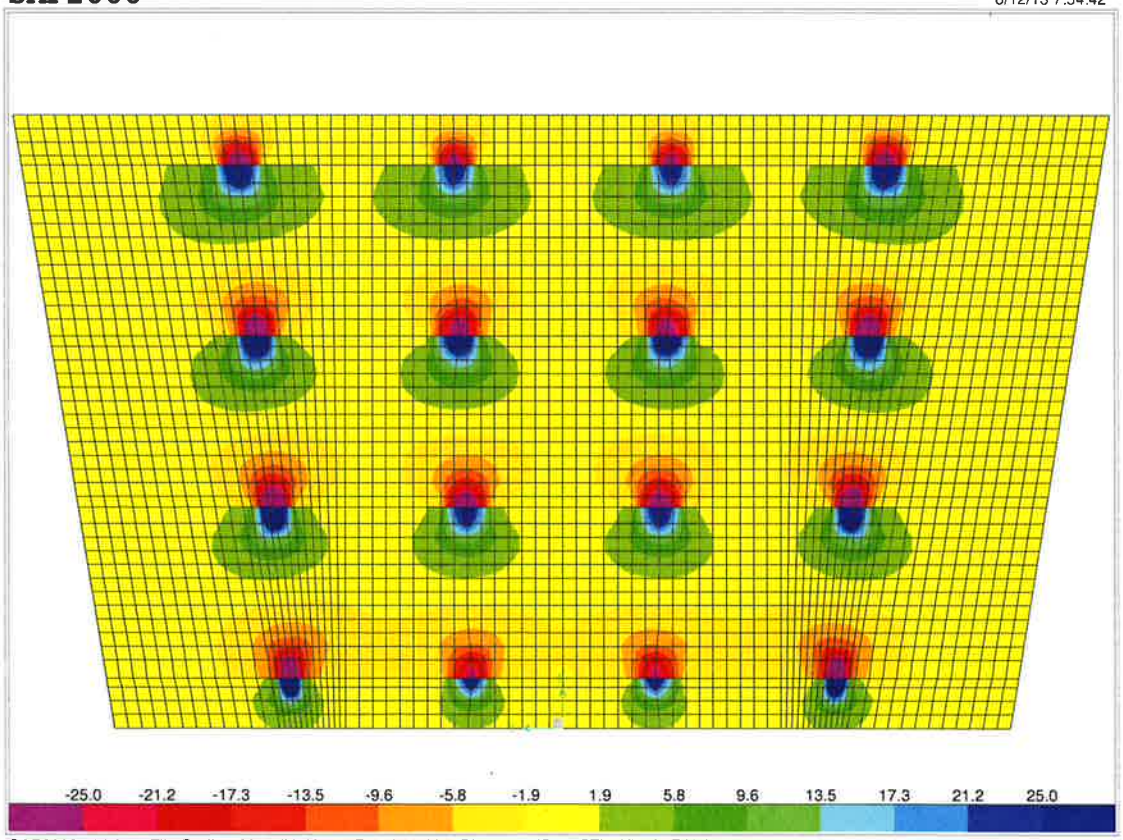
RESULT IMAGES FOLLOW THIS SPREADSHEET. WALL RESULTS FOR SETTLEMENT CASES NOT PRESENTED B/C THEY ARE = TO TRADITIONAL CASES.

SAP2000 SETILEMENT CASES - SHEAR 8/12/13 7:51:51



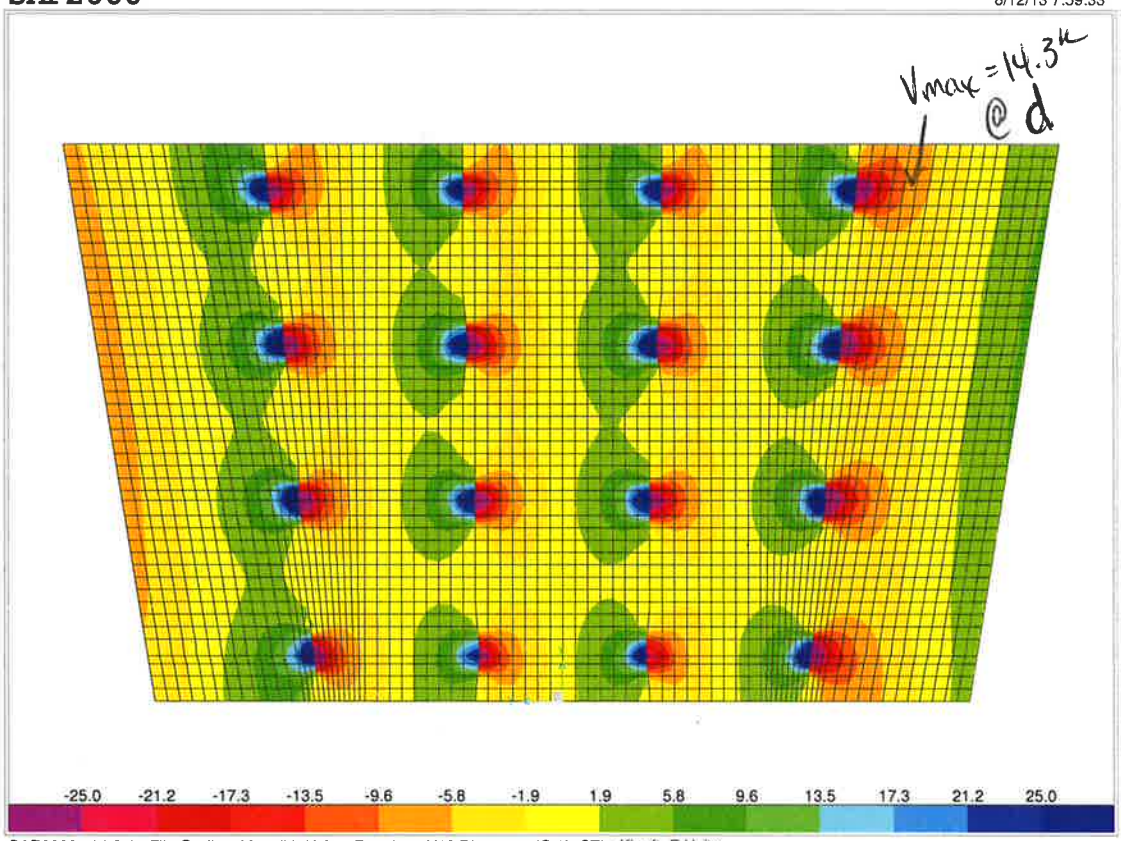
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 8/12/13 7:54:42



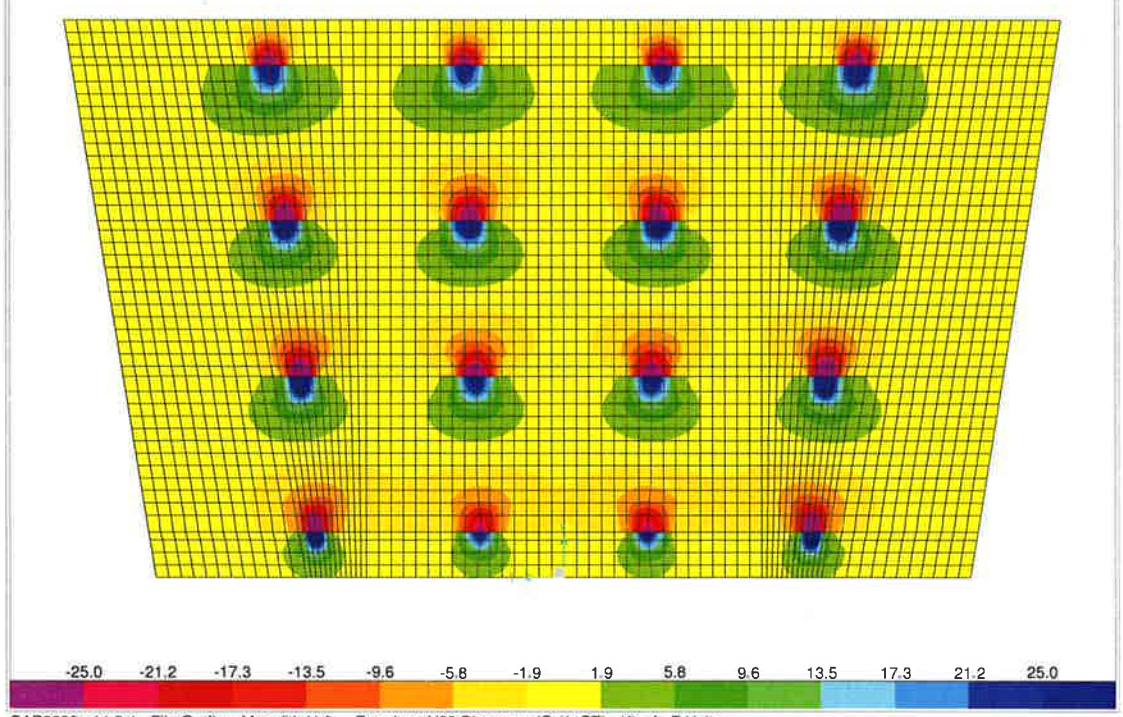
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1a-ST) - Kip, ft, F Units

SAP2000 8/12/13 7:59:33



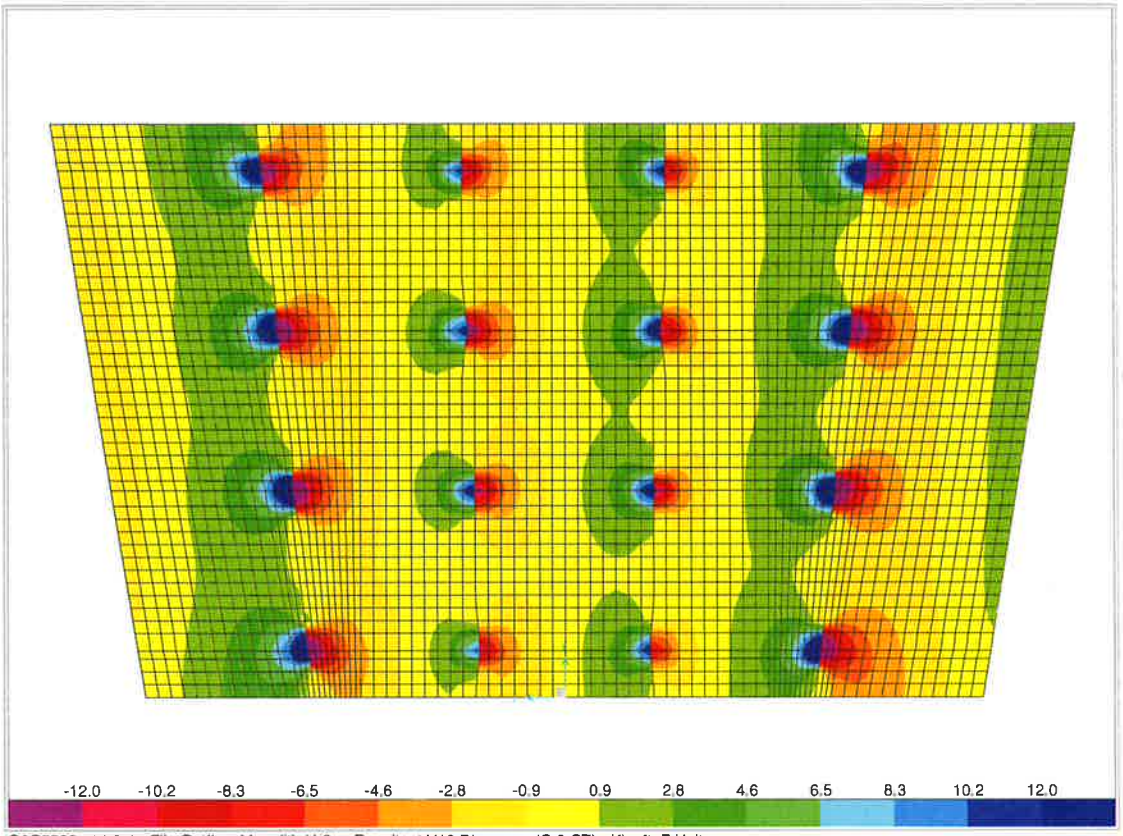
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 8/12/13 8:00:02



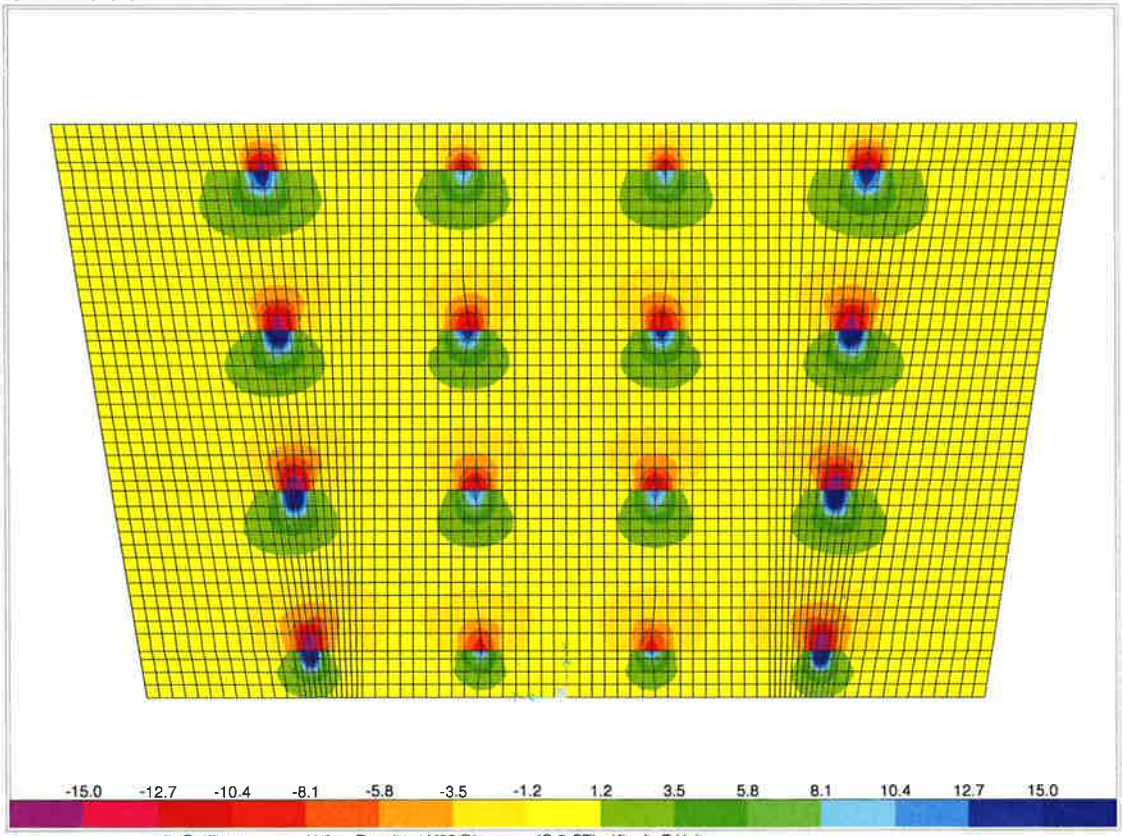
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 1b-ST) - Kip, ft, F Units

SAP2000 8/12/13 8:08:21



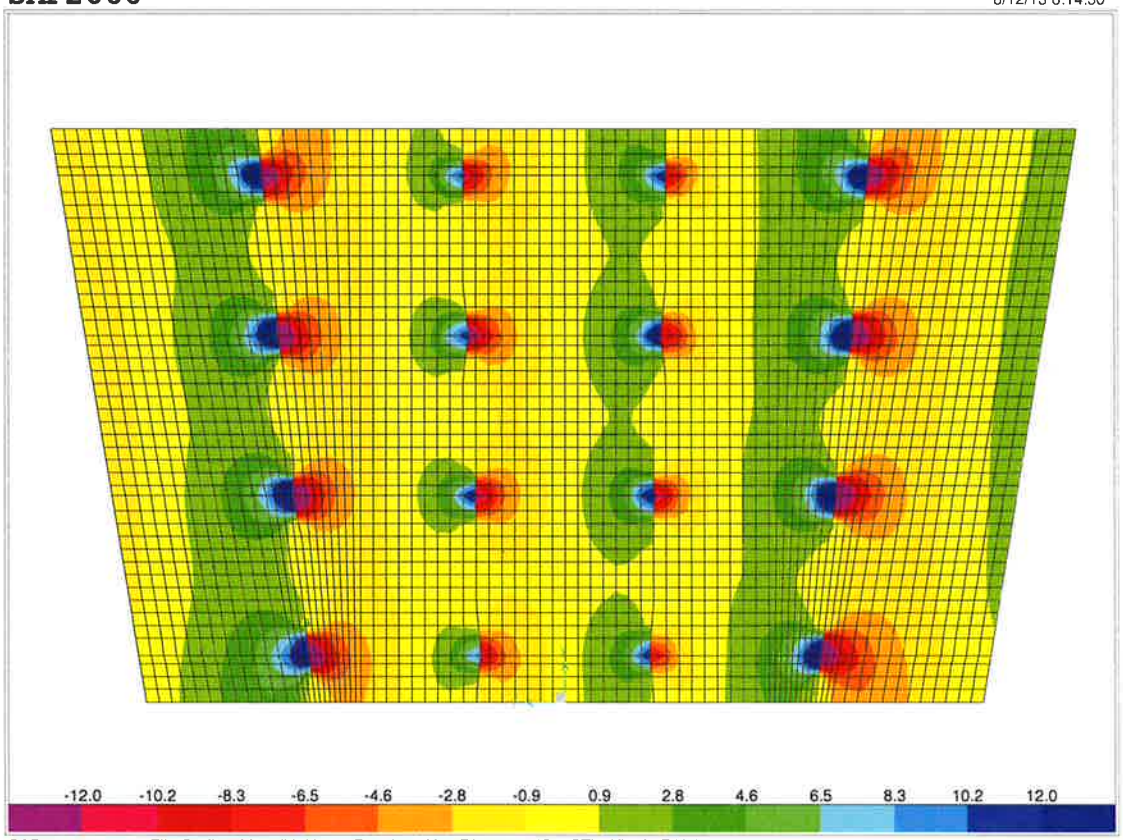
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/12/13 8:10:37



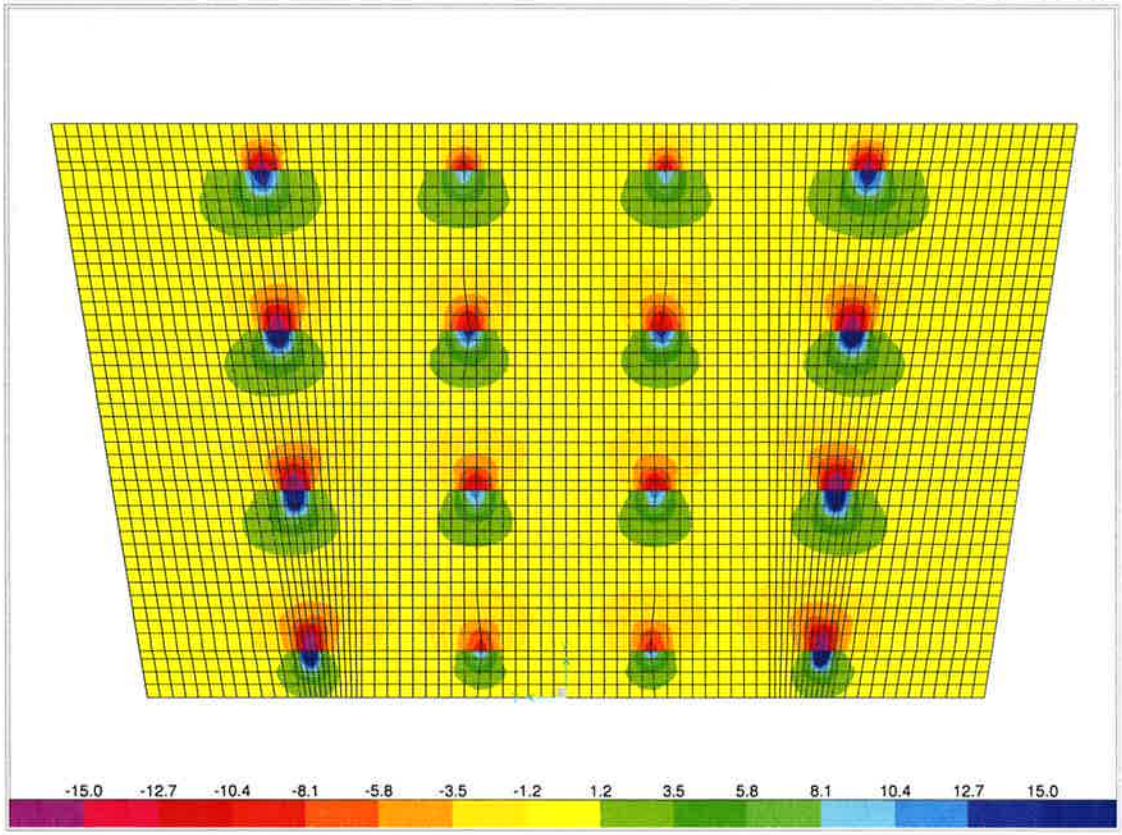
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/12/13 8:14:30



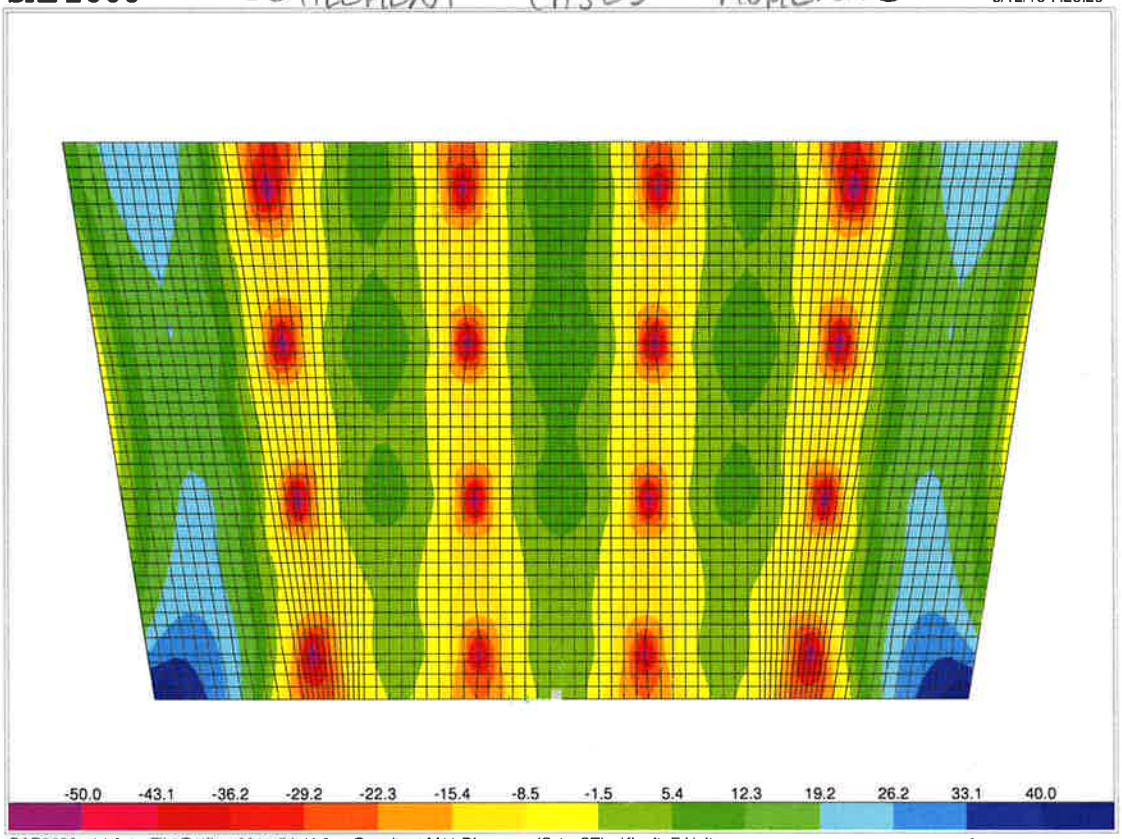
SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V13 Diagram (C 3-ST) - Kip, ft, F Units

SAP2000 8/12/13 8:13:00



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant V23 Diagram (C 3-ST) - Kip, ft, F Units

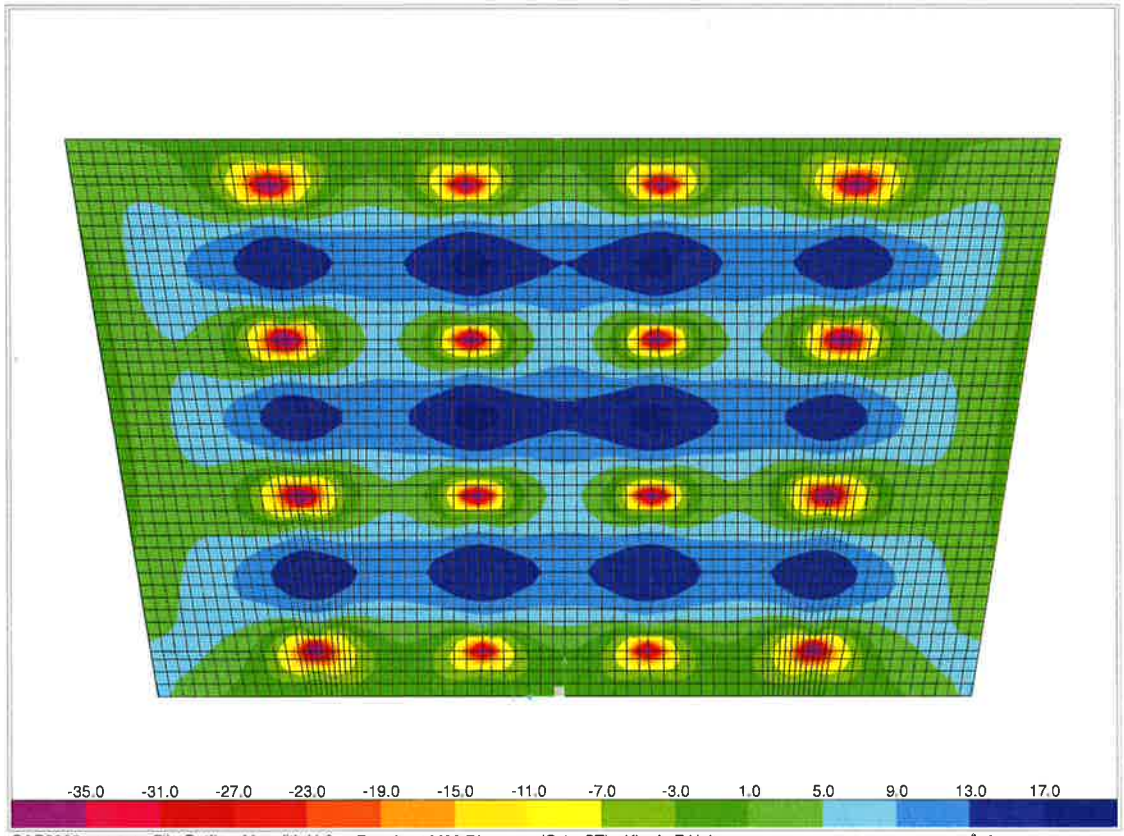
SAP2000 SETTLEMENT CASES - MOMENTS 8/12/13 7:28:20



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1a-ST) - Kip, ft, F Units

TRANSVERSE

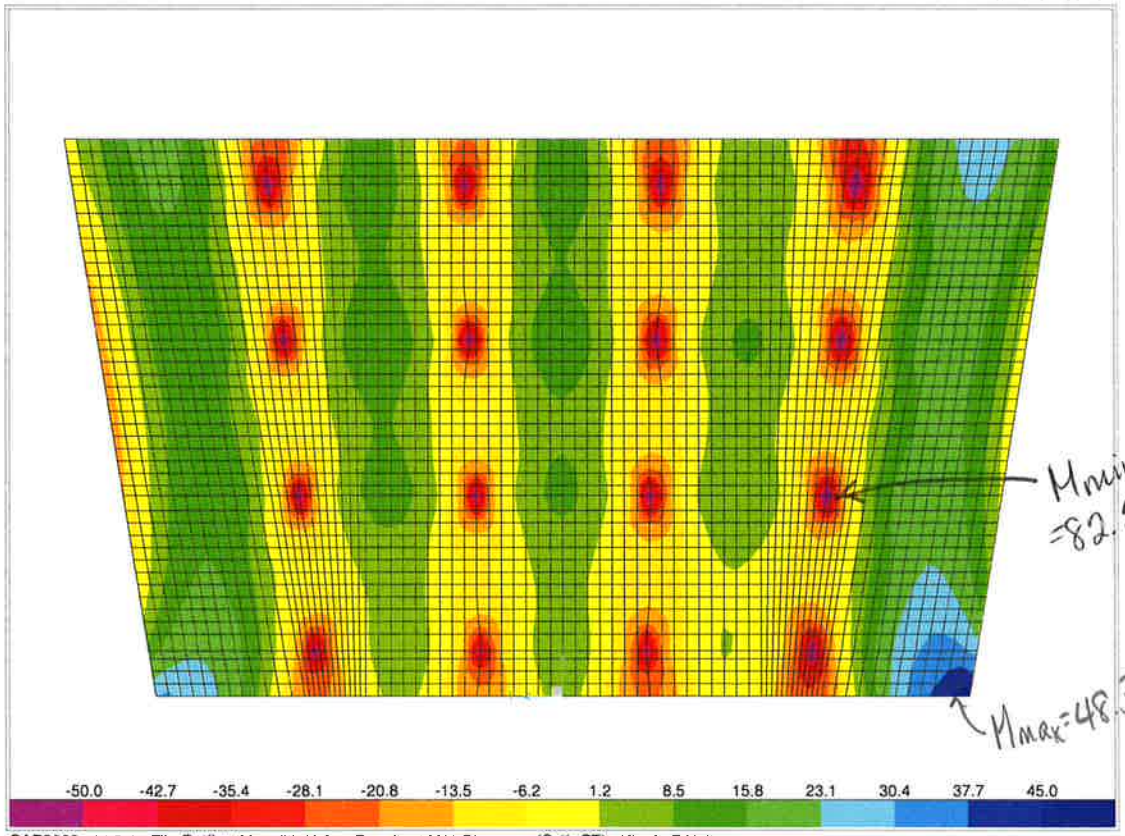
SAP2000 8/12/13 7:30:56



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1a-ST) - Kip, ft, F Units

LONGITUDINAL

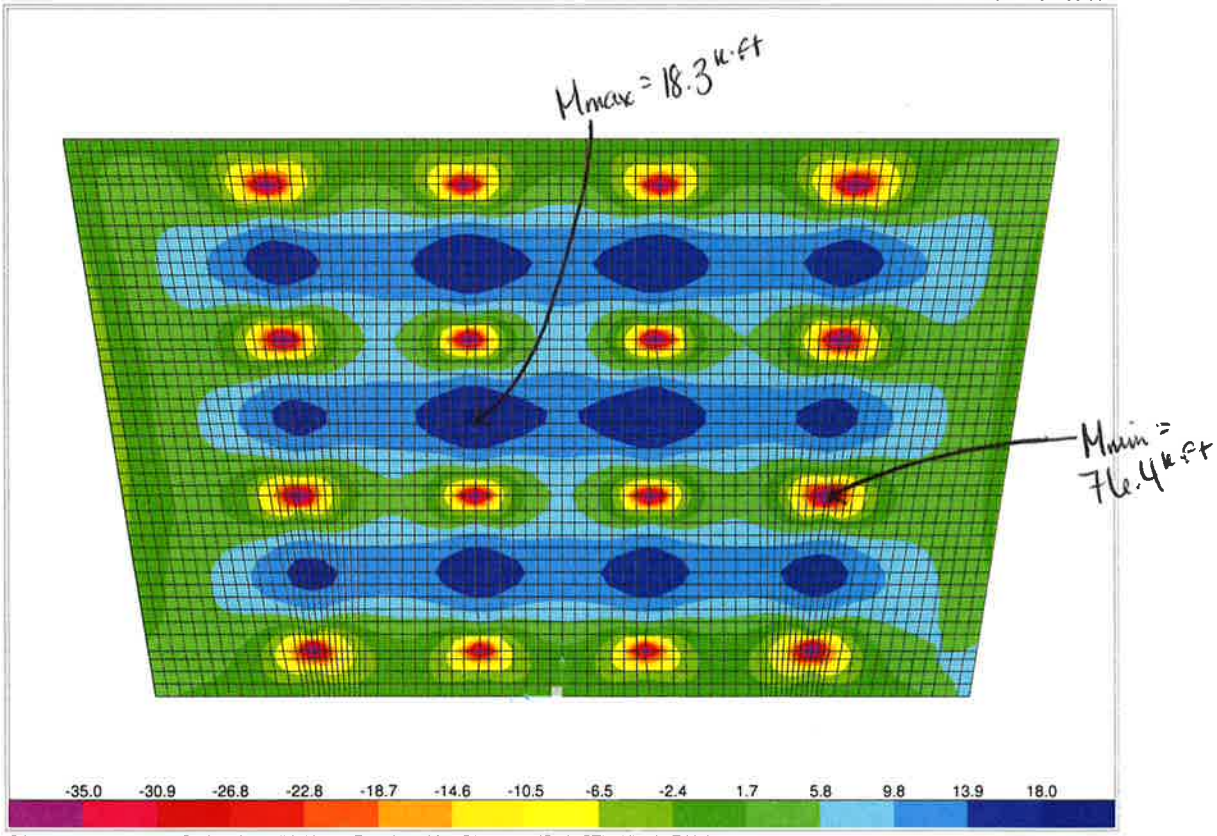
SAP2000 8/12/13 7:33:29



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M11 Diagram (C 1b-ST) - Kip, ft, F Units

TRANSVERSE

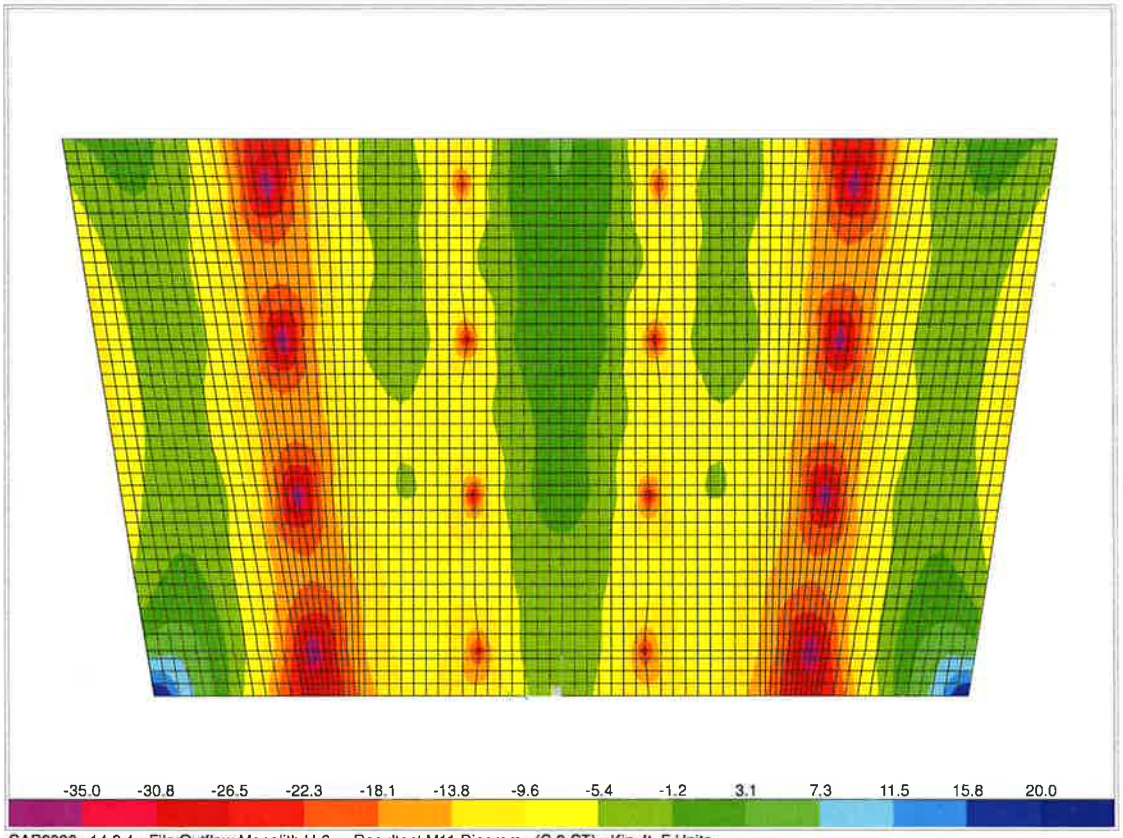
SAP2000 8/12/13 7:35:38



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 1b-ST) - Kip, ft, F Units

LONGITUDINAL

SAP2000 8/12/13 7:38:12



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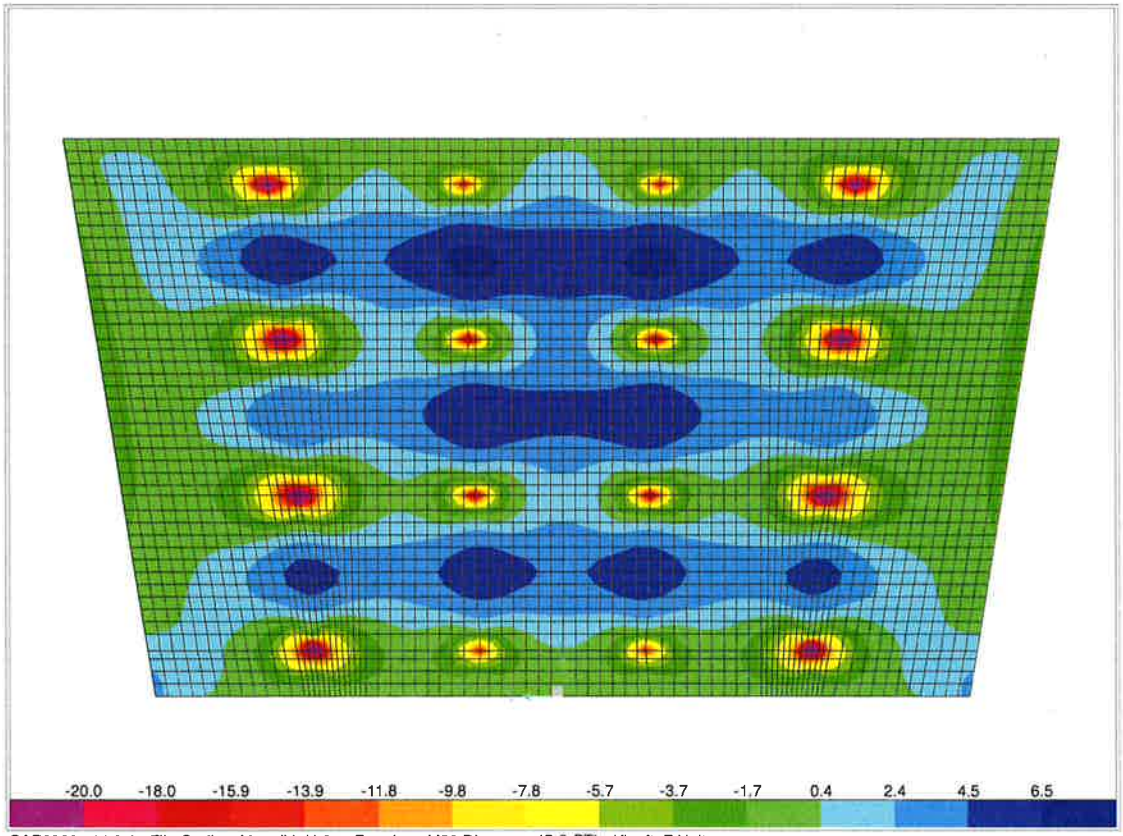
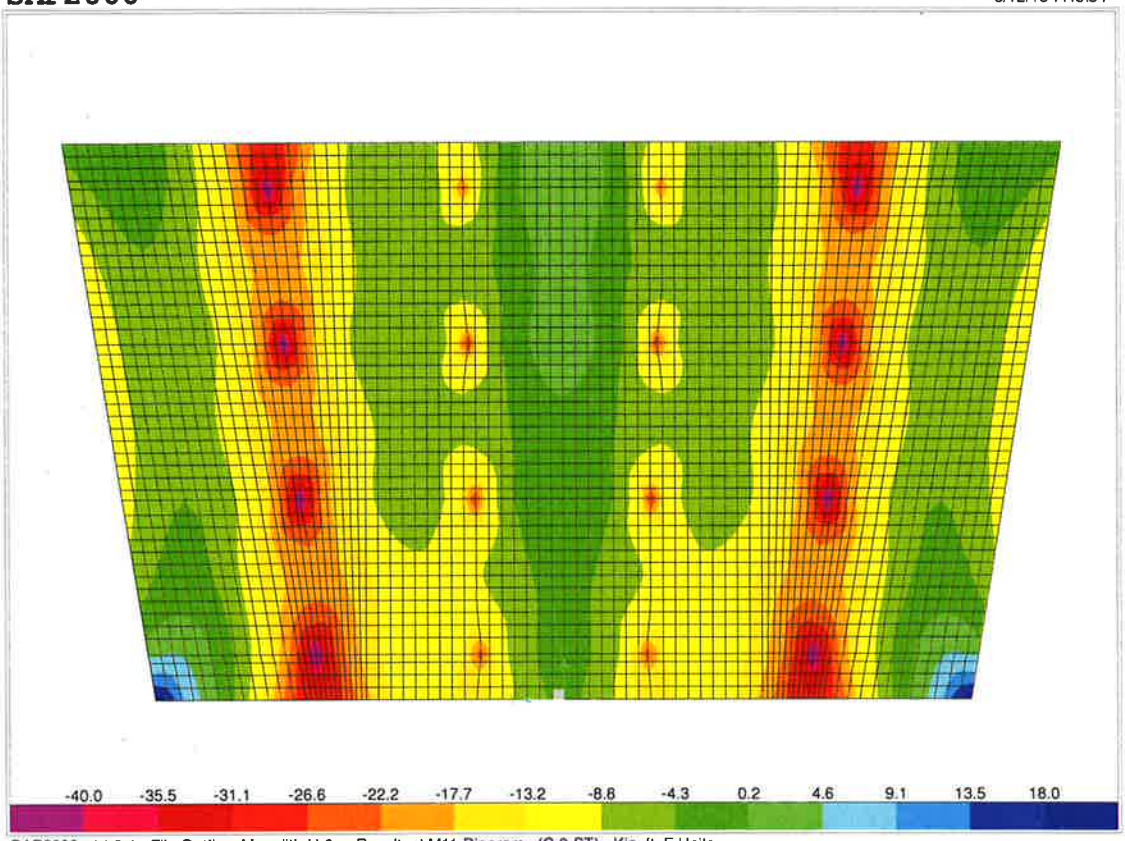
SAP2000 8/12/13 7:41:31



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 2-ST) - Kip, ft, F Units

SAP2000 8/12/13 7:45:54



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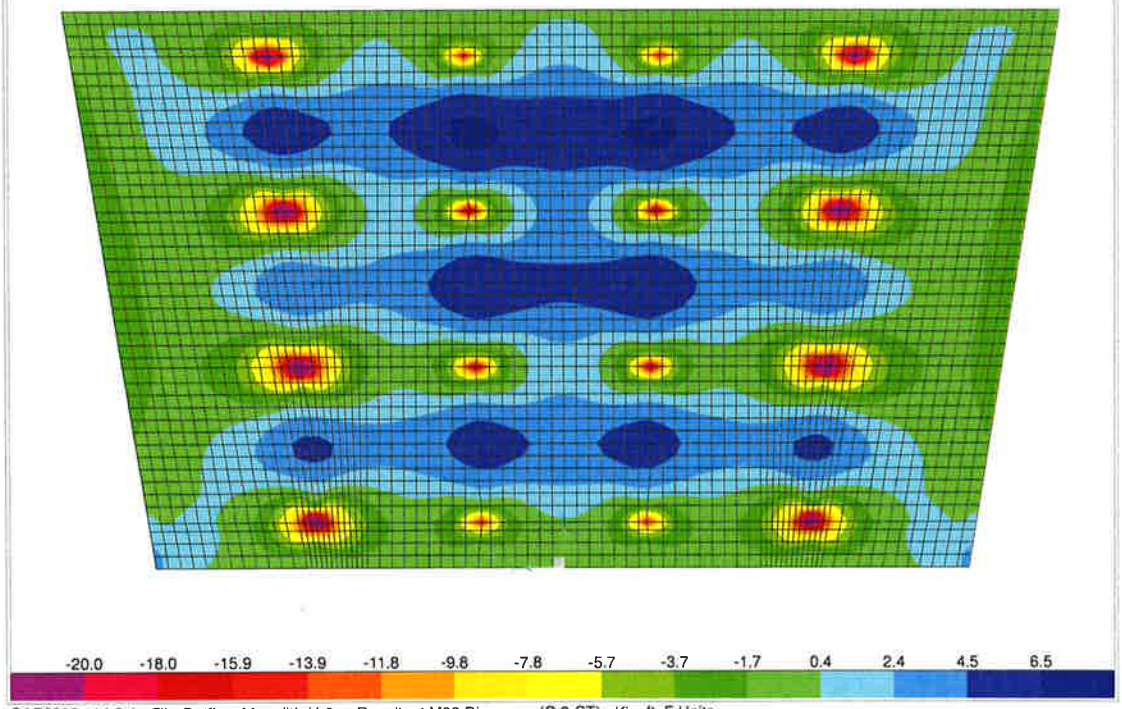
SAP2000 8/12/13 7:43:47



SAP2000 v14.2.4 - File:Outflow Monolith U-6 - Resultant M22 Diagram (C 3-ST) - Kip, ft, F Units

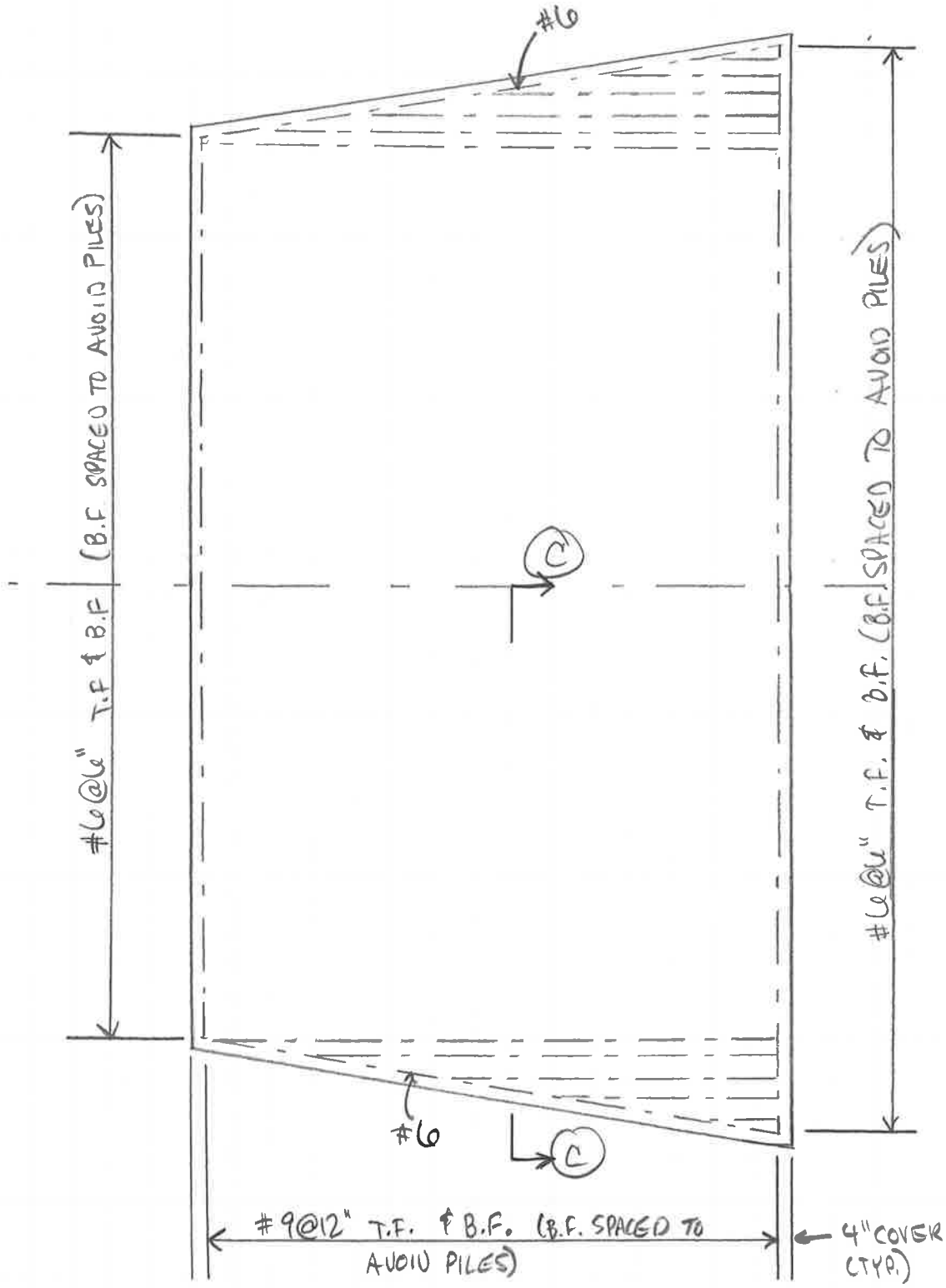
URS

Job: MAUREPAS DIVERSION
Description: MONOLITH U-6 REINFORCEMENT

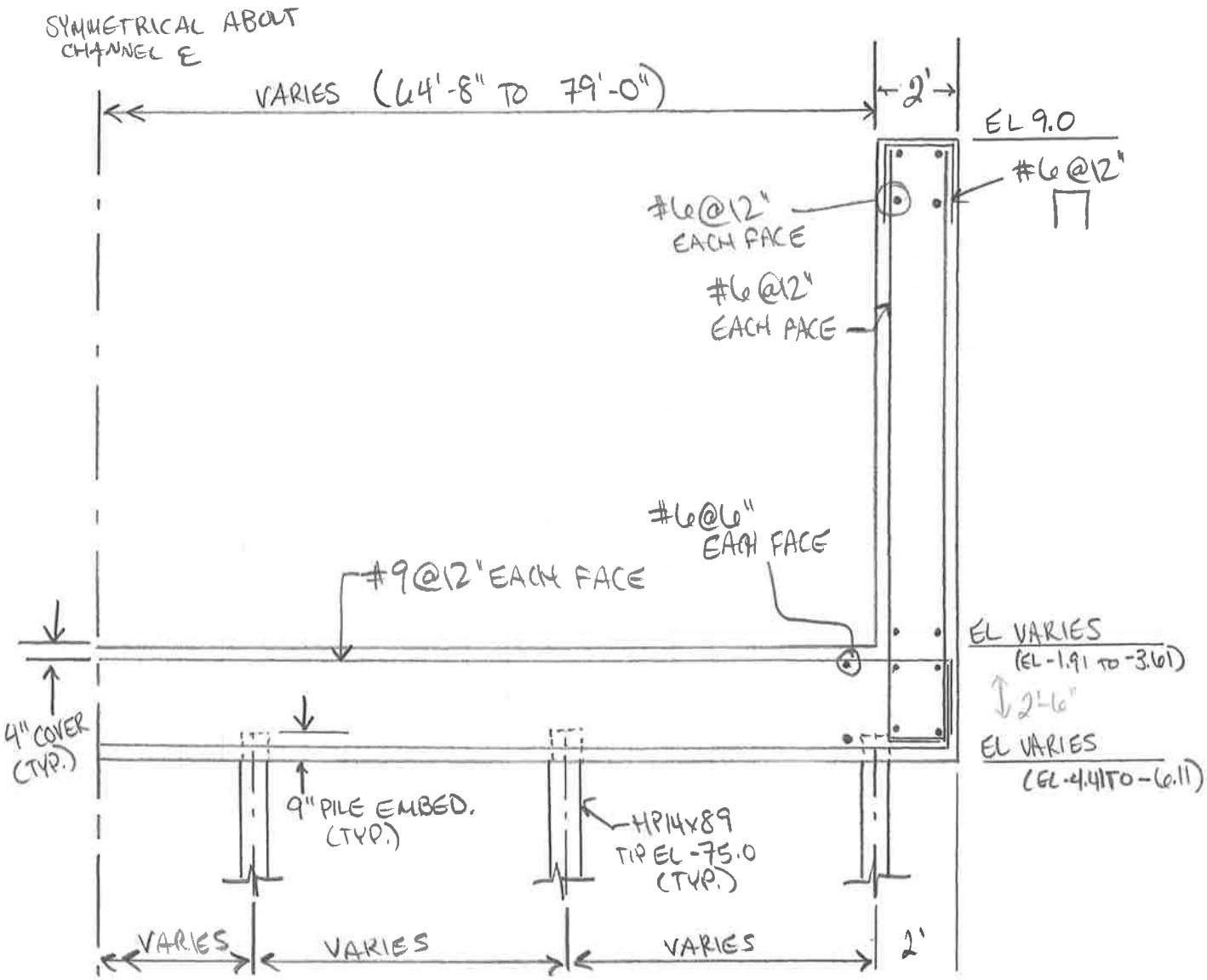
Project No. 10001876
Computed by: LBR
Checked by:

Page ____ of ____
Sheet ____ of ____
Date: 8/2013
Date:

Reference



URS

Job MADREPAS | Project No. 10001876 | Page ___ of ___
Description U-6 REINF. | Computed by LBR | Sheet ___ of ___
Checked by ___ | Date 8/2013
Date ___

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